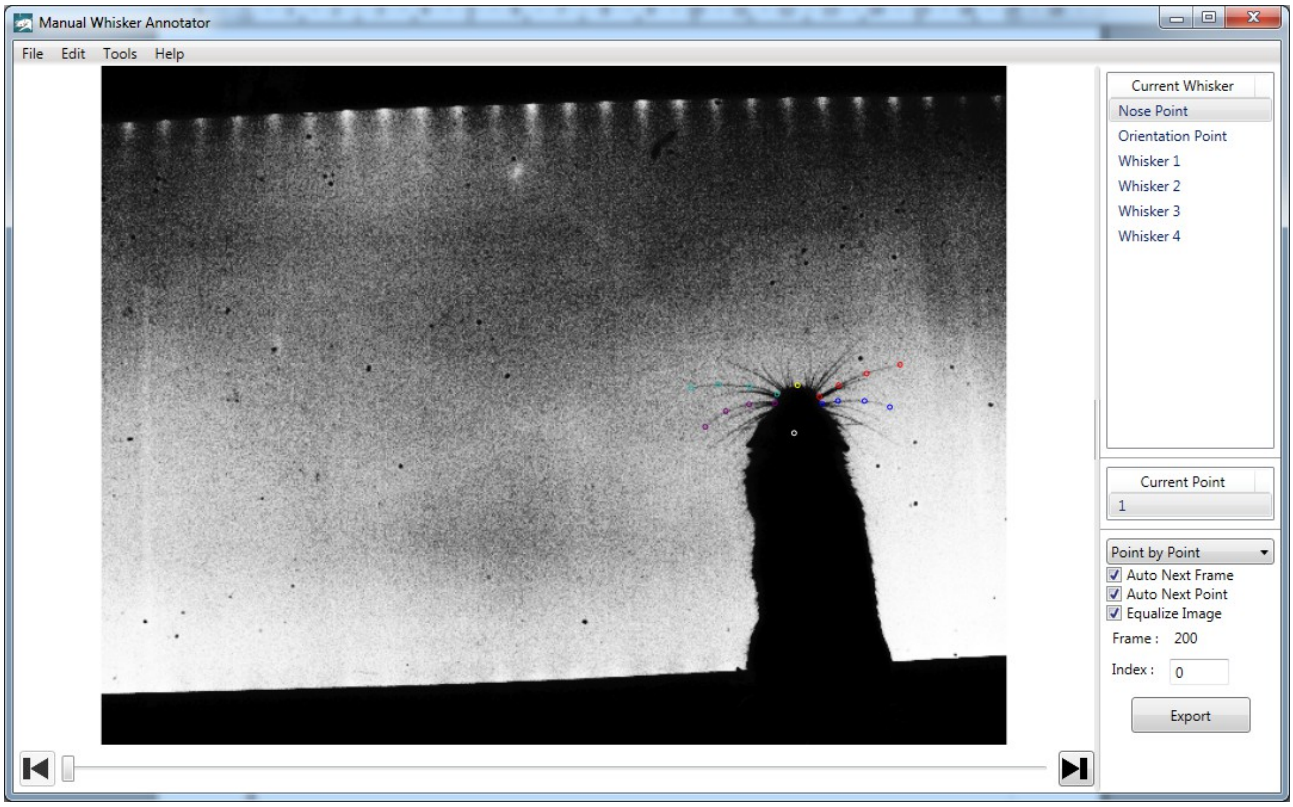
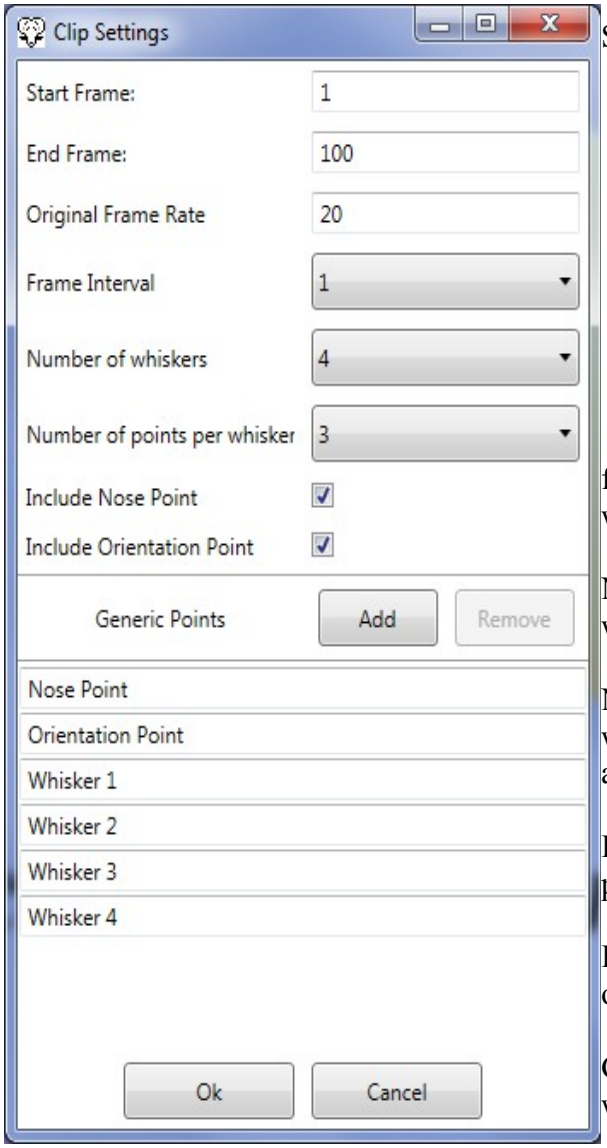
Manual Whisker Annotator



Homepage: http://www.mwa.bretthewitt.net

Getting Started

To get started, go to file → new, and browse to the video you wish to annotate. Once the video has been selected, you will be presented with the following screen



Start Frame: Enter the frame number where you would like to begin annotating.

End Frame: Enter the frame number where you would like to end annotating.

Original Frame Rate: The original frame rate the video was recorded in. This is set to the current frame rate by default, but some videos may have been slowed down.

Frame Interval: How many frames to advance by, for eg. A frame interval of 2 and a start frame of 1 would result in frames 1, 3, 5, 7... being processed.

Number of whiskers: How many whiskers you are wishing to track.

Number of points per whisker: How many points per whisker should be used, 2 for linear, 3 for quadratic and 4 for cubic.

Include Nose Point: Do you want to track the nose point

Include Orientation Point: Do you want to track the orientation

Generic Points: Add any generic points you also wish to track here.

You can name the whiskers and points as you please.

Once all the parameters have been entered, pressed ok and you will be able to begin annotating. Do not forget to save your annotation! If a user tries to exit without saving, a prompt will be displayed saying so, and asking if the user would like to save before exiting.

The User Interface

1
The currently selected whisker

2
The currently selected point

3
Annotation settings and the current frame number. The index number is also provided, and can be edited to skip to a specific point in the video (hit tab after editing).

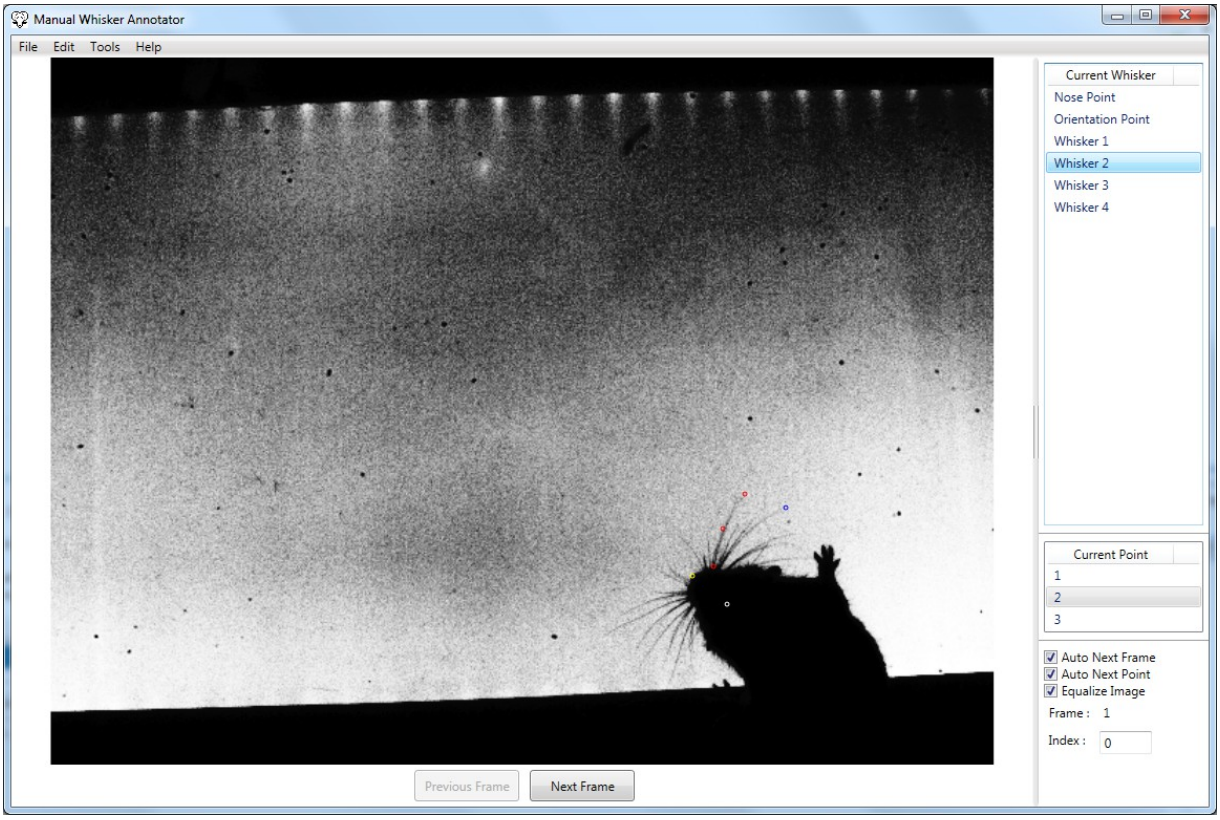
4
The export button to generate an excel file with all the raw pixel values from the annotation.

5
The current frame being annotated. Clicking on this area will place a point.

6
The menu.

7
Next frame, previous frame and frame slider commands.

If you have included a nose point and an orientation point, these will be the first to be placed, followed by the whiskers, followed by the generic points. When annotating the whiskers **ALWAYS START FROM THE OUTSIDE (TIP) OF THE WHISKER**.



This will ensure the analysis methods work correctly. When using quadratic or cubic curves to model the whiskers, place the points equal distances from each other, so if using a quadratic, the first point would be at the tip, the second point half way along the whisker shaft, and the third point at the base; and if using a cubic, the second and third points would be placed 1/3 and 2/3 along the whisker shaft. Once all the points have been placed, the program will automatically go to the next frame, and you start placing the points again. Once all the frames have been annotated, you can export the raw pixel values, or analyse them using the Analysis section. Annotations can also be saved at any point for editing later.

Settings

Color Settings

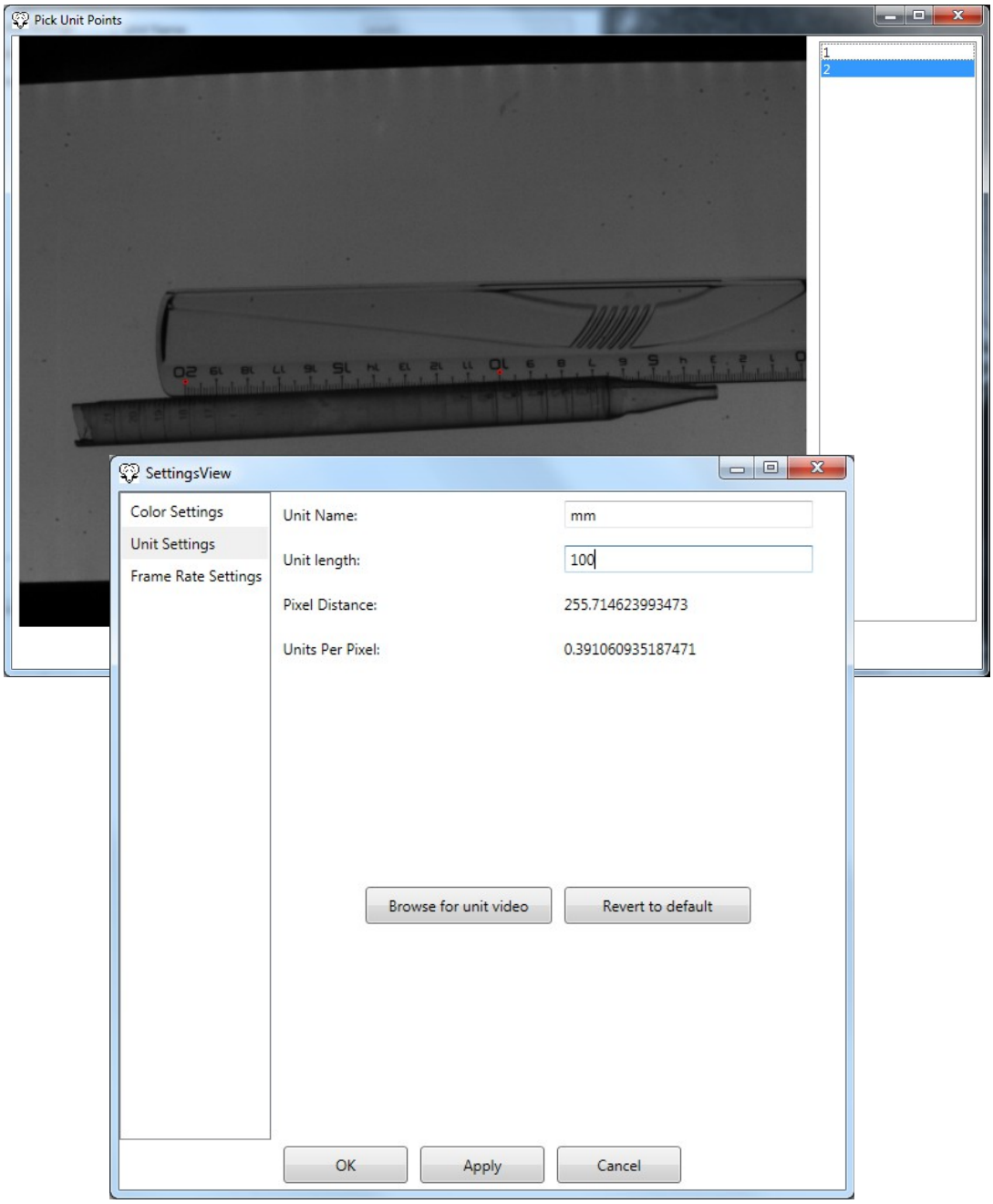
Here you can select which colors you would like to use to represent the annotation points.

Frame Rate Settings

This is where you can modify the original frame if you didn't do so when choosing the starting parameters. This is important as if the frame rate has been modified, any analysis methods which are time dependant will be altered.

Unit Settings

All the units are measured in pixels. However, some datasets will begin with a calibration picture, allowing the conversion from pixels into any unit of your choice. Select browse for unit video, select the calibration video, then select two points where you know the distance and enter your preferred unit.



Analysis Methods
Manual Whisker Annotator provides several analysis methods.

Nose Displacement
The total distance travelled over the course of the annotation. This can only be used for nose points.

Head Orientation
The orientation of the head at every frame.

Whisker Spread
This will give you the average whisker spread (average angle between whiskers) and the maximum whisker spread (angle between foremost and rearmost whisker), for both the left and right side whiskers.

Whisker Curvature
Curvature is modelled using Bezier curves. Depending on how many points per whisker you selected, the whisker will be modelled using either a linear, quadratic or cubic Bezier curve. Curvature can only be calculated for quadratic and cubic curves, and is defined as

$$\kappa = \frac{|x'y'' - y'x''|}{(x'^2 + y'^2)^{3/2}},$$

Whisker Angle
Several methods were identified for how to calculate the angle of the whisker, and the program will try to cater for all those different methods. If a nose and orientation point have been included, you can measure the angle against the center line, otherwise you can measure the angle against the horizontal or vertical. You can also choose how far along the whisker shaft you wish to measure the angle.

Whisking Frequency
The frequency is calculated against the angle signal. Options are provided to choose the angle measuring method. Two more options are provided to choose how to calculate the frequency, the Autocorrelogram, and Discrete Fourier Transforms.

Whisker Mean Offset
The mean angle of each whisker

Whisker Amplitude
The maximum angle and minimum angle are calculated over the entire video, giving the maximum amplitude. The maximum and minimum angle, and the amplitude are also calculated for the current whisk cycle. Average amplitude and the RMS value are also measured.

Protraction/Retraction Angular Velocity
The average protraction and retraction velocities are given over the entire video. Velocities are also calculated for the current whisk cycle.

Whisker Velocity
This gives the linear velocity of the end points of the whiskers, as well as any generic points.

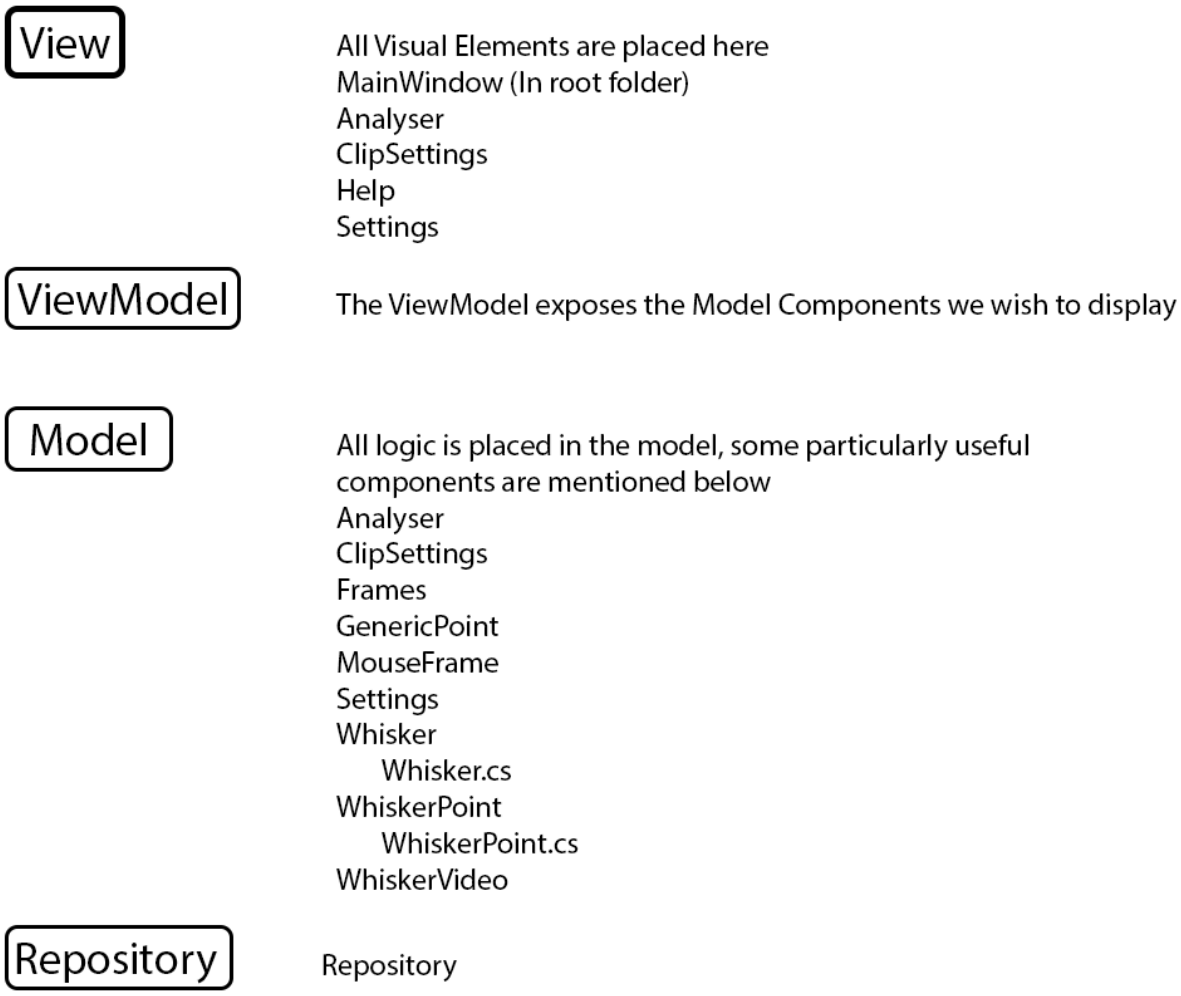
Analyse Everything
This section allows you to collect summaries from all viable sections.

Every analysis method allows you to export the results as an excel spreadsheet. Analysis methods that give frame by frame information can only be generated on the section itself, and not in the "Analyse Everything" section, as this is reserved for summaries only.

Other Options

Frame by Frame/Point by Point – You can either select to process each point individually (place a point (eg. Nose point) on every frame before proceeding to place the next point (eg. Orientation Point), or you can place every point on the current frame, before proceeding to the next frame.
Auto Next Frame – Automatically skip to the next when all points have been placed
Auto Next Point – Automatically skip to the next point when the current point has been placed
Equalize image – Perform histogram equalisation on the image to highlight features

System Diagram



All windows and UI's are placed in the view. This section contains no logic, and should never do so. The ViewModel also contains no logic, and simply exposes properties and/or methods from the Model to the View, this is so if the program is ported to another operating system, only the View and ViewModel layers need to be replaced, and all the logic in the Model layer can remain the

same.

As mentioned above, the Model layer contains all the logic, this is where you will find the analysis computations, and all the classes that store data that is required for successful operation. Whisker.cs and WhiskerPoint.cs in particular are widely used throughout the program. WhiskerPoint.cs stores the user defined points needed to model a whisker. They are stored as ratios, and as such they must be multiplied by either the image width (for the X value) or the image height (for the Y value). All classes in the Model layer should be marked as "Internal" instead of "public", and should derive from "ModelObjectBase"

Finally, the repository layer handles loading and saving user specific data (eg. Point colour). If a new method for saving and loading data is required, then only the repository layer needs to be altered.

How to create additional analysis modules

The first step to creating an additional analysis module is to identify what type of analysis you want to perform. The method for creating a module that gives a measurement for a single whisker (eg. angular velocity) is different than if you want to create a measurement for a group (eg. Whisker Spread).

Below we will follow an example for creating a way to measure whisker length. The first step is to create the correct folder structure. All logic must go in the Model layer, so we navigate to

Model → Analyser → Methods

If the measurement is Whisker Specific, (such as curvature, which we will use for this example), then 3 classes need to be created, one called SingleWhiskerCurve.cs which handles each individual whisker, one called WhiskerCurveFrame.cs which will handle all the whiskers for one particular frame, and one called WhiskerCurve.cs which will handle all the whiskers in all the frames.

WhiskerCurveFrame.cs must derive from AnalyserFrame<SingleWhiskerCurve>, and WhiskerCurve.cs must derive from MethodBase<WhiskerCurveFrame>.

Once you have created the logic for the single whisker, you must implement a Load and Export function for WhiskerCurveFrame.cs and WhiskerCurve.cs. This is relatively easy, and follows the same pattern for each method.

If you wish to display information regarding the new measurement, then you must also create a "User Control" in View → Analyser → Methods and a corresponding ViewModel (derived from MethodBase, or MethodBaseWithImage if you want to display an image) in ViewModel → Analyser → Methods. Finally, you must then include the module in the constructor for AnalyserViewModel.cs. Once this is complete, the new module should be available in the analysis section.