Bachelor Thesis Proposal Nr.

Topic: Open World Bat Re-Identification

Bat monitoring and conservation efforts depend on tracking and identifying individuals over time to study their behavior, life history, and migration patterns. Traditional monitoring methods, such as tagging and GPS tracking, are highly invasive and may affect the animal's behavior [1]. Recent advancements in deep learning offer a promising alternative for non-invasive animal re-identification (Re-ID) by utilizing models on images or videos. A particularly favorable aspect of bat Re-ID is leveraging the unique wing structure of each bat. Bats have visible blood vessels and collagen-elastin bundle patterns inside and on the wing membranes, serving as candidates for a biometric identifier [2]. The research group that introduced these biometric features also successfully re-identified the bats by manually analyzing their wing structures. Moreover, previous work on images of bat wings has demonstrated a strong performance of deep learning Re-ID models [3]. However, these approaches assumed a closed-world setting, where all individuals are known during training. Instead, this thesis aims to address the challenge of open-world bat re-identification, where new previously unseen individuals appear over time.

Common re-identification approaches involve comparing captured images of an individual (query) against a database of known identities (gallery) and identifying the one with the highest similarity [4]. In an open-world setting, the model – typically a convolutional neural network [5] – extends this approach by additionally identifying if the query is a novel individual that is not present in the gallery. In this context, this thesis will explore the use of pre-trained convolutional neural networks, ResNet-50 and EfficientNet-B0, combined with a feature extractor head and the loss functions Cross Entropy, Triplet, and ArcFace [6], to determine their capability in distinguishing both known and novel individuals. The evaluation of these frameworks will be performed on the same bat image dataset as used in the previous work of the closed-world approaches. The dataset consists of approximately 40,000 images of 15 individual bats, each depicting the right wing of the bat and its associated blood vessels and collagen-elastin bundle patterns.

In short, the thesis will involve the following steps:

- Comprehensive literature review of deep learning open-world re-identification methods.
- Design of a framework for open-world bat Re-ID that implements at least two neural networks, loss functions, and novel class clustering methods.
- Offer insight into the inner workings of the model's learning process by the use of common explainability methods like saliency maps and UMAP plots.
- Evaluation of the different models' performances in correctly distinguishing between known and unknown individuals.

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