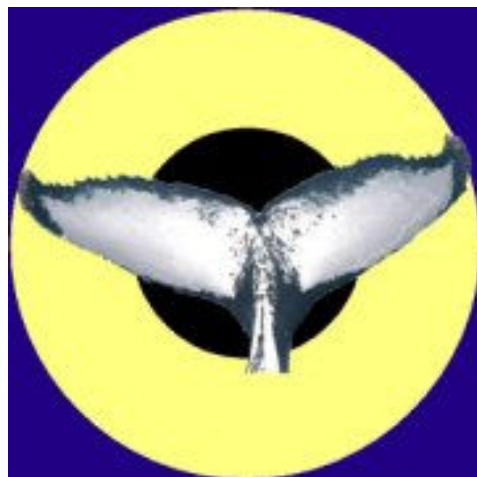


I³S Contour MANUAL

**Interactive Individual Identification
System**



September 2011, v3.0

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Interactive Individual Identification System - Contour version

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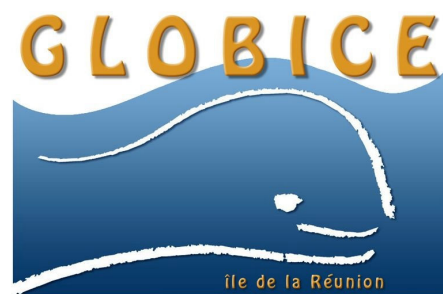
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1 Introduction to I³S Contour

1.1 What is I³S Contour?

I³S is an acronym of Interactive Individual Identification System. I³S Contour is an extension of the I³S system using the contour of e.g. the tail, dorsal fins or lining along the side. This name explains most of I³S Contour's functionality. First, we will focus on the interactive part. I³S Contour requires user interaction and is meant to support and not to replace the researcher. Initially, you have to point out the relevant part of the contour of the unknown individual animal. I³S Contour has a semi-automatic tracing algorithm which tries to find the optimal contour between the points selected by you. In the next step, I³S Contour assists you in the tedious task of matching animals for identification purposes. It automatically matches an annotated image of an unknown animal with all annotated images in the identification database and shows a ranked list of images. However, you will always be responsible for making the final match between the unknown image and an image from the identification database. Please note that we distinguish between your database with all images taken and the identification database. The identification database contains only the best images of known individuals and preferably 3 to 5 of each individual.

I³S Contour is the third release in a series of related software tools. The first was I³S (now referred to as I³S Classic). This package is based on annotation of the spot centers and is used for animals with lots of similarly shaped spots such as whale sharks. The second package was named I³S Manta. I³S Manta focuses on animals with less spots and more variation. Instead of annotating the centers only, spots are annotated by the closest fitting ellipse around each spot, in this way taking spot size and shape into account.

We refer in the remainder of this manual to I³S Contour as I³S.

1.2 The algorithm

To help recognize individual characteristics like the tail flukes of whales, I³S first traces and extracts the fluke contours of the unknown tail. The image should be taken ideally perpendicular to the line of sight and no more than 30 degrees off that line. The algorithm for automatic tracing and extracting the contour is based on the algorithm as described by Eric N. Mortensen and William A. Barrett in their paper on '*Intelligent Scissors for Image Composition*' [1].

For contour tracing, the goal is to find the optimal path between a start node and a set of goal nodes. This means finding the globally optimal path from a start pixel to a goal pixel where the pixels represent nodes and edges are created between each pixel and its 8 neighbors. Optimality is defined as the minimum cumulative cost path from a start pixel to a goal pixel where the cumulative cost of a path is the sum of the local edge (or link) costs along the path.

PLEASE DO NOT accept the results from the *automatic* contour tracing too easily. It is essential that the contour is an exact fit to the image. The automatic tracing algorithm frequently results in small errors, especially if the body part overlaps with e.g. the waves or the horizon. In this case you should take smaller steps or use the *manual* algorithm.

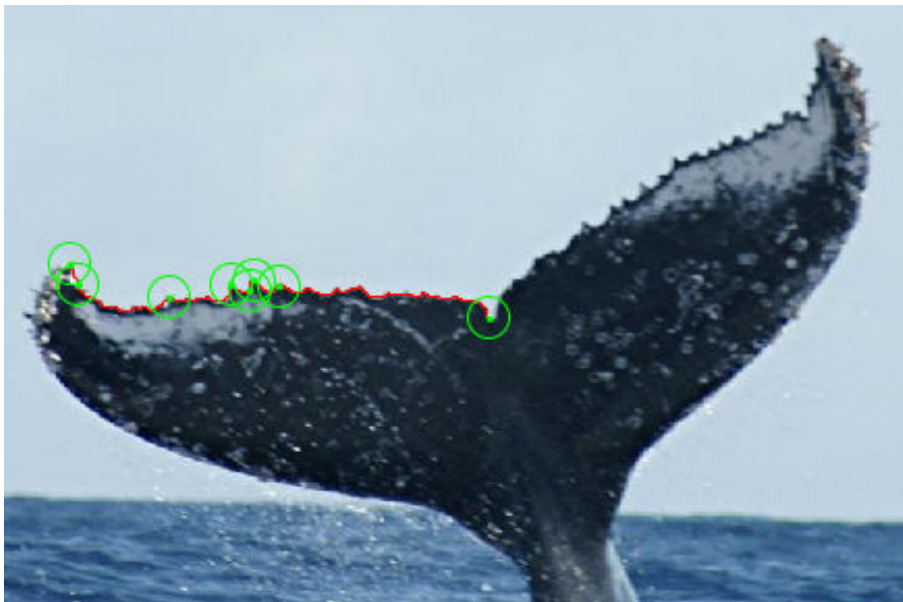
The next step is to match the contour with all identified contours in the identification database. The contour matching software is based on the ideas from the EUROPHLUKES project (for more



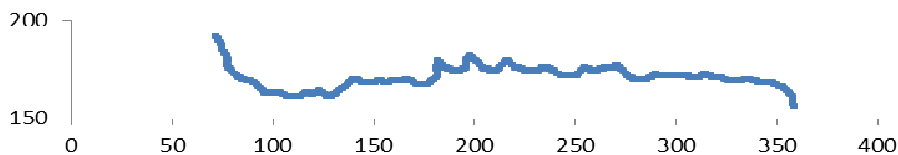
information see [2] and [3]) developed by the Center for Mathematics and Computer Science in Amsterdam (CWI). Version 3.0 contains a completely new implementation based on their ideas.

To be able to compare two contours it is essential to transform them into a single common space. This is done in a number of consecutive steps:

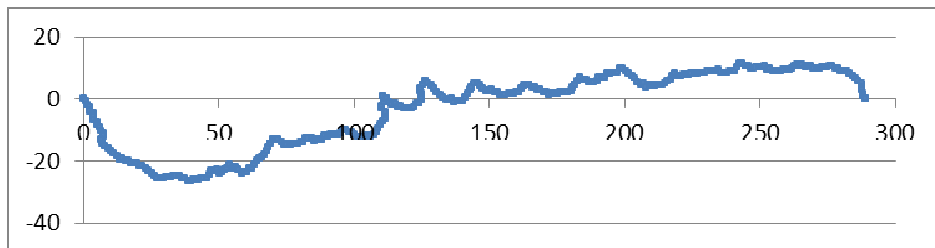
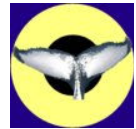
1. Translation and rotation. The entire contour is translated such that the start of the contour has coordinates (0,0). Simultaneously, the contour is rotated to start and end at the x-axis (Figure 1-1a, b and c).
2. Scaling. The contour is scaled to have the last point on the contour end at (500,0) (Figure 1-1d).
3. Histogram. To allow for fast comparison the area below each line piece in the contour is discretized into 500 bins. Each bin represents the total area below the contour in this bin (Figure 1-1e).



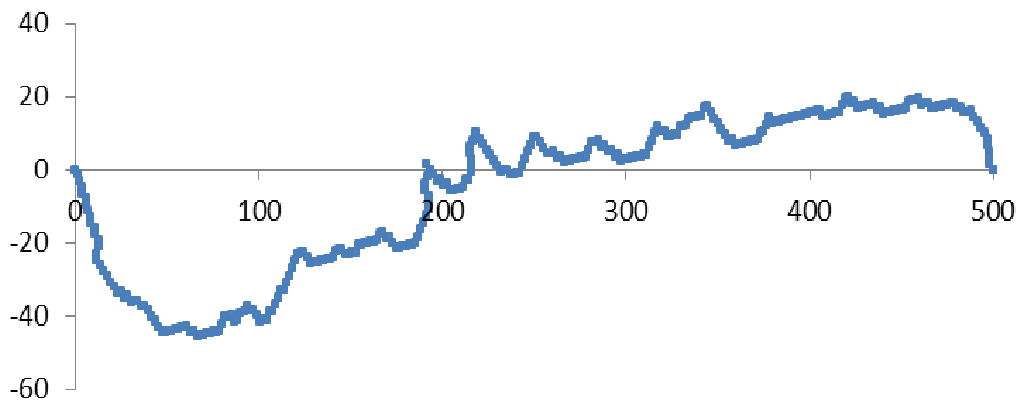
(a) The original image. Only the left fluke is annotated.



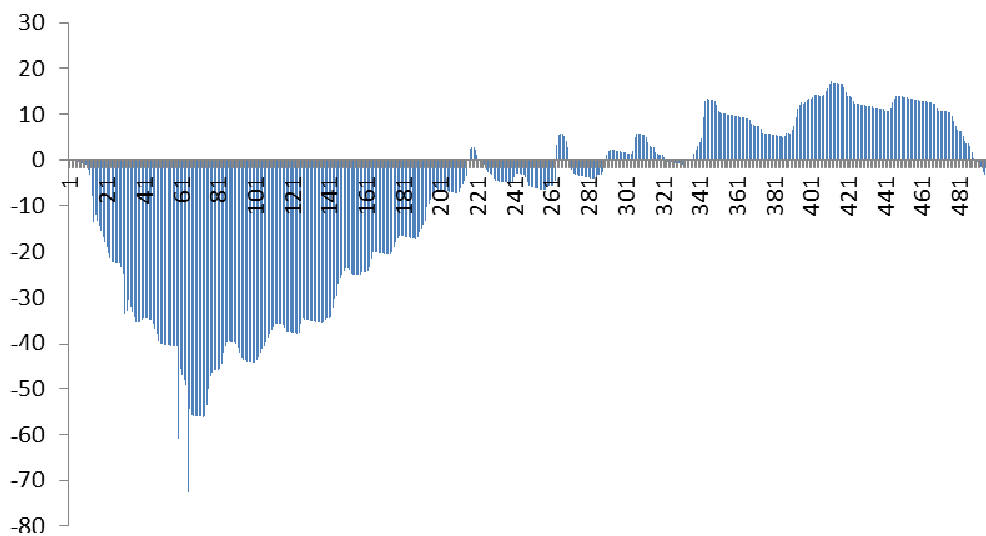
(b) The extracted contour pixels of the left fluke.



(c) The contour after translation and rotation.



(d) The contour after scaling.



(e) The final histogram for fast comparison.

Figure 1-1: Transforming the contour into a normalized space.

Comparing two histograms is as simple as comparing the 500 bins one by one and calculating the total absolute difference. The more they overlap the better the match (a perfect match will result in



score 0). This simple operation can be carried out very fast. However, in practice various circumstances will make the straightforward comparison fail. The main reasons are:

1. The body part is not photographed from an exact perpendicular angle. Tilt for example, may influence the amplitude of the contour function.
2. The body part, especially the tail, is not a rigid shape and subject to various distortions.

To find an optimal match between two contours, one of the contours is simultaneously rotated, scaled and translated in a brute force approach. In pseudo-code the algorithm looks like this:

```
// Comparing contour C1 and C2
For all angles between -5° and +5° do
  Rotate C1
  For all scales between 25% and 400% of the original size do
    Scale C1
    For all shifts between 25 bins to the left and 25 bins to
      the right do
      Shift C1
      score = compare(C1, C2)
      If score < bestScore then // lower score is better match
        bestScore = score
      Endif
    Endfor
  Endfor
Endfor
```

To speed-up the algorithm, the brute force approach is first carried out with relatively large steps in all three for-loops. Around the best angle, scale and translation found in this coarse approach, the algorithm is repeated but now with much finer steps. The best match found in the fine approach is ultimately the final score between two contours.

In case of a whale tail with two fluke contours, the algorithm is repeated for the other fluke and the average of the two flukes is returned for the entire image.

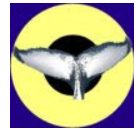
I³S finally gives a ranked list of potential matches with images from the identification database. These images can be shown so a visual comparison can be made. You always have to make the final decision in the comparison. The better the match, the lower the score. The best possible score is zero or close to zero.

1.3 I³S Version numbering

Version numbers are related to I³S Classic and I³S Manta. So even though I³S Contour is new, the current version is version 3.0. Most of the underlying software for metadata and user interfacing is an update of existing software from I³S Manta v2.1, hence the v3.0 version of I³S Contour.

1.4 I³S Updates

I³S will automatically check for updates and new releases. This feature will be implemented in all I³S software packages in version 3.0 and higher. Every 30 days, upon start-up of I³S, it will check for



updates. If an update is available, it will ask you if it should download and install a new version. After each update I³S will ask if you want to see the release notes on the website.

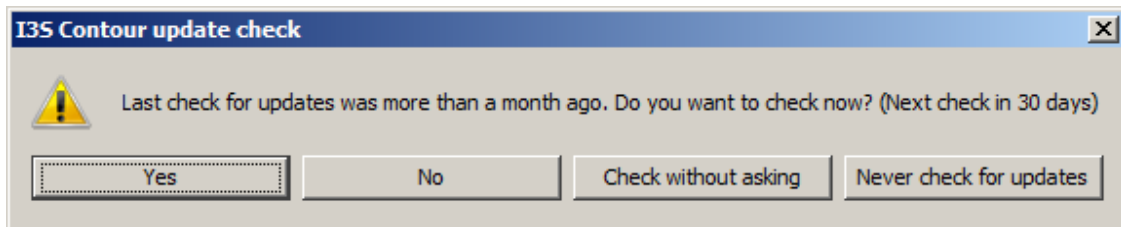


Figure 1-2 Update check.

Please note that downloading and installing updates only works in Windows Vista or Windows 7 if *User Account Control* is turned off and if you have sufficient rights. UAC prevents Java to copy files to protected locations such as `C:\Program Files` even if you have administrator rights. You can manually set this parameter via the *Control Panel* of your computer.

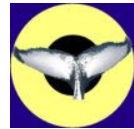
1.5 Reading this document

In this document all file name, directory names and shell commands are written using the font `Courier New`. All names relating to a part of the I³S user interface, such as `button names` or `menu options`, are boxed.

1.6 Bug reports, comments and requests

Please send all bugs, comments and questions to `i3s@reijns.com`. In case of a bug, describe clearly how we can reproduce the bug ourselves. If possible provide us with all relevant data such as images and fgp-files. We will always treat your data as confidential. Data will not be distributed to others without your explicit consent.

An error log file will be written in the `_ErrorLogs` directory in your data directory when internal errors are reported by the software. This file (or files) can also be sent to the I³S team along with any bug report.



2 Installation of I³S Contour

2.1 System requirements

This version of I³S requires a Windows 32-bits or 64-bits operation system (XP/Vista/Windows7). The software is developed using Java 1.6/1.7 and C++ (MS Visual C++ 2008 Express edition). Both Java and most of the C++ code are platform independent and it should therefore be relatively simple to port it to other platforms such as Linux or Mac OS.

Hardware requirements are at least 1024 MB of memory (preferably 2048 MB or more), and a 1 GHz CPU or faster. Increase of the identification database to hundreds of images will increase the minimal requirements on CPU speed but will have a limited impact on the memory requirements. Comparison is linear in computational requirements, i.e. an identification database with twice the number of individuals will require twice the time to compare.

2.2 Software and data requirements

Because the main program is developed in Java, the Java Run-time Environment (JRE) is required. **This distribution will only work with JRE version 1.7.0 or higher!** The JRE 7 (or higher) can be downloaded for free from the Java website (<http://www.java.com/getjava>) or the Oracle website (<http://www.oracle.com/technetwork/java/javase/downloads/java-se-jre-7-download-432155.html>).

Note: I³S currently only works with the 32-bits version of the JRE. I³S has been developed on a 64-bits version of Windows 7, however with a 32 bits JRE. If a 64-bit JRE is installed I³S will report an error while loading a dll.

I³S supports both JPEG (extension .jpg) and GIF (extension .gif) images. Support of other image types is currently not foreseen as all known digital cameras can store images as JPEG.

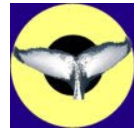
2.3 Installation

Make sure you have administrator rights and turn User Account Control off. UAC prevents the proper installation of the Windows environment variables.

Run the file `I3SC_v3.0_Setup.exe`. If your current Java version is not sufficient you will be notified and installation terminates. It is required to install the Java Runtime Environment 1.7.0 or higher first.

Apart from some information about the GNU-license, the installation consists of the following steps:

1. Choosing the home directory where to install the program. Default will be in the directory `C:\Program files\I3SC` or `C:\Program Files (x86)\I3SC` in case of a 64-bits OS.
2. Choosing whether you want to store an example data directory with image and fingerprint files.
3. You can indicate if you want I³S to create a folder in the Start menu folder.
4. Finally, you can select some additional tasks:
 - a. Creating a desktop item.
 - b. Copy tutorial examples in the installation directory.
 - c. Copy the source code. Only if you are interested in using or changing the source code you need to check this item.
5. If you selected to copy the tutorial images, you will be asked for the location.



Because an environment variable has been added you are asked if you want to restart the computer now or later. I³S will not work properly until you restart the computer or logout and login again.

If you want to install I³S under another account this is possible. At start-up the application will search for the I3SC_INSTALL environment variable which has as value the directory where I³S is installed. The default location is C:\Program Files (x86)\I3SC. The installer creates this variable in the HKEY_LOCAL_MACHINE section of the registry which means that it is available for all users. If this variable is not found, the application terminates. At the first start-up of another user select an existing database or create a new database.

2.4 Uninstall

You can uninstall I³S in two simple steps:

1. Uninstall I³S, using the entry in the start menu folder.

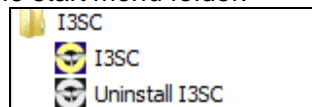


Figure 2-1 Uninstall via start menu.

2. Optionally you can also uninstall the Java Runtime Environment (JRE). In general it is not a good idea to uninstall JRE without replacing it for a newer version because other programs may depend on it. However, if you still want to uninstall JRE use the standard procedure: Select Programs and Features in the Control Panel. Then select the appropriate item from the list and click on the Add/Remove button.

2.5 Tutorials

Examples are shown in our instruction videos. These video's are available online at our website http://www.reijns.com/i3s/download/I3S_download.html.

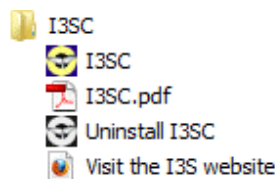


Figure 2-2 I3S Contour Start menu

The following tutorial topics are available:

1. Easy annotation.
2. Difficult annotation.
3. Search.
4. Using metadata.
5. Editing metadata.
6. Adding a new database.



3 Data management

3.1 Introduction

I³S compares unknown images with an identification database consisting of a collection of image-fingerprint pairs. In this document, with identification database a structured directory containing the collection of all known images used for reference by I³S is meant. Possibly you will have another database or collection of unknown images, but that is considered an entirely different database.

A fingerprint file containing all information added in the annotation process accompanies each image file. Always treat these images as an inseparable pair. If you move one of the files manually to another directory you should always move the other file along.

Previous versions of I³S only allowed one identification database. At installation the user had to select a specific directory where the data was stored. Multiple identification databases (either other types of animals or other locations) were not supported and resulted in the need to rename and swap database directories.

I³S Contour v3.0 allows you as many identification databases you need. The locations of data directories are stored at an individual level (specific: in the registry in `HKEY_CURRENT_USER`), so it is possible to have multiple users using the same pc or laptop and manage their own databases as well as manage shared databases.

All database management is found under the menu item **Database**, see paragraph 4.1.3 for details on their use.

3.2 Database type

Currently, I³S Contour supports three database types:

1. **Whale tail.** Choose this option when you have two contours simultaneously visible.
2. **Dorsal fin.** This option is suitable for body parts which have a left and a right view such as a dorsal fin. When choosing this type the metadata elements will automatically get a field named 'view' with possible values 'left' and 'right'. For each image it must be clear which side is viewed because when comparing a left and a right view image the contour has to be mirrored.
3. **Generic.** The last option is suitable for any animal with a single contour per image which can only be viewed from a single side, such as the contour between the dark and the light half of a white shark.

3.3 I³S management tools

I³S offers the following tools for data management:

1. **Search in database** Compare an annotated image against the entire identification database and show a ranked list of results. The lower the score, the better the match.



2. **Insert in database** Add an annotated image to the identification database. Either add it to an existing individual or insert it as the first image of a new individual.
3. **Reload database** In case you have manually added or removed files to the identification database directory you can reload the current database to incorporate the changes.
4. **Change database** Load another database from the list of known databases.
5. **New database** Start a new identification database and add it to the list of known databases.
6. **Edit database list** Remove a directory from the list of known identification databases or add a directory. The latter is used to add an existing identification database.
7. **Edit metadata** Edit the metadata structure of the current identification database.

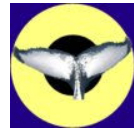
3.4 The database directory

All data in an identification database is structured by means of a directory tree. Images are stored in a separate subdirectory for each individual in the identification database. Each image is described by its contour(s) and by means of metadata fields stored in the fingerprint file with extension `.fgp`. In older versions of I³S, the sex and various views were stored by means of subdirectories under the subdirectory for the individual. Starting with v3.0, sex and views can be covered by the metadata structure. You are however required to define this yourself.

The top-level directory of an identification database contains for all known individuals a corresponding directory, the file `metadata.xml`, a directory named `_ErrorLogs` for error reports by the software, and an optional directory `_SearchResults` with the outcome of the various searches.

For example:

Directory	Description
C:\I3S\WhaleData	Top-level directory. It contains directories for the individuals Jimmy, Ronald, George and Bill and the directory <code>_ErrorLogs</code> .
C:\I3S\WhaleData\Jimmy	This subdirectory contains image and fingerprint files <code>Jimmy001.jpg</code> , <code>Jimmy001.fgp</code> , <code>Jimmy002.jpg</code> , <code>Jimmy002.fgp</code> .
C:\I3S\WhaleData\Ronald	This subdirectory contains image and fingerprint files <code>Ronald.jpg</code> , <code>Ronald.fgp</code> , <code>Ronald2.jpg</code> , <code>Ronald2.fgp</code> , <code>DSC_00261.jpg</code> and <code>DSC_00261.fgp</code> . The naming of the latter two files is not very useful as it does not refer to the individual Ronald. When it shows up in the result list it will not be clear which individual is meant. However, it is not illegal.



The subdirectories for individuals should only contain image files and fingerprint files (extension `.fgp`). Other file types are ignored. The image files should be of type JPEG (extension `.jpg` or `.jpeg`) or GIF (extension `.gif`). Each fingerprint file corresponds with the identically named image file (apart from the extension). A fingerprint file contains all the contour and extra information of the corresponding image file. The sample identification database provided with the distribution contains several individual humpbacks (i.e. subdirectories).

At start-up, I³S looks up the list of known databases. In case the list contains only one, this database is loaded directly. If the list is empty, you have to create a new identification database first or select an existing database. In case the list contains more than one, you are asked to select a database. After selection, the application starts to parse all the fingerprint files in the corresponding individual subdirectories. All fingerprint files are stored in memory for quick future reference during execution of search tasks. Since the fingerprint files are quite small (usually a few kilobytes) the memory use of the database will be limited.

3.5 Metadata

Each identification database has its own metadata definition. For example it is possible to define metadata fields to indicate length, size, sex, scars, or whatever you want to define for an individual. When searching the identification database, it is possible to search on the metadata as well. The exact metadata definition is stored in the file `metadata.xml` stored at the top of a database directory. It is strongly advised not to edit this file manually but to use the graphical interface provided by I³S for this purpose.

I³S currently supports four types of metadata fields: `number`, `smallmediumlarge`, `yesno` and `Custom`. The `number` format will accept any number such as 0, 12, 4.2 and -5. The type `smallmediumlarge` is a variable with three possible values (small, medium and large). Analogous, the `yesno` type is a Boolean variable with values yes or no. `Custom` lets you define a discrete set of values yourself.



4 The I³S user interface

This chapter will address the possibilities of the I³S user interface. First, the menu bar and toolbar are described. Next, the interaction with the annotation panel is discussed.

4.1 The menu bar

I³S offers a standard Windows look & feel menu-based interface to perform most operations. In the paragraphs below, the current five menu items will be briefly discussed. An overview of the title and menu bar is shown in Figure 4-1. The title shows the application name version and some details about the database: name, type and between brackets the number of fingerprints (not individuals) in the database.



Figure 4-1: The I³S menu bar.

4.1.1 The File menu

This is the main I³S menu. Figure 4-2 shows the various operations, which are discussed below:

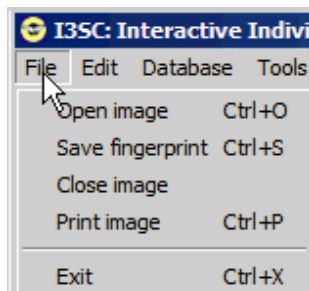


Figure 4-2: the file menu.

- **Open image** (shortcut **CTRL+O**). It will open a window to choose an image file. The supported image types are JPEG and GIF. The starting directory will be the value in the environment variable `I3SC_DATA`. If an image file has a corresponding fingerprint file (i.e. the same name but extension `.fgp`) a whale tail logo is shown, a standard image logo otherwise. The logos are shown below:



- **Save fingerprint** (shortcut **CTRL+S**). If you have been tracing a contour in an image this operation will write a fingerprint file in the same directory as the corresponding image together with any metadata. Apart from the extension, which is `.fgp`, the name will be identical to the name of the image file.
- **Close image**. It closes the image in the main window. If you have unsaved data I³S will prompt you whether you want to save the data first.



- **Print image** (shortcut **CTRL+P**). It will print the current image including comments (see paragraph 4.2).
- **Exit** (shortcut **CTRL+X**). This operation will close all windows. In case of unsaved data I³S will prompt you whether you want to save the data first.

4.1.2 The Edit Menu

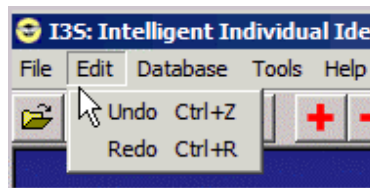


Figure 4-3: The edit menu.

- **Undo** and **Redo** are completely analogous to standard Windows functionality. The last 500 edit actions are kept in memory (Shortcuts: **CTRL+Z** and **CTRL+R**).

4.1.3 The Database menu

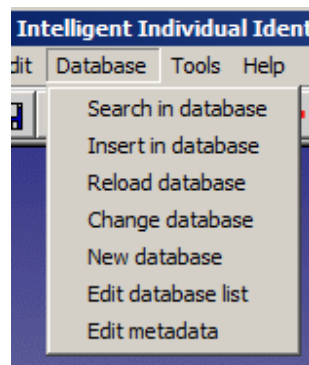


Figure 4-4: The database menu.

- **Search in database** will compare the current image with the rest of the identification database. See Chapter 5 for details.
- **Insert in database** In case of a loaded and annotated image, selecting this operation will allow you to add a new animal (i.e. a new subdirectory) to the identification database. This operation pops up a new window first that will prompt you for the name of the new animal. Selection of the checkbox **Rename file** will allow you to change the name of the image (note: not only the name of the animal which is determined by the subdirectory name, add a number, date, etc. as well). Since the results of a search operation only shows the names of the best matching images, it makes sense to make sure all filenames clearly indicate the name of the individual animal. By pressing **Ok** the image and its fingerprint file are copied (not moved) to the appropriate directory in the identification database. The figure below shows an example. If the file has been renamed, you are asked whether the original file needs to be renamed as well.

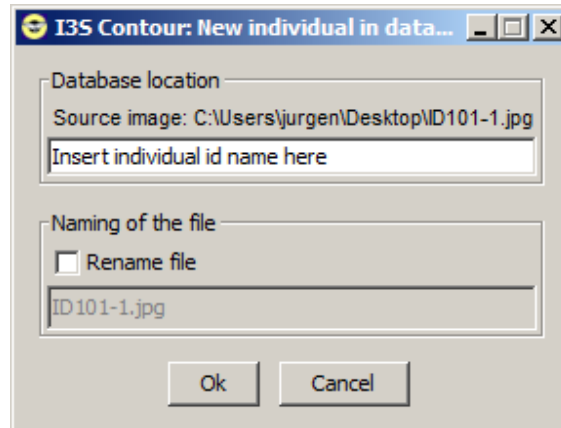
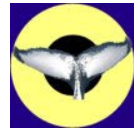


Figure 4-5: Insertion in the identification database.

- **Reload database** If the identification database has been changed, i.e. fingerprint files have been manually added or removed using e.g. Windows explorer, this operation will reload the entire database. You do not have to call this operation after insertion of a new animal in the identification database. In this case, I³S will reload the database automatically.

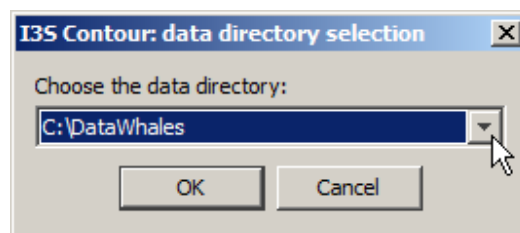


Figure 4-6: Changing the database.

- **Change database** If you have multiple identification databases it is possible to load another identification database without exiting the application. This menu option will offer you a list to choose the database. Choosing the current database is identical to **Reload database**. Before changing the database, open files are closed and/or you are asked whether to save first.
- **New database** If you want to create a new identification database choose this menu option. First, you are asked to select a **new** directory, either by typing it in at the text field **Folder name** or selecting the **Create new folder** button. Figure 4-7 shows the window. When you nevertheless choose an existing directory, the application will ask to create a new directory within the chosen one. After selecting a new directory, you are offered a window to specify the database (e.g. type, metadata). This window is almost identical to Figure 4-11.

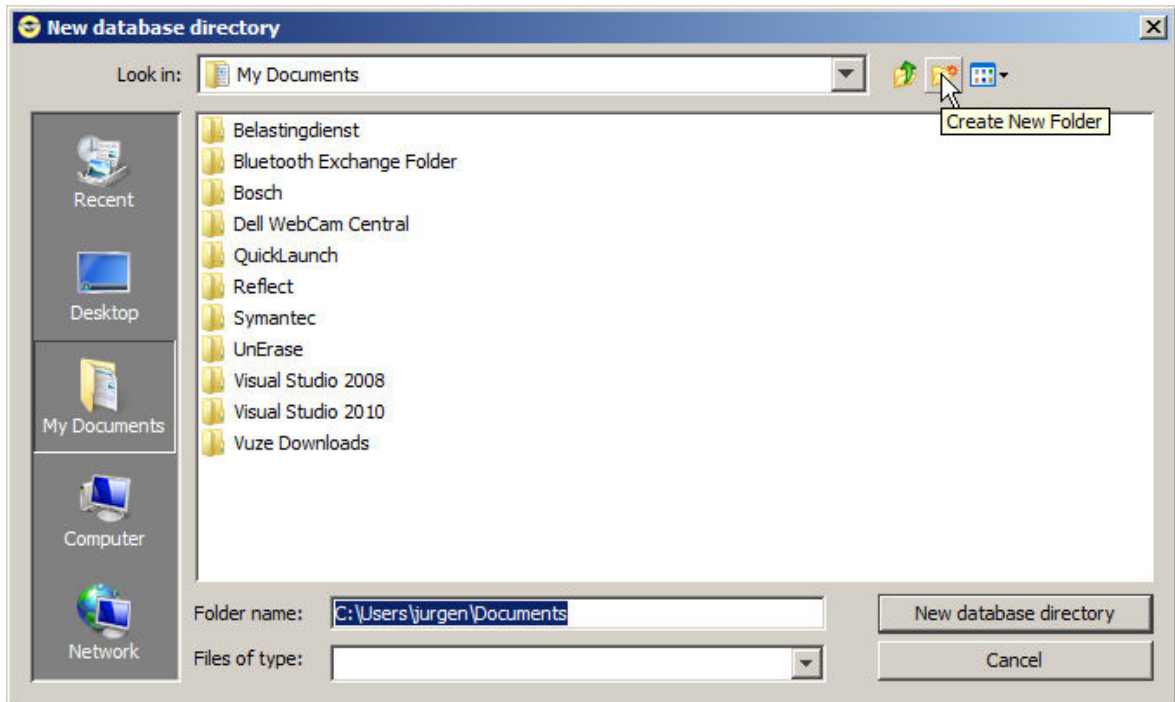
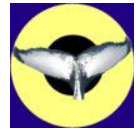


Figure 4-7: The first step in creating a new database, directory selection.

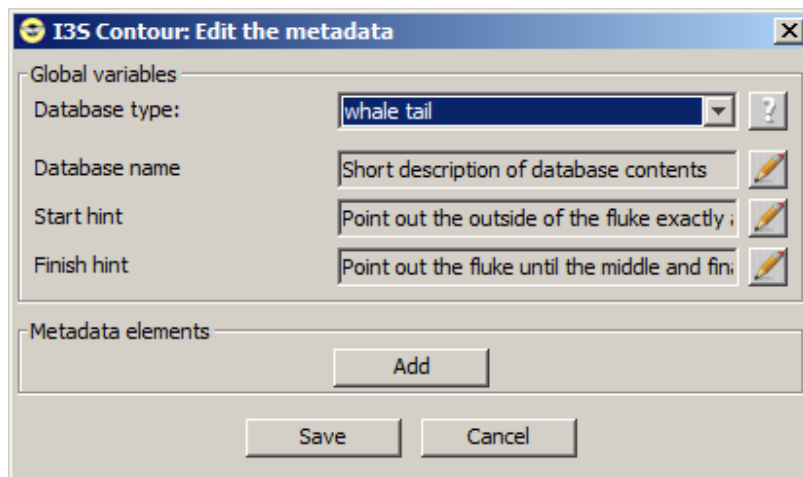
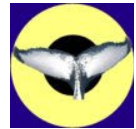


Figure 4-8: Setting-up the database.



Figure 4-9: The three database types: 'whale tail', 'dorsal fin' and 'generic'.



The most important selection to make is the database type. Three options are available:

1. Whale tail. Choose this option when you have two contours per individual.
2. Dorsal fin. This option is suitable for body parts which have a left and a right view such as a dorsal fin. When choosing this type the metadata elements will automatically get a field named 'view' with possible values 'left' and 'right'. For each image it must be clear which side is viewed because when comparing a left and a right view image the contour must be mirrored.
3. Generic. The last option is suitable for any animal with a single contour per image which can only be viewed from a single side, such as the contour between the dark and the light half of a white shark. This contour, unlike dorsal contours, will not be mirrored during comparison. Of course, you can have left and right side images of a white shark or other animal. With a metadata field "view" you can distinguish between multiple views.

Other variables to specify are the database name. Type in a concise name as it is also shown in the top of the main application window. 'Start hint' and 'Finish hint' is the text shown in the instruction field during annotation (see also paragraph 4.2). The start hint is shown before the starting point is selected, and should indicate how to select the starting point. The finish hint is shown after the starting point is selected and it should give instructions where to end. Further, it is possible to add a number of metadata fields to the identification database.

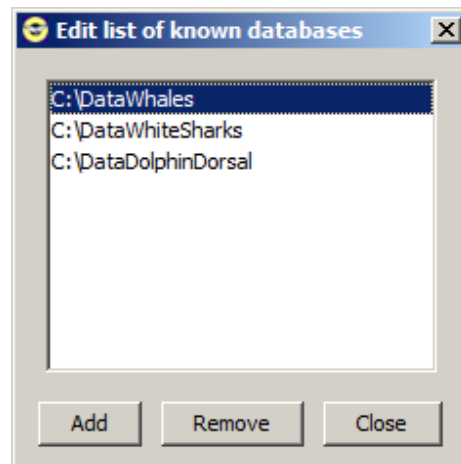


Figure 4-10: The window to edit the database list.

- **Edit database list** If you want to remove an old database from the list of known databases or add an existing database directory you can use this option. Figure 4-10 shows the corresponding window. **Remove** deletes the selected directory from the list. **Add** lets you select an existing directory and adds it to the list without checking whether it is a valid identification database directory (this will happen when the database is actually loaded).

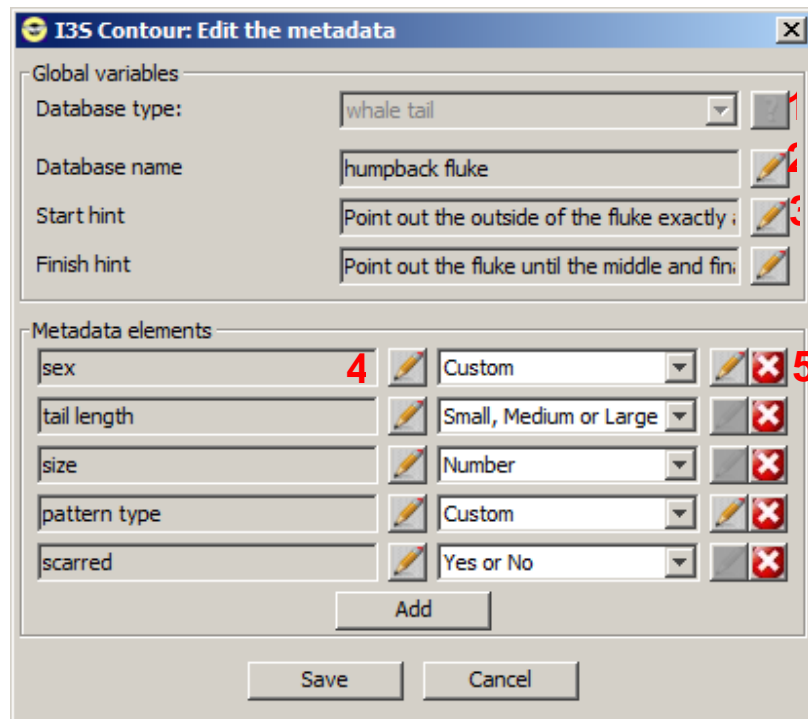


Figure 4-11: The window to edit the metadata.

- **Edit metadata** This last option allows to edit the metadata fields for the current database. Figure 4-11 shows the window.

The red numbers 1 to 5 indicate some important aspects of this window:

1. The database type. Please note that this field is 'greyed out'. The database type can only be established at creation of the database and cannot be altered afterwards.
2. The field database name defines the name which is shown in the title of the application. Press the button to alter the name. When editing a field, it is not possible to select other buttons, except **Cancel** or again to save the result.
3. Start hint and finish hint are texts which are shown during annotation to help users to annotate properly.
4. Use the left column of buttons to edit the names of the metadata elements. When the database type is 'dorsal fin' the element 'view' with values 'left' and 'right' is obliged and as a consequence, this element cannot be edited or removed.
5. Press the button to remove the field. Press the button to edit the names of the custom field type. This button is only available for type custom as only this type allows you to define a list of possible values. When pressing this button the window is enlarged to show the fields to edit the possible values. Figure 4-12 (left) shows the result after pressing for element 'edit'. All other elements are greyed out, except for **Cancel** and the buttons to edit the fields for the custom element. The minimum number of values must be two, the maximum is limited to 10. **Close editor** stores the list of values (if valid) and returns the window to the previous state.

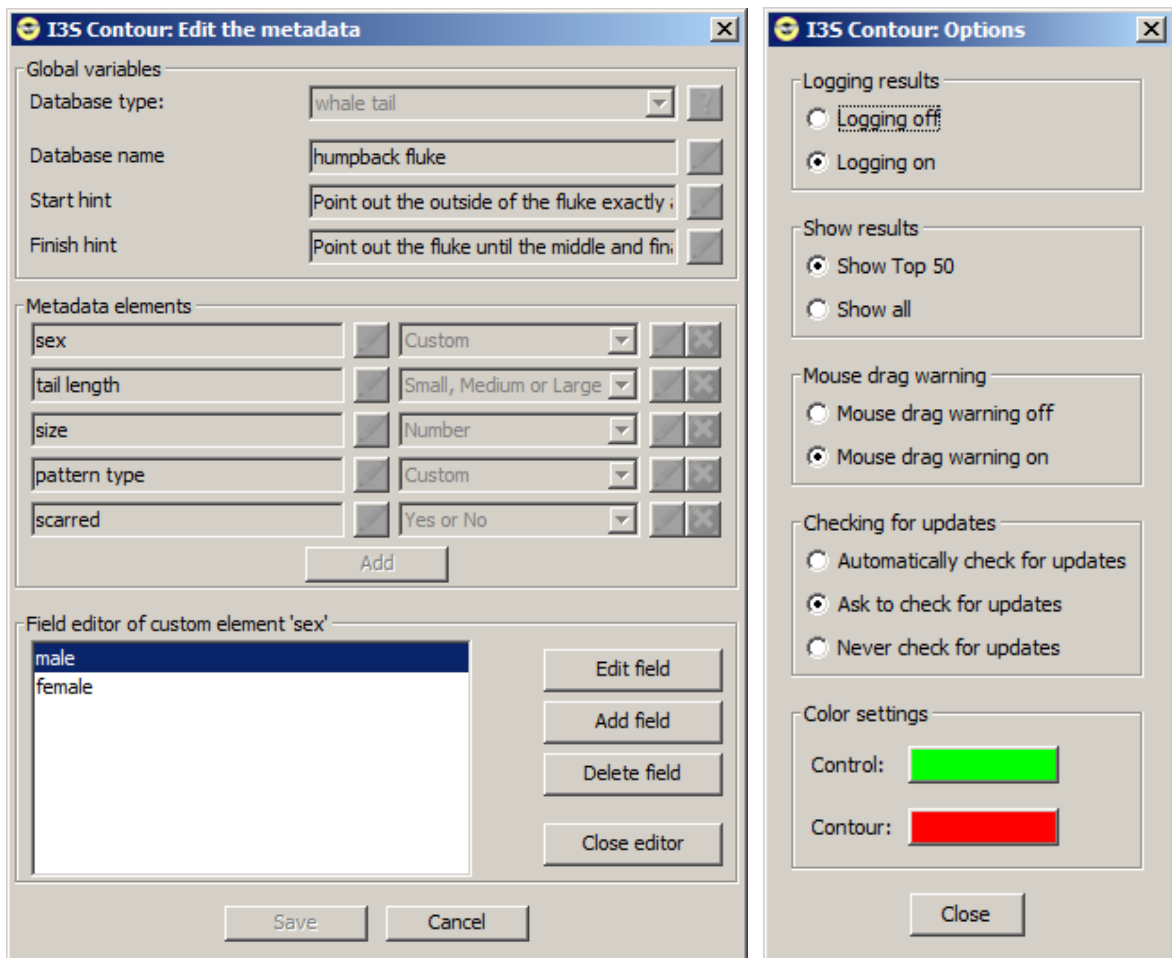
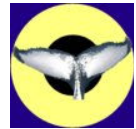


Figure 4-12: The enlarged metadata edit window (left) and the Options window (right).

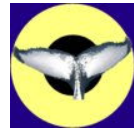
4.1.4 The Tools menu

Options will pop-up the window shown in Figure 4-12 (right).

The first part **Logging results** of the options window concerns the automated logging of the searches performed. If logging is on, the outcome of each search will be written to a file in the database directory (subdirectory `_SearchResults`).

The naming of the file is `SearchResults__<date>_<time>.log`. For example, a search on the second of July 2010, at the time of 17:22:10 will be written to the file named `SearchResults__20100702_172210.log`. The content of the log file is identical to the results in the search results window. Each line contains a filename and the score separated by tabs. Excel can process this format.

The second part **Show results** can be used to indicate whether you are interested in the top 50 of best matches or the entire identification database. This choice will affect both the logging and the search results window.



Next you can choose whether you want to get a warning when you drag your mouse during contour annotation. I³S requires you to keep the mouse completely still when clicking a point on the contour. If you have once chosen never to be bothered ever again you can correct this here.

The fourth part allows you to choose the interaction with respect to updates. When choosing **Automatically check for updates** the software will check periodically without interaction. Only when an update is found you will be asked whether you want to install. **Ask to check for updates** will make sure I³S gets permission before an update check. **Never check for updates** will make sure I³S never bothers you about updates, unless you manually choose **Check for updates** from the help menu.

The last part named **Color settings** allows you to select which colors to use for the annotation elements. This can be particularly helpful if the species under study happens to show colors similar to the default colors used or if you are color-blind.

4.1.5 The Help menu

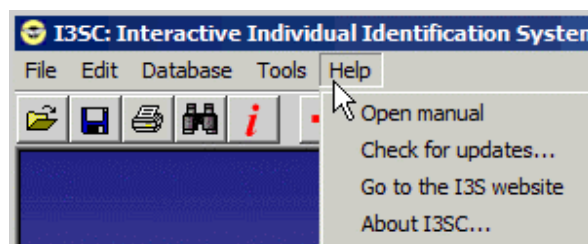


Figure 4-13: The Help menu.

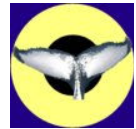
- **Open manual** will start your default pdf reader and open the manual.
- **Check for updates...** will check if there are updates. If an update is available you will be asked only once to install at the next start-up of I³S, even if update checking is disabled. For successful installation Windows User Account Control has to be turned off.
- **Go to the I3S website** will open your default web browser and show the I³S website.
- **About I3S...** shows a window with information on version number, authors, copyright and contact details.

4.2 The tool bar








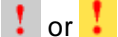
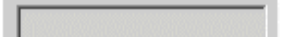




Below the menu bar I³S shows a tool bar, which offers short cuts to functions described in the previous paragraphs and some new functions. An overview of the tool bar is shown in Figure 4-14.



Figure 4-14: The tool bar.



The table below describes the various items in detail.

	Open file. Button for the menu option described in paragraph 4.1.1.
	Save file. Button for the menu option described in paragraph 4.1.1.
	Print file. Button for the menu option described in paragraph 4.1.1.
	Search. Button for database search described in Chapter 5. A keyboard shortcut is ALT+S .
	Edit the information field. Each fingerprint file contains an information field. Upon pressing the button, a metadata editor is opened (see paragraph 5.1 for details).
	Show the normalized contour and corresponding histogram of the contour(s).
	Controls for zoom. Pressing the plus will zoom in on the image. If the enlarged image does not fit the screen two sliders will appear. The mouse wheel can also be used for zooming. The minus will zoom out. The zoom factor is displayed right of the minus. The maximum allowed zoom factor is 1000%.
	Change indicator. If the annotation has changed the button becomes yellow until the fingerprint is saved.
	A field, which will show instructions during annotation. The field is larger in the application.
	In case of automatic contour annotation between user defined control points this button is yellow. Automatic contour tracing is the default.
	If automatic tracing fails pressing this button will switch to manual annotation. In this case straight lines are drawn between subsequent control points.
	An annotation may consist of two contours (flukes). The button, which is yellow, indicates which fluke is currently available for annotation. In case of dorsal fin or generic database types these buttons are not available.
	A contour can be active or final. An active contour is not annotated or is being annotated. When finished you are required to mark this by pressing final.



<p>N / A</p>	<p>Only in case of database type 'whale tail' there are two contours per image, most likely flukes of a whale tail. Only in this case it may happen that only one of the contours is of sufficient quality. If a fluke is of very poor quality and not suitable for annotation, you should press N/A. When a fluke is already annotated, choosing for not available will not discard your work. The contour will be shown in a lighter color to indicate it is not used. If you reconsider you can make it active or final again without re-annotation.</p> <p>If the database type is not 'whale tail', this button will not be available.</p>
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4.3 Contour annotation

A contour is annotated by clicking with the left mouse button along the contour. Before and after the first interaction the application will show a different help text how to annotate. The software will follow the contour automatically between two selected control points. Clicking the right mouse button will remove the last control point and the corresponding contour part. For details on the annotation you are referred to the tutorial videos available on our website on the download section. of the website. To prevent problems with video codecs the videos are made available as executables.

The better the contour quality the better the results. In case the automatic tracking gives (even small) errors, make the distance between the control points smaller or select manual tracking and apply it in very small steps to get around difficult parts.



5 Searching and using metadata

This chapter discusses the search process in more detail. First, the options to add metadata are discussed. Next, the search process is described in detail.

5.1 Adding metadata

I³S allows you to add metadata to an image. Metadata is additional information, which describes the individual, or perhaps the conditions in which the image was taken. If you press the **i** button in the toolbar a new window pops up. The window is shown in Figure 5-1.

The upper text field allows you to store plain text. There is no limitation to its length. If no text has been added yet, the string 'Empty comment field' is shown.

The **Metadata elements** field below allows for a more structured input. Four types of fields are available: numeric, general size with three possible values (small, medium, large), Boolean (yes/no) and enumerator. The latter is a finite user defined set of values. The window below shows an example of each type. The numeric field expects a number using the keyboard. Selecting a value from the dropdown menu sets the other types. I³S allows you to include metadata elements in the search process described below.

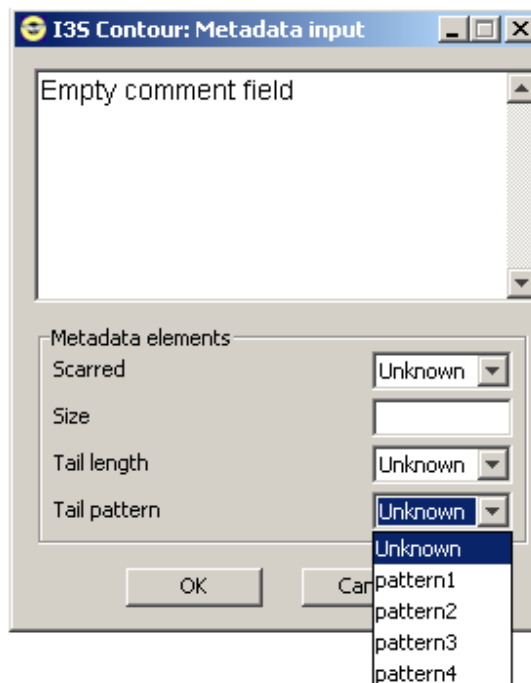



Figure 5-1: The metadata window.

The metadata fields are not fixed and can easily be edited manually. The metadata structure is defined in the file `metadata.xml` in the database directory but I³S provides a tool to edit the metadata using more easily. For more information you are referred to paragraph 4.1.3.



5.2 The search process

After selection of search from the menu or pressing the search button , a new window will appear as shown in Figure 5-2 (left).

Only if the database type is 'whale tail' the part named 'fluke parts' will be visible. It allows you to search on only a single fluke or both flukes.

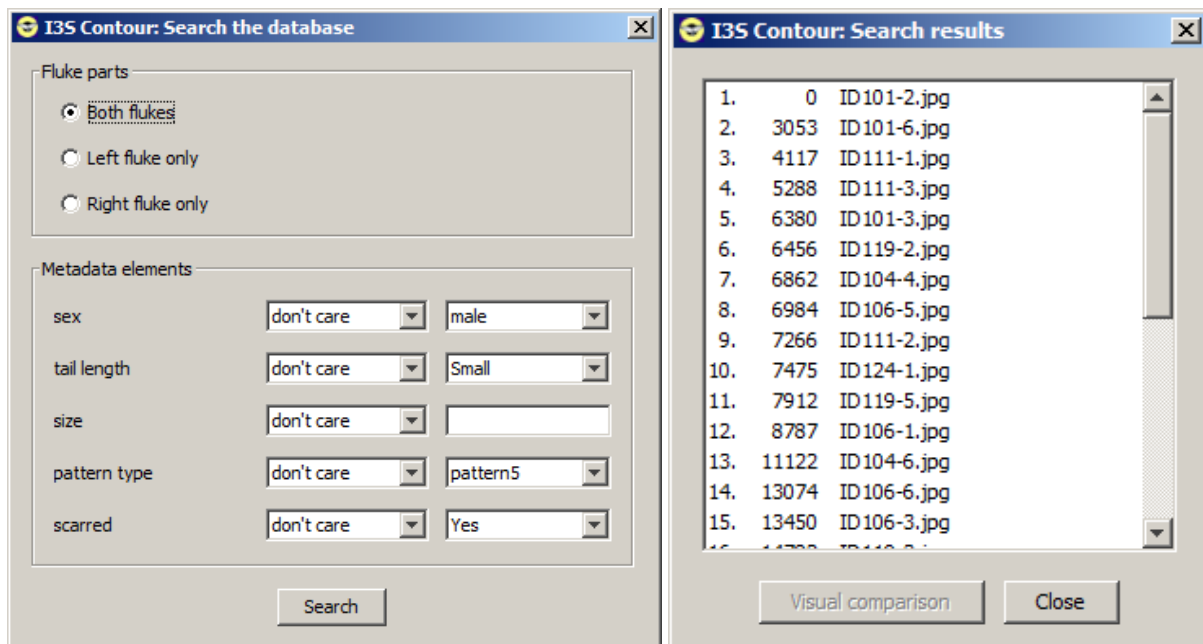


Figure 5-2: Search window (left) and search results window (right).

You can also search on specific metadata. The metadata is defined for the entire database in the file `metadata.xml` in the top of the database directory. You can select per type of field the appropriate constraints (e.g. `equals`, `is less than`, `is greater than` or `don't care`). If you select the default `don't care`, that field will not affect the search process. If one or more metadata elements do not satisfy the search constraints, the specific image is put at the end of the list of search results. If a metadata element is not available (i.e. not yet annotated) the search process will ignore this specific element and not exclude the image.

When you click `Search` the Search result window appears. If the search takes more than a second a progress bar is shown. By clicking one of the results in the list the button `Visual comparison` becomes clickable. When clicking it a new window will appear as shown in Figure 5-3. The window contains four tab panes. The first shows both images together with the annotated contour and comments. The second and third tab pane shows the image of the unknown animal and the selected animal from the results list respectively. The fourth tab shows the normalized contours and histograms of all contours with optimal parameters concerning scaling, rotation and translation to have the best fit.



Figure 5-3: Visual comparison tab.

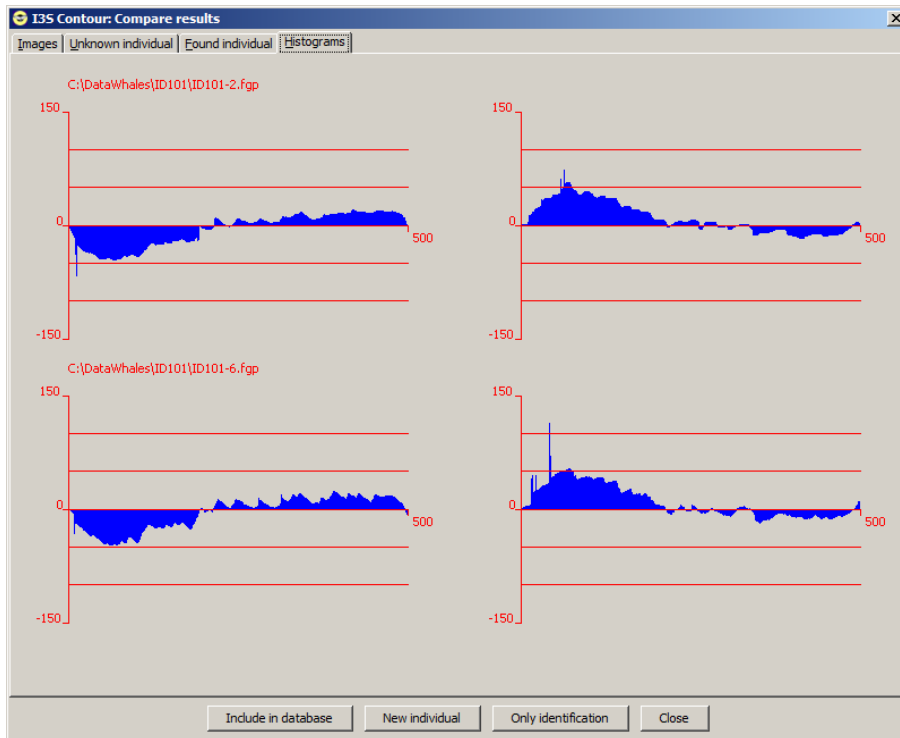
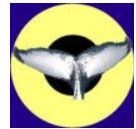


Figure 5-4: Histogram comparison.



5.3 Actions after the search is completed

Based on the information in the 'Compare results' window you will ultimately decide whether the individual is already known or unknown. You have four options how to proceed:

1. The individual is known and because the image is of good quality you want to add it to the identification database as reference in future searches.
2. The individual is new and you want to add it to the identification database in a new individual directory.
3. The individual is recognized but you do not want to add it to the identification database. You only want to rename the image at the current location, e.g. in your own database.
4. You do not want to undertake any action.

These four options are provided in the same order by the buttons at the bottom of the window. Figure 5-5 shows these buttons in more detail.

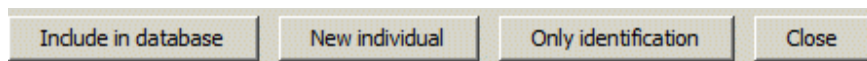


Figure 5-5: The four buttons at the bottom of the window.

5.3.1 Include in database

Only add good quality images to the identification database. Poor quality images (e.g. large deviations from a perpendicular viewing angle with respect to the animal) will lead to poor quality search results. Ideally, aim at having about three reference images per individual in the identification database. When clicking on the 'Include in database' button the following window will appear.

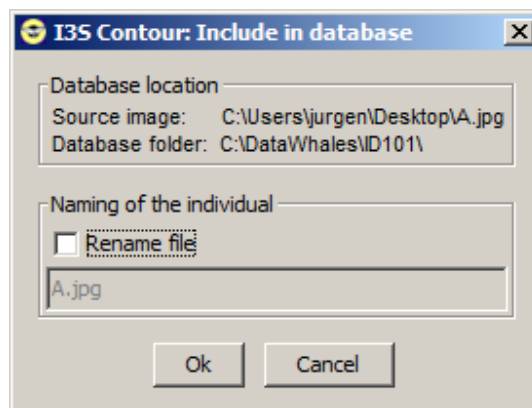


Figure 5-6: The 'Include in database' window.

By clicking the field **Rename file** you can also edit the filename. The fingerprint file will get the same name, only with extension . *f*gp. We strongly advise to make sure that each filename contains the identification number or name of the individual. After clicking **Ok** both the image and the fingerprint file are copied (not moved) to the same directory as the matching image you selected. If you have renamed the file, you will be asked whether you want to rename the original file as well.



5.3.2 New individual

If no matching individual was found you will probably assume it is not yet in the identification database. To add it to the database, click on the appropriate button. The following window will appear.

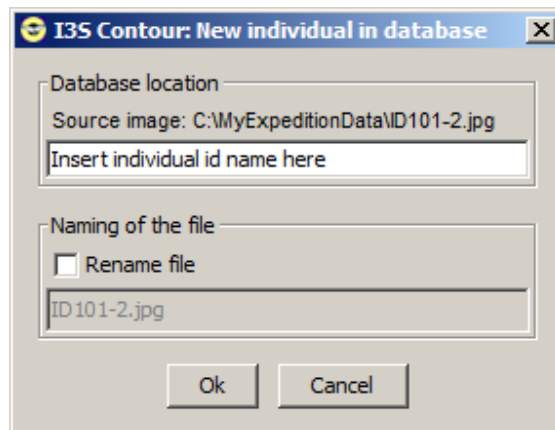


Figure 5-7: The 'New individual in database' window.

Fill in the name of the individual. This can be a name like 'Gregory' or just a number such as 'Humpback 301'. This name will be the name of the new directory. In the next section you can choose to rename the image and fingerprint file. We strongly advise to rename the file so it represents the identity. For example, in case of Gregory you could name the file `Gregory-12March2009Yap.jpg`. After clicking **Ok** both the image and the fingerprint file are copied (not moved) to the new directory in your identification database you just specified. If you have renamed the file (which you should have), you will be asked whether you want to rename the original file as well.

5.3.3 Only identification

If you have successfully identified an individual but do not want to include the image in the identification database, you still might want to rename the file. In this case, press **Only identification** and the following window will appear.

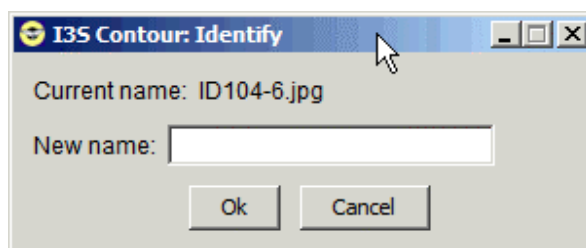


Figure 5-8: The 'Only identification window'.

Fill in the new name and make sure it ends with the proper extension (most likely `.jpg`) and press **Ok** next. Both image and fingerprint file will be renamed.



6 Some final thoughts on I³S

6.1 Limitations of I³S

Although the family of I³S tools has been shown to work on a large group of animals, there are some limitations you should consider. Below we will discuss the two most important issues.

1. **2D vs. 3D.** The main limitation is that a 2D model is used for a 3D animal. Especially with increasing observation angles the limitations of the 2D approach become apparent. Experiments on I³S Classic showed that accuracy deteriorates considerably with angles larger than 40 degrees. For the moment we therefore advise to use photos taken from a viewing angle smaller than 30 degrees whenever possible. This is particularly important for the photos (to be) included in the identification database.
2. **Linearity.** Even in case of a 3D model, we still assume linearity of the animals. In plain English: we assume that the animals are rigid and their body parts are always in the same position with respect to each other, which is an optimal situation for comparison. Unfortunately, this is often not the case for e.g. the tails of humpback whales. Especially the flukes are often subject to deformation, which hinder proper comparison and identification.

6.2 Future work

When the database gradually increases, search time will increase as well. On standard hardware, the algorithm can do 15 comparisons per second. There are several options to further increase comparison speed, for example by using multiple cores and some fine tuning of the algorithm. However, it is not likely this will be implemented unless we get signals from users that this is necessary.



7 References

- [1] "*Intelligent Scissors for Image Composition*", Eric N. Mortensen and William A. Barrett, 1995, International Conference on Computer Graphics and Interactive Techniques archive, Proceedings of the 22nd annual conference on Computer graphics and interactive techniques table of contents, 191 – 198, ISBN:0-89791-701-4,
http://web.engr.oregonstate.edu/~enm/publications/SIGGRAPH_95/scissors_comp.pdf
- [2] <https://www.cwi.nl/en/node/889>
- [3] <http://euophlukes.maris2.nl/>