

## Instructions for using Whalength

To run the Whalength program:

1. Unzip the 'Whalength code' zip file. This folder contains the main function 'Whalength.m' and sub-functions that are automatically called from within Whalength.m. Please retain these files in the original folder (as downloaded).
2. Start Matlab. In the 'HOME' tab, use the 'open file' button in the top left to browse to the 'Whalength code' folder and open the file 'Whalength.m' - the Whalength script will open in the editor.
3. Click on the 'EDITOR' tab and press the green 'Run' button. This will open the Whalength GUI.

Whalength.m runs the GUI for measuring the length and widths of whales in images, using image information (image name, tilt angle of drone (if known) and LIDAR height) provided in an Excel sheet created by the user. The measurements for each image are given as an excel sheet output.

Instructions are provided in the GUI itself in most panels and above the image.

**Note:** Before running the program make sure the accompanying Excel sheet (with image names and LIDAR heights etc.) follows the template exactly (see Fig. 1), and make sure the names of the folders in the excel file match the names of the actual folders exactly. This GUI was built to accommodate the image folder structure and excel sheet layout used in the present study (the code can easily be altered to accommodate different structures). This assumes:

- There is a folder of images for each day, within this folder there may be subfolders within subfolders that contain the actual images (e.g. am and pm folders)
- The excel file is the same for each folder, with a different sheet for each day (the names of the sheets are arbitrary). Alternatively, a separate excel file can be made for each folder of images.

	A	B	C	D	E	F	G	H	I	J	K
1	<b>Folder</b>	Content	<b>notes</b>	<b>best image</b>			<b>time</b>		<b>tilt</b>	<b>Lidar</b>	<b>long</b>
2	<b>2016-08-01 am</b>	sa		<b>134</b>							
3		mc		<b>160</b>							
4		sa		<b>170</b>			<b>9:36:03</b>		<b>2.3</b>	<b>2913</b>	166.215988
5		sa		<b>171</b>			<b>9:36:15</b>		<b>4.1</b>	<b>2781</b>	166.21585
6		sa	<b>measure both</b>	<b>183</b>			<b>9:42:36</b>		<b>2.2</b>	<b>2070</b>	166.215332
7		2 sa		<b>196</b>			<b>9:53:22</b>		<b>3.8</b>	<b>2916</b>	166.213287
8		sa		<b>200</b>			<b>9:54:05</b>		<b>2.9</b>	<b>2656</b>	166.212982
9		sa		<b>203</b>			<b>9:54:20</b>		<b>1.7</b>	<b>2664</b>	166.212982
10		sa		<b>210</b>			<b>9:54:57</b>		<b>2.3</b>	<b>2682</b>	166.213027
11		sa		<b>214</b>			<b>9:55:38</b>		<b>4.1</b>	<b>2662</b>	166.212997
12		sa		<b>227</b>			<b>10:04:19</b>		<b>2.2</b>	<b>2934</b>	166.213725
13											
14	<b>2016-08-01 pm1</b>	mc		<b>238</b>			<b>12:29:16</b>		<b>2.9</b>	<b>2863</b>	166.216018
15											
16	<b>2016-08-01 pm2</b>	a		<b>253</b>			<b>14:29:33</b>		<b>3.4</b>	<b>2475</b>	166.21672
17											
18	<b>2016-08-01 pm3</b>	2sa		<b>265</b>			<b>15:00:02</b>		<b>1.4</b>	<b>2137</b>	166.221618
19											
20	<b>2016-08-01 pm4</b>	mc		<b>271</b>			<b>15:40:10</b>		<b>0.2</b>	<b>2699</b>	166.227565
21		sa		<b>282</b>			<b>15:55:53</b>		<b>0.3</b>	<b>2176</b>	166.223297
22		sa		<b>292</b>			<b>15:57:59</b>		<b>1.5</b>	<b>2078</b>	166.223144
23		a		<b>307</b>			<b>16:01:09</b>		<b>0.2</b>	<b>2636</b>	166.222457
24		mc		<b>321</b>			<b>16:18:22</b>		<b>0.3</b>	<b>2879</b>	166.215377
25		mc		<b>338</b>			<b>16:34:01</b>		<b>1.5</b>	<b>2905</b>	166.219482
26											
27	<b>2016-08-01pm5</b>	mc		<b>401</b>			<b>17:10:01</b>		<b>1.4</b>	<b>2478</b>	166.216335
28											
29											
30											
31											
32											
	◀ ▶	2016-07-28	2016-07-29	<b>2016-08-01</b>	2016-08-02	2016-08-03	2016-08-04	2016-08-05	2016-08-06	2016_08 ...	

Figure 1. Template for excel sheet containing image folder, image number, time and LIDAR height.

To use the code as provided, make sure the data in bold are in the correct columns, i.e. subfolder names in column A, tilt angle of drone in degrees (if known, otherwise leave blank) in column I, LIDAR heights (in cm) in column J etc.

## Lens corrections

Lens distortion parameters have been calculated for our system - DJI Inspire 1 Pro (I1P) camera with Olympus M. Zuiko 25mm f1.8 lens - in order to correct photo-coordinates of points before calculating lengths in images. If the same system was used these corrections can be applied by ticking the checkbox shown in figure 2. Note that different examples of the same camera/lens combination are likely to differ slightly. This setting will be saved for future use but can be changed at any time before image processing.

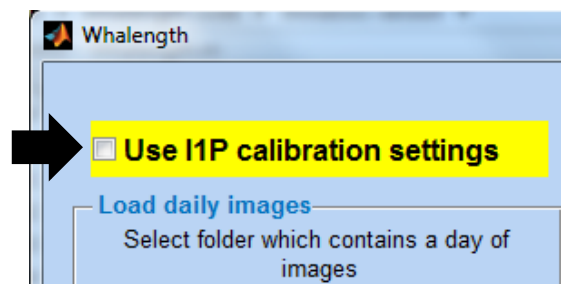


Figure 2

### Offset between camera image plane and LIDAR

If the LIDAR and camera are mounted on the drone in such a way that they are at different heights from the ground, the offset can be accounted for in the GUI. For example, if the LIDAR is 1.5 cm higher above the ground than the camera image plane, press the 'Set offset' button (Fig. 3), a dialog box will appear, enter the offset (-1.5) in centimetres, type in a negative number if the LIDAR is higher above the ground than the camera image plane. The offset (in cm) will be printed next to the button. This offset will be saved for future use but can be changed at any time. The corrected height (accounting for the offset and, if provided, the tilt angle) will be given in the output excel file.

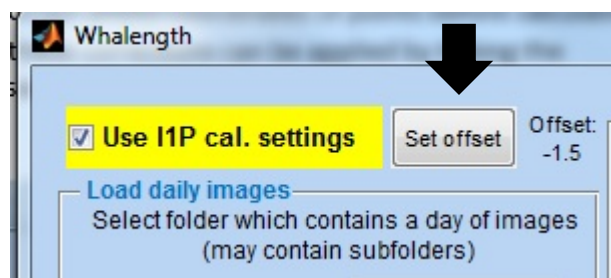


Figure 3

This program relies on each step being carried out in the correct order as described below. It is strongly advised to regularly check the output files to ensure it is as expected. For any questions or bugs please contact Eva Leunissen, [eva.leunissen@gmail.com](mailto:eva.leunissen@gmail.com)

*NOTE: Intermediate data files will be created in the same folder as the application or the shortcut to it. These files (named 'count', 'Imquals', 'fnsh', 'oops' and 'A' ) will be created (or overwritten) each time the program is run, and can be deleted afterward without affecting any data processing. Two additional files named 'I1P' and 'Offset' store the user-specified lens correction and offset settings. Do not delete these unless you no longer want to use these settings and use the default instead (no lens corrections and no offset).*

## Section 1. Steps for standard 'day-folder' processing

1. Click the 'Select image folder' button (Fig. 4) to select the folder that contains all the folders for a day of images (see figure 5 for subfolder structure which matches names in Excel sheet). A window will open that allows you to browse to the folder. Once selected the name of the folder will appear in the box beside the button (see figure 4).

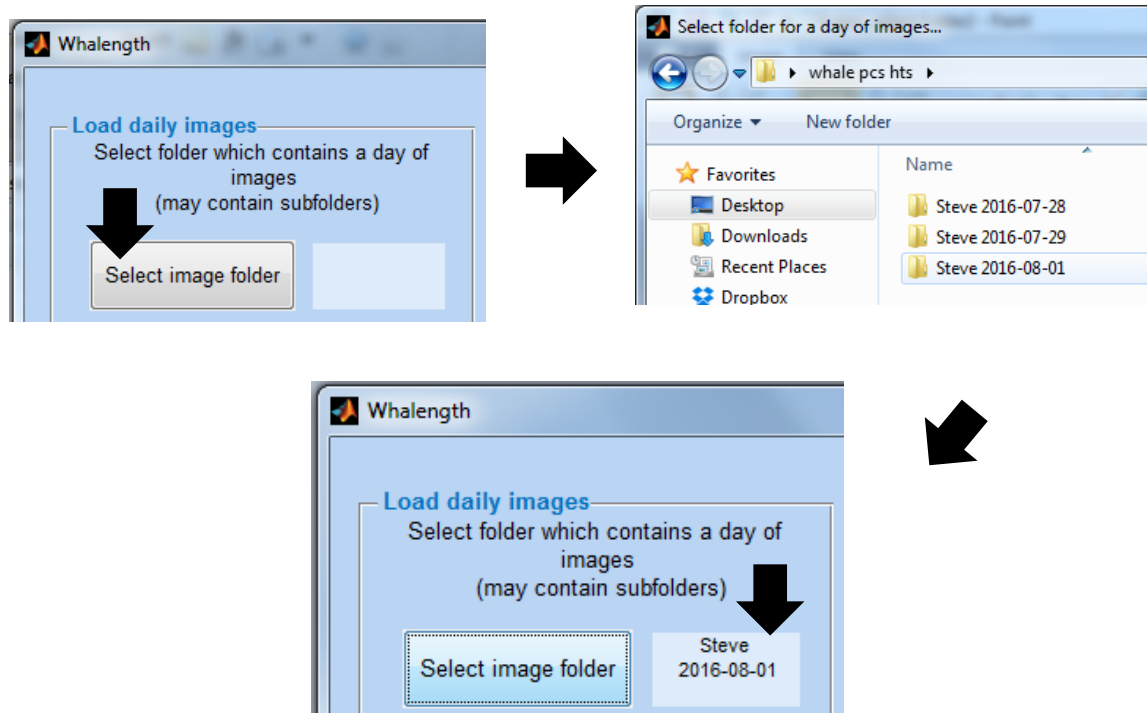


Figure 4.

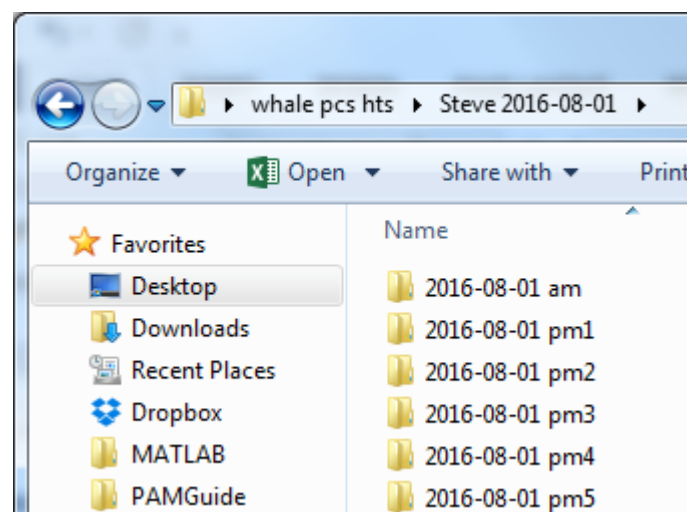
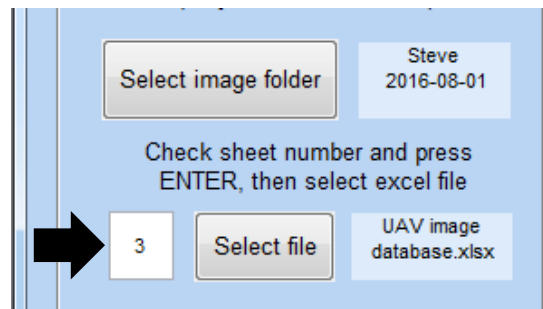


Figure 5. Subfolder structure of main folder selected in step 1. Subfolder names match those in excel sheet.

2. Change the sheet number in the white dialog box (indicated by arrow in figure 6) if the corresponding sheet number for the current working folder is different from the default ('1'). Once you have entered the number press ENTER on the keyboard. In this example the sheet which contains the data for the current folder of images ('Steve 2016-08-01') is the 3<sup>rd</sup> sheet so 3 is entered in the dialog box. Then click the 'Select file' button to browse to the excel file with image numbers and LIDAR heights (as in figure 1) - the file name will appear in the box next to the button. The file will have to be loaded each time a new image folder is loaded.



*Figure 6. Step 2: select Excel sheet number which corresponds to current day of images then the file.*

3. If the folder, Excel file and sheet number are all correct select 'RUN' - this will bring up the first image and a cross in place of the mouse pointer - use it to drag a rectangle around the whale, make sure to include the entire whale (Fig. 7). The image will zoom in to this rectangle and crosshairs will appear in place of the mouse pointer (Fig. 8).

Now there are 2 options: if the user wants to zoom on a section of the image, click the right mouse button in the region to be expanded. The zooming is set to a frame 500 pixels each side to the position clicked with the right mouse button - you cannot zoom further. Use the left mouse button to indicate the first location to measure from at the rostrum and the second location at the blowhole. Positions can be indicated without zooming.

Continue indicating points along the body axis (Fig. 9) (as many as you like, so long as they are sequential along the axis) to the notch in the tail then press ENTER. A smoothed curve will be fitted to the points and the length of this curve in metres will be displayed in the box below the image (Fig. 10). Note: If no LIDAR height was provided for the current image in the excel sheet, the length in pixels will be stored in the program to be used for width calculations, these width measurements will then be given as a percentage of the total length in the output file.

Any notes about the image can be entered into the dialog box below the image on the right, this will be stored in the output file with the measurement data.

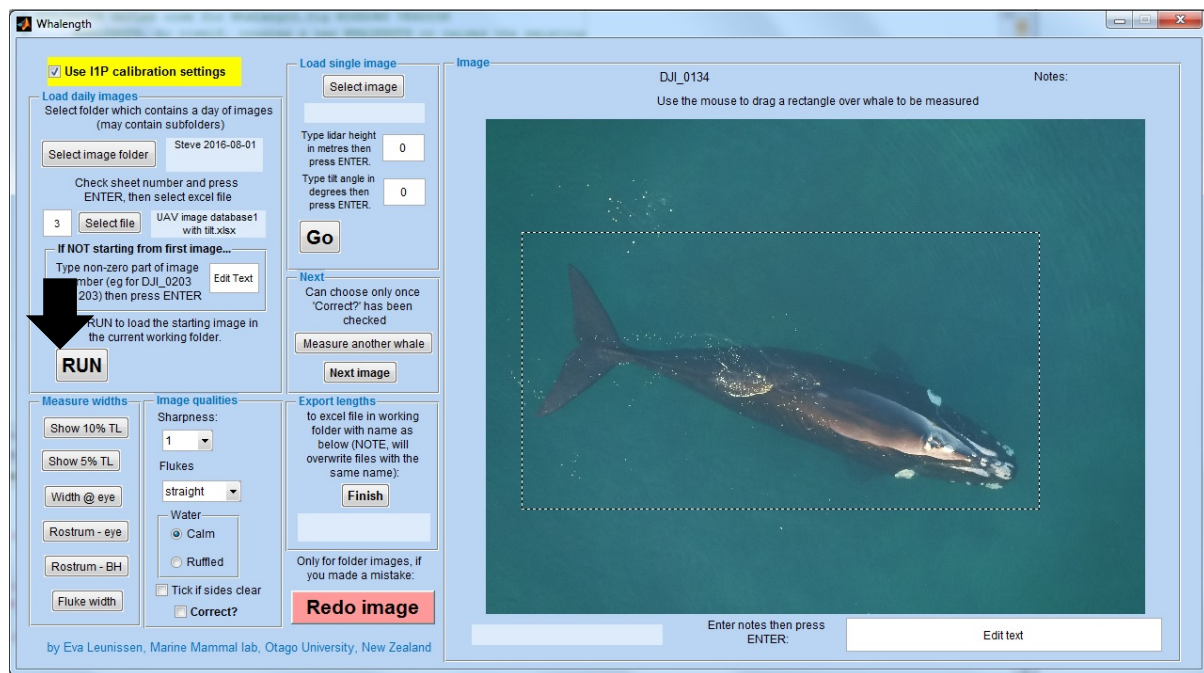


Figure 7. Use mouse to drag a rectangle around the whale



Figure 8. Using crosshairs indicate tip of rostrum as starting point for measuring length.





Figure 9. Indicate points along the body axis using the mouse, ending at the notch in the fluke

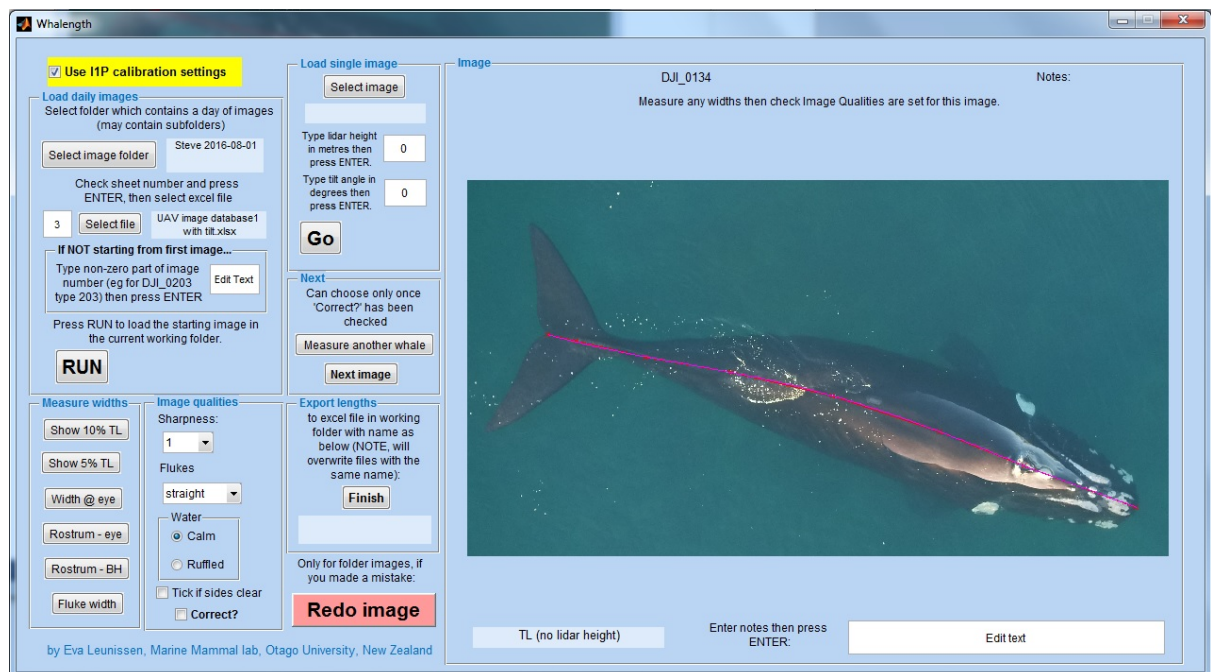
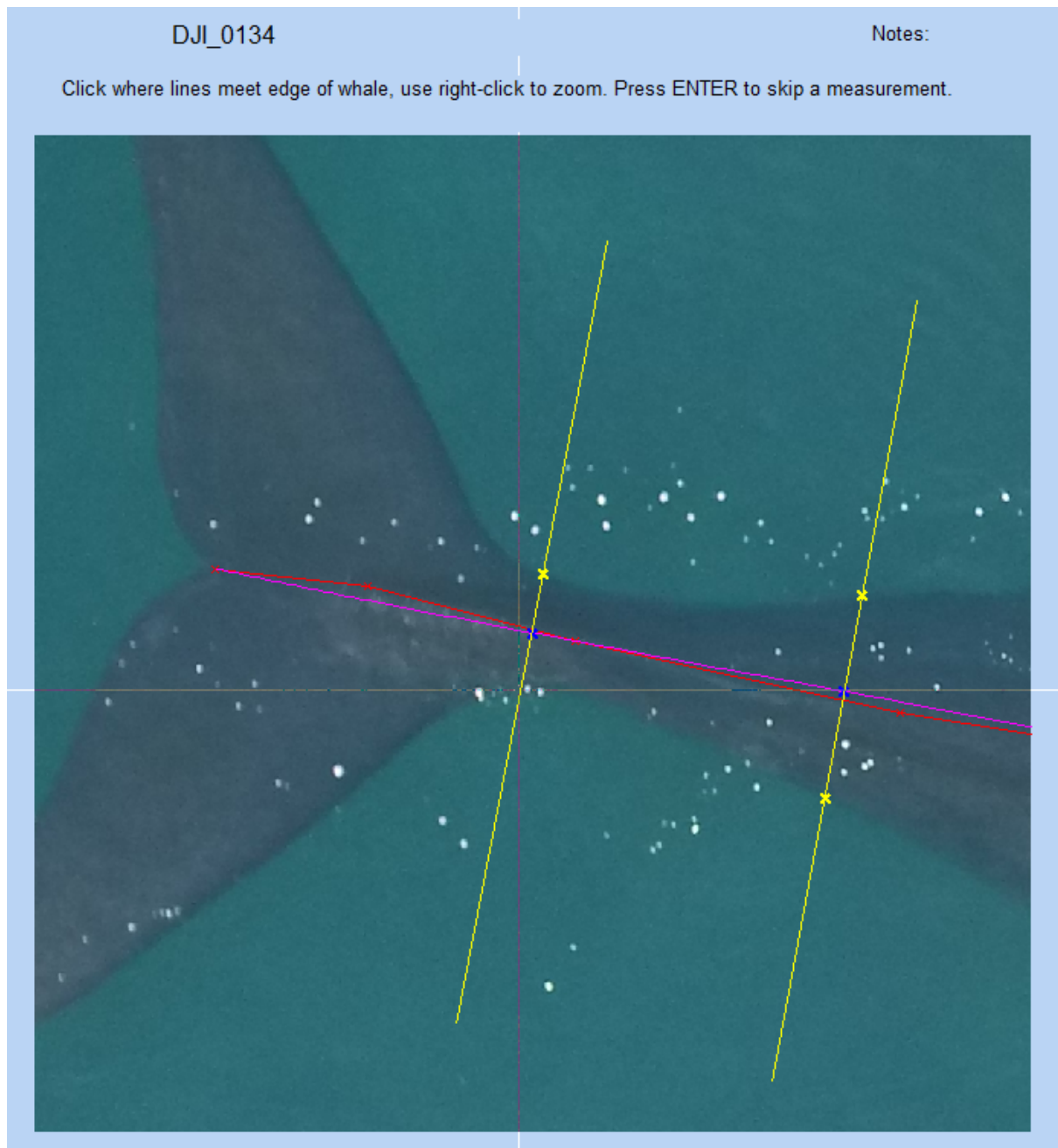


Figure 10. Press ENTER to calculate the length, the length (in m) will appear in the left box below the image

6. Using the buttons in the 'Measure widths' panel:

- "Show 10% TL" draws guiding lines at 10% intervals along the length of the whale, perpendicular to the body axis curve. Use the crosshairs to indicate where the edges of the whale meet these lines to

measure the widths at these intervals (Fig. 11). If, for instance, the whale's sides are obscured and the user wants to skip a width measurement, press ENTER.



*Figure 11. Yellow guide lines at 10% intervals along the body axis curve (pink line), with whale edges indicated by the user with crosshairs (shown as yellow crosses).*

- "Show 5% TL": as for "Show 10% TL" but with intervals spaced at 5% of the total length.
- "Width @ eye", "Rostrum – eye", "Rostrum – BH" (Rostrum to blowhole) and "Fluke width" are all measured using 2 points indicated by the user with the crosshairs which appear when any of these buttons is pressed. See for example for "Fluke width" below in figure 12.





*Figure 12. Tips of flukes indicated by user to measure fluke width*

7. Set the image qualities in the 'Image qualities' panel: Sharpness from 1-4, fluke position – straight, @ surface or drooped; water surface – calm or ruffled, and tick if the whale's sides are clear (or leave unchecked if not), then check the 'Correct?' box. Once this box is checked you can choose out of 3 next steps (Fig. 13):

The screenshot shows a software interface with the following components:

- Top-left panel:** Contains an 'Edit Text' button and instructions about the starting image in the working folder.
- Top-right panel (Next):** Contains a warning 'Can choose only once 'Correct?' has been checked' and two buttons: 'Measure another whale' (labeled #2) and 'Next image' (labeled #3).
- Bottom-left panel (Image qualities):** Contains settings for Sharpness (set to 1), Flukes (set to straight), Water (Calm selected, Ruffled unselected), 'Tick if sides clear' (unchecked), and 'Correct?' (unchecked).
- Bottom-right panel (Export lengths):** Contains instructions to export to an excel file, a 'Finish' button, and a 'Redo image' button (labeled #1) with the note 'Only for folder images, if you made a mistake:'.

Figure 13. Three options after measuring a whale in an image.

- **#1. 'Redo Image':** if a mistake was made somewhere along the measuring process (e.g. drew a bad rectangle that cuts off part of the whale, drew a bad line along body axis, indicated a wrong width in the 10% interval measurements (all other width option mistakes can be fixed by simply clicking the relevant button again and cross hairs will reappear, the new measurement will overwrite the old one in the excel output) etc.) press the 'Redo image' button to reload the current image and start again. This button only has effect once the length of the whale has been measured and the 'Correct?' box has been checked. So, if a mistake is made early on you still have to go through these steps before pressing this button (you don't have to measure the whale properly or indicate the image qualities properly as these will be overwritten in the output file once you reload the image and repeat the measurements). This function cannot be used during single image analysis.

- **#2. 'Measure another whale':** if there is more than one whale in the picture press this button to restart the process for the same picture, but this time focusing on another animal. Once this button is pressed a dialog box will appear requesting a label for the most recent whale measured - this will be stored in the output excel file to help identify the whale in the image for photo ID purposes later on. Once the 'Correct?' checkbox has been ticked for the 2<sup>nd</sup> whale another dialog box will appear requesting a label for the second whale. **Note:** if a mistake has been made while measuring a second whale in the picture, it is still important to label the animals properly using the dialog box, as you will only be asked once to give identifiers. Other properties (e.g. image qualities) or measurements will be overwritten once the measuring process for that particular animal starts again.

- **#3. 'Next image':** Once all whales have been measured in an image use this button to move onto the next image in the folder. If the current image is the last image in the day-folder a message will appear next to the image name at the top of the GUI indicating this is the last image in the folder. At this point if you want to save the measurement data for this folder you will need to press the 'Finish' button (Fig. 14). This creates an excel file in the current working directory (which contains the day folder) with the name as shown in the box below the 'Finish' button (see Fig. 14) (Note that the output file is updated each time the 'Correct?' checkbox is checked so the measurements are

Width @ eye

Rostrum - eye

Rostrum - BH

Fluke width

straight

Water

☒ Calm

☐ Ruffled

☐ Tick if sides clear

☐ Correct?

Export lengths

to excel file in working folder with name as below (NOTE, will overwrite files with the same name):

**Finish**

Steve 2016-08-01 lengths.xlsx

Only for folder images, if you made a mistake: ->

**Redo image**

Figure 14.

already saved after each image is processed).

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1					Image quality							Body width along body axis at 10% increments				
					Image sharpness (1-4)	Flukes up? (@surface/straight/drooped)	Water (calm/ruffled)	Sides clear? (Y/N)	Tilt (degrees)	Corrected height (m)	Total Length (m)	Width at 10% TL	Width at 20% TL	Width at 30% TL	Width at 40% TL	Width at 50% TL
2	Whale ID	Image date	Image time	Filename												
3		1-Aug-16	9:04:36	DJI_0134	1	straight	Calm	N	1.5	36.564	14.3569	1.5997	1.9604	2.4067	1.8786	1.7654
4		1-Aug-16	9:16:06	DJI_0160	1	straight	Ruffled	Y	0	N/A	TL	11.37294	16.915	20.577	19.295	18.977
5		1-Aug-16	9:36:10	DJI_0170	1	@surface	Calm	Y	2.1	29.09725	10.88406	1.5997	1.9604	2.4067	1.8786	0

Figure 15. Example output file

**More on the 'Finish' button.** This button can be pressed after measuring any image, it doesn't have to be the last image in the folder. The output Excel file will store the data of all the images measured

so far. You need to create an output file for each day-folder - you cannot save data from multiple folders in the same output file. Beware that the Excel writing function creates a file with the same name per day-folder each time images in that day-folder are processed, it will overwrite old files with the same name. Therefore if you want to save the old data make sure to rename the file before creating a new output file for the same folder of images. If you do overwrite the old data it only overwrites the rows with the new rows just measured - so if there are more rows in the old file, the new file will contain rows from the old file.

## Section 2. Steps for resuming 'day-folder' image processing

If the 'finish' button was pressed part-way through processing a day-folder of images it is possible to start from a user identified image in the folder (and the Excel sheet).

1. Ensure day-folder, sheet number and Excel file are entered as in step 1-2 in the previous section.
2. Enter the image number in the dialog box found in the panel labelled "If NOT starting from first image..." (see figure 16), type only the non-zero end of the image number (e.g. for image DJI\_0001 enter 1, for DJI\_1000 enter 1000). After entering the number press ENTER.

Whalength

☒ Use I1P calibration settings

**Load daily images**  
Select folder which contains a day of images  
(may contain subfolders)

Select image folder Steve 2016-08-01

Check sheet number and press  
ENTER, then select excel file

3 Select file UAV image database1  
with tilt.xlsx

**If NOT starting from first image...**  
Type non-zero part of image  
number (eg for DJI\_0203  
type 203) then press ENTER 42

Press RUN to load the starting image in  
the current working folder.

**RUN**

Figure 16.

3. Measure images using the process described in the previous section, steps 3-7. Note: before resuming processing make sure the file containing the previously processed images from this folder has been renamed by the user (e.g. Steve 2016-08-01 lengths **part1.xlsx**) otherwise the output file created from the current process (which will have the same default output filename as it is the same day-folder) will overwrite the old one.

### Section 3. Single image processing

The measurement process can also be carried out on single images, rather than a folder of images, and does not require a corresponding Excel sheet.

1. In the panel labelled 'Load single image' click the 'Select image' button and browse to the image to be processed. Once the image is selected the name will appear below the button (see figure 17).
2. Enter the LIDAR height in metres in the dialog box then press ENTER, if not known leave as '0'.
3. Enter the tilt angle (if known) in the second dialog box and press ENTER.

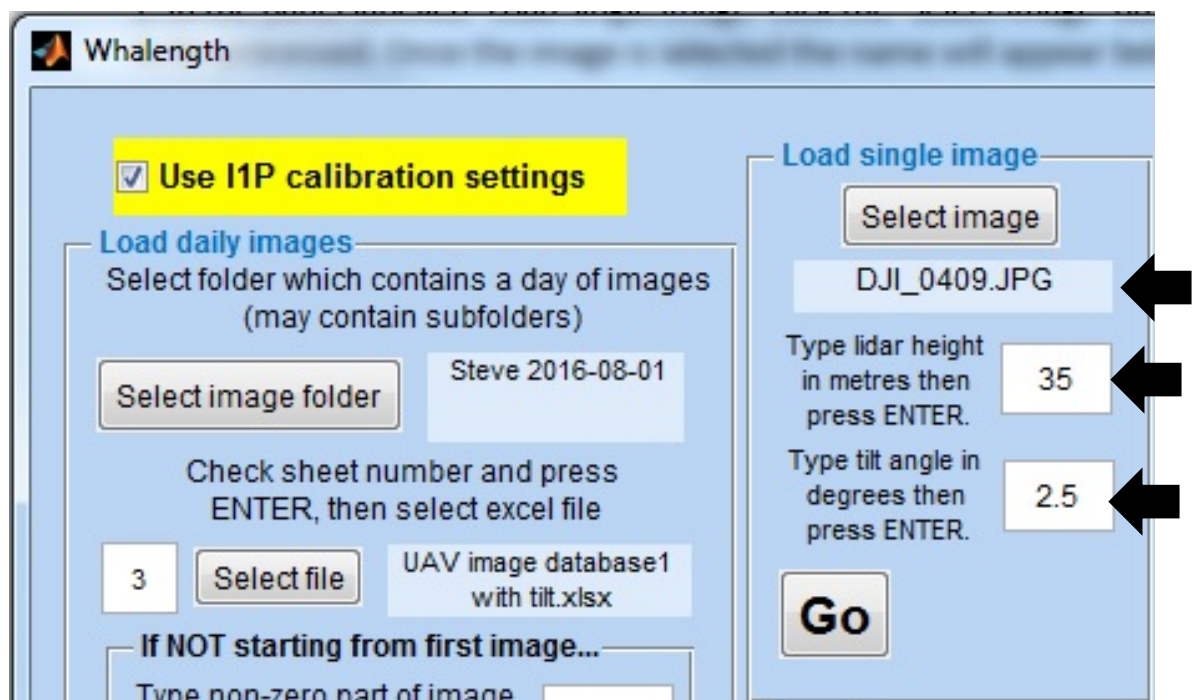


Figure 17

3. Press 'Go' – this starts the same process as 'Run' but for the single image. Measure as described in section 1 steps 3-7. Once all whales are measured in the image press 'Finish' - this creates an output file in the same folder as the image. The 'Redo image' button does not apply in single image processing.

NOTE: If continuing with day-folder image processing (section 1 and 2) following single image processing, **please restart the GUI** (before continuing with day-folder image processing) to ensure any stored image names are cleared.



