Evolution in Electrical and Electronic Engineering Vol. 3 No. 1 (2022) 243-251

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

The Prototype of Pest Repellent System and Insect Light Trap using Solar Energy for Small Agriculture

Muhammad Afiq Fikri Md Khairi[1], Siti Amely Jumaat[1,2]*

[1] Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, MALAYSIA

[2]Green & Sustainable Energy Focus Group,
Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2022.03.01.028
Received 20 January 2022; Accepted 13 April 2022; Available online 30 June 2022

Abstract: Nowadays, agriculture is a source of income for Malaysians from mass cultivation to courtyards. This study is to find an alternative for farmer from using pesticides that can be harmful to the health of consumers. This study also demonstrates the level of stimulation animals towards sound through certain frequencies and how to trap insects with light at night. Thus, the project was tackled farmer from using chemical on plants by developing of prototype pest repellent and insect light trap using solar energy as alternative power supply. For the pest repellent development, Passive Infra-Red (PIR) sensor as a main function to detect a motion before Arduino UNO read and give the frequency value specified by user using potentiometer. The ESP8266 board also through used to know the motion between system devices to the Blynk platform. Blynk is a Platform used to achieve the Internet of Thing (IoT) for this project. LCD display also will display the signal from PIR sensor whether pest detected or pest not detected. For insect light trap development, relay is the main component to turn on the light. When solar panel not generate energy, the relay will trigger to turn up the light. One container with half of water will trap the insect when it's come near the light.

Keywords: Pest Repellent System, Insect Light Trap, Solar Energy

1. Introduction

The agriculture sector in Malaysia is a source of national income through the export earnings of crops as well as creating many employment opportunities for the people. This sector is a supplier main food as well as raw materials for resource-based industries. In line with its key role, the Government continues to take on adjustment measures to accelerate the competitiveness of this sector in order to enabling it to face new challenges at the domestic level and international. In the government's efforts

*Corresponding author: amely@uthm.edu.my

to stabilize the agriculture system in Malaysia, there are several issues that are a problem for farmers such as insects or pests. An insect can be known as any numerous small invertebrate (without backbone) animals that are more or less obviously segmented [1]. To provide the pest to destroy the crops, there are many ways to control it including chemicals, insect-repelling plants and insects trap. Electronic pest control and insect light trap devices also have a convenient means for controlling the pest in agricultural areas.

An electronic-based pest repellent and insect light trap are presented as an alternative to pesticides commonly in used in farmlands and homes [2]. So, the use of chemicals on crops can be avoided. This project presented the application of ultrasonic sound in repelling pests and LED lights to trap insects. Pest is very familiar to human and agriculture. Getting rid of using alternative ways to conventional pesticides is considered a crucial and strategically important step to the future.

This project is using solar energy with battery as alternative electrical energy from the main source in Malaysia which is "Tenaga Nasional Berhad" (TNB). Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), indirectly using concentrated solar power, or a combination. For the project, solar energy will be supplied to power electronic equipment for ultrasound as well as LED light. By using this method, electric energy can be saved without using energy from TNB. This can also save costs because ultrasound and LED light are combined for this project.

The objectives of this project are to design a solar pest repellent and insect light trap using Sketchup software, to develop a circuit using ultrasonic sensor and LED lights for pests using the solar system for save on agricultural costs and to test and evaluate the effectiveness of the ultrasonic sensor for pests and LED lights to trap insect at night.

2. Materials and Methods

This chapter, explains the method and the flow process of this project. The main focus is the step for modeling and hardware design for the prototype of Pest Repellent and Insect Trap Light Using Solar Energy for Agriculture. The development process of this product consisted of several phases which are Project Planning, Design, and Development of Hardware.

2.1 Project planning

In the first phase, it must decide the title of the project. This project mainly focuses on the design and development of A Pest Repellent and Insect Trap Light Using Solar Energy for Agriculture. The function of this project is to evaluate the effectiveness of A Pest Repellent and Insect Trap Light Using Solar Energy for Agriculture based on the frequency, distance, and insect trap of the project.

As all the studies related to A Pest Repellent and Insect Trap Light Using Solar Energy for Agriculture were explained in previous chapter 2. The working principle and the limitation of the solar system also have been discovered in order to understand the flow of the project and all the fundamentals about the pest repellent and insect trap light using solar energy for agriculture.

A Pest repellent system and insect light trap using solar energy should be affordable to help users to overcome the problem of pests without the use of any poisons on plants at a lower cost. In this way, this idea can attract people to use this product.

2.2 Design

Every project has software that will use either to design, to simulate or to run the programming code. So, in the project, the main software used in this project is the SketchUp, Proteus 8 professional and Arduino IDE to run the testing and simulation process.

(i) SketchUp Software

For the design, it uses SketchUp software to design the 3D for solar pest repellent and insect light trap. The design for this project is followed by the characteristic of the design which is suitable for agricultural use. Pest repellent and insect light trap are combined in one prototype characterized by a simple design, low cost, and ease of construction. The characteristics of the prototype shown in Table 1 that are suitable to put on the small agricultural farms.

The circuits of this project will be covered by solar as a roof. The characteristics of the prototype design are shown in Figure 1.

Table 1: Characteristics of the prototype

Characteristics	measurement (cm)
Height	50
Surface width	40
Surface length	40

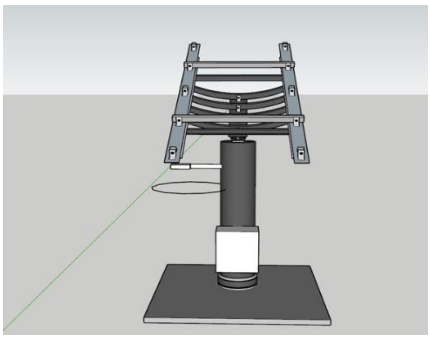


Figure 1: Solar pest repellent and insect light trap for agriculture

2.3 Development of Hardware

This project is combining the pest repellent and insect light trap that used a generator limited to 12V. The main voltage supply for this project is solar energy. PV solar panel is to convert solar energy to electrical energy. This project used Arduino UNO to control the frequency with sound as the main controller for pest repellent. For the insect light trap, the main component is a relay. the relay is set to trigger the LED light to turn on when the solar panel does not generate any energy. Figure 2 shows the prototype of a pest repellent and insect light trap using solar energy.

Figure 2: The prototype of pest repellent and insect light trap

2.4 Pest Repellent System

Table 2 shows the results that the PIR sensor was able to detect motion near it in 5 tests. The range of the PIR sensor is based on Eq. 1 and Figure 3.

Based on Table 2, the PIR sensor detected motion within 1 meter. The test for the PIR sensor to detect motion was carried out 5 times shown in Figure 4.

Table 2: PIR sensor detects any motion

Test	Distance	LCD Display	Blynk Software	
			Motion	Led Light
1	0.2 meter	Pest Detected	Pest Detected	Red
2	0.4 meters	Pest Detected	Pest Detected	Red
3	0.6 meters	Pest Detected	Pest Detected	Red
4	0.8 meters	Pest Detected	Pest Detected	Red
5	1.0 meter	Pest Detected	Pest Detected	Red

(i) Wide PIR sensor range

$$\tan\theta = \frac{y}{x} \qquad \textit{Eq. 1}$$

$$\tan 35° = \frac{1m}{x}$$

$$x = \frac{1m}{\tan 35°} = 2.11m$$

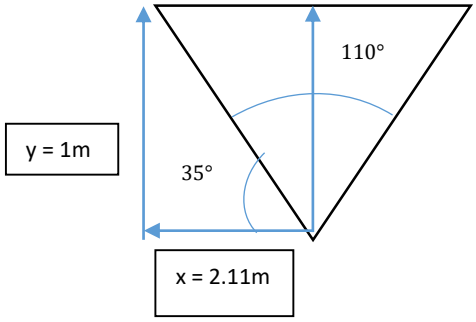


Figure 3: PIR sensor wide range

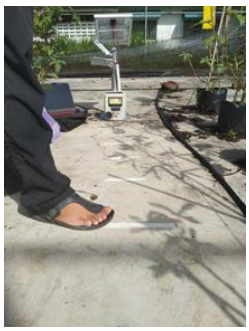


Figure 4: Pest Repellent System Test with Different Distances

3. Results and Discussion

The results of the design of the pest repellent system were composed of the ATmega328P microcontroller with the Arduino Uno board as the information control centre. Ultrasonic tweeters were used as actuators to produce sound waves based on the frequency and pulse width that the user decided. The testing process was found on the PIR sensor's detection level and the response of Arduino Uno to the interference. The sensor was tested from a distance of 1 meter from the control system. The first stage of the testing has been done before the complete installation of the electrical box and test at the site. The test is to find the feasibility of motion detected and the response on the LCD display. The test also carried out the value of frequency and pulse-width for sound using an oscilloscope.

3.1 Ultrasonic Sound Generation

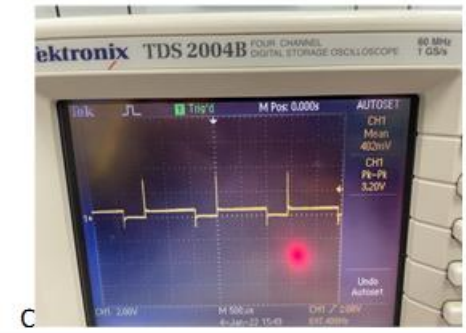
This device has a manual system using a potentiometer so that a farmer can keep it at a fixed frequency by manual switches that the device will generate different frequencies within a range after certain time intervals. There are five modes of operations. Table 3 shows the detection and response of the system with different frequency ranges. Each mode has different frequency ranges for different purposes.

- Mode 1: To active mode 1, the user has to set both potentiometers to 0% for both sides. It will generate a frequency ranging 69kHz.
- Mode 2: For mode 2, the user must set the left potentiometer to 50% and the other side is 0%. The frequency range that will generate is 41kHz.
- Mode 3: When the potentiometer left in mode 3 is set to 0% and the right side is 50%, the frequency range is 27kHz.
- Mode 4: In mode 4, the frequency range is 52kHz when the right side of the potentiometer is set to 100% and the left side 0%.
- Mode 5: The user is set the left potentiometer to 100% and the right side to 0%. The frequency range that generates is 69kHz.

Table 3: Detection and response of the system with different frequency ranges

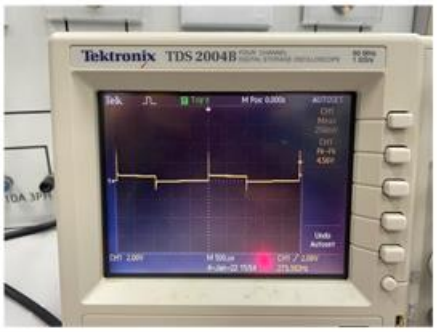
Mode	Detection (%)	Response System (s)	Potentiometer (%)		Frequency
			Left	Right	
1	100	0.1	0	0	69kHz
2	100	0.1	50	0	41kHz
3	100	0.1	0	50	27kHz
4	100	0.1	0	100	52kHz
5	100	0.1	100	0	69kHz

The average of the detection for the system is 100% in 5 tests. The result shows that the PIR sensor is able to detect motion near it. Furthermore, the average for the control system to detect the motion is less than 1 second. The result for performance testing was obtained to see the natural frequencies of difference mode via oscilloscope shown in Figure 5.



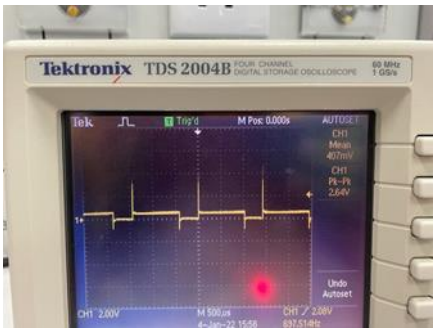
(a) Mode1: 69kHz

(b) Mode2: 41Khz



(c) Mode3: 27kHz

(d) Mode4: 52kHz



(e) Mode5: 69kHz

Figure 5: The Output Frequency of ultrasonic sensor

The result shows when PIR sensor detect motion in 1meter, the LCD display will show “PEST DETECTED” based on Figure 6. It also sent the result to Blynk software which is motion detected and LED signal will turn to red. The Blynk software result that can be notified by user show in Figure 7.

Figure 6: LCD Display Show Pest Detected

Figure 7: Pest Detected Display on Blynk Platform

Table 4 shows the results that the PIR sensor not able to detect any motion near it. The LCD display and Blynk software also show the different results when it detects pest motion.

Table 4: Results of PIR sensor does not detect any motion

Test	Distance	LCD Display	Blynk Software	
			Pest Motion	Led Light
1	0.2 meter	No Pest Detected	No Pest Detected	Green
2	0.4 meters	No Pest Detected	No Pest Detected	Green
3	0.6 meters	No Pest Detected	No Pest Detected	Green
4	0.8 meters	No Pest Detected	No Pest Detected	Green
5	1 meter	No Pest Detected	No Pest Detected	Green

Based on Table 4, PIR sensor did not detect any motion within 1 meter. The test for the PIR sensor to detect motion was carried out 5 times. At Figure 8, the result shows when PIR sensor does not detect any motion in 1meter, the LCD display will show “PEST NOT DETECTED”. It also sent the result to Blynk software motion not detected. The LED red signal also change to green as shown in Figure 9.

Figure 8: LCD Display show pest not detected

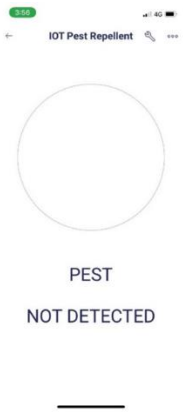


Figure 9: Pest not detected display on Blynk platform

3.3 Result for Insect Light Trap

The result for the insect light trap consists of how effective the light to attracting insects coming near the trap. Figure 10 shows the setup for the insect light trap at night. When the solar panel does not produce electrical energy, the relay will trigger the LED to light up and attract insects to the trap using water in the water container. The user can refill and remove water from the water container every morning. This method is very effective as it can attract a variety of insects especially grasshoppers are the most attractive insect around the site. Figure 11 shows the method must change from water to stinky thrips due to prolonged rainy weather conditions at night on the trial days.

Figure 10: LED Light Turn on at Night situation

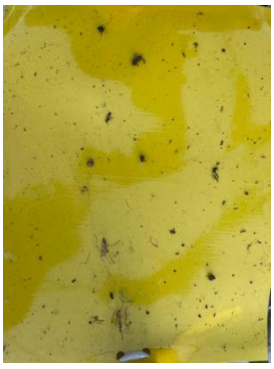


Figure 11: Sticky Thrip Trap the Variety of Insect

4. Conclusion

Pest Repellent and Insect Light Trap system using solar energy is an integration of sensor, microcontroller and Internet of Things (IoT) platform which can reduce the risk of an attack of pests and insects for small agriculture or crops. This prototype has been successfully developed and reached the objective of the project. The use of chemicals such as poisons in plants can be avoided and the use of electricity can also be saved by converting to renewable energy through solar energy. The system of a pest repellent that involved a sensor and microcontroller technically functioned with IoT platform (Blynk application). An insect light trap is also successful to turn on the light by using a relay to control the battery to give supply for LED and detect electrical energy from the solar panel. The light for LED will attract insects to come near the trap. PIR sensor detects any motion near the prototype and give information to the microcontroller for the speaker to emit the sound with a certain frequency set by the user using a potentiometer. Arduino UNO ATmega328P microcontroller connected to ESP8266 Wi-Fi module was used for pest repellent system using C++ coding in Arduino IDE. Other than that, the user will know the movement of pests near the crops using Blynk application on a smartphone. In overall, the prototype pest repellent and insect light trap can be the alternative solution for farmers to use other than chemicals to kill the insects or pests.

Acknowledgement

The authors would like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] Selbi Melayeva. “Frequency Based Fly Repellent” 2015. Information and Communication Technology Programme Universiti Teknologi PETRONAS.

[2] Humayun Rashid1, Iftekhar Uddin Ahmed1, S M Taslim Reza1, M. A. Islam2. “Solar Powered Smart Ultrasonic Insects Repellent with DTMF and Manual Control for Agriculture” 2017 Electrical and Electronic Engineering (EEE), International Islamic University Chittagong (IIUC), Chittagong-4314, Bangladesh. Nara Institute of Science and Technology, 8916-5 Ikoma, Nara, Japan.