Key Facial Parameter Extraction: User Notes

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File list:

- Batch_run.m
- add_grad.m
- align_face.m
- correct_profile.m
- find_bridge.m
- find_mouth.m
- find_width2.m
- find_z_coord.m
- mean_profile.m
- point_int.m
- point_transl.m
- process_profile.m
- stl_check.m
- take_cprofile.m
- tri_rotate.m
- userinput_refpoints.m

Overview

The attached functions are intended to read facial scan data (*.stl format), accept user input to define key facial locations to aid alignment, and extract facial landmark information. Extracted information comprises of:

- Inner Corners of Eyes
  - As defined by the user
  - XYZ coordinates
- Bridge of Nose
  - Gaussian fit parameters A, σ for profile taken perpendicular to bridge
  - Error of estimation for fit compared to extracted mean profile, σ_{ess}
  - Angle of nose compared to facial plane
- Tip if Nose
  - XYZ coordinate defined as greatest Z above facial plane
- Mouth
  - XYZ coordinate along facial midline
  - Defined by change in gradient of profile from tip of nose downwards corresponding with the point where the subject's lips meet
- Chin
  - XYZ coordinate
  - Taking user input as a starting point defined by point of 45^o gradient moving along facial midline downwards
- Width 1 (eyeline)
  - Facial width at eyeline defined by XYZ coordinates either side of face where gradient reaches 65^o from facial plane
- Width 2 (Nose tip)
  - Facial width at eyeline defined by XYZ coordinates either side of face where gradient reaches 65^o from facial plane
- Width 1 (mouth)
  - Facial width at eyeline defined by XYZ coordinates either side of face where gradient reaches 65^o from facial plane

Method of feature/characterisation has been kept deliberately simple to allow for a range of scan method inputs. Nevertheless performance may vary depending on the resolution and quality of input data.

Upon exiting batch_run parameters are written to excel file for further analysis. Additionally a figure is saved for each scan processed showing 3D data, identified points, and extracted nose profile plotted.

User Guide

File setup: Add all listed *.m files and stl's to be processed to a single directory. Open Matlab and set this same location as the working directory.

In the command window enter the command "*batch_run*" to execute the main program loop script

Open File:

Command Window Prompt: "`Enter STL Filename:`"

- Enter the STL filename to be processed including the extension. In the event that the file is not found the script will return to this prompt.

Review STL File:

A figure window will open displaying the current STL data. Please check the following:

- Face is (approximately) facing the positive Z direction (ie. facing 'upwards')
- The dimensions (in mm) appear to be sensible.
    - *Some STL's work in m, it should be obvious that the dimensions are a factor of 1000 out.*

Command Window Prompt:

```
STL File Check:

Preprocessing Options:

(M) - Convert from m to mm
(I) - Invert in Z axis
(Y) - Proceed to processing

Selection:
```

- To convert from m to mm enter option 'M' and press return
- To invert the face in the Z axis enter options I and press return
- Once satisfied enter option 'Y' to continue

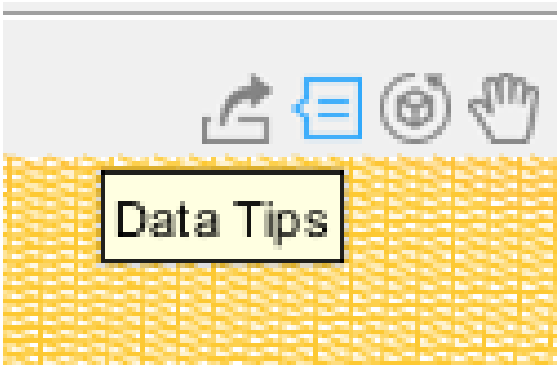
Align Face:

A figure window will open displaying the current STL data. The user will be prompted to select three key locations using the 'data tips' tool. In order to select these points accurately it will likely be necessary to pan/zoom on the correct regions of the plot. *This should be done **without** the 'data tips' tool selected.*

- Zoom: Use scroll wheel to zoom in or out on a specific location or use the zoom tool (magnifying glass) from the figure menu

- Pan: use the left mouse button to hold and pan the figure or use the ‘hand’ tool from the figure menu

Once in the correct location select the ‘data tips’ tool by hovering over the figure with the cursor and selecting the tool:

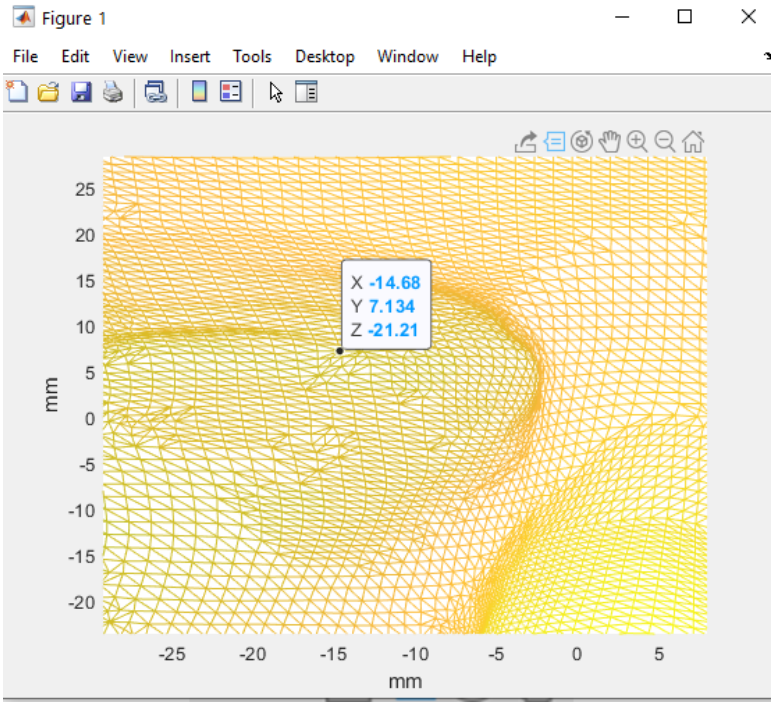


To change the view between selections it is advised to unselect ‘data tips’ pan/zoom as required and reselect ‘data tips’

Command Window Prompt:

```
Using Datatips, select Right Eye inside corner then press "Return"
```

- Zoom to the subject’s Right Eye
- Select a point at the inside corner near the nose (Medial Canthus). This should be done with a reasonable amount of care and accuracy (within a mm or so) as it will define the alignment of the face.

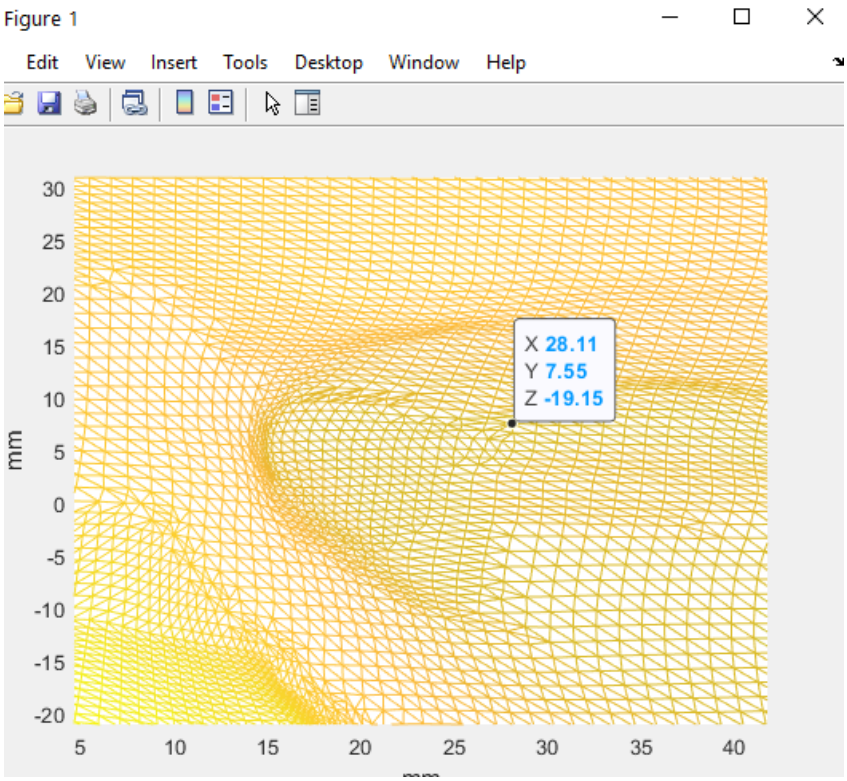


- Press return to enter the selected coordinates

Command Window Prompt:

```
Using Datatips, select Left Eye inside corner then press "Return"
```

- Perform the same operation for the other eye
- Aim for consistency between the points selected on each eye

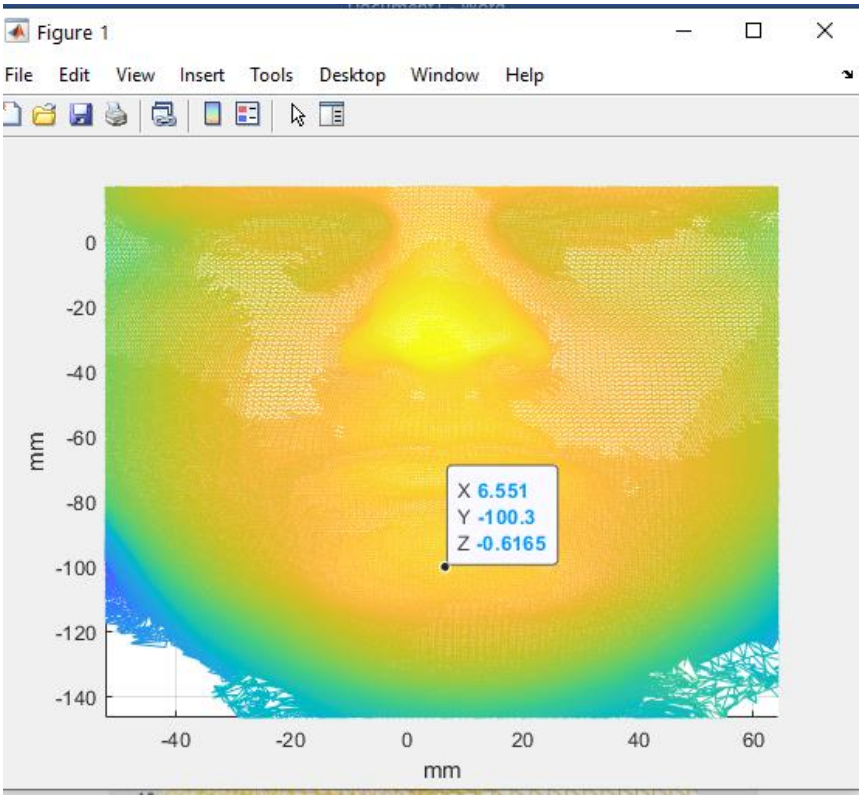


- Press return to enter the selected coordinates

Command Window Prompt:

```
Using Datatips, select chin then press "Return"
```

- Select a point approximately in the centre of the ‘flat’ portion of the subject’s chin



- Press return to enter the selected coordinates

Confirm Alignment Points:

The command window will list the coordinates for each of the selected points

Command Window Prompt:

```
Proceed? (Y/N)
```

- Entering 'N' will restart the alignment process
- Entering 'Y' will proceed with the analysis

Processing and Result:

Processing may take a few seconds. A figure will be displayed showing the facial data with the extracted points indicated alongside a plot of the extracted nose profile and Gaussian fit.

- A *.jpg of this figure is automatically created in the working directory so the figure window can be safely closed as necessary
- Extracted points/parameters have been added to the table variable '*f_data*'

Next File & Data Export:

Command Window Prompt:

```
Another File? (Y/N):
```

- Entering 'Y' will being the process again for the next scan. Data from each subsequent face scan processed without exiting the '*batch_run*' script will be added to the *f_data* table. This should allow for a full batch of scans to be processed in one sitting
- Entering 'N' will automatically export the processed data (from the *f_data* variable) to an excel file in the working directory named with the date and time of creation
    - The excel file will contain the extracted data from all face scans processed in that session
    - The *f_data* variable will be cleared after this export to avoid confusion should more scans be processed in a subsequent session.

The key outputs are therefore the exported excel file and the *.jpg images.

Troubleshooting

- *What if the batch_run script terminates due to an error, or the user uses "ctrl+c" to terminate the script?*
    - Don't worry! The f_data variable storing the data from all processed faces so far should still be in the workspace. Simply restart the batch_run script and continue. Additional data will be added to that variable until it is cleared following export.
- *Points don't appear to be identified in the correct location?*
    - Please report these back to me where possible. The success of identification will depend on the STL file. Ideally it will be high resolution of the facial region only with little noise. If one point consistently fails to register (for example maybe the mouth is just not being identified due to the can data resolution). Continue processing the data. It should simply export that point as 'Nan'.
- My scan data is in a weird orientation and the script doesn't seem to like it
    - I haven't tested a large variety of inputs. It may be possible to modify the initial check with some functions to do bulk transformations ad overcome these problems. Please report these back to me.