How Unique is Wing-Beating Sound? Classifying Mosquitoes from Wing-Beating Sounds

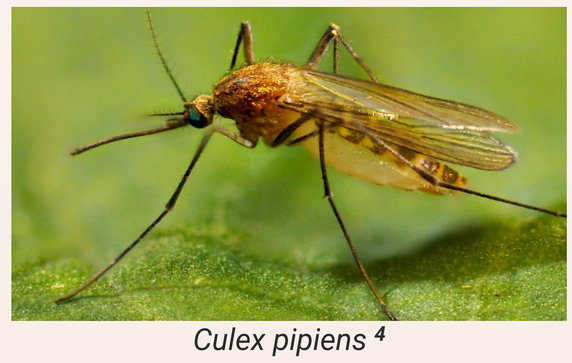
Xutong Wei[1], Md Zakir Hossain[1,2,3], Khandaker Asif Ahmed[4]
[1]School of Computing and [2]School of Biology, Australian National University, ACT 2601, Australia.
CSIRO [3]Agriculture & Food and [4]Land & Water, ACT 2601, Australia.
Contacts: (xutong.wei; zakir.hossain)@anu.edu.au; (zakir.hossain; khandakerasif.ahmed)@csiro.au;

Background

- Mosquitoes are the vectors of numerous deadly diseases including Yellow Fever, Malaria, Dengue fever, Zika and Chikungunya.
- Approximately 7 million people get infected with mosquitoes-borne diseases every year, causing 1 million deaths worldwide[1].
- Proper identification of mosquito species can be helpful to study population dynamics in a target area and develop control-measures for population reduction.
- Traditional key-based phenotypic and DNA barcode based genotypical studies are time consuming, error-prone and need experts of relevant fields.
- Recently, numerous image-based machine learning (ML) approaches has been utilized in mosquito systematics, but considering the small body size, these models often required high resolution images and sophisticated pre-processing algorithm to result in high accuracy.
- Wing-beating sounds of mosquito showed potential to be used as a classifier in mosquito systematics[5,6]
- **The aim of the study is to develop a fast, user friendly and low-cost ML algorithm to identify mosquitoes' species and genera using wing-beating sounds.**

Aedes aegypti [2]

Anopheles gambiae [3]



Culex pipiens [4]

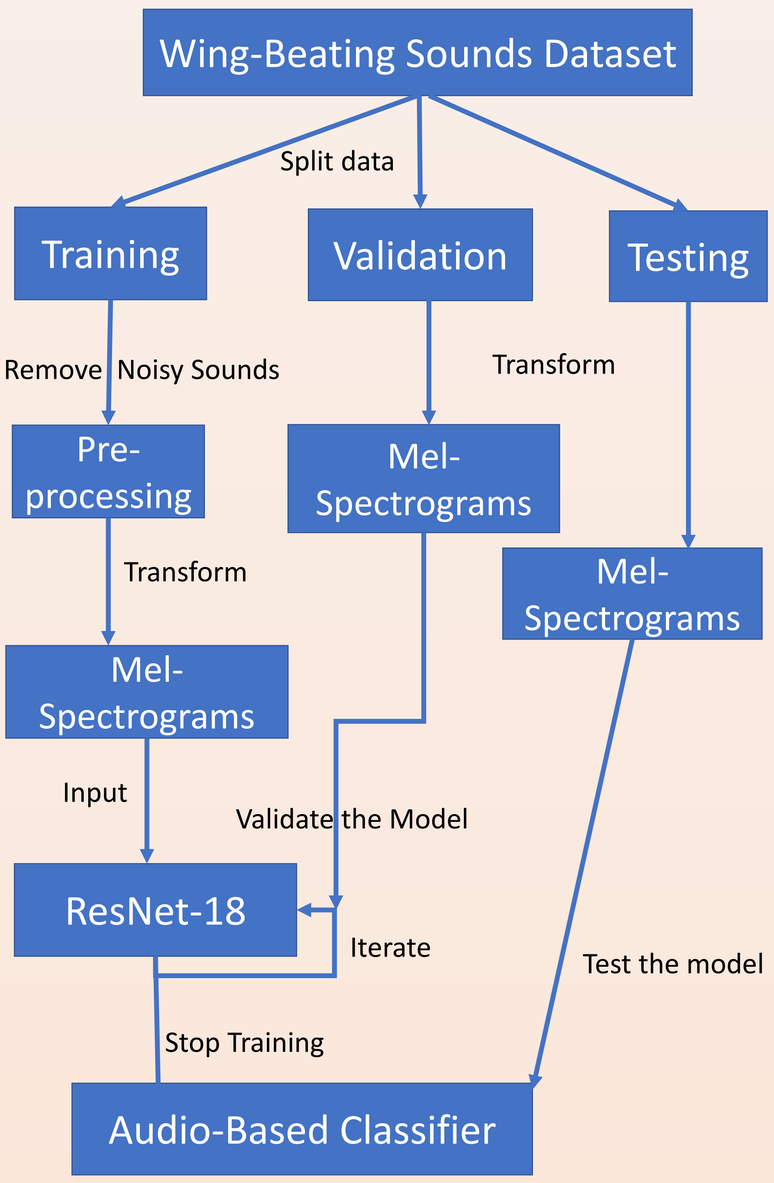
Data collection

- We collected wing-beating sound from publicly available dataset[5]
- The dataset contains raw audio sounds of six mosquito species from three different genera, namely - *Aedes aegypti*, *Aedes albopictus*, *Anopheles arabiensis*, *Anopheles gambiae*, *Culex pipens,* and *Culex quinquefasciatus*.
- Raw audio contains sounds collected from both male and female

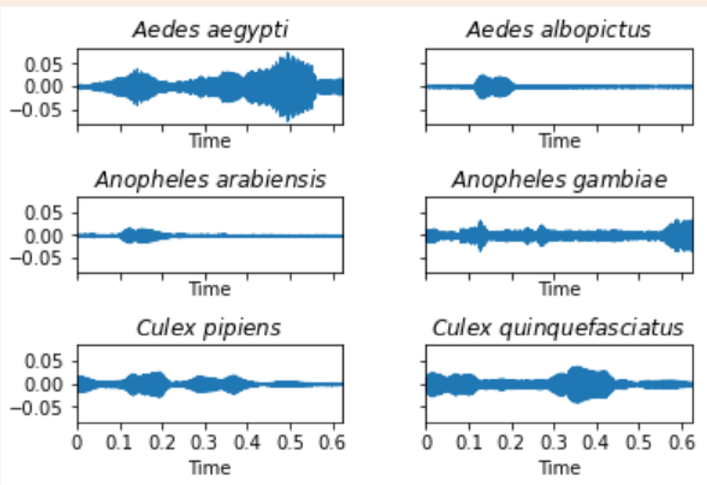
Implementation

- Downloaded mosquito wing-beating raw audio sounds from website and split into training (60%), validation (20%) and testing (20%) data.
- Pre-processed training data to remove noisy background and uninformative sounds
- Extracted features from both raw audios and transformed mel-spectrograms.
- Applied training spectrograms into different pre-trained ML models, fine-tuned and validated the trained model
- Tested the accuracy of our model

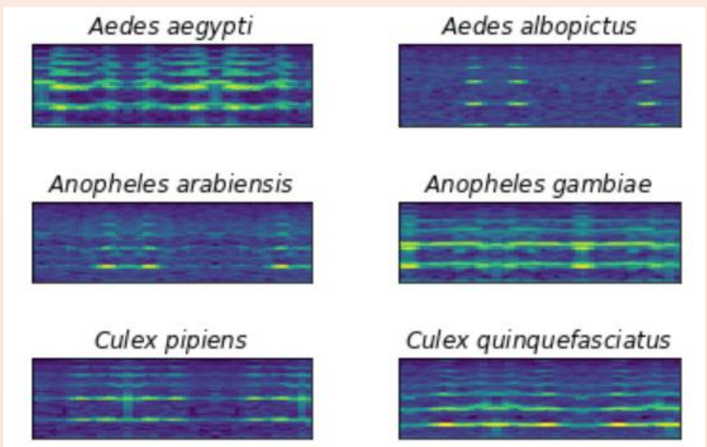
Methodology



Data pre-processing



Mel-Spectrograms



Preliminary results

Model	Accuracy
ResNet-18	**86.1%**
ResNet-34	85%
ResNet-50	85.3%

Model	Input Data	Accuracy
3 Dense Layers MLP	Raw Audio	59%
ResNet-18	Spectrogram	**86.1%**

Expected outcomes

- Establish mosquito wing-beating sound as better classifier than image
- Develop a highly accurate model to classify mosquitos' up to species level
- Further development of the model to identify different genera and species from composite audio inputs.

Future works

- Develop a low-cost and fast tool to be used in mosquito control measures
- Improve the accuracy by applying Attention-based models.
- Add Data Augmentation techniques to make the model more robust.
- Adopt the model for the identification of different mosquitoes' sexes.

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