

Enhancement of IoT-Based Home Security System to Detect Intruder

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Abstract— Internet of Things (IoT) is a prove that technology rapidly evolves. As technology advanced, the need for home security system using IoT has become more crucial. The problem about the existing home security system is the devices would not work together because people purchased their security products from various firms such as Do It Yourself (DIY) resulting in a decentralized access control. Many people who have home security cameras with sensors mounted around their home also can encounter false alarms due to the animals detected moving through the sensors. Therefore, the aim of the project is to enhance the home security system by creating a single access control using IoT implementation to detect the presence of an intruder. This project implements Agile development model that is designed to tolerate and even embraces change. Mobile application will be used as the main controller to monitor the sensors and view the captured intruder image. The system will use a double-layer sensors which is Passive Infrared (PIR) motion sensor that will detect motion and ultrasonic sensor that uses sonar to determine the distance of an object to differentiate between human and animals that passed through the sensors. The camera will be turned on if the system has detects the intruder and capture the intruder image. The server will receive data from the system that can helps the administrator to monitor the house and send real-time notifications to the user through mobile application. The system can detect the presence of intruder with high availability and reliability. The outcome of this project aims at multiple benefits such as saving on electricity bills of the home as well as keeps the users updated about their home security.

Keywords- IoT; Mobile application; Double-layer sensors.

I. INTRODUCTION

Nowadays, urban population that has a home within a residential neighborhood can connect to each other easily within the area. Some of the citizens does not give any attention to their house security and this will be good news to the intruder who want to break in any house. With the rapid urbanization and growth of large cities and towns, crime rates are rising as well.

Some of the common home security problems that home owners have is their home security products work separately thus resulting in a decentralized access control model. Many people who have home security cameras with sensors mounted around their home can encounter false alarms, which can be very frustrating. False alarms usually sound when pets such as dogs, cats or birds move pass the sensors [1]. Furthermore, the current home security system also does not have an extensive action that will allow the user to contact the police easier if the intruder has been detected at the house premises.

Therefore, an IoT device that can monitor the home to detect intruder is proposed as a solution for the homeowner. This system will use double-layer sensors which is PIR sensor and ultrasonic sensor to detect the presence of intruder more effectively and to avoid false alarms. This system also can capture the intruder image if there is any intrusion detected.

II. LITERATURE REVIEW

Three IoT project examples were chosen for the system analysis, and they were investigated to establish their characteristics, strengths, and weaknesses, which are:

- i. Home Security Systems based on Internet of Things Via Favoriot Platform
 - ii. IoT Based Smart Security and Home Automation System
 - iii. HIVE: Home Automation System for Intrusion Detection
- A. Home Security Systems based on Internet of Things Via Favoriot Platform

This project focuses on the prototype as they using devices like a microcontroller. For this project, they use ESPresso Lite V2.0. The sensor that they use are Passive Infrared sensor and Infraredsensor. The system also has a friendly user application

interface using Blynk that aims to switch on or off the device. The Favoriot platform will act as a server to receive and send data from the ESPresso Lite V2.0 [2].

B. IoT Based Smart Security and Home Automation System

This project uses minimum requirements to take care of both home security and home automation. This home protection system does not use a mobile application or any kind of user interface, but instead use digits from the phone's keypad. The system is platform independent and can be used with a variety of phones running on various operating systems. This machine does not need to have records connection enabled in the consumer cellphone because the machine runs best with launchpad linked to Wi-Fi at domestic or office. This device does not enable the person to manually set off an alarm, but it gives the user an option of assessing the scenario and then remotely activating the security alarm from his phone [3].

C. IoT HIVE: Home Automation System for Intrusion Detection

The system employs sensors to detect intruder activity and trigger a system alert. As a sensor management function, the system is meant to make installing and configuring new sensor and actuator devices simple. Through an Android application, homeowners may monitor the system via a notification message and allow the system to transmit the notification message to police officers or other approved users [4].

System A above focuses on limited budget and only uses PIR motion sensor to sense movement of the intruder and for the data input. It also has main panel to let the user know about the status of the system and database server that will be used to store the data from the sensor. System B above only has a very limited features which is the home alarm to alert about the intruder and PIR motion sensor as an input data. System C above has an alarm, PIR motion sensor, magnetic switch sensor to detect the status of the door whether it is open or not, and load cell sensor to detect the pressure on footstep of the door. The system also has a main panel and the database server.

The proposed system aims to enhance the current home security systems weaknesses. Therefore, the proposed systems will be equipped with home alarm and motion sensor to detect intruder which will be enhanced to prevent false alarms. The motion sensor will implement a double-layer sensor which is the PIR motion sensor and ultrasonic sensor to differentiate between the human and animal object that passes through the sensor by detecting the distance between the object and the sensor. The system also will be enhanced with friendly-user main panel and database server connection. The proposed system is equipped with a camera to cover all of the three existing system weakness. The three existing system does not have a camera to confirm whether the people entering the house is an intruder or not. Therefore, the proposed system will have a camera to confirm the presence of an intruder. The proposed system does not use magnetic switch sensor and load cell sensor because the system has been equipped with double-layer sensors to detect the intruder effectively. Table 1 shows the comparison between the features of each different systems.

Table 1 Comparison between the features of each systems.

NO	SYSTEM	FEATURES							
		Alarm	Camera	PIR sensor	Ultrasonic sensor	Magnetic switch	Load cell sensor	Main panel	Database server
A	Home Security Systems based on Internet of Things Via Favoriot Platform	✗	✗	✓	✗	✗	✗	✓	✓
B	IoT Based Smart Security and Home Automation System	✓	✗	✓	✗	✗	✗	✗	✗
C	HIVE: Home Automation System for Intrusion Detection	✓	✗	✓	✗	✓	✓	✓	✓
D	(Proposed system) Enhancement of IoT-based Home Security System to Detect Intruder	✓	✓	✓	✓	✗	✗	✓	✓

III. METHODOLOGY

Agile emphasizes user testing and reviews when delivering a working product as soon as possible. Agile also emphasizes versatility, speed, collaboration with cross-functional teams, and iterative growth for continuous improvement. Agile divides the development phase into distinct time intervals known as sprints, which span anywhere from one to four weeks.

There are four phases in total of the Agile development model that will be explained in this section which are system requirement, system design, system development and testing, and lastly system evaluation. During system requirement phase, a literature review have been carried out in order to understand the challenges that users face for their home security system. The primary goal of this phase is to ensure that the system produced meets the needs of the users and solves their problems. In system design phase, the design of the system has been made based on the requirements that have been collected during the first phase. During system development and testing phase, the hardware and software have been assembled and send to the user for testing. In the system evaluation phase, the system gets a review and feedback from the user that has used the proposed system to patch any bugs or errors found in the system.

The minimum hardware requirements for this project are computer (Windows 7 32-bit., 4GB of RAM), smartphone (Able to connect Internet, 2GB of RAM), and IoT (ESP32 Cam, FT232, Breadboard, Piezzo buzzer, PIR motion sensor, Ultrasonic sensor, LED). The minimum software requirements for this project are VS Code v1.68.1, Arduino IDE v1.8.15, and Android Studio v11.0.11.

IV. SYSTEM DESIGN AND DEVELOPMENT

The study of the design is an important phase in the system development process because it provides more information about the system's goal in solving the problem. The actions, procedures, and tasks related to each user who interacts with the system are depicted in sequence diagrams when the use cases are developed. Sequence diagrams shows detail information from the use cases, the actors and processes that are associated in the system. Figure 1 show the sequence diagram of capture intruder image. First, Secure ONE will signal the camera to turn on if the intruder has been detected. After that, Secure ONE will collect the data image from the camera and send it to the camera widget at the homepage of the mobile controller application and display it to the user

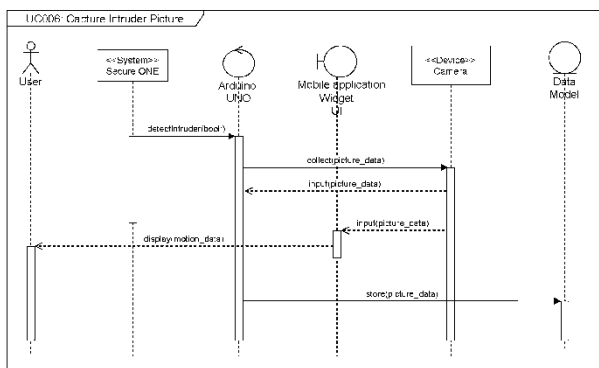


Figure 1. Sequence diagram of capture intruder picture

Activity diagrams is a UML diagram that were used to model a process as a collection of activities and transitions between the activities. Figure 2 show the activity diagram of capture intruder image. The user can view the captured image on the mobile application after Secure ONE has captured the image of the intruder at the house premises.

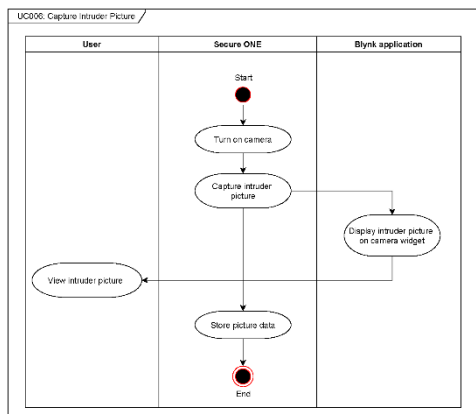


Figure 2. Activity diagram of capture intruder picture.

Model-View-Controller (MVC) architecture is the system architecture that is used to construct the project. The user will need to login first to the mobile controller application to access the system. Then, the mobile controller application will connect to the system's hardware, Secure ONE via Wi-Fi. The system's hardware will detect any intruder that move towards the door of the user's house. If the intruder is detected, mobile controller application will send notification to the user. Then, the data of sensors and image of intruder from Secure ONE will be transferred to Firebase database server. Then, the administrator needs to login to the web application to access the administrator functionality. Administrator can view the mobile user information and view the event logs of the house to check whether any intrusion was detected. Finally, the police will receive an alert message and go to the crime scene at the user's house. Figure 3 shows the system architecture diagram of the system.

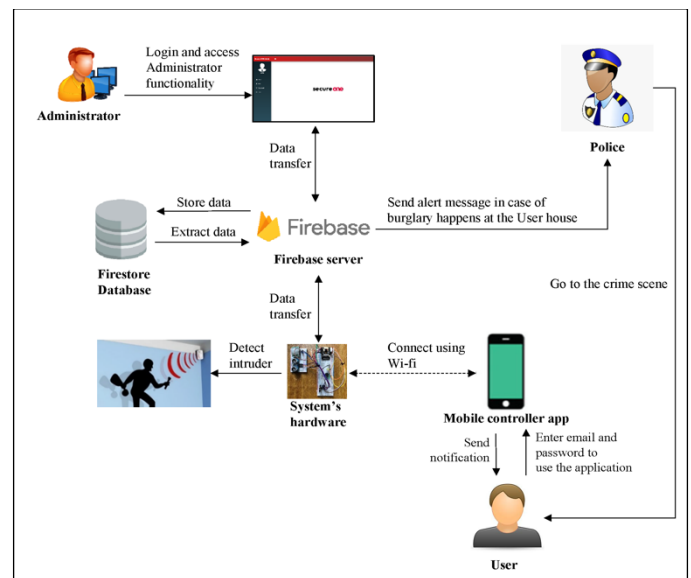


Figure 3. System Architecture Diagram.

The hardware of the system consists of IoT devices and has been programmed through the microcontroller to send input data for the system. Figure 4 shows the hardware setup for the system.

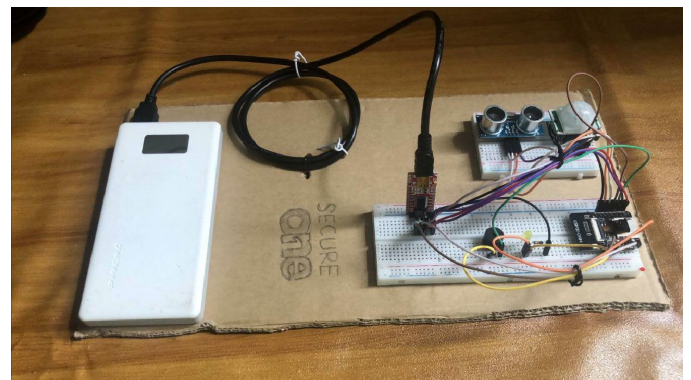


Figure 4. Secure ONE hardware setup

The interface of the system makes the process of interaction between users and the system more efficient, as well as the lower learning curve for new users. Figure 5 show the interface for mobile application. The user can view the sensor meter in real time and also can navigate to the camera capture page to view the captured intruder image.

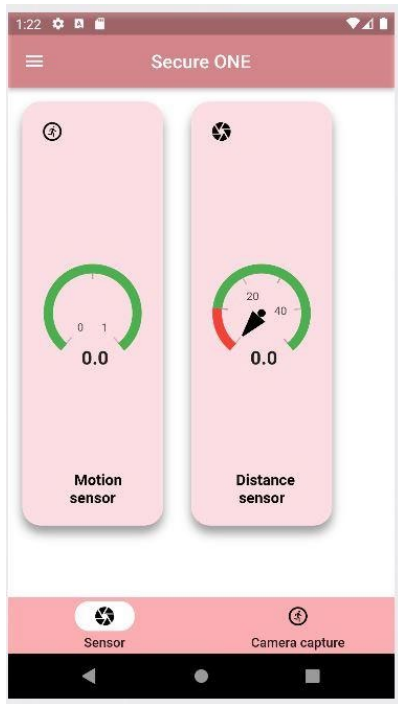


Figure 5. Secure ONE hardware setup

For web application, the administrator can view the event logs that display possible intrusion data of the house at the dashboard page as shown in Figure 6.

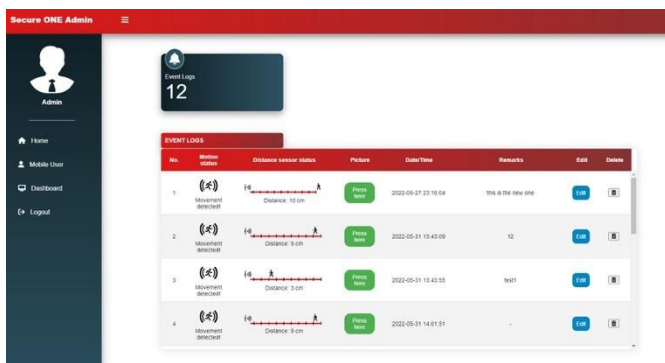


Figure 1. Web application dashboard

V. SYSTEM TESTING AND RESULTS

The users of the system, which are the homeowner and administrator has completed a User Acceptance Test (UAT). Google Form was used to collect the homeowner and administrator feedback while they were testing the developed system. Figure 7 show an example of a questionnaire for mobile application users.

D. Figure 2. Questionnaire for mobile application users

VI. CONCLUSION

The importance of this project is to assist the homeowner to keep their house safe from intruders. The objective of this project is to enhance the home security system by having a single access controller for the security system in the house. To improve the system as a house security system, double-layer sensors have been implemented to detect the intruders more effectively. The system's development should also be upgraded for future use to ensure that it remains up to date with new technology and concepts that meet user demands.

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