Title

Striped Ambiguity: A Quantitative Approach Towards Understanding Camouflage Using Computer Vision

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Abstract: This research examines the effect of disruptive camouflage by studying the coloration of bees. Using the OpenCV and scikit-learn libraries in Python and incorporating the image theory, I developed a procedure that quantifies and analyzes the visual hotspots on bees, which is mainly applied to identify camouflage effects of different abdominal colors, namely, black and white stripes, black and yellow stripes, and iridescent hues. Patterns that contribute to disruptive camouflage are highlighted by K-mean clustering method. Through the application of the CV methods, we may obtain a quantitative perspective when assessing the qualitative coloration of the bees. Based on image theory-driven clustering, our method provides a foundation that could be extended to further hypothesize the camouflage functionality of coloration patterns.

Keywords: Disruptive Camouflage, OpenCV

Methods:

Selected 9 black and white striped bees, 9 black and yellow striped bees, and 9 iridescent bees. High-res images were downloaded from the BigBee Library.

Image Processing Packages

OpenCV (cv2): This serves as the main tool for imagery processing. By applying OpenCV, I applied Gaussian blurring and morphological opening to filter out small noises, detected edges, and identified and marked clusters of visual interests (blobs). Hotspots in the code are identified as significant brightness regions which stand out from the surrounding pixels.

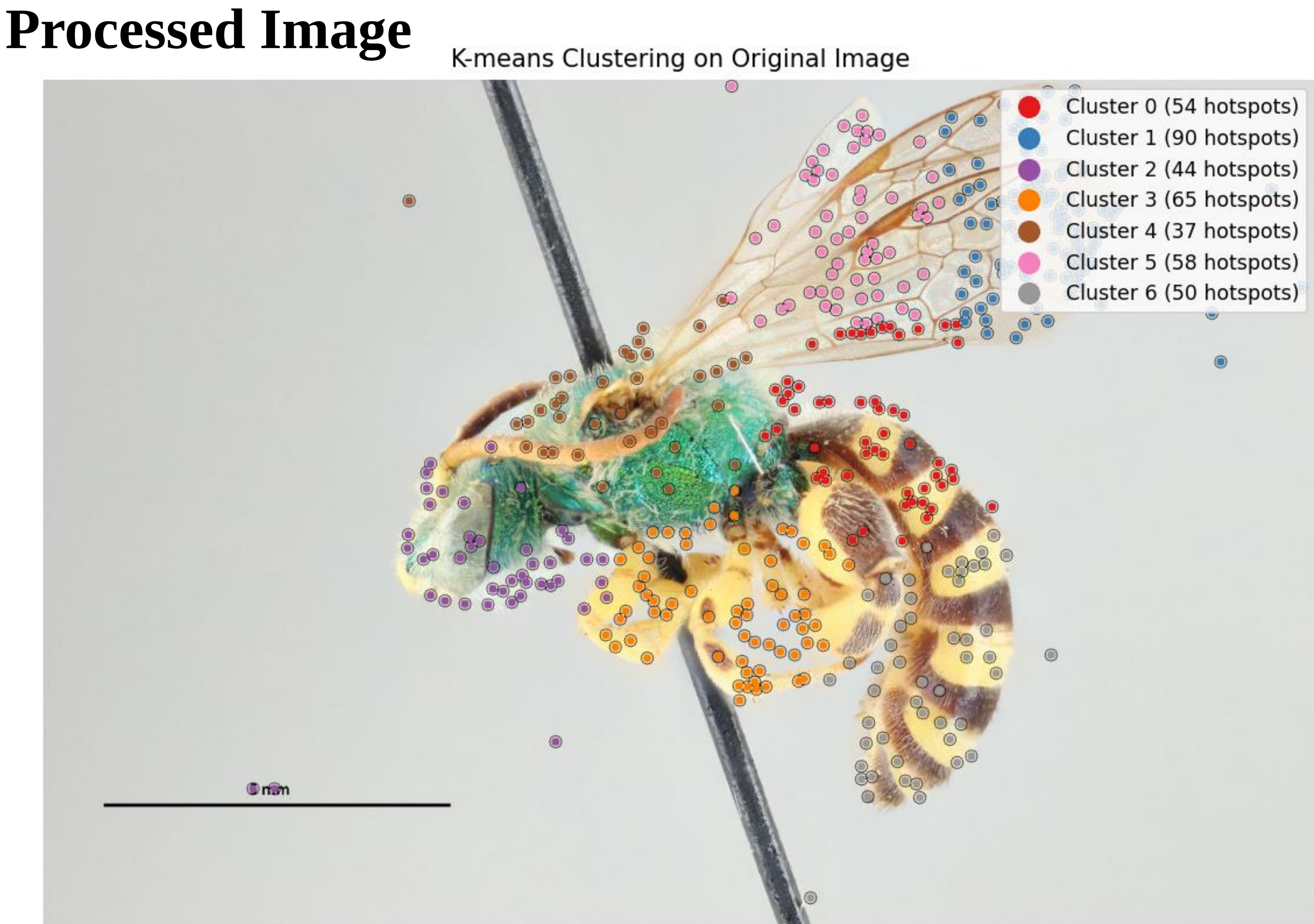
scikit-learn (sklearn): This supports all the machine learning algorithms. By applying scikit-learn, I performed K-means clustering to group the previously detected blobs, and analyzed how the mapped hotspots are distributed over the bees' colored abdomens.

Data Processing & Visualization Tool

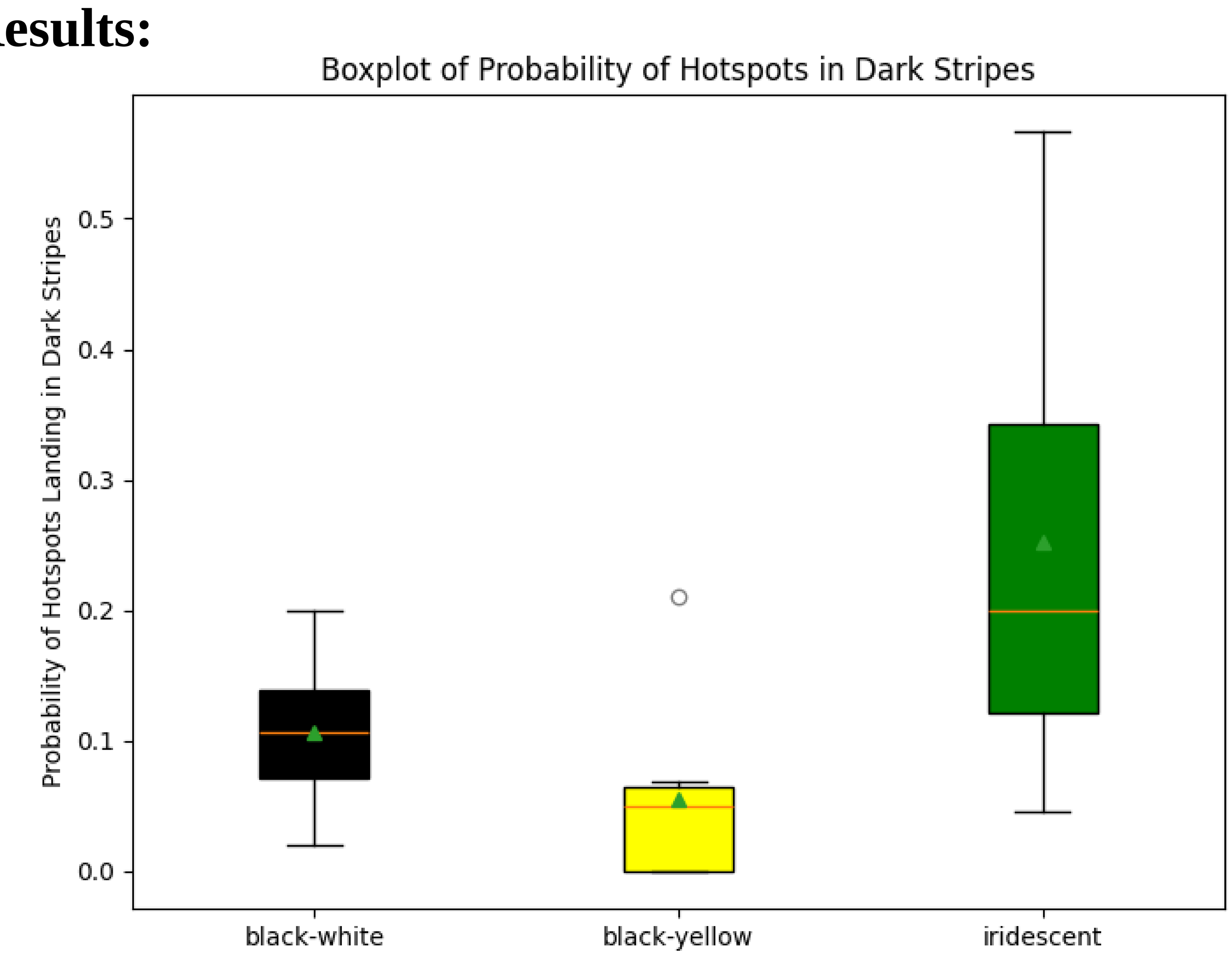
Python (NumPy, Matplotlib)

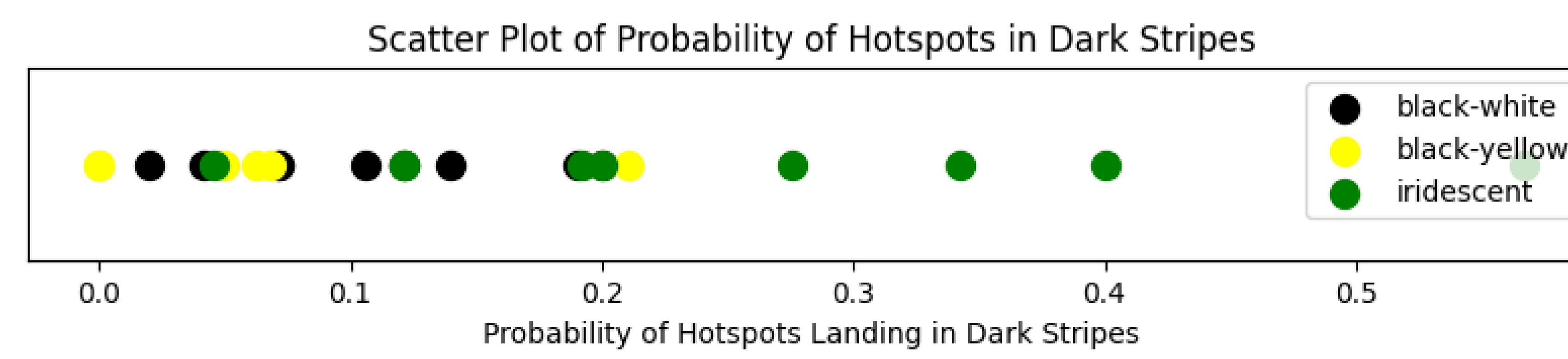
Hotspot numbers are calculated with Python and corrected manually.

Processed Image



Results:





Conclusion and Further Discussion:

As centroids of significant visual contrast areas, hotspots interrupt the smooth, continuous outline of an object. The mapping of calculated hotspots on bees implies visual interruptions that distract and mislead the observer's eyes. This prevents the predators from capturing the true shapes and boundaries of the bees, reflecting the mechanism of disruptive camouflage. According to the data above, black and yellow stripes are likely to enhance camouflage effectiveness.

Regarding further research, the disruptive camouflage properties of the iridescent and metallic bees could be explored, especially under different lighting conditions. My preliminary results imply that when the lights are coming from the side, the iridescent bees may obtain comparable camouflage levels with other bees, whereas lights from other angles lead to more normally distributed hotspots over the entire abdomen.

Bibliography:

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