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Designing an Autonomous Triggering Control System via Motion Detection for IoT Based Smart Home Surveillance CCTV Camera

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KEYWORDS

Automated surveillance
Smart home system
Closed-circuit television

ABSTRACT

Security is essential in our daily lives, whether in a personal, home, business, or industrial setting. As a result, to ensure high security, a complicated surveillance system is required. This is typically not cost effective, necessitates more consumable electronic devices, requires more maintenance, and needs more storage space in settings. Hence, the goal of this research is to create a single, small, and simple IOT-based smart closed-circuit television (CCTV) control system. A low-cost smart security system can well be built using the Raspberry Pi microprocessor. The components involve are a camera, a sensor, and a Raspberry Pi board. The proposed smart surveillance system creates a comfortable and safe environment for households to initiate immediate recording of the surrounding upon triggering of sensors assemble at the specific entrance or exit points at home. Raspberry Pi microprocessor is used to be integrated with closed-circuit surveillance camera with motion detection, allowing smart automation of home surveillance system at a cost-effective manner. When the Raspberry Pi is connected to the Internet, the user may even remotely turn on or off the CCTV using the smartphone application. The system was tested with movement at the sensor from a range of distances based on the location setting. It can deliver the anticipated output such as alarm triggering, automated initiating recording of surrounding from the CCTV camera, sending an alert notification to the user's mobile phone, allowing monitoring of the location setting through the user's device, as well as turning off the CCTV camera through the user's device via the developed system.

1. INTRODUCTION

Security plays an important role in our everyday lives be it in a personal, residential, commercial or enterprise setting. Video surveillance had been proven as a well adapted method of monitoring a given space via a closed-circuit television (CCTV) system. CCTVs may be used to monitor an area 24 hours a day, seven days a week, and the film can be accessed as needed [1]. Many locations such as universities, homes and businesses need video capturing systems that can notify and record intruders in addition to live video broadcasting. Thanks to the advancements in video capture technology, we may now remotely access the CCTV camera from any internet-connected PC or mobile phones around the globe. The fallacy of traditional practices includes higher maintenance costs to set up the camera networks by contractors, required technical personnel to service the equipment and labor fees to hire secuirty guards to actively monitor the video feeds to check for any emergency scenario as the traditional system implemented now is normally without much automation to identify specific emergency situation without human intervention. As such, introduction of automation smart system with integration of microprocessor with configured closed-circuit surveillance with motion detection can effectively enable a smart survellience system at a cost efficient manner which at the same time still allow consumers to safeguard their property.

The proposed system inculcates the idea of Internet of Things (IoT) which explains a conglomeration of devices connected to each other through the internet to share data

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collectively [2]. The proposed microprocessor which is a Raspberry Pi can be adapted to be used to create a low-cost smart security system [3] which is only switch on the CCTV when detected any motion by a sensor when a door is open and the CCTV do not need to be continuously in the active to save electricty and reduce electricity wastage. The system's goal is to recognize human movements through a motion sensor and then only switch on the CCTV to record any scenario in the surrounding as well as sends notifications to the user through the configured Cayenne application available on mobile and on PC [1]. The user can also use the app to switch on or off the CCTV remotely through the mobile application at own preference as long as the Raspberry Pi is connected to the Internet. The components to be used comprises of a smart CCTV camera, a motion sensor and Raspberry Pi board. The proposed system offers a simple smart home IoT based surveillance system solution for homeowners to monitor their houses at a minimal cost and able to minimize usage of electricity at a minimum level.

2. LITERATURE REVIEW

Enabling a smarter home surveillance and monitoring system with higher automation entity and higher reliability to monitor the environment effectively had been one of the interests of research in finding innovative methods for smart home based IoT system.

Among the research done, it is found that Kousalya et. al. proposed a model that can act as a smart security system, a smart home automation system as well as environment monitoring system. The Arduino board, an air purity sensor and a humidity and temperature sensor are connected to Node MCU. The model proposed in this paper comprises of air purity sensor and humidity and temperature sensor which are useful in detecting weather condition. The values of air purity and temperature and humidity will be updated to user's mobile phone every second. User can monitor the environment and turn on the fans when the air purity or temperature is high. User can use their mobile phone to turn on the lights and fans in the house to warn the intruder. The lights and fans can be controlled by user through mobile phone through Internet [4].

Subart, Salim & Paul introduces design of an intelligent bell that is capable of providing information of strangers to its user and user can answer the door remotely on mobile phones. If the stranger is a trusted person, user can use keypad to unlock the door. When PIR sensor detects motion, notification will be sent to notify user. The Raspberry Pi camera module will turn on and capture the image and live stream videos of strangers. By utilizing ATmega 328 Microcontroller, user can directly access to the images and live stream videos on webpage. User can also control other electrical appliances such as light, fan and alarm through the webpage. User can also access to the videos using static IP address or stream on local domain [5].

Research published by Sendhilkumar et al. proposed a security system using a simple robot. The robot has a motor driver circuit that helps to interface motor with controller and avoid back current from motor that may destroy the microcontroller. The robot is equipped with ultrasonic sensor to avoid obstacles in the house and PIR sensor to sense human movement. The robot moves around the house when the user is out of the house. When PIR sensor detects motion, the Arduino board triggers Raspberry Pi, turning on the web camera to capture images in the house and send them to user [6].

Besides that, Gulve, Khoje & Pardeshi focuses on the proposed system that works on the presence of any individual in the premises, likewise giving greater security by recording the movement of that individual. While leaving the premises, concerned individual initiates the system by entering a password. The proposed system's is upheld by Raspberry Pi and Arduino board. As for the video monitoring, the software is given by OpenCV whereas for SMS and email notifications, Global System for Mobile communication (GSM) module is utilized [7].

The paper proposed by Shirisha, Kumar & Swarnalatha integrates Google Assistant to the home security system. This helps visually impaired and physically challenged people to control the electrical appliances connected over Internet using voice input. When user is notified, they can give voice command to turn on the lights to warn intruders using Adafruit app. When PIR sensor detects motion, notification with image captured by the ESP31 CAM Node MCU are sent to user's email using Google Support API. The system also integrates IFTTT (If This Then That) module to connect an app called Adafruit app developed to implement Google Assistant Commands. The system uses Raspberry Pi and Node MCU that has inbuilt Wi-Fi module to control the devices over Internet [8].

In addition, Kodali, Jain & Boppana focuses on building a smart wireless home security framework which sends alert message to the concerned individual by utilizing Internet in the event of any trespass. The author explained on the components, devices and software required such as Microcontroller (TI CC3200 LaunchPad), Accesible Wi-Fi, PIR Motion Detector Sensor, Relays, Mobile Phone and Energia Software [9].

Based on the work by Patil, Ambatkar & Kakde , the author focused to consolidate IoT in safety designs to notice motion, similar to each day when oneself were at action, you would be able to observe when there is notification sent to you regarding the activity happens at the space the system is installed. After introducing the theory, the author explained on the components, devices and application used to create IoT based smart surveillance security system. The major components and devices used in this system are Raspberry Pi (Model B), Web Camera, Wi-Fi Adapter, Display Monitor, Memory Card and Power Supply [10].

Hence, based on the literature review analysed here, it is noted that there is a research gap where none of the past research done that focus on switching on a home based commonly used CCTV system upon detection of motion by sensor installed in the door or windows which provide as the entrance or exit points towards a premises which usually are the main gateway used by trespasser to enter a house. The CCTV is preferred to be switch on upon detection of motion rather than to be continuously in the active mode is to enable reduce electricity wastage but at the same time enable smart sensing surveillance system in IoT based smart home system.

3. METHODOLOGY

In order to develop the solution the control system for the proposed solution, a waterfall model has been implemented to structure the process required. Figure 1 shows the waterfall model.

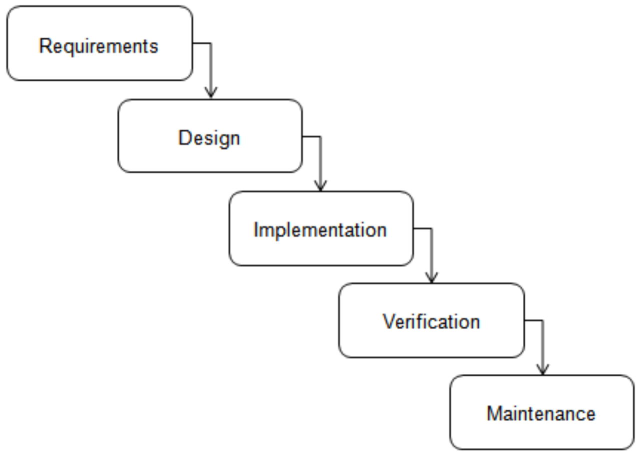


Fig. 1. The Waterfall Model

3.1 The Waterfall Model

3.1.1 Requirements

From the beginning, the objectives of the developed project are defined, requirements are identified and outline to carry out the project. One of the foremost objectives is to design and develop IoT based Smart CCTV control system.

The requirements are classified into two parts, which are software requirements and hardware requirements. The major hardware requirements were Raspberry Pi 4 model B, CCTV camera, ultrasonic sensor, and a power bank. The software requirements are discussed in the initial design.

3.1.2 Initial Design

Here, an initial design is made based on the requirements that are defined. The hardware and software specification were set in this section. For the hardware connection, the Raspberry Pi is connected to an ultrasonic sensor and a relay module to detects motion and automatically turn on the CCTV Camera. Simultaneously the software connections, PuTTY is used to access terminal window of Raspberry Pi and Virtual Network Computing (VNC) viewer is utilized to access and take control of the Raspberry Pi. Lastly, a Cayenne software is used to control components on Raspberry Pi while utilizing a Mi Home application to connect and control the camera through mobile phone.

3.1.3 Implementation

The pin diagrams of every component are studied and based on the info, a circuit design is drafted here . Breadboard and jumper wires are initially used to connect the components. VNC Viewer is downloaded in laptop to access to the Raspberry Pi Desktop. Mi Home application is installed in mobile phone and the smart camera is connected in the application. The Cayenne application is also installed too in the mobile phone. The Raspberry Pi board is connected in the Cayenne application. The components connected to the GPIO pin of Pi board such as ultrasonic sensor, buzzer and relay module are added in the Cayenne interface accordingly. A trigger is added to send user notification when buzzer is ON. Lastly, all the components are integrated into a single working prototype.

3.1.4 Testing

After connecting the components, test cases are defined based on the functionality of each component. The test cases are used to test the outputs from the circuit built to verify if it meets the expected output. The test results are recorded and compared with the expected output to determine if the test passed or failed.

3.1.5 Maintenance

The prototype is tested to be used for real life usage and is be checked regularly over a period of a month to examine its .product functionality and reliability over the long run. Any faulty wire, faulty components, loose wire connection and exposed wire need to be fixed and replaced. Tests are conducted on the Raspberry Pi program, hc-sr04.py to ensure its functionality of detecting motion within the specified distance. The software program is improved to optimized the system.

3.2 Use Case Diagram

Figure 2 depicts the use case diagram of user, Mi Home and Cayenne Application. User will be notified by Cayenne Application when ultrasonic sensor detects object. From here, the user can view the CCTV image from Mi Home application. User can switch off the relay module to switch off the smart camera from the Cayenne Application GUI.

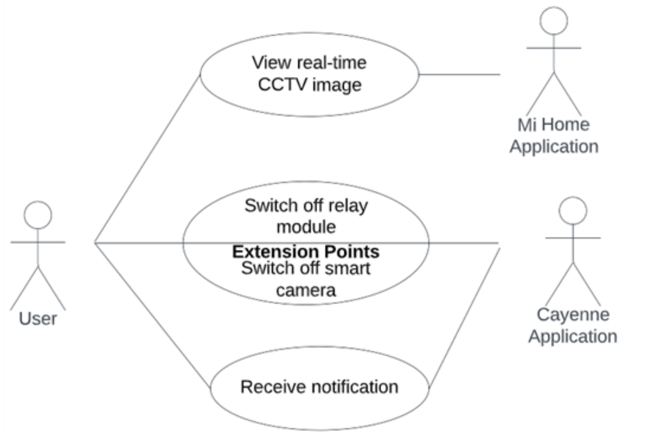


Fig.2. Use case diagram of user, Mi Home and Cayenne Application.

3.3 Activity Diagram

Figure 3 shows the activity diagram of the control system designed. When power is supplied to the Raspberry Pi, the ultrasonic sensor enters standby mode. If there is no object detected, the sensor remains idle. Upon object detection, the sensor sends signal feedback to Raspberry Pi.

The Pi board then sends signals to its GPIO pins to switch on the buzzer and relay module. When relay module is switched on, it allows current flow and thus the camera is switched on. Cayenne Application is used to monitor the components connected on the Raspberry Pi. It detects changes in Pi board's pin status and send notification message to user. When user receives notification from Cayenne Application, user can open the Mi Home App to view the camera image. If user decides to switch off the camera, he or she can use the Cayenne App to directly switch off the relay module. When relay module is switched off, current flow to the smart camera is blocked and the camera is switched off.

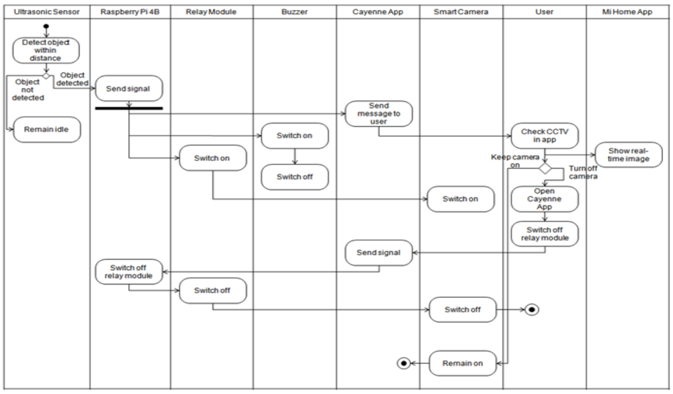


Fig.3. Activity diagram of the control system designed.

3.4 Sequence Diagram

Figure 4 shows the sequence diagram of user interaction with Mi Home and Cayenne Application. When user uses Mi Home Application to view the live video feeds from smart camera, the application requests the information from smart camera. The smart camera then returns the information required back to the application and back to user. This applies when user use Cayenne Application to access components connected on the Raspberry Pi. Upon user request, Cayenne forwards user request to Raspberry Pi. Raspberry Pi then sends back its parameters back to Cayenne, and the parameters are shown to user.

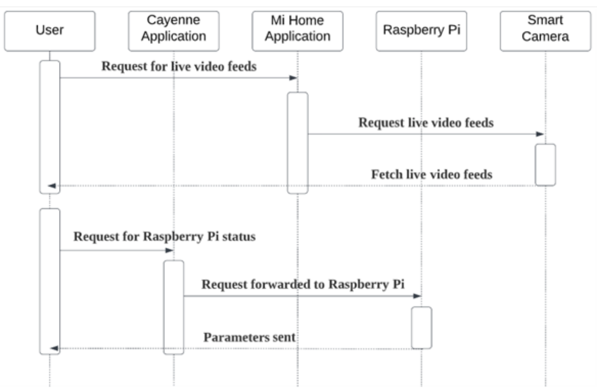


Fig. 4. Sequence diagram of user interaction with Mi Home and Cayenne Application.

4. DESIGN SPECIFICATION

The design specification of the system is categorize into 3 sections below covering the main module description, components and deployment diagram, and the schematic diagram.

4.1 Main Modules Description

This control system comprises of two integrated circuits. The first circuit includes a two channel 5V relay module, a Raspberry Pi, an ultrasonic sensor, and a buzzer. The second circuit consists of connections between the relay module and a smart camera.

The Raspberry Pi is powered by 5V DC supply. The Pi board PIN2 (5V power) then supplies 5V to the solder board. PIN6 (Ground) of Raspberry Pi is connected to the solder board as ground. VCC of solder board is connected to the VCC pin of ultrasonic sensor. Trigger pin of ultrasonic sensor connects to Raspberry Pi PIN16 (GPIO23). The Echo pin of ultrasonic sensor connects to a 1kΩ resistor then further connects parallel to Raspberry Pi PIN18 (GPIO24) and to two series 1kΩ resistors. The resistor is then connected to ground. A buzzer positive is connected to Raspberry Pi PIN22 (GPIO25). The buzzer negative and Ground pin of ultrasonic sensor connect to ground.

The VCC of relay module connects to PIN4 (5V power) Raspberry Pi. Another 5V DC supply is introduced into the circuit. The positive of the power supply connects to COM pin of relay module. The negative of power supply connects to negative of Smart Camera. The Smart Camera positive is connected with NO pin of the relay module.

4.2 Component and Deployment Diagrams

Figure 5 shows the circuit diagram of the control system. This circuit diagram is to be used as the PCB circuit layout for the proposed prototype.

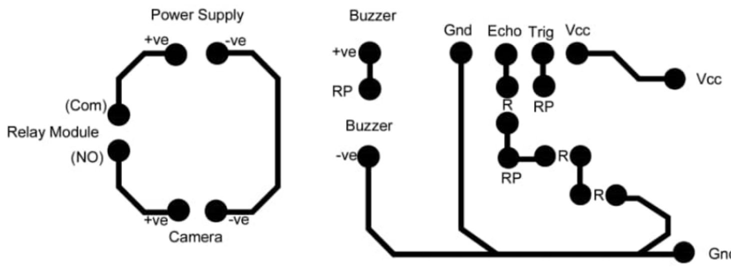


Fig. 5. Circuit diagram of the control system.

4.3 Schematic Diagram

Figure 6 shows the schematic diagram of the control system circuit. The schematic diagram shows the connection between the raspberry pi, the ultrasonic sensor, the relay switch, the camera, and the buzzer. It is layout the circuit structure to determine to connectivity of each components and to enable integration into a single system as planned as the proposed prototype.

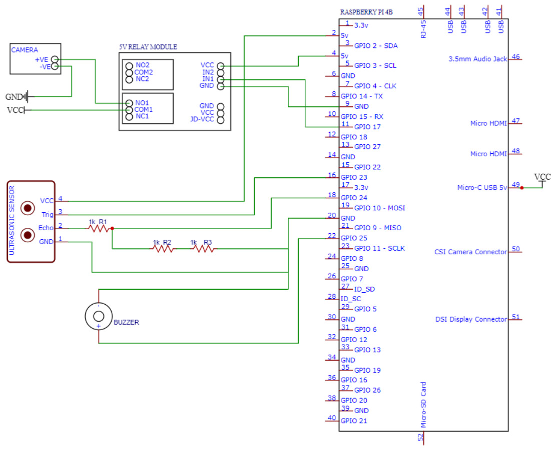


Fig. 6. Schematic diagram of the control system circuit.

5. RESULT AND DISCUSSION

The proposed prototype build is tested for its functionality and reliability of usage via a various type of test cases developed covering unit testing where of each single components or modules are tested, integration testing where each of the components and modules after integrated together is check for its overall cooperative functionality to serve as a minimum viable prototype and system testing which compare the prototype developed with the initial requirement specification set. The unit testing includes the testing of the motion sensing by the ultrasonic sensor, relay switching activation, CCTV camera ability to record upon triggered, while integration testing covers the integration of the hardware and software to support for hardware functionality together when combine and the software ability to enable user notification upon sensing of motion, linking of camera to active live recording, ability to remotely control the camera via the Cayenne software utilized. The test cases scenario is developed separately to test the Raspberry Pi microprocessor functionality in table 1, the buzzer in table 2, the relay module in table 3, the Mi Home smart camera application in table 4, the whole system ntegration into a single prototype in table 5 and the workability of the Cayenne app developed to support the system in table 6. Finally, the whole prototype is design to be a single module and as a complete prototype which function according to the initial requirement specification required.

Figure 7 shows the proposed system built for its first initial version for integration testing. it shows the connection between the Raspberry Pi microprocessor, the ultrasonic sensor, the relay module, the smart camera, and the power supply. Here, unit testing for Raspberry Pi microprocessor functionality and its connectivity of the circuit and modules are verified in Table 1.

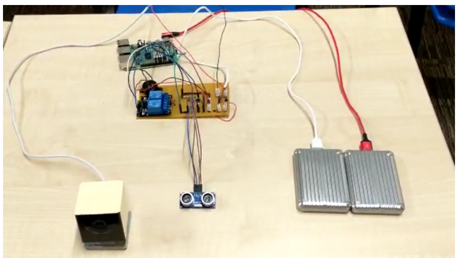


Fig. 7. The proposed system built at the initial version.

Table 1. Raspberry Pi test case.

No.	Raspberry Pi Test Case			
	Description	**Test Steps**	**Expected Result**	**Actual Result**
RP #1	Check if Raspberry Pi board can be viewed in VNC viewer via Secure Shell (SSH)	1. Open VNC Viewer. 2. Enter the Raspberry Pi IP address. 3. Connect. Raspberry Pi.	Raspberry Pi Desktop should be displayed.	Raspberry Pi Desktop is displayed.

Figure 8 shows the unit testing to confirm the functionality of the ultrasonic sensor and the buzzer. Movement of hand at the ultrasonic sensor is performed for motion sensing test. The movement of the hand is to test whether the ultrasonic sensor detects the motion and able to send the signal to trigger the buzzer.

Fig. 8. Motion detection testing by ultrasonic sensor.

Table 2. Buzzer test case

No.	Smart Camera Test Case			
	Description	**Test Steps**	**Expected Result**	**Actual Result**
XF# 1	Check if the camera is connected to Mi Home Application.	1. Connect the camera to power supply. 2. Open Mi Home App, select the camera and view the real-time image captured. 3. Camera should be switch on when relay module is triggered.	Yellow LED at back of camera should light up. Real-time image should be shown	Yellow LED light up. Real-time image captured is viewed.

Figure 9 shows the relay module switched on upon motion is detected at the ultrasonic sensor. The red light on the relay module indicates that the relay is switched on and it sends the signal to turn on the camera. It also sends signal to the Raspberry Pi to send notification to the user's device.

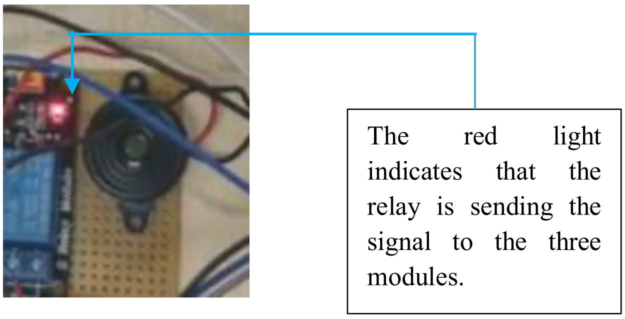


Fig. 9. Relay module switched on upon motion detection.

Table 3. Relay Module test case

Buzzer Test Case				
No.	Description	Test Steps	Expected Result	Actual Result
BZ# 1	Check if buzzer and motion sensor are in good condition	1. Connect buzzer and motion sensor to the system and checked with motion testing.	Buzzer should buzz when the motion sensor detected motion.	Buzzer buzzed when motion sensor detected motion.

Figure 10 shows the smart camera is switched on once the relay module is turned on. The yellow light indicates that the camera is on. The unit testing for the CCTV connectivity and its appropriate triggering by using relay module is tabled in Table 4 to summarize the testing conditions.

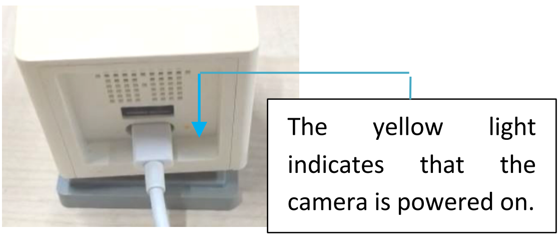


Fig. 10. Smart camera switched on after relay turned on.

Once all the unit testing of each of the hardware modules is tested to check for their functions once connected with the Raspberry Pi module, the next step is to proceed with the integration testing. The integration testing is to check each of the component's ability to work in a proper sequence of procedure once integrated as a single working prototype without any error when they are connected via simple plug and play wires compared to each components functionality once they are connected via a developed solder board connection. Here, the test cases for the integration testing are summarize in Table 5.

Table 4. Smart camera test case

Relay Module Test Case				
No.	Description	Test Steps	Expected Result	Actual Result
RM# 1	Check if relay module is in good condition.	Connect relay module to the system and relay should be switch on upon motion detection by ultrasonic sensor.	LED should light up.	LED light up.

Table 5. System Integration test case

System Integration Test Case				
No.	Description	Test Steps	Expected Result	Actual Result
SI# 1	Check if ultrasonic sensor is connected to Raspberry Pi.	1. Open Raspberry Pi terminal. 2. Run program distance.py.	Distance captured should show in terminal.	Distance captured is showed in the terminal.
SI# 2	Check if buzzer connected to Raspberry Pi.	1. Open Raspberry Pi terminal. 2. Run program buzz.py in terminal.	The buzzer should buzz.	The buzzer buzzed.
SI# 3	Check if relay module connected to Raspberry Pi.	1. Open Raspberry Pi terminal. 2. Run program relay.py.	The relay module should produce clicking sound and IN1 should light up.	Clicking sound heard and IN1 light up.
SI# 4	Check if buzzer buzz when ultrasonic detects within distance.	1. Open Raspberry Pi terminal. 2. Run program hc-sr04.py.	Buzzer should buzz for 0.5 seconds when ultrasonic sensor detects object within 60cm.	Buzzer buzzed for 0.5 seconds when object detected within distance less than 60cm.
SI# 5	Check if relay module turns ON upon object detection by ultrasonic sensor.	1. Open Raspberry Pi terminal. 2. Run program hc-sr04.py.	The relay module should produce clicking sound and IN1 should light up upon detection within 60cm.	Buzzer buzzed for 0.5 seconds when object detected within distance less than 60cm. Clicking sound was heard and IN1 light up upon detection within 60cm.

SI#6	Check if smart camera turns on when relay module is ON	1. Open Raspberry Pi terminal. 2. Run program hc-sr04.py.	Blue light should be observed from the camera power LED.	Blue light was observed from the camera power LED.
SI#7	Prepare solder board.	1. Arrange components according to circuit on solder board. 2. Solder the components.	The components are soldered stably on the board.	The componen ts were soldered stably on the board.
SI#8	Check connection of the solder board.	1. Connect all components according to the circuit diagram. 2. Connect Raspberry Pi in VNC viewer. 3. Run program hc-sr04.py.	1. Ultrasonic sensor should detect distance and sends feedbacks. 2. Buzzer should buzz 0.5 seconds when object detected within 60cm. 3. Relay module should switch ON when object detected within 60cm. 4. Blue light should be observed from the camera power LED.	1. Distance feedbacks from ultrasonic sensor were received. 2. Buzzer buzzed for 0.5 seconds when object detected within 60cm. 3. Relay module switched on when object detected within 60cm. 4. Blue light was observed from camera power LED.

Next, it proceeds to evaluate the prototype integration with external software utilized and paired to the entire system which is the Cayenne application and the Mi Home application. Both are open-source free software which needs to be setup and manipulated to fit in as the control system for the numbers of related components which needed remote activation and monitoring in the prototype. Cayenne software is used for remote control and user notification of the CCTV when activated by motion sensing while the Mi Home Application is to enable live recording and saving of the video recorded by the CCTV upon activation. Test cases are developed to verify the connectivity and the functionality of the Cayenne application with the Raspberry Pi microprocessor. Test conditions are performed to check the sequence of the prototype in motion detection, relay activation, buzzer activation remotely and ability of user to receive notification by using the Cayenne application paired to the prototype as portrayed in Table 6.

Table 6. Cayenne Application test case

No.	Cayenne Application Test Case			
	Description	**Test Steps**	**Expected Result**	**Actual Result**
CA #1	Check if Raspberry Pi connected in Cayenne platform.	1. Login to Cayenne account. 2. Select the Raspberry Pi and view.	Condition and informatio n of Raspberry Pi should be displayed.	Condition and informatio n of Raspberry Pi were viewed.
CA #2	Check if relay module is connected	1. Toggle the switch for relay module in Cayenne Application	The relay module should produce clicking sound and change state.	Relay module produced clicking sound and changed state.
CA #3	Check if buzzer connected	1. Toggle the switch for buzzer in Cayenne Application	The buzzer should buzz.	Buzzer buzzed.
CA #4	Send notification	1. Run hc-sr04.py in Raspberry Pi terminal. 2. Place an object within 60cm from ultrasonic sensor.	Notificati on should be received via SMS showing that the buzzer buzzed.	Notificati on is received via SMS showing that the buzzer buzzed.

Figure 11 shows the notification received by the user when the ultrasonic sensor detected the motion. The notification is sent through the Cayenne Application.

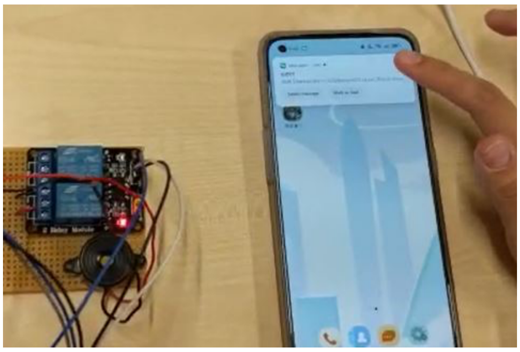


Fig. 11. User receives notification when ultrasonic sensor.

Figure 12 shows when the alert notification is received through the Cayenne Application, the user opens the Mi Home Application, and the linked camera is shown.

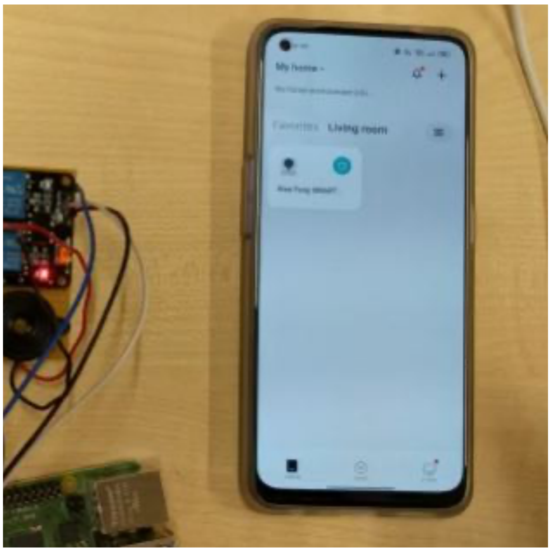
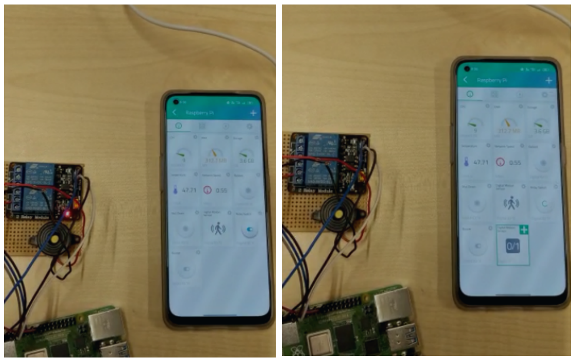


Fig. 12. User open Mi Home app and the linked camera is shown.

Figure 14 shows the live video feed from the camera through the Mi Home Application in the user's device.

Fig. 14. Live video feed from the camera is presented.

Figure 15 shows the Cayenne Application opened by the user to switch off the relay module. When the relay module is switched off, it automatically switches off the smart camera too.



(A) **(B)**

Fig. 15. User open Cayenne Application to switch off relay module in Figure 15 (A) and the relay module is in off mode without any LED notification after command is send from Cayenne app enabling the camera to be off too in Figure 15 (B).

Once all the test conditions passed, the final system built is installed into a single module encapsulation to act as a single product to enhance safety and ease of installation as shown in Figure 16. Hence, the prototype can be portable and easy to be install in any wall of a premise which can be connected to the CCTV camera placed near the entrance or exit points such as door or window with the motion sensor constantly detecting motion. Once a motion is detected, the CCTV camera only will be activated to start recording the important scenario and user will be notified of abnormal movement via mobile notification. Thus, in this way, the CCTV camera do not need to be constantly switch on to avoid wastage of electricity while the CCTV camera only capture the specific emergency scenario with user notified, thus decreasing the needs of constant monitoring of the CCTV video scene at every point of time.

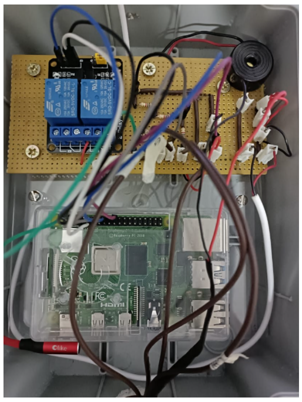


Fig. 16. The system built is installed into an electrical box.

6. Conclusion

The prototype which serves as an autonomous triggering control system via motion detection for IoT based smart home surveillance CCTV Camera is successfully build. By implementing the system, user can received notification upon motion detection and the system will automatically swich on the CCTV camera connected to the prototype via the relay system activation to enable live recording of the environment and to be save the video in Mi Home application software. User also can view live video feed from the Mi Home Application as well as remotely turn on or off the camera and alarm which represented as a buzzer here by switching on or off the relay module from Cayenne App. This is to give the user an option to activate the house alarm and record the video if they see any trespasser detected in the house or the ignored and switch off the system for false alarm. Thus, in this manner, the CCTV camera is only activated whenever it is needed rather than continuously activated such as of traditional CCTV camera. Second, the proposed system automatically alert only the important scenario worth to be recorded and alert the user immediately rather than needing a security personal to constantly monitor the CCTV camera video such as in traditional CCTV camera. Hence, the system can be proposed to be used for installation in premises such as apartments, condominium and houses to enable smart monitoring system and alert system for home owners using surveillance camera system.

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