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ScareDuino: Smart-Farming with IoT

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Abstract: Internet of Things has inhibited many parts of our modern day lifestyles impacting the simplest to the most complex of our daily activities. Ranging from smart homes, smart water and even smart living, now even farming have been made easier by the intervention of technology. By focusing on pest control in smart farming, we apply the usage of sound alarms, passive infrared sensor, light dependent resistor sensor and Bluetooth connectivity to enhance the performance of pest control farmers have currently. The research deploys a sequential mix mode to collect primary data and experimental validation.

Keywords: Scarecrow; Arduino; PIR Sensor; LDR Sensor; Mobile Device; Smart Farm; Wireless Network; MSE; IoT

1.0 Introduction

Farming contributes a major income to the Malaysian economy. It is a huge concern to farmers when they are away from their crops and exposing it to crops' threat such as crow damaging the crops and theft. Farming has contributed to nearly up to 22% of a country's Gross Domestic Product (GDP) and due to this fact, countries are trying to their best to keep the industry safe. Due to that cause, countries has been spending billions in order to safe keep their farms and in the long run, this is a heavy blow towards the country itself. [i]

1.1.1 Research Objective 1

Agricultural damage caused by birds and rodents presents a huge blow towards a country's economy. Although these small animals are relatively harmless, the damage they do could be devastating. These happen to be a continuous problem as the type of damage varies across time and the geographic landscape. [ii]

1.1.2 Research Objective 2

Many types of research have been made to involve controlling birds by the use of sound alarms to scare them off. One of the research implemented the use of sound wave which is also a type of technique used to produce some kind of sound alarm which affects birds discouraging them from attacking the vineyard. [iii]

1.1.3 Research Objective 3

There are plenty of methods to repel birds from damaging the agricultural produce but in this paper, we are focusing on a non-harmful method to deter these flying creatures. Inspired by the scarecrow, we aim to build an Arduino device that is able to emit sound, light, and motion to scare off the birds. The system should allow farmers to control it wirelessly via the internet. With this invention, we aim to achieve a few objectives. Firstly, our main target is to improve the efficiency of repelling birds such as crows using our device. Next is to have a device that is effective and affordable which can achieve significant results. Lastly, the device should use motion sensors to detect birds in real time to respond as soon as possible.

1.2 Research Question

This paper aims to answer the above research objective via the research questions as shown below:-

RQ1: How will the usage of automated affect the quality of crops produced?

RQ2: What are the best ways to improve the current bird control system?

RQ3: Will implement a network controlled scarecrow help farmers to save cost compared to traditional scarecrow?

RQ4: Will the use of machine scarecrow effectively substitute the current traditional ones?

2.0 Literature Review

As the implementation of IoT in lifestyle has been progressing rapidly, the same goes for agriculture. Though IoT consists of connecting a series of devices into a network which could be controlled through the internet, connectivity is poor in farms as they are located in the rural areas. Professionally, there are the various things to consider before implementing IoT into agriculture. The requirements to consider when implementing are; Robust model, scalability, affordability and sustainability. [iv][v]

The agricultural production plays a major role in today's economy. In a research done in California, growers reported that an average of $24 per acre is spent to reduce damage by 50% within their orchards. [vi] After comparing ScareDuino with the current technology, we have determined a few advantages and disadvantages of our current implementation. First and foremost, WiFi connection is being chosen to be part of our implementation to connect the mobile phone and the system. WiFi offers greater mobility as the user can monitor ScareDuino with the availability of an internet connection. A farmer may focus on other daily jobs and leave crop caring to ScareDuino. The machine is programmed to be able to automatically detect particular activity in their vicinity, such as the presence of birds near the crops.

2.1 Passive Infrared (PIR) Sensor

ScareDuino is designed in a way that it can detect living being presence. In our research, this applies to detecting the presence of birds and theft intruders on a farm. PIR sensor detects living beings by having 2 slots that emit the same amount of Infrared (IR) energy. In an idle state, both of the slots in PIR detect the same amount of IR. All living beings with body temperature emit heat energy in the form of radiation. When a living being intercepts the PIR sensor, it detects a potential difference between the 2 slots and triggers the alert system it is connected to. Once the living being leaves the PIR sensor environment, it will once again show a potential difference of zero. [vii] An existing company in the market right now, Scarecrow Bio-Acoustic Systems Ltd [viii], uses PIR as a detector at night to prevent birds attempting to roost in the area of the potential collision with airplanes. [ix] By using the similar concept of what Scarecrow Bio-Acoustic Systems Ltd has performed to avoid bird roosting, using a PIR sensor will prevent birds from damaging the crops.

2.1.1 Advantages

- PIR sensor has the ability to differentiate between objects using body heat.
- The working temperature is between -20 degrees and 80 degrees Celsius. Hence, PIR is able to work for different the season for temporal countries.
- PIR sensor can cover a huge perimeter of the farm.
- IR detectors are safe and do not affect human and pets health.

2.1.2 Disadvantages

- Unable to differentiate between threats and farmers.
- Limited induction angle.
- Hot temperature environment may affect the sensitivity of the sensor.

2.2 Light Dependent Resistor (LDR)

To improve the scarecrow's efficiency, the implementation of LDR in ScareDuino allows it to switch its activation status or functionalities based on the time of day. Previous application of LDR has revolutionized current technology in the activation of a mechanism through the presence of light. [x] Other known applications of LDR include in the use of street lights and camera shutter control where lights are automatically activated in dim environments (such as at night). [xi] In the case of ScareDuino, its bird deterrence applications are more suited for the daytime when birds are active. The implementation of LDR allows ScareDuino to adapt its functionalities according to the time of day - which in our research is a bird deterrence function in the daytime and theft intruder alarm at night.

This can also extend to energy conservation through powering down unneeded components based on the ScareDuino's current function or status.

2.2.1 Advantages

- Needs small power and voltage use in practical usage.
- Low in cost.

2.2.2 Disadvantages

- Reading could be inaccurate with the influence of surrounding light sources.
- There is a delay in reading compared to using photodiodes.

2.3 Passive Buzzer

A buzzer is implemented to work alongside the LDR and PIR sensors to emit sounds when a presence or activity is detected. For the daytime bird deterrence function, the buzzer will emit a noise to scare birds away from the crops. During the night, the buzzer can function as an alarm in case of theft intrusions.

2.4 Stepper motor

Stepper motor (model: 28byj-48) will be attached to the main motor in the ScareDuino. The function of the stepper motor is to provide maneuverability to the PIR sensor so that the sensor is able to cover a bigger area across the farm to monitor for any living objects. Whenever a heat energy is detected from an object, the stepper motor will stop and triggered an alarm and send an alert to the farmer.

2.5 Servo Motor

Servo motor will be acting as a secondary motor in ScareDuino. The servo motor makes movements to the ScareDuino to imitate human motion and frighten away birds. When a living object is detected, the stepper motor will stop, and servo motor will be activated instead until the object leaves the area and no sign of living object is detected. During the night, the servo motor is the unnecessary and will be turned off from the detection of low light from LDR sensor.

2.6 Network Connectivity

In comparison between Bluetooth and WiFi, WiFi connection is being chosen to be implemented in our system.

2.6.1 Advantages

- WiFi nature allows the user to connect to the network from any convenient location as long the device is connected to the Internet. Whereas, Bluetooth only covers a short-range area. [xii]
- WiFi allows multiple accesses of devices to connect to ScareDuino.
- The speed of WiFi data transmission can be up to 250mbps, which is 10 times faster compared to Bluetooth.

2.6.2 Disadvantages

- Relies on the availability of internet connection in order to be connected to ScareDuino.
- WiFi connectivity is sensitive to electromagnetic radiation generated by household appliances.
- WiFi is more insecure due to the wider range coverage which also exposed to threats and intrusion.

3.0 Methodology

For the research process, we will be taking a mixed-method approach of explanatory sequential design. Both quantitative and qualitative aspects are covered in order to obtain reliable data for our project. The data is to be collected via the following methodology as summarized in Table 1 below.

Table 1: Research Methodology [xiii]-[xv]

Research Dimension	Explanatory Sequential Design
Research Methodology	Quantitative Generalization Qualitative Reasoning
Data Collection	Online Survey Personalized Interview
Result Validation	Experimental Simulation

The techniques used for data gathering are conducting an online survey and personalized interviews through which have received helpful feedback regarding the research. Additionally, the overall results are validated through creating an experimental simulation with Arduino. The simulation is a miniature model of ScareDuino used to demonstrate its functionality and controllability. The model's control system is similar to that of the actual proposed solution, using a mobile phone application connected to the internet to wirelessly control the ScareDuino.

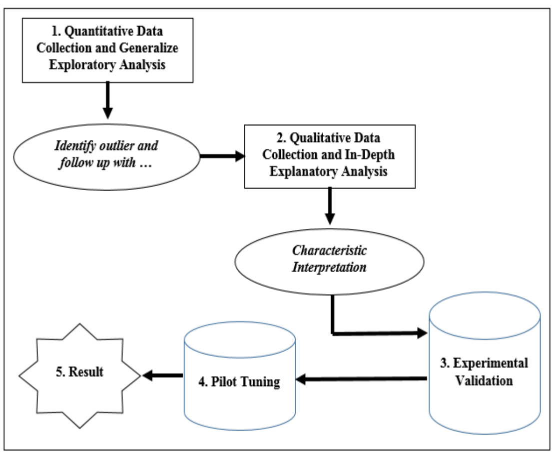

Figure 1.1 Sequential Design [xiii]-[xv]

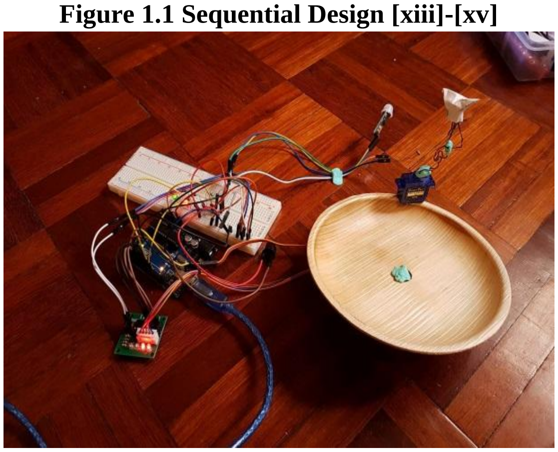

Figure 1.2 ScareDuino

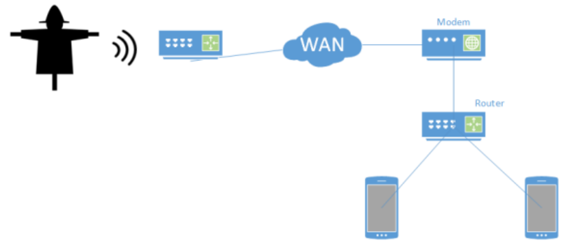

Figure 1.3 Network diagram

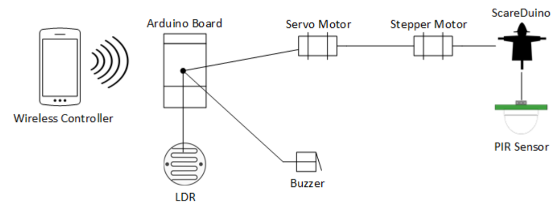

Figure 1.4 Component Diagram

For this research, the network methodology will be focused on Medium Sized Enterprises which will house up to 200 or more connections. [xvi] The star topology proves to be efficient in providing the necessary connectivity capabilities to effectively use ScareDuino. Using the wireless controller as the central hub, multiple scarecrows could be controlled using one mobile phone. Lastly, three participants were interviewed to gain insights and opinions regarding the functionality and practicality of ScareDuino. The interviewees were questioned on the function of ScareDuino and local agriculture aspects and the changes it will make when implementing it on a real life agriculture industry.

4.0 Result and Finding

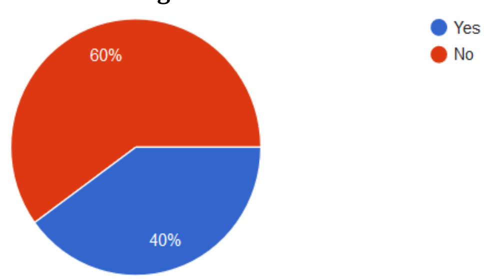

Figure 2.1 Interview Result

During the research process, we had conducted an interview with three experts regarding the implementation of this research into smart farming. In total, we had eight participants who we asked regarding our research and they provided various results. In our survey research, we asked our survey participants if they think farmers with being hindered by the implementation of new technology into their daily lives. Based on figure 2.1, 60% of the participants believe that implementing technology will not hinder their working habits and lifestyles. This may be due to the fact that they might have issues with operating it, or they might find using the device to be bothersome in their line of work. This reasoning can be backed up by figure 2.2 below which shows the percentage of the participants with knowledge about IoT.

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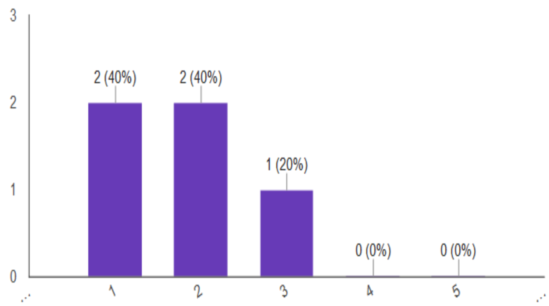

Figure 2.2 Survey Result

Figure 2.2 shows that out of the ten survey participants, 40% of them have close to no knowledge about IoT and another 40% of them have very minimal knowledge on it. The remaining 20% have either heard of IoT or also understand the concept of the term. As for our interview responses, our participants find that the integration of technology in the use of scarecrow could effectively replace the traditional scarecrow and enhance their effectiveness in deterring crows and other invasive birds. Through the introduction of ScareDuino, the participants were both hopeful and confident that the new technology can help farmers solve the issue of invasive crows and allow more time for other chores.

5.0 Conclusion, Limitation, and Future Work

The capabilities of technology have been shifting forward together with time and its intervention has been helpful. Applying technology in the agriculture sector has significantly enhanced the country's agriculture sector.

During the course of this research, various limitations were evident and might have hindered the progress of the research. One acknowledged limitation involved the implementation of internet connectivity for IoT in the project. As mentioned in an earlier section, as farms are located in the rural areas, connectivity for the device may be an issue and this creates a barrier to finalizing the actual project. Over time this research will progress where it will apply full IoT functionality to the record data based on the motion detection and save it to a cloud server. For future improvement, these statistics could offer better experience enhancements and help farmers to control and analyze the attacks that may come during the coming season.

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