FAST MOSQUITO ACOUSTIC DETECTION WITH FIELD CUP RECORDINGS: AN INITIAL INVESTIGATION

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ABSTRACT

In terms of vectoring disease, mosquitoes are the world's deadliest. A fast and efficient mosquito survey tool is crucial for vectored disease intervention programmes to reduce mosquito-induced deaths. Standard mosquito sampling techniques, such as human landing catches, are time consuming, expensive and can put the collectors at risk of diseases. Mosquito acoustic detection aims to provide a cost-effective automated detection tool, based on mosquitoes' characteristic flight tones. We propose a simple, yet highly effective, classification pipeline based on the mel-frequency spectrum allied with convolutional neural networks. This detection pipeline is computationally efficient in not only detecting mosquitoes, but also in classifying species. Many previous assessments of mosquito acoustic detection techniques have relied only upon lab recordings of mosquito colonies. We illustrate in this paper our proposed algorithm's performance over an extensive dataset, consisting of cup recordings of more than 1000 mosquito individuals from 6 species captured in field studies in Thailand.

Index Terms— Mosquito detection, acoustic signal processing, multi-species classification, convolutional neural networks

1. INTRODUCTION

Malaria results in half a million deaths each year and mosquitoes are the only vector for malaria [1]. Among more than 3500 mosquito species, only around 60 out of the 450 *Anopheles* species can transmit malaria parasites to infect humans, i.e. are vectors [2]. Therefore, detailed mosquito surveying in areas of endemic malaria is crucial to identify the distribution of malaria-vectoring mosquitoes.

Standard mosquito sampling approaches, including human landing catches, odour-baited traps and cow-baited tents, can be effective in sampling malaria vectors [3, 4]. However, they expose volunteers to potentially infectious bites or are not sufficiently efficient for large-scale and frequent monitoring of mosquito distributions. An alternative solution, using mosquito flight tones to distinguish species, has been researched for some 60 years [5, 6]. In recent years, proof-of-concept mosquito acoustic sensing paradigms, based on embedded devices such as mobile phones, have been proposed [7, 8, 9]. Embedded devices provide a compelling platform for such environmental acoustic sensing tasks due to their cheap and efficient sensors, wide availability and built-in storage and wireless connectivity [10].

Research in the signal processing aspect of mosquito acoustic sensing has often focused on two areas. Firstly the use of domain knowledge to extract hand-crafted features to then allow high-quality detections and secondly the construction of machine learning frameworks which are well-suited to not just detect mosquitoes but importantly also to distinguish species. In much work, fundamental frequencies and associated harmonics form the basis for models which identify mosquito species [11, 9]. However, these low-dimensional features suffer from high intra-species variances and significant overlaps between different species [11, 12], hence limiting their application in multi-species classification. Alternative approaches look to avoid such feature construction and instead allow machine learning algorithms to extract relevant information direct from e.g. the spectrogram. Promising detection results have been reported [8, 13], though we note that the datasets used in evaluations of most previous work are limited in their sample sizes and were usually collected with mosquitoes raised in lab environments.

As a part of the HumBug project[1], a two-month mosquito survey was conducted in rural Thailand. A total of 1256 individual mosquitoes of 9 different mosquito species were captured and the flight tones of these mosquitoes were recorded for each captured individual. We here present the development of a machine learning algorithm that is computationally efficient (as it needs to be for implementation on low-powered embedded devices) and report in this paper on its performance over this field-recorded dataset.

The rest of this paper is organised as follows. We describe in Section 2 the dataset and the proposed mosquito acoustic detection algorithm. In Section 3 we report detection performance and discuss results. We conclude the paper and discuss future directions in Section 4.

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