Butterfly scan

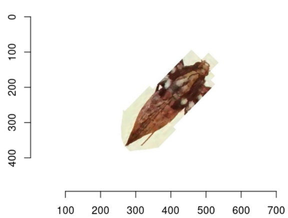
The algorithms and programs described here are in the repository on GitHub:

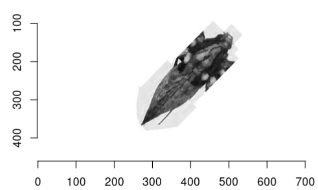
https://github.com/andy-aa/butterfly_scan

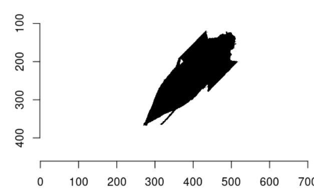
Calculation of the body volume of a butterfly

The algorithm for estimating the volume of the body of a butterfly:

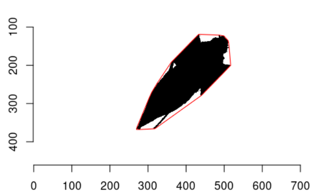
1. Converting a color image to black and white. Three-channel RGB image → Single-channel grayscale image → Single-channel black and white images. When converting an image to black and white, it is necessary to use an empirical coefficient that is in the range from 0 to 1. The empirical coefficient is a color code used to separate all colors in an image into two groups, black and white.



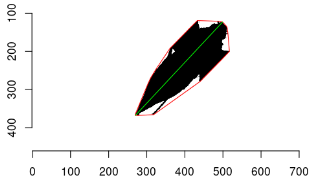




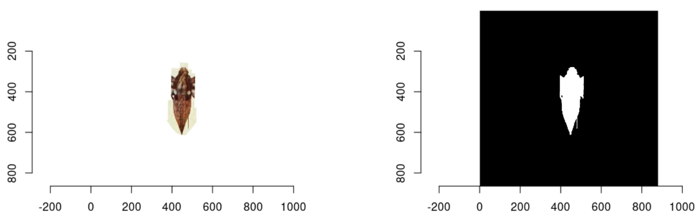
2. Search for the axis of rotation of an arbitrarily oriented body of a butterfly. The axis of rotation is a line connecting the two most distant points from each other. To reduce the search time, the convex hull of the figure is first constructed.



3. In the set of points of the convex hull, we need to find two points that have a maximum distance function: $d = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$.



4. Finding the angle between the rotation axis and the x-axis. Rotate the image so that the rotation axis is perpendicular to the x-axis and parallel to the y-axis.

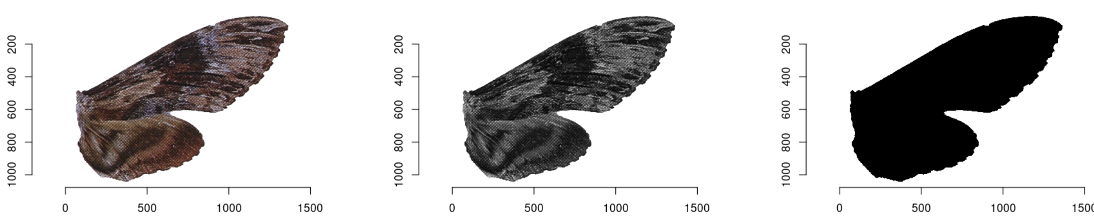


5. Dividing the silhouette into layers parallel to the x-axis. Finding the width of each layer. The width (w_i) of a layer is equal to the number of pixels in that layer multiplied by the physical size of a pixel. The layer height (h) is equal to the physical pixel size. Layer volume is: $v_i = (w_i/2)^2 * pi * h$. The total volume (V) is the sum of the volumes of its layers $V = \sum_{i=1}^{n} v_i$.

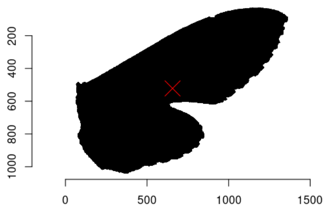
Calculation of the moment of inertia of a butterfly wing

The algorithm for estimating the moment of inertia of a butterfly wing:

1. Converting a color image to black and white.



2. Calculation of the coordinates of the conditional center of mass. The classic formula for calculating the center of mass is: $\vec{r}_c = \frac{\sum\limits_i m_i \vec{r}_i}{\sum\limits_i m_i}$. In the case of a two-dimensional object, the formula takes the form: $x_c = \frac{\sum_{i=1}^{n} m_i x_i}{\sum_{i=1}^{n} m_i}$ and $y_c = \frac{\sum_{i=1}^{n} m_i y_i}{\sum_{i=1}^{n} m_i}$; If we take the mass of each point equal to 1, the formulas are noticeably simplified: $x_c = \bar{x}$ and $y_c = \bar{y}$.



3. The classical formula for calculating the moment of inertia is: $J_a = \sum_{i=1}^{n} m_i r_i^2$, where m_i is the mass of i-th point; r_i is the distance from the i-th point to the axis. If we take the mass of each point equal to 1, and for the point of the axis we take the center of mass, the formula will take the form: $J_a = \sum_{i=1}^{n} r_i^2 = \sum_{i=1}^{n}((x_i - x_c)^2 + (y_i - y_c)^2)$

Finding the wing mount

To be continued…