Hovering Hummingbird Automated Segmentation

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Motivation

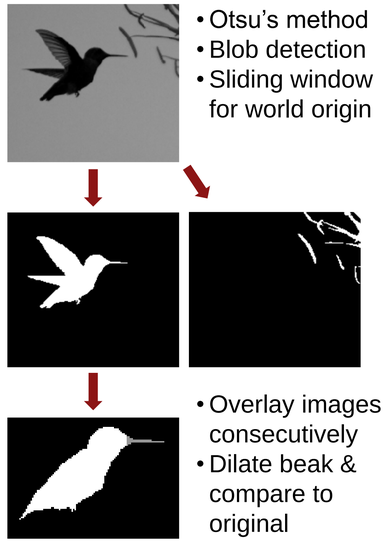
Hummingbirds are well equipped for hovering flight, and past studies have used image analysis to analyze the kinematics of their flapping motion [1], [2]. These studies had the benefit of using multiple cameras to pinpoint motion. In this study, video taken with a single camera view is analyzed through segmentation with the future goal of using this information for kinematic analysis of tail oscillation. While past studies have used techniques such as normalized cuts [3] and mean shift [4] for image segmentation, here the movement between consecutive frames is primarily utilized because the backlighting of some videos does not allow for segmentation of single frames.

References

[1] B. W. Tobalske and et. al., "Three-dimensional kinematics of hummingbird flight," Journal of Experimental Biology, vol. 210, no. 13, pp. 2368-2382, 2007.
[2] D. L. Altshuler, "Wingbeat kinematics and motor control of yaw turns in Anna's hummingbirds," Journal of Experimental Biology, vol. 215, no. 23, pp. 4070-4084, 2012.
[3] J. Shi and J. Malik, "Normalized Cuts and Image Segmentation," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 22, no. 8, pp. 888-905, 2000.
[4] D. Comaniciu, "Mean shift: A robust approach toward feature space analysis," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 24, no. 5, pp. 603-619, 2002.

Methods

Bird/Background

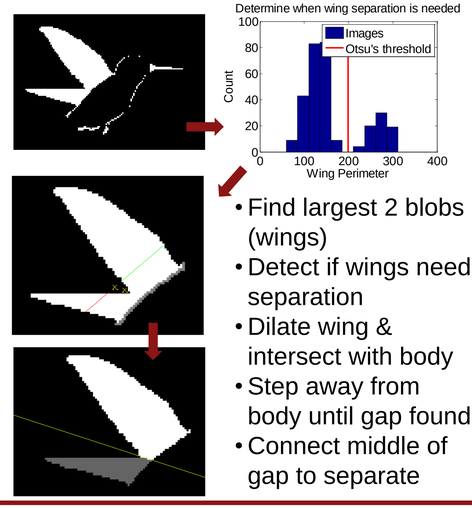


- Otsu's method
- Blob detection
- Sliding window for world origin
- Overlay images consecutively
- Dilate beak & compare to original

Tail

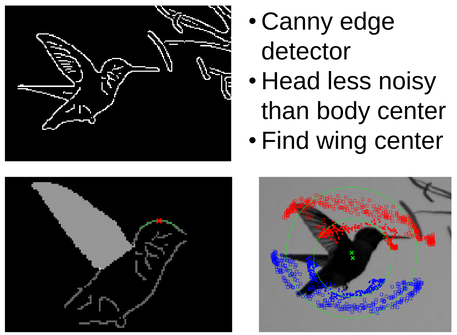
1st Approximation
- Vertical middle position
- Middle position perpendicular to 1st approx. line
- Fill to threshold tail area

Wings



- Find largest 2 blobs (wings)
- Detect if wings need separation
- Dilate wing & intersect with body
- Step away from body until gap found
- Connect middle of gap to separate

Center Point



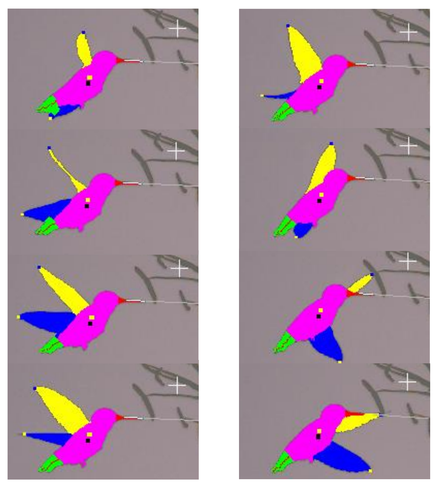
- Canny edge detector
- Head less noisy than body center
- Find wing center

Beak Angle

- Laplacian of Gaussian
- Fit quadratic → center of beak

Experimental Results

Segmented Images



Different Video

Extracted Data

4th order Butterworth filter with zero phase shift