Behavior Analysis of Birds/Bats Activity in the Vicinity of Wind Turbines

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Introduction

Although **Green Energy** is beneficial, the impact of an ever increasing number of constructed and proposed wind turbines should be considered in the context of living in harmony with the ecosystem. There are numerous reports of bird/bat mortality in the vicinity of wind turbines due to collision with turbine blades or barotraumas. Some of the birds and bats are protected under MBTA and may also be on endangered species list. Therefore, the identification of impacted bird/bat species needs to be considered in areas of proposed wind farm construction.

Objective

The goal of this work is to monitor, quantify and recognize birds/bats in the vicinity of wind turbines using acoustic monitoring techniques. This research may contribute towards their preservation if appropriate mitigation measures are employed. Algorithms for acoustic monitoring have been developed and tested using real data.

Data Collection

Location :

- 1) Toledo
- 2) Ottawa National Wildlife Refuge(Ottawa NWR)
- 3) Put-in-Bay in Ohio

Equipment:

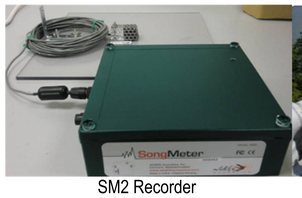
- SM2 detector for recording Bird flight calls
- SM2BAT detector for recording Bat echolocation calls

Sampling Frequency rate

- Birds: 22050 Hz
- Bats: 192 KHz

Time

- Spring 2011: May –July (one hour after the sunset to one hour before sunrise)
- Fall 2011: Aug-Oct



SM2 Recorder

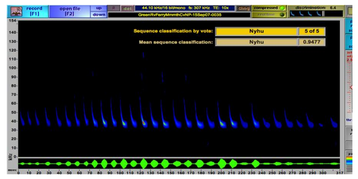
PZM Microphone

Google satellite view of the project area in Ohio, USA

Acoustic Analysis of Bats

Acoustic analysis and identification of avian is divided in two main parts

- Feature extraction : Extract acoustic frequency features of calls
- Classification: Identify different species according to the calls features

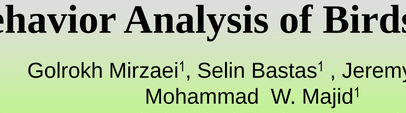


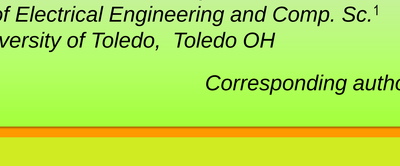
Bat Echolocation call shown in Sonobat Software

Bat Feature Extraction

- Feature Extraction algorithm is developed based on three techniques:
  - Fast Fourier Transform(FFT)
  - Mel Frequency Cepstrum Coefficient (MFCC)
  - Discrete Wavelet Transform(DWT)

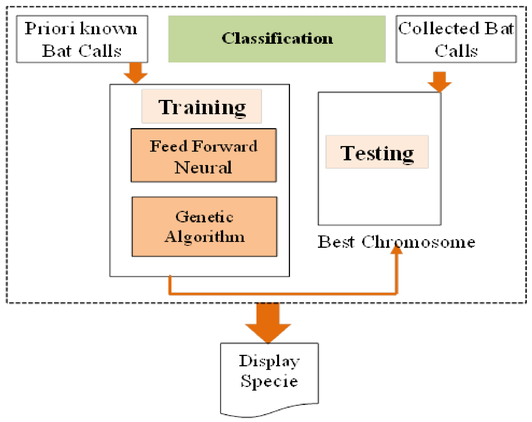
Features are calculated for each echolocation signal.





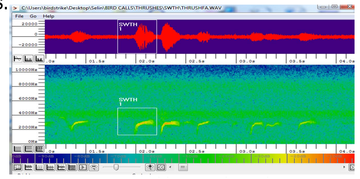
Bat Classification

- An Identification Algorithm is developed based on Evolutionary Neural Network. The inputs of the network is the call features extracted in the previous step. The output of the Neural Network is species to be classified. Genetic Algorithm is used to train the network based on the priori- known calls from Eastern US bats database.



Acoustic Analysis of Birds

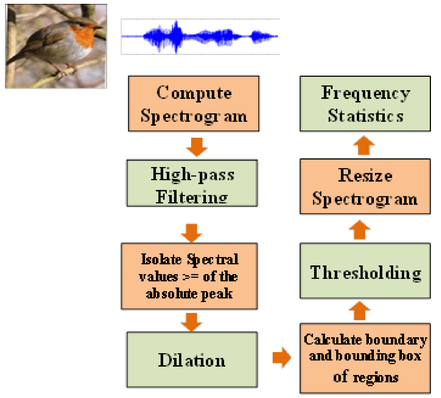
Similarly, the identification of birds is performed by extracting the features of bird calls and then their classification using these features.



Bird Flight call shown in Song Scope Software

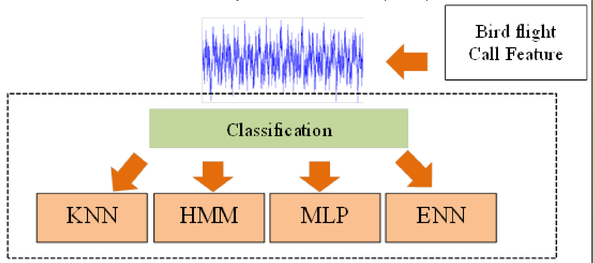
Bird Feature Extraction

- **Spectrogram-based Image Frequency Statistics (SIFS) :** SIFS features represent the statistical image properties of bird calls . A spectrogram is constructed by applying a sequence of FFTs to the each windowed data segment in time domain.



Bird Classification

- Four different technique are used for birds classification algorithm:
  - K-Nearest Neighborhood (K-NN)
  - Multilayer Perceptron(MLP)
  - Hidden Markov Models (HMM)
  - Evolutionary Neural Network (ENN)

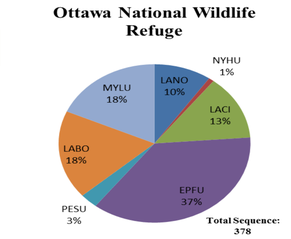


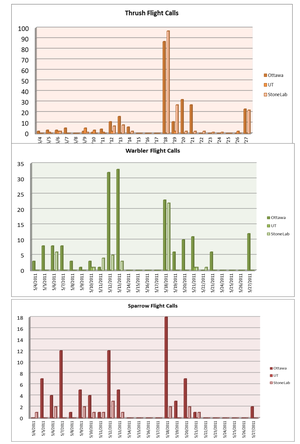
Results

Scientific Name	Common Name	Acronym
Lasiurus noctivagans	Silver Haired Bat	LANO
Lasiurus cinereus	Hoary Bat	LACI
Eptesicus fuscus	Big Brown Bat	EPFU
Lasiurus borealis	Eastern Red Bat	LABO
Myotis lucifugus	Little Brown Bat	MYLU
Perimyotis subflavus	Eastern Pipistrelles	PESU
Nycticeius humeralis	Evening bat	NYHU

SIFS

HMM (%)	kNN (%)	MLP (%)	ENN (%)
65	65	57	67
76	89	98	94
62	84	84	85
77	90	96	87
66	79	85	90
72	85	90	93





Conclusion

The developed algorithms gives higher accuracy than available techniques. Different species and their numbers have been quantified in the project area. This work can be employed by wildlife biologist for developing mitigation techniques for both on-shore/off-shore wind farm applications.

References

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Acknowledgement

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