Buzznet

Introduction

This page provides a comprehensive and current state of the project. Also see blog posts tagged research and demos.

Phase 0: Proposal

This basic outline provides background for the scope and goals of this project.

“Our best defense is to eradicate mosquitoes and destroy breeding habitats, all over Singapore.”

Prime Minister Loong’s goals to address the mosquito-transmitted Zika virus are still relevant today (Baker, 2016). Despite investment in advanced technologies, like mosquito gene-editing, the most effective mosquito control technique is to eliminate stagnant water that mosquitoes breed in, like rain-filled ditches. Today, the Singapore National Environmental Agency (NEA) uses manually intensive methods to inspect urban areas for millions of mosquito breeding grounds due to Singapore’s tropical climate. This approach must be refined.

Singapore is a success story of urban planning at scale. This approach should be utilized in re-envisioning mosquito prevention strategies. Prof. Clayton Miller, head of the Building and Urban Data Science (BUDS) group at the National University of Singapore (NUS) combines urban design with data science. Their approach is similar to companies like Google, that use human-centered data science to revolutionize their products. The BUDS group investigates sustainable urban resource usage to improve quality of life by collecting and analyzing large environmental data sets from Internet-of-Things (IoT) sensors. IoT sensors are connected, modifiable devices which can transmit data remotely via the internet.

I propose an approach to mosquito control by combining my technical experience with BUDS’s human-centric urban data science methodology. I would implement the BUDS methodology by creating an IoT sensor network with a feedback loop, which I have named BuzzNET. The feedback loop of BuzzNet consists of analyzing sensor data (CO2, humidity, noise, temperature, etc.), suggesting and implementing mosquito control actions from that analysis, and then collecting more data to evaluate those actions. I will use IoT sensor data to determine environmental factors that allow mosquitoes to breed, like humidity near drains. Knowing that will guide me to recommend simple mosquito control actions, like unclogging the drain. These solutions will then be evaluated with new data analysis, like observing decreasing humidity readings. Using BuzzNET, we can determine factors that cause mosquito breeding grounds, and then suggest, implement, and evaluate mosquito control actions. BuzzNET demonstrates

the feasibility of data science for mosquito control in urban design and opens the possibility of enormous benefit to human well-being globally.

Objective: The objective is to prototype an IoT sensor network with a feedback loop, BuzzNET, to detect and design against mosquito breeding grounds for Singaporean urban planners.

The project has four key phases:

Phase 1

Goal: Understand mosquito breeding grounds in Singapore by interviewing exterminators, the NEA, and residents about the environment, waste habits, and mosquito awareness.

Outcome: Find the optimal setting for 10 BuzzNETs

Phase 2

Goal: Setting up and testing the 10 sensor systems indoors and outdoors with suitable environmental protection.

Outcome: BuzzNETs are set-up.

Phase 3

Goal: Perform sensor upkeep, log human interaction data, and manually test for mosquito larvae counts. Simultaneously, use machine learning and computer vision techniques to quantify human interaction with the environment, determine breeding grounds (stagnant water breeding grounds are usually cooler than ambient air), and use data science to make environmental models of the breeding grounds.

Outcome: Identify environmental factors to be controlled to eliminate breeding grounds.

Phase 4

Goal: Use data models to recommend simple control actions in the urban environment, like unclogging drains. These would be evaluated using the Integrated Pest Model, where I would compare the mosquito counts, ambient environment, and impression of residents before and after the intervention. Finally, I will update the environmental models, thus completing the feedback loop.

Outcome: The models inform Singaporean urban planners about addressing and preventing mosquito breeding grounds.

Results: I will present NUS and NEA a BuzzNET prototype of data science applied to mosquito control. I will also write a report detailing my process and generalize it to IoT sensor feedback loops for other uses. The code and report will be public.