Estimating Elephant Population StructureUsing Machine Learning

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Introduction

Elephants are keystone species vital for ecosystem balance. Monitoring their populations is crucial for conservation efforts. This research leverages machine learning to:

- Detect elephants in high-resolution aerial images.
- Uniquely identify individuals elephants using a distinct physical feature, which is the skin texture.

Figure: Side-by-side comparison of two elephant images.

Figure: Side-by-side images of two elephant.

- Some images include vehicles, which may appear in the background or foreground.
- Animals like zebras are also present in the dataset, adding to the diversity of the images.
- Some images only show the front of the elephants and makes it impossible to extract unique features from them.

Methodology

1 Data Collection & Preprocessing

- Dataset: 2,747 RGB images (4000×6000 pixels) with elephants, vehicles, and other animals.
- Challenges: high resolution Resized to 640×640 for YOLOv8 input.
- some images do not show elephants and some the elephant is to far away.

2 Detection with YOLOv8

- Model: YOLOv8[2] Medium (yolov8m.pt) for bounding box localization
- Output: Cropped regions of interest (ROIs) for individual elephants

Figure: Side-by-side comparison of two elephant images.

3 Feature Extraction

- HOG [1]: Captures shape/contours (e.g. ear edges, trunk).
- LBP [3]: Encodes skin texture/wrinkles for individual identification.
- Grayscale & Edge Detection: Enhances structural features.

4 Matching & Database

- Similarity Metric: Weighted cosine similarity (HOG: 0.5, LBP: 0.3, pixels: 0.2).
- Threshold: Match confirmed if similarity > 0.85
- Storage: SQLite database

Results

- Grayscale, Edge Detection (Sobel), and Local Binary Patterns (LBP) are applied to the cropped elephant regions.
- These steps highlight structural and textural features critical for distinguishing individuals.
- Two elephants are compared using their LBP features.
- We output the ones that achieves a high similarity score.

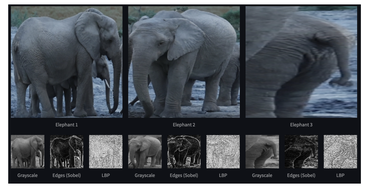

Figure: Feature Extraction.

Figure: Matching Results.

References

[1] Navneet Dalal and Bill Triggs. *Histograms of Oriented Gradients for Human Detection*. https://ieeexplore.ieee.org/document/1467360. In Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05), Accessed: 2025-05-24. 2005.

[2] Glenn Jocher et al. *Ultralytics YOLOv8*. https://github.com/ultralytics/ultralytics. Accessed: 2025-05-24. 2023.

[3] Matti Pietikäinen. *Local Binary Patterns*. http://www.scholarpedia.org/article/Local_binary_patterns. Scholarpedia, 5(3):9775, Accessed: 2025-05-24. 2010.