MOSQUITOBELL: A MOSQUITO DETECTION SYSTEM

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Abstract - Cameroon is a lower-middle-income country located at the junction of West and Central Africa[1]. It is home to around 26 million people. The backbone of its economy is based on agriculture. 70% of the population lives thanks to agriculture. According to WHO (The World Health Organization), Africa is the world region that is most affected by malaria[2]: In 2017, the African continent held 90% of malaria cases. Many efforts have been carrying out to fight malaria. The various existing prevention systems, ranging from insecticide-treated nets, indoor residual spraying with insecticides to antimalarial drugs have obvious limitations. Also, the malaria parasite has begun to develop resistance to insecticides and drugs currently used. Mosquitoes, despite their size, are the biggest killers of the human race superseding by far humans themselves or any fearsome animal [3]. Anopheles mosquito is the main transmission vector and the main cause of malaria[4]. In this paper, I present "MosquitoBell", the first version of a mosquito detection system aiming at detecting mosquito. Detecting mosquitoes is the first step to be achieved in order to develop a full system that will be able to monitor mosquitoes and provide real-time information to end-users, researchers on their mobile phones or personal devices. The MosquitoBell system is made up of sensors (Passive Infrared and Ultrasonic Sensors), a Camera, and a Raspberry Pi. The MosquitoBell system has been developed and tested. The results obtained enlighten us on the next move. This system is intended to be used alongside other technologies to come up with a holistic solution to fight mosquitoes, hence reduce the rate of malaria in Africa and the South-East Asia.

Keywords - Malaria, Mosquitoes, Passive Infrared, Ultrasonic, Raspberry Pi.

I. INTRODUCTION

1.1 Background

The Malaria disease is still severe in many countries as the Figure1 shows Communicable Diseases (CD),

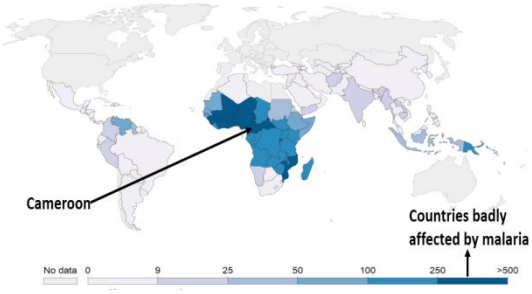


Figure 1 Countries affected by Malaria

in particular, remain a difficult problem in Cameroon. Figure 2 shows that malaria is ranked as the first deadliest disease, which causes the most premature death in Cameroon[5].

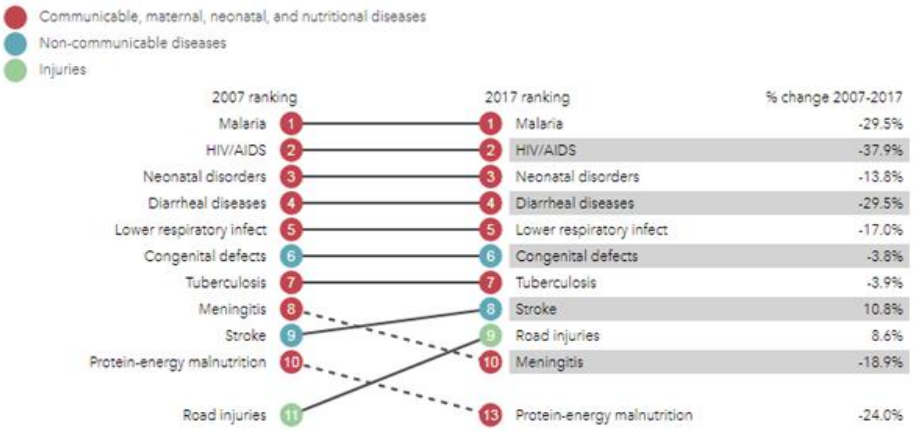


Figure 2 Top 10 causes of life lost in 2017

According to a recent study undertaken in Yaoundé, the capital of Cameroon, there is a high risk of malaria transmission sustained by Anopheles gambiae [1]occurring both indoors and outdoors in the capital city Yaoundé [6].

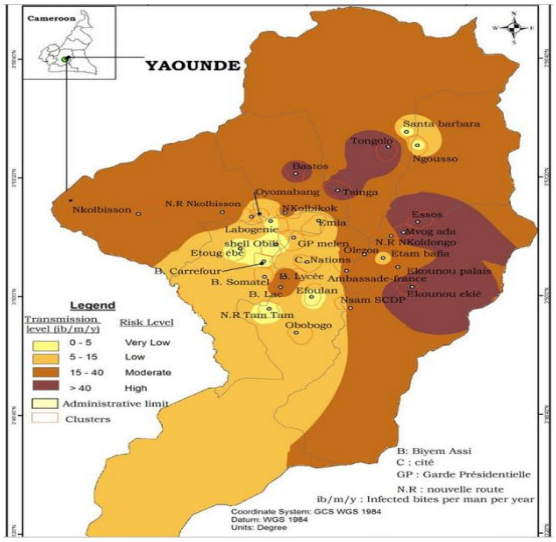


Figure 3 Malaria transmission rate in Yaoundé

The same study suggests that the average biting rate of anopheline funestus[2] was significantly high outdoor than indoor. Based on the limitation of the current prevention system, it is necessary to come up with a different approach to fight malaria.

1.2 The Goal of the system

Many reasons cause Malaria However, the bite of a mosquito is the main issue to tackle in order to prevent malaria. Despite the existence of various solutions, from Mosquito Nets, sprays, to Mosquito Traps, the malaria disease remains. The different interviews underwent allowed me to find out that both victims and researchers have common needs. There is no way for people to have real-time information about mosquitoes, the main vector agent. Furthermore, most current methods to monitor mosquitoes like CDC light traps[3], human Landing catching are laborious and need expensive equipment and highly trained people. This makes them less suitable for resource-poor areas, which typically have the highest levels of mosquito-borne disease. Mosquito Monitoring, the long term solution that I am developing has potential in malaria prevention. With the main objective to reduce malaria, it will allow everyone to be involved in the fight against malaria. However, mosquito monitoring involves a lot of different activities. One of them is presented in this paper. Figure 4 provides a summary of the issue to be solved, existing solutions, the proposed solution and its novelty, and the activities to be taken in order to achieve the final goal.

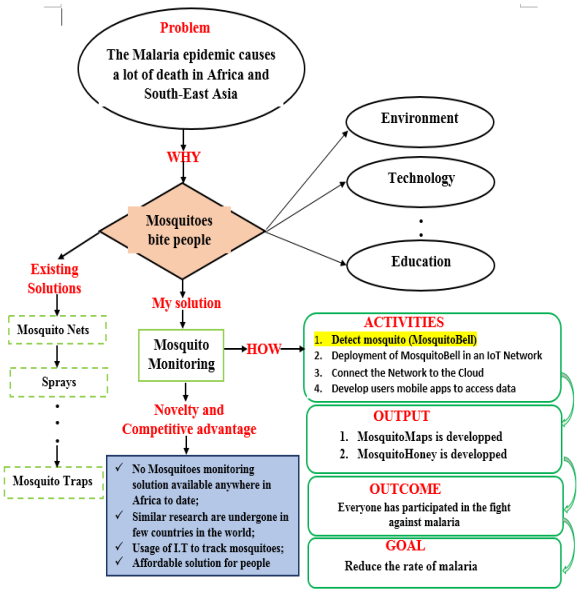


Figure 4 Process and novelty of Mosquito Monitoring

In alliance with the SDG goal 3.3 [4][7], this paper presents "MosquitoBell", a detection system aiming at detecting mosquitoes on the fly. Such a system will be useful to effectively track mosquitoes and provide real-time information to researchers and end-users about mosquito activities. One of the advantages of this system is that it will also reduce the cost compared to other solutions that remain so expansive for the African market. In the rest of the paper, we will introduce relevant related work. Then, present the MosquitoBell sensor, detailing its architecture and components alongside other technologies used to attract mosquitoes. After, we will proceed with the experimentation undergone in a production environment, and show the results. Finally, we conclude the paper with final remarks and future work.

II. RELATED WORK

The Cambridge dictionary defines mosquito as a small insect that bites people and animals and sucks their blood[8]. In recent years, a few researchers have studied the concept of detecting insects using sensors. According to research [9], it is possible to detect insects by mainly using ultrasonic and infrared sensors. The ultrasonic sensor will detect the sound of insects by detecting ultrasonic signals generated by insects. After that, the presence of insects will be confirmed by the heat generated by the insect's body through the infrared sensor. Another research [10] uses the Raspberry Pi and a simple Raspberry Pi Camera to monitor insects. I am using a combination of those technologies to develop MosquitoBell. It will

[1] One of the main malaria vector species
[2] Species of mosquito which is a major vector of malaria in sub-Saharian Africa
[3] Centers for Disease Control to provide provide a reliable and portable sampling device for the collection of mosquitoes
[4] SDG 3.3: *Fight Communicable diseases*

have the sole purpose of detecting mosquito insect in a determined perimeter, then take pictures and videos of them. I am using the Mosquito Magnet device to attract mosquitoes close to MosquitoBell[11].

III. THE MOSQUITOBELL SYSTEM

Figure 5 shows the architecture of the MosquitoBell system. It is composed of an ultrasonic sensor, a passive infrared sensor, a raspberry pi, and a Raspberry Pi camera.

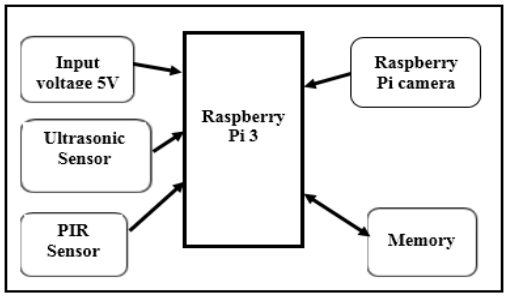


Figure 5 MosquitoBell Architecture

Hardware	Type
Raspberry Pi	Raspberry Pi 3 Model B+
Camera	Raspberry Pi Camera module
PIR Sensor	PIR (motion) sensor
Ultrasonic Sensor	Hc-SR04

Table 1 Components used to compose the system

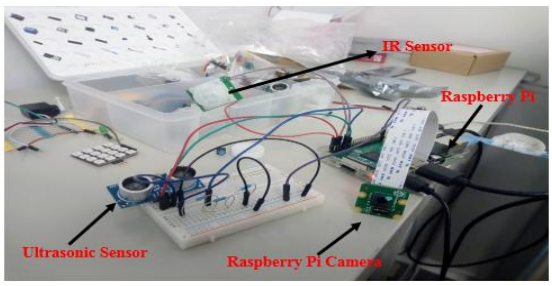


Figure 6 Overview of MosquitoBell system

A. Ultrasonic Sensor

An ultrasonic sensor measures the distance to an object by using ultrasonic waves[12]. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic sensors measure the distance to the target by measuring the time between the emission and reception. The ultrasonic sensor of the MosquitoBell system detects the insect (mosquito) activity by detecting sound generated by insects in the audio frequency range (20-20.000 Hz) [9].

B. PIR Motion Sensor module

All objects in the world emit heat if they have a temperature higher than absolute temperature[9]. The radiation is in the range of infrared radiation. Passive Infrared (PIR) sensor is also known as Pyroelectric or IR motion sensor. PIR sensor is used to detect motion whether human or animal has moved in or out of the range of the sensor. The PIR sensor is made of a crystalline material; it produces infrared radiation when the surface is exposed to heat which generates an electric charge.

C. Raspberry Pi

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse[13].

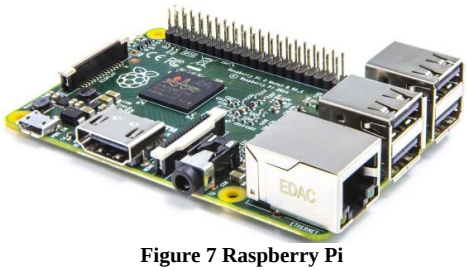


Figure 7 Raspberry Pi

It is a capable little device that enables people of all ages to explore computing and to learn how to program in languages like Scratch and Python. It's capable of doing almost everything you would expect a desktop computer to do. From browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games. It also has the ability to interact with the outside world.

IV. EXPERIMENT AND RESULTS

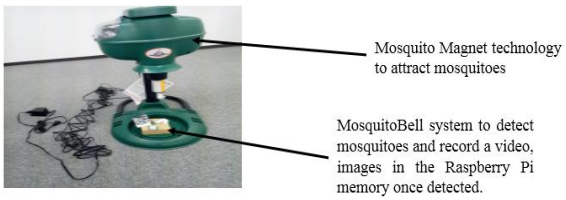


Figure 8 Experimental system set

The experiment has been carried out in Japan for three weeks in a row in two different locations both indoor and outdoor. The following results were observed:

- Indoor: Inside of the dormitory schools in Kobe city



Figure 9 Indoor experiment



Figure 10 Experimental disposition changed

Results:
After one week of operation, we found no pictures nor videos saved in the memory of the Raspberry Pi. Many reasons could explain it:

- MosquitoBell did not detect anything;
- No mosquitoes were attracted at all by the Mosquito magnet devices;
- the place was not appropriate for the experiment;

- Outdoor: In the school backyard in Kobe city



Figure 11 Outdoor Experiment



Figure 12 Experimental disposition changed

Results:
I have checked twice per week to see if something happened. At every checking step, roughly 1000 pictures and videos were saved in the system memory. Some of the videos effectively capture mosquitoes, some others showed nothing. This is a success. MosquitoBell has effectively detected insects and saved them in the memory as expected. However, some aspects remain to be seen. I am curious to know if MosquitoBell was triggered only and only by mosquitoes rather than other external factors.

V. CONCLUSION

This paper has succinctly presented a new approach to how current cross-cutting edge technologies could be used to detect mosquito through the MosquitoBell system. Although positive results obtained throughout the whole testing experience, with more improvements, we believe that it is possible to develop an operational system able to detect mosquitoes. That system could have a tremendous impact on the fight against malaria disease in affected countries in the World.

FUTURE WORK

We will keep improving the system using a better approach to detect mosquito. Using acoustic sensors to detect mosquito wingbeat sound and machine learning to classify different types of mosquitoes presents a lot of potential for that aspect. After that, in order to have more data and a more successful test, we long to carry out the next experiment in Cameroon during the rainy season which is the period where mosquito activity is at the peak.

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REFERENCES

[1] "Cameroon Population 2019 (Demographics, Maps, Graphs)." [Online]. Available: http://worldpopulationreview.com/countries/cameroon-population/. [Accessed: 08-Oct-2019].
[2] "WHO | This year's World malaria report at a glance," WHO, 2019.
[3] "The Deadliest Animal in the World | Bill Gates." [Online]. Available: https://www.gatesnotes.com/Health/Most-Lethal-Animal-Mosquito-Week. [Accessed: 01-Sep-2019].
[4] "Malaria." [Online]. Available: https://www.who.int/news-room/fact-sheets/detail/malaria. [Accessed: 08-Oct-2019].
[5] "Cameroon | Institute for Health Metrics and Evaluation." [Online]. Available: http://www.healthdata.org/cameroon. [Accessed: 01-Sep-2019].
[6] P. Doumbe-Belisse et al., "High malaria transmission sustained by Anopheles gambiae s.L. occurring both indoors and outdoors in the city of Yaoundé, Cameroon [version 1; referees: 2 approved]," Wellcome Open Res., vol. 3, 2018.
[7] "Goal 3: Good Health and Well-Being - SDG Tracker." [Online]. Available: https://sdg-tracker.org/good-health. [Accessed: 01-Sep-2019].
[8] "MOSQUITO | signification, définition in Cambridge dictionary." [Online]. Available: https://dictionary.cambridge.org/fr/dictionnaire/anglais/mosquito. [Accessed: 08-Oct-2019].
[9] K. Sisodiya and M. Singh, "Design and Development of Ultrasonic and IR Insect Detector for Oilseeds Crop," vol. 7109, pp. 52–56, 2016.

[10] "Monitoring insects at the Victoria and Albert Museum - Raspberry Pi." [Online]. Available: https://www.raspberrypi.org/blog/monitoring-insects-at-the-victoria-and-albert-museum/. [Accessed: 28-Sep-2019].

[11] "Mosquito Traps To Protect Your Home Or Business | Mosquito Magnet®." [Online]. Available: http://www.mosquitomagnet.com/. [Accessed: 08-Oct-2019].

[12] "Ultrasonic Sensor | What is an Ultrasonic Sensor?" [Online]. Available: http://cmra.rec.ri.cmu.edu/content/electronics/boe/ultrasonic_sensor/1.html. [Accessed: 08-Oct-2019].

[13] "What is a Raspberry Pi?" [Online]. Available: https://www.raspberrypi.org/help/what- is-a-raspberry-pi/. [Accessed: 08-Oct-2019].

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