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Real time home-security monitoring using smartphone based IoT

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ABSTRACT

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One of the most widely used security systems is the CCTV. The use of CCTV is not only as a security system on multistory buildings or offices, but also has already graduated homes are mainly in big cities where sometimes living functions aren't can be felt as comfortably as possible. This is happening because it is concerns the living owners who haven't been able to monitor in person thorough. Therefore, CCTV cameras are required for viewing it used to monitor home security conditions. The study uses IoT-based automation method, among others hardware design of CCTV boxes, 3d CCTV camera design, system wiring, and layout boards. Software design includes block diagram and flowchart the system. The testing of the tool work is deploy on ESP32-cam, ultrasonic sensor, PIR sensor, and buzzer. The research was able to build a home security monitoring system from a long distance based on a IoT in real time. Remote test results obtained average HC-SR04 ultrasonic sensor error with a standard roll gauge 1.18%.

1. Introduction

In previous research a CCTV camera surveillance application was designed for Android-based mobile devices that can be accessed anytime and anywhere using an adequate internet connection and stable bandwidth, especially for video streaming purposes [1] [2]. The Android platform can be used to monitor directly via Motion-JPEG via an IP camera on a mobile device [3].

Applications that are built can run successfully on Android devices [4]. Applications built based on connections between CCTV controllers are connected, some CCTV controllers can still be controlled [5]. The use of Wi-Fi networks or data packets to access images from CCTV camera highlights via a smartphone depends on signal strength [6]. Each transmission medium has different attenuation depending on the material used [7]. Internet connection testing can be done with a ping test [8].

Smart Home is a combined application of technology and services specifically for the home environment with certain functions aimed at increasing the safety, efficiency and comfort of its occupants. Smart home systems usually consist of monitoring devices, control devices and automatically there are several devices that can be accessed using a computer [9]. The Internet of Things (IoT) is a network of objects that are connected to each other via the internet and communicate independently without human intervention. Many things in this world would be very useful if phenomena were observed and recorded, but on the other hand humans have limitations. in time and many things [10]. Therefore, we need tools that can capture symptoms and record any changes in these symptoms. In addition, it will be very efficient if the results of recording symptoms can be observed in real-time and the data can be immediately analyzed for decision making [11]. IoT is a structure in which objects, people are provided with exclusive identities and the ability to move data across networks without the need for two-way traffic [12]. IoT is a technological development that promises to be able to optimize life with intelligent sensors and objects that have networks and work together on the internet [13]. As an IoT-based home security system, it can be made using online monitoring [14].

In this study using ESP32 as a series of low-cost and low-power systems on a microcontroller chip with integrated Wi-Fi and dual-mode Bluetooth, the ESP32-CAM microcontroller equipped with an OV2640 camera is used to retrieve data from sensors, take pictures as visual documentation of human presence. [15]. This microcontroller already has a Wi-Fi module on the chip so it is very supportive for creating IoT application systems [16]. Ultrasonic sensor is a sensor that works based on the principle of sound wave reflection and is used to detect the presence of an object or certain objects in front of the working frequency in the area above sound waves from 20 kHz to 2 mHz. Ultrasonic wave reflection occurs when there is a certain object and ultrasonic wave reflection will be received returned by the receiving sensor unit. Furthermore, the receiving sensor unit will cause the vibrating diaphragm to vibrate and the piezoelectric effect produces an alternating voltage with the same frequency [17]. The PIR sensor is a sensor that captures infrared signals emitted by the human body or other moving objects [18]. Buzzer is a component that has the function of converting electric current into sound. This alarm function is for home security when suspicious things occur in the house [19]. Blynk to monitor the condition of the house so as to facilitate the remote monitoring process [20].

2. Method

2.1. System Design

System design in this research is divided into two stages, namely hardware design and software design. The design of this system refers to theory and data sheets that have been obtained from reliable sources. The overall system design is shown in Fig. 1.

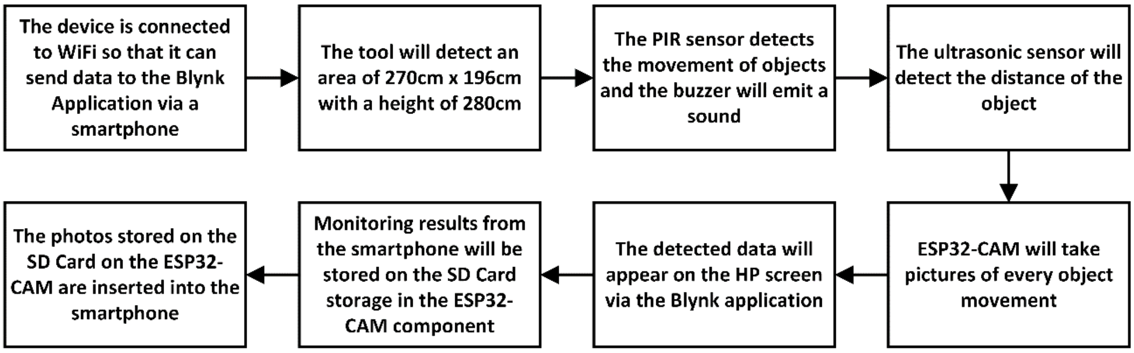


Fig. 1. System block diagram

In the system design in Fig. 1, make sure the tool is connected to Wi-Fi so that it can send data to the Blynk application via a smartphone, when the tool is connected to the internet the tool will detect an area of 270cm x 196cm with a height of 280cm. The PIR sensor detects object movement and the buzzer will sound 3 times. The ultrasonic sensor will detect the distance of the object. ESP32-CAM will take pictures of every movement. The detected data will appear on the HP screen via the Blynk application. The results of taking pictures produced by the ESP32-Cam will be automatically saved on the SD Card storage in the ESP32-CAM component and the photos stored on the SD Card on the ESP32-CAM are inserted into the smartphone.

Hardware design and layout is the first step in making a system. Home security monitoring tools align all the components used so that sensors and cameras work optimally. This IoT-based automatic monitoring camera uses a panel box that has an important role. The box design of the tool is shown in Fig. 2.

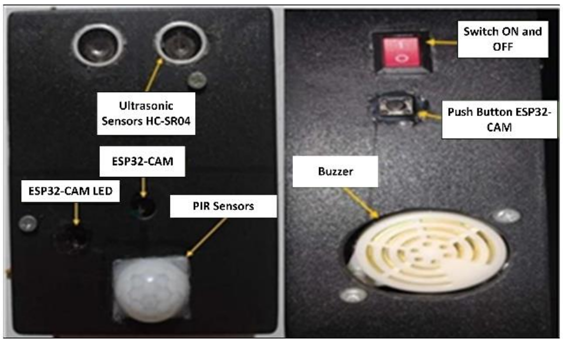


Fig. 2. CCTV box design

In Fig. 2, you can see the design of a home CCTV camera box online using an IOT-based smartphone. The function of the box is to protect the components in the box because these components are very sensitive to the impact of other objects.

2.2. CCTV Camera Design

CCTV camera design using the 3D Solid Work application. CCTV camera overview is designed with length and width. A 3D CCTV camera design drawing is shown in Fig. 3.

Fig. 3. 3D CCTV box design

Fig. 3 is a 3D design of a home CCTV camera body online using an IoT-based smartphone. The purpose of the 3D design in this study is to minimize the error rate in the design of the components used in the manufacture of this system.

2.3. System Cabling

System cabling is the process of connecting all the component instruments used in the tool so that it can read the PIR sensor and ultrasonic sensor values which will later trigger the performance of the output. The circuit of all the hardware can be seen in Fig. 4, while the system wiring on the ESP32-CAM is shown in Table 1.

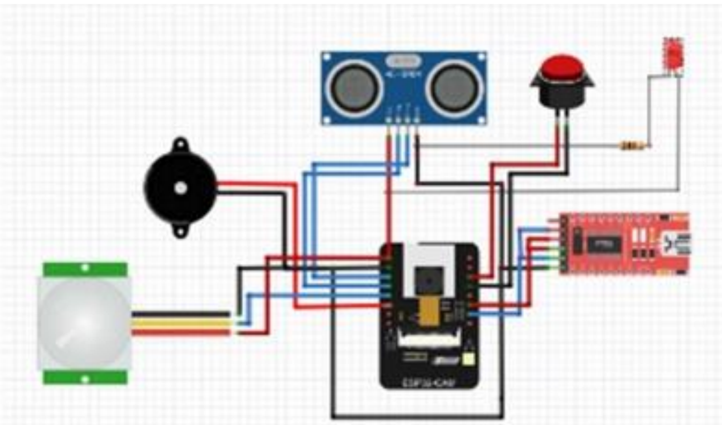


Fig. 4. Wiring diagram

In Table 1 it can be seen that all components are supplied by the power bank and all are connected to each other through the ESP32-CAM control center which operates at 5-12 V directly connected to the power bank. ESP32-CAM provides supply to other sensors.

Table 1. System cabling

No	Component	ESP32-CAM Pins
1	PIR Sensors	GPIO 15
2	Ultrasonic Sensors	GPIO12 dan GPIO13
3	FTDI Moduls	GPIO1
4	Buzzer	GPIO14
5	Switch	GPIO0

2.4. System Block Diagram

The tool design process in this study includes the design of a system block diagram as shown in Fig. 5.

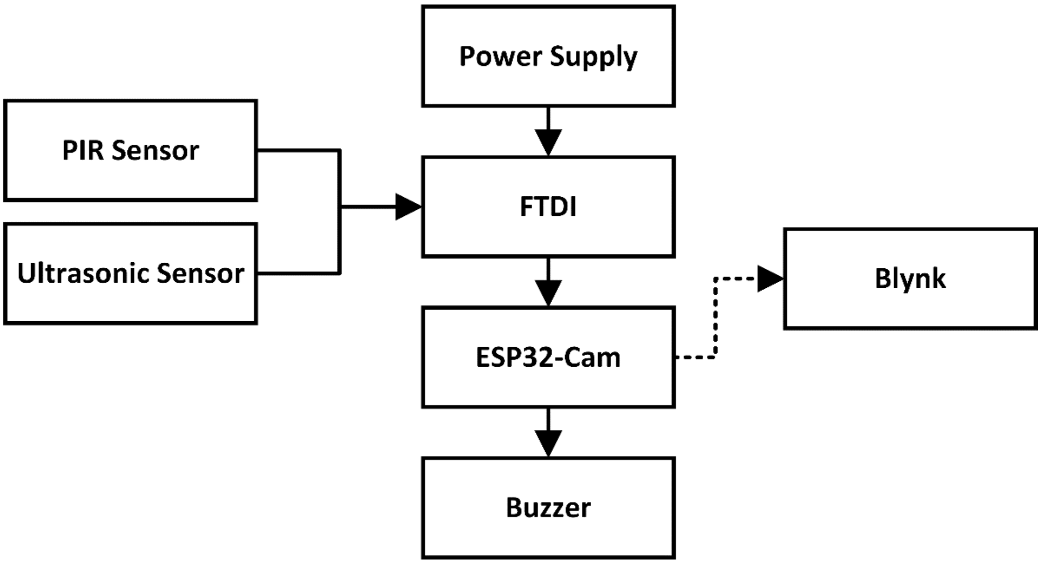


Fig. 5. System block diagram

The working principle of this tool is that the power supply as a resource provides a 5 V voltage to the FTDI component so that the ESP32-CAM works because the FTDI functions as a USB adapter for ESP32-CAM which does not have USB function, then turns on the switch to upload the program when the program has been uploaded the switch is turned off. When an object moves, the buzzer will sound and the PIR and ultrasonic sensors will send data to the ESP32-CAM. ESP32-CAM will process the read code so that moving objects will be captured as images and displayed on the Blynk application screen. The image will be stored on Micro SD and the LED will function as an indicator to find out whether it is on or off.

2.5. System Flowchart

The design of the tools in this study includes the flowchart shown in Fig. 6.

In Fig. 6 starting from connecting the IoT-based monitoring camera tool to the Blynk application, then activating the Wi-Fi that is already connected to the tool. If there is an object that is detected as moving within a predetermined distance, the tool sends movement and distance data to the Blynk application. When the tool does not detect any movement, the tool does not send notifications to the Blynk application. The captured image will appear on the Blynk application screen display.

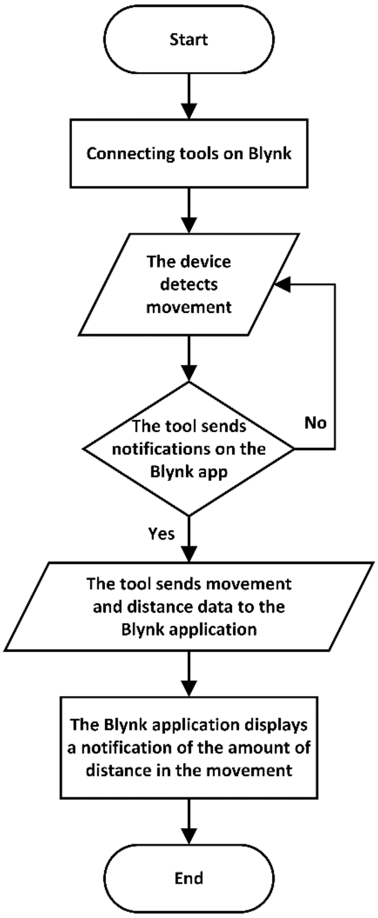


Fig. 6. Flowchart

3. Method

3.1. Camera Testing

Camera testing in this study was carried out by looking at the results of the camera used on the tool with the diameter of the area that can be monitored from the tool which covers a camera monitoring area of 270 cm long and 196 cm wide with a height of 280 cm. already able to see the situation around the tool shown in Fig. 7.

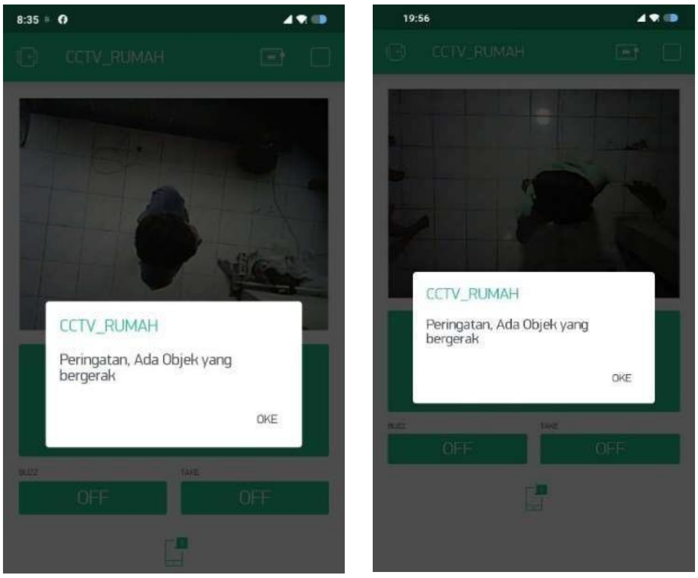
(a) (b)

Fig. 7. Camera testing (a) Morning and (b) Evening

Camera testing on this tool was carried out in two conditions, namely morning and night. Fig. 7 is the result of camera captures found in (a) morning conditions taken at 08.32-08.45 WIB and (b) night conditions taken at 20.22-20.43 WIB. Based on the camera test contained in Fig. 7, the tool can already detect objects that are around the tool.

3.2. PIR Sensor Testing

Testing the PIR sensor on this tool by moving around the tool to ensure the tool can detect the movement of objects around it. The tool can send a signal of the movement of objects around the tool as shown in Fig. 8.



(a) (b)

Fig. 8. PIR sensor testing (a) Morning (b) Evening

Based on the PIR testing that has been carried out on the tool, the test results show that it is able to send information if there is movement of objects around the tool which is sent via a warning signal to the Blynk application that is connected to the tool. The PIR sensor test was carried out in two conditions, namely (a) in the morning and (b) at night. Based on these two tests, the PIR sensor can operate or work properly as expected.

3.3. Ultrasonic Sensor Testing

Ultrasonic sensor testing is carried out by detecting the distance of objects moving around the device. The data obtained from the object's movement is the distance from the object moving around the tool. The data obtained is distance data in cm units from the tool. The ultrasonic sensor testing that has been carried out is shown in Fig. 9.

Fig. 9. Testing of ultrasonic sensors

Tests that have been carried out on the ultrasonic sensor as shown in Fig. 9 can be seen that the sensor is able to detect the distance from the movement of objects caught by the tool. The test results obtained data in the form of object distances as far as 5-280 cm from the tool.

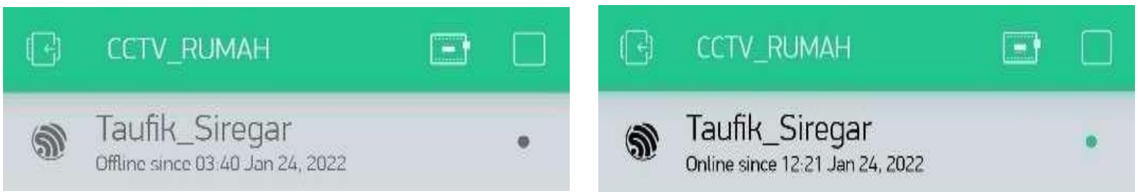
Experiments with several variations of object distance to CCTV were carried out to test the range of ultrasonic capabilities in identifying objects as shown in Table 2. Based on the test data it was found that the tool was able to detect changes in objects in the range of 5-280 cm.

Table 2. Detection of objects with varying distances

No	Object Distance (cm)	Information
1	5	Detected
2	25	Detected
3	50	Detected
4	100	Detected
5	130	Detected
6	250	Detected
7	270	Detected
8	280	Detected

3.4. Blynk Testing

The Blynk test is carried out by checking the Blynk application on the Arduino IDE application to ensure that the program provided via the Arduino IDE to the tool can be connected to the Blynk application on the smartphone. The results of the tests carried out are shown in Fig. 10.



(a) (b)

Fig. 10. Testing the Blynk application (a) Not connected yet and (b) Already connected

Testing the Blynk application that has been carried out obtained the data in Fig. 10 with (a) Blynk has not been connected to the tool and (b) Blynk has been connected to the tool. Thus the tool can monitor the device through the Blynk application on the smartphone.

In Fig. 11 there is a CCTV security indicator in the form of a buzzer button on the Blynk application which functions as an alarm to minimize house crime if something unexpected happens.

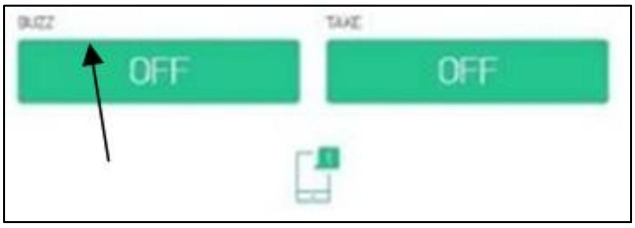


Fig. 11. Buzzer button

3.5. Results of Object Movement

In this research, data collection was carried out by monitoring the movement of objects obtained by the tool in the area covered by the tool.

Experiments with several variations of the type and movement of objects on CCTV were carried out to test the ability of the tool to identify each type and movement of objects as shown in Table 3. Based on the test data, it was found that the tool was able to detect the movement of any object.

Table 3. Detection of object type and movement

No	Object Types and Movements	Information
1	Adult standing	Detected
2	Adult Sneaking	Detected
3	Children Sneaking	Detected
4	Children Stand	Detected
5	Children Walk	Detected
6	Cat Moves	Detected
7	Moving Gallons of Water	Detected
8	The Ball Moves	Detected

3.6. Results of Object Distance Data

The results of the tests that have been carried out in this study obtained data that has been processed into data in the form of Table 4 which was carried out in the morning and at night conditions which are data on the distance of moving objects.

Table 4. Object distance data

Participant	Object Height (cm)	Morning		Evening	
		Standing state (cm)	Sitting state (cm)	Standing state (cm)	Sitting state (cm)
Participant 1	169	101	249	104	254
Participant 2	174	96	252	98	254
Participant 3	174	96	257	99	261
Participant 4	154	116	264	111	269
Participant 5	163	111	266	107	269

Based on the results of the tests that have been carried out, the data obtained in Table 4 were carried out in the morning and at night with five participants in the study. Participants made movements in the tool area while sitting and standing which were carried out in the morning and at night so that in testing the tool using an ultrasonic sensor it could detect the distance from objects in the vicinity. From the data that has been done, a comparison is obtained from the tests carried out with these two conditions. This difference in distance might have occurred because the position taken by the participants had a different distance from the experiment which was carried out in the morning.

3.7. Testing the Results of Ultrasonic Sensor Object Distance Data with a Roll Meter Measuring Tool

Testing the HC-SR04 ultrasonic sensor in this study was carried out by measuring the distance from the ultrasonic sensor to the object. The purpose of testing the HC-SR04 ultrasonic sensor is to calculate the accuracy of the distance sensor measurement results. The measuring results of the HC-SR04 ultrasonic sensor will be compared with a standard measuring instrument, namely the Roll meter in Fig. 11.

The reading results obtained by the HC-SR04 ultrasonic sensor will be displayed on the Blynk application. The results of the HC-SR04 ultrasonic sensor test for distances carried out on objects are shown in Table 5.

Table 5 shows the results of the HC-SR04 ultrasonic sensor test on the distance to the object. At a distance from the floor to the camera has a distance of 280 cm. To find the distance the meter roll measurement is measured from the camera to the height of the object and the results are obtained in Table 5. The results of the test tool obtained an average error of the HC-SR04 ultrasonic sensor with a standard roll meter measuring tool of 1.18%. In testing object measurements using the HCSR04 ultrasonic sensor numbered 1, 2, 8, 9, and 10, the lowest percentage was 0% because the HC-SR04 ultrasonic and roll meter have the same value when collecting data. In testing object measurements using the HC-SR04 ultrasonic sensor numbered 3, 4, 5, 6, and 7, the largest percentage is obtained because the HC-SR04 ultrasonic and the roll meter have different values when collecting data because they have different values due to the object there is movement that is not exactly under ultrasound so that the values obtained are different.

Fig. 12. Testing of the HC-SR04 ultrasonic sensor

Table 5. Test results of the HC-SR04 ultrasonic sensor on objects

No	HC-SR04 Ultrasonic Sensor Measurement	Roll Meter Measurement	Difference	Errors (%)
1	101	101	0	0
2	96	96	0	0
3	96	99	3	3.03
4	116	111	5	4.50
5	111	107	6	5.60
6	104	101	3	2.97
7	98	96	2	2.08
8	99	99	0	0
9	111	111	0	0
10	107	107	0	0
Average				1.18

4. Conclusion

This research has successfully designed an IoT-based home security monitoring tool that can run according to the research objectives, namely a system that can monitor the condition of the house in the morning and at night automatically. The system can also make it easier to monitor the state of the house when the house is empty and can be monitored remotely by the user. This system is connected to the internet so that the system can be controlled and monitored remotely. The system works with the IoT method. The performance of this IoT-based CCTV camera system uses ultrasonic sensors and PIR sensors, and the ESP32-CAM camera as a microcontroller in this tool can work well to take pictures of objects when objects move around the camera which covers a camera monitoring area of 270 cm long and 196 cm wide. cm with a height of 280 cm. The use of the Blynk application as a remote interface can be used appropriately so that object monitoring can be seen in the Blynk application when the house is empty or there is something suspicious. The research has also been successfully tested from the tool, obtained an average error of the HC-SR04 ultrasonic sensor with a standard roll meter measuring instrument of 1.18%. In testing, the lowest percentage was obtained, namely 0% because the HC-SR04 ultrasonic sensor and roll meter obtained the same value when data collection was obtained and there was also a value other than 0% because the HC-SR04 ultrasonic sensor had a different value because the object had a different movement. not exactly under ultrasonic so the values obtained are different.

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