Bioacoustic Monitoring of Birds/Bats in the Vicinity of Wind Turbines

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Introduction

Wind energy has great potential to supplements energy needs of the nation. It has been reported that there are large number of bat/bird mortality due to collision or other factors near wind turbines. There is also large number of bat mortality due to White Nose Syndrome (WNS) . These phenomena's are reducing bird and bat populations and has become an important issue. Therefore, quantification of bird/bat populations is critical for their preservation. It is also necessary to identify bats listed on endangered species list to determine if they are affected or at risk in the vicinity of wind turbines.





Objectives

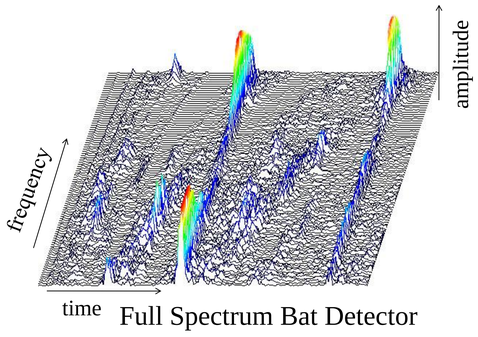
The goal of this work is to monitor, quantify and recognize bats/birds in the vicinity of wind turbines using acoustic techniques. This research will develop acoustic monitoring based system for monitoring, detection of wildlife near on-shore and offshore wind turbine farms. This work will help in identifying behavior of nocturnally active birds and bats. This research may result in contributing towards their preservation if appropriate mitigation measures are employed.

BAT Monitoring Method

Data Collection

Ultrasound Receiver (AR125)

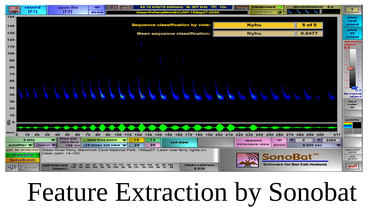
SM2BAT



Full Spectrum Bat Detector

Feature extraction

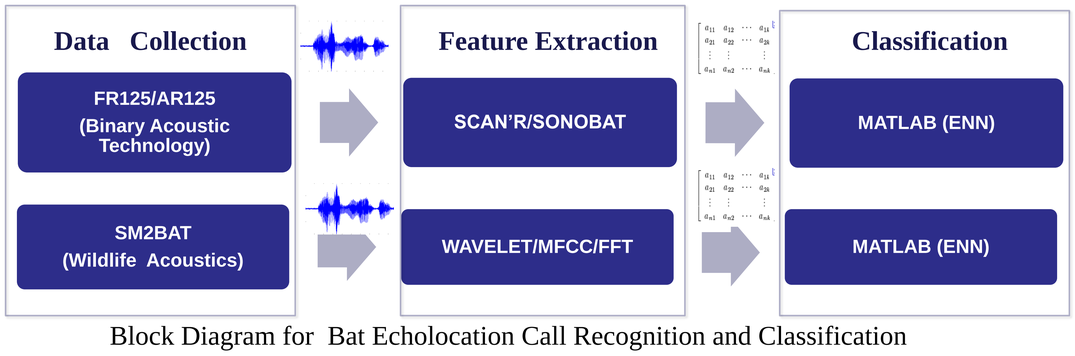
- **Commercial Software:** Sonobat Software
- **Signal Proccesing Technques:** FFT, MFCC, Wavelet



Feature Extraction by Sonobat

Classification

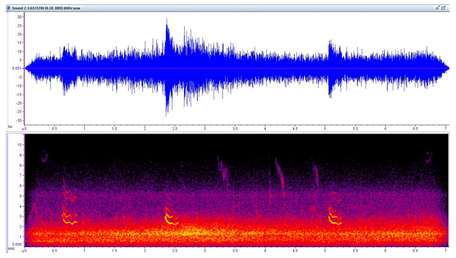
- **Evolutionary Neural Network**: The Evolutionary Neural Network (ENN) utilizes Genetic Algorithm(GA) for neural network weight selection used in bat echolocation call classification. GA has shown in practice to be very effective for optimizing functions and can efficiently search large and complex spaces to find nearly global optima.



Block Diagram for Bat Echolocation Call Recognition and Classification

Bird Monitoring Method

Data Collection



RAVEN recording software

Wildlife acoustics SM2 recorder and PZM microphone

Designed Microphone array UEM-88 minishotgun's

First Scenario for data collection and processing:

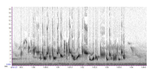
MICROPHONE ARRAY → MAYA USB INTERFACE → 10 BIT ATMEGA 328 A/D MICRO-CONTROLLER → PERSONAL COMPUTER → MATLAB

Second Scenario for data collection and processing

SM2 RECORDER → SONGSCOPE/ MATLAB

Feature Extraction and dimension reduction

- Mel-Frequency Cepstral Coefficients (MFCC) were extracted with 13 Mel-filters from recorded bird calls. Acoustic features of each bird call were compared with ones in the database. Principal Component Analysis (PCA) were applied to the MFCC features to map the high dimension data to lower dimension.

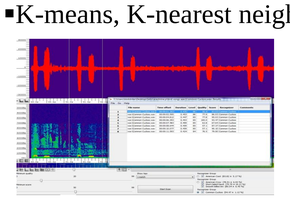


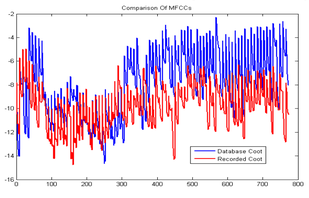
Continuous Bird Call

FRAME BLOCKING → WINDOWING → FFT → MEL-FILTER BANK → LOG SPECTRUM → DCT

Classification

- Pearson's correlation coefficients were calculated in the case of one call sample for each bird species.
- K-means, K-nearest neighbor algorithms were developed for larger database.





Classification with Song Scope and Matlab-Correlation

Conclusion

This work uses feature extraction techniques (FFT, MFCC, DWT) and classification techniques (ENN, Pearson's Correlation, K-means) for automated bird/bat call recognition. The research was conducted in an effort to quantify bird/bat species populations in the vicinity of wind turbines. In the scope of bird/bat call classification, these algorithms are new techniques and can be effectively used as a bird/bat call classifier. Several bat/bird recognition algorithms and commercially available software have also been used for identification of bats and birds. Our developed algorithms perform better than available techniques in the literature and commercial software.

Acknowledgment

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