

# Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface

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**Abstract**— This research paper focuses on the design and implementation of an intelligent mosquito monitoring and control system model with android-enabled user interface and bzig camera system to monitor and repel mosquitoes as a preventive remedy for mosquito bites that cause malaria infection. Several techniques aimed at combating mosquitoes to stop malaria spread ranging from environmental fumigation; the use of mosquito treated net; the use of herbal repellent sticks with low smoking technique; the spray of mosquito insecticide chemical repellents to electronic spray control, have health and environmental concerns. The method adopted for this design includes: microcontroller-based system, bzig camera system and Android-enabled system. These combined approaches were used to develop a human and environmentally friendly device. The bzig camera system intelligently scans for mosquitoes within its range of coverage and processes the images of mosquitoes automatically to give a feedback to a microcontroller. The controller receives the image signal and sends a notification to the home owners and also produces a sound frequency of about 38kHz to 45kHz that forces the available mosquitoes into a specified vacuum for the house owner's disposal. This frequency range does not permit the survival of mosquitoes and this operation is monitored using a developed Android-enabled user interface. The design was tested under an indoor space of 12ft x 12ft confinement. The results from this intelligent mosquito repelling system model proves its suitability for the control of mosquitoes and as such seen to be an adequate technique to replace other less human and environmentally friendly approaches.

**Keywords**— Android-enabled, Mosquito Repellent, Intelligent system, Bzig Monitoring, Control Model

## I. INTRODUCTION

Engineering principles exist to develop systems that make life easy for mankind. Though, human health deteriorates daily as a result of diseases emanating from the environment. One of these diseases is the mosquitoes-borne menace known as malaria which has now become a major source of attack to global public health [1]. Machine learning finds application in monitoring mosquitoes' action and controlling their activities. Mosquito repellents are combined constituents of substances developed to make surfaces unfriendly or deterring to mosquitoes thereby limiting their spread.

Mosquito repellents contain some active ingredients that aid their capacity to repel mosquitoes with some other ingredients [2]. Advancements in engineering have proven to be the only sustaining strategy for mankind globally; this is due to its inventions, innovations and enhancement of the already existing technologies. Malaria was discovered long ago to be one of the infectious diseases caused by Anopheles mosquitoes. The Anopheles mosquitoes on biting human being introduce the parasite plasmodium into the body that causes malaria. Due to the fact that this infectious disease has proven to be universal, the World Health Organization decided that some ways of controlling, eliminating and eradicating this global menace be formulated [3]. Several of these approaches from scientific research have attempted to control, eradicate and eliminate malaria spread. These methods range from keeping the environment clean, the use of treated net, treated swatter, UV lamps, LED trapping system, burning of dry leaves to application of liquid or dry inflammable repellent. The electronic approach of tackling mosquito spread using the frequency range of 20 kHz to 40 kHz was proposed. In this proposed design, 20 kHz to 40 kHz frequency range is invisible to human but the sound is capable of displacing mosquitoes after an intelligent camera has established the presence of mosquitoes within the experimented area. Mosquitoes are made to sense the sound waves constantly thereby compelling them to move to far distance with the embedded internet of things device[4].

Mosquito bites resulting an infectious disease known as malaria from the associated parasite plasmodium has remained a source of health concern in our society[5][6]. Several efforts have been made by researchers to combat this infectious disease ranging from keeping the environment clean, production of liquid or dry inflammable mosquito repellent and burning of mosquito coils. These means of combating this menace have proven not to be environmentally safe and healthy. The use of insecticides has proven to be one of the ways of combating this epidemic but its effects on human health and environment still makes it unsafe for continued use. Electricity driven mosquitoes repellent promisingly provides the solution to mosquito attack but the unguaranteed steady supply of electricity becomes another setback for a developing economy, hence the need to design and implement an intelligent, android-enabled mosquito monitoring and repelling control system as it will aid the elimination of the malaria disease condition resulting from mosquito bite with minimal power consumption. Plasmodium is transmitted through bites from the female anopheles mosquitoes that serve as its host which in turn causes fever, vomiting within 15 to 20 days of human infection [5], there is need for a design that will completely prevent the transmission of this disease causing organism like this design with minimal health and environmental concerns.

[7] explained that since mosquito disease is severe worldwide and with adverse effects on human health, a low-cost acoustic mosquitoes sensing system is needed. The sounds from their wing beat are used to identify different mosquito species automatically and to monitor its activities.

The primary objective of this work is to develop an intelligent android-enabled mosquito monitoring and repelling control system model as a preventive remedy to mosquito transmitted malaria disease conditions. This primary task will be achieved with the implementation of the following secondary objectives: to develop an enhanced intelligent mobile microcontroller-based device using piezo electric sensor for mosquito repellent action; to incorporate image processing concept into the mosquito repellent system using bzipo camera; to develop a remote monitoring and control system using Android Applications; to formulate, evaluate and analyze criteria capable of ascertaining the performance of the mosquito repellent system.

The intelligent android-enabled mosquito repelling system would curtail the high cost of fumigating public places such as educational institution, banks and hospital etc and eliminate the associated health and environmental hazards for popular acceptance. With this proposed design, the environment will not witness any form of pollution. The low initial cost, easy installation and cost-free maintenance system are some attributes of the proposed design. These will make the design adventurous over other mosquito monitoring and control approaches. The era of moving round to spread or burn mosquito coils would be over. The system could also be deployed in our places of worship, banks, hospital, prison, homes and industrial zones. The listed places are where humans spend most of their time on daily engagements. This design will not have adverse effects on environment in terms of pollution and it will seek to reduce malaria infection rate through prevention of mosquito bites. The existing method of mosquito monitoring and control has effect on both human and environment, hence this proposed model.

The reason for this study is to develop an intelligent-based, camera-based, android-enabled mosquito monitoring and repelling control system model for health enhancement purpose and explore the means of using insect repelling frequency sound waves to scare them away or direct them to a specific zone for safe elimination with minimal health and environmental concerns

## II. LITERATURE REVIEW

Mosquito Monitoring and Control requires global attention, several health agencies both governmental and individual are on the process of eliminating this disease-causing organism. [8] attributes the rapid increase in public health issues as reported from mosquito-malaria infection to inadequate application of insecticide when trying to control its operation. This is in consideration of many other factors like inadequate sanitation of the environment geared towards removing stagnant water around every habitation. The proposed method uses the efficient ways of controlling mosquitoes by surveillance and detection. [9] proposed a preliminary diagnosis device for mosquito-borne diseases (dengue, chikungunya, and malaria) as a measure for monitoring the Mosquitos disease spread using Raspberry Pi-based system. The system has built-in human machine interface, temperature sensor, blood pressure monitoring device with capability of recording vital disease symptoms check.

The wide and rapid spread of mosquito (Chickugunya Infection) disease required sophisticated monitoring and control system thus, mobile device with global positioning system (GPS) was introduced for Smart malaria Healthcare system and presented a cloud based system which aids data collection through Android device and sensor with edge servers [10]. [11] also confirmed that disease causes risk on human. [12] developed low power system for

monitoring and control with wireless system from Radio-frequency identification (RFID).

[13] reviewed several chemicals and their structures as they are used for production of mosquito repellents. Although several achievements were recorded involving continuous advancement and improvement, the research demonstrated chemical influence over mosquito and suggested many other compounds that could be used for repellents production. Despite these research efforts, there were some setbacks on human and environmental safety from these chemical approaches, as attempts to make them human and environmentally safe were not completely achieved. Similarly, [14] posited that Chemical mosquito repellents gained wide acceptance though harmful in comparison with the natural plant-based repellents. Mosquito repellents are considered suitable means for human protection against mosquito attack as it causes malaria because of the pathogens it transmits known as plasmodia [6].

[15] examined mosquito repellent and proposed that it should be used on fabric. With this, textile materials were treated with repellent to protect humans from mosquito bites. The essence of mosquito repellent is to make life within a given environment uncomfortable for mosquitoes. Common ways of eliminating mosquitoes are by applying smoke or burning herbs, extracting oil from the plants, tars, and mud [2].

[16] formulated a repellent stick with a low smoke herbal content for mosquitoes control with several important oils. The ingredients of these oils were combined in different proportions and proved to support burning and smelling which would aid repelling of mosquitoes. The example of one of the formulated oils was Azadiractaindica which has continuous burning and repellency capability. It was discovered that with combined ingredients, this herbal-based and eco-friendly herbs will not have adverse inhalation effect on human but it was not implemented.

Similarly, [17] carried out a research using Azadiractaindica and experimented in two days of six hours for both indoor and outdoor scenario and its mosquito repellent activities were ascertained. Citronella grass oil also gained wide acceptance in mosquito repelling herbal chemical production, this used natural binders in an attempt to eliminate the traditionally available mosquito repellents made of chemicals that were found unsuitable for human health. This was prepared with 100% herbal ingredients and [18] [19] validated essential plant oils that are good mosquito repellents.

[20] evaluated and analyzed the available electronic mosquito repelling system and concluded that the available mosquito repellent devices as at the time of the research failed to reduce human-mosquito bites but the advancement in researches has proffered solution to this problem.

[4] posited that to traditionally eliminate mosquitoes in our environment, the existing approaches like spraying of repellents, mosquito traps and mosquito killer bats were used. Their disadvantages were enormous, ranging from reaction of human skin, pollution to excessive use of the repellents with the attendant hazards. Those systems could not trap and kill the mosquitoes instantly. Another means used to combat mosquito bite was by developing a swatter, swatter is designed with thick plastic and placed such that mosquito net can be wrapped around the bed to prevent it from having contacts with human. Their design proposed that the elimination of mosquitoes can be achieved by trapping and killing. The introduction of the UV Light, mosquito liquidator with the ultrasonic sensor was also demonstrated. With these, an electric fence could be activated in an ON and OFF mode with a microcontroller via cloud to repel mosquitoes.

The electronic approach to pest control has proven that science and technology research is effective, electronic approach considers generating a certain frequency which is not audible to human ear but deterring to mosquitoes. Research shows that the sound frequencies of 10 kHz to 100 kHz make insects feel uncomfortable

thereby scaring them away. This continuous audio stress has no adverse effect on humans and the environment. Whereas an audio frequency range of 20 Hz to 20 kHz can be heard by human, frequencies above this range are not audible to human but mosquitoes can hear sound with frequency higher than 20 kHz, and get irritated and forced to leave the radius of the area under the frequency coverage. The Electronic approach posed no harm to human health and the environment thereby proving a better alternative to chemical pesticides and others. Among other advantages of electronic pest control are: low power consumption of about 1.5watts; affordability for individual and family; portability and compactness; user operational status indicator; simplicity and ease of mass production capabilities [21].

This design will introduce some modifications to improve on the already existing work by using android application for monitoring and control of the device to enhance its smart status for a better user interface, considering it's human and environmental safety attributes and effectiveness in repelling of mosquitoes.

Most recently, further effort aimed at eliminating mosquito attack on human using electronic repelling technique was demonstrated with a solar energy powered device. The design proffers a solution to a prevailing absence of constant electric power supply since electronic repelling systems rely on electric power for their optimal operation. [22] opines that for effective mosquitos' eradication, monitoring and control of their breeding Sites should be ensured. Wireless network and electromechanical technologies was adopted. The stagnant pools was identify and the short message service through Android phone was sent via GPS for the stagnant water to be removed using electromechanical pump-out techniques.

[23] [24] state that critical human threatening disease condition are caused by malaria include dengue fever, yellow fever and west Nile virus infection. The deadly disease can be control using Sterile Insect Technique.

This method was frequency dependent for evening and night mosquito repelling operations. The system incorporated wire meshes such that when mosquitoes come in contact with it, the capacitor discharges violently and creates an electrocuting electric field immediately to kill mosquitoes. With this, it was imperative to have a constant power supply which necessitated a solar-powered device. The researcher improved on the hand held device to produce a solar-powered design [25].

In [25] Arduino system was programmed with calendar update encapsulation. The recorded status of the system makes the relay either high or low to show the device operational mode. Malaria disease is a vector-borne disease and is increasingly becoming problematic mostly for urban dwellers because of indiscriminate waste dumping. The threat posed to human health requires multi-disciplinary approach to combat the spread using Remotely Piloted Aircraft Systems[26].

In another research development, the use of sound in scaring mosquitoes was demonstrated [27], with an inexpensive and scalable system which records and analyzes mosquito sounds, and posited that there is a sound frequency level that is allergic to mosquitoes. [5] developed a low energy consumption device to detect and trap mosquitoes using optical fiber sensor. The device was able to count, capture and detain live mosquitoes entering the trap using renewable energy source. [1] developed a trapping box for the collection of mosquitoes using wood made of Pinus kesiya to reduce threats posed by mosquitoes to public health. Three species of mosquitoes were captured namely: epiroticus, quinquefasciatus and sitiens which were likely to transmit malaria that will affect human health. The device was tested and proved to control the spread of malaria around the experimented zone.

[28] developed a system that traps insect with one or more optical mosquito image recording devices positioned to monitor insects passing through a particular trap inlet. The data were

captured and recorded from the light scattered or shadow cast. Their method combined both mosquitoes counting and image capturing. [29] reviewed all the tools used in tracking mosquitoes, the device used in recording mosquito activities also analyzed mosquito flights. Their research opined that as long as mosquitoes exist, malaria disease will continue to affect human health and economic activities if not managed properly. Bzigo is a recent image processing device with embedded artificial intelligent encapsulation combined with laser system and AI system capability. The camera intelligently detects any mosquito that enters the house and points the laser light on it and alerts the owner of the house on the detected mosquito.

With the use of computer vision, Bzigo camera can detect mosquitoes as they enter the house within minutes at a distance of about 26 feet. Whenever mosquitoes enter the room, the camera detects them and a laser pointer is automatically directed on the mosquitoes and sends a notification alert via Wi-Fi to the user device [30]. The device has no means of repelling the mosquitoes which this work seeks to incorporate. This design will develop a highly efficient and power conservative mosquito repelling system with incorporated image processing and android applications user interface.

In this work, several researches so far reviewed showed that various measures aimed at mosquitoes monitoring ,detection, elimination and control were offered ranging from keeping of the environment clean, evacuation of drainage system around the environment to get rid of stagnant water, burning of natural herb, rubbing of repellents on clothes, use of mosquitoes treated & untreated nets , use of combined chemical for fumigation and spraying of insecticides or pesticides, automatic trapping & killing approach to electronic techniques. The electronic techniques used frequencies that are deterring and allergic to mosquitoes to scare them away without causing harm to humans and environment.

The basis of this work is on the electronic approach with sound frequency technique and its contribution aims to improve on the existing electronic repelling systems and develop a portable, energy saving and rechargeable system. It also incorporates AI camera system for mosquitoes' image processing, and android application for monitoring and control with smart user interface operation.

This research proposed a combined Artificial Intelligent-based system, camera monitoring, sound repelling system, android-enabled user interface mosquito monitoring and control model as a health enhancement remedy. It also creates a reservoir for the traps mosquito to be kept until the room owners come to dispose the accumulated mosquitoes that have been channeled into a waste disposal system designed to trap and hold mosquitoes.

### III. METHODOLOGY

#### A. MATERIALS AND RESOURCES

**Software:** Proteus, Android studio, Arduino IDE: Arduino Integrated Development Environment, Sublime text, MYSQL, Android Gap and Arduino

**Hardware:** Arduino Uno, Liquid Crystal Display, GSM Module, Capacitor, Audio Amplifier IC, Voltage Regulator, Light Emitting Diode, Rechargeable Battery, Resistors, Android Phone, Piezoelectric buzzer/Speaker and Bzigo Camera

#### B. METHODS

##### i. The System Conceptual Design Model



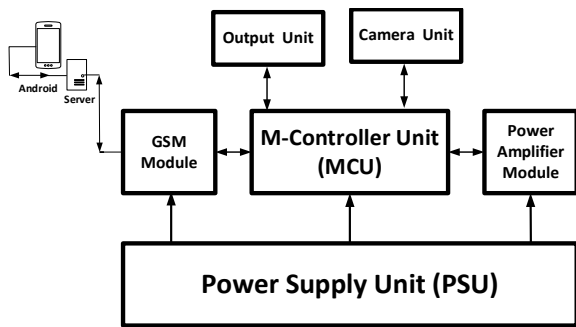


Figure 1: An Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System Architecture

In Figure 1, the conceptual model has the power supply which provides power to the entire system; the power amplifier module which provides the audio amplified sound frequency to scare mosquitoes; the microcontroller unit which coordinates and initiates the overall monitoring and control actions; GSM module which links the controller action to the android via the server and the output unit. The output unit consists of the light emitting diode to indicate the system ON/OFF status; the Liquid crystal display which gives the physical display of the frequency of the operation and the Sound alarm buzzer which generates sound waves allergic to mosquitoes

**ii. Software Implementation of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System**

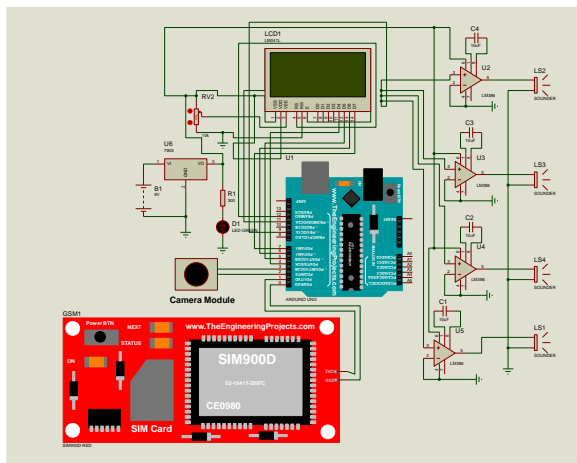


Figure 2: An Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System Circuit

In figure 2, the circuit was simulated with proteus 8.0 and the command code was written in Arduino IDE. The software functionality was ascertained. The design of microcontroller-based device system using piezoelectric sensor was achieved, with the in-built portable rechargeable scheme. The hardware design implementation stage and the remote monitoring and repellent control of Mosquitoes using Android Applications was not implemented during the pre-circuit demonstration.

**iii. Hardware Implementation of an Artificial Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System**

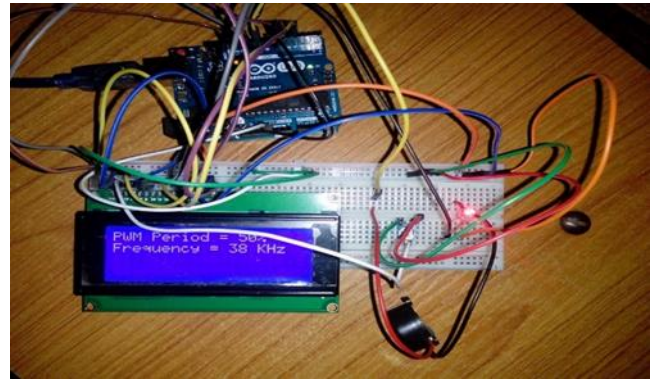


Figure 3: Pre-hardware Validation Test for an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

Figure 3 gives the pre-hardware demonstration test with bread board to ascertain its functionality and to validate the system performances and conformity with design specifications.

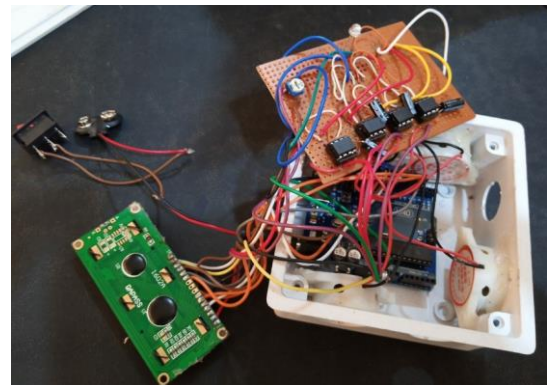


Figure 4: Hardware configuration of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

Figure 4 shows the smart system design configuration without the incorporation of the bzigo camera, the system generates the allergic sound frequency that sends mosquito away from a radius of specified frequency coverage. The bzigo camera system smartly detects when there are mosquitoes in the surrounding and sends the resulting image signal to the controller unit to initiate the repelling action that will scare mosquitoes away. The system will run for 20minutes repelling detected mosquitoes after which it pauses while the environment is being scanned for 10minutes but within the interval, the system can still intelligently come up if there are mosquitoes present.

iv. Flow Chart

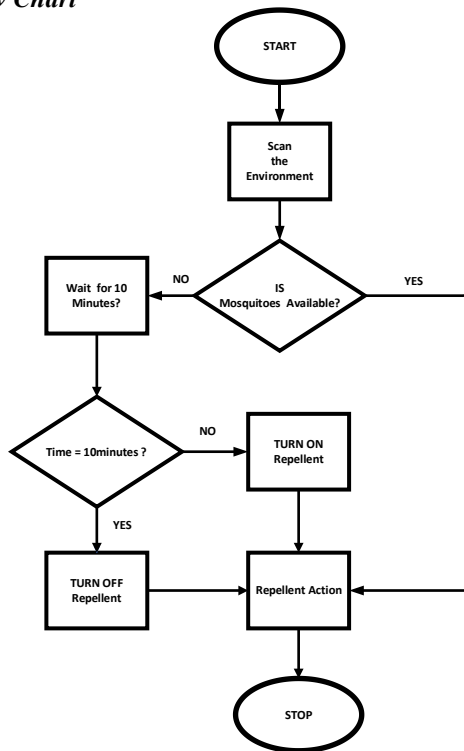


Figure 5: Flowchart of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

v. Android Application design

The android design model used the sublime text to design the signup/sign in page; Graphical user interface for visual observation of the system actions and the database for the documentation were developed using MYSQL. In the sublime text the HTML, CSS and JavaScript code were edited

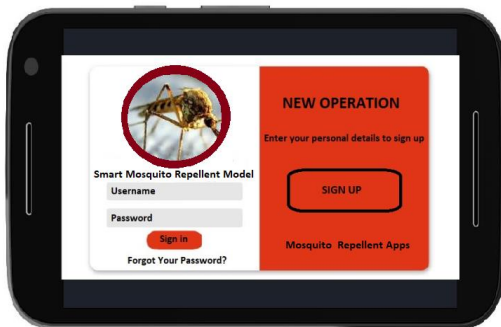


Figure 6: Android application design for an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

IV. RESULTS, DISCUSSION AND ANALYSIS

A. The results from the software implementation of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

In figure 2, the system was simulated with proteus software, the Arduino uno control was coded with the program code written in Arduino IDE. The embedded program aids the artificial intelligent actions by actuating sound buzzers to produce allergic sound frequency from the operational amplifier (Op-amps) output signal. Figure 4 also provides the soft/hardware preliminarily test platform, where hardware components were connected on a breadboard to

ascertain the system functionality. The soft/hardware pre-confirmatory test gives the sound at 38Hz and relates the signal to the android application through the GSM Module.

B. The results from the hardware implementation of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System



Figure 6: Hardware implementation of an Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

Figure 4 shows the hardware implementation of an Intelligent and Android-Enabled user interface mosquitoes monitoring and control system. Figure 6 shows the proposed bzigo camera incorporated system such that when the system smartly detects the presence of mosquitoes in the room at about 1metre distance, the artificial intelligent system initiates the repelling action and after 10minutes will pause while the environment is being scanned. An alert will be sent to the room occupants' phone while mosquitoes will then be driven to reservoir trap for disposal through a connected channel.

C. The results from the Mobile Application for an Artificial Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System

Figure 6 shows the signup/in page for the Artificial Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System applications, the new user has to download and install the applications so that when there is an alert from the artificial intelligent system, the message will be displayed for the user to see and on logging in to view his room mosquitoes status from the user machine interface designed on the phone for control purpose. Every room that has this device with its manufacturing part number can monitor and control mosquito activities remotely. With this, there is a database documentary from the android device, the documentary aids the determination of mosquito presence within a certain environment.

V. CONCLUSIONS

An Artificial Intelligent Mosquito Monitoring and Control System Model with Android-enabled User Interface and Bzigo Camera System was developed. These designs add to other known techniques of combating mosquito habitation within a human living environment aimed at stopping malaria spread. Environmental fumigation, use of mosquito treated net; herbal repellent sticks with low smoking technique and the spray of mosquito insecticide chemical repellents which are harmful to human lives and environment will no longer be needed with the

advent of this new system. An electronic sprayer for the control of mosquitoes has also not been safe for both environment and humans. This developed Intelligent-based and Android-enabled user interface portable system is a human and environmentally friendly device. The results reveal that the system produces a sound frequency of about 38 kHz to 45kHz which does not permit the existence of mosquitoes within the demonstrated area. The mosquitoes are scared away by the allergic sound frequency from the design after the camera has captured and processed mosquitoes' images to signal the presence of mosquitoes within the experimented area. The artificial intelligent camera now sends a notification via GSM module to the owner's android phone while scaring the mosquito to a specified trap location outside the area of interest for disposal. The design was demonstrated under an indoor space area of 12ft x 12ft confinement. The results from this artificial intelligent and android-enabled user interface mosquito repelling system proved its suitability to replace the conventional human and environmental hazardous approaches. Future research should consider incorporating other systems for further enhancement of this system.

#### ACKNOWLEDGMENT

We appreciate the Almighty God for his inspiration and guidance which has led to success of this research.

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