

Audio Detection and Identification of Bat Species

Sara Stojkov

1. Problem Definition

Bats (order Chiroptera) are the only mammals capable of active flight. They have become the focus of ecological research because they are sensitive to climate change and habitat loss. Audio detection has become popular because it is non-invasive for bats, and the method itself is quite informative.

Detection of echolocation calls involves classifying audio files based on the presence of bat sounds. Bat sound detection has already been addressed in previous research with data on Finnish bats.

Species identification is performed based on call characteristics obtained from the literature. Since the data in this study are specific to Serbia and Southeastern Europe, we will only consider bat species confirmed to be present in these areas and train the model accordingly. Processing recordings and identifying species based solely on identification keys is extremely demanding and slow, sometimes nearly impossible (e.g., distinguishing species of the genus *Myotis*). Therefore, the goal of this project is to create a model that can determine the species or at least the genus of a bat call with minimal error.

2. Methodology

2.1. Sound Processing and Detection

It consists of three steps: generating spectrograms, noise removal, and call detection. Sound processing and conversion into images will follow the methodology from previous studies.

2.2. Feature Extraction from Calls

Image processing techniques will be used to extract call features from spectrograms, which appear in identification keys (tables) in research papers.

2.3. Model Training and Optimization for Identification

The data will be trained using audio files where species have been manually identified based on literature. Thus, predictions will rely on pre-processed audio files with recorded parameters, and values from the literature will be considered. By adjusting sound processing parameters, we aim to achieve the best possible accuracy.

3. Dataset

The dataset used in this project consists of audio recordings collected using AudioMoth devices during previous research conducted in Valjevo. These are .wav audio files with a duration of 300 seconds, which can be segmented into shorter clips. Currently, there are just under 40 hours of recordings available, which must be carefully processed before use, as some data may not be functional due to noise (rain, anthropogenic sounds, etc.).

4. Evaluation Method

1. Measures taken from other studies – such as the F β measure, which considers precision and recall.
2. Comparison with commercial software “Kaleidoscope” – which has its own processing and file segmentation methods and allows automatic species identification with a license.

5. Technologies

The programming language used will be Python. The scipy library will be used to create spectrograms, and potentially the wave library for sound processing. The numpy and matplotlib libraries will be used for data handling and visualization. Additionally, OpenCV, scikit-image, and other libraries may be employed.

6. Goals and Expected Results

The goal of the project is to determine whether an audio file contains a bat echolocation call and, for the species included in the dataset, predict the species. Thus, the objectives of this project are to establish a model for bat detection and species identification based on previously processed data.

7. References

- [1] Babić, A., Stojkov, S. (2023). Diversity of Bats and Determination of Activity Time via Audio Detection in Various Urban Zones of Valjevo. Conference 'Step into Science', IS Petnica. <https://konferencija.petnica.rs/konferencija-2023/apstrakti-radova/biologija/>
- [2] Rannisto, M. (2020). Detecting Bat Calls from Audio Recordings. Master's Thesis, University of Helsinki, Faculty of Science. <https://helda.helsinki.fi/server/api/core/bitstreams/138d9886-3aa6-4792-84bd-696cc439aa26/content>
- [3] Paunović, M. (2016). <https://nardus.mpn.gov.rs/handle/123456789/7989>
- [4] Obrist, M.K., Boesch, R., and Flückiger, P.F. (2004). Variability in Echolocation Call Design of 26 Swiss Bat Species: Consequences, Limits, and Options for Automated Field Identification with a Synergetic Pattern Recognition Approach. *Mammalia*, 68(4). <https://doc.rero.ch/record/290229/files/mamm.2004.030.pdf>
- [5] Russo, D., Jones, G. (2002). Identification of Twenty-Two Bat Species (Mammalia: Chiroptera) from Italy by Analysis of Time-Expanded Recordings of Echolocation Calls. *Journal of Zoology*, 258(1): 91-103. https://www.researchgate.net/publication/280317673_Identification_of_twenty-two_bat_species_Mammalia_Chiroptera_from_Italy_by_analysis_of_time-expanded_recordings_of_echolocation_calls
- [6] Wildlife Acoustics. <https://www.wildlifeacoustics.com/products/kaleidoscope-pro>