About Attrasoft ImageFinder

Attrasoft ImageFinder matches whole images or image segments**. The ImageFinder can be used for:**

- **Image Verification (1:1 Matching);**
- **Image Identification (1:N Matching); and**
- **Image Search or Retrieval (1:N Matching).**

Software Requirements

Software Requirements:
(1) Windows .Net Framework.
(2) Internet Explorer.

To get the latest version of .Net Framework 1.1, use Internet Explorer, then click "Tools\Windows Update".

Installing the Software

1. If you have not done so, go to Internet Explorer, then click "Tools\Windows Update" to download Windows .Net Framework .

2. Click "CD:\setup.exe" to install the **ImageFinder**.

3. The serial number is the word "attrasoft".

Information and Support

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Savannah, GA. 31406
USA

http://attrasoft.com

imagefinder@attrasoft.com (Email Subject: Attrasoft)

Phone: (912) 484-1717

Online Demo Website: http://www.imagequery.net

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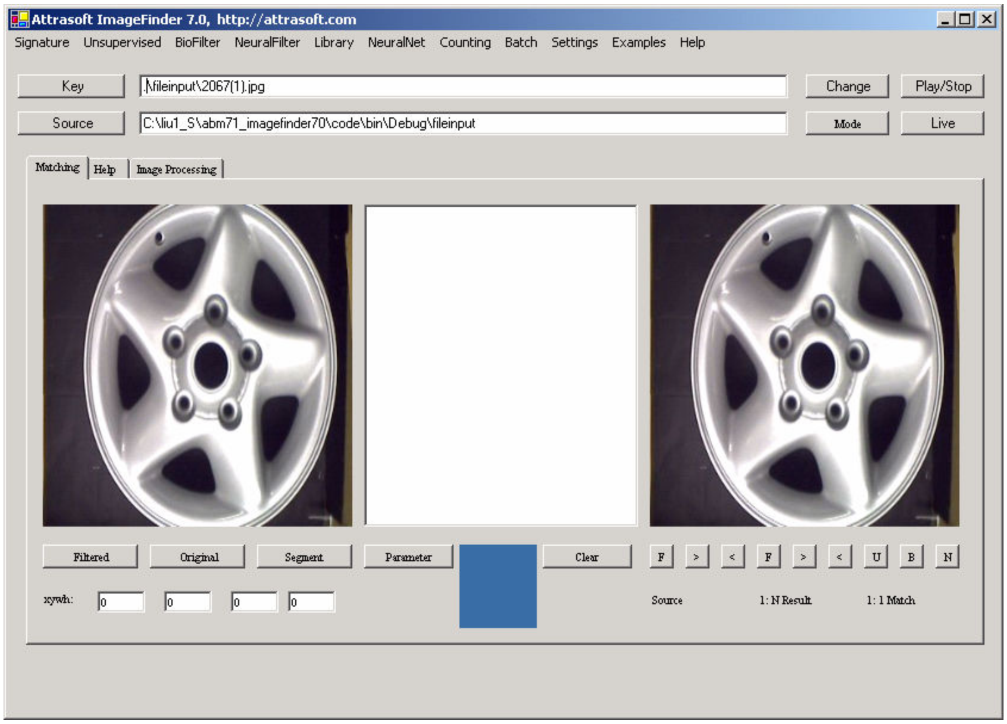
Contents

1. Introduction

The **Attrasoft ImageFinder** matches two images.

It can be used for Verification (1:1 Match), Search (1:N Match), Identification (1:N Match), and Batch processing (N:N Matching or N:M Match).

The primary focus of this version is whole image matching. It can also be used for various other applications, such as locating a segment in an image.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Source
Change
Play/Stop
Mode
Live
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F > < F > < U B N
Source
1: N Result
1: 1 Match

Key: .\fileinput\2067(1).jpg

Source: C:\liu1_S\abm71_imagefinder70\code\bin\Debug\fileinput

xywh: 0 0 0 0

Figure 1.1 ImageFinder.

Image Recognition technology will increasingly replace human labor in the form of:

- Creating new products; or
- Improving existing products/processes to increase productivity,

which will translate into saving man-hours, saving money, making more money with fewer resources, doing new things, and/or shorten service turnaround time. **Applications are limited only by your imagination:**

Biometrics
Video - Image Recognition
Content-Based Advertisement
Statistics Collection (advertisement statistics, …)

Internet Audio-Visual Search Engine
Satellite Image Recognition (defense)
Cancer Detection (medical)
Content-base Image Retrieval (digital library)
Space Image Recognition (space exploration)
Object Detection (military)
Face Recognition, Fingerprints, Palm Prints (security locks & systems)
Stamp Recognition (post office)
Trademark Search
Real Time Event Detection
Forensic Identifications

1.1 What will the ImageFinder do?

The primary task of this version is to match whole images accurately.

The secondary task is to locate similar segments in an image; the ImageFinder locates all similar segments in an image, including:

- Translated segments;
- Rotated segments;
- Scaled segments;
- Rotated and Scaled segments;
- Brighter or Darker segments;
- ...
- All of the above simultaneously.

1.2 Software Requirements

Software Requirements:

(1) Windows (including all versions);
(2) Windows .Net Framework;
(3) Internet Explorer.

To get the latest version .Net Framework, use Internet Explorer, and then click:

“Tools\Windows Update".

The serial number is the word “attrasoft”.

1.3 Customized Software

The **ImageFinder** for Windows has 70 open parameters for the user to adjust for their particular image type. You should get Identification Rates ranging from 60% to 89%; this is because the off-the-shelf **ImageFinder** only has 70 open parameters for users to adjust. The best rate, one of our customers (without any customization) was able to obtain, was an 89% Identification Rate.

However, the **ImageFinder** itself has 3000+ internal parameters, which the users have no access to at all. Fine-tuning these 3000+ internal parameters is called customization, which is Attrasoft's area of expertise. If you need increased accuracy beyond what you are able to achieve when using the **ImageFinder** for Windows, then customization will provide you with ***your*** desired level of accuracy (ranging from 95% to 99.9%).

If you need a customized version of the **ImageFinder**, please contact imagefinder@attrasoft.com .

Customized versions can accommodate:

- Reducing the operation Complexity via Attrasoft tuning the 3000+ internal parameters to one specific image type;
- Speed Optimization;
- Internal Structure Optimization;
- Graphical User Interface Customization;
- Database other that Microsoft Access;
- Database Interface;
- Video Formats other than .avi files;
- New Image Preprocessing Filters;
- Customized Filters;
- Programming Library;
- Specific Symmetries or Combination of Symmetries;
- Attrasoft can implement any symmetry (or combination of symmetries) which can be described by mathematics;
- Further refinement Tuning for small image segments;
- Fine Tuning of the Neural Parameters;
- Digital Image Database (Combine **ImageFinder** with Database);
- Image Formats other than jpg and gif;
- Counting objects which are NOT physically separated;
- Reducing all images by the same amount without distortion to 100x100;
- Internet Image Search Engines;
- Multi-layers of image matching;
- Web Interface (solutions that will provide users with a searchable database using a web interface);
- Other Specific Needs.

1.4 Demo Website

Http://www.imagequery.net

2. ImageFinder Overview

2.1 ImageFinder Internal Structures

For the **ImageFinder**, the Image Matching is divided into:

Image Preprocessing
Image Processing
Normalization
Feature Recognition
Pixel Recognition

One or more filters further implement each step. For the beginners, Image Preprocessing, Image Processing, and Normalization can be set by default.

2.2 Chapter Overview – Whole Images

Chapter 3 introduces the **ImageFinder**'s Graphical User Interface (GUI). This chapter introduces 1:1 Matching, 1:N Matching, and N:N Matching, and shows you how to enter data into the **ImageFinder**.

Chapter 4 introduces Image Signatures. Features of an image are computed and the collection of features is grouped into a signature.

Chapter 5 introduces Unsupervised Matching. Unsupervised Matching matches two whole images. The Unsupervised Matching is based on the image signatures alone. The Unsupervised Matching is used to assess a problem.

- In general, *for an easy problem*, Unsupervised Matching will do well.
- *For a hard problem*, Unsupervised Matching will NOT do well.
- The advantage of the Unsupervised Matching is that it is easy to use.
- The disadvantage of the Unsupervised Matching is that it has a low identification rate.

Chapter 6 discusses result analysis and displays.

Chapter 7 introduces the BioFilter. BioFilter matches two whole images. BioFilter is better than Unsupervised Matching, but it requires a process called training. Training teaches the BioFilter who should match with whom. The BioFilter learns how to match the image features.

- The advantage of the BioFilter is that it does not require a lot of training data.
- The disadvantage of the BioFilter is that it has a lower identification rate than the Neural Filter.

Chapter 8 introduces the Neural Filter. The Neural Filter matches two whole images. The Neural Filter is better than BioFilter, but it requires far more training data. The Neural Filter learns how to match the image features from a huge amount of data.

- The advantage of the Neural Filter is that it is accurate.
- The disadvantage of the Neural Filter is that it requires a large volume of training data.

Chapter 9 presents an example: finding duplicated Document images.

Chapter 10 presents an example: identifying Faces from a photo ID.

Chapter 11 presents an example: identifying Auto Parts.

Chapter 12, Dynamic Library, briefly describes the matching process where the Master Library is constantly updated via insertion and deletion**.**

2.3 Chapter Overview – Beyond Whole Images

Chapter 13 introduces the Neural Net. The Neural Net matches a segment of an image with the other images; therefore, it is doing a different job from the three previous filters. Neural Net Matching is similar to the Unsupervised Filter, but instead of matching the whole image against another whole image, it matches a part of the images. Neural Net does require training, but the training is different from the other filters. The training is to set up the neural net for an Unsupervised Matching between an image segment and a whole image.

Chapter 14 introduces several examples using the Neural Net Filters.

Chapter 15 presents an example: finding Advertisement on TV program (digitized images).

Chapter 16 introduces Counting and Tracking. Counting counts the number of objects in an image, assuming there is no overlap between objects. Tracking finds the most obvious object in an image and tracks it from image frame to image frame.

2.4 Chapter Overview - Advanced Users

Chapter 17, **Image Preprocessing**, briefly describes the image preprocessing process required for the **ImageFinder.**

Chapter 18, **Image Processing**, briefly describes the image processing process required for the **ImageFinder.** You have to set three filters: Edge Filters, Threshold Filters, and Clean-Up Filters. The Threshold Filter is required; the other two filters are optional.

Chapter 19, Batch, introduces the batch command, which allows you to save your setting and execute your problem in a few clicks.

Chapter 20, Parameters, describes the parameters in the **ImageFinder**.

Chapter 21, Input Option, introduces some other possible modes of input, other than simply using a directory.

Chapter 22, Application Developer, introduces the procedure for developing an image recognition application.

Chapter 23, Reference Manual, lists and explains each of the menu items and buttons.

Chapter 24, ImageFinder Support, lists the Support Services.

Chapter 25, “Readme.txt”, lists the contents of the “readme.txt” file.

3. ImageFinder GUI (Graphical User Interface)

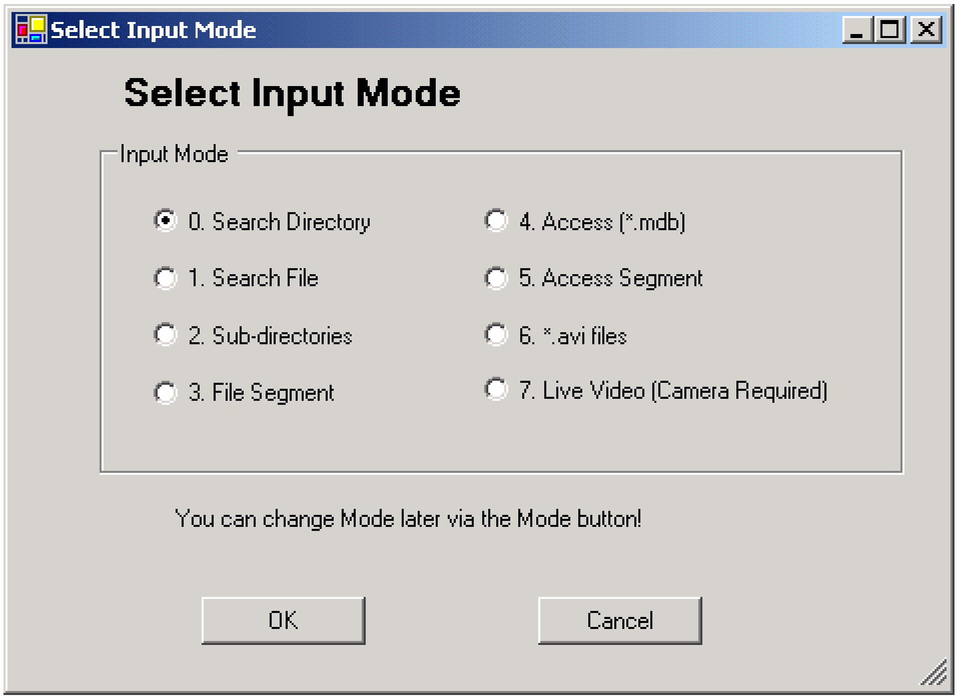
The **ImageFinder** matches images. There are several selections:

1:1	(1 to 1)	Match
1:N	(1 to N)	Match
N:N	(N to N)	Match
N:M	(N to M)	Match

In this chapter, we introduce the user interface, which allows you to specify the images used in a 1:1 Matching or 1:N Matching.

3.1 Starting the ImageFinder

Starting the **ImageFinder**, you will see Figure 3.1. Simply click the OK button to go to Figure 3.2. There are many input options to specify a search source. For simplicity, we will use the default setting, the "Search Directory" option. We will discuss all of the other options later.



Select Input Mode

Select Input Mode

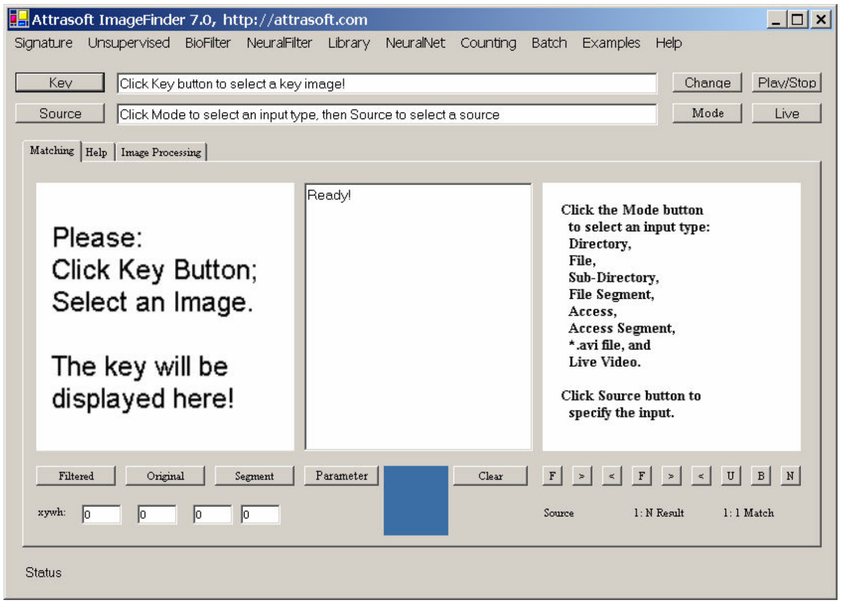
Input Mode

● 0. Search Directory
○ 1. Search File
○ 2. Sub-directories
○ 3. File Segment
○ 4. Access (*.mdb)
○ 5. Access Segment
○ 6. *.avi files
○ 7. Live Video (Camera Required)

You can change Mode later via the Mode button!

OK Cancel

Figure 3.1 ImageFinder Input Modes.



Click Key button to select a key image!

Click Mode to select an input type, then Source to select a source

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

Ready!

Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

Click Source button to
specify the input.

Figure 3.2 Starting ImageFinder.

3.2 Entering 1-Image

In the **ImageFinder**, there are two picture boxes and a text area in Figure 3.2. The left picture box will show the sample image, key image, or 1-Image; the right picture box will show one of the source images. The center text area will display computation messages.

In a 1:1 Matching, you will enter a key image (1-image) and a search image (1-image).

In a 1:N Matching, you will enter a key image (1-image) and a directory (folder), containing many images (N-images or search images).

In an N:N Matching, you will enter a folder (N-images) only.

We will discuss N:M Matching later.

There are two long text boxes on the top, one for the key image (1-image) and one for the search director/folder (N-images). To enter 1-image, click the Key button before the first long text box, and select an image.

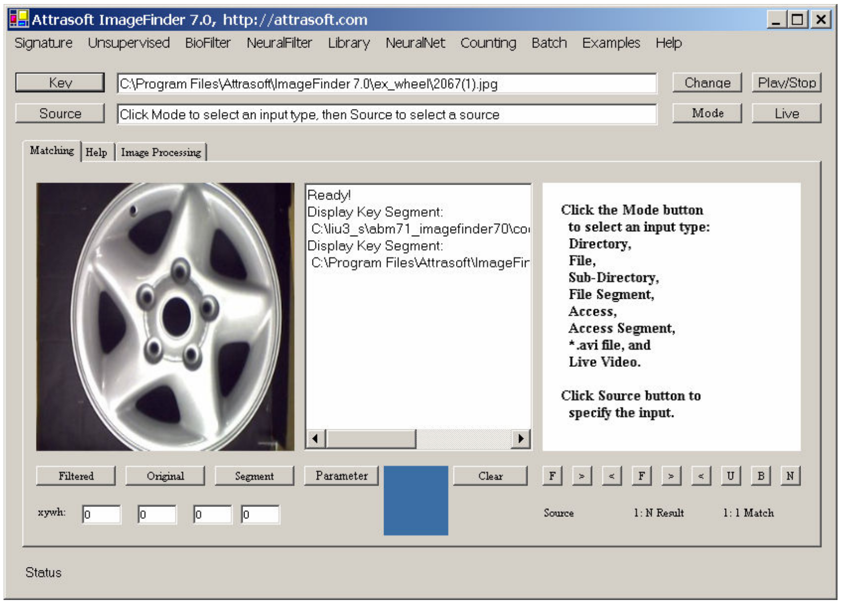
Example. Select a key image:

- Click the "Key" button;
- Select image, ./chap3/ 2067(1).jpg, here "./" meaning the folder where the **ImageFinder** is located;

Now you will see Figure 3.3.

3.3 Entering N-Images

Again for simplicity, we will use the directory input only and discuss other modes of N-images later. To enter N-images, click the Source button located just before the second long text box, and select a file in a folder.



C:\Program Files\Attrasoft\ImageFinder 7.0\ex_wheel\2067(1).jpg

Click Mode to select an input type, then Source to select a source

```
Ready!
Display Key Segment:
 C:\liu3_s\abm71_imagefinder70\co
Display Key Segment:
 C:\Program Files\Attrasoft\ImageFir
```

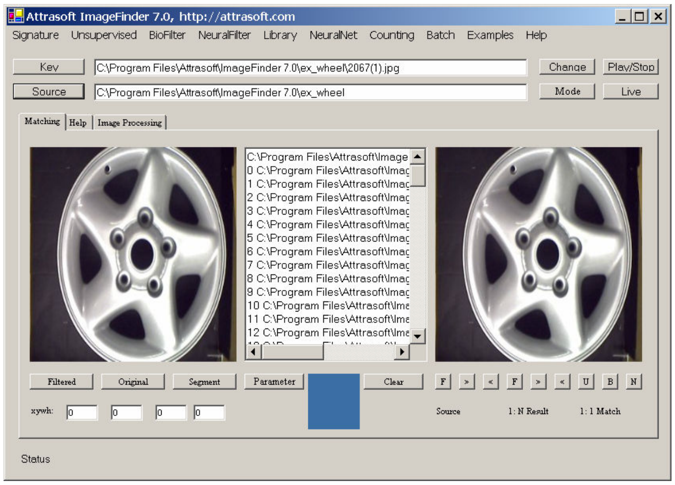
Click the Mode button to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
***.avi file, and**
Live Video.

Click Source button to specify the input.

xywh: 0 0 0 0

Status

Figure 3.3 1-Image.



C:\Program Files\Attrasoft\ImageFinder 7.0\ex_wheel\2067(1).jpg

C:\Program Files\Attrasoft\ImageFinder 7.0\ex_wheel

```
C:\Program Files\Attrasoft\Image
0 C:\Program Files\Attrasoft\Imag
1 C:\Program Files\Attrasoft\Imag
2 C:\Program Files\Attrasoft\Imag
3 C:\Program Files\Attrasoft\Imag
4 C:\Program Files\Attrasoft\Imag
5 C:\Program Files\Attrasoft\Imag
6 C:\Program Files\Attrasoft\Imag
7 C:\Program Files\Attrasoft\Imag
8 C:\Program Files\Attrasoft\Imag
9 C:\Program Files\Attrasoft\Imag
10 C:\Program Files\Attrasoft\Ima
11 C:\Program Files\Attrasoft\Ima
12 C:\Program Files\Attrasoft\Ima
```

xywh: 0 0 0 0

Status

Figure 3.4 N-Images.

Example. Select N-images:

- Click the “Source” button;
- Select image, ./chap3/ 2067(1).jpg, here “./” meaning the folder where the **ImageFinder** is located;

Now you will see Figure 3.4.

Below the right picture box, there are three buttons above “Source”: F (First), > (Next), < (Previous). Use the F button to go to the first image in the search directory; use the “>” button to see the next image in the search directory; and use the “<” button to see the previous image in the search directory.

- In a 1:1 Matching, the left image will match the current right image.
- In a 1:N Matching, the left image will be matched against each image in the selected directory.
- In a N:N Matching, all images in the selected directory will be matched against all other images in the directory.

4. Image Signatures

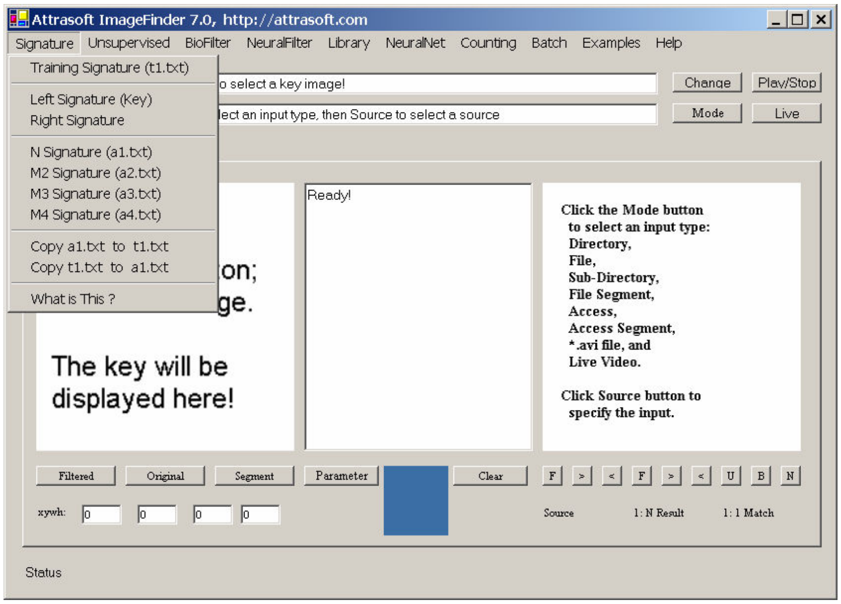
Image Matching is done through something called Image Signature. An image has a set of computed values called features. A collection of features is grouped into a signature.

Signature Menu computes signatures in the **ImageFinder**: the input is an image and the output is a signature.

We will show how to use the image signatures in the next chapter. This chapter introduces how to compute signatures only, which will take an input image and produce a signature.

4.1 Signature Menu

Figure 4.1 shows the menu items under the Signature Menu.



o select a key image!

lect an input type, then Source to select a source

The key will be displayed here!

Ready!

Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

Click Source button to
specify the input.

Figure 4.1 Signature Menu.

4.2 Key Signature

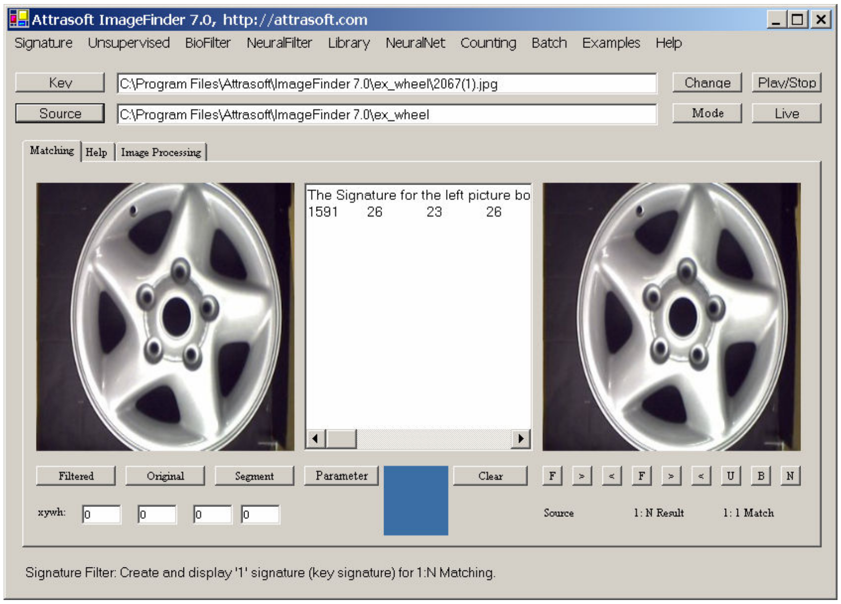
You can collect the signature(s) of the left image, the right image, and all of the images in a folder.

To compute the signature of an image:

- Click the "Key" button to select a key image or sample image;
- Click the "Signature/Left Signature (Key)" to compute the signature.

Example. Left Signature.

To continue from Figure 3.4, click the Clear button to clear the text box. Click “Signature/Left Signature (Key)” and you will see Figure 4.2.



Key: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_wheel\2067(1).jpg

Source: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_wheel

```
The Signature for the left picture bo
1591    26      23      26
```

xywh: 0 0 0 0

Signature Filter: Create and display '1' signature (key signature) for 1:N Matching.

Figure 4.2 Click “Signature/Left Signature (Key)”.

The Signature looks like:

1591 26 23 26 23 …

Similarly, Click “Signature/Right Signature” and you will get an image signature for the right image.

In 1:1 Matching or 1:N Matching, the signatures are computed behind the screen; you do not need to use the signature directly. The menu item “Signature/Left Signature (Key)” shows you the mechanism behind the screen so you can see what a signature looks like.

4.3 Signature Files

Signatures files are divided into three groups: Training Signature File, N-Signature File, and M-Signature File. In a 1:N Match, the 1-signature is computed at run time and the N-signature is computed in advance.

Training teaches the **ImageFinder** who should match with whom. Training is done through two files, a training signature file with a fixed name “.\data\t1.txt” and a match file with a fixed name “.\data\match.txt”. Menu item, Signature/Training Signature (t1.txt), generates training signatures from a specified directory of images.

In 1:N Matching, the Key image will be matched against all images in a directory. The key signature is computed first, as we have shown in the last section. Then this signature will be matched against all signatures in the N-signature file. The N-signature file has a fixed name, ".\data\a1.txt".

In N:M Matching, the N-signature file, a1.txt, and the M-signature file, a2.txt, a3.txt, a4.txt, are computed first. Then all of the signatures in a1.txt will be matched against all of the signatures in a2.txt. The three M-signature files have fixed names, ".\data\a2.txt", ".\data\a3.txt", and ".\data\a4.txt".

There are 5 menu items:

Signature/Training Signature (t1.txt)
Signature/N Signature (a1.txt)
Signature/M2 Signature (a2.txt)
Signature/M3 Signature (a3.txt)
Signature/M4 Signature (a4.txt)

These commands compute the signatures for all images in a directory. The only difference is where to save the signatures.

Menu item, Signature/Training Signature (t1.txt), computes the signatures for all images in a directory and saves the signatures to t1.txt, the training signature file.

Menu item, Signature/N Signature (a1.txt), computes the signatures for all images in a directory and saves the signatures to a1.txt, the N-signature file.

Menu item, Signature/M2 Signature (a2.txt), computes the signatures for all images in a directory and saves the signatures to a2.txt, the M-signature file.

Menu item, Signature/M3 Signature (a3.txt), computes the signatures for all images in a directory and saves the signatures to a3.txt, the M-signature file.

Menu item, Signature/M4 Signature (a4.txt), computes the signatures for all images in a directory and saves the signatures to a4.txt, the M-signature file.

4.4 Examples

To compute the N-signatures:

- Click the "Source" button to select a directory;
- Click "Signature/N Signature (a1.txt)" to compute the signatures in a1.txt.

Example. Select N-images:

- Click the "Source" button;

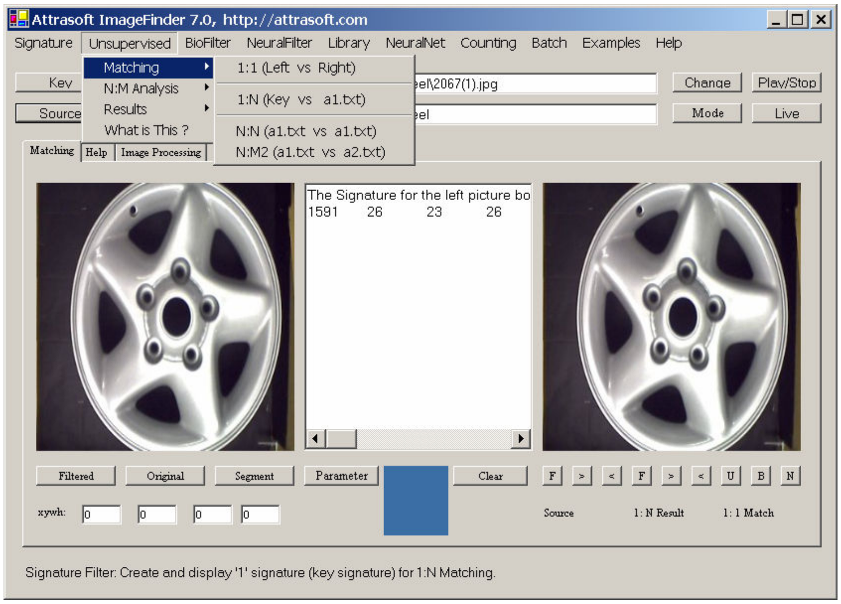
- Select image, ./chap3/2067(1).jpg, here “./” means the folder where the **ImageFinder** is located;
- Click “Signature/N Signature (a1.txt)”;
- Open “./data/a1.txt” to see the results.

You can repeat the above example for the following menu items:

Signature/Training Signature (t1.txt)
Signature/M2 Signature (a2.txt)
Signature/M3 Signature (a3.txt)
Signature/M4 Signature (a4.txt)

And the results will go to t1.txt, a2.txt, a3.txt and a4.txt, respectively.

5. Unsupervised Filters



```
The Signature for the left picture bo
1591      26        23        26
```

Signature Filter: Create and display '1' signature (key signature) for 1:N Matching.

Figure 5.1 Unsupervised Filter.

This chapter will demonstrate how the Unsupervised Filter works using a Label-Matching example.

5.1 The Problem

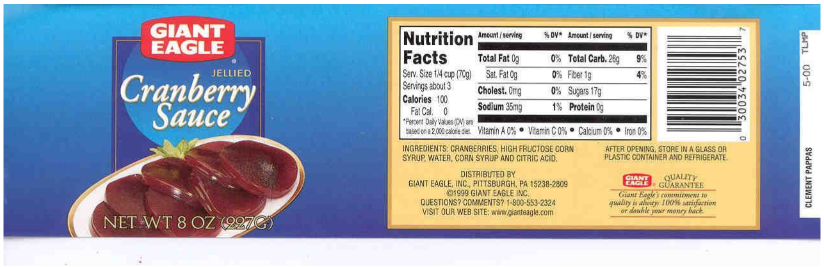


Figure 5.2 Newly Captured Image.

The problem is: assuming we have a newly captured image in Figure 5.2, let us match it against the existing master library and see if there is a match. There are 304 images in 152 pairs. The data is stored at ".\ex_label\" folder.

5.2 N-Signature

An Unsupervised Matching process has three steps:

- Signature;

- Matching;
- Results and Analysis.

To get the N-signature file, a1.txt:

- Click the “Source” button, go to “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the Source “>” button a few times to see the images;
- Click menu item “Signature/N Signature (a1.txt)” to get the signatures in a1.txt file.

5.3 N:N Matching

Continuing from the last section, we will do N:N Matching first:

- Click menu item “Unsupervised/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

The result is in a file, b1.txt, which will be opened at this time. The name, b1.txt, is fixed. The file looks like this:

```
C:\…\L01008gi-020501.jpg
C:\...\L01008gi-020501.jpg
110
C:\...\L01008gi_r90.jpg
95
C:\...\L02016alb-090100_m.jpg
65

C:\...\L01008gi_r90.jpg
C:\...\L01008gi-020501.jpg
95
C:\...\L01008gi_r90.jpg
110
…
```

The result file contains many blocks. The number of blocks is the same as the number of images in the search directory, i.e. each image has a block. Line 1 in each block is the input and the rest of the lines are output; i.e. the first line is the image matched against all images in the search directory; the rest of the lines represent the matched images. For example, “C:\…\L01008gi_r90.jpg” is matched against all 304 images in the search directory; there are three matches.
The first match is:

```
C:\...\L01008gi-020501.jpg
110
```

Here “110” is a score.

The second match is:

C:\...\L01008gi_r90.jpg
95

and the third match is:

C:\...\L02016alb-090100_m.jpg
65

Higher scores indicate a closer match.

5.4 1:N Matching

1:N Matching compares one key image with the images in a search directory; the key image is selected by the "Key" button. In a 1:N match, the 1-signature is computed at run time and the N-signature is computed in advance.

To continue the Label Recognition problem for 1:N Matching:

- Click the "Key" button, in the "ex_label"directory, select the first image "L01008gi-020501.jpg";
- Click menu item "Unsupervised/Matching/1:N (Key vs. a1.txt)" button to complete a 1:N Match.

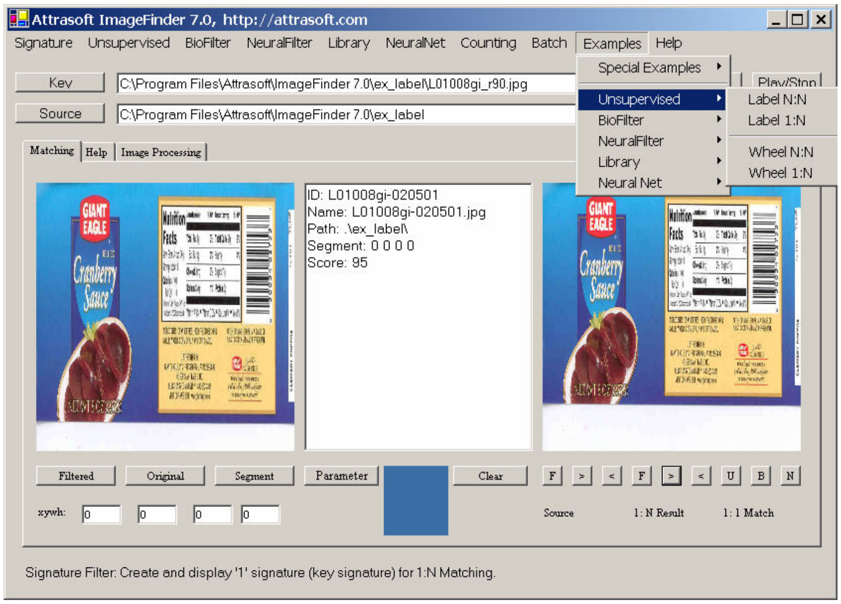
The result is in file, b1.txt, which will be opened at this point:

```
ID                   Name                     Path    Score  X    Y    W    H
L01008gi-020501      L01008gi-020501.jpg      C:\...\ 110    0    0    0    0
L01008gi_r90         L01008gi_r90.jpg         C:\...\ 95     0    0    0    0
L02016alb-090100_m   L02016alb-090100_m.jpg   C:\...\ 65     0    0    0    0
```

The output will always go to b1.txt and will overwrite earlier results. If you need to save the results, simply save it to a different file.

5.5 Batch Duplication

You can quickly duplicate the above two examples via the Example Menu and the Batch Menu in Figure 5.3 and Figure 5.4. Two clicks will duplicate one example.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Examples Help
Special Examples
Unsupervised
BioFilter
NeuralFilter
Library
Neural Net
Label N:N
Label 1:N
Wheel N:N
Wheel 1:N
Key
Source
Play/Stop
Matching Help Image Processing
Filtered Original Segment Parameter Clear
F > < F > < U B N
xywh:
Source 1: N Result 1: 1 Match

Key: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_label\L01008gi_r90.jpg

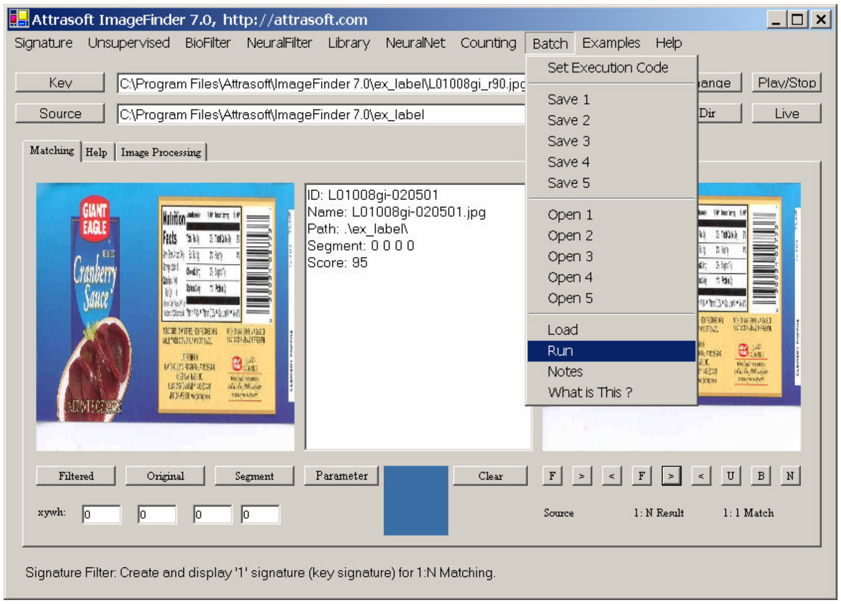
Source: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_label

ID: L01008gi-020501
Name: L01008gi-020501.jpg
Path: .\ex_label\
Segment: 0 0 0 0
Score: 95

xywh: 0 0 0 0

Signature Filter: Create and display '1' signature (key signature) for 1:N Matching.

Figure 5.3 The Example Menu.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Examples Help
Set Execution Code
Save 1
Save 2
Save 3
Save 4
Save 5
Open 1
Open 2
Open 3
Open 4
Open 5
Load
Run
Notes
What is This ?
Key
Source
ange
Dir
Play/Stop
Live
Matching Help Image Processing
Filtered Original Segment Parameter Clear
F > < F > < U B N
xywh:
Source 1: N Result 1: 1 Match

Key: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_label\L01008gi_r90.jpg

Source: C:\Program Files\Attrasoft\ImageFinder 7.0\ex_label

ID: L01008gi-020501
Name: L01008gi-020501.jpg
Path: .\ex_label\
Segment: 0 0 0 0
Score: 95

xywh: 0 0 0 0

Signature Filter: Create and display '1' signature (key signature) for 1:N Matching.

Figure 5.4 The Batch Menu.

To duplicate the N:N Label Matching,

- Click “Example/Unsupervised/Label N:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

To duplicate the 1:N Label Matching,

- Click “Example/Unsupervised/Label 1:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

6. Results & Analysis

In this chapter, we will continue the Unsupervised Filter; however, the discussion in this chapter will also apply to the next two filters, BioFilter and Neural Filter.

In this chapter, we will first introduce a new example, Wheel Rim Identification. Then we will discuss three different ways to see the results and several commands that allow you to do some simple analysis.

6.1 Wheel Rim Example

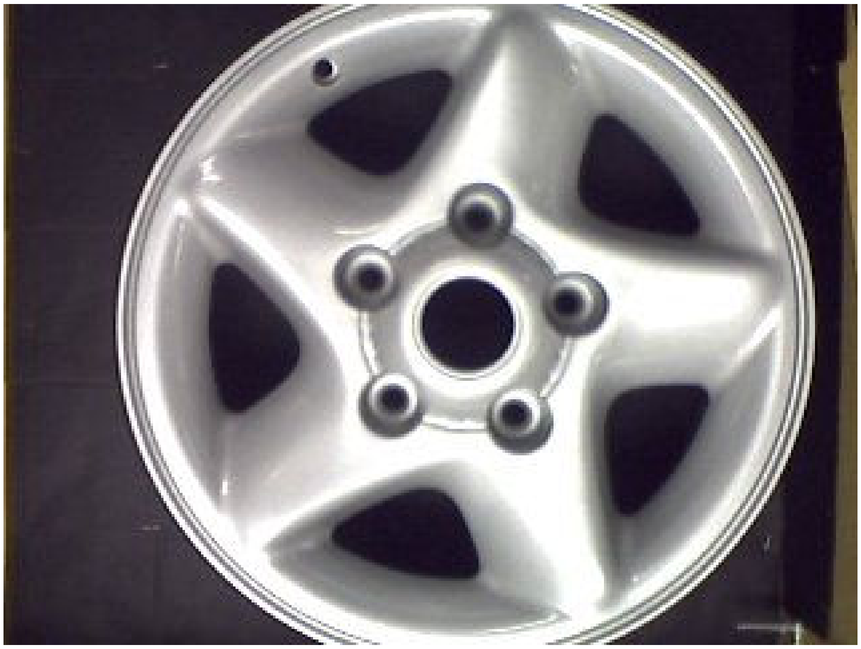


Figure 6.1 Newly Captured Image.

The problem is: assuming we have a newly captured image in Figure 6.1, let us match it against the existing master library and see if there is a match. There are 100 images in 25 quadruplets. The data is stored at ".\ex_wheel\" folder.

6.2 N:N Matching

Let us walk through the process again:

Signatures

- Click the "Source" button, go to ".\ex_wheel" directory and select any file in the folder. This will specify the input directory.
- Click the Source ">" button a few times to see the images;

- Click menu item “Signature/N Signature (a1.txt)” to get the signatures in a1.txt file.

N:N Matching

- Click menu item “Unsupervised/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

Results

The result is in a file, b1.txt, which will be opened at this time:

```
C:\...\2067(2).jpg
C:\...\2067(1).jpg
83
C:\...\2067(2).jpg
110
C:\...\2067(3).jpg
68
C:\...\2067(4).jpg
95
…

Total Number of Matches = 812
```

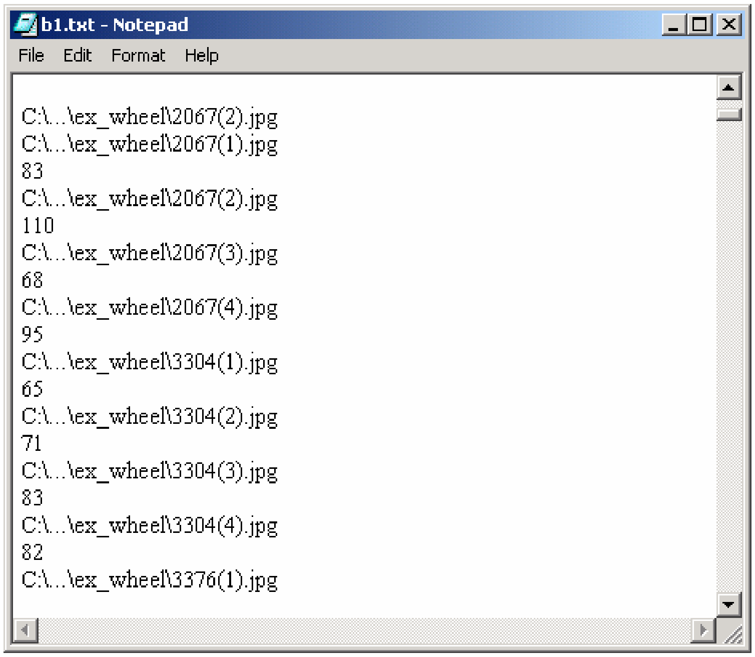
The last line indicates the number of matches in this file.

6.3 Three Output Files

A matching will produce three output files: b1.txt, b1.htm, and b1.html. The text file, b1.txt, will be opened at the end of a run. This file can also be reopened via clicking “Unsupervised/Results/b1.txt”. The other two files have to be opened by clicking “Unsupervised/Results/b1.htm” and “Unsupervised/Results/b1.html”, respectively.

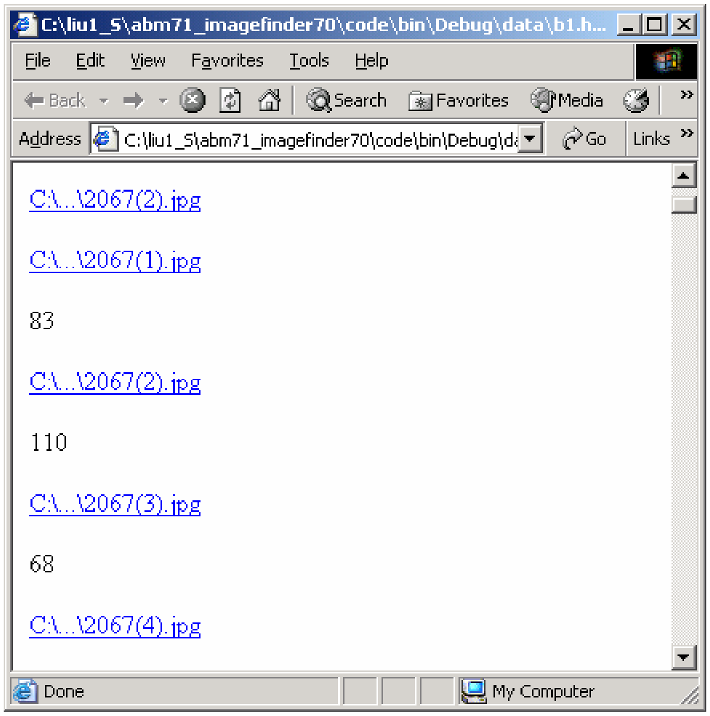
The first result file is a text file. In each block, the first line is the input and the rest of the lines are output:

Key
Match 1
Match 1 score
Match 2
Match 2 score
…



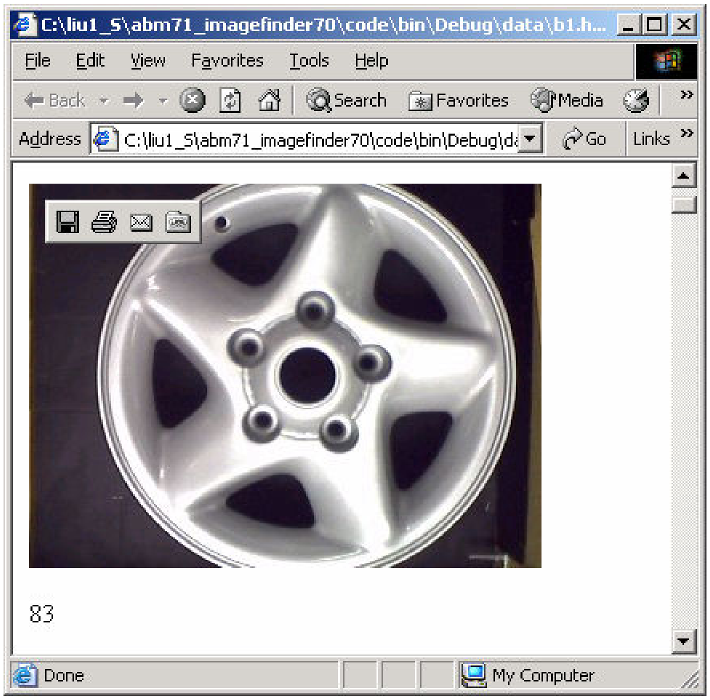
```
C:\...\ex_wheel\2067(2).jpg
C:\...\ex_wheel\2067(1).jpg
83
C:\...\ex_wheel\2067(2).jpg
110
C:\...\ex_wheel\2067(3).jpg
68
C:\...\ex_wheel\2067(4).jpg
95
C:\...\ex_wheel\3304(1).jpg
65
C:\...\ex_wheel\3304(2).jpg
71
C:\...\ex_wheel\3304(3).jpg
83
C:\...\ex_wheel\3304(4).jpg
82
C:\...\ex_wheel\3376(1).jpg
```

Figure 6.2 Click "Unsupervised/Results/b1.txt" to open result file, 1 of 3.


C:\liu1_S\abm71_imagefinder70\code\bin\Debug\data\b1.h...
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Media
Address
C:\liu1_S\abm71_imagefinder70\code\bin\Debug\da
Go
Links
Done
My Computer

```
C:\...\2067(2).jpg

C:\...\2067(1).jpg

83

C:\...\2067(2).jpg

110

C:\...\2067(3).jpg

68

C:\...\2067(4).jpg
```

Figure 6.3 Click "Unsupervised/Results/b1.htm" to open result file, 2 of 3.



C:\liu1_S\abm71_imagefinder70\code\bin\Debug\data\b1.h...
File Edit View Favorites Tools Help
Back Search Favorites Media
Address C:\liu1_S\abm71_imagefinder70\code\bin\Debug\d
Go Links
Done
My Computer

83

Figure 6.4 Click "Unsupervised/Results/b1.html" to open result file, 3 of 3.

The second result file is a html file. In each block, the first line is the input and the rest of the lines are output:

Key
Match 1
Match 1 score
Match 2
Match 2 score

Each of these lines is a link to the original images.

The third result file is a html file. In each block, the first line is the input and the rest of the lines are output:

Key
Match 1
Picture 1
Match 1 score
Match 2
Picture 2
Match 2 score

This result file displays all of the matched images.

6.4 Checking the Results

You can find out the identification rates of your matching by a few clicks. You must prepare a file, which indicates the matching pairs. To test the results in b1.txt, you must prepare a file called b1_matchlist.txt file, which states who in b1.txt should match with whom.

An example of b1_matchlist.txt is:

```
400
101     2067(1)         2067(1)
102     2067(2)         2067(2)
103     2067(3)         2067(3)
104     2067(4)         2067(4)
105     2067(1)         2067(4)
106     2067(2)         2067(1)
107     2067(3)         2067(2)
108     2067(4)         2067(3)
…
```

Line 1 is the number of matches in this file. In our example, there are 25 quadruplets, so each image should match with 4 other images, giving a total of 100 * 4 = 400 positive matches. The format is b1_matchlist.txt is:

Number, tab, filename, tab, filename**.**

Note:

You MUST have a tab between the three columns;
The file names do not contain ".jpg".

There are two common errors:

(1) The Tab is replaced by a space;
(2) The number of rows is less than the first number in the file.

To continue our recognition example, we must prepare the b1_matchlist.txt file now. This file is already prepared for you and we will simply open it and save it to b1_matchlist.txt (overwrite the existing file). The steps are:

- Open "./data/b1_matchlist_ex_wheel.txt. Save it to b1_matchlist.txt (overwrite the existing file). Now this file is prepared.
- Click "Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" to check the results of the BioFilter.

You will see something like the following in the text window:

```
Blocks = 101
```

```
…
Total Matches = 218
```

The message indicates b1.txt has 101 blocks: the 100 image blocks plus the last line indicating the total number of matches retrieved. The message "Total Matches = 218" indicates that 218 matches in b1.txt agrees with those in b1_matchlist.txt. Matching 218 out of 400 is not accurate; we will get this rate to 100% by training.

6.5 Analysis

Analysis means to calculate 3 indexes and a composite index. We will first introduce several variables.

Possible Matches

Let the total number of images be N, the Possible Matches will be N*N. In our example:
N * N = 100 * 100 = 10,000.

Attrasoft Matches

The number of retrieved matches is listed in the last line of b1.txt. Go to the end of b1.txt, you will see something like this:

Total Number of Matches = 812

Actual Match

This number depends on your problem. It should be the first number in b1_matchlist.txt. In our example, it is 400.

Attrasoft Found Pairs

Click "Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" menu item to get this number, as discussed in the last section.

Now that you have all of the numbers, you can make an analysis. The analysis consists of three individual rates and a Composite Index:

Positive Identification Rate

Positive Identification Rate = the results of clicking "Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" menu item divided by the first number in file, b1_matchlist.txt.

<u>In our example</u>, it is 218/400. We will show you how to get this number to 100% in the next chapter.

Elimination Rate

The Elimination Rate is 1 minus the number at the end of b1.txt divided by the number of possible matches. This number should be normalized so that if all mismatches are eliminated, it should be 100%. <u>In our example</u>, this number is:

Elimination Rate = 1 – 812/10,000

Normalized Elimination Rate = 1 – (812 – 218) / (10,000 – 400)

Hit Ratio

The Hit Ratio is the number indicated by “BioFilter/Check (b1_matchlist.txt required)” menu item divided by the number at the end of b1.txt. In our example, this number is: 218/812.

Composite Index

Finally, an identification is measured by multiplication of **Positive Identification Rate * Elimination Rate * Hit Ratio.** In our example, this number is (218/400) * (1 – 812/10000) * (218/812).

The Unsupervised Filter is not accurate. It is used to assess how hard your image recognition problem is.

6.6 False Rejection Pairs

You can find out exactly which pairs the **ImageFinder** has failed to match. Click “Unsupervised/N:M Analysis/Report (b1_matchlist.txt required)” in the text window, you will get:

```
Total Matches = 218
 ***** Matching List *****
0       2067(1).jpg    2067(1).jpg
1       2067(1).jpg    2067(2).jpg
2       2067(1).jpg    2067(4).jpg
…
216     9016(4).jpg    9016(3).jpg
217     9016(4).jpg    9016(3).jpg
 ***** Missing List *****
0       2067(4).jpg    2067(3).jpg
1       2067(1).jpg    2067(3).jpg
2       2067(3).jpg    2067(1).jpg
…
180     63781(3).jpg   63781(2).jpg
181     63781(4).jpg   63781(3).jpg
```

You get a matching list and a missing list.

6.7 Threshold

In a 1:N Matching, scores are generated for each comparison. Generally, the highest scores exceeding the threshold results in identification. You can compute the Threshold. By clicking "Unsupervised/N:M Analysis/Threshold (b1_matchlist.txt required)", you will get:

```
Possible Threshold = 68
Absolute Threshold = 97
```

To satisfy the requirements in b1_matchlist.txt, **<u>you will need to set a threshold of 68</u>**. If you want an image to only match itself, the threshold is 97.

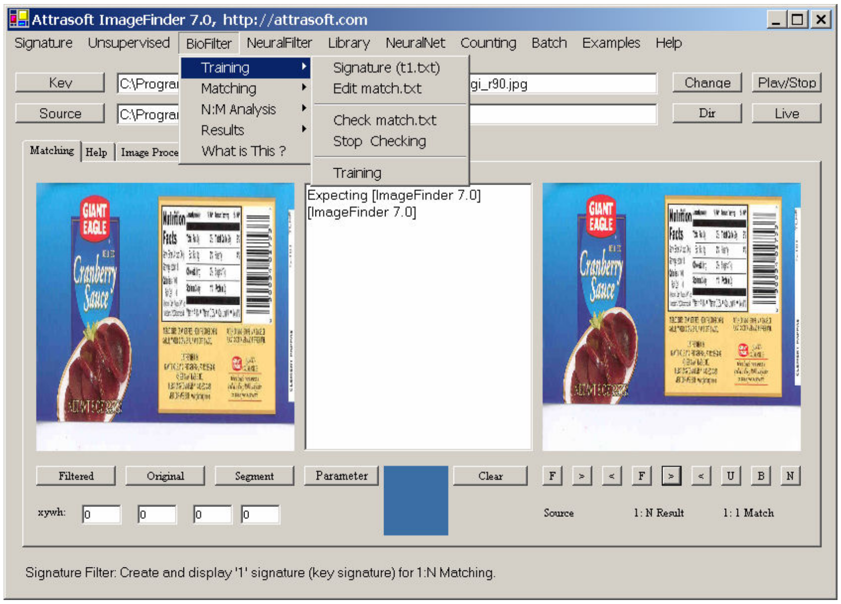
Indeed, if we set the Threshold to 68, the output will be 538 retrieved images instead 812. There are still 218 correct matches.

Setting parameters are the topics of later chapters.

7. BioFilters

BioFilter matches two whole images. BioFilter is better than Unsupervised Matching, but it requires a process called **training**. Training teaches the BioFilter who should match with whom. The BioFilter learns how to match the image features.

- The advantage of the BioFilter is that it does not require a lot of training data.
- The disadvantage of the BioFilter is that it has a lower identification rate than the Neural Filter.



Expecting [ImageFinder 7.0]
[ImageFinder 7.0]

Signature Filter: Create and display '1' signature (key signature) for 1:N Matching.

Figure 7.1 Training Menu.

7.1 BioFilter Overview

The BioFilter Matching will have four steps:

- Signatures
- Training
- Matching
- Analysis

We discussed Signature Computation earlier in chapter 4. The BioFilter Matching is very similar to the Unsupervised Matching in chapter 5. The Analysis procedure for BioFilter is exactly the same as the Unsupervised Filter in chapter 6.

Training uses the data collected in advance to teach the BioFilter how to match. Training requires two files, t1.txt and match.txt. T1.txt is the signature file, which contains many signatures. Each image is converted into a signature. Match.txt is a list of matching pairs. This file will teach the **ImageFinder** who will match with whom. You must prepare this file.

7.2 Training

Training teaches the **ImageFinder** what to look for. Unsupervised Matching does not require training.

The BioFilter training requires two files, t1.txt and match.txt:

- T1.txt is the signature file, which contains many signatures. Each image is converted into a signature.
- Match.txt is a list of matching pairs. This file will teach the ImageFinder who will match with whom.

These two file names, t1.txt and match.txt, for training are fixed; you cannot change the names of these two files. You obtain t1.txt through the signature computation process in chapter 4. You have to prepare match.txt for each problem.

The match.txt looks like this:

```
152
1	L01008gi_r90	L01008gi-020501
2	L01008KEY_m	L01008key-082301_m
3	L010103C	L010103C-081502_m
4	L01010co_m	L01010CODE_m
5	L010163C_m	L010163C-083100_m
…
```

Line 1 is the number of matches in this file. This match file indicates images, L01008gi_r90, will match with image, L01008gi-020501. Each line has the following format:
Number, tab, filename, tab, filename**.**

Note:

You MUST have a tab between the three columns;
The file names do not contain ".jpg".

There are two common errors:

(1) The Tab is replaced by a space;
(2) The number of rows is less than the first number in the file.

Once you get the two files prepared, click “BioFilter\Training\Training” to train the BioFilter. (Figure 7.1)

7.3 Parameters

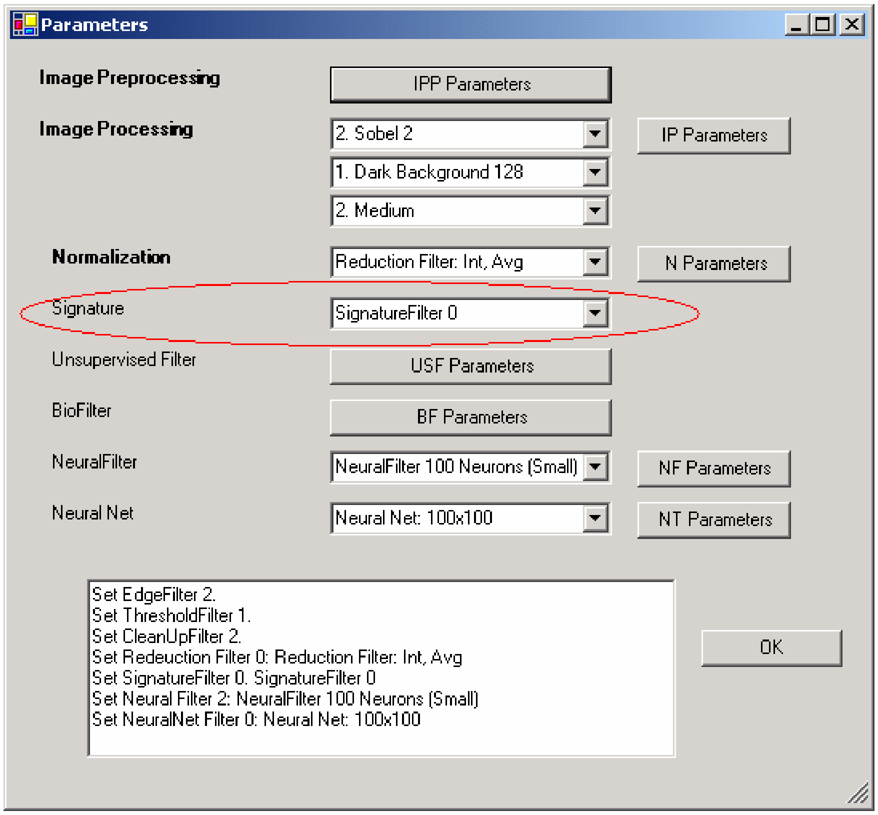


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 0

Unsupervised Filter

BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 7.2 Parameter Window.

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. The Parameters are set by clicking the Parameter button, which will open the Parameter Window in Figure 7.2. You will adjust the **ImageFinder** parameters here.

The default setting uses the Signature Filter 0, which is the least accurate Signature Filter. There are 20 Signature filters in the current version of the **ImageFinder**. In general, when you have less data, use less accurate Signature filters; when you have more data, use more accurate Signature filters.

There are really no hard guidelines; the following is only a rough reference for BioFilter:

Signature Filter	Training Pairs
0	10
1	30
2	30

3	70
4	70
5	150
6	150
7	310
8	310
9	630
10	630
> 11	1000

We have 152 pairs, so we will choose Signature Filter 6. In Figure 7.2, select Signature Filter 6 from line 6.

7.4 Label Recognition Training

We now revisit the Label Recognition example first introduced in the Unsupervised Filter. We must prepare the match.txt file for training. This file is already prepared for you and we will simply open it and save it to match.txt. The steps are:

Match.txt

- Open the file, ".\data\match_ex_label.txt". This file lists 152 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- Click the "Source" button, go to "ex_label" directory and select any file in the folder. This will specify the input directory.
- Click the Source ">" button a few times to see the images;
- Click menu item "Signature/N Signature (a1.txt)" to get signature file, a1.txt file;
- Click menu item "Signature/Copy a1.txt to t1.txt" to get the training file, t1.txt.

Note: Here t1.txt is for training and a1.txt is for 1:N Matching and N:N Matching.

Training

- Click "BioFilter\Training\Training" to train the BioFilter.

You should get this message at the end of the text window:

```
Total Number of Matches = 152
Number of Images that have No Match = 152
```

There are 304 images in 152 pairs. The match.txt listed 152 pairs. The first line, Total Number of Matches = 152, indicates the training used 152 pairs. The second line, Number of Images that have

No Match = 152, indicates 152 out of 304 images does not have a match, which is correct. This is because in match.txt which has 152 pairs, (A, B), only A will match with B, but B will not match with A.

Now, the **BioFilter** is trained for the Label Recognition problem. We will continue this example in the next section, N:N Matching.

7.5 N:N Matching

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item "BioFilter/Matching/N:N (a1.txt vs. a1.txt)" button to complete a N:N Match.

The results will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\L01008gi-020501.jpg
C:\...\L01008gi-020501.jpg
638
C:\...\L01008gi_r90.jpg
510

C:\...\L01008gi_r90.jpg
C:\...\L01008gi-020501.jpg
510
C:\...\L01008gi_r90.jpg
638
…
```

Again, line 1 in each block is the input and the rest of the lines are output. Go all the way to the end of the file; the last line indicates the number of matches in the N:N Matching**.**

7.6 1:N Matching

1:N Matching compares one key image with the images in a search directory; the key image is selected by the "Key" button.

To continue the Label Recognition problem for 1:N Matching:

- Click the "Key" button, in the "ex_label"directory, select the first image "L01008gi-020501.jpg";
- Click menu item "BioFilter/Matching/1:N (Key vs. a1.txt)" button to complete a 1:N Match.
- The results are in file, b1.txt, which will be opened at this point:

ID	Name	Path	Score	X	Y	W	H
L01008gi-020501	L01008gi-020501.jpg	C:\...\ex_label\	638	0	0	0	0
L01008gi_r90	L01008gi_r90.jpg	C:\...\ex_label\	510	0	0	0	0

7.7 Analysis

We went through the analysis process in the last chapter.

Possible Matches

Let the Total Images in the input file be N, the Possible Matches will be N*N. In our example, N * N = 304 * 304 = 92,416.

Attrasoft Matches

The number of retrieved matches is listed in the last line of b1.txt. Go to the end of b1.txt, you will see something like this:

Total Number of Matches = 8320

Actual Match

This number depends on your problem. It should be the first number in b1_matchlist.txt. In our example, it is 608.

Attrasoft Found Duplicates

To check the results, we must prepare the b1_matchlist.txt file now. This file is already prepared for you and we will simply open it and save it to b1_matchlist.txt (overwrite the existing file). The steps are:

- Open “./data/b1_matchlist_ex_label.txt. Save it to b1_matchlist.txt (overwrite the existing file). Now this file is prepared.
- Click “BioFilter/Check(b1_matchlist.txt required)” to check the results of the BioFilter.

The result is:

Total Matches = 608

All of the pairs are identified. Now that you have all of the numbers, you can make an analysis.

Positive Identification Rate

In this example, the **Positive Identification Rate is 100%,** i.e., 608/608 = 100%.

Elimination Rate

Elimination Rate = 91 % = (1 – 8320/92,416).

Hit Ratio

The Hit Ratio = 608/8320 = 8.2 %.

Composite Index

The composite index is = 100% * 91% * 8.2% = 7.5%.

The composite index is low, largely because it retrieved 8320 images. This can be improved in many ways, such as:

- Setting a Threshold higher than 0;
- Setting other parameters;
- Choose a more accurate Signature Filter;
- Choose a Neural Filter.

We will discuss these topics later.

7.8 Batch Duplication

You can quickly duplicate the above two examples via the Example Menu and the Batch Menu in Figure 5.3 and Figure 5.4. Two clicks will duplicate one example.

To duplicate the N:N Label Matching,

- Click “Example/BioFilter/Label N:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

To duplicate the 1:N Label Matching,

- Click “Example/BioFilter/Label 1:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

8. NeuralFilters

NeuralFilter matches two whole images, which is similar to the BioFilter. NeuralFilter is better than both Unsupervised Filter and BioFilter, but it requires a large amount of training data. Training data teaches the NeuralFilter who should match with whom. In comparison to early filters:

- The advantage of the NeuralFilter is that it is more accurate.
- The disadvantage of the NeuralFilter is that it requires more training data than BioFilter.

8.1 NeuralFilter Overview

The NeuralFilter Matching will have four steps:

- Signatures
- Training
- Matching
- Analysis

This process is identical to the Bio Filter in the last chapter.

Training teaches the **ImageFinder** what to look for. The Neural Filter training is similar to the BioFilter training and requires two files, t1.txt and match.txt:

- **T1.txt is the signature file, which contains many signatures. Each image is converted into a signature.**
- **Match.txt is a list of matching pairs. This file will teach the ImageFinder who will match with whom.**

Once you get the two files prepared, click "NeuralFilter\Training\Training" to train the Neural Filter.

8.2 Parameters

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. The Parameters are set by clicking the Parameter button, which will open the Parameter Window in Figure 8.1. You will adjust the **ImageFinder** parameters here.

The default setting uses the Signature Filter 0, which is the least accurate Signature Filter. There are 20 Signature filters in the current version of the **ImageFinder**. In general, when you have less data, use less accurate Signature filters; when you have more data, use more accurate Signature filters.

There are really no hard guidelines; the following is only a rough reference for NeuralFilter:

Signature Filter	BioFilter (Pairs)	Neural Filter (Pairs)
0	10	50
1	30	150
2	30	150
3	70	200
4	70	200
5	150	400
6	150	400
7	310	600
8	310	600
9	630	1000
10	630	1000
> 11	1000	2000

8.3 Label Recognition Training

We introduced the Label Recognition problem in both Unsupervised Filter and BioFilter. We will choose "Signature Filter 9" in this chapter. In Figure 8.1, select Signature Filter 9 from line 6.

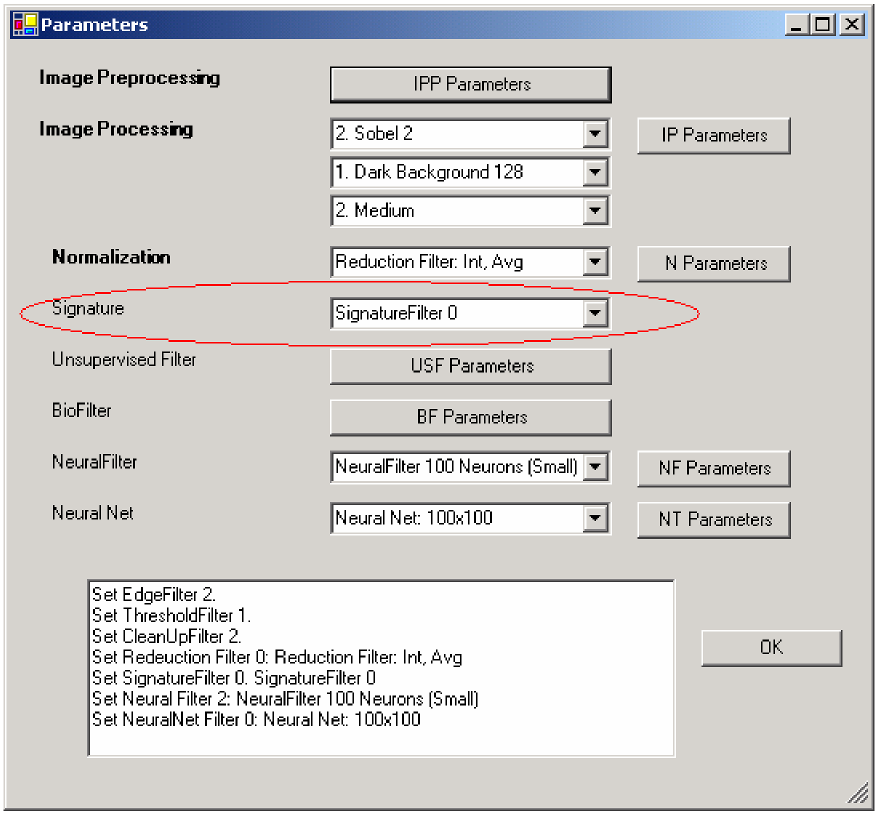


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 0

Unsupervised Filter

BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 8.1 Parameter Window.

We now revisit the Label Recognition example. We must prepare the match.txt file for training. This file is already prepared for you and we will simply open it and save it to match.txt. The steps are:

Match.txt

- Open the file, ".\data\match_ex_label.txt". This file lists 152 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- Click the "Source" button, go to "ex_label" directory and select any file in the folder. This will specify the input directory.
- Click the Source ">" button a few times to see the images;
- Click menu item "Signature/N Signature (a1.txt)" to get signature file, a1.txt file;
- Click menu item "Signature/Copy a1.txt to t1.txt" to get the training file, t1.txt.

Note: Here t1.txt is for training and a1.txt is for 1:N Matching and N:N Matching.

Training

- Click "Neural Filter\Training\Training" to train the BioFilter.

You should get this message at the end of the text window:

```
Number of Matches = 152
Neural Filter Training Completed!
```

The match.txt listed 152 pairs. The first line, Total Number of Matches = 152, indicates the training used 152 pairs. Now, the **Neural Filter** is trained for the Label Recognition problem. We will continue this example in the next section, N:N Matching.

8.4 N:N Matching

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item "NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)" button to complete a N:N Match.

The results will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\ex_label\L01008gi-020501.jpg
C:\...\ex_label\L01008gi-020501.jpg
242307
C:\...\ex_label\L01008gi_r90.jpg
```

```
153038

C:\...\ex_label\L01008gi_r90.jpg
C:\...\ex_label\L01008gi-020501.jpg
153038
C:\...\ex_label\L01008gi_r90.jpg
242307
…
```

Again, line 1 in each block is the input and the rest of the lines are output. Go all the way to the end of the file; the last line indicates the number of matches in the N:N Matching**.**

8.5 1:N Matching

1:N Matching compares one key image with the images in the a1.txt; the key image is selected by the "Key" button.

To continue the Label Recognition problem for 1:N Matching:

- Click the "Key" button, in the "ex_label"directory, select the first image "L01008gi-020501.jpg";
- Click menu item "Unsupervised/Matching/1:N (Key vs. a1.txt)" button to complete a 1:N Match.
- The result is in file, b1.txt, which will be opened at this point:

```
ID                  Name                  Path           Score  X     Y     W     H
L01008gi-020501     L01008gi-020501.jpg   C:\...\ex_label\  242307  0     0     0     0
L01008gi_r90        L01008gi_r90.jpg      C:\...\ex_label\  153038  0     0     0     0
```

8.6 N:N Analysis

The analysis will be similar to the BioFilter.

8.7 Batch Duplication

You can quickly duplicate the above two examples via the Example Menu and the Batch Menu in Figure 5.3 and Figure 5.4. Two clicks will duplicate one example.

To duplicate the N:N Label Matching,

- Click "Example/NeuralFilter/Label N:N" in Figure 5.3;
- Click "Batch/Run" in Figure 5.4.

To duplicate the 1:N Label Matching,

- Click “Example/NeuralFilter/Wheel 1:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

8.8 Wheel Recognition

To duplicate the N:N Wheel Matching,

- Click “Example/NeuralFilter/Label N:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

To duplicate the 1:N Wheel Matching,

- Click “Example/NeuralFilter/Label 1:N” in Figure 5.3;
- Click “Batch/Run” in Figure 5.4.

9. Finding Duplicated Documents

Click menu item “Example/Special Example/Document Duplication”; then click “Batch/Run”, this chapter is done. Now, we will walk through the Document duplication example.

Recent development in scanner technology has made it very easy to convert paper documents into digital documents. A $1000 scanner, for example Fujitsu 4120c, can scan and save 50 pages in a single click. The scanner creates image names via auto-numbers you have specified. More expensive scanners can scan and save 1,000 pages in a single click.

This chapter attempts to solve a particular problem: to retrieve duplicated Document images. Assume you have a million pages of documents already converted into digital form, and you want to retrieve documents that meet some specified constraints. A typical Document retrieval system should have several components:

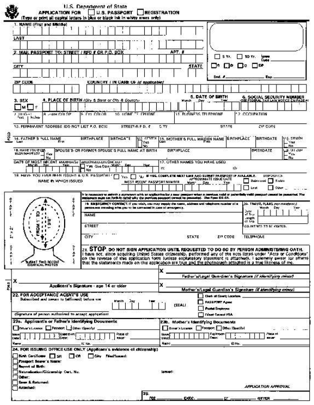
1. Text;
2. Image;
3. 1-D barcode; and
4. 2-D barcode.

Each component addresses a particular area of retrieval and their functions generally do not overlap. A complete solution should use all of the above options. This software deals with the image matching only.

9.1 Why Image Matching?

Image matching deals with several particular problems, which cannot be addressed by text search, 1D barcode search, or 2D barcode search:

(1) **Tables**: image matching is responsible for retrieving documents with similar Tables.



U.S. Department of State
APPLICATION FOR □ U.S. PASSPORT □ REGISTRATION
(Type or print all capital letters in blue or black ink in white areas only)

1. NAME (First and Middle)
LAST
2. MAIL PASSPORT TO: STREET / RFD # OR P.O. BOX APT. #
CITY STATE
ZIP CODE COUNTRY / IN CARE OF (if applicable)
□ 5 Yr. □ 10 Yr. Issue Date
□ R □ D □ O □ DP
End. # Exp.
3. SEX □ M □ F
4. PLACE OF BIRTH (City & State or City & Country)
5. DATE OF BIRTH Month Day Year
6. SOCIAL SECURITY NUMBER (SEE FEDERAL TAX LAW NOTICE ON PAGE 4)
7. HEIGHT Feet Inches
8. HAIR COLOR
9. EYE COLOR
10. HOME TELEPHONE
11. BUSINESS TELEPHONE
12. OCCUPATION
13. PERMANENT ADDRESS (DO NOT LIST P.O. BOX) STREET/R.F.D. # CITY STATE ZIP CODE
14. FATHER'S FULL NAME Last First BIRTHPLACE BIRTHDATE U.S. CITIZEN □ Yes □ No
15. MOTHER'S FULL MAIDEN NAME Last First BIRTHPLACE BIRTHDATE U.S. CITIZEN □ Yes □ No
16. HAVE YOU EVER BEEN MARRIED? □ Yes □ No
SPOUSE'S OR FORMER SPOUSE'S FULL NAME AT BIRTH BIRTHPLACE BIRTHDATE U.S. CITIZEN □ Yes □ No
DATE OF MOST RECENT MARRIAGE Month Day Year
WIDOWED/DIVORCED? □ Yes Give Date Month Day Year □ No
17. OTHER NAMES YOU HAVE USED (1) (2)
18. HAVE YOU EVER BEEN ISSUED A U.S. PASSPORT? □ Yes □ No IF YES, COMPLETE NEXT LINE AND SUBMIT PASSPORT IF AVAILABLE. DISPOSITION
NAME IN WHICH ISSUED
MOST RECENT PASSPORT NUMBER
APPROXIMATE ISSUE DATE Month Day Year
□ Submitted □ Stolen
□ Lost □ Other

STAPLE STAPLE STAPLE STAPLE
FROM 1" TO 1 3/8"
SUBMIT TWO RECENT IDENTICAL PHOTOS

It is necessary to submit a statement with an application for a new passport when a previous valid or potentially valid passport cannot be presented. The statement must set forth in detail why the previous passport cannot be presented. Use Form DS-64.

19. EMERGENCY CONTACT. If you wish, you may supply the name, address and telephone number of a person not traveling with you to be contacted in case of emergency.
NAME
STREET
CITY STATE ZIP CODE TELEPHONE

20. TRAVEL PLANS (not mandatory)
Date of Trip Month Day Year
Length of Trip
COUNTRIES TO BE VISITED

21. STOP. DO NOT SIGN APPLICATION UNTIL REQUESTED TO DO SO BY PERSON ADMINISTERING OATH.
I have not, since acquiring United States citizenship, performed any of the acts listed under "Acts or Conditions" on the reverse of this application form (unless explanatory statement is attached). I solemnly swear (or affirm) that the statements made on this application are true and the photograph attached is a true likeness of me.

X
Applicant's Signature - age 14 or older

X
Father's/Legal Guardian's Signature (if identifying minor)

X
Mother's/Legal Guardian's Signature (if identifying minor)

FOLD FOLD

22. FOR ACCEPTANCE AGENT'S USE
Subscribed and sworn to (affirmed) before me Month Day Year (SEAL)
(Signature of person authorized to accept application)
□ Clerk of Court; Location
□ PASSPORT Agent
□ Postal Employee
□ (Vice) Consul USA

23a. Applicant's or Father's Identifying Documents
□ Driver's License □ Passport □ Other (Specify)
Issue Date: Expiration Date: Place of Issue:
Name ID No.

23b. Mother's Identifying Documents
□ Driver's License □ Passport □ Other (Specify)
Issue Date: Expiration Date: Place of Issue:
Name ID No.

24. FOR ISSUING OFFICE USE ONLY (Applicant's evidence of citizenship)
□ Birth Certificate □ SR □ CR □ City Filed/Issued:
□ Passport Bearer's Name:
□ Report of Birth:
□ Naturalization/Citizenship Cert. No. Issued:
□ Other:
□ Seen & Returned:
□ Attached:
APPLICATION APPROVAL
25.
DOC EXEC. EF OTHER

Figure 9.1 Documents with Tables.

(2) **Images**: image matching is responsible for retrieving documents with similar images.

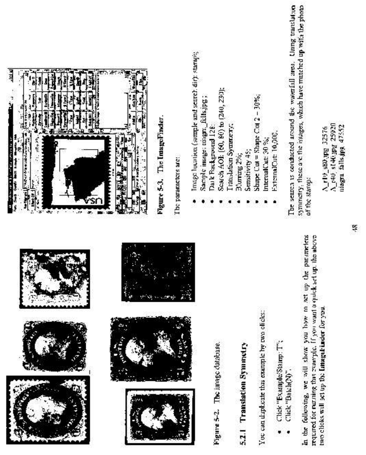


Figure 5-2. The image database.

5.2.1 Translation Symmetry

You can duplicate this example by two clicks:

- Click "Example/Stamp: T";
- Click "Batch(N)".

In the following, we will show you how to set up the parameters required for running this example. If you want a quick set up, the above two clicks will set up the **ImageFinder** for you.

Figure 5-3. The **ImageFinder**.

The parameters are:

- Image location (sample and search dir): stamp;
- Sample image: niagra_falls.jpg ;
- Dark Background 128;
- Search AOI: (60, 80) to (240, 230);
- Translation Symmetry;
- Blurring 2%;
- Sensitivity 45;
- Shape Cut = Shape Cut 2 – 30%;
- InternalCut: 30 %;
- ExternalCut: 10,000.

The search is conducted around the waterfall area. Using translation symmetry, these are the images, which have matched up with the photo of the stamp:

A_r10_s80.jpg 32576
A_r40_s140.jpg 25920
niagra_falls.jpg 47552

48

Figure 9.2 Documents with images.

(3) **Special Symbols**: image matching is responsible for retrieving documents with similar Special Symbols.

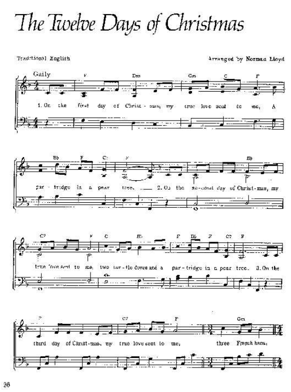
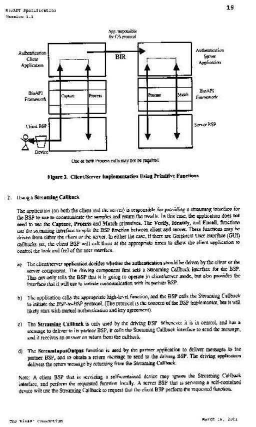

The Twelve Days of Christmas
Traditional English
Arranged by Norman Lloyd
Gaily
F
Dm
Gm
C
F
1. On the first day of Christ - mas, my true love sent to me, A
Bb
F
C
F
Bb
par - tridge in a pear tree. 2. On the second day of Christ-mas, my
C7
F
C
Bb
F
Bb
F
C7
F
true love sent to me, two tur-tle doves and a par-tridge in a pear tree. 3. On the
F
C7
F
Gm
third day of Christ-mas, my true love sent to me, three French hens,
28

Figure 9.3 Documents with Special Symbols.

(4) **Figures, Drawing, Designs**: image matching is responsible for retrieving documents with similar Figures, Drawing, and Designs.



BioAPI Specification
Version 1.1

19

Figure 3. Client/Server Implementation Using Primitive Functions

2. Using a **Streaming Callback**

The application (on both the client and the server) is responsible for providing a streaming interface for the BSP to use to communicate the samples and return the results. In this case, the application does not need to use the **Capture, Process** and **Match** primitives. The **Verify, Identify,** and **Enroll**, functions use the streaming interface to split the BSP function between client and server. These functions may be driven from either the client or the server. In either the case, if there are Graphical User Interface (GUI) callbacks set, the client BSP will call them at the appropriate times to allow the client application to control the look and feel of the user interface.

a) The client/server application decides whether the authentication should be driven by the client or the server component. The driving component first sets a Streaming Callback interface for the BSP. This not only tells the BSP that it is going to operate in client/server mode, but also provides the interface that it will use to initiate communication with its partner BSP.

b) The application calls the appropriate high-level function, and the BSP calls the Streaming Callback to initiate the BSP-to-BSP protocol. (The protocol is the concern of the BSP implementer, but it will likely start with mutual authentication and key agreement).

c) The **Streaming Callback** is only used by the driving BSP. Whenever it is in control, and has a message to deliver to its partner BSP, it calls the Streaming Callback interface to send the message, and it receives an answer on return from the callback.

d) The **StreamInputOutput** function is used by the partner application to deliver messages to the partner BSP, and to obtain a return message to send to the driving BSP. The driving application delivers the return message by returning from the Streaming Callback.

Note: A client BSP that is servicing a self-contained device may ignore the Streaming Callback interface, and perform the requested function locally. A server BSP that is servicing a self-contained device will use the Streaming Callback to request that the client BSP perform the requested function.

The BioAPI Consortium

March 16, 2001

Figure 9.4 Documents with Figures, Drawing, and Designs.

(5) **Maps:** image matching is responsible for retrieving documents with similar Maps.

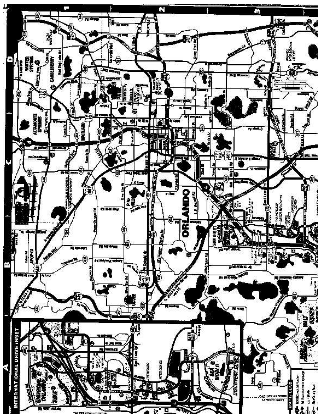
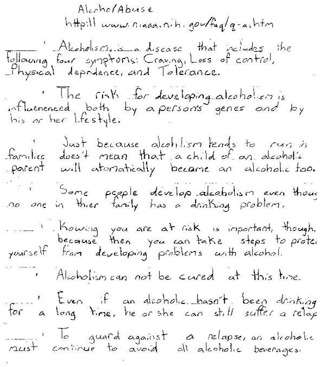


Figure 9.5 Documents with maps.

(6) **Hand Written Notes**: image matching is responsible for retrieving documents with Hand Written Notes.



Alcohol Abuse
http:// www.niaaa.nih.gov/faq/q-a.htm

Alcoholism is a disease that includes the following four symptoms: Craving, Loss of control, Physical depndence, and Tolerance.

The risk for developing alcoholism is influenenced both by a persons genes and by his or her lifestyle.

Just because alcohilism tends to run in families does't mean that a child of an alcoholic parent will atomatically became an alcoholic too.

Some people develop alcoholism even thoug no one in thier family has a drinking problem.

Kowing you are at risk is important, though, because then you can take steps to protec yourself from developing problems with alcohol.

Alcoholism can not be cured at this time.

Even if an alcoholic hasn't been drinking for a long time, he or she can still suffer a relap

To guard against a relapse, an alcoholic must continue to avoid all alcoholic beverages.

Figure 9.6 Documents with handwritten notes.

(7) …

9.2 Data

The data is located in the following folder:

Name	Location	# of Images
Misc	.\sp_document\misc\	93 x 2 = 186
BioAPI	.\sp_document \bioapi\	119 x 3 = 357
Abm54	.\sp_document \abm54\	160 x 3 = 480
Total		1,023 images

The "Misc" example has 93 matching pairs, or 186 images. It has various types of documents such as Tables, Images, Music, Figures, Drawings, Designs, Maps, …

The "BioAPI" example has 119 matching triplets, or 357 images. BioAPI is a document, which attempts to set up a standard for the biometric templates. This document has 119 pages.

The "Abm54" example has 160 triplets, or 480 images.

Positive Match

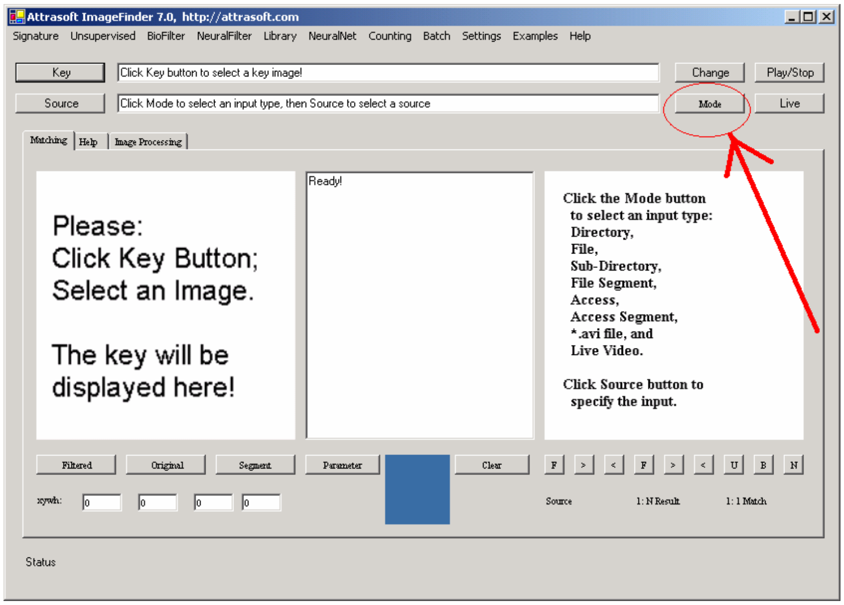
- The "Misc" example has 93 matching pairs, or 186 images; there are 186*2 positive matches.
- The "BioAPI" example has 119 triplets, or 357 images; there are 357*3 positive matches.
- The "Abm54" example has 160 triplets, or 480 images; there are 480*3 positive matches.
- In the file, ".\data\b1_matchlist_ex_doc.txt", which is the summation of all positive matches, there are 186*2 + 357*3 + 480*3 = 2883 positive matches.

9.3 Parameters

The NeuralFilter Matching will be used to retrieve duplicated Documents; there are five steps:

- Parameters
- Signatures
- Training
- Matching
- Analysis

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. The Parameters are set by clicking the Parameter button, which will open the Parameter Window in Figure 7.2. You will adjust the **ImageFinder** parameters here.



Attrasoft ImageFinder 7.0, http://attrasoft.com

Click Key button to select a key image!

Click Mode to select an input type, then Source to select a source

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

Ready!

Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

Click Source button to
specify the input.

Figure 9.7 Set the Input Mode as "Sub Dir", Sub-directory Input. Click the Mode button until you see "Sub Dir".

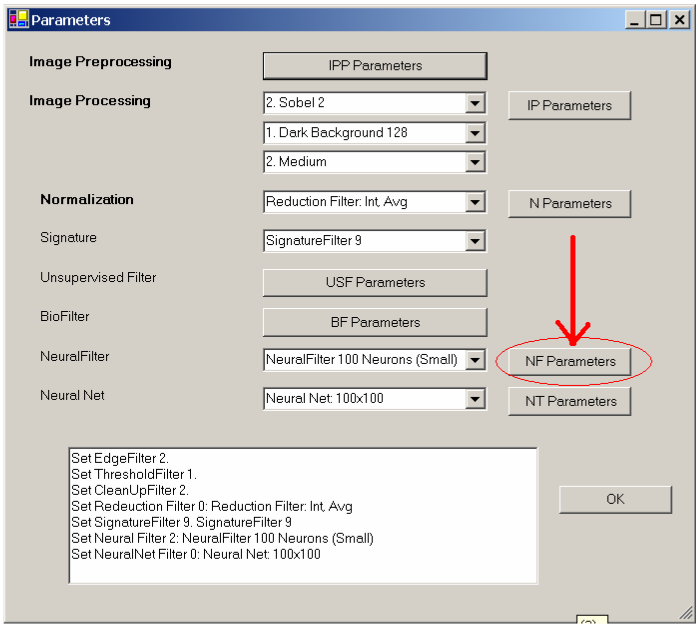


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 9

Unsupervised Filter

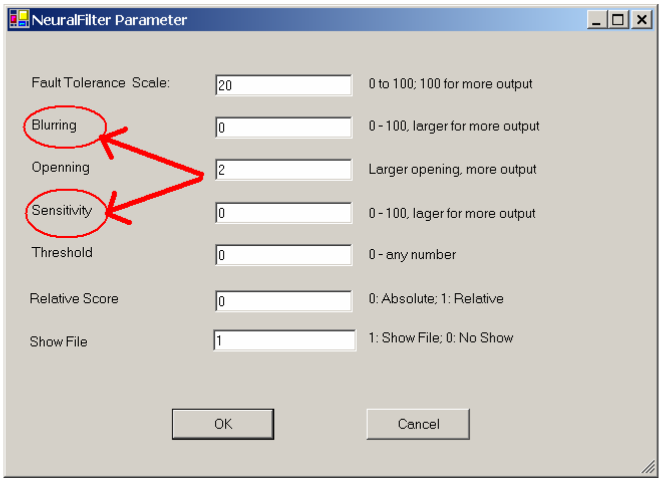
BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 9. SignatureFilter 9
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 9.8 Parameters for the Neural Filter.



Fault Tolerance Scale:	20	0 to 100; 100 for more output
Blurring	0	0 - 100, larger for more output
Openning	2	Larger opening, more output
Sensitivity	0	0 - 100, lager for more output
Threshold	0	0 - any number
Relative Score	0	0: Absolute; 1: Relative
Show File	1	1: Show File; 0: No Show

Figure 9.9 Neural Filter parameters, Blurring, & Sensitivity.

We will set several parameters in this chapter:

- Signature Filter = "Signature Filter 9" (See Figure 8.1)
- Input Mode = "Sub Dir" (See Figure 9.7)
- Blurring = 0 (See Figure 9.8, 9.9)
- Sensitivity = 0 (See Figure 9.8, 9.9)

Setting:

- The Signature Filter will be set to "Signature Filter 9" (See Figure 8.1).
- The input mode will be the sub-directory input, i.e. the **ImageFinder** will find the signature from all sub-folders of a specified folder. Click the Mode button until you see "Sub Dir" in Figure 9.7.
- Click the Neural Filter parameter button in Figure 9.8, you will get Figure 9.9. Set both Blurring and Sensitivity to 0 in Figure 9.9.

9.4 Signature

To compute the N-signatures:

- Click the Mode button until you see "Sub Dir";
- Click the "Source" button to select directory, ".\sp_document\"; then select any file in this folder;
- Click "Signature/N Signature (a1.txt)" to compute the signatures in a1.txt.

9.5 Training

Again, training requires two files:

Match.txt

- Open the file, “.\data\match_ex_doc.txt”. This file lists 930 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- In the last step, we have obtained a1.txt;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Training

- Click “NeuralFilter\Training\Training” to train the Neural Filter.

9.6 Matching

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

The result will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\sp_document\abm54\abm54_a_0001.jpg
C:\...\sp_document\abm54\abm54_a_0001.jpg

242307
C:\...\sp_document\abm54\abm54_a_0157.jpg
103862
C:\...\sp_document\abm54\abm54_b_0001.jpg
119753
C:\...\sp_document\abm54\abm54_b_0152.jpg
107823
C:\...\sp_document\abm54\abm54_c_0001.jpg
123101
…
Total Number of Matches = 13277
```

9.7 Analysis

Possible Matches

Let the Total Images in the input file be N, the Possible Matches will be N*N. In our example, N * N = 1023 x 1023 = 1,046,529.

Attrasoft Matches

The number of retrieved matches is listed in the last line of b1.txt. Go to the end of b1.txt, you will see something like this:

Total Number of Matches = 13277

Actual Match

This number depends on your problem. It should be the first number in b1_matchlist.txt. In our example, it is 2883.

Attrasoft Found Duplicates

To check the results, we must prepare the b1_matchlist.txt file now. This file is already prepared for you and we will simply open it and save it to b1_matchlist.txt (overwrite the existing file). The steps are:

- Open "./data/b1_matchlist_ex_doc.txt. Save it to b1_matchlist.txt (overwrite the existing file). Now this file is prepared.
- Click "NeuralFilter/Check(b1_matchlist.txt required)" to check the results of the BioFilter.

The result is:
Total Matches = 2883

All of the pairs are identified. Now that you have all of the numbers, you can make an analysis.

Positive Identification Rate

In this example, the **Positive Identification Rate is 100%,** i.e., 2883/2883 = 100%.

Elimination Rate

Elimination Rate = 98.7 % = (1 – **13277/1,046,529**).

Hit Ratio

The Hit Ratio = 2883/13277 **= 21.8 %.**

Composite Index

The composite index is = 100% * 98.7% * 21.8% = 21.5%.

10. Face Recognition

Click menu item “Example/Special Example/Face recognition”; then click “Batch/Run”, and this chapter is done. Now, we will walk through the Face Recognition example.

This chapter attempts to solve a particular problem: to scan a document (passport, ID card, …) with a Face Photo ID and match this face image against an existing database. Assume you have millions of Photo ID’s already converted into images, and you want to make a 1:N Matching with the newly captured image.

10.1 Data

The data is located in the following folder:

.\sp_face\.

There are 516 pairs, or 1032 images. Each image will match itself and its partner; giving a total of 1032 * 2 = 2064 matches**.**

10.2 Parameters

The NeuralFilter Matching will be used to match Face images; there are five steps:

- Parameters
- Signatures
- Training
- Matching
- Analysis

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. The Parameters are set by clicking the Parameter button, which will open the Parameter Window in Figure 7.2. You will adjust the **ImageFinder** parameters here.

We will set several parameters in this chapter:

- Signature Filter = “Signature Filter 15” (See Figure 8.1)
- Blurring = 0 (See Figure 10.1, 10.2)
- Sensitivity = 0 (See Figure 10.1, 10.2)

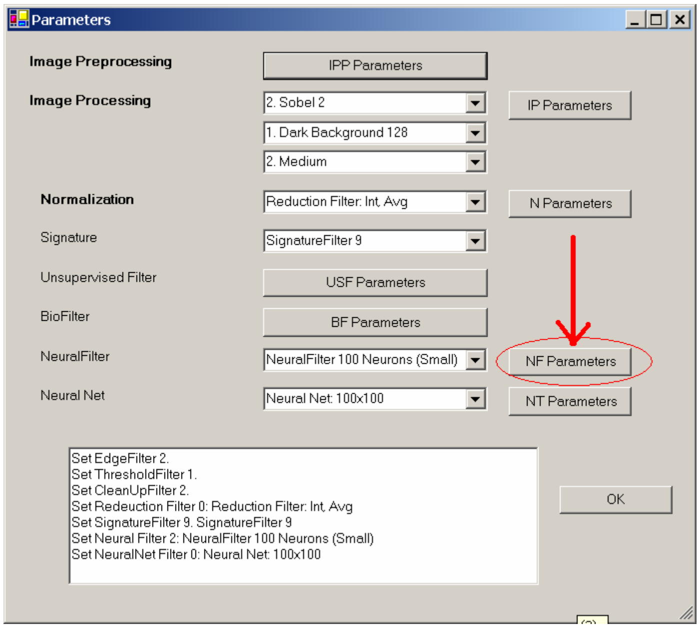
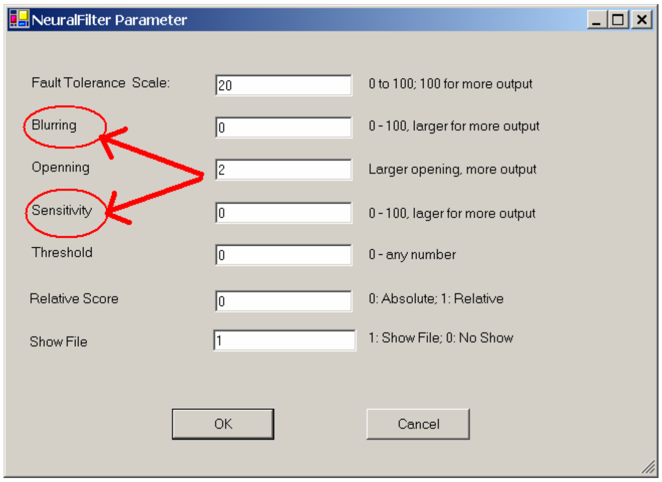


Image Preprocessing
Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium
Normalization: Reduction Filter: Int. Avg
Signature: SignatureFilter 9
Unsupervised Filter
BioFilter
NeuralFilter: NeuralFilter 100 Neurons (Small)
Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int. Avg
Set SignatureFilter 9. SignatureFilter 9
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 10.1 Parameters for the Neural Filter.



Fault Tolerance Scale:	20	0 to 100; 100 for more output
Blurring	0	0 - 100, larger for more output
Openning	2	Larger opening, more output
Sensitivity	0	0 - 100, lager for more output
Threshold	0	0 - any number
Relative Score	0	0: Absolute; 1: Relative
Show File	1	1: Show File; 0: No Show

Figure 10.2 Neural Filter parameters: Blurring, & Sensitivity.

Setting:

- The Signature Filter will be set to "Signature Filter 15" (See Figure 10.1).
- Set both Blurring and Sensitivity to 0 in Figure 10.2.

10.3 Signature

To compute the N-signatures:

- Click the "Source" button to select directory, ".\sp_face\", then select any file in this folder;

- Click “Signature/N Signature (a1.txt)” to compute the signatures in a1.txt.

10.4 Training

Again, training requires two files:

Match.txt

- Open the file, “.\data\match_ex_face.txt”. This file lists 516 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- In the last step, we obtained a1.txt;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Training

- Click “NeuralFilter\Training\Training” to train the Neural Filter.

10.5 Matching

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

The results will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\sp_face\00019ba010_960521.jpg

C:\...\SP_FACE\00019BA010_960521.JPG
345857
C:\...\sp_face\00019bj010_960521.jpg
147782
C:\...\sp_face\00802fb010_941205.jpg
124425

C:\...\sp_face\00019bj010_960521.jpg
C:\...\sp_face\00019ba010_960521.jpg
147782
C:\...\sp_face\00019bj010_960521.jpg
345857
…
Total Number of Matches = 6354.
```

10.6 Analysis

Possible Matches

Let the Total Images in the input file be N, the Possible Matches will be N*N. In our example, N * N = 1032 x 1032 = 1,065,024.

Attrasoft Matches

The number of retrieved matches is listed in the last line of b1.txt. Go to the end of b1.txt; you will see something like this:

Total Number of Matches = 6354.

Actual Match

This number depends on your problem. It should be the first number in b1_matchlist.txt. In our example, it is 2064.

Attrasoft Finds Matches

To check the results, we must prepare the b1_matchlist.txt file now. This file is already prepared for you and we will simply open it and save it to b1_matchlist.txt (overwrite the existing file). The steps are:

- Open "./data/b1_matchlist_ex_face.txt. Save it to b1_matchlist.txt (overwrite the existing file). Now this file is prepared.
- Click "NeuralFilter/Check(b1_matchlist.txt required)" to check the results of the BioFilter.

The result is:
Total Matches = 2064

All of the pairs are identified. Now that you have all of the numbers, you can make an analysis.

Positive Identification Rate

In this example, the **Positive Identification Rate is 100%,** i.e., 2064/2064 = 100%.

Elimination Rate

Elimination Rate = 99.4 % = (1 – **6354/1,065,024**).

Hit Ratio

The Hit Ratio = 2064/6354 = 32.5 %.

Composite Index

The composite index is = 100% * 99.4% * 32.5% = 32.3%.

11. Auto Part Recognition

Click menu item “Example/Special Example/Wheel Recognition”; then click “Batch/Run”, this chapter is done. Now, we will walk through the Auto Part Recognition example.

Auto Parts consist of products like wheel rims, doors, bumpers, converters, ... There are more than 70,000 wheel rim designs, more than 200 bumpers, ... In any given month, about 1,500 types of wheel rims are used. It is hard for a human eye to identify each wheel rim, bumper, and other car parts.

This chapter attempts to solve a particular problem: given a wheel rim, identify what it is.

11.1 Why Wheel Rim Identification?

Given a wheel rim, what is its identification number? This has broad applications, from simply ordering a damaged part, to placing the wheel rim in the right place on a shelf.

11.2 Data

The data is located in the following folder:

Name	Location	# of Images
Quadraplet	.\sp_wheel\	25 x 4 = 100
Doublet	. \sp_wheel\	60 x 2 = 120
Singlet	. \sp_wheel\	44 x 1 = 44
Total		264 images

There are 25 “Quadruplet” images: 60 pairs, and 44 singlets in this data set. The “Quadruplet ” set has 25 quadruplets, or 100 images; there are 100*4 positive matches. The “Doublet” set has 60 doublets, or 120 images; there are 120*2 positive matches. There are 100*4 + 120*2 + 44 x 1= 681 positive matches in total.

11.3 Parameters

The NeuralFilter Matching will be used for the Auto Part Recognition; there are five steps:

- Parameters
- Signatures
- Training
- Matching
- Analysis

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. Clicking the Parameter button, which will open the Parameter Window in Figure 11.1, sets the Parameters. You will adjust the **ImageFinder** parameters here.

We will set several parameters in this chapter:

- Signature Filter = "Signature Filter 9" (See Figure 11.1)
- Preprocessing Filter/Skip Empty Border = 6 (See Figure 11.2)
- Preprocessing Filter/Skip Percent = 5 (See Figure 11.2)
- Preprocessing Filter/Skip Threshold Filter = 1 (See Figure 11.2)
- Preprocessing Filter/Skip Edge Filter = 2 (See Figure 11.2)

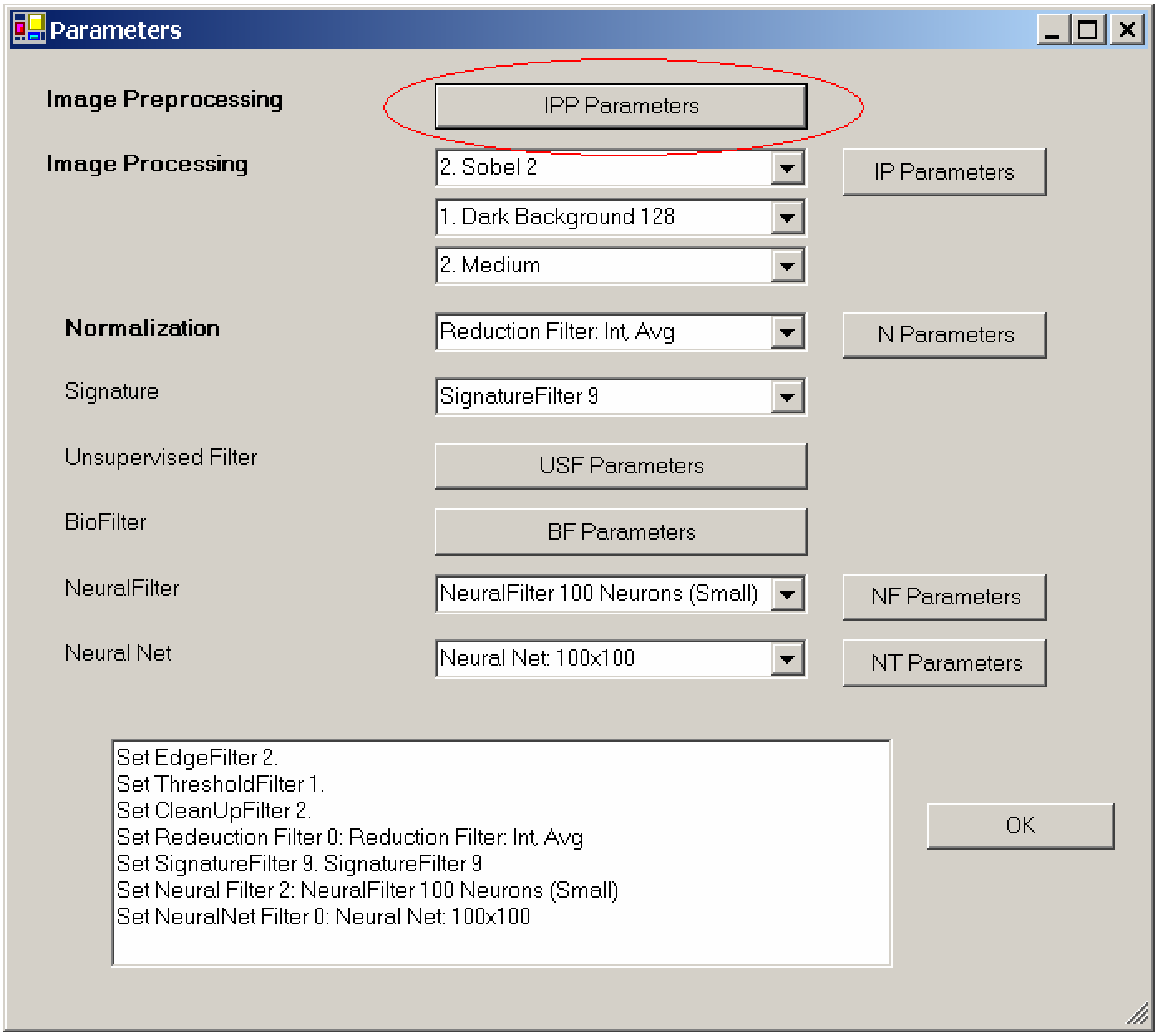


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 9

Unsupervised Filter

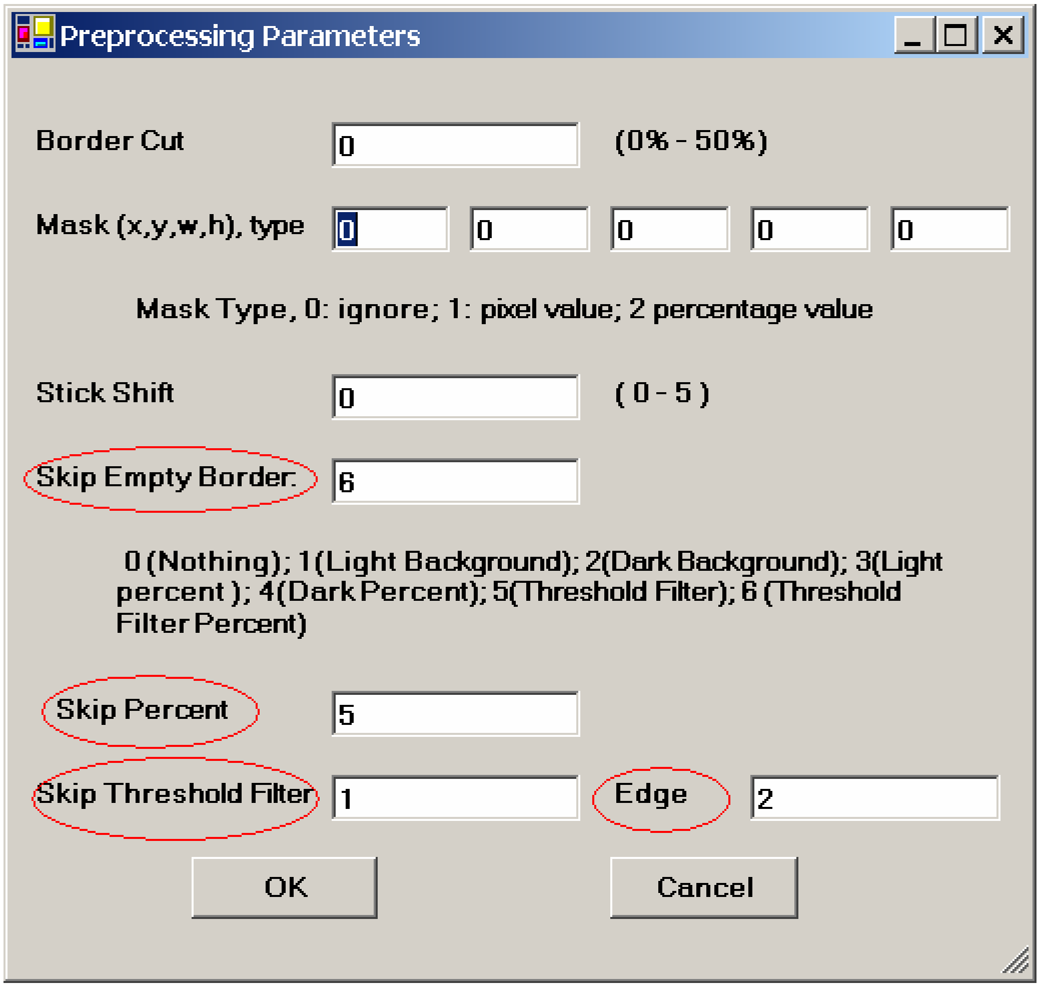
BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 9. SignatureFilter 9
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 11.1 IPP (Image Pre-Processing) Filter parameters.



Border Cut: 0 (0% - 50%)

Mask (x,y,w,h), type: 0 0 0 0 0

Mask Type, 0: ignore; 1: pixel value; 2 percentage value

Stick Shift: 0 (0 - 5)

Skip Empty Border: 6

0 (Nothing); 1(Light Background); 2(Dark Background); 3(Light percent); 4(Dark Percent); 5(Threshold Filter); 6 (Threshold Filter Percent)

Skip Percent: 5

Skip Threshold Filter: 1 Edge: 2

Figure 11.2 Preprocessing Filter parameters. Set Preprocessing Filter/Skip Empty Border = 6, Preprocessing Filter/Skip Percent = 5, Preprocessing Filter/Skip Threshold Filter = 1, Preprocessing Filter/Skip Edge Filter = 2.

Setting:

- The Signature Filter will be set to “Signature Filter 9” (See Figure 11.1).
- Click the IPP (Image Pre-Processing) Parameter button in Figure 11.1, you will get Figure 11.2. Set the parameters.

11.4 Signature

To compute the N-signatures:

- Click the “Source” button to select directory, “.\sp_wheel\”; then select any file in this folder;
- Click “Signature/N Signature (a1.txt)” to compute the signatures in a1.txt.

11.5 Training

Again, training requires two files:

Match.txt

- Open the file, “.\data\match_ex_wheel.txt”. This file lists 420 matching pairs, 300 from the quadruplets and 120 doublets. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- In the last step, we obtained a1.txt;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Training

- Click “NeuralFilter\Training\Training” to train the Neural Filter.

11.6 Matching

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

The results will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\sp_wheel\1056a.JPG
C:\...\sp_wheel\1056a.JPG
242307
C:\...\sp_wheel\1056b.JPG
83106

C:\...\sp_wheel\1056b.JPG
C:\...\sp_wheel\1056a.JPG
83106
C:\...\sp_wheel\1056b.JPG
242307
…
Total Number of Matches = 754.
```

11.7 Analysis

Possible Matches

Let the Total Images in the input file be N, the Possible Matches will be N*N. In our example, N * N = 264 x 264 = 69,696.

Attrasoft Matches

The number of retrieved matches is listed in the last line of b1.txt. Go to the end of b1.txt, you will see something like this:

Total Number of Matches = 754.

Actual Match

This number depends on your problem. It should be the first number in b1_matchlist.txt. In our example, it is 100*4 + 120*2 + 44 x 1= 681**.**

Attrasoft Found Duplicates

To check the results, we must prepare the b1_matchlist.txt file now. This file is already prepared for you and we will simply open it and save it to b1_matchlist.txt (overwrite the existing file). The steps are:

- Open "./data/b1_matchlist_ex_wheel.txt. Save it to b1_matchlist.txt (overwrite the existing file). Now this file is prepared.
- Click "NeuralFilter/Check(b1_matchlist.txt required)" to check the results of the BioFilter.

The result is:
Total Matches = 640 (quadruplet and doublet) + 41 (singlet)

All of the matching images are identified. Now that you have all of the numbers, you can make an analysis.

Positive Identification Rate

In this example, the **Positive Identification Rate is 100%,** i.e., 681/681 = 100%.

Elimination Rate

Elimination Rate = 99 % **=** (1 – **754/69,696**).

Hit Ratio

The Hit Ratio = 681/754 **= 90 %.**

Composite Index

The composite index is = 100% * 99% * 90% = 89%.

12. Dynamic Library

In the last a few chapters, we introduced 1:N Match and N:N Match, where N is fixed. This chapter will introduce the Dynamic Library where N can be updated via insertion, deletion, and update. We will introduce a Logo Recognition example.

12.1 Why Logo Identification?

Barcodes have a very broad application. Barcodes have one shortcoming; they have to be prepared in advance. In the near future, many products, pictures, and logos can replace barcodes with one advantage; they do not have to be prepared in advance.

In 2050, you will walk into a movie theater; use your cell phone to dial a number on the wall; then point and click, taking a picture of a movie poster on the wall; and then, push a button on your cell phone to order a movie ticket. A second later, you will receive an email with a pass code; you will enter the pass code at the gate which allows you to enter the theater.

12.2 Data

The data is located in the following folder:

.\ex-dynamic_lib\	Original logo data
.\ex-dynamic_lib\add\	Add to the library later

12.3 Parameters

The Dynamic Library works only for the NeuralFilter Matching; there are six steps:

- Parameters
- Signatures
- Training
- Matching
- Update Dynamic Library and Match Again
- Analysis

The **ImageFinder** has many parameters. Changing these parameters will change the output of the computations. Click the Parameter button, and set:

- Signature Filter = "Signature Filter 15";
- NeuralFiilter/Fault Tolerance scale = 10;
- NeuralFilter/Blurring = 0;

- NeuralFilter/Sensitivity = 0;

12.4 Signature

To compute the N-signatures:

- Click the “Source” button to select directory, “.\sp_dynamic_lib\”, then select any file in this folder;
- Click “Signature/N Signature (a1.txt)” to compute the signatures in a1.txt.

12.5 Training

Again, training requires two files:

Match.txt

- Open the file, “.\data\match_ex_dynamic_lib.txt”. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- In the last step, we obtained a1.txt;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Training

- Click “NeuralFilter\Training\Training” to train the Neural Filter.

12.6 N:N Matching

N:N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

The results will go to a file, b1.txt, which will be opened right after the click. The file will look like this:

```
C:\...\ex_dynamic_lib\A10.jpg
C:\...\ex_dynamic_lib\A10.jpg
345857
C:\...\ex_dynamic_lib\A100.jpg
165737
C:\...\ex_dynamic_lib\A155.jpg
155305
C:\...\ex_dynamic_lib\A23.jpg
```

```
163925
C:\...\ex_dynamic_lib\A35.jpg
179006
C:\...\ex_dynamic_lib\A354.jpg
152442
C:\...\ex_dynamic_lib\A47.jpg
201112
C:\...\ex_dynamic_lib\B10.jpg
176355
…
```

12.7 Dynamic Library

Up to this point when we have done 1:N or N:N Matching, the N-images have been fixed.

The Dynamic Library allows you to update the N-images, including inserting, deleting, and replacing signatures.

To use the Dynamic Library, you have to create a library from file lib1.txt or lib2.txt, so the first two things we will do are:

- Create lib1.txt;
- Load the library, lib1.txt.

To create a library file, lib1.txt, click "Library/Maintenance/Create Lib1 (Copy a1.txt to lib1.txt)".

To load the library file, click "Library/Maintenance/Load lib1.txt".

12.8 Library 1:N Matching

To make 1:N Matching via the library,

- Click the "Key" button, in the "ex_dynamic_lib"directory, select the first image "A10.jpg";
- Click menu item "Library/Matching/1:N (Key vs. lib1.txt)" button to complete a 1:N Match.

12.9 Library M:N Matching

In an N:M Matching, the N-images are in a1.txt and M-images are in lib1.txt. To make a M:N Matching,

- Click menu item "Library/Matching/N:M (a1.txt vs. lib1.txt)" button to complete a N:M Match.

12.10 Library Updating

Now, we will add images in folder, ".\ex_dynamic_lib\add\". To make 1:N Matching via the library,

- Click the "Key" button, in the ".\ex_dynamic_lib\add\" directory; select the image "**A416.jpg**";
- Click menu item "Library/Matching/1:N (Key vs. lib1.txt)" button to complete a 1:N Match.

You will get:

```
ID     Name       Path                     Score      X    Y    W    H
A324   A324.jpg   C:\...\ex_dynamic_lib\   142953     0    0    0    0
B10    B10.jpg    C:\...\ex_dynamic_lib\   137606     0    0    0    0
A166   A166.jpg   C:\...\ex_dynamic_lib\   135926     0    0    0    0
A142   A142.jpg   C:\...\ex_dynamic_lib\   133745     0    0    0    0
B206   B206.jpg   C:\...\ex_dynamic_lib\   132967     0    0    0    0
B11    B11.jpg    C:\...\ex_dynamic_lib\   130253     0    0    0    0
B35    B35.jpg    C:\...\ex_dynamic_lib\   124340     0    0    0    0
B76    B76.jpg    C:\...\ex_dynamic_lib\   123182     0    0    0    0
```

To add this image, A416.jpg, to the library, click "Library/Maintenance/Add (Key)".

Now, make a 1:N Match again:

- Click menu item "Library/Matching/1:N (Key vs. lib1.txt)" button to complete a 1:N Match.

You will get:

```
ID     Name       Path                        Score     X    Y    W    H
A416   A416.jpg   C:\...\ex_dynamic_lib\add\  345857    0    0    0    0
A324   A324.jpg   C:\...\ex_dynamic_lib\142953     0    0    0    0
B10    B10.jpg    C:\...\ex_dynamic_lib\137606     0    0    0    0
A166   A166.jpg   C:\...\ex_dynamic_lib\135926     0    0    0    0
A142   A142.jpg   C:\...\ex_dynamic_lib\133745     0    0    0    0
B206   B206.jpg   C:\...\ex_dynamic_lib\132967     0    0    0    0
B11    B11.jpg    C:\...\ex_dynamic_lib\130253     0    0    0    0
B35    B35.jpg    C:\...\ex_dynamic_lib\124340     0    0    0    0
B76    B76.jpg    C:\...\ex_dynamic_lib\123182     0    0    0    0
```

As you can see, A416.jpg has been added to the library. Now we will delete it from the library by clicking "Library/Maintenance/Delete (Key)". Now make a 1:N Match again:

- Click menu item "Library/Matching/1:N (Key vs. lib1.txt)" button to complete a 1:N Match.

Now **A416.jpg** will no longer be in the output.

13. NeuralNet Filter

Up to this point, we have focused on matching whole images. The NeuralNet filter matches a segment of an image(s).

As we have seen, accurate matching via the Neural Filter requires many matching pairs. Preparing matching pairs for whole images means listing all pairs in the match.txt file.

Preparing matching pairs for image segments is much harder; therefore, rather than using the NeuralFilter for image segments, we will use the Unsupervised Filter for image segments. As we have seen, the Unsupervised Matching for image segments is not as accurate as the Neural Filter.

Matching image segments is not the primary focus of the current version of the **ImageFinder**. If you need accurate Segment Matching, you need customization.

13.1 Trademark Recognition

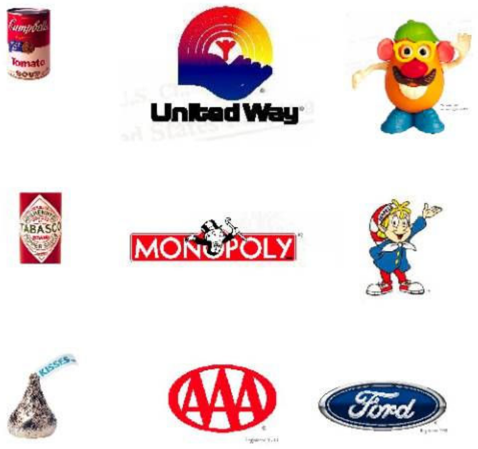


Figure 13.1 Locating an Image Segment.

In this chapter, we will introduce a Trademark Recognition example. The objective is to identify and locate the trademarks in an image. Figure 13.1 shows a typical image. The data is stored in the folder, ".\input_auto_track".

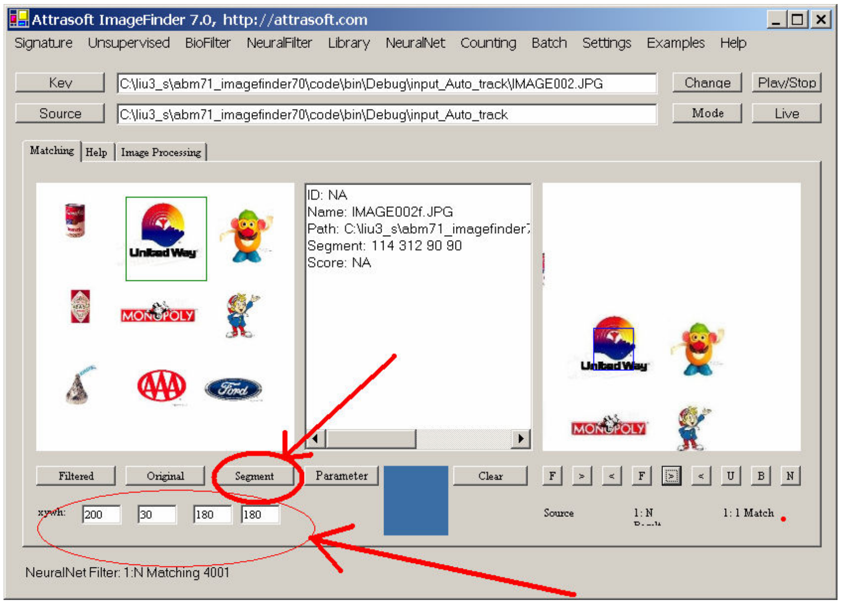
13.2 Key Segment

A path, such as c:\abc\xyz.jpg, specifies the key image. The key segment is specified by a path and (x, y, w, h). Here (x, y) is the coordinate of the upper left corner, w is the width, and h is the height.

An image segment is specified via its pixel values. For example, let an image be 256 x 256, then (0, 0, 128, 128) specifies a quarter of the image located in the upper left corner.

Figure 13.2 shows how to specify an image segment in 2 steps:

- Enter (x, y, w, h) into the four textboxes in Figure 13.2;
- Click the Segment button to enter (x, y, w, h) to the software.



Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\IMAGE002.JPG

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

ID: NA
Name: IMAGE002f.JPG
Path: C:\liu3_s\abm71_imagefinder7
Segment: 114 312 90 90
Score: NA

xywh: 200 30 180 180

NeuralNet Filter: 1:N Matching 4001

Figure 13.2   Specify an Image Segment.

Example. Specifying a Key Segment:

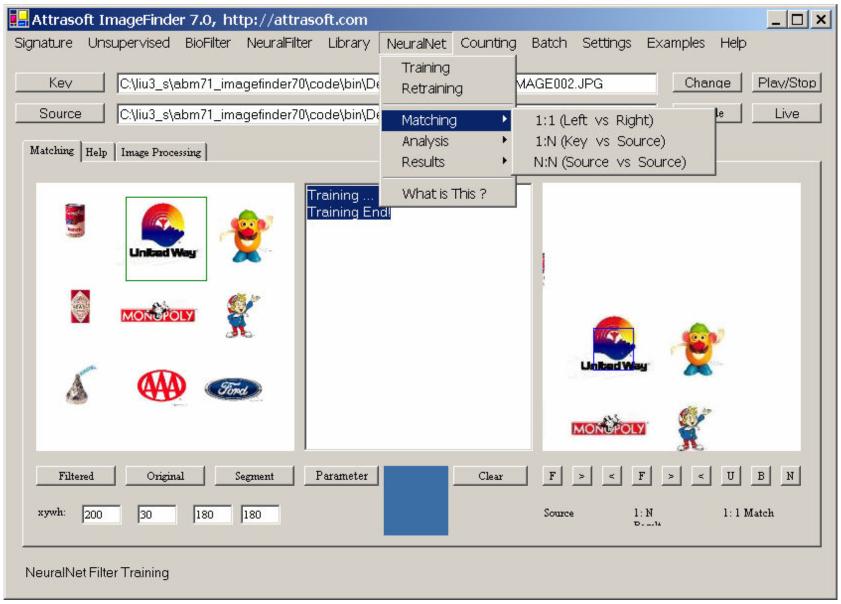
- Click the "Key" button, in the ".\input_auto_track" directory, select image "IMAGE002.jpg";
- Enter (200, 30, 180, 180) to the segment textboxes in Figure 13.2.
- Click the "Segment" button and the segment is marked by a square in Figure 13.2..

13.3 Training

Training here means setting up the NeuralNet Filter. Continuing from the last section, click "NeuralNet/Training" in Figure 13.3 to complete the training. You should see this message:

```
Training ...
Training End!
```

13.4 1:N Matching



Key: C:\liu3_s\abm71_imagefinder70\code\bin\De … IMAGE002.JPG

Source: C:\liu3_s\abm71_imagefinder70\code\bin\De

xywh: 200 30 180 180

Figure 13.3 Neural Net Training and Matching.

To make a 1:N Matching:

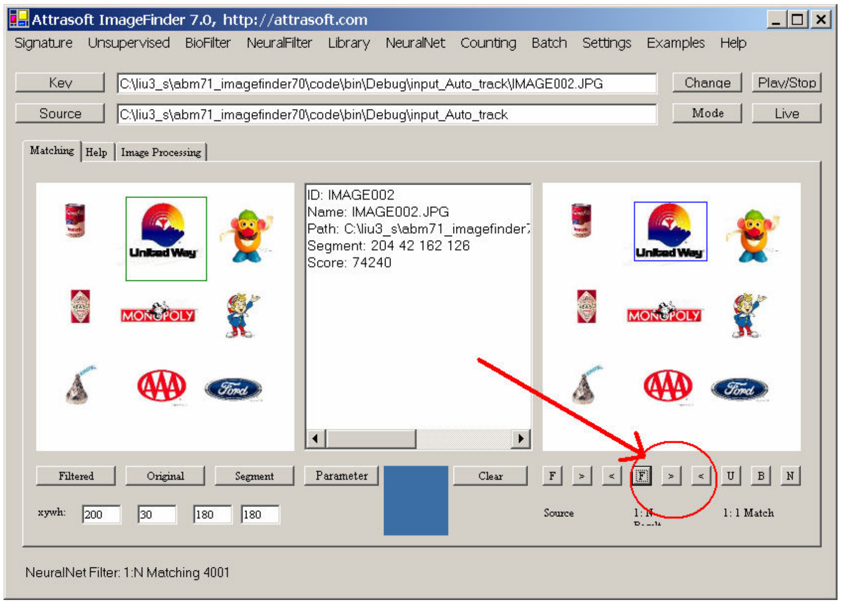
- Click the "Source" button to select directory, ".\input_auto_track"; then select any file in this folder;
- Click "NeuralNet/Matching/1:N (Key vs Source)" to make a 1:N Matching (See Figure 13.3).

The output will look like this:

ID	Name	Path	Score	X	Y	W	H	R
IMAGE002	IMAGE002.JPG	C:\...\input_Auto_track\	74240	204	42	162	126	0
IMAGE002a	IMAGE002a.JPG	C:\...\input_Auto_track\	70080	228	42	162	126	0
IMAGE002b	IMAGE002b.JPG	C:\...\input_Auto_track\	71616	240	30	162	126	0
IMAGE002c	IMAGE002c.JPG	C:\...\input_Auto_track\	72640	246	66	162	126	0
IMAGE002d	IMAGE002d.JPG	C:\...\input_Auto_track\	70720	246	120	162	126	0
IMAGE002e	IMAGE002e.JPG	C:\...\input_Auto_track\	71104	138	150	162	126	0
IMAGE002f	IMAGE002f.JPG	C:\...\input_Auto_track\	108096	84	288	162	126	0
IMAGE004	IMAGE004.JPG	C:\...\input_Auto_track\	70080	12	24	162	126	0
IMAGE006	IMAGE006.JPG	C:\...\input_Auto_track\	67008	378	204	162	126	0
IMAGE008	IMAGE008.JPG	C:\...\input_Auto_track\	67200	48	60	162	126	0

13.5 Results

Although the output file specifies the segment location, it is not obviously where (x, y, w, h) is in a given image. For example, it is not clear where (202, 42, 162, 126) is in image, image002.jpg.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Change
Play/Stop
Source
Mode
Live
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F
>
<
F
>
<
U
B
N
xywh:
Source
1:N
Result
1:1 Match

Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\IMAGE002.JPG

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

ID: IMAGE002
Name: IMAGE002.JPG
Path: C:\liu3_s\abm71_imagefinder7
Segment: 204 42 162 126
Score: 74240

xywh: 200 30 180 180

NeuralNet Filter: 1:N Matching 4001

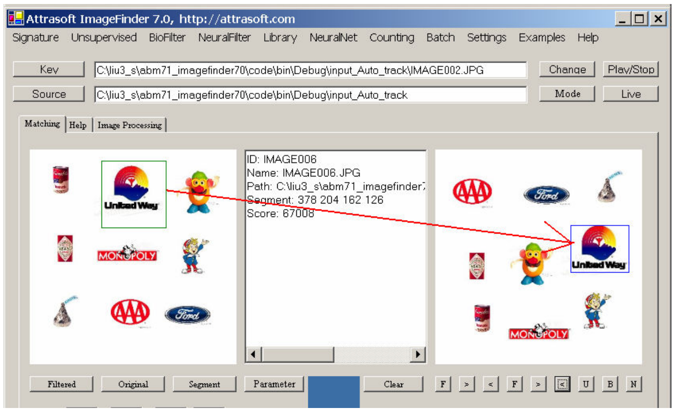
Figure 13.4. Matched Segment.

In Figure 13.4, the first picture box shows the training segment; and the second segment shows the matched segment.

To see where the matching segment is, there are three buttons in Figure 13.4:
F, > (Next), and < (Previous), that can be used to show where the matched segment is:

Click the “F” button to see the first matched segment;
Click the “>” to see the next matched segment;
Click the “<” button to see the previous matched button.

Figure 13.5 shows another matched segment.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Change
Play/Stop
Source
Mode
Live
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F
>
<
F
>
<
U
B
N

Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\IMAGE002.JPG

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

ID: IMAGE006
Name: IMAGE006.JPG
Path: C:\liu3_s\abm71_imagefinder7
Segment: 378 204 162 126
Score: 67008

Figure 13.5 Matched Segment.

13.6 Mr. Potato

Now, we want a match of the Mr. Potato trademark in Figure 13.3:

- Click the "Key" button, in the ".\input_auto_track" directory, select image "IMAGE002.jpg";
- Enter (400, 30, 150, 180) to the segment textboxes in Figure 13.2.
- Click the Segment button.

To train the NeuralNet Filter:

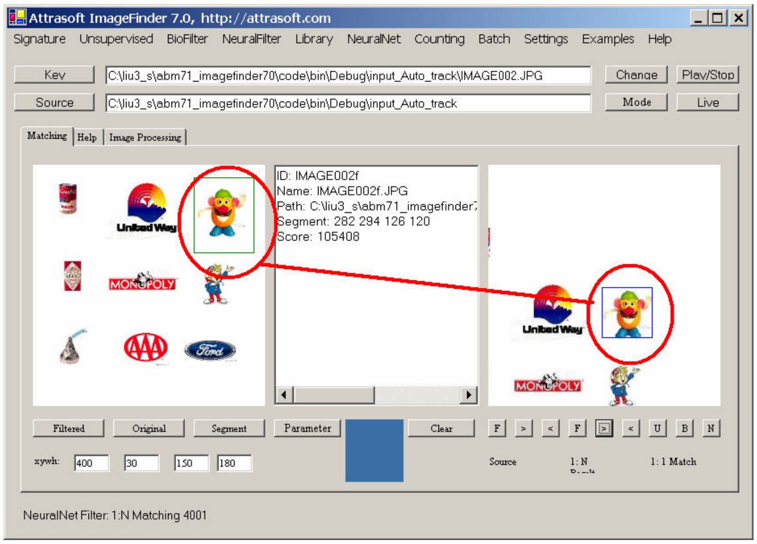
- Click "NeuralNet/training" in Figure 13.3 to complete the training.

To make an 1:N Matching:

- Click the "Source" button to select directory, ".\input_auto_track"; then select any file in this folder;
- Click "NeuralNet/Matching/1:N (Key vs Source)" to make a 1:N Matching (See Figure 13.3).

To see where the matching segment is, there are three buttons in Figure 13.4:
F, > (Next), and < (Previous), that can be used to show where the matched segment is:

Click the "F" button to see the first matched segment;
Click the ">" to see the next matched segment;
Click the "<" button to see the previous matched button.



Attrasoft ImageFinder 7.0, http://attrasoft.com

Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\IMAGE002.JPG

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

```
ID: IMAGE002f
Name: IMAGE002f.JPG
Path: C:\liu3_s\abm71_imagefinder7
Segment: 282 294 126 120
Score: 105408
```

xywh: 400 30 150 180

NeuralNet Filter: 1:N Matching 4001

Figure 13.6 Mr. Potato.

13.7 Monopoly

Now we want a match of the Monopoly trademark in Figure 13.3.

To specify the key segment:

- Enter (180, 320, 200, 180) to the segment textboxes in Figure 13.2.
- Click the Segment button.

To train the NeuralNet Filter:

- Click “NeuralNet/training” in Figure 13.3 to complete the training.

To make a 1:N Matching:

- Click “NeuralNet/Matching/1:N (Key vs Source)” to make a 1:N Matching (See Figure 13.3).

To see where the matching segment is, there are three buttons in Figure 13.4:
F, > (Next), and < (Previous), that can be used to show where the matched segment is:

Click the “F” button to see the first matched segment;
Click the “>” to see the next matched segment;
Click the “<” button to see the previous matched button.

14. Segment Variation

In this chapter, we will identify 4 trademarks and 2 stamps. We will try to demonstrate the symmetry. Symmetry means objects in images have been changed, such as:

- moved to a different place (Translation Symmetry),
- enlarged (Scaling Symmetry), or
- rotated (Rotation Symmetry).

The first two examples demonstrate Rotation Symmetry, the next two examples demonstrate Scaling Symmetry, and the last example demonstrates Translation Symmetry.

In the current version, the segment location (x, y, w, h) is implemented for Translation Symmetry and Rotation Symmetry, but is not implemented for Scaling Symmetry and Mixed Symmetry.

14.1 Neural Net Parameters

In this chapter, we will need to set up the Neural Net Parameters. To set the parameters, click the Parameter button and you will see Figure 14.1. In Figure 14.1, click the "NT (NeuralNet) Parameter" button; you will see Figure 14.2. You will set the parameters in Figure 14.2.

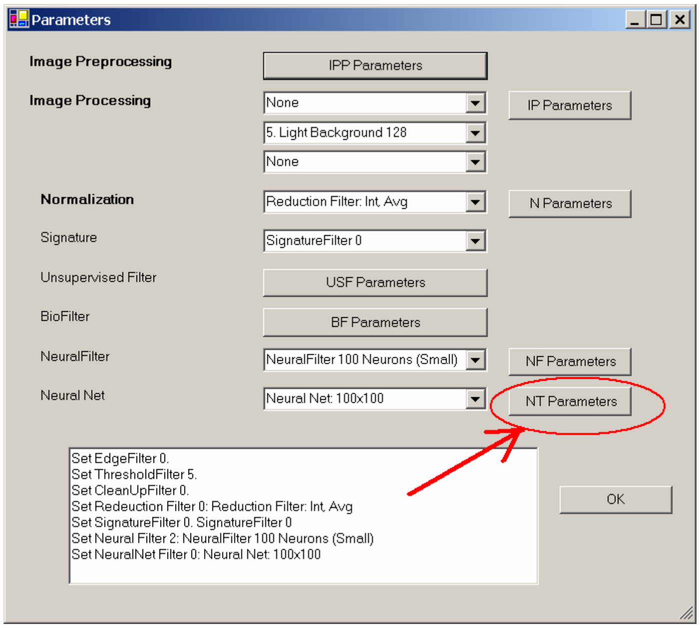


Image Preprocessing

Image Processing: None; 5. Light Background 128; None

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 0

Unsupervised Filter

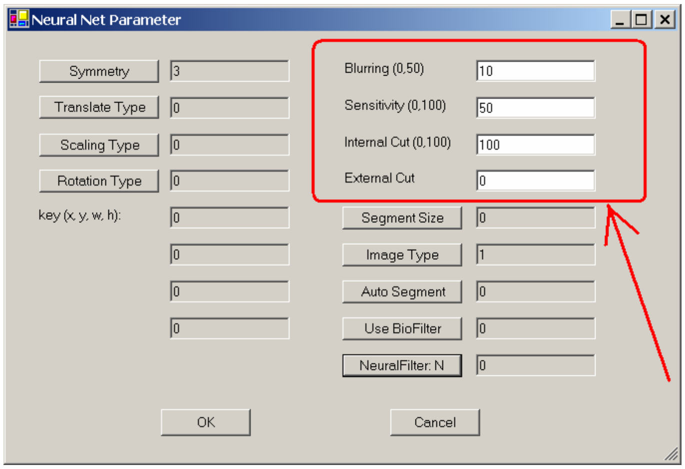
BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 0.
Set ThresholdFilter 5.
Set CleanUpFilter 0.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 14.1 Setting up the Neural Net Parameters.



Symmetry	3	Blurring (0,50)	10
Translate Type	0	Sensitivity (0,100)	50
Scaling Type	0	Internal Cut (0,100)	100
Rotation Type	0	External Cut	0
key (x, y, w, h):	0	Segment Size	0
	0	Image Type	1
	0	Auto Segment	0
	0	Use BioFilter	0
		NeuralFilter: N	0

Figure 14.2 Setting the Neural Net Parameters.

In Figure 14.2:

- The first four parameters are set through buttons: Symmetry, Translation Type, Scaling Type, and Rotation Type.
- The next four parameters, (x, y, w, h), are set in the main form.
- The next four parameters are set via text boxes: Blurring, Sensitivity, Internal Cut (Internal Threshold), and External Cut (Threshold).
- The last five parameters are set through buttons: Segment Size, Image Type, Auto Segment, Use BioFilter, Use Neural Filter.

We will explain these parameters in a later chapter.

14.2 United Way - Rotation Symmetry

There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click “Examples/Neural Net/United Way - R” ;
Click “Batch/Run”.

The **Manual Run** requires a few more clicks:

Input:

Training: .\ex_trademark\image036.jpg
Search: .\ex_trademark\

Parameters

Edge Filter:

None

Threshold Filter:

Light Background 192

NeuralNet Filter:

Symmetry: Rotation Symmetry
Blurring = 25
Sensitivity = 25
Internal Cut = 40
External Cut (Threshold) = 68000

Operation

- Click the “Key” button and select “.\ex_trademark\image036.jpg”;
- Click the “Source” button and select “.\ex_trademark\”;
- Set the Parameters as specified above;
- Click the “NeuralNet/Train” button to train the filter;
- Click the “NeuralNet/Matching/1:N (Key vs Source)” button to make a search.

Results

ID	Name	Path	Score	X	Y	W	H	R
I036_r10	I036_r10.jpg	C:\...\ex_trademark\	105088	36	36	160	124	350
I036_r20	I036_r20.jpg	C:\...\ex_trademark\	84608	36	24	160	124	340
I036_r30	I036_r30.jpg	C:\...\ex_trademark\	113408	24	12	160	124	330
I036_r40	I036_r40.jpg	C:\...\ex_trademark\	76544	24	12	160	124	320
I036_r50	I036_r50.jpg	C:\...\ex_trademark\	69248	36	36	160	124	310
I036_r60	I036_r60.jpg	C:\...\ex_trademark\	96768	24	24	160	124	300
I036_r70	I036_r70.jpg	C:\...\ex_trademark\	98176	48	48	160	124	290
I036_r80	I036_r80.jpg	C:\...\ex_trademark\	107328	36	12	160	124	280
I036_r90	I036_r90.jpg	C:\...\ex_trademark\	118592	24	12	160	124	270
IMAGE036	IMAGE036.JPG	C:\...\ex_trademark\	128000000	30	18	160	124	0

Summary

# Images	= 126
# To be retrieved	= 10
# Retrieved Correctly	= 10
# Missed	= 0
Hit Ratio	**= 100%**

Here, Hit Ratio is the number of correctly retrieved images divided by the number of retrieved images. In this particular case, **Hit Ratio = 100%** = 10/10.

14.3 Tabasco - Rotation Symmetry

There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click the “Examples/Neural Net/Tabasco - R” ;
Click “Batch/Run”.

The **Manual Run** requires a few more clicks:

Input:

Training: .\ex_trademark\image026.jpg
Search: .\ex_trademark\

Parameters

NeuralNet Filter Parameter:

Symmetry = Rotation
Blurring = 25
Sensitivity = 80
Internal Cut = 50
ExternalCut = 60000

Operation

- Click the “Key Segment” button and select “.\ex_trademark\image036.jpg”;
- Click the “Source” button and select “.\ex_trademark\”;
- Set the Parameters as specified above;
- Click the “NeuralNet/Train” button to train the filter;
- Click the “NeuralNet/Matching/1:N (Key vs Source)” button to make a search.

Results

ID	Name	Path	Score	X	Y	W	H	R
I026_r10	I026_r10.jpg	C:\...\ex_trademark\	77632	70	20	225	375	0
I026_r20	I026_r20.jpg	C:\...\ex_trademark\	74496	30	0	225	375	350

I026_r30	I026_r30.jpg	C:\...\ex_trademark\	70592	32	0	246	397	340
I026_r40	I026_r40.jpg	C:\...\ex_trademark\	70400	0	0	225	375	140
I026_r50	I026_r50.jpg	C:\...\ex_trademark\	72896	0	0	230	401	310
I026_r60	I026_r60.jpg	C:\...\ex_trademark\	68288	0	33	225	416	120
I026_r70	I026_r70.jpg	C:\...\ex_trademark\	69824	0	30	225	375	290
I026_r80	I026_r80.jpg	C:\...\ex_trademark\	69760	0	0	225	375	290
I026_r90	I026_r90.jpg	C:\...\ex_trademark\	106432	30	90	225	375	270
IMAGE026	IMAGE026.JPG	C:\...\ex_trademark\	128000000	90	50	225	375	0

Summary

# Images	= 126
# To be retrieved	= 10
# Retrieved correctly	= 10
# Missed	= 0
Hit Ratio	**= 100%**

14.4 Mr. Potato - Scaling Symmetry

There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click “Example/Neural Net/ Mr.Potato -S” ;
Click “Batch/Run”.

The **Manual Run** requires a few more clicks:

Input:

Training: .\ex_trademark\image042.jpg
Search: .\ex_trademark\

Parameters

Edge Filter:
None
Threshold Filter:
Light Background 192
Clean Up Filter:
None
NeuralNet Filter Parameters:
Scaling Symmetry
Blurring = 10
Sensitivity = 20
InternalCut = 50
ExternalCut = 100000

Results

ID	Name	Path	Score	X	Y	W	H	R
i042_s110	i042_s110.jpg	C:\...\ex_trademark\	120128	27	315	27	306	0
i042_s120	i042_s120.jpg	C:\...\ex_trademark\	121600	27	359	27	337	0
i042_s130	i042_s130.jpg	C:\...\ex_trademark\	114496	27	381	27	372	0
i042_s140	i042_s140.jpg	C:\...\ex_trademark\	102848	13	403	13	394	0
I042_S50	I042_S50.JPG	C:\...\ex_trademark\	123712	27	293	27	271	0
I042_S60	I042_S60.JPG	C:\...\ex_trademark\	416000	13	184	13	175	0
I042_S70	I042_S70.JPG	C:\...\ex_trademark\	625000	13	206	13	197	0
I042_S80	I042_S80.JPG	C:\...\ex_trademark\	126848	27	228	27	206	0
I042_S90	I042_S90.JPG	C:\...\ex_trademark\	122176	27	249	27	241	0
IMAGE038	IMAGE038.JPG	C:\...\ex_trademark\	106880	100	321	100	145	0
IMAGE042	IMAGE042.JPG	C:\...\ex_trademark\	128000000	20	421	20	400	0

The segment location is not implemented for Scaling Symmetry.

Summary

# Images	= 126
# To be retrieved	= 10
# Retrieved	= 11
# Retrieved Correctly	= 10
# Missed	= 0
Hit Ratio	= 10/11

14.5 Monopoly - Scaling Symmetry

There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click “Example/Neural Net/Manopoly -S” ;

Click “Batch/Run”.

The **Manual Run** requires a few more clicks:

Input:

Training: .\ex_trademark\image046.jpg
Search: .\ex_trademark\

Parameters

Edge Filter:
None
Threshold Filter:
Default
Clean Up Filter:
None
NeuralNet Filter Parameter:
Scaling Symmetry
Blurring = 3
Sensitivity = 25
Internal Cut = 40
External Cut = 3200
Image Type = 5

Results

ID	Name	Path	Score	X	Y	W	H	R
I46_S105	I46_S105.JPG	C:\...\ex_trademark\	3252	0	0	0	0	0
I46_S110	I46_S110.JPG	C:\...\ex_trademark\	3801	0	0	0	0	0
I46_S115	I46_S115.JPG	C:\...\ex_trademark\	3378	0	0	0	0	0
I46_S120	I46_S120.JPG	C:\...\ex_trademark\	3318	0	0	0	0	0
I46_S80	I46_S80.JPG	C:\...\ex_trademark\	4815	0	0	0	0	0
I46_S85	I46_S85.JPG	C:\...\ex_trademark\	4614	0	0	0	0	0
I46_S90	I46_S90.JPG	C:\...\ex_trademark\	4140	0	0	0	0	0
I46_S95	I46_S95.JPG	C:\...\ex_trademark\	5040	0	0	0	0	0
IMAGE046	IMAGE046.JPG	C:\...\ex_trademark\	2100000000	0	0	0	0	0

Summary

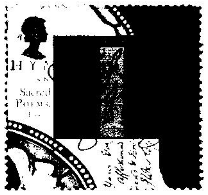
# Images = 126
# To be retrieved = 9
# Retrieved Correctly = 9
# Missed = 0
Hit Ratio = 100%

14.6 Stamp – Translation Symmetry

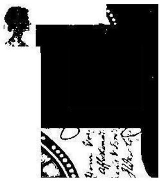
The images used in this section are in the directory ".\ex_stamp\". In this section, we try to identify 2 stamps. Rather than use an existing image to search, we will focus on building a sample image for matching.

14.6.1 Example 1

The first example retrieves images like the following:



We will build a sample image as follows:



There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click "Examples/Neural Net/Stamp 1" ;
Click "Batch/Run".

The **Manual Run** requires a few more clicks:

Input:

Training: .\stamp\class1.jpg
Search: .\stamp\

Parameters

Edge Filter:
None
Threshold Filter:
Default
Clean Up Filter:
None
NeuralNet Filter Parameters:
Translation Symmetry
Blurring = 8
Sensitivity = 45
InternalCut = 40 %

Results

ID	Name	Path	Score	X	Y	W	H
CLASS1	CLASS1.JPG	C:\...\ex_stamp\	128000000	36	24	244	272
CLASS1_1	CLASS1_1.JPG	C:\...\ex_stamp\	39680	64	24	244	272
class1_10	class1_10.jpg	C:\...\ex_stamp\	18112	12	28	244	272
CLASS1_2	CLASS1_2.JPG	C:\...\ex_stamp\	44160	44	20	244	272
CLASS1_3	CLASS1_3.JPG	C:\...\ex_stamp\	19584	4	24	244	272
CLASS1_4	CLASS1_4.JPG	C:\...\ex_stamp\	45120	68	24	244	272
CLASS1_5	CLASS1_5.JPG	C:\...\ex_stamp\	53312	36	24	244	272
CLASS1_6	CLASS1_6.JPG	C:\...\ex_stamp\	43136	68	36	244	272
CLASS1_7	CLASS1_7.JPG	C:\...\ex_stamp\	40960	56	52	244	272
CLASS1_8	CLASS1_8.JPG	C:\...\ex_stamp\	43648	44	44	244	272
CLASS1_9	CLASS1_9.JPG	C:\...\ex_stamp\	28544	88	24	244	272

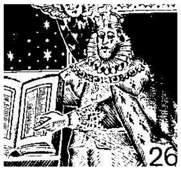
Summary

# Images	= 104
# To be retrieved	= 11
# Retrieved Correctly	= 11
# Missed	= 0
Hit Ratio	**= 100%**

14.6.2 Example 2

The second example retrieves images like the following:

We will build a sample image as follows:



There are two ways to run this example:

- Batch
- Manual

The **Batch Run** takes only two clicks:

Click “Example/Neural Net/Stamp 2” ;
Click “Batch/Run”.

The **Manual Run** requires a few more clicks:

Input:

Training: .\stamp\class7.jpg
Search: .\stamp\

Parameters

Edge Filter:
None
Threshold Filter:
Default
Clean Up Filter:
None
NeuralNet Filter Parameters:
Translation Symmetry
Blurring = 12
Sensitivity = 40
InternalCut = 70

Results

ID	Name	Path	Score	X	Y	W	H
CLASS7	CLASS7.JPG	C:\...\ex_stamp\	128000000	36	24	272	256
CLASS7_1	CLASS7_1.JPG	C:\...\ex_stamp\	61184	36	24	272	256
class7_10	class7_10.jpg	C:\...\ex_stamp\	29504	48	36	272	256
CLASS7_2	CLASS7_2.JPG	C:\...\ex_stamp\	26240	56	28	272	256
CLASS7_3	CLASS7_3.JPG	C:\...\ex_stamp\	22336	40	52	272	256
CLASS7_4	CLASS7_4.JPG	C:\...\ex_stamp\	26880	56	28	272	256
CLASS7_5	CLASS7_5.JPG	C:\...\ex_stamp\	21184	52	32	272	256
CLASS7_6	CLASS7_6.JPG	C:\...\ex_stamp\	21568	56	32	272	256
CLASS7_7	CLASS7_7.JPG	C:\...\ex_stamp\	50688	72	4	272	256
CLASS7_8	CLASS7_8.JPG	C:\...\ex_stamp\	33536	28	0	272	256
CLASS7_9	CLASS7_9.JPG	C:\...\ex_stamp\	44096	48	0	272	256

Summary

# Images = 104

# To be retrieved = 11

# Retrieved Correctly = 11

# Missed = 0

Hit Ratio = 100%

15. Finding Advertisements on TV

Click menu item "Example/Special Example/TV Ads"; then click "Batch/Run", this example is done. Now, we will walk through the Ads Recognition example. This chapter attempts to solve a particular problem: to locate Advertisement Logos on digitized TV images.

15.1 Why Advertisement Matching?

When advertisers display their logo on TV, they want to know the exposure parameters, such as duration of each display, time of display, size, location on the screen, etc. Obviously, the larger an advertisement is, the closer to the center, and the longer the duration is, the better it will be for the advertisers.

15.2 Data

The data is located in the following folder, ".\sp_tv". The example has 200 images. The images are numbered from 800 to 999.

The TV program is digitized to 3 images per second, so 200 images represent 66.7 seconds of TV. There are two groups of ads, which are of interest to this example: 831 to 866 and 875 to 904. Images 831 to 866 represent 36 frames and 12 seconds of ads. Images 874 to 904 represent 29 frames and close to 10 seconds of ads.

These two groups are different in size; we will locate this first group of images.

15.3 Parameters

We will set several parameters for theNeural Net Filter:

Input
Training: .\ex_tv\ V-ITFD04-PART01-832.jpg
- Segment (x, y, w, h) = (45, 232, 410, 30)
- Search Source: .\ex_tv\

Edge Filter:
- None

Threshold Filter:
- Dark Background 128

Clean Up Filter:
- 16. Very Large (11,0)

NeuralNet Filter Parameters:
- Blurring = 2 (See Figure 14.1, 14.2)
- Sensitivity = 27

Internal Cut = 10
External Cut = 63000

15.4 Run

To run this example,

- Click the “Key” button and select “.\ex_trademark\image036.jpg”;
- Click the “Source” button and select “.\ex_trademark\”;
- Set the Parameters as specified above;
- Click the “NeuralNet/Train” button to train the filter;
- Click the “NeuralNet/Matching/1:N (Key vs Source)” button to make a search.

The results are:

ID	Name	Path	Score	X	Y	W	H	R
V-...800	V-...800.jpg	...	96384	60	0	409	24	0
V-...801	V-...801.jpg	...	94656	12	0	409	24	0
V-...802	V-...802.jpg	...	96640	66	0	409	24	0
V-...803	V-...803.jpg	...	95104	78	0	409	24	0
V-...804	V-...804.jpg	...	94976	90	0	409	24	0
V-...810	V-...810.jpg	...	85824	108	360	409	24	0
V-...831	V-...831.jpg	...	72448	48	228	409	24	0
V-...832	V-...832.jpg	...	86336	48	228	409	24	0
V-...833	V-...833.jpg	...	82048	48	228	409	24	0
V-...834	V-...834.jpg	...	75072	48	228	409	24	0
V-...835	V-...835.jpg	...	80512	48	228	409	24	0
V-...836	V-...836.jpg	...	83456	48	228	409	24	0
V-...837	V-...837.jpg	...	82240	48	228	409	24	0
V-...838	V-...838.jpg	...	76928	48	228	409	24	0
V-...839	V-...839.jpg	...	79808	48	228	409	24	0
V-...840	V-...840.jpg	...	86016	48	228	409	24	0
V-...841	V-...841.jpg	...	88192	48	228	409	24	0
V-...842	V-...842.jpg	...	72960	48	228	409	24	0
V-...843	V-...843.jpg	...	69568	48	228	409	24	0
V-...844	V-...844.jpg	...	67840	48	228	409	24	0
V-...845	V-...845.jpg	...	67584	48	228	409	24	0
V-...846	V-...846.jpg	...	63232	48	228	409	24	0
V-...847	V-...847.jpg	...	65536	48	228	409	24	0
V-...848	V-...848.jpg	...	70080	48	228	409	24	0
V-...849	V-...849.jpg	...	76416	48	228	409	24	0
V-...850	V-...850.jpg	...	75776	48	228	409	24	0
V-...851	V-...851.jpg	...	74624	48	228	409	24	0
V-...852	V-...852.jpg	...	69568	48	228	409	24	0
V-...853	V-...853.jpg	...	71296	48	228	409	24	0
V-...854	V-...854.jpg	...	67904	48	228	409	24	0
V-...855	V-...855.jpg	...	72960	48	228	409	24	0
V-...856	V-...856.jpg	...	76160	48	228	409	24	0
V-...857	V-...857.jpg	...	78656	48	228	409	24	0
V-...858	V-...858.jpg	...	76608	48	228	409	24	0
V-...859	V-...859.jpg	...	78656	48	228	409	24	0
V-...860	V-...860.jpg	...	78144	48	228	409	24	0
V-...861	V-...861.jpg	...	74432	48	228	409	24	0
V-...862	V-...862.jpg	...	68480	48	228	409	24	0
V-...863	V-...863.jpg	...	71808	48	228	409	24	0

V-...864	V-...864.jpg	...	74176	48	228	409	24	0
V-...865	V-...865.jpg	...	76096	48	228	409	24	0
V-...866	V-...866.jpg	...	67520	48	228	409	24	0
V-...883	V-...883.jpg	...	64000	72	300	409	24	0
V-...884	V-...884.jpg	...	65152	72	300	409	24	0
V-...896	V-...896.jpg	...	64384	72	300	409	24	0
V-...897	V-...897.jpg	...	64896	72	300	409	24	0
V-...898	V-...898.jpg	...	64704	72	300	409	24	0
V-...901	V-...901.jpg	...	66624	84	300	409	24	0
V-...902	V-...902.jpg	...	66048	72	300	409	24	0
V-...903	V-...903.jpg	...	65664	72	300	409	24	0
V-...904	V-...904.jpg	...	72064	72	300	409	24	0

There are 51 retrieved images. Images 831 to 866 represent 36 frames and 12 seconds of ads. **All images in this group are identified**.

Images 874 to 904 represent 29 frames and close to 10 seconds of ads. The second group is a bit smaller, and needs a separate search. Some of the images in this group are identified. There are 6 errors; this error rate can be solved by customization.

16. Counting and Tracking

‘Counting’ counts the number of objects in an image, assuming there is no overlap between objects. If you need to count objects which are NOT physically separated, then you need a customized version. ‘Tracking’ finds the most obvious object in an image and tracks it from image frame to image frame.

16.1 Data

The data is located in the following folder, “.\input_auto_track”. The example has one basic image in Figure 16.1. This image is shifted, so the ImageFinder can track the largest segment in the images, see Figure 16.2.

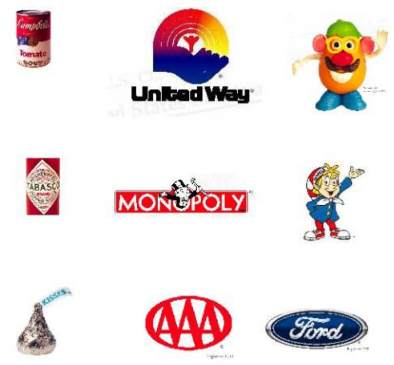


Figure 16.1 Original Images.

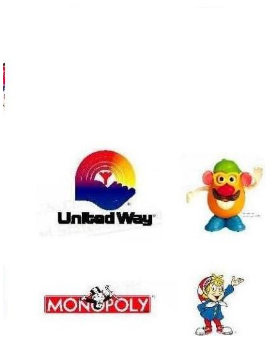
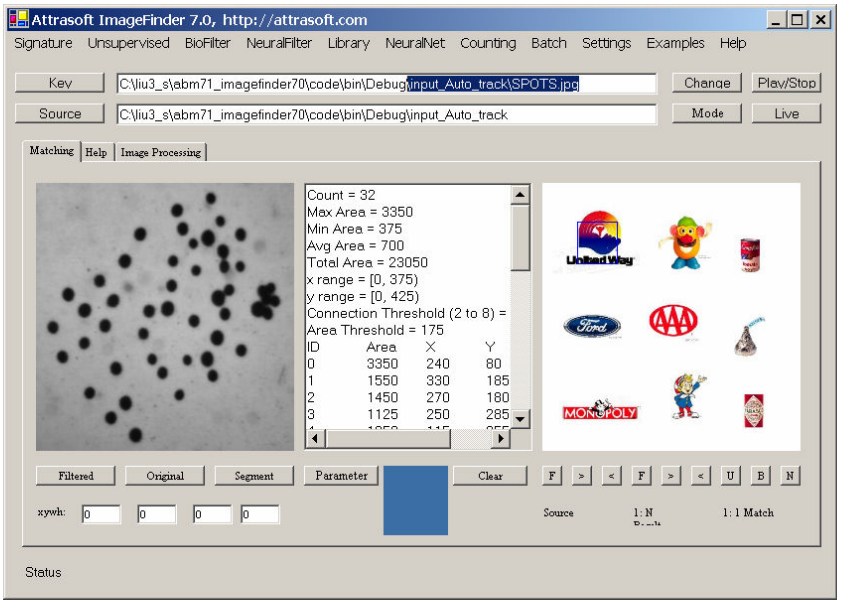


Figure 16.2 Shifted Images.

16.2 Counting the Left Image



Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\SPOTS.jpg

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

xywh: 0 0 0 0

```
Count = 32
Max Area = 3350
Min Area = 375
Avg Area = 700
Total Area = 23050
x range = [0, 375)
y range = [0, 425)
Connection Threshold (2 to 8) =
Area Threshold = 175
ID      Area    X      Y
0       3350    240    80
1       1550    330    185
2       1450    270    180
3       1125    250    285
```

Figure 16.3 Counting the Left Image.

Please restart your ImageFinder so you do not carry over the old setting.

'Counting' will count the number of physically separated objects. To count the number of segments in the key image:

Input:

Key: .\ input_Auto_track\SPOTS.jpg

Parameters

All default values.

Operation

- Click the "Key" button and select ".\input_Auto_track\SPOTS.jpg";
- Click the "Source" button and select ".\input_Auto_track \";
- Set the Parameters as specified above;
- Click the "Counting/Count Left" button to count the number of segments on the left image.

Results

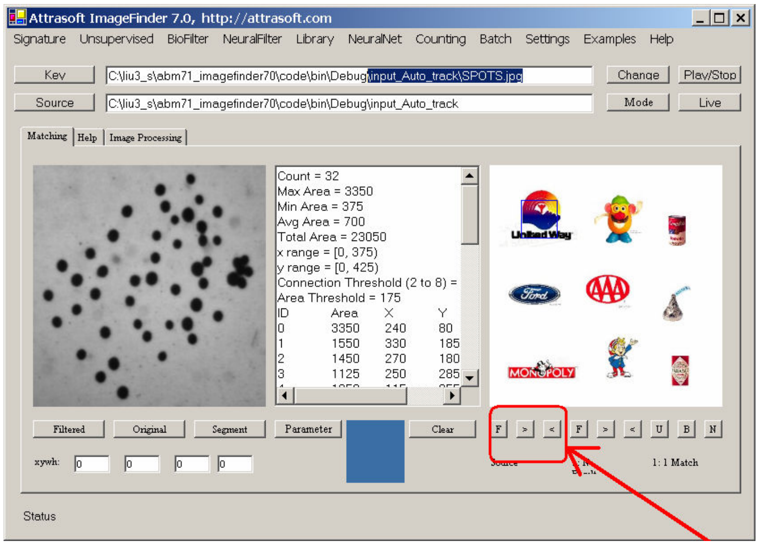
```
Count = 32
Max Area = 3350
Min Area = 375
Avg Area = 700
```

Total Area = 23050
x range = [0, 375)
y range = [0, 425)
Connection Threshold (2 to 8) = 3
Area Threshold = 175

ID	Area	X	Y	Perimeter
0	3350	240	80	610
1	1550	330	185	285
2	1450	270	180	245
3	1125	250	285	200
4	1050	115	355	200
5	1050	175	195	190
6	875	175	285	140
7	650	260	240	120
8	625	140	395	115
9	600	90	150	100
10	600	150	75	100
11	575	115	290	105
12	575	65	195	110
13	550	105	180	110
14	550	125	120	110
15	525	95	220	95
16	525	225	210	95
17	525	45	170	105
18	500	65	250	95
19	500	295	75	95
20	475	75	325	85
21	475	35	270	90
22	475	20	225	90
23	450	295	260	85
24	450	150	235	80
25	450	195	160	90
26	450	195	120	80
27	425	215	275	75
28	425	230	135	75
29	425	295	130	75
30	425	250	20	75
31	375	205	330	75

Here:

(x, y) is the center of the segment;
Area is the area of each segment in pixel-square;
Perimeter is the perimeter of the segment in pixel;
x range = [0, 375) and y range = [0, 425) are the x- and y-dimensions of the image.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Source
Change
Play/Stop
Mode
Live
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F
>
<
F
>
<
U
B
N
xywh:
1: 1 Match
Status

Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track\SPOTS.jpg

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

xywh: 0 0 0 0

```
Count = 32
Max Area = 3350
Min Area = 375
Avg Area = 700
Total Area = 23050
x range = [0, 375)
y range = [0, 425)
Connection Threshold (2 to 8) =
Area Threshold = 175
ID      Area     X       Y
0       3350     240     80
1       1550     330     185
2       1450     270     180
3       1125     250     285
```

Figure 16.4 Counting the Right Image.

16.3 Counting the Right Image

In the last section, we counted the number of physically separated objects in the key image. We can count any image in the search source also. Note: Customization will allow you to count non-physically separated objects.

To count, select an image in a search source, use the F (First), > (Next), and < (Previous) buttons in Figure 16.4:

- Click the “F” button to see the first image in the search directory;
- Click the “>” to see the next image in the search directory;
- Click the “<” button to see the previous image in the search directory.

To count, click the “Counting/Count Right” button to count the number of segments on the right image. For Figure 16.3, the results are:

```
    Count = 9
    Max Area = 3024
Min Area = 1116
    Avg Area = 1920
    Total Area = 17280
    x range = [0, 288)
    y range = [0, 384)
    Connection Threshold (2 to 8) = 3
    Area Threshold = 84

    ID       Area    X       Y       Perimeter
    0        3024    60      84      616
    1        2328    159     80      580
```

2	2256	144	196	452
3	2196	63	324	316
4	2064	54	200	312
5	1812	159	300	288
6	1320	234	320	204
7	1164	228	100	168
8	1116	225	220	168

16.4 Automatic Tracking

‘Tracking’ finds the most obvious object in an image and tracks it from image frame to image frame. To track these images, you have to specify the source and click the “Counting/ Track Largest segment” button.

Input:

Search directory: .\ input_Auto_track\

Parameters

All default values.

Operation

- Click the “Source” button and select “.\input_Auto_track \”;
- Set the Parameters as specified above;
- Click the “Counting/Track Largest segment” button to track.

Results

IMAGE002.JPG	234	66	90	90
IMAGE002a.JPG	264	66	84	84
IMAGE002b.JPG	270	54	90	90
IMAGE002c.JPG	276	90	90	90
IMAGE002d.JPG	282	144	90	90
IMAGE002e.JPG	168	174	90	90
IMAGE002f.JPG	114	312	90	90
IMAGE004.JPG	42	48	90	90
IMAGE006.JPG	402	222	96	96
IMAGE008.JPG	78	84	90	90
SPOTS.jpg	216	55	55	55

To see where the matching segment is, there are three buttons in Figure 13.4:
F (First), > (Next), and < (Previous), that can be used to show where the matched segment is:

- Click the “F” button to see the first matched segment;
- Click the “>” to see the next matched segment;
- Click the “<” button to see the previous matched button.

17. Image Preprocessing

Attrasoft ImageFinder learns an image in a way similar to human eyes:

- Ignore the background;
- Focus on an object in the image.

The image preprocessing in this chapter and the image processing in the next chapter prepare the image for the **ImageFinder**. The image processing process is not unique; there are many options available. Some are better than others.

The principle of choosing the image preprocessing and processing filters is to make the **sample objects stand out, otherwise change the options**.

Image preprocessing has the following functions:

- Cut off the border areas;
- Impose a mask;
- Speed up the computation;
- Skip the empty border areas;

If you do not have a good image preprocessing/processing filter in the off-the-shelf **ImageFinder**, **a customized filter has to be built**.

Do not make too many things stand out, i.e. as long as the area of interest stands out, the rest should show as little as possible.

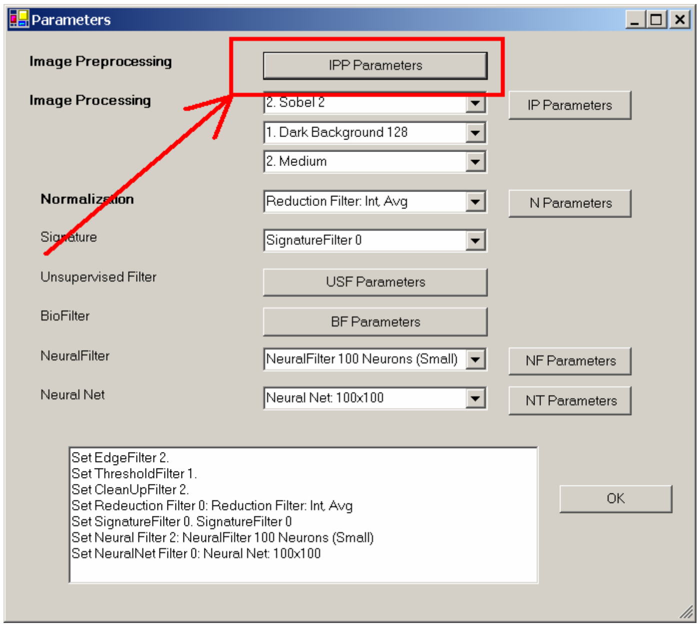
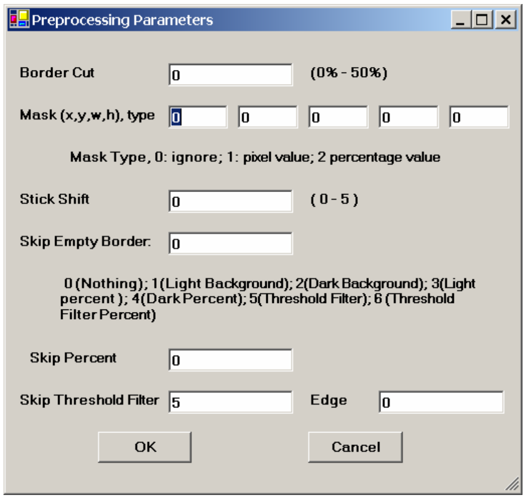


Image Preprocessing
Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium
Normalization: Reduction Filter: Int, Avg
Signature: SignatureFilter 0
Unsupervised Filter
BioFilter
NeuralFilter: NeuralFilter 100 Neurons (Small)
Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 17.1 Parameter Window.



Border Cut 0 (0% - 50%)

Mask (x,y,w,h), type 0 0 0 0 0

Mask Type, 0: ignore; 1: pixel value; 2 percentage value

Stick Shift 0 (0 - 5)

Skip Empty Border: 0

0 (Nothing); 1(Light Background); 2(Dark Background); 3(Light percent); 4(Dark Percent); 5(Threshold Filter); 6 (Threshold Filter Percent)

Skip Percent 0

Skip Threshold Filter 5 Edge 0

Figure 17.2 Image Preprocessing.

17.1 Set Image Preprocessing Filter

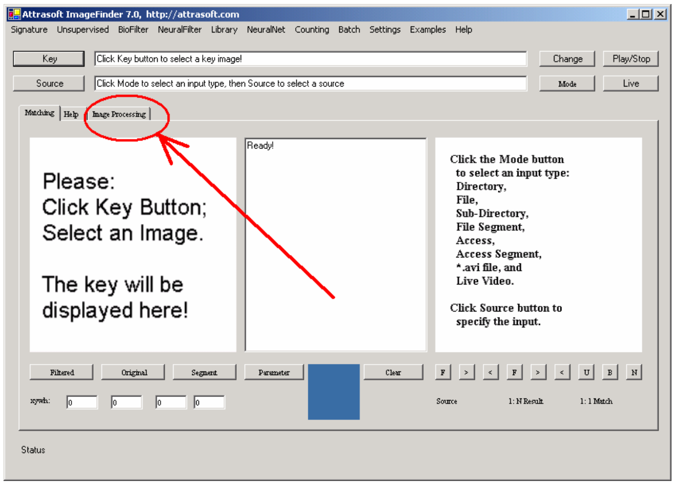
To set the Image-Preprocessing Filter, click the Parameter button to get Figure 17.1. Click the "IPP (Image PreProcessing) Parameters" button in Figure 17.1, you will see Figure 17.2. You will set the Image-Preprocessing Filter on Figure 17.2.

To see the effect of the image preprocessing and image processing filters, you have to go to the Image Processing Tab (See Figure 17.3). You will see Figure 17.4.

In Figure 17.4, there are three buttons:

- Original Image
- Preprocessing
- Processing

After entering a key image by clicking the key button, these three buttons will show you the original image, preprocessed image, and image with both preprocessing and processing.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Change
Play/Stop
Source
Mode
Live
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F
>
<
F
>
<
U
B
N
xywh:
Source
1: N Result
1: 1 Match
Status

Click Key button to select a key image!

Click Mode to select an input type, then Source to select a source

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

Ready!

Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

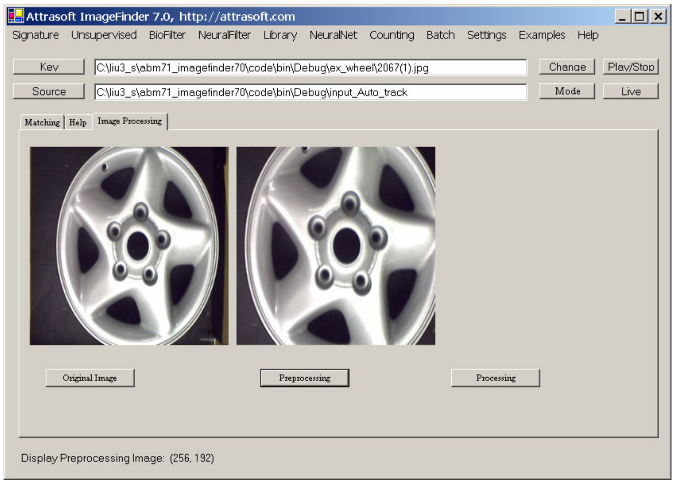
Click Source button to
specify the input.

xywh: 0 0 0 0

Figure 17.3 Go to Image Processing Tab.

17.2 Cut Off the Border Areas

Let us assume we want to cut off 10 % of the border, enter 10 to the first textbox in Figure 17.2 and you will have 17.4. Click the Original Button in Figure 17.4 and the Preprocessing button in Figure 17.4, you will see that the second image is the first image with 10 % of the border cut off.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
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Change
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Mode
Live
Matching
Help
Image Processing
Original Image
Preprocessing
Processing

Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\ex_wheel\2067(1).jpg

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

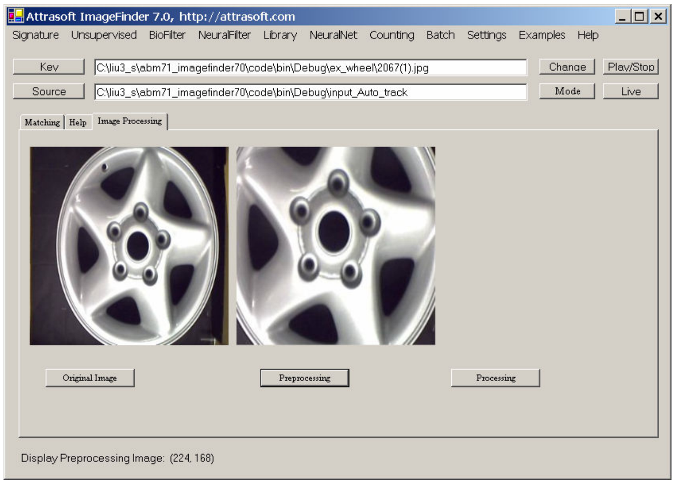
Display Preprocessing Image: (256, 192)

Figure 17.4 Five Percent Border Cut.

17.3 Impose a Mask

Let us assume we want to cut off 20 % of the border on top, 20% on the left, 10% on the right, and 10% on the bottom, then enter (20, 20, 70, 70, 2) to the second row textboxes in Figure 17.2 and we will have 17.5.

Click the Original Button in Figure 17.4 and Preprocessing button in Figure 17.4, you will see the second image is the first image with a mask (20%, 20%, 70%, 70%). Here 2 in (20, 20, 70, 70, 2) means in percentage rather than pixels. You will see that the second image is the first image with the following cut: cut off 20 % of the border on top, 20% on the left, 10% on the right, and 10% on the bottom.



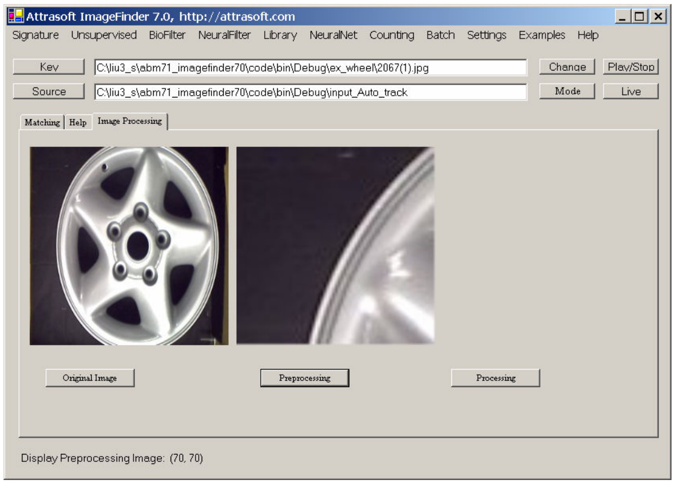
Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\ex_wheel\2067(1).jpg

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

Display Preprocessing Image: (224, 168)

Figure 17.5 Mask (20, 20, 70, 70, 2).

Now, if we use pixels rather than percentage, enter (20, 20, 70, 70, 1) to the second row textboxes in Figure 17.2 and we will have 17.6.



Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\ex_wheel\2067(1).jpg

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_Auto_track

Display Preprocessing Image: (70, 70)

Figure 17.6 Mask (20, 20, 70, 70, 1).

17.4 Speed Up the Computation

To speed up the computation, set the parameter “Stick Shift” in Figure 17.2 between 0 and 5, with 0 being the slowest and 5 being the fastest.

17.5 Skip the Empty Border by Content Percent

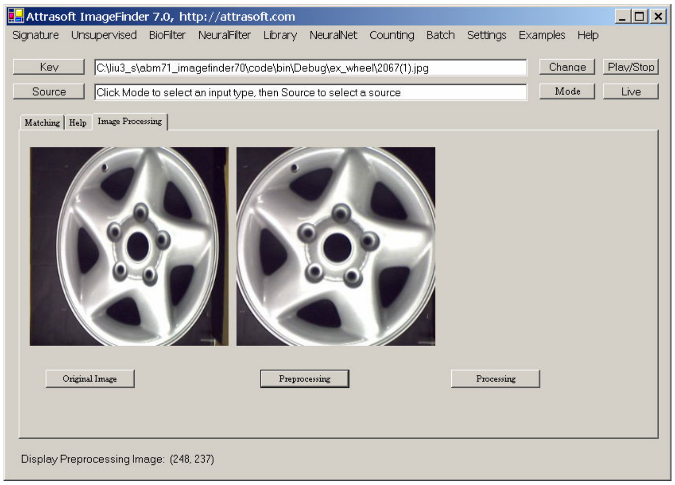
The last function for the Preprocessing filter is to skip border by content percent, not pixel percent.

The "Skip Empty Border" field in Figure 17.2 specifies the type:

0 No skip;
1 Skip the white empty border space;
2 Skip the black empty border space;
3 Skip x percent of the contents on the white background space;
4 Skip x percent of the contents on the black background space;
5 Skip empty border space on the user defined Threshold Filter;
6 Skip x percent of the contents on the user defined Threshold/Edge Filters.

We will discuss Threshold/Edge Filters in the next chapter, Image Processing.

Example 1. Set "Skip Empty Border" = 2, meaning skipping black empty space on the edge. The result is shown in Figure 17.7; you will see that the second image is the first image without a black border.



Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Change
Play/Stop
Source
Mode
Live
Matching
Help
Image Processing
Original Image
Preprocessing
Processing

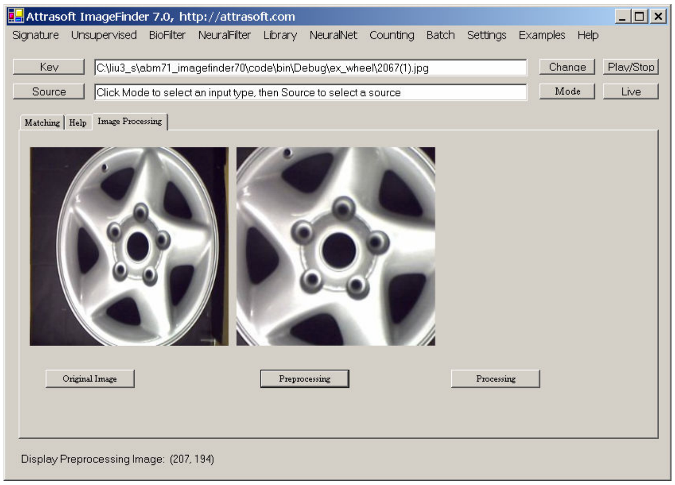
C:\liu3_s\abm71_imagefinder70\code\bin\Debug\ex_wheel\2067(1).jpg

Click Mode to select an input type, then Source to select a source

Display Preprocessing Image: (248, 237)

Figure 17.7 Skipping the black empty space.

Example 2. Set "Skip Empty Border" = 4, meaning skipping black empty space on the edge. Set "Skip percent" = 10. The result is shown in Figure 17.8; you will see that the second image is the first image with 10% of the contents cut on each side.



C:\liu3_s\abm71_imagefinder70\code\bin\Debug\ex_wheel\2067(1).jpg

Click Mode to select an input type, then Source to select a source

Display Preprocessing Image: (207, 194)

Figure 17.8 Skipping 10% of the contents on black background.

18. Image Processing

Attrasoft ImageFinder learns an image in a way similar to human eyes:

- Ignore the background;
- Focus on an object in the image.

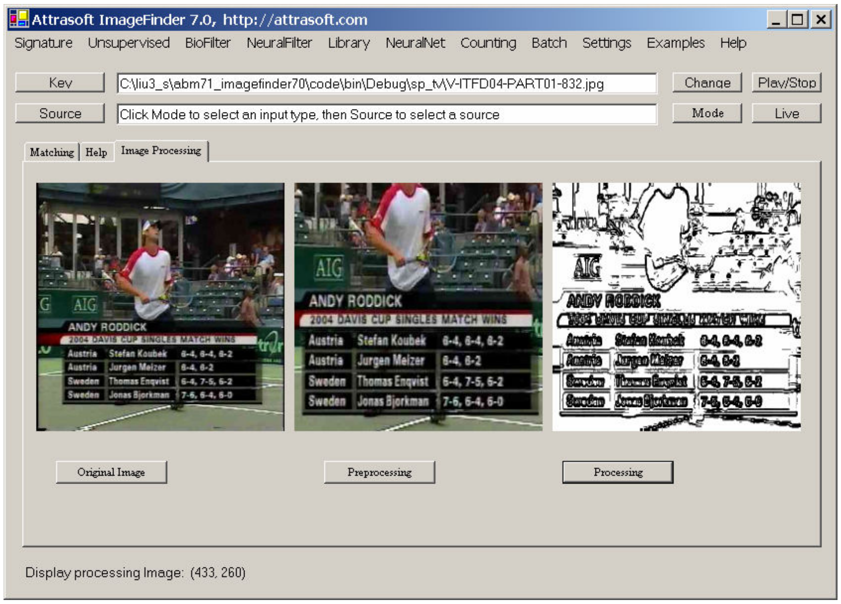
The Image Preprocessing in the last chapter and the Image Processing in this chapter prepare the image for the **ImageFinder**.

The Image Processing process is not unique; there are many options available. Some are better than others. **Image Processing can make it or break it. For many problems like fingerprints, palm prints, …, special image processing filters will be required.**

18.1 Good & Bad

The principle of choosing the image preprocessing and processing filters is to make the **sample objects stand out, otherwise change the options**.

Do not make too many things stand out, i.e. as long as the area of interest stands out, the rest should show as little as possible.

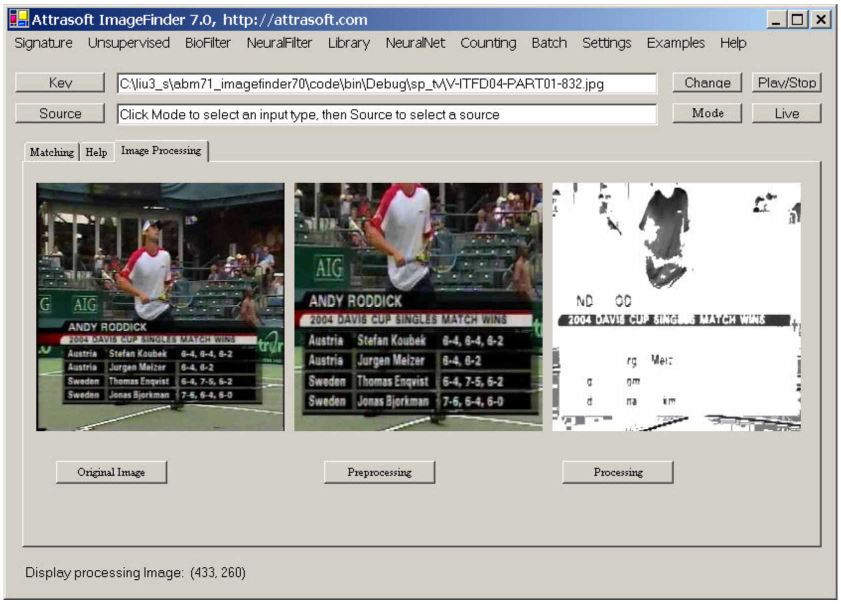

Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Change
Play/Stop
Source
Mode
Live
Matching
Help
Image Processing
AIG
ANDY RODDICK
2004 DAVIS CUP SINGLES MATCH WINS
Austria Stefan Koubek 6-4, 6-4, 6-2
Austria Jurgen Melzer 6-4, 6-2
Sweden Thomas Enqvist 6-4, 7-5, 6-2
Sweden Jonas Bjorkman 7-6, 6-4, 6-0
Original Image
Preprocessing
Processing

C:\liu3_s\abm71_imagefinder70\code\bin\Debug\sp_tv\V-ITFD04-PART01-832.jpg

Click Mode to select an input type, then Source to select a source

Display processing Image: (433, 260)

Figure 18.1 Bad Image Processing Example.



Key: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\sp_tv\V-ITFD04-PART01-832.jpg

Source: Click Mode to select an input type, then Source to select a source

Display processing Image: (433, 260)

Figure 18.2 Good Image Processing Example.

In Figure 18.1, the first image is the selected key image. The objective is to identify the logo, "2004 Davis Cup …".

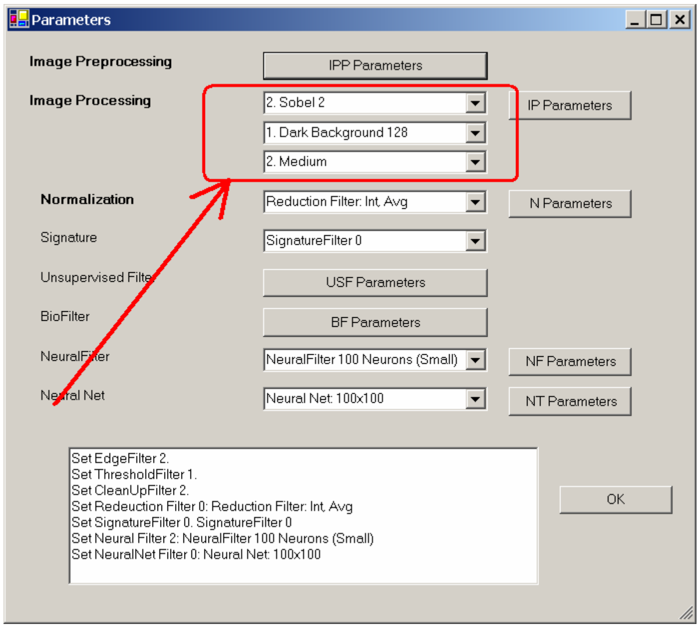


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int. Avg

Signature: SignatureFilter 0

Unsupervised Filter

BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int. Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 18.3 shows the default setting.

First of all, let us use the default setting:

Edge Filter = 2
Threshold Filter = 1
Clean-Up Filter = 2

The second image in Figure 18.1 is a preprocessed image; and the third image is the processed image. This is a bad example of image processing, because the **sample object, "2004 Davis Cup …", does not stand out.**

Now, we will try a different setting:

Edge Filter = 0
Threshold Filter = 1
Clean-Up Filter = 16

The third image in Figure 16.2 is the processed image. This is a good example of image processing, because the **sample object, "2004 Davis Cup …", does stand out.**

18.2 Set Image Processing Filters

The image processing will be applied to all images before recognition. As far as the operation is concerned, this means setting three filters:

Edge Filters;
Threshold Filters; and
Clean-Up Filters.

In Figure 18.3,

- to select an Edge Filter, click the Edge Filter Drop Down List, which is the first List in the red box;
- to select a Threshold Filter, click the Threshold Filter Drop Down List, which is the second List;
- to select a Clean-Up Filter, click the Clean-Up Filter Drop Down List, which is the third List.

The Edge Filters attempt to exaggerate the main features a user is looking for.

The Threshold Filters attempt to suppress the background.

The Clean-Up Filters will smooth the resulting image to reduce recognition error.

The default setting is:

Edge Filter = 2
Threshold Filter = 1
Clean-Up Filter = 2

18.3 First Two Settings

The default setting should be your first choice:

Edge Filter = 2 or “Sobel 2”.
Threshold Filter =1 or “Dark Background 128”.
Clean-Up Filter = 2

Your second choice should be:

Edge Filter = 0
Threshold Filter =5
Clean-Up Filter = 2

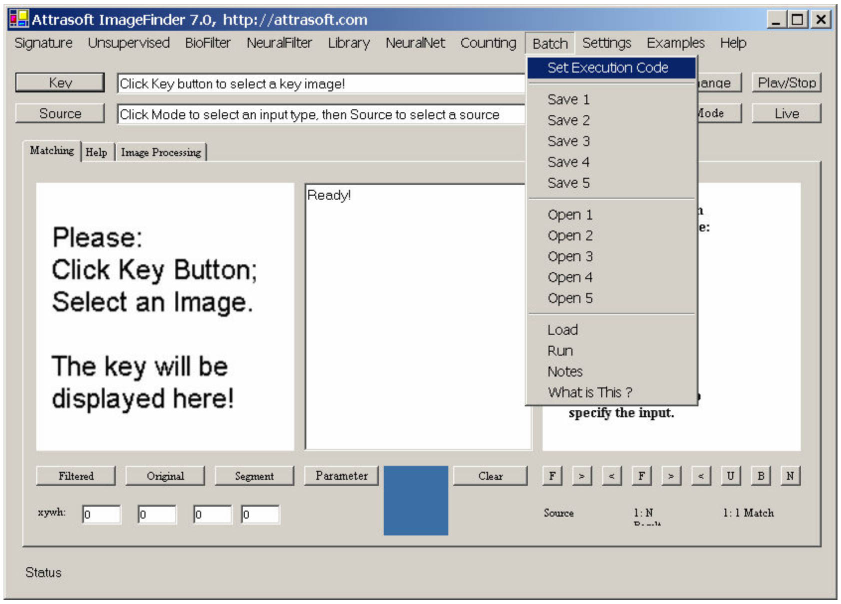
To see how this setting works, select the “Image Processing” tab which will take you to Figure 18.1. There are three buttons:

- Original Image
- Preprocessing
- Processing

After entering a key image by clicking the key button, these three buttons will show you the original image, preprocessed image, and image with both preprocessing & processing, respectively.

19. Batch Job

We have been using the batch commands throughout this guide. Now, we introduce the Batch commands. When matching images, you will need to select many filters. For each selected filter, you will need to select many parameters.



Click Key button to select a key image!

Click Mode to select an input type, then Source to select a source

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

Ready!

specify the input.

Figure 19.1 Batch Menu.

If this is your first matching and you do not like the default values, you will have go through a trial and error process**.**

However, <u>if this is your second matching</u>, you can save everything in the first matching and then use a Batch command. Click the "Batch/Save" menu command; you will get the batch file in the text area.

19.1 Creating Batch Code

The Filter selection and Parameter setting can be saved in one of 5 files by the following commands:

Batch/Save
Batch/Save 2
Batch/Save 3
Batch/Save 4
Batch/Save 5

These 5 commands create the batch codes and save them to 5 different files. The batch codes can also be recalled later by clicking the following commands:

Batch/Open

Batch/Open 2

Batch/Open 3

Batch/Open 4

Batch/Open 5

These 5 commands open existing batch codes.

19.2 Sample Batch

Click "Example/Special Example/Document Duplication"; you will get the following batch code, which is very typical.

```
[ImageFinder 7.0]
        ExecutionCode=3002
[Input]
        keyFileName=Click Key button to select a key image!
        keysegmentX=0
        keysegmentY=0
        keysegmentW=0
        keysegmentH=0
        searchSource=.\Debug\sp_document
        searchSourceType=2
        searchSQLStatement=NA
[ImagePreProcessing]
        BorderCut=0
        MaskX=0
        MaskY=0
        MaskW=0
        MaskH=0
        MaskType=0
        StickShift=0
        SkipEmptyBorder=0
        SkipEmptyBorderPercent=0
        SkipEmptyBorderEdgeFilter=0
        SkipEmptyBorderThresholdFilter=5
        Parameter12=0
        Parameter13=0
        Parameter14=0
        Parameter15=0
[Image Processing Filters]
        EdgeFilter=2
        ThresholdFilter=1
        CleanUpFilter=2
        DoubleProcessing=0
        R1=0
        R2=128
        R3=2
        G1=0
        G2=128
        G3=2
        B1=0
        B2=128
        B3=2
        Parameter14=0
        Parameter15=0
        Parameter16=0
        Parameter17=0
        Parameter18=0
        Parameter19=0
[Reduction Filter]
        ReductionFilter=0
        SegmentCut=0
        SizeCut=0
        BorderCut=0
        lookAtX=0
        lookAtY=0
        lookAtXLength=0
        lookAtYLength=0
[Signature Filter]
        SignatureFilter=9
[Unsupervised Filter]
        UnsupervisedFilter=0
        FaultToleranceScale=20
        Mode=0
        Threshold=0
        OutputFileType=0
        Show File=1
        Blurring=2
        Sensitivity=4
        UseRelativeScore=0
        ShowScore=1
        AutoSegment=0
        Parameter12=0
        Parameter13=0
        Parameter14=0
        Parameter15=0
        Parameter16=0
        Parameter17=0
        Parameter18=0
        Parameter19=0
[BioFilter]
        bioFilter=0
        FaultToleranceScale=20
        Mode=0
        Threshold=0
        OutputType=0
        ShowFile=1
        Blurring=2
        Sensitivity=4
        UseRelativeScore=0
        ShowScore=1
        AutoSegment=0
        Parameter12=0
        Parameter13=0
        Parameter14=0
        Parameter15=0
        Parameter16=0
        Parameter17=0
        Parameter18=0
        Parameter19=0
[NeuralFilter]
        neuralFilter=2
        FaultToleranceScale=20
        Mode=0
        NeuralFilterSize=2
        Threshold=0
        OutputFileType=0
        ShowFile=1
        Blurring=0
        Sensitivity=0
        UseRelativeScore=0
        ShowScore=1
        AutoSegment=0
        Parameter13=0
        Parameter14=0
        Parameter15=0
        Parameter16=0
        Parameter17=0
        Parameter18=0
        Parameter19=0
[Neural Net]
        neuralNetFilter=0
        symmetry=3
        rotationType=0
        translationType=0
        scalingType=0
        sensitivity=50
        blurring=10
        internalWeightCut=100
        Threshold=0
        segmentSize=0
        imageType=1
        OutputFileType=0
        AutoSegment=0
        Mode=0
        Parameter15=0
        Parameter16=0
        Parameter17=0
        Parameter18=0
        Parameter19=0

    End
```

When you create the batch code by command, Batch/Save, you will see the above code in the text area. When you open a batch file by command, Batch/Open, you will see the above code in the text area.

19.3 Batch Operation

This section will explain how the batch code is used.

(1) Create an application using the **ImageFinde**r;
(2) Save the setting to a batch code with the following commands:

    Batch/Save
    Batch/Save 2
    Batch/Save 3
    Batch/Save 4
    Batch/Save 5

    You might find the following online note useful in helping you remember what you saved into these 5 batch files:

        Batch/Notes

(3) Later, you can open the batch file with the following commands:

    Batch/Open

    Batch/Open 2

    Batch/Open 3

    Batch/Open 4

    Batch/Open 5

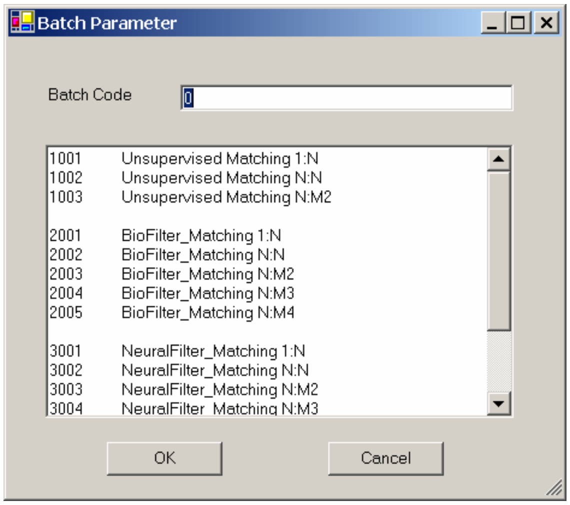
(4) To load the parameter without running, click:
    Batch/Load.

(5) To load the parameter and run, click:
    Batch/Run.

The Batch/Save command saves the following information:

- Filter selection and their Parameter settings;
- The signature file, which contains the signatures from images.

19.4 Batch Execution Code



Batch Code 0

1001	Unsupervised Matching 1:N
1002	Unsupervised Matching N:N
1003	Unsupervised Matching N:M2
2001	BioFilter_Matching 1:N
2002	BioFilter_Matching N:N
2003	BioFilter_Matching N:M2
2004	BioFilter_Matching N:M3
2005	BioFilter_Matching N:M4
3001	NeuralFilter_Matching 1:N
3002	NeuralFilter_Matching N:N
3003	NeuralFilter_Matching N:M2
3004	NeuralFilter_Matching N:M3

Figure 19.2 Execution Code Window.

There are many commands in the **ImageFinder.** Each command has an integer for identification. This integer is called **Batch Execution Code**. The "Batch/Run" command uses this code to run the command specified by the batch file.

To find the batch code for each command, click:

Batch/Set Execution Code

You will see a textbox and the following codes:

1001	Unsupervised Matching 1:N
1002	Unsupervised Matching N:N
1003	Unsupervised Matching N:M2
2001	BioFilter_Matching 1:N
2002	BioFilter_Matching N:N
2003	BioFilter_Matching N:M2
2004	BioFilter_Matching N:M3
2005	BioFilter_Matching N:M4
3001	NeuralFilter_Matching 1:N
3002	NeuralFilter_Matching N:N

3003	NeuralFilter_Matching N:M2
3004	NeuralFilter_Matching N:M3
3005	NeuralFilter_Matching N:M4

4001	NeuralNet_Matching 1:N
4002	NeuralNet_Matching N:N

The current batch code is the code of the last run. When the software started, the current batch code is 1001. To change it:

- Click Batch/Set Execution Code;
- Enter the Batch Execution Code to the text box and click the OK button.

You can also make changes directly in the batch files. The batch files are abm60.txt, abm60_2.txt, abm60_3.txt, abm60_4.txt, abm60_5.txt.

20. Parameters

This chapter will describe the parameters in the **ImageFinder**.

20.1 Overview

Attrasoft ImageFinder can:

- Match whole images;
- Match a portion of an image.

When matching a portion of an image, similar images are defined as images containing the sample segments, or:

- Translated segments;
- Rotated segments;
- Scaled segments;
- Rotated & Scaled segments;
- Brighter or Darker segments.

To match an image, the **ImageFinder** pushes the image through many filters. For example, a set of filters could be:

Preprocessing Filters
Edge Filters
Threshold Filters
Clean-Up Filters
Reduction Filters
Unsupervised Filters
BioFilters
NeuralFilters
NeuralNet Filters

Many parameters and options of the **ImageFinder** are hidden. The users have only limited control of the parameters. Still, the **ImageFinder** has many parameters, which can be adjusted by users.

The **ImageFinder** for Windows has 70 open parameters for the user to adjust for their particular image type. You should get Identification Rates ranging from 60% to 89%; this is because the off-the-shelf **ImageFinder** only has 70 open parameters for users to adjust. The best rate, one of our customers (without any customization) was able to obtain, was an 89% Identification Rate.

However, the **ImageFinder** itself has 3000+ internal parameters, which the users have no access to at all. Fine-tuning these 3000+ internal parameters is called customization, which is Attrasoft's area of expertise. If you need increased accuracy beyond what you are able to achieve when using the **ImageFinder** for Windows, then customization will provide you with ***Your*** desired level of accuracy (ranging from 95% to 99.9%). If you need a customized version of the **ImageFinder**, please contact imagefinder@attrasoft.com .

In a typical search, <u>you will set these parameters and leave the other parameters with default values</u>.

Click the Parameter Button; you will see Figure 20.1, where you can set the parameters.

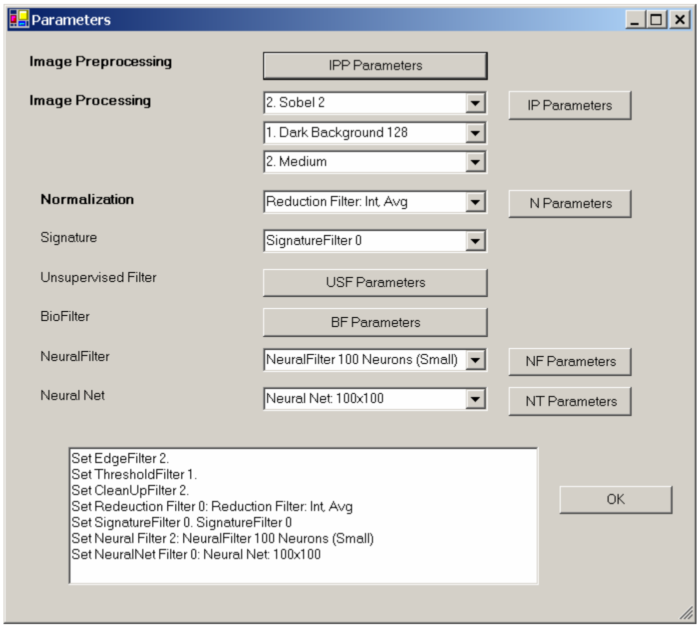


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 0

Unsupervised Filter

BioFilter

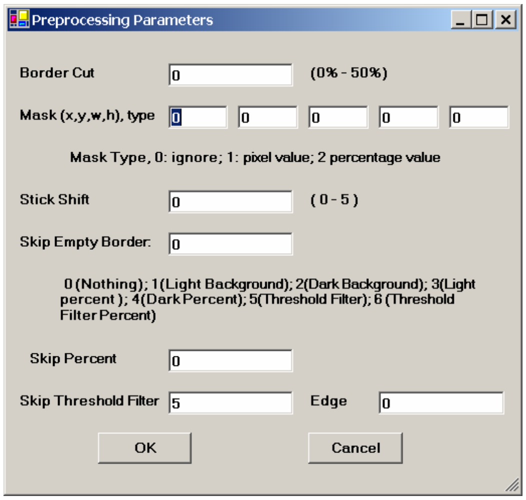
NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 20.1 Parameter Window.

20.2 Image Preprocessing



Border Cut: 0 (0% - 50%)

Mask (x,y,w,h), type: 0 0 0 0 0

Mask Type, 0: ignore; 1: pixel value; 2 percentage value

Stick Shift: 0 (0 - 5)

Skip Empty Border: 0

0 (Nothing); 1(Light Background); 2(Dark Background); 3(Light percent); 4(Dark Percent); 5(Threshold Filter); 6 (Threshold Filter Percent)

Skip Percent: 0

Skip Threshold Filter: 5 Edge: 0

Figure 20.2 Image Preprocessing.

Border Cut

Use the "Border Cut" parameter to cut the border areas. Enter N to the first textbox in Figure 20.2, then N% near the border will be cut off.

Mask

Use the "Mask" parameter to impose a mask on the input images. Enter (x, y, w, h, 2) to the second row in Figure 20.2; then a mask in percent value will be imposed on the input images. Enter (x, y, w, h, 1) to the second row in Figure 20.2; then a mask in pixel value will be imposed on the input images.

Stick Shift

Use the "Stick Shift" parameter to speed up the computation. Set "Stick Shift" in Figure 20.2 between 0 and 5, with 0 being the slowest and 5 being the fastest.

Skip Empty Board
Skip Percent
Skip Threshold Filter
Skip Edge Filter

Use these parameters to skip the border area by cutting off N% percent of the contents. The "Skip Empty Border" parameter in Figure 20.2 specifies the type:

0 No skip;
1 Skip the white empty border space;
2 Skip the black empty border space;
3 Skip x percent of the contents on the white background space;
4 Skip x percent of the contents on the black background space;
5 Skip empty border space on user defined Threshold Filter;
6 Skip x percent of the contents on user defined Threshold/Edge Filters.

Use the "Skip Percent" parameter to specify the percentage of content you want to cut off for Options 3, 4, and 6.

Options 1, 2, and 5 use the default setting, which is 2%. Use the "Skip Threshold Filter" and "Skip Edge Filter" to set the Edge Filter and Threshold Filter, respectively.

20.3 Image Processing

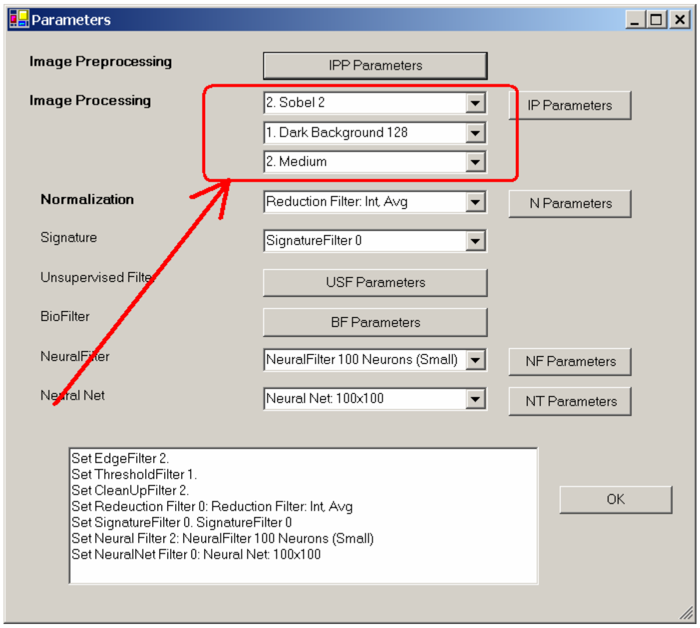


Image Preprocessing

Image Processing: 2. Sobel 2; 1. Dark Background 128; 2. Medium

Normalization: Reduction Filter: Int, Avg

Signature: SignatureFilter 0

Unsupervised Filte

BioFilter

NeuralFilter: NeuralFilter 100 Neurons (Small)

Neural Net: Neural Net: 100x100

```
Set EdgeFilter 2.
Set ThresholdFilter 1.
Set CleanUpFilter 2.
Set Redeuction Filter 0: Reduction Filter: Int, Avg
Set SignatureFilter 0. SignatureFilter 0
Set Neural Filter 2: NeuralFilter 100 Neurons (Small)
Set NeuralNet Filter 0: Neural Net: 100x100
```

Figure 20.3 Image Processing.

20.3.1 Edge Filters

Edge Filters extract and enhance edges & contours in an image by expressing intensity differences (gradients) between neighboring pixels as an intensity value. The basic variables are the differences between the top and bottom rows, the differences between the left and right columns, and the differences between the center point and its neighbors.

Edge Filters have the following selections:

Code	**Meaning**
0	No Edge Filter
1	Sobel 1 (Prewitt)
2	Sobel 2 (Sobel)
3	Sobel 3
4	Sobel 4
5	Gradient
6	Gradient, 45°
7	Sobel 1, 45°
8	Sobel 1, - 45°
9	Laplacian 4
10	CD 11
11	FD 11
12	FD 9

13	FD 7
14	FD 13
15	Laplacian 5
16	Laplacian 8
17	Laplacian 9
18	Laplacian 16
19	Laplacian 17

All other filters have to be ordered in a Customized Version.

These names really do not make any sense to common users; the best way to figure out what these filters are, is to select a training image and try each of the filters. In general, these filters require the "Dark Background 128" Threshold Filter.

If you do not want to know the details, please skip the rest of this section.

The details will be given below so you will know how to order a customized filter:

Sobel 1:

$$\begin{matrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{matrix} \qquad \begin{matrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{matrix}$$

Sobel 2:

$$\begin{matrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{matrix} \qquad \begin{matrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{matrix}$$

Sobel 3:

$$\begin{matrix} -1 & 0 & 1 \\ -3 & 0 & 3 \\ -1 & 0 & 1 \end{matrix} \qquad \begin{matrix} -1 & -3 & -1 \\ 0 & 0 & 0 \\ 1 & 3 & 1 \end{matrix}$$

Sobel 4:

$$\begin{matrix} -1 & 0 & 1 \\ -4 & 0 & 4 \\ -1 & 0 & 1 \end{matrix} \qquad \begin{matrix} -1 & -4 & -1 \\ 0 & 0 & 0 \\ 1 & 4 & 1 \end{matrix}$$

Gradient:

$$\begin{matrix} 0 & 0 & 0 \\ -1 & 0 & 1 \\ 0 & 0 & 0 \end{matrix} \qquad \begin{matrix} 0 & -1 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{matrix}$$

Gradient, 45°

$$\begin{matrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ -1 & 0 & 0 \end{matrix} \qquad \begin{matrix} -1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{matrix}$$

Sobel 1, 45°

$$\begin{matrix} 0 & 1 & 1 \\ -1 & 0 & 1 \\ -1 & -1 & 0 \end{matrix} \qquad \begin{matrix} 1 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & -1 & -1 \end{matrix}$$

Sobel 2, 45°

$$\begin{matrix} 0 & 1 & 2 \\ -1 & 0 & 1 \\ -2 & -1 & 0 \end{matrix} \qquad \begin{matrix} 2 & 1 & 0 \\ 1 & 0 & -1 \\ 0 & -1 & -2 \end{matrix}$$

Laplacian 4

$$\begin{matrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{matrix}$$

Laplacian 5

$$\begin{matrix} 0 & -1 & 0 \\ -1 & 5 & -1 \\ 0 & -1 & 0 \end{matrix}$$

Laplacian 8

$$\begin{matrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{matrix}$$

Laplacian 9

$$\begin{matrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{matrix}$$

Laplacian 16

$$\begin{matrix} 0 & 0 & -1 & 0 & 0 \\ 0 & -1 & -2 & -1 & 0 \\ -1 & -2 & 16 & -2 & -1 \\ 0 & -1 & -2 & -1 & 0 \\ 0 & 0 & -1 & 0 & 0 \end{matrix}$$

Laplacian 17

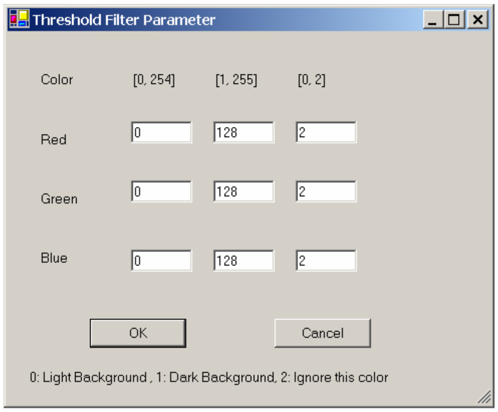
$$\begin{matrix} 0 & 0 & -1 & 0 & 0 \\ 0 & -1 & -2 & -1 & 0 \\ -1 & -2 & 17 & -2 & -1 \\ 0 & -1 & -2 & -1 & 0 \\ 0 & 0 & -1 & 0 & 0 \end{matrix}$$

20.3.2 Threshold Filters

After Edge Filters, the Threshold Filter will be applied to images. **Choose these two filters where the sample objects stand out, otherwise change the filters**.

If no filter in this version fits your problem, **a Customized Filter has to be built**. DO NOT make too many things stand out, i.e. as long as the area of interest stands out, the rest should show as little as possible.

Once you make a selection, the objects in the images are black and the background is white (like a book: white paper, black print). **You should make the black area as small as possible, as long as it covers the key-segment(s). Otherwise, switch to a different background.**



Color	[0, 254]	[1, 255]	[0, 2]
Red	0	128	2
Green	0	128	2
Blue	0	128	2

0: Light Background , 1: Dark Background, 2: Ignore this color

Figure 20.4 Threshold Filter Parameters.

There are 30 Threshold filters in the **ImageFinder**.

A few filters, including the average-filter and the customized-filter, allow you to specify any color range. Color is specified by three separate colors: Color = (red, green, blue). Each of the colors ranges from 0 to 255. (0, 0, 0) is black; (255, 255, 255) is white.

You should choose a filter where the sample object(s) stand out. You may want to know the meaning of the filters; example, "Light Background 128" means:

- "RGB Average in 0 – 127 " ➔ objects; and
- "RGB Average in 128 - 255" ➔ background.

To Summarize:

- **Choose an Edge Filter and a Threshold Filter where the sample object(s) stand out**;
- **Choose an Edge Filter and a Threshold Filter where the black area is as small as possible, as long as it covers the key-segment(s).**

20.3.3 Clean-Up Filters

Clean-Up Filters will clear noise off the image, but it will take more computation time.

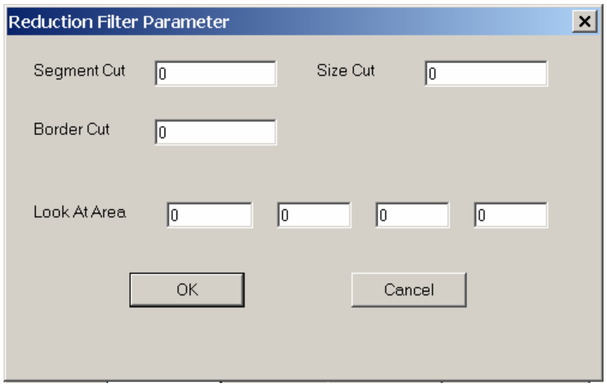
20.4 Normalization Filter

The Normalization Filter connects the image to the underlying neural nets.

Let the underlying neural net be 100x100: if an image is larger than 100x100, say 350x230, then this image will be reduced to 100x100 or smaller.

When reducing images, a scaling factor can be introduced easily. Although scaling symmetry can compensate for this scaling factor, scaling symmetry is computationally expensive.

It is important to know that the Reduction Filter will match the selected underlying neural net, therefore, the behavior of the Reduction Filter not only depends on the selection of this filter itself, but also depends on the NeuralNet Filter chosen.



Reduction Filter Parameter

Segment Cut 0 Size Cut 0

Border Cut 0

Look At Area 0 0 0 0

Figure 20.5 Selecting Reduction Filter.

There are several ways to reduce images:

- Integer,
- Real, or
- All images are reduced by the same amount.

Integer Reduction

Images are reduced by an integer factor to maximally fit 100x100 without distortion. For example, a 350x230 image will be reduced to 87x57.

Real Reduction

Images are reduced by a real number to maximally fit 100x100 without distortion. For example, a 350x230 image will be reduced to 100x65.

Within each type of reduction, there are 3 more settings. Assume a 3x3 pixel array is reduced to 1 pixel,

- Avg: Assign the average of the 3x3 pixel array to the new pixel;
- Max: Assign the maximum of the 3x3 pixel array to the new pixel; or
- Min: Assign the minimum of the 3x3 pixel array to the new pixel.

To select the Reduction Filter, use the fourth drop down list. The Reduction Filter has seven parameters.

Segment Cut

This parameter deals with the edges of the segments in the images. The Segment Cut parameter ranges from 0 to 12. The larger this parameter is, the smaller the segment the **ImageFinder** will use. The possible settings in the user interface are: 0, 1, 2, .., and 12.

Size Cut

In some applications, the users only want to search images of certain dimensions and ignore other images. An example is given below:

In this example, the two stamps belong to two different classes based on the image dimension alone.

The Size Cut parameter ranges from 0 to 9. If the setting is 0, this parameter will be ignored.

- If the parameter is 1, then the longest edge of the image to be considered must be at least 100, but less than 199.
- If the parameter is 2, then the longest edge of the image to be considered must be at least 200, but less than 299; …

Border Cut

The Border Cut parameter ranges from 0 (no cut) to 9 (18% border cut). For some images (see the picture below), you might want to get rid of the sections of images close to the borders. To get rid of the border section, use the Border Cut.

The possible settings in the user interface are: 0, 1, 2, .., and 9.
Assume an image is (0,0; 1,1),

- setting Border Cut to 1 means the **ImageFinder** will look at the section (0.02, 0.02; 0.98, 0.98);
- setting Border Cut to 2 means the **ImageFinder** will look at the section (0.04, 0.04; 0.96, 0.96); … .

Look-At Area

The Look-At Area is the area the **ImageFinder** will use in a matching operation. A 100 x 100 window specifies a whole image. If an integer Reduction Filter is used, the actual area can be less than 100x100.

Four numbers specify the Look-At Area:

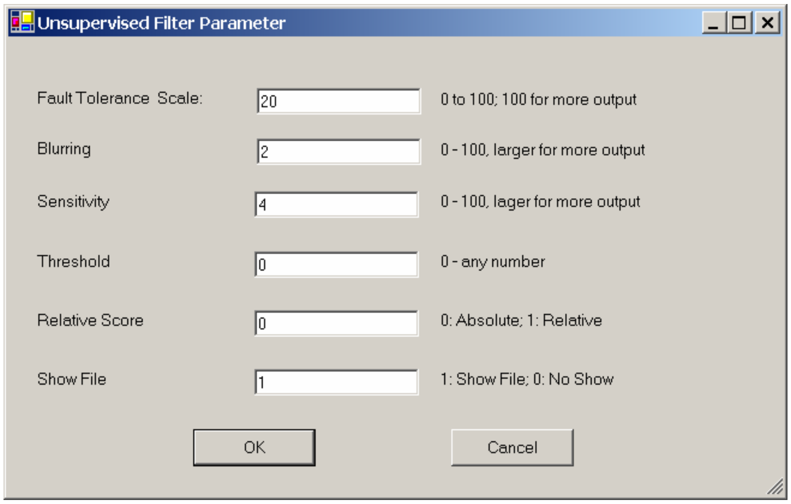
(x, y, w, h)

(x, y) are the coordinates of the upper-left corner and (w, h) are the width and height of the Look-At window.

To use this Look-At window, enter (x, y, w, h) to the 4 text boxes.

20.5 Unsupervised Filter & BioFilter

The Unsupervised Filter and BioFilter have similar parameters; so we have combine these two filters together.



Unsupervised Filter Parameter

Fault Tolerance Scale:	20	0 to 100; 100 for more output
Blurring	2	0 - 100, larger for more output
Sensitivity	4	0 - 100, lager for more output
Threshold	0	0 - any number
Relative Score	0	0: Absolute; 1: Relative
Show File	1	1: Show File; 0: No Show

Figure 20.6 Unsupervised Filter or BioFilter Parameter.

Fault Tolerance Scale

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Blurring

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Sensitivity

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Threshold

The result of image comparison is a "score", indicating the degree to which a match exists. This score is then compared to a pre-set Threshold to determine whether or not to declare a match. This parameter sets the threshold. To decide what threshold to use, you should make a test run first and look at the scores. Matching images have higher scores; unmatched images have lower scores. Select a threshold to separate these two groups. There will be a few images in the middle, representing both groups. Under these circumstances, the threshold selection depends on your application.

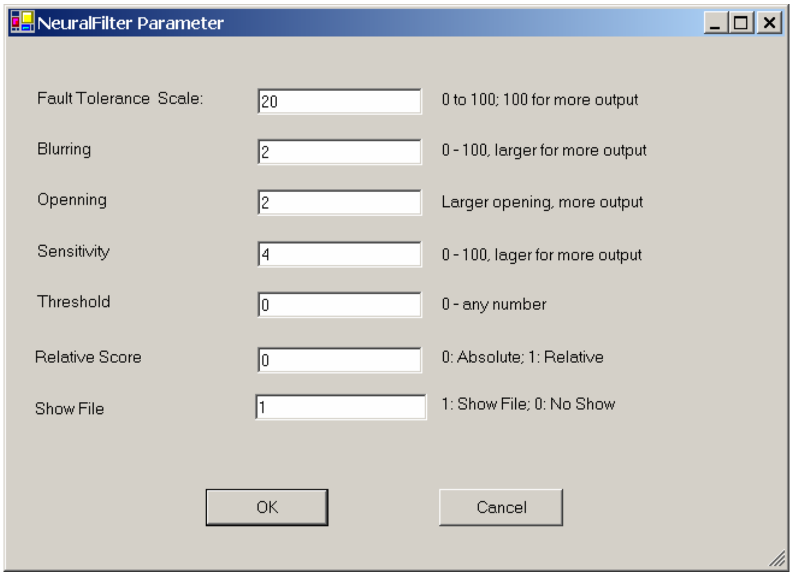
Relative Score

Use the relative score to set the range of matching score between 0 and 100.

Show File

This parameter is set to 1 by default, which will show the output file. If this parameter is set to 0, then output file will not be shown.

20.6 Neural Filters



NeuralFilter Parameter

Fault Tolerance Scale:	20	0 to 100; 100 for more output
Blurring	2	0 - 100, larger for more output
Openning	2	Larger opening, more output
Sensitivity	4	0 - 100, lager for more output
Threshold	0	0 - any number
Relative Score	0	0: Absolute; 1: Relative
Show File	1	1: Show File; 0: No Show

Figure 20.7 NeuralFilter Parameter.

Fault Tolerance Scale

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Blurring

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Sensitivity

Use this parameter to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Threshold

The result of image comparison is a "score", indicating the degree to which a match exists. This score is then compared to a pre-set Threshold to determine whether or not to declare a match. This parameter sets the threshold. To decide what threshold to use, you should make a test run first and look at the scores. Matching images have higher scores; unmatched images have lower scores. Select a threshold to separate these two groups. There will be a few images in the middle, representing both groups. Under these circumstances, the threshold selection depends on your application.

Relative Score

Use the relative score to set the range of matching scores between 0 and 100.

Neural Filter Opening

This parameter controls the amount of output. This parameter has 5 settings:

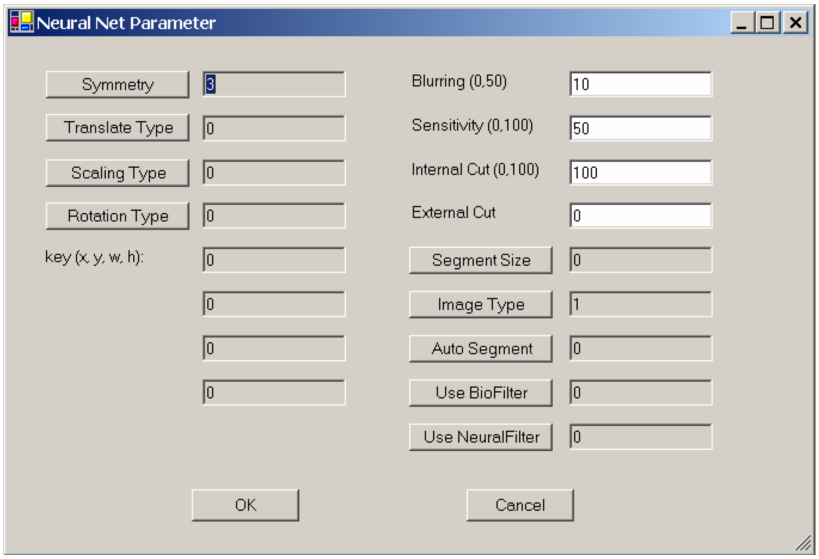
Very Large
Large
Normal
Small
Very Small

Large openings will allow more output than small openings. To set the parameter, keep clicking the button; the setting will switch from one to the next each time you click the Blurring button.

Show File

This parameter is set to 1 by default, which will show the output file. If this parameter is set to 0, then output file will not be shown.

20.7 NeuralNet Filter



Neural Net Parameter

Symmetry: 3
Translate Type: 0
Scaling Type: 0
Rotation Type: 0
key (x, y, w, h): 0 0 0 0

Blurring (0,50): 10
Sensitivity (0,100): 50
Internal Cut (0,100): 100
External Cut: 0
Segment Size: 0
Image Type: 1
Auto Segment: 0
Use BioFilter: 0
Use NeuralFilter: 0

Figure 20.8 Neural Net Parameter.

The available NeuralNet filters are:

- 100x100 (Most Accurate)
- 90x90
- 80x80
- 70x70
- 60x60

- 50x50 (Least Accurate)

Let the speed of 100x100 filter be a base, then the overall speed for:

- 90x90 filter is 1 times faster;
- 80x80 filter is 1.6 times faster;
- 70x70 filter is 2.7 times faster;
- 60x60 filter is 5 times faster; and
- 50x50 filter is 10 times faster.

The NeuralNet Filter has many parameters. The following sections will explain these parameters.

20.7.1 Symmetry

Symmetry or Invariance means similarity under certain types of changes. For example, considering two images, one with a face in the middle and the other with the face moved to the edge; we say these two images are similar because of the face.

The symmetry defines "similar images". The **Attrasoft ImageFinder** supports five symmetry settings:

- No symmetry (0);
- Translation symmetry (3);
- Scaling symmetry (4);
- Rotation symmetry (5); and
- Rotation & Scaling symmetries (6).

The numbers are the codes in the batch file. Currently, Scaling symmetry and Oblique symmetry are the same.

Other symmetries, or combination of symmetries, can be built for Customized Orders.

A customized Attrasoft ImageFinder can implement any symmetry (or combination of symmetries), which can be described by mathematics.

However, symmetries are computationally expensive.

Every symmetry setting has the Translation symmetry, except "No Symmetry". In addition, each of the above settings support:

- Intensity symmetry.

Symmetries are computationally expensive, meaning it will take a longer time to do the job. You should use them only when they are required.

To set the Symmetry, keep clicking the Symmetry button; the setting will switch from one to the next each time you click the button. The default setting in this version is Translation Symmetry.

For example, it seems that Stamp Recognition requires Translation and Rotation symmetries. But because the edges of a stamp can be detected easily, the stamp can be rotated and shifted to a fixed position where the horizontal side is longer than the vertical side. All you need to do is recognize a stamp or an upside-down stamp. Therefore, Stamp Recognition does not really require Translation and Rotation symmetries.

20.7.2 Translation Type

The Translation Type defines the accuracy of the Translation symmetry.

The Translation Type settings (and their codes) are:

- Most Accurate (0);
- Accurate (1); and
- Least Accurate (2).

To set the Translation Type, keep clicking the "T Type" button; the setting will switch from one to the next each time you click the button. The default setting is 0, the most accurate setting.

20.7.3 Scaling Type

The Scaling Type defines the accuracy of the Scaling symmetry.

The Scaling Type settings (and their codes) are:

- Least Accurate (0);
- Accurate (1);
- Accurate (2); and
- Most Accurate (3).

To set the Scaling Type, keep clicking the "T Type" button; the setting will switch from one to the next each time you click the button. The default setting is 0, the least accurate setting.

20.7.4 Rotation Type

The Rotation Type defines the accuracy of the Rotation symmetry.

The Rotation Type settings (and their codes) are:

- 360° rotation, least accurate (0);
- -5° to 5° rotation (1);
- -10° to 10° rotation (2);
- 360° rotation, accurate (3);

- 360° rotation, more accurate (4);
- 360° rotation, most accurate (5).

To set the Rotation Type, keep clicking the "Rotation Type" button; the setting will switch from one to the next each time you click the button. The default setting is 360° rotation, the least accurate setting (0).

20.7.5 Area of Interest (AOI)

Selecting an image segment is very important for training.

- Use image segments for searching **similar images**.
- Only use the whole image for **exact matches**.

Training requires an "Area of Interest" (AOI) or "Set Focus", which selects a key-segment. If an AOI is not chosen, the whole image is the AOI. Four numbers specify AOI: the upper-left corner coordinates, and the length & width. Once the segment specification is successful, a box will cover the selected area. When you look at the training image, if the selected area is not what you want, just re-select the area again and click the Segment button.

The default setting is the whole image; the code is (x y w h) = (0 0 0 0). (0000) means ignore the segment. The units are pixels.

There are two situations where you should create a new sample image out of a sample segment:

- You repeatedly use an image segment;
- The image segment is not a rectangle; say a polygon.

The Windows Paint program will help you to create an image from a segment. When you create an image segment, please do not change the original image size. For example, if your image is 512x512 and you want create a segment of 400x200, please paste the 400x200 segment into a 512x512 empty image.

20.7.6 Blurring

This is one of the most important search parameters and the first parameter you should adjust.

Blurring compensates for minor image changes, which are not visible to human eyes. For example, if you use software to compress an image, to change the intensity of an image, or to translate, scale, or rotate an image, the image will be distorted a bit at the pixel level. You have to set "Blurring" to compensate for this.

The Blurring setting ranges from 0 to 50. The default setting is 10. You should set the parameters in the following order:

Blurring, Internal Weight Cut, Sensitivity, External Weight Cut.

To Summarize:

- **When a search yields no results, increase Blurring;**
- **When a search yields too many results, decrease Blurring.**

20.7.7 Sensitivity

The Sensitivity parameter ranges from 0 (least sensitive) to 100 (most sensitive).

- To search small segment(s), use high sensitivity search.
- To search large segment(s), use low sensitivity search.
- **The higher this parameter is, the more results you will get.**

The Sensitivity parameter ranges from 0 to 100. The default is 50. **To Summarize:**

- **When a search yields no results, increase sensitivity;**
- **When a search yields too much result, decrease sensitivity.**

20.7.8 Internal/External Weight Cut

You can set the "**Internal Weight Cut**" (Internal Cut) or "**External Weight Cut**" (External Cut) to list only those retrieved images with scores or weights greater than a certain value (called Threshold).

It is better to give no answer than a wrong answer.

Assume you are searching images and all similar images have weights ranging from 1,000 to 10,000. It is possible that some other images pop up with weights ranging from 10 to 100. To eliminate these images, you can set the “External Weight Cut” to 1,000.

The Internal Cut plays a similar role as the External Cut. There are two differences between these two cuts:

- The Internal Cut ranges from 0 to 99; the External Cut can be any number;
- The Internal Cut stops the images from coming out, whereas the External Cut can bring the eliminated images back if you set the External Cut to 0. You might need to see the eliminated images sometimes for the purpose of adjusting the parameters.

To Summarize:

- **Set the “Internal Cut” or “External Cut” to eliminate errors.**

20.7.9 Segment Size

The **ImageFinder** is currently tuned to search for large image segments (size of the whole image). It can look for small segments via the "Small Segment" setting; however, only Translation symmetry is supported for small segments.

A Customized Version can be ordered for other symmetries.

To search large segments, use setting 0.
To search small segments, use setting 1.

For example:

- If a sample segment is one quarter of the sample image, it is a large segment.
- If the segment is 1/20 of the sample image, it is a small segment.

Currently, "S Segment" only supports Translation symmetry. If you need Rotation or/and Scaling symmetry, please use "L Segment".

Other symmetries can be added in a Customized Version.

20.7.10 Image Type

There are BW and Color images. For each of them, there are “sum-search”, “maximum-search”, and “average-search”. This generates 6 image types:

- BW Sum
- BW Max
- BW Avg
- Color Sum
- Color Max
- Color Avg

"BW Sum” is like an integration of function f (x).
"BW Max” is like a maximum value of f (x); and
"BW Avg” is the average of the above two.

"Color Sum” is like an integration of function f (x).
"Color Max” is like a maximum value of f (x); and
"Color Avg” is the average of the above two.

To set the image type, keep clicking the Image Type button; the setting will switch from one to the next each time you click the Image Type button.

20.7.11 Use BioFilter & Use Neural Filter

These two parameters, “Use BioFilter” and “Use NeuralFilter” will decide whether the BioFilter and NeuralFilter will be used before the NeuralNet Filter is used to eliminate some images.

20.7.12 Auto Segment

The training segment can be specified in two ways:

Manual Specification
Automatic Specification

The default is Manual Specification. In this setting the segment will be specified by the four text boxes (x, y, w, h), as we discussed earlier.

If you do not want to pick up a training segment, then let the **ImageFinder** pick up the segment for you by using the Automatic Specification. This parameter has several settings:

NO Auto Segment
Very Large Segment
Very Large Segment
Large Segment
Large Segment
Medium Segment
Medium Segment

20.7.13 Summary

The NeuralNet filter is hard to use because it has so many parameters. Not all parameters are equal. We divide the parameters into two groups. The beginners should use only parameters in the first group. Note that:

- **The most important parameters for Training are Image Processing, AOI, Symmetry, and Segment Cut (in the Reduction Filter).**
- **The most important parameters for Matching are Blurring, and Sensitivity.**

In a typical search, you will set these parameters and leave other parameters with default values. These are the 7 parameters you should focus on first**:**

Training (3 parameters):

- Segment: selecting "Large AutoSeg 3" so the **ImageFinder** will select a training segment for you at the beginning.
- Symmetries
- Segment Cut (in the Reduction Filter)

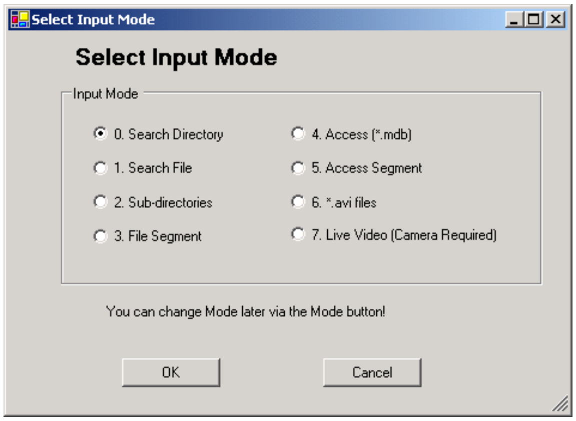
Matching (4 parameters):

- Sensitivity
- Blurring
- External Weight Cut
- Internal Weight Cut

Ignore the rest of the parameters at the beginning.

21. Input Option

When you start the software, the first thing you will see is Figure 21.1. **ImageFinder** requires a key image and a search source. Up to this point, we have been using directory input for the search source. In this chapter, we will introduce a few more options.



Select Input Mode

Select Input Mode

Input Mode

● 0. Search Directory

○ 1. Search File

○ 2. Sub-directories

○ 3. File Segment

○ 4. Access (*.mdb)

○ 5. Access Segment

○ 6. *.avi files

○ 7. Live Video (Camera Required)

You can change Mode later via the Mode button!

Figure 21.1 Input options.

The default search source is directory input, i.e. the **ImageFinder** will search through the images in a directory. The **ImageFinder** also will support a number of other options. See Figure 21.1.

21.1 File Input

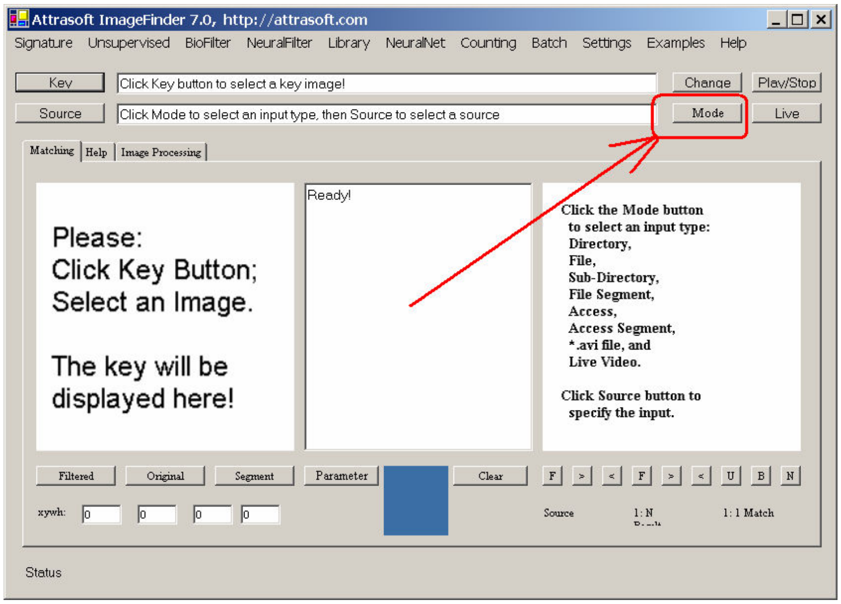
You can specify the search source with a file. The Input Files must list one image per line. Each line specifies an absolute path. For example,

C:\xyz1\0001.jpg
C:\xyz1\0002.jpg
C:\xyz2\0003.jpg
C:\xyz2\0004.jpg
…

<u>The only difference between the Directory Input and the File Input is how images are entered into the **ImageFinder**</u>; after that, all other steps are the same.

You can specify File Input either in Figure 21.1, or in Figure 21.2.

- In Figure 21.1, select the second option for File Input.
- In Figure 21.2, keep clicking the Mode button and the setting will switch from one to the next.



Click Key button to select a key image!

Click Mode to select an input type, then Source to select a source

Please:
Click Key Button;
Select an Image.

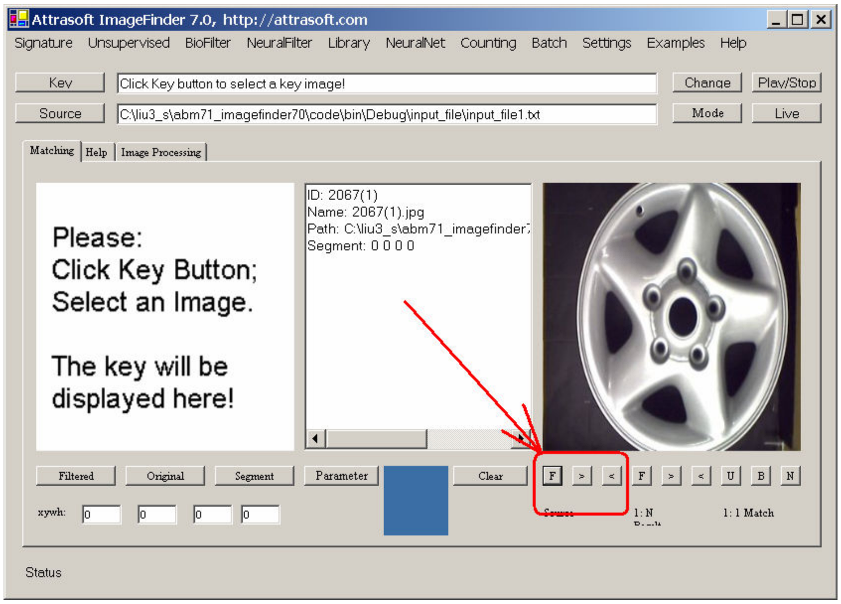
The key will be
displayed here!

Ready!

Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

Click Source button to
specify the input.

Figure 21.2 Input Mode Button.



Click Key button to select a key image!

C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_file\input_file1.txt

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

ID: 2067(1)
Name: 2067(1).jpg
Path: C:\liu3_s\abm71_imagefinder7
Segment: 0 0 0 0

Figure 21.3 File Input example.

Example. File Input

- Start the software;
- Select option, “Search File”;
- Click the Source Button, and select file, “.\input_file\input_file1.txt”;

- Click the “F” button in Figure 21.3 to see the first image, and click the “>” button to see the next image.

21.2 Sub-Directory Input

The default search source is Directory Input only. If the directory has sub-directories, the **ImageFinder** will not search through the sub-directories. To search through the sub-directories, use the Sub-directory Input option.

You can specify sub-directory source either in Figure 21.1, or in Figure 21.2.

- In Figure 21.1, select the third option for file input.
- In Figure 21.2, keep clicking the Mode button and the setting will switch from one to the next.

Example. Sub-Directory Input:

- Start the software;
- Select option, “Sub-directory”;
- Click the Source Button, and select file, “.\input_subdir\1001A.jpg”;
- Click the “F” button in Figure 21.3 to see the first image, and click the “>” button to see the next image.

21.3 File Segment Input

The first three options are for whole images.

If you want compute the signature for a segment of an image, you have to select File Segment Input.

The Input Files must list one image per line. Each line specifies an absolute path, Image_ID, x, y, w, and h. A sample segment file looks like this:

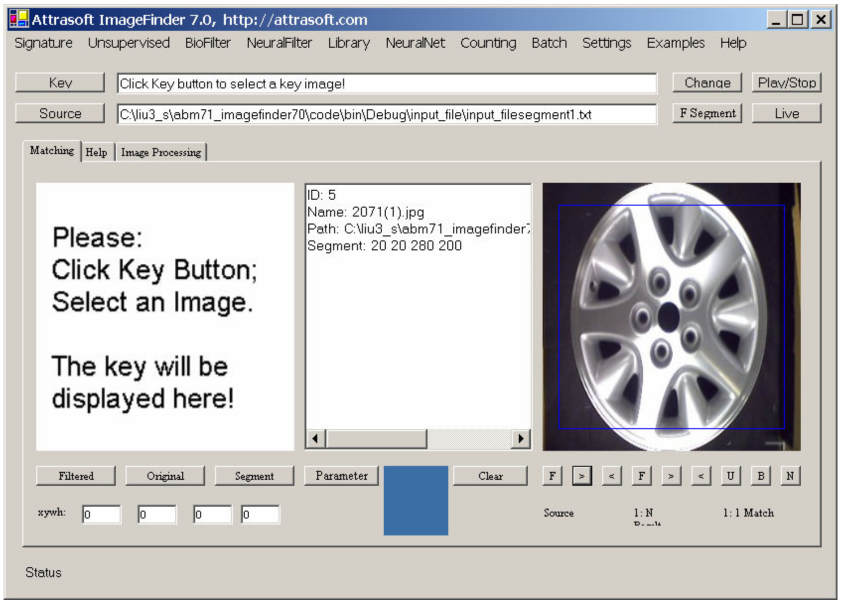
```
.\2067(1).jpg   1     20     20     280    200
.\2067(2).jpg   2     20     20     280    200
.\2067(3).jpg   3     20     20     280    200
.\2067(4).jpg   4     20     20     280    200
.\2071(1).jpg   5     20     20     280    200
.\2071(2).jpg   6     20     20     280    200
.\2071(3).jpg   7     20     20     280    200
```

Here (x, y, w, h) are in the unit of pixels. You can specify File Segment source either in Figure 21.1, or in Figure 21.2:

- In Figure 21.1, select the “File Segment”.
- In Figure 21.2, keep clicking the Mode button and the setting will switch from one to the next.

Example. File Segment Input:

- Start the software;
- Select Option, “File Segment”;
- Click the Source Button, and select file, “.\input_file\input_filesegment1.txt”;
- Click the “F” button in Figure 21.3 to see the first image, and click the “>” button to see the next image.
- The segment is marked by a box in Figure 21.4.



Attrasoft ImageFinder 7.0, http://attrasoft.com

Key: Click Key button to select a key image!

Source: C:\liu3_s\abm71_imagefinder70\code\bin\Debug\input_file\input_filesegment1.txt

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

ID: 5
Name: 2071(1).jpg
Path: C:\liu3_s\abm71_imagefinder7
Segment: 20 20 280 200

xywh: 0 0 0 0

Status

Figure 21.4 File Segment.

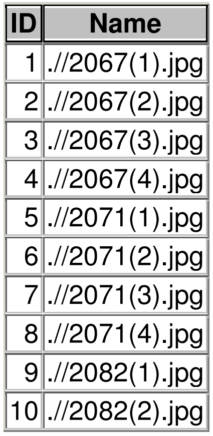
21.4 Database Input, Whole Image

The only database supported in this version is Microsoft Access. If you need a different Database supported, customization will solve this problem.

The Database consists of a set of tables. The table contains the locations of the images.

The data in a table is obtained by a SQL statement; therefore, to use this option, you must be able to write a SQL statement. The SQL output must list one image per row. When all fields in each row are combined, it must specify an absolute path.

A sample access table is:



ID	Name
1	.//2067(1).jpg
2	.//2067(2).jpg
3	.//2067(3).jpg
4	.//2067(4).jpg
5	.//2071(1).jpg
6	.//2071(2).jpg
7	.//2071(3).jpg
8	.//2071(4).jpg
9	.//2082(1).jpg
10	.//2082(2).jpg

Some sample SQL statements are:

```
select Path, Name from List1
select Name from List2
```

Do not add the semicolon, ";" at the end of the SQL statement!

The result of a query must produce a list of paths for images. The result is either a single column or two columns, like path and name, which forms an absolute path when combined together.

Example. Database Input:

- Start the software;
- Select the option, "Access";
- Click the Source Button, and select file, ".\input_access\db1.mdb";
- Enter the SQL statement, "Select Name from List2";
- Click the "F" button in Figure 21.3 to see the first image, and click the ">" button to see the next image.

21.5 Database Input, Image Segment

The only database supported in this version is Microsoft Access. If you need a different Database supported, customization will solve this problem.

The Database consists of a set of tables. The table contains the locations of the images segments. Six fields specify the image segments: path, ID, x, y, w, and h. Database retrieval is specified by a query. For example, "Select Path, ID, x, y, w, h from List3". **Do not add ";" at the end of the SQL statement!**

The result of a query must produce a list of (Path, ID, x, y, w, h). No other formats are accepted!

Example. Database Segment Input:

- Start the software;
- Select the Option, “Access Segment”;
- Click the Source Button, and select file, “.\input_access\db1.mdb”;
- Enter the SQL statement, “Select Path, ID, x, y, w, h from List3”;
- Click the “F” button in Figure 21.3 to see the first image, and click the “>” button to see the next image.

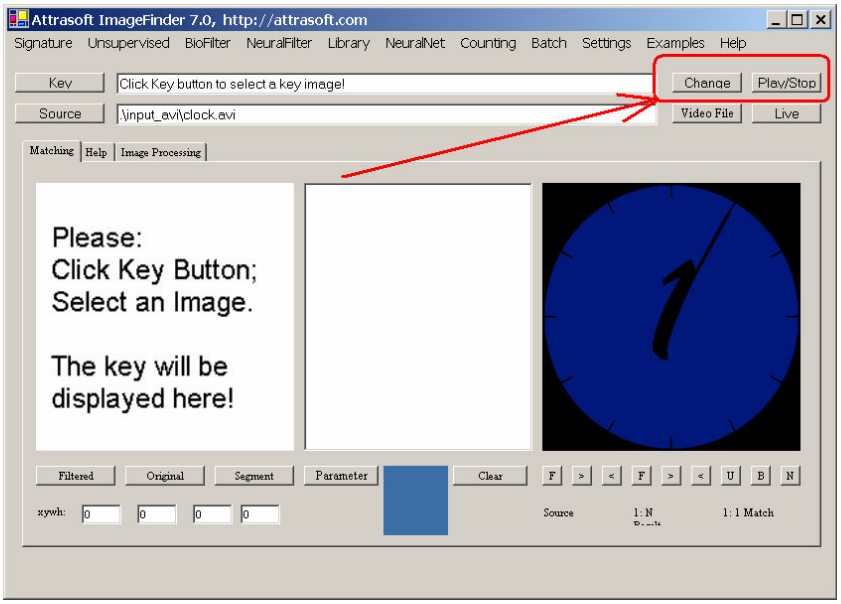
21.6 Converting AVI Video to Images

The only video format supported in this version is *.avi. If you need a different video format supported, customization will solve this problem.

After selecting an *.avi file, the **ImageFinder** will convert the avi video file to a set of images. After that, they are the same as the rest of the images.

Example. Converting AVI Video:

- Start the software;
- Select the option, “*.avi File”;
- Click the Source Button, and select file, “.\input_avi\clock.avi”;
- Click the “Play/Stop” button in Figure 21.5 to convert the button to a “Play” button;
- Click the “Play” button to Play, which also converts the button to a “Stop” button;
- Click the “Stop” to stop the video;
- Click the “Change” button in Figure 21.5 to get Figure 21.6;
- Click “*.avi to Images” button to convert the avi file to images.



Attrasoft ImageFinder 7.0, http://attrasoft.com

Key: Click Key button to select a key image!

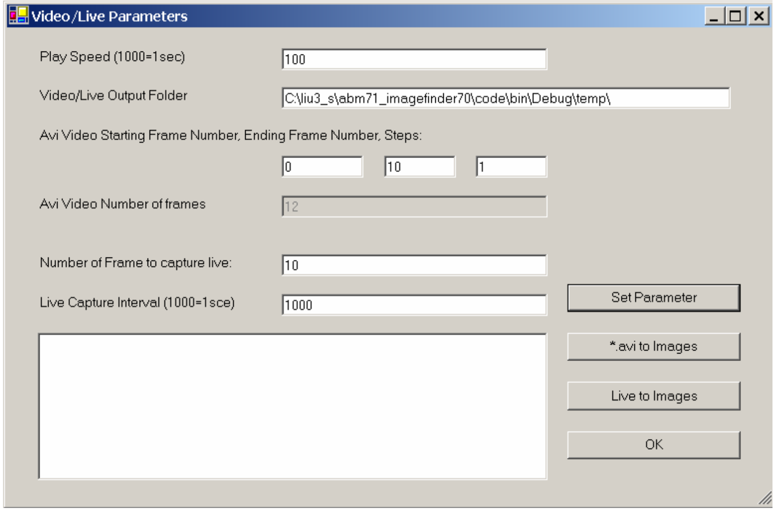
Source: .\input_avi\clock.avi

Please:
Click Key Button;
Select an Image.

The key will be displayed here!

xywh: 0 0 0 0

Figure 21.5 Converting AVI Video File to Images, Step 1.


Video/Live Parameters

Play Speed (1000=1sec) 100

Video/Live Output Folder C:\liu3_s\abm71_imagefinder70\code\bin\Debug\temp\

Avi Video Starting Frame Number, Ending Frame Number, Steps: 0 10 1

Avi Video Number of frames 12

Number of Frame to capture live: 10

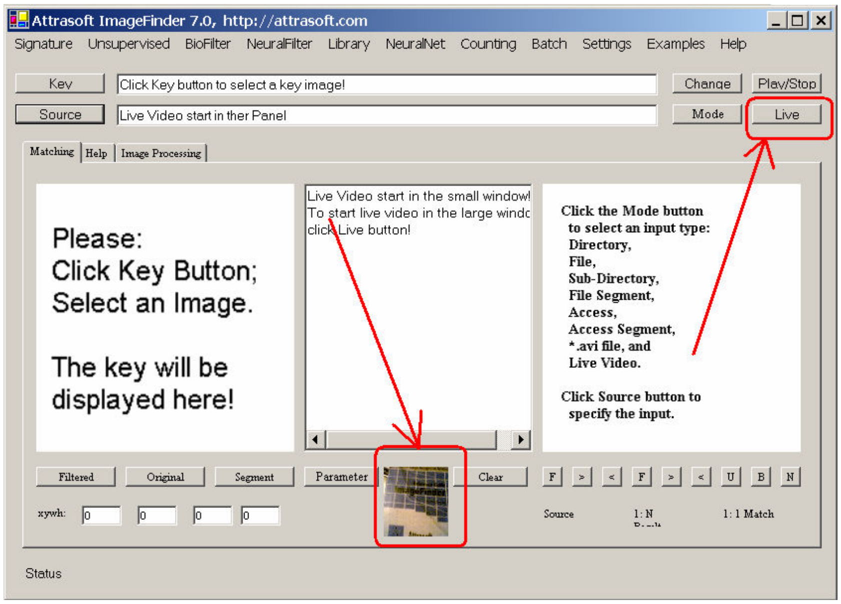
Live Capture Interval (1000=1sce) 1000

Figure 21.6 Converting AVI Video File to Images, Step 2.

21.7 Converting Live Video to Images

You will need a Logitech camera for this section.

After starting the camera live, the **ImageFinder** will convert the live video file to a set of images. After that, they are the same as the rest of the images.


Attrasoft ImageFinder 7.0, http://attrasoft.com

Key: Click Key button to select a key image!

Source: Live Video start in ther Panel

Please:
Click Key Button;
Select an Image.

The key will be
displayed here!

Live Video start in the small window!
To start live video in the large windc
click Live button!

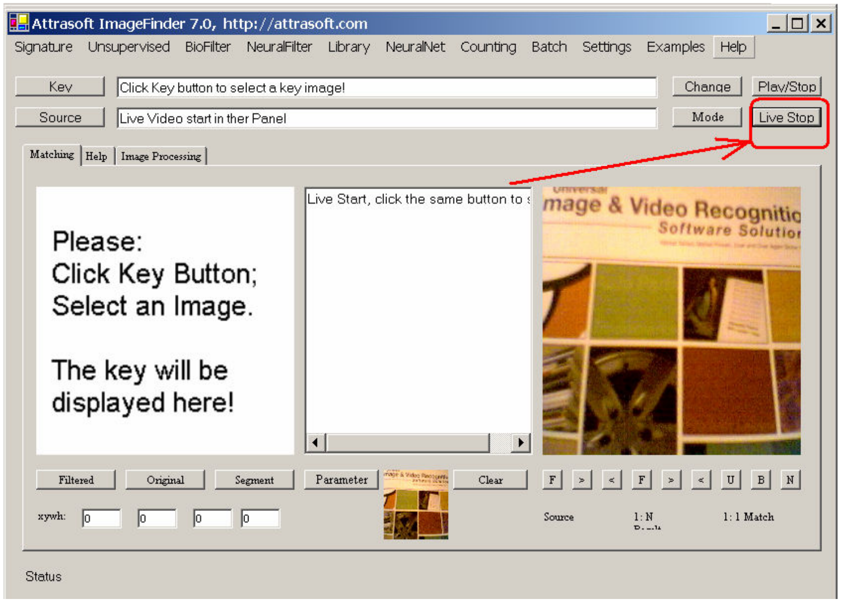
Click the Mode button
to select an input type:
Directory,
File,
Sub-Directory,
File Segment,
Access,
Access Segment,
*.avi file, and
Live Video.

Click Source button to
specify the input.

xywh: 0 0 0 0

Status

Figure 21.7 Converting Live Video File to Images, before clicking the "Live" button.


Attrasoft ImageFinder 7.0, http://attrasoft.com
Signature Unsupervised BioFilter NeuralFilter Library NeuralNet Counting Batch Settings Examples Help
Key
Source
Change
Play/Stop
Mode
Live Stop
Matching
Help
Image Processing
Filtered
Original
Segment
Parameter
Clear
F > < F > < U B N
xywh:
Source
1:N
1:1 Match
Status

Click Key button to select a key image!

Live Video start in ther Panel

Live Start, click the same button to s

Please:
Click Key Button;
Select an Image.

The key will be displayed here!

Figure 21.8 Converting Live Video File to Images, after clicking the "Live" button.

Example. Converting Live Video:

- Start the software;
- Select the option, "Live Video";
- Click the Source Button to get Figure 21.7, where live video is shown on a small window on Figure 21.7;
- Click the Live Button on 21.7 to get Figure 21.8.
- Click the "Change" button in Figure 21.7 to get Figure 21.8;
- Click the "Live to Images" button in get Figure 21.6 to convert the Live Video to images;
- Click the "Live Stop" button in Figure 21.8 to stop.

22. Application Developers

This chapter answers some common questions raised by image recognition solution developers.

22.1 Application Structure

An image recognition application is roughly divided into:

Level 5: User Interface;
Level 4: Data Management;
Level 3: Image-Matching Layer;
Level 2: Scanner, Camera, and their drivers;
Level 1: PC with Windows.

Attrasoft provides programming tools for the image matching layer through customization.

22.2 Available Products

The **ImageFinder** family has three products:

ImageFinder for Windows is off-the-shelf application software that enables a quick testing of Image Recognition ideas.

ImageFinder for Dos is command-line software that enables a quick & dirty system integration to test product prototypes & services.

TransApplet is .Net Class Library that enables addition of Image Recognition capability to products & services.

22.3 Development Procedure

The Image Recognition Solution Development Procedure is:

(1) Set up the system (you will do that).

(2) Collect the data (you will do that).

(3) **Preliminary Assessment** via our off-the-shelf software, the **ImageFinder.**

> You should get Identification Rates ranging from 60% to 89%. The best rate, one of our customers (without any customization) was able to obtain, was an 89% Identification Rate.
>
> Note: The off-the-shelf **ImageFinder** has 70 open parameters for users to adjust, which is the reason customers are only able to achieve Identification Rates ranging from 60% to 89%.

See chapter 24.3 ImageFinder Support Service Levels.

(4) **Feasibility Project** via Customized Stand-alone Software.

- The **ImageFinder** itself has 3,000+ internal parameters which users have no access to.
- Customization is the process of adjusting these 3,000+ internal parameters for your specific image type; this is where the high degree of accuracy for your specific image type is obtained.
- ATTRASOFT will develop a stand-alone software, which will address the special needs / requirements of your application. This will allow you to show your upper management the practicality of a larger project.
- See chapter 24.3 ImageFinder Support Service Levels.

(5) Programming Library in .Net.

Attrasoft will provide you with an API and develop a .Net class library for your application(s).

(6) System Integration to your Production Line.

Attrasoft will provide Support to your system integration.

(7) Licensing & Annual Support.

23. Reference Manual

This manual is divided into the following sections:

1. Input
2. Image PreProcessing
3. Image Processing
4. Normalization
5. Image Signatures
6. Unsupervised Filter
7. BioFilter
8. Neural Filter
9. Library
10. Neural Net Filter
11. Counting
12. Batch
13. Examples
14. Help
15. Others

23.1 Input

Key Button

Use the "Key" button to specify a key. For example, click the button, go to directory, "C:\images\", and then click "attrasoft.jpg". The selected image will be shown in the **ImageFinder** to indicate the specification is successful and the key-image is ready.

Source Button

Use the "Source" button to specify a search-directory, search file, …. To select a search-directory, go to the directory, **then click any file in the directory.** The first image in the search-directory will be shown in the **ImageFinder** to indicate the specification is successful and the search-directory is ready..

Initial Input Window
Mode Button

Use the Initial Input Window or Mode Button to select an input mode. The options are:

- Directory Input
- File Input
- Sub-directory Input
- File Segment
- Access File
- Access Image Segment

23.2 Image Preprocessing

Border Cut

Use the Border Cut parameter to cut off N% of the border. Let us assume we want to cut off 10 % of the border, enter 10 to the Border textbox.

Mask

Use the mask, (x, y, w, h, “Mask Type”), to set the mask. Here (x, y) are the coordinates of the upper left corner, w is the width, and h is the height.

- When the “Mask Type” parameter in (x, y, w, h, “Mask Type”) is set to 1, the units for (x, y, w, h) are pixels. Let a mask be (20, 20, 70, 70, 1), then the cut is based on pixel value.
- When the “Mask Type” is set to 2, the units are percent. For example, let a mask be in (20, 20, 70, 70, 2), then the original is modified by cutting off 20 % of the border on the top, 20% on the left, 10% on the right, and 10% on the bottom. Here 2 in (20, 20, 70, 70, 2) means in percentage rather than pixels.

Stick Shift

Use “Stick Shift” to speed up the computation. The range for this parameter is between 0 to 5, with 0 being the slowest and 5 being the fastest.

Skip Empty Border
Skip Percent
Skip Threshold Filter
Skip Edge Filter

Use the “Skip Empty Border” to specifies the type:

0 No skip;
1 Skip the white empty border space;
2 Skip the black empty border space;
3 Skip x percent of the contents on the white background space;
4 Skip x percent of the contents on the black background space;
5 Skip empty border space on user defined Threshold Filter;
6 Skip x percent of the contents on user defined Threshold/Edge Filters.

Once the type is chosen:
“Skip Percent” specifies the percent of contents to be cut for Options 4, 5, & 6.
“Skip Threshold Filter” specifies the Threshold Filter used for Options 5 & 6, and
“Skip Edge Filter” specifies the Edge Filter used for Options 5 and 6.

23.3 Image Processing

Edge Filter Drop Down List

Use the “Edge Filter Drop Down List” to select an Edge Filter. The Edge Filter is an optional filter. The Edge Filters attempt to exaggerate the main feature(s) a user is looking for. The Edge Filters usually require a dark threshold filter. The Edge Filters extract and enhance edges & contours in an image by expressing intensity differences (gradients) between neighboring pixels as an intensity value. The basic variables are the differences between the top and bottom rows; the differences between the left and right columns; and the differences between the center point and its neighbors.

The batch codes for the Edge Filters are:

Code	**Meaning**
0	No Edge Filter
1	Sobel 1 (Prewitt)
2	Sobel 2 (Sobel)
3	Sobel 3
4	Sobel 4
5	Gradient
6	Gradient, 45°
7	Sobel 1, 45°
8	Sobel 1, - 45°
9	Laplacian 4
10	CD 11
11	FD 11
12	FD 9
13	FD 7
14	Laplacian 5
15	Laplacian 8
16	Laplacian 9
17	Laplacian 16
18	Laplacian17

Threshold Filter Drop Down List

Use the “Threshold Filter Drop Down List” button to set the Threshold Filter. The Threshold Filters attempt to suppress the background. **The Threshold Filter is NOT optional;** if you do not set the Threshold Filter, the default filter will be used.

Choose an Edge Filter and a Threshold Filter where the sample objects will stand out, otherwise change the filter. If you do not have a filter, a customized filter has to be built. DO NOT make too many things stand out, i.e. as long as the area of interest stands out, the rest should show as little as possible.

Once you make a selection, the objects in the training images are black and the background is white. **You should make the black area as small as possible, as long as it covers the key-segment(s), otherwise, switch to a different filter.**

Clean-Up Filter Drop Down List

Use the “Clean-Up Filter Drop Down List” to select a Clean-Up Filter. The Clean-Up Filters will smooth the resulting image to reduce recognition error. The Clean-Up Filter is an optional filter.

23.4 Normalization

Reduction Filter Drop Down List

Use the "Reduction Filter Drop Down List" to select a Reduction Filter. **When reducing images, a scaling factor can be introduced easily.** Although Scaling symmetry can compensate for this scaling factor, the Scaling symmetry is expensive. The Internal Reduction parameter is introduced to avoid unnecessary scaling.

There are several ways to reduce images:

- Integer;
- Real; or
- All images are reduced by a same amount. (Customized Version Only)

Integer Reduction

Images are reduced by an integer factor to maximally fit 100x100 without distortion. For example, a 350x230 image will be reduced to 87x57.

Real Reduction

Images are reduced by a real number to maximally fit 100x100 without distortion. For example, a 350x230 image will be reduced to 100x65.

All

All training images and images in the search-directory are reduced by the same integer to fit 100x100 without distortion. (Customized Version Only)

Within each type of reduction, there are 3 more settings:

- Avg: AOI (Area Of Interest) is half black and half white;
- Max: AOI is mostly white, or the black areas are thin lines; or
- Min: AOI is mostly black.

Reduction Filter Parameter / Segment-Cut Button

Use the "Segment-Cut" button to shape the segment considered by the **ImageFinder**. The Segment-Cut parameter ranges from 0 to 12. This parameter deals with the edges of segments in the images. The larger this parameter is, the smaller the segment the **ImageFinder** will use. The possible settings of this parameter in the user interface are: 0, 1, 2, ... , and 12. To set the parameter, keep clicking the button.

Reduction Filter Parameter/Size-Cut Button

Use the "Size-Cut" button to limit the dimensions of the images to be searched. In some applications, the users only want to search images of certain dimensions and ignore the other images.

The dimension setting ranges from 0 to 9. To set the parameter, keep clicking the "Dimension" button; the setting will switch from one to the next each time you click the button.

- If the setting is 0, this parameter will be ignored.
- If the parameter is 1, then the longest edge of the image to be considered must be at least 100, but less than 199.
- If the parameter is 2, then the longest edge of the image to be considered must be at least 200, but less than 299, …

Reduction Filter Parameter / Border-Cut

Use the "Border-Cut" button to ignore the sections of the image near the borders. The Border-Cut parameter ranges from 0 (no cut) to 9 (18% border cut). The possible settings in the user interface are: 0, 1, 2, ..,and 9.

Assume an image is (0,0; 1,1):

- setting Border-Cut to 1 means the **ImageFinder** will look at the section (0.02, 0.02; 0.98, 0.98);
- setting Border-Cut to 2 means the **ImageFinder** will look at the section (0.04, 0.04; 0.96, 0.96); … .
- To set the parameter, keep clicking the button.

Reduction Filter Parameter / Look-At Area

The "Look-At Area" is the area the **ImageFinder** will use. A 100 x 100 window specifies a whole image. In the Integer-Reduction, the actual area can be less than 100x100. The Look-At Area is specified by 4 numbers:

(x, y, w, h)

(x, y) are the coordinates of the upper-left corner and (w, h) are the width and height of the Look-At window.

To use this Look-At window, enter values for (x, y, w, h) in the four textboxes. Note that the image display area in the **ImageFinder** is 300x300, therefore, the training segment is specified within a 300x300 area. The Look-At window is 100x100. The default value is (0,0,0,0), meaning the Look-At area setting is ignored.

23.5 Signature Menu

Signature Filter Drop Down List

Use the "Signature Filter Drop Down List" to select a BioFilter.

Signature/Left Signature (Key)

Use the "Signature/Left Signature (Key)" menu item to compute the signature of the specified key image. This menu item has no direct application in the software; it merely show users what a signature looks like.

Signature/Right Signature

Use the “Signature/Right Signature” menu item to compute the signature of the image on the right picture box. This menu item has no direct application in the software; it merely shows users what a signature looks like.

Signature/N Signature (a1.txt)

Use the menu item “Signature/N Signature (a1.txt)” to compute the signatures specified in the search source and save the signature in a1.txt. This file will be used for 1:N Matching and N:N Matching.

Signature/N Signature (a2.txt)

Use the menu item “Signature/N Signature (a1.txt)” to compute the signatures specified in the search source and save the signature in a2.txt. This file will be used for 1:N Matching and N:N Matching.

Signature/N Signature (a3.txt)

Use the menu item “Signature/N Signature (a1.txt)” to compute the signatures specified in the search source and save the signature in a3.txt. This file will be used for 1:N Matching and N:N Matching.

Signature/N Signature (a4.txt)

Use the menu item “Signature/N Signature (a1.txt)” to compute the signatures specified in the search source and save the signature in a4.txt. This file will be used for 1:N Matching and N:N Matching.

Signature/Training Signature (t1.txt)

Use the menu item “Signature/Training Signature (t1.txt)” to compute the signatures specified in the search source and save the signature in t1.txt. This file will be used for training the BioFilter and Neural Filter.

Signature/Copy a1.txt to a1.txt
Signature/Copy t1.txt to a1.txt

Use these menu items to copy from the matching signature file, a1.txt, to the training signature file, t1.txt and vise versa.

Signature/What is this?

Use the menu item “Signature/What is this?” to open a text file, which gives a quick explanation of the Image Signatures. This file will also be displayed in the Help tab.

23.6 Unsupervised Filter

23.6.1 Matching

"Unsupervised /Matching/1:1 (Left vs Right)" Menu Item

Use the "Unsupervised /Matching/1:1 (Left vs Right)" menu item to make a 1:1 Matching. 1:1 Matching compares the key with the image displayed in the right picture box. The "Key" button selects the key image. The right image can be selected by "F", ">", "<" buttons.

"Unsupervised/Matching/1:N (key vs a1.txt)" Menu Item

Use the "Unsupervised/Matching/1:N (key vs a1.txt)" menu item to make a 1:N Matching. 1:N Matching compares the key with the images in a1.txt. The "Key" button selects the key image. 1:N Matching requires the images in the search source being converted into signatures in advance and saved in a1.txt.

To make an 1:N Matching:

- Click the "Key" button, and select an image;
- Click "Unsupervised/Matching/1:N (key vs a1.txt)".

The results are in file, b1.txt, which will be opened at the end of the computation.

"Unsupervised/Matching/N:N Match (a1.txt vs a1.txt)" Menu Item

Use the "Unsupervised/Matching/N:N Match (a1.txt vs a1.txt)" menu item to make an N:N Matching. N: N Matching compares each image, in a1.txt, with every image in a1.txt. N:N Matching requires the images in the search source being converted into signatures in advance and saved in a1.txt. The results are in file, b1.txt, which will be opened at the end of the computation.

23.6.2 Analysis

"Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" Menu Item

Use the "Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" menu item to check the matching results. If this is a test run (i.e., you know the correct answers), you can see the matching results in seconds. To test the results in b1.txt, you must prepare b1_matchlist.txt file, which indicates the matching pairs. Once b1.txt and b1_matchlist.txt are prepared, this command will let you know your matching results in seconds.

"Unsupervised/N:M Analysis/Report (b1_matchlist.txt required)" Menu Item

Use the "Unsupervised/N:M Analysis/Check (b1_matchlist.txt required)" menu item to get a matched list and an unmatched list. The matched list contains those pairs in b1_matchlist.txt file that have been found by the **ImageFinder**. The unmatched list contains those pairs in b1_matchlist.txt file that have been missed by the **ImageFinder**.

"Unsupervised/N:M Analysis/Threhold (b1_matchlist.txt required)" Menu Item

Use the "Unsupervised/N:M Analysis/Threhold (b1_matchlist.txt required)" menu item to get the recommended threshold, based on b1_matchlist.txt file. This menu item will first find the matched list. From the matched list, it will find the minimum score and recommend it to you as the threshold. The output looks like this:

```
Possible Threshold =  x
```

Absolute Threshold = y

The Possible Threshold is the threshold.
The Absolute Threshold specifies the score if an image only matches itself and no other images.

23.6.3 Results

"Unsupervised/Results/b1.txt" Menu Item
Use the "Unsupervised/Results/b1.txt" menu item to open b1.txt, which is the file containing the last matching result in text format.

"Unsupervised/Results/b1.htm" Menu Item
Use the "Unsupervised/Results/b1.htm" menu item to open b1.htm, which is the file containing the last matching result in html format.

"Unsupervised/Results/b1.html" Menu Item
Use the "Unsupervised/Results/b1.html" menu item to open b1.html, which is the file containing the last matching result in html format, with both input images and output images displayed in the web page.

23.6.4 Parameters

Unsupervised Parameter/Fault Tolerance Scale
Use the Fault Tolerance Scale textbox to control the amount of output. This parameter ranges from 0 to 100. The larger this number is, the more matches you will get. To set this parameter, enter a number between 0 and 100 to the text box.

Unsupervised/Parameter/Blurring Text Box
Use the Blurring Text Box to control the amount of output. "0%" Blurring means the exact match. When the "Blurring" is increased, you will get more and more similar images. As the Blurring goes higher, the speed will be slower. The Blurring settings range from 0 – 50. To set the Blurring, enter a number between 0 and 50 to the text box.

Unsupervised/Parameter/Sensitivity Text Box
Use the Sensitivity Text Box to adjust the search segment size. The Sensitivity parameter ranges from 0 (least sensitive) to 100 (most sensitive).

- To search small segment(s), use a high sensitivity search.
- To search large segment(s), use low sensitivity search.

The higher the parameter is set, the more results you will get. To set the Sensitivity, enter a number between 0 and 100 the text box. The default setting is 50.

Unsupervised/Parameter/Threshold Text Box
Use the Threshold to eliminate those retrieved images with the weights below a certain value. The result of image comparison is a "score", indicating the degree to which a match exists. This score is then compared to a pre-set Threshold to determine whether or not to declare a match.

To decide what threshold to use, you should make a test run first and look at the scores.

- Matching images have higher scores;
- Unmatched images have lower scores.

Select a threshold to separate these two groups. There will be a few images in the middle, representing both groups. Under these circumstances, the threshold selection depends on your application. In general, it is better to give no answer than a wrong answer. Assume you are searching images and all similar images have weights ranging from 1,000 to 10,000. It is possible that some other images will pop up with weights ranging from 10 to 100. To eliminate these images, you can set the External Cut to 1,000.

Unsupervised/Parameter/Relative Score Text Box

Use the "Relative Score" textbox to switch between two settings: the first setting gives the score in the range (0 – 100) and the second setting gives a score in the range (0 to maximum value).

Unsupervised/Parameter/Show File Text Box

Use the "Show File" textbox to decide whether you want the output file, b1.txt, to be displayed at the end of a matching.

23.7 BioFilter

23.7.1 Training

"BioFilter\Train\Signature (t1.txt)" Menu Item

Use the "BioFilter\Train\Signature (t1.txt)" menu item to open one of two training files, t1.txt, so that you can see this training file is ready.

"BioFilter\Train\Edit match.txt" Menu Item

Use the "BioFilter\Train\Edit match.txt" menu item to open one of two training files, match.txt, so that you can see this training file is ready.

"BioFilter\Train\Check match.txt" Menu Item

Use the "BioFilter\Train\Check match.txt" menu item to check match.txt. The matching pairs in match.txt will be displayed in the left and right picture box so that you can see whether an unintended pair is in the file match.txt.

"BioFilter\Train\Stop Checking" Menu Item

Use the "BioFilter\Train\Stop Checking" menu item to stop checking match.txt.

"BioFilter\Train\Training" Menu Item

Use the "BioFilter\Train\Training" menu item to train the BioFilter. Training uses the data collected in advance to teach the BioFilter how to match. Training requires two files, a1.txt and match.txt:

- t1.txt is the signature file, which contains many signatures. Each image is converted into a signature. A signature represents features of an image in a Feature Space.

- Match.txt is a list of matching pairs. This file will teach the **ImageFinde**r who will match with whom.

23.7.2 Matching

"BioFilter/Matching/1:1 (Left vs Right)" Menu Item

Use the "BioFilter/Matching/1:1 (Left vs Right)" menu item to make a 1:1 Matching. 1:1 Matching compares the key with the image displayed in the right picture box. The "Key" button selects the key image. The right image can be selected by the "F", ">", "<" buttons.

"BioFilter/Matching/1:N (key vs a1.txt)" Menu Item

Use the "BioFilter/Matching/1:N (key vs a1.txt)" menu item to make a 1:N Matching. 1:N Matching compares the key with the images in a1.txt. The "Key" button selects the key image. 1:N Matching requires the images in the search source being converted into signatures in advance and saved in a1.txt.

To make a 1:N Matching:

- Click the "Key" button, and select an image;
- Click "BioFilter/Matching/1:N (key vs a1.txt)".

The results are in file, b1.txt, which will be opened at the end of the computation.

"BioFilter/Matching/N:N Match (a1.txt vs a1.txt)" Menu Item

Use the "BioFilter/Matching/N:N Match (a1.txt vs a1.txt)" menu item to make an N:N Matching. N: N Matching compares each image, in a1.txt, with every image in a1.txt. N:N Matching requires the images in the search source being converted into signatures in advance and saved in a1.txt. The results are in file, b1.txt, which will be opened at the end of the computation.

"BioFilter/Matching/N:M2 Match (a1.txt vs a2.txt)" Menu Item

Use the "BioFilter/Matching/N:M2 Match (a1.txt vs a2.txt)" menu item to make a N:M Matching. N: M Matching compares each image, in a1.txt, with every image in a2.txt. N:M Matching requires the images in the search source being converted into signatures in advance and saved in a1.txt and a2.txt, respectively. The results are in file, b1.txt, which will be opened at the end of the computation.

"BioFilter/Matching/N:M3 Match (a1.txt vs a3.txt)" Menu Item

Similar to the "BioFilter/Matching/N:M2 Match (a1.txt vs a2.txt)" Menu Item, except it matches a1.txt against a3.txt.

"BioFilter/Matching/N:M4 Match (a1.txt vs a4.txt)" Menu Item

Similar to the “BioFilter/Matching/N:M2 Match (a1.txt vs a2.txt)” Menu Item, except it matches a1.txt against a4.txt.

23.7.3 Analysis

For the menu items under BioFilter/Analysis, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.7.4 Results

For the menu items under BioFilter/Results, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.7.5 Parameters

For the BioFilter parameter, please see the Unsupervised Filter section. The parameters are the similar.

23.8 Neural Filter

23.8.1 Training

For the menu items under NeuralFilter/Training, please see the BioFilter Filter section. The functions of the menu items are similar.

23.8.2 Matching

For the menu items under NeuralFilter/Matching, please see the BioFilter Filter section. The functions of the menu items are similar.

23.8.3 Analysis

For the menu items under NeuralFilter/Analysis, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.8.4 Results

For the menu items under NeuralFilter/Results, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.8.5 Parameters

Neural Filter Drop Down List

Use the “Neural Filter Drop Down List” to select a Neural Filter. The Neural Filter is the main matching filter for the Feature Space.

NeuralFilter Parameter/Opening

Use the “Opening” parameter to control the “Openness” of this filter. This parameter has the following settings:

- Very Large
- Large
- Normal
- Small
- Very Small

A large opening will allow more matches in the results.

For the rest of the NeuralFilter parameters, please see the Unsupervised Filter section. The parameters are the similar.

23.9 Library

23.9.1 Maintenance

“Library/Maintenance/Create Lib1 (Copy a1.txt to lib1.txt)” Menu Item

Use the “Library/Maintenance/Create Lib1 (Copy a1.txt to lib1.txt)” menu item to create a library file, lib1.txt, from a1.txt. The NeuralFilter library requires a library file to be created and then loaded. The library file names must be lib1.txt or lib2.txt. This menu item copies from a1.txt to lib1.txt.

“Library/Maintenance/Create Lib2 (Copy a2.txt to lib2.txt)” Menu Item

Use the “Library/Maintenance/Create Lib2 (Copy a2.txt to lib2.txt)” menu item to create a library file, lib2.txt, from a2.txt. The NeuralFilter library requires a library file to be created and then loaded. The library file names must be lib1.txt or lib2.txt. This menu item copies from a2.txt to lib2.txt.

“Library/Maintenance/Load lib1.txt” Menu Item

Use the “Library/Maintenance/Load lib1.txt” menu item to load the library file, lib1.txt.

“Library/Maintenance/Load lib2.txt” Menu Item

Use the “Library/Maintenance/Load lib2.txt” menu item to load the library file, lib2.txt.

“Library/Maintenance/Load lib1.txt and lib2.txt” Menu Item

Use the “Library/Maintenance/Load lib1.txt and lib2.txt” menu item to load the library files, lib1.txt and lib2.txt.

“Library/Maintenance/Print Library” Menu Item

Use the “Library/Maintenance/Print Library” menu item to print the library to the text window.

"Library/Maintenance/Clear Library" Menu Item

Use the "Library/Maintenance/Print Library" menu item to clear the current library.

"Library/Maintenance/Backup (lib1_bk.txt)" Menu Item

Use the "Library/Maintenance/Backup (lib1_bk.txt)" menu item to create a backup copy of the currently loaded library to lib1_bk.txt.

"Library/Maintenance/Backup (lib2_bk.txt)" Menu Item

Use the "Library/Maintenance/Backup (lib2_bk.txt)" menu item to create a backup copy of the currently loaded library to lib2_bk.txt.

"Library/Maintenance/Save lib1.txt, lib2.txt to lib3.txt" Menu Item

Use the "Library/Maintenance/Save lib1.txt, lib2.txt to lib3.txt" menu item to create a combination of the two library files, lib1.txt and lib2.txt, into a new library file, lib3.txt. To use this file, save it to lib1.txt, or lib2.txt, and load.

"Library/Maintenance/Add (Key)" Menu Item

Use the "Library/Maintenance/Add (Key)" menu item to add a signature to the loaded library. The inserted signature is computed from the key image.

"Library/Maintenance/Delete (Key)" Menu Item

Use the "Library/Maintenance/Delete (Key)" menu item to delete a signature from the loaded library. The deleted signature is computed from the key image.

"Library/Maintenance/Replace (Key)" Menu Item

Use the "Library/Maintenance/Replace (Key)" menu item to replace a signature in the loaded library. The replaced signature is computed from the key image.

23.9.2 Matching

"Library/Matching/1:N (Key vs Lib.txt)" Menu Item

Use the "Library/Matching/1:N (Key vs Lib1.txt)" menu item to make a 1:N Matching. 1:N Matching compares the key with the loaded library. The "Key" button selects the key image.

"Library/Matching/N:M (a1.txt vs Lib.txt)" Menu Item

Use the "Library/Matching/N:M (a1.txt vs Lib.txt)" menu item to make a N:M Matching. N:M Matching compares the signatures in a1.txt with the loaded library.

23.9.3 Analysis

For the menu items under Library/Analysis, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.9.4 Results

For the menu items under Library/Results, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.10 NeuralNet Filter

23.10.1 Training

NeuralNet/Training Menu Item

Use the “NeuralNet/Training” menu item to train the NeuralNet Filter to learn the key (what image to look for). These commands **will first delete all old training and start to train the software from the beginning**. After clicking a button, wait one second. If everything is O.K., a message "Training End!" will be printed in the Status Text Area.

NeuralNet/Retraining Menu Item

Use the “NeuralNet/Retraining” menu item to retrain the software to learn additional keys.

If several keys are used for training, the first learning uses **training** and all the subsequent learning uses **retraining**. After clicking the button, wait one second. If everything is O.K., a message "Retraining End!" will be printed in the Status Text Area.

23.10.2 Matching

“NeuralNet/Matching/1:1 (Left vs Right)” Menu Item

Use the “NeuralNet/Matching/1:1 (Left vs Right)” menu item to make a 1:1 Matching. 1:1 Matching compares the key with the image displayed in the right picture box. The “Key” button selects the key image. The right image can be selected by the “F”, “>”, “<” buttons. You must train the software first before 1:1 Matching. Note that, next to each image, a score is printed. The larger the number is, the more similarity between the training image(s) and the retrieved images.

“NeuralNet/Matching/1:N (Key vs Source)” Menu Item

Use the "NeuralNet/Matching/1:N (Key vs Source)" menu item to retrieve images in the search source. You must train the software first before searching. If everything is O.K., a message "Retrieval End!" will be printed in the text area, then a file with a list of retrieved images will be opened.

Note that, next to each image, a score is printed. The larger the number is, the more similarity between the training image(s) and the retrieved images.

“NeuralNet/Matching/N:N (Source vs Source)” Menu Item

Use the " NeuralNet/Matching/N:N (Source vs Source)" menu item to match each image in the search-directory against all other images in the directory. After clicking the button, if everything is O.K., a message "Retrieval End!" will be printed in the text area, then a file with a list of retrieved images will be opened. In the output file, each image in the search-directory has a block; the first line in a block is the input, and the rest of the lines in a block are the output.

Note that, next to each image, a score is printed. The larger the number is, the more similarity between the training image(s) and the retrieved images.

23.10.3 Analysis

For the menu items under NeuralNet/Analysis, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.10.4 Results

For the menu items under NeuralNet/Results, please see the Unsupervised Filter section. The functions of the menu items are similar.

23.10.5 Parameters on the Main Form

"xywh" Text Boxes

Use the "xywh" Text Boxes to set the training segment. The key-segment is specified by 4 integers: the upper-left corner (x, y) and the length and height (w, h) of the segment. The units for these four variables are pixels. Once the segment specification is successful, a black box will cover the selected area. If the selected area is not what you want, just re-select the area again.

Segment Button

Use the Segment Button to refresh the training segment setting.

23.10.6 Parameters on the Parameter Window

Neural Net Filter Drop Down List

Use the "Neural Net Filter Drop Down List" to set the Neural Net Filter. The default filter is 100x100. All images are scaled down by an integer amount. For example, 640x480 will be scaled down 7 times to 91x68. <u>You need to understand this, so when you translate, or rotate an image, you will make sure no additional scaling factors are introduced.</u>

The search speed crucially depends on the Neural Net Filter. For example, if the 50x50 filter is used, then the underlying neural net size is reduced by a factor of 4, and the neural computation speed will be increased by a factor of 16.

The filters available are:

- 100x100 (Most Accurate)
- 90x90
- 80x80
- 70x70
- 60x60

- 50x50 (Least Accurate)

Let the speed of 100x100 representation be a base, then the overall speed for:

- 90x90 representation is 1 times faster;
- 80x80 representation is 1.6 times faster;
- 70x70 representation is 2.7 times faster;
- 60x60 representation is 5 times faster; and
- 50x50 representation is 10 times faster.

23.10.7 Parameters on the NeuralNet Parameter Window

NeuralNet/Parameter/Symmetry

Use the "Symmetry" button to set the symmetry. The symmetry settings are:

- No symmetry;
- Translation symmetry;
- Rotation symmetry;
- Scaling symmetry; and
- Rotation and Scaling symmetry.

The default setting is Translation Symmetry. To set the symmetry, keep clicking the button; the setting will switch from one to the next each time you click the button.

NeuralNet/Parameter/Translation Type Button

Use the “Translation Type” button to select the accuracy of the Translation Symmetry. The Translation Type settings (and their codes) are:

- Most Accurate (0);
- Accurate (1); and
- Least (2).

To set the Translation Type, keep clicking the “T Type” button; the setting will switch from one to the next each time you click the button. The default setting is 0, the most accurate setting.

NeuralNet/Parameter/Scaling Type Button

Use the “Scaling Type” button to select the accuracy of the Scaling Symmetry. The Scaling Type settings (and their codes) are:

- Least Accurate (0);
- Accurate (1);
- Accurate (2); and
- Most Accurate (3).

To set the Scaling Type, keep clicking the “S Type” button; the setting will switch from one to the next each time you click the button. The default setting is 0, the least accurate setting.

NeuralNet/Parameter/Rotation Type Button

Use the R Type (Rotation Type) buttons to set the Rotation Types. The settings are:

- 360° rotation (0);
- -5° to 5° rotation (1);
- -10° to 10° rotation (2);
- 360° rotation, accurate (3);
- 360° rotation, more accurate (4);
- 360° rotation, most accurate (5).

Other settings can be ordered in a Customized Version.

To set the Rotation Type, keep clicking the “R Type” button; the setting will switch from one to the next each time you click the button. The default setting is 360° rotation (0).

NeuralNet/Parameter/Blurring Text Box

Use the Blurring Text Box to control the amount of output. "0%"-Blurring means the exact match. When the "Blurring" is increased, you will get more and more similar images. As the Blurring goes higher, the speed will be slower. The Blurring settings range from 0 – 50. To set the Blurring, enter a number between 0 and 50 to the text box. The default setting is 10.

NeuralNet/Parameter/Sensitivity Text Box

Use the Sensitivity Text Box to adjust search segment size. The Sensitivity parameter ranges from 0 (least sensitive) to 100 (most sensitive).

- To search small segment(s), use a high sensitivity search.
- To search large segment(s), use low sensitivity search.
- The higher the parameter is set, the more results you will get.

To set the Sensitivity, enter a number between 0 and 100 the text box. The default setting is 50.

NeuralNet/Parameter/External Cut (Threshold) Text Box

Use the External Cut Text Box to eliminate those retrieved images with the weights below the External Cut. This parameter is also called Threshold. To set the External Cut, enter a number to the text box. The default setting is 0. In general, it is better to give no answer than a wrong answer. Assume you are searching images and all similar images have weights ranging from 1,000 to 10,000. It is possible that some other images will pop up with weights ranging from 10 to 100. To eliminate these images, you can set the External Cut to 1,000.

NeuralNet/Parameter/Internal Cut Text Box

The Internal Cut plays a similar role as the External Cut. The Internal Cut ranges from 0 to 100, and the External Cut can be any number. To set the Internal Cut, enter a number between 0 and 100 to the text box. The default setting is 100.

NeuralNet/Parameter/Segment Size Button

Use the “Segment Size” button to select the segment size. The default setting is "L Segment".

- To search Large Segments, use option 0. For example, if a sample segment is one quarter of the sample image, it is a large segment.
- To search Small Segments, use option 1. If the segment is 1/25 of the sample image, it is a small segment.

To set the segment size, keep clicking the Segment Size button; the setting will switch from one to the next each time you click the button.

Currently, "Small Segment" only supports Translation Symmetry. If you need Rotation and Scaling symmetry, please use "Large Segment".

Additional symmetries can be added very quickly in a Customized Version.

NeuralNet/Parameter/Image Type Button

There are Black-&-White and Color images. For each of them, there are “sum-search”, “maximum-search”, and “average-search”. This generates 6 image types:

- BW Sum
- BW Max
- BW Avg
- Color Sum
- Color Max
- Color Avg

"BW Sum” is like an integration of function f (x).
"BW Max” is like a maximum value of f (x); and
"BW Avg” is the average of the above two.

"Color Sum” is like an integration of function f (x).
"Color Max” is like a maximum value of f (x); and
"Color Avg” is the average of the above two.

To set the image type, keep clicking the Image Type button; the setting will switch from one to the next each time you click the Image Type button.

NeuralNet/Parameter/File Display Type Button

Use the “File Display Type” button to set the output file type. The options are text file and html file.

NeuralNet/Parameter/Auto Segment Button

Use the “Auto Segment” button to select a training segment automatically. The training segment can be specified in two ways:

Manual Specification
Automatic Specification

The default is Manual Specification. In this setting the segment will be specified by the four text boxes (x, y, w, h), as we discussed earlier. If you do not want to pick up a training segment, then let the **ImageFinder** pick up the segment for you by using the Automatic Specification. This parameter has several settings:

NO Auto Segment
Very Large Segment
Very Large Segment
Large Segment
Large Segment
Medium Segment
Medium Segment

NeuralNet/Parameter/Use BioFilter Button

Use the "Use BioFilter" button to determine whether the BioFilter will be used to eliminate search images.

NeuralNet/Parameter/Use NeuralFilter Button

Use the "Use NeuralFilter" button to determine whether the NeuralFilter will be used to eliminate search images.

23.11 Counting

"Counting/Count Left" Menu item

Use the "Counting/Count Left" menu item to count the number of objects physically separated in the key.

"Counting/Count Right" Menu item

Use the "Counting/Count Right" menu item to count the number of objects physically separated in the image displayed in the right picture box. The "Key" button selects the key image. The right image can be selected by "F", ">", "<" buttons.

"Counting/Top 5 Segment Left" Menu item

Use the "Counting/Top 5 Segment Left" menu item to count the number of objects physically separated in the key and list the top five segments in detail.

"Counting/Top 5 Segment Right" Menu item

Use the "Counting/Top 5 Segment Right" menu item to count the number of objects physically separated in the image displayed in the right picture box and list the top five segments in detail.

"Counting/Tracking largest Segment" Menu item

Use the "Counting/Tracking largest Segment" menu item to find the most obvious object in an image and track it from image frame to image frame. To track these images, you have to specify the source by clicking the "Source" button.

23.12 Batch Commands

Batch/Set Execution Code Menu Item

Use the "Batch/Set Execution Code" menu item to set the Set Execution Code. There are many commands in the **ImageFinder.** Each command has an integer for identification. This integer is called Batch Execution Code. This number is used before you save your batch code.

Batch/Save Menu Item

Use the "Batch/Save" menu item to save the last **ImageFinder** setting in the batch code. The batch code is saved to a file, abm70.txt.

Batch/Save 2 Menu Item

Use the "Batch/Save 2" menu item to save the last **ImageFinder** setting in the batch code. The batch code is saved to a file, abm70_2.txt.

Batch/Save 3 Menu Item

Use the "Batch/Save 3" menu item to save the last **ImageFinder** setting in the batch code. The batch code is saved to a file, abm70_3.txt.

Batch/Save 4 Menu Item

Use the "Batch/Save 4" menu item to save the last **ImageFinder** setting in the batch code. The batch code is saved to a file, abm70_4.txt.

Batch/Save 5 Menu Item

Use the "Batch/Save 5" menu item to save the last **ImageFinder** setting in the batch code. The batch code is saved to a file, abm70_5.txt.

Batch/Open Menu Item

Use the "Batch/Open" menu item to open the batch code file saved by the Batch/Save command.

Batch/Open 2 Menu Item

Use the "Batch/Open 2" menu item to open the batch code file saved by the "Batch/Save 2" command.

Batch/Open 3 Menu Item

Use the "Batch/Open 3" menu item to open the batch code file saved by the "Batch/Save 4" command.

Batch/Open 4 Menu Item

Use the "Batch/Open 4" menu item to open the batch code file saved by the “Batch/Save 4” command.

Batch/Open 5 Menu Item

Use the "Batch/Open 5" menu item to open the batch code file saved by the “Batch/Save 5” command.

Batch/Notes

Click the “Batch/Notes” menu item to create an online note so you can remember which batch code is for which problem.

Batch/Run

Use the "Batch/Run" menu item to execute the batch code in the display area.

Batch/Load

Use the "Batch/Load" menu item to load the parameters specified by the batch code in the display area. The Load command will NOT execute the batch code.

23.13 Examples

Example/Special Example/Document Duplication

Use “Example/Special Example/Document Duplication” to open the Document Duplication Example and click Batch/Run to run the example.

Example/Special Example/Face Recognition

Use “Example/Special Example/Face Recognition” to open the Face Recognition Example and click Batch/Run to run the example.

Example/Special Example/Wheel Recognition

Use “Example/Special Example/Wheel Recognition” to open the Wheel Recognition Example and click Batch/Run to run the example.

Example/Special Example/TV Ads Recognition

Use “Example/Special Example/TV Ads Recognition” to open the TV Ad Recognition Example and click Batch/Run to run the example.

Example/Unsupervised

Use “Example/Unsupervised” to open the Examples for the Unsupervised Filter Chapter and click Batch/Run to run the examples.

Example/BioFilter

Use “Example/BioFilter” to open the Examples for the BioFilter Chapter and click Batch/Run to run the examples.

Example/Library

Use “Example/Library” to open the Examples for the Library Chapter and click Batch/Run to run the examples.

Example/NeuralNet Filter

Use “Example/NeuralNet Filter” to open the Examples for the NeuralFilter Chapter and click Batch/Run to run the examples.

Example/NeuralNet Filter

Use “Example/NeuralNet Filter” to open the Examples for the NeuralFilter Chapter and click Batch/Run to run the examples.

23.14 Help

Help/Help Menu Item

Use the “Help” button or the “Help/Help” menu item to display the html version of this document.

Help/Clear Window Menu Item
Clear Button

Use the “Clear” button or the “Help/Clear Window” menu item to clear the text area.

Help/About Menu Items

Display email, website, and version number.

Help/Small (650x510)

Use “Help/Small (650x510)” to display the software in size 650x510 pixels.

Help/Large (850x610)

Use “Help/Small (850x610)” to display the software in size 850x610 pixels.

23.15 Buttons, Text Window, and Picture Boxes

Left Picture Box

Use the “Left Picture Box” to see the key image.

Right Picture Box

Use the “Right Picture Box” to see the source image.

Text Window

Use the “Text Window” to see the current status of your execution, results, error messages, and suggestions.

Filtered Button

Use the Filtered Button to see the image after the preprocessing and processing filters.

Original Button

Use the Original Button to see the original image after the filtered image is displayed.

“Source F” Button, “Source >” Button, “Source <” Button

Use the “Source F” button, the “Source >” button, and the “Source <” button to display source images on the right picture box.

“1:N Results F” Button, “1:N Results >” Button, “1:N Results <” Button

Use the “1:N Results F” button, the “1:N Results >” button, and the “1:N Results <” button to display matched images after 1:N Matching on the right picture box.

“1:1 Matching U” Button, “1:1 Matching B” Button, “1:1 Matching N” Button

Use the “1:1 Matching U” button, the “1:1 Matching B” button, and the “1:1 Matching N” button to make 1:1 Matching using the Unsupervised Filter, BioFilter, and Neural Filter.

24. ImageFinder Support Service Packages

Attrasoft's **ImageFinder Services** are designed to accelerate a company's path to deploy Image Recognition Solutions. Our structured Service Offerings help you to develop your products/services with the **ImageFinder** as a component.

24.1 What is Support Service?

ImageFinder Support Service Packages are designed to help a person/company to understand the process of integrating Image Recognition technology into their product/service. From a large set of possible paths, a person/company must plan the most realistic execution to ensure the success of the project.

- The focus of Support Service is to follow the right development path and shorten the learning curve for developers.
- Based on dozens of past projects, Attrasoft's development experience will specify the required work and map the shortest path to the system integration;
- Most importantly, Attrasoft Services might prevent you from following a wrong path, thus saving you from an unnecessary waste of resources, or even failure of the project.

The **ImageFinder Support Service** is divided into several levels:

Support Service Level	Cost	#Images
Level 0 Service	NA	NA
Level 1 Service	$1,000	100
Level 2 Service	$5,000	1,000
Level 3 Service	$10,000	1,000
Level 4 Service	$20,000	1,000

A Section below will explain the definitions of each of these Support Service Levels.

24.2 What is a Feasibility Study?

Attrasoft Image Recognition technology offers a suite of products,

- **ImageFinder** (off-the-shelf),
- **ImageFinder for Dos,**
- **TransApplet** (Library version of the ImageFinder**)**,
- **Customized-ImageFinder,**
- **Customized-TransApplet**),

that enables the success of projects a person/company will develop with Attrasoft's software components.

A **Feasibility Study** is very valuable because experience from many past projects will be naturally deployed into your project. The very first question we encountered, and you will be asked when you justify your project to your company, is "Can this be done?" Very often, the answer is more than a simple "Yes"; a Feasibility Study will be necessary to respond this question, which is further divided into a:

- **Preliminary Assessment** with 200 of your images (i.e., 100 image pairs), and a
- **Feasibility Study** with 2,000 of your images (i.e., 1,000 image pairs).

24.3 ImageFinder Support Service Levels

With **ImageFinder** Level 0 Service (this comes with the purchase of the **ImageFinder**), you can:

- Get Help for installing the software.
- Get Help on how to operate the software by running examples in the **ImageFinder** and trying some of your own examples.
- Evaluate the **ImageFinder** and justify a product/service development opportunity to your organization based on this Preliminary Evaluation, if such a project is not already in place. This Preliminary Evaluation is usually based on a few of your own image pairs.
- Select an additional Service Package based on your need.

With **ImageFinder** Level 1 Service ($1,000):

- You will provide 100 pairs of your own normalized images.
- We do all the work (i.e., tuning the off-the-shelf ImageFinder 70 open parameters for your 100 pairs of images), thus saving you a LOT of time to learn the software.
- You will receive software ready to go. We will give you written instructions for the software will be receiving.
- You will be provided with the various Identification Rates based on your 100 image pairs (i.e., false acceptance rate, false rejection rate.), based on 40,000 comparisons in an N: N Matching.

- These initial results will promote confidence and gather internal support from your company when you are seeking internal justification to establish a project.
- You will get an implementation roadmap. Attrasoft development experience will specify the required work and map the shortest path to the System Integration; most importantly, Attrasoft Services might prevent you from following a wrong path.

- Once a Level 1 Service has been completed, it will be easier to *Define* necessary performance requirements for a more in-depth Customized project as you will be more familiar with what functions are and are not available in the off-the shelf ImageFinder.

With **ImageFinder** Level 2 Service ($5,000), in addition to Level 1 Service:

- You will provide 1000 pairs of your own normalized images.
- We do all the work (i.e., tuning the off-the-shelf ImageFinder 70 open parameters for your 1000 pairs of images), thus saving you a LOT of time.
- You will receive software ready to go. We will give you written instructions for the software will be receiving.
- <u>The software you will receive will be a Far more accurate software than a Level 1 Service software.</u>
- You will be provided with the various Identification Rates based on your 1000 image pairs (i.e., false acceptance rate, false rejection rate.), <u>meaning, 4 million comparisons in an N: N Matching.</u>
- For some projects, a Level 2 Service may completely satisfy your requirements.

With **ImageFinder** <u>Level 3 Service</u> ($10,000 per year), in addition to Level 2 Service, you can:

- Get extensive **Consultation Help** from Attrasoft **throughout your entire Development Phase**, from device setup, data collection, layered approach, **up to the System Integration,** ensuring smooth development.

In all of the above cases, the off-the-shelf **ImageFinder** is used. However, because projects using Image Recognition are Pioneer Initiatives, it is sometimes necessary to make minor modifications to the **ImageFinder**; sometimes, a major effort will be necessary.

With **ImageFinder** <u>Level 4 Service</u> ($20,000), in addition to Level 3 Service, you can:

- Get a <u>**Customized ImageFinder** with Minor Programming Efforts</u> (<500 non-recurring engineering hours);
- Reducing the operation Complexity via Attrasoft tuning the 3000+ internal parameters to one specific image type;
- Speed Optimization;
- Internal Structure Optimization;
- Graphical User Interface Customization;
- Database other that Microsoft Access;
- Database Interface;
- Video Formats other than .avi files;
- New Image Preprocessing Filters;
- Customized Filters;
- Programming Library;
- Specific Symmetries or Combination of Symmetries;
- Attrasoft can implement any symmetry (or combination of symmetries) which can be described by mathematics;
- Further refinement Tuning for small image segments;
- Fine Tuning of the Neural Parameters;
- Digital Image Database (Combine **ImageFinder** with Database);
- Image Formats other than jpg and gif;

- Counting objects which are NOT physically separated;
- Reducing all images by the same amount without distortion to 100x100;
- Internet Image Search Engines;
- Multi-layers of image matching;
- Web Interface (solutions that will provide users with a searchable database using a web interface);
- Other Specific Needs.

See chapter 22.3 for **The Image Recognition Solution Development Procedure.**

25. Readme.txt

25.1 Software Requirement

Software Requirements:
(1) Windows (any version).
(1) Windows .Net Framework.
(2) Internet Explorer.

To get the latest version of .Net Framework, open Internet Explorer and click “Tools\Windows Update".

25.2 Installing the Software

1. If you have not done so, go to Internet Explorer, then click “Tools\Windows Update" to download Windows .Net Framework.

2. Click “CD:\setup.exe” to install the **ImageFinder.**

3. The serial number is the word “attrasoft”.

25.3 Image Recognition

Attrasoft ImageFinder matches whole images or image segments.

The ImageFinder can be used for:

- **Multiple Verification (1:1 Matching);**
- **Identification or Search (1:N Matching); and**
- **Multiple Identification (N:N and N:M Matching).**

The image recognition process is to push images through a set of filters:

Preprocessing Filters
Edge Filters
Threshold Filters
Clean-Up Filters
Reduction Filters
Unsupervised Filters
BioFilters
NeuralFilters
NeuralNet Filters

You will need two inputs, key and source. Then you will match the key against the source. The key has one image. The source can be 1 image (1:1 matching), N images (1:N matching). You can also match the source against source (N:N matching).

The whole image matching will use image signatures.
The segment matching will NOT use image signatures.

25.4 Image Signature

Image Matching is done through something called Image Signature. An image has a set of computed values called features. A collection of features is grouped into a signature.

Signature Menu computes signatures in the ImageFinder: the input is an image and the output is a signature.

In a 1:N Match, the 1-signature is computed at run time and the N-signature is computed in advance. To compute the N-signatures:

- Click the “Source” button to select a directory;
- Click “Signature/N Signature (a1.txt)” to compute the signatures in a1.txt.

Example. Select N-images:

- Click the Source button;
- Select image, ./input_file/2067(1).jpg, here “./” means the folder where the **ImageFinder** is located;
- Click “Signature/N Signature (a1.txt)”;
- Open “./data/a1.txt” to see the results.

25.5 Unsupervised Matching Example

An Unsupervised Matching process has three steps:

- Signature;
- Matching;
- Results and Analysis.

To get the N-signature file, a1.txt:

- Click the “Source” button, go to “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the Source “>” button a few times to see the images;
- Click menu item “Signature/N Signature (a1.txt)” to get the signatures in a1.txt file.

To make N:N Matching:

- Click menu item “Unsupervised/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

To make 1:N Matching:

- Click the “Key” button, in the “ex_label”directory, select the first image “L01008gi-020501.jpg”;
- Click menu item “Unsupervised/Matching/1:N (Key vs. a1.txt)” button to complete a 1:N Match.

25.6 BioFilter Matching Example

The BioFilter Matching will have four steps:

- Signatures
- Training
- Matching
- Analysis

The BioFilter training requires two files, t1.txt and match.txt:

- T1.txt is the signature file, which contains many signatures. Each image is converted into a signature.
- Match.txt is a list of matching pairs. This file will teach the ImageFinder who will match with whom.

To get the N-signature file, a1.txt:

- Click the “Source” button, go to “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the Source “>” button a few times to see the images;

- Click menu item “Signature/N Signature (a1.txt)” to get the signatures in a1.txt file.

Match.txt

- Open the file, “.\data\match_ex_label.txt”. This file lists 152 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- Click the “Source” button, go to “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the Source “>” button a few times to see the images;
- Click menu item “Signature/N Signature (a1.txt)” to get signature file, a1.txt file;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Note: Here t1.txt is for training and a1.txt is for 1:N Matching and N:N Matching.

Training

- Click “BioFilter\Training\Training” to train the BioFilter.

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “BioFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

1:N Matching:

- Click the “Key” button, in the “ex_label”directory, select the first image “L01008gi-020501.jpg”;

- Click menu item “BioFilter/Matching/1:N (Key vs. a1.txt)” button to complete a 1:N Match.

25.7 NeuralFilter Matching Example

The NeuralFilter Matching will have four steps:

- Signatures
- Training
- Matching
- Analysis

The NeuralFilter training requires two files, t1.txt and match.txt:

- T1.txt is the signature file, which contains many signatures. Each image is converted into a signature.
- Match.txt is a list of matching pairs. This file will teach the **ImageFinder** who will match with whom.

To get the N-signature file, a1.txt:

- Click the “Source” button, go to the “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the Source “>” button a few times to see the images;
- Click menu item “Signature/N Signature (a1.txt)” to get the signatures in a1.txt file.

Match.txt

- Open the file, “.\data\match_ex_label.txt”. This file lists 152 matching pairs. Save it to match.txt (overwrite the existing file). Now the training file is prepared.

T1.txt:

- Click the “Source” button, go to “ex_label” directory and select any file in the folder. This will specify the input directory.
- Click the source “>” button a few times to see the images;
- Click menu item “Signature/N Signature (a1.txt)” to get the signature file, a1.txt file;
- Click menu item “Signature/Copy a1.txt to t1.txt” to get the training file, t1.txt.

Note: Here t1.txt is for training and a1.txt is for 1:N Matching and N:N Matching.

Training

- Click “NeuralFilter\Training\Training” to train the NeuralFilter.

N: N Matching compares each image, a1.txt, with every image in the a1.txt:

- Click menu item “NeuralFilter/Matching/N:N (a1.txt vs. a1.txt)” button to complete a N:N Match.

1:N Matching:

- Click the “Key” button, in the “ex_label”directory, select the first image “L01008gi-020501.jpg”;
- Click menu item “NeuralFilter/Matching/1:N (Key vs. a1.txt)” button to complete a 1:N Match.

25.8 Neural Net Example

Neural Net matches an image segment.

Key Segment

- Click the “Key” button, in the “.\input_auto_track” directory, select image “IMAGE002.jpg”;
- Enter (200, 30, 180, 180) to the segment textboxes.
- Click the Segment button.

Training

- Click “NeuralNet/Training” in Figure 13.3 to complete the training. You should see this message:

  Training ...
  Training End!

To make a 1:N Matching,

- Click the “Source” button to select directory, “.\input_auto_track”, then select any file in this folder;
- Click “NeuralNet/Matching/1:N (Key vs Source)” to make a 1:N Matching (See Figure 13.3).

Results

To see where the matching segment is, there are three buttons (First set): F, > (Next), and < (Previous), that can be used to show where the matched segment is:

Click the “F” button to see the first matched segment;
Click the “>” to see the next matched segment;
Click the “<” button to see the previous matched button.

25.9 Batch File

Batch commands allow you to save your setting and to execute your problem in a few clicks.

- Click Batch/Save to save your setting;
- Later click Batch/Open to open your setting, and
- Click Batch/Run to run your problem.