Design Of A Security System Tool For Tapis Fabric Object In Lampung Museum Based On Internet Of Things (IoT) Technology

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Abstract

The Lampung Museum has many historical collections, including tapis cloth. The tapis cloth collection at the Lampung Museum is still unsafe because the layout is open and the distance is far from CCTV. This study aims to design a series of security systems using two Passive Infra-Red (PIR) sensor inputs, a buzzer output, and a VC0706 camera at the Lampung Museum, which can be monitored remotely with notifications on the Telegram platform. The research method used is design and testing (subsystem and overall system testing). The data from this research are the system design results, how the security system works on filter cloth objects, and the overall system. The security system was tested using Telkomsel, Indosat, and Tri providers. The results obtained for image quality 640 x 480 Pixels obtained an average delivery time from Telkomsel providers of 25.2 seconds, providers for Indosat at 27.4 seconds, and Tri providers at 28.6 seconds. then an experiment was carried out with 3 different image qualities, namely 640 x 480 Pixels, 320 x 240 Pixels, and 160 x 120 Pixels, with Telkomsel provider with an average sending value for image quality 640 x480 Pixels for 25.2 seconds, image quality 320 x 240 Pixels for 20.5 seconds and 160 x 120 Pixel image quality for 17.7 seconds. Then, testing sending Telegram notifications remotely from a security system tool and obtaining that the time sent notifications from the Arduino IDE serial monitor is the same as the time received notifications on the Telegram platform, which means sending notifications takes place in real-time.

Keywords: Security System, PIR Sensor, Camera VC0706, Tapis Cloth, Museum.

I. Introduction

The Museum is a place for storing historical relics which is very important as proof that these relics are true and has other functions as an important place for a country to show the public that the importance of historical relics is a treasure that must be preserved.

The Lampung Museum is an institution for the care, observation and preservation of material objects resulting from human culture as well as nature and the environment in Lampung province which contain historical relics. The Lampung State Museum was inaugurated by the Minister of Education and Culture, Prof. Dr. Fuad Hasan on 24 September 1988 [1].

One of the collections in the Lampung Museum is Tapis cloth which is exhibited on the 2nd floor of the Lampung Museum exhibition building. Tapis cloth is a traditional craft of the people of Lampung which has been passed down from generation to generation and was born as a "means" for harmonizing people's lives with the surrounding environment and the creator of the universe. Lampung tapis cloth is carried out through several stages that lead to the perfection of weaving techniques as well as the application of decoration that continues to grow with the cultural developments of the local community [2]. The tapis cloth collection in the Lampung Museum is still very open so visitors can touch and even steal the tapis cloth collection. Because of this, it is important to have a security system specially made for the tapis cloth collection in the Lampung Museum so that it can reduce the chances for visitors to be able to touch and even commit theft of the tapis cloth collection in the Lampung Museum. Based on the results of interviews with sources, Mr. I Made Giri Gunadi, SS, M.Sc. explained the collection of tapis cloth which is located on the 2nd floor of the Lampung Museum exhibition building. Given a layout with glass walls around it and an open area above the filter cloth object.

Because of that we need a design tool that can be implemented as a security system for tapis cloth objects at the Lampung Museum which allows the prevention of disturbances and even theft of the tapis cloth collection at the Lampung Museum. The security system is designed using a Passive Infra Red (PIR) sensor which can detect infrared radiation approaching objects so that it can be directly monitored by officers remotely and can find out through screenshots via smartphone screens of officers at the Lampung Museum.

II. Materials and Methods

This security system tool is made using the NodeMCU ESP 8266 microcontroller as a microcontroller which is equipped with a VC0706 camera module in making tools with Passive Infra Red (PIR) sensors which can be monitored directly remotely by Lampung Museum staff by using the telegram application in the form of image notifications that will send if there is a disturbance to the filter cloth object at the Lampung Museum and will output the buzzer and the LED will light up.

A. NodeMCU

NodeMCU ESP8266 is an Internet of Things (IoT) product development board based on eLua Firmware and System on a Chip (SoC) ESP8266-12E. ESP8266 itself is a WiFi chip with the TCP/IP protocol stack. NodeMCU can be analogous to the Arduino ESP8266 board. The ESP8266 program is a bit inconvenient because it requires several wiring techniques and an additional USB to serial module to download the program. But NodeMCU has packaged the ESP8266 into a compact board with various features such as a microcontroller + access capability to Wifi as well as a USB to serial communication chip. So to program it only requires the exact USB data cable extension used charging smartphones [5].

B. Camera VC 0706

The VC0706 camera is a serial camera that supports microcontroller devices, one of which is Arduino, this camera is connected to the Arduino board via the TX, RX, GND, and 5V ports. Camera VC0706 is a serial camera that supports microcontroller devices, one of which is Arduino, this camera is connected to the Arduino board via TX, RX, GND, 5V ports [6].

B. MG 90 S Servo Motors

The Servo motor is an electronic component in the form of a motor that has a feedback system to provide information on the actual motor rotation position which is forwarded to the microcontroller control circuit. Servo motors are widely used as actuators that require precise motor rotation positions. If in ordinary DC motors only the speed and direction of rotation can be controlled, it is different for servo motors, namely the addition of parameter sizes that can be controlled based on angles/degrees. The main components of the servo motor include DC motors, gears, potentiometers and servo controllers.

C. PIR sensor

PIR sensors (Passive Infrared) are an electronic component of the sensor type that is capable of detecting infrared radiation. sensorsPEARis a passive component that acts as a receiver of infrared radiation from outside and does not produce infrared light itself. The name SensorPassive Infrared, which means sensors PIR it can only act as a receiver of infrared rays from every object that is successfully detected by the sensor. Objects that can be detected by this sensor are usually the human body.

E. Buzzer

Buzzer is an electronic component that functions to convert electrical vibrations into sound vibrations. The working principle of a buzzer is almost the same as a loudspeaker, so the buzzer also consists of a coil attached to the diaphragm and then the coil is energized so that it becomes an electromagnet, the coil will be pulled in or out, depending on the direction of the current and the polarity of the magnet, because the coil mounted on the diaphragm, every movement of the coil will move the diaphragm back and forth to make the air vibrate which will produce sound.

F. Arduino IDE

Arduino IDE (Integrated Development Environment) is software that is used to program Arduino, in other words Arduino IDE as a medium for programming the Arduino board. Arduino IDE can be downloaded for free on the official Arduino IDE website. Arduino IDE is useful as a text editor for creating, editing, and also validating program code. can also be used to upload to the Arduino board. The program code used on Arduino is called the Arduino "sketch" or also called Arduino source code, with the source code file extension.ino [7]. Figure 6 is a display of the Arduino IDE.

Figure 5. Arduino IDE

G. Telegram

Telegram is a free application that is used to send short messages, make calls or send photos and videos and even send files. Telegram is here to make it easier for humans to communicate. Telegram can be used on smartphones, tablets and even computers. Telegram for the iOS platform was launched on August 14, 2013. While the alpha version of the Android platform was officially launched on October 20, 2013. For iOS it can run on iOS 6 and above, Android runs on Android 4.1 and above, and Windows *Phone*. Apart from smartphones, Telegram can also use the Web version of Telegram or by installing the Telegram Desktop application for Windows, OSX and Linux operating systems.

III. Results and Discussions

This device is implemented in the filter cloth collection on the 2nd floor of the Lampung Museum exhibition building. By using the NodeMCU ESP8266 microcontroller, Passive Infra Red (PIR) sensors as input and Buzzer and Camera VC0706 as output which are connected to the Internet of Things (IoT) via the Telegram platform which can be accessed on a smartphone or personal computer (PC).

A. System Flow Chart

Figure 1 shows a system flow diagram of a security system.

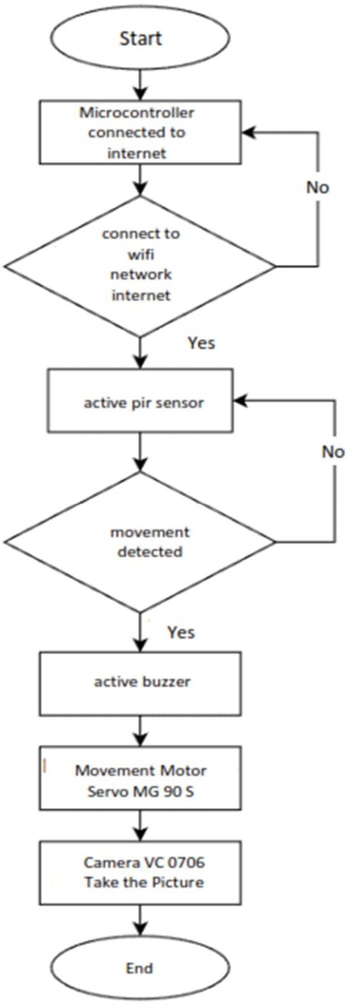
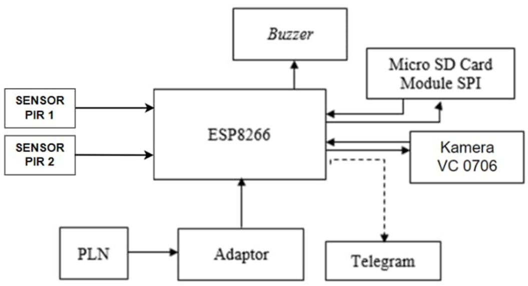


Figure 1. System Flow Chart

B. Block System Diagram

Figure 2 is a system diagram blog which is a system design of a security system tool that will be implemented in the tapis cloth collection at the Lampung Museum. Where is NodeMCU V1.0 ESP 8266 as a microcontroller that will be connected to an adapter that gets power from PLN. With input from a Passive Infra Red (PIR) sensor with an output in the form of a buzzer and a VC0706 camera that will capture images which will then be processed by NodeMCU V1.0 ESP 8266 to send notifications via the telegram application.



Figures 2. Research Block Diagram

C. Tool Design

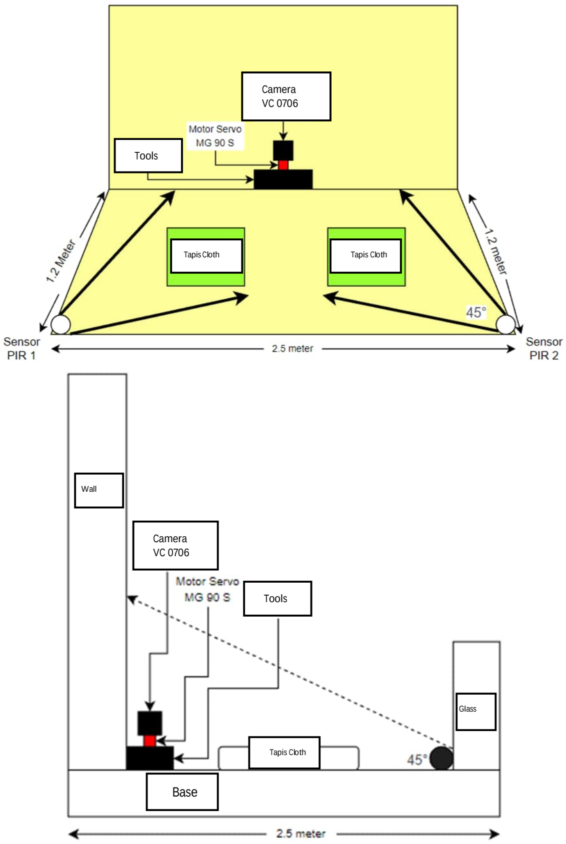


Figure 3. Tools Placement Design

The design of the tool with the VC0706 camera is placed against the wall which will make it easier for the VC0706 camera to capture images that will be used as notifications from BOT telegrams. Then the two Passive Infra Red (PIR) sensors which will be placed on each front side of the object will emit a capture radius with a width of 45 degrees as far as 4 meters, but the actual distance from the sensor to the wall is 1.1 meters. Figure 3 is the design of tool placement.

The designed tool is mounted on a filter cloth object at the Lampung Museum. Figure 4 shows the Implementation of the Security System and testing of the tool at the Lampung Museum.

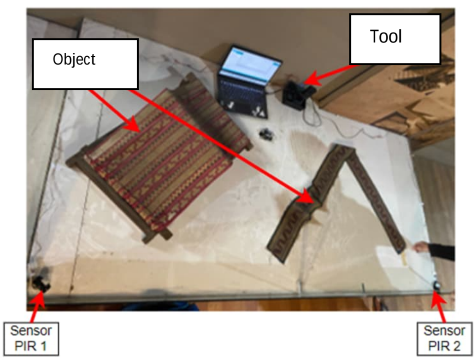


Figure 4. Security System Implementation

This tool uses the NodeMCU V1.0 ESP 8266 microcontroller as the main microcontroller which is connected to 2 Passive Infra Red (PIR) sensors as input from the device with an output in the form of a VC0706 camera with a buzzer. The buzzer functions as a trigger if there is an infrared beam in the range of 8-12 mm infrared received by one of the two Passive Infra Red (PIR) Sensors by sending notifications to the Telegram application in the form of photos which are captured images from the VC0706 camera used as tool output.

Here is the layout of the components used:

1. The inside part.
A box that is used to store several important components in it which can be seen as shown in the picture. The box contains the ESP 8266, Micro SD Card Module SPI and buzzer. ESP 8266 functions as a microcontroller to run security system tools. The SPI Micro SD Card Module functions as a temporary image storage area from the captures of the VC0706 Camera which is used to capture images when one of the PIR sensors detects movement within its range. Then the buzzer functions as an alarm that emits a sound when the PIR sensor is in high state.

2. The outside part.
On the outside is a part that has an important function in this security system. There are several components used, namely 2 PIR sensors, the MG 90 S Servo Motor and the VC0706 Camera. The PIR sensor functions as a sensor that captures infrared radiation from outside with a captured beam range of 8-12 micrometers, in this case the human body have an infrared range of 9-10 micrometers so it is very suitable to be used as a sensor to detect theft. The MG 90 S Servo Motor functions as a directional movement of the VC0706 Camera which is used according to the direction of the active PIR sensor. Then the VC0706 camera functions to capture images when the PIR sensor detects movement in its coverage area.

C. Analysis of the Security System on Tapis Cloth at the Lampung Museum

This research uses some hardware and software used to run security system tools on filter cloth objects that can be monitored via the Telegram application. The following is the hardware and software used.

The design of the security system tool on the filter cloth object that has been made is shown in Figure 5.

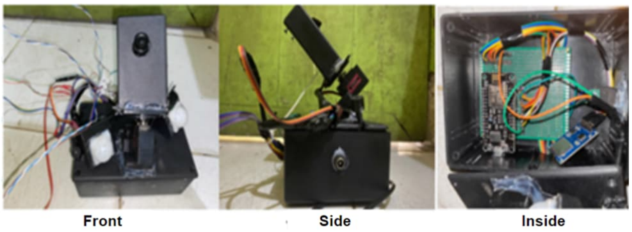


Figure 5. Security system tools

Figure 5 shows the security system tool section. The inside of the box consists of ESP 8266, Micro SD Card Module SPI and a buzzer. Then outside the box which consists of 2 PIR Sensors, MG 90 S Servo Motor and VC0706 Camera. Figure 6 shows the wiring of the created device.

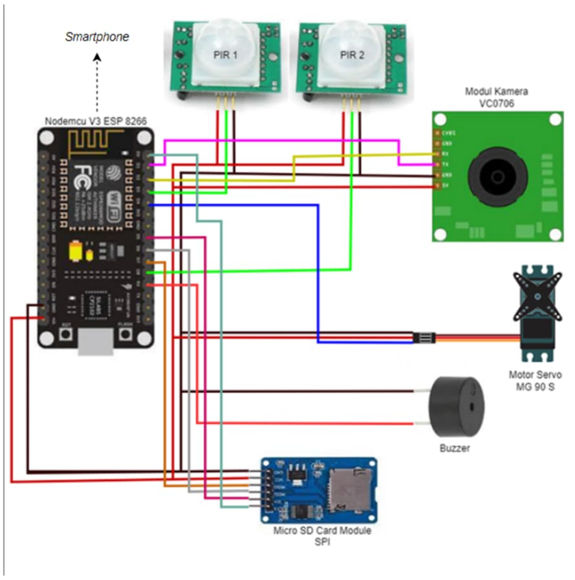


Figure 6. Wiring Security System Tools

Telegram is an instant and free cloud-based text, image, audio, video and sticker messaging application that focuses on speed and security. At this time the Telegram application is not only used as a social media for sending messages but is also used as a learning medium. Figure 7 shows the results of Telegram notifications.

Figure 7. Telegram Bot Notifications

D. Overall System

To ensure the tool can work as needed. So, it is necessary to test the security system tool on the Tapis cloth object at the Lampung Museum.

1. PIR Sensor Range
This research has 2 stages, namely the work of a security system tool using a Passive Infra Red (PIR) sensor as input with an output in the form of a buzzer and a VC0706 camera. As well as sending captured images from Camera VC0706 which are sent to the Telegram platform. The width of the detection angle is made at 45° due to minimizing areas that don't need to enter the range of the PIR sensor.

a. Vertical PIR Sensor Range
Testing with the PIR sensor is used using 2 inputs from the left and right sides of the filter cloth object. PIR sensors are placed on each side of the corner of the filter cloth object. Based on the range of the PIR sensor which is located with a sensor area width of 45° with a long distance from the sensor to the back wall of 1.2 meters. Figure 8 shows the vertical PIR sensor distance.

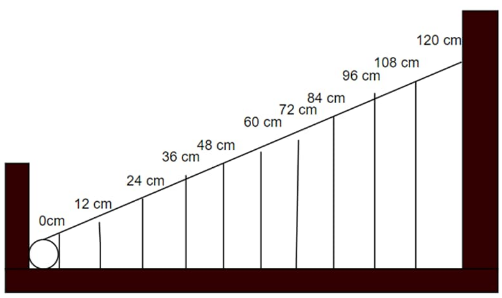


Figure 8. Vertical PIR Sensor Distance

b. Horizontal PIR Sensor Range

Testing with the PIR sensor is used using 2 inputs from the left and right sides of the filter cloth object. PIR sensors are placed on each side of the corner of the filter cloth object. Based on the range of the PIR sensor which is located with a sensor area width of 45° with a long side of 1.2 meters and a width of 2.5 meters. Figure 9 is the horizontal PIR sensor distance.

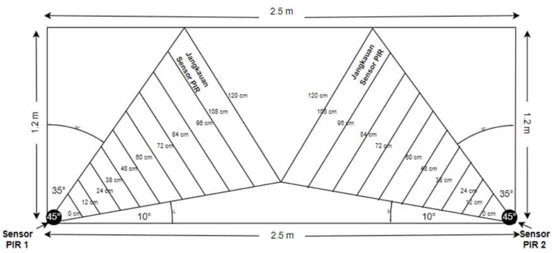


Figure 9. Horizontal PIR Sensor Distance

2. Camera Movement

   The next test is testing the movement of the Camera VC0706 and the MG 90 S Servo Motor. In this test the movement of the Servo Motor is only set for 3 movement conditions. The three movement conditions are 90°, 0° and 180°. When the PIR 1 sensor is active, the MG 90 S Servo Motor will move towards the PIR 1 sensor which is given a source code of 0°, then when the PIR 2 sensor is active, the MG 90 S Servo Motor will move towards the PIR 2 sensor which is given a source code of 180°. And when the two PIR sensors are in an inactive state, they are given a source code of 90°.

a. *Servo Motor At 90° Position*

Figure 15 shows when the PIR 1 sensor and PIR 2 sensor are in a non-active condition with the MG 90 S Servo Motor positioning at 90°. Testing the Servo Motor at a 90° position using the Telegram bot command "/snap" which can capture images to monitor the condition around objects remotely if no movement is received from the two installed PIR sensors.

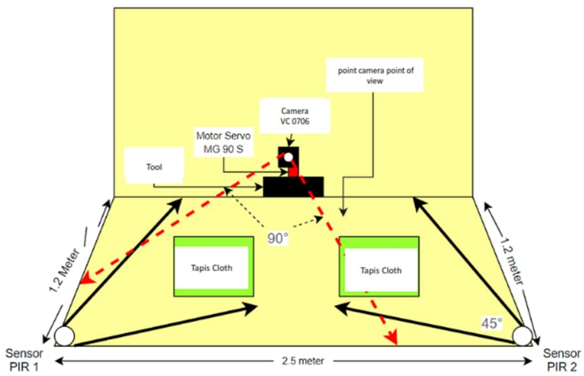


Figure 10. Servo Motor At 90° Position

a. *Servo Motor At 0° Position*

Figure 16 explains when the PIR 1 sensor is active with the condition of the MG 90 S Servo Motor in position 0°. Testing the Servo Motor at position 0° using the PIR 1 sensor as input. If any movement is captured by the PIR 1 sensor, the Servo Motor will move to position 0° to capture images.

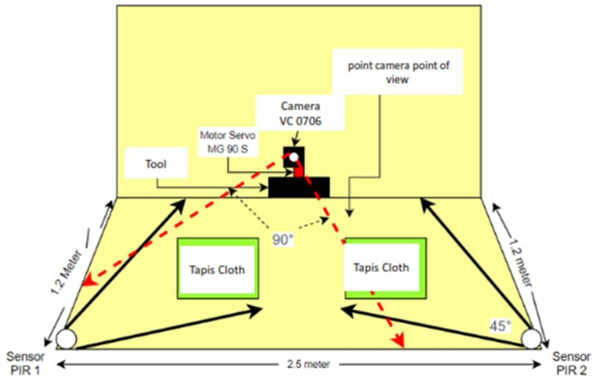
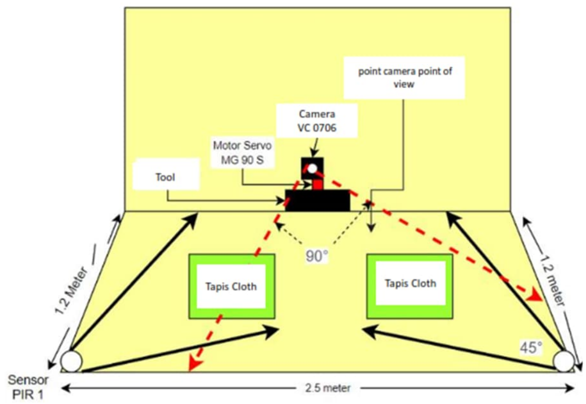


Figure 11. Servo Motor At 0° Position

b. *Servo Motor At 180° Position*

Figure 17 explains when the PIR 2 sensor is active with the condition of the MG 90 S Servo Motor in the 180° position. Servo Motor Testing at 180° using the PIR 2 sensor as input. If any movement is captured by the PIR 2 sensor, the Servo Motor will move to a 180° position to capture images.



Figures12. Servo Motor At 180° Position

3. Image Delivery Time Testing

   This research was tested 10 times using three providers, namely Telkomsel, Indosat and Tri. With 3 quality image sizes, namely 640 x 480 pixels, 320 x 240 pixels and 160 x 120 pixels. The test results of this security system tool are as follows: Based on 3 tests of the movement of the Servo Motor and VC0706 Camera with VC0706 160 x 120 Pixel image quality, it was found that the wifi used as an internet connection to NodeMCU ESP 8266 greatly affects the travel time to the Telegram bot through the Internet of Things (IoT). Based on these results, a trial was carried out using 3 providers with 3 image qualities used to get the best results.

Based on the trials of the three providers, namely Telkomsel, Indosat and Tri using 640 x 480 Pixel image quality, the difference in the quality of the speed of delivery time is shown graphically in Figure 13 as follows.

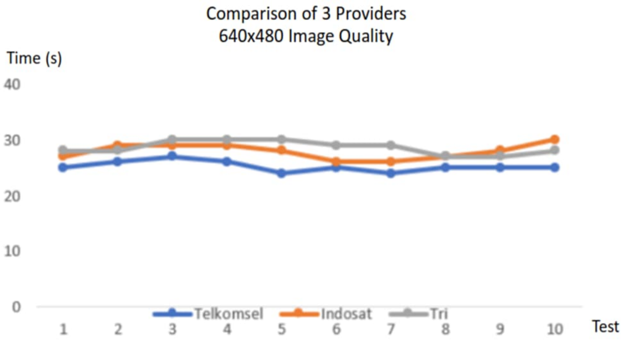


Figure 13. Comparison of 3 Providers

x= average value (*mean*)

Telkomsel (640 x 480 Pixels)

$$x = \frac{Number\ of\ Second}{Lots\ of\ Experiment}$$

$$x = \frac{252}{10} = 25.2\text{second}$$

Indosat (640 x 480 Pixels)

$$x = \frac{Number\ of\ second}{lost\ of\ Experiment}$$

$$x = \frac{274}{10} = 27.4\text{second}$$

Tri (640 x 480 Pixels)

$$x = \frac{Number\ of\ Second}{Lost\ of\ Experiment}$$

$$x = \frac{286}{10} = 28.6\text{second}$$

Based on calculations from a comparison of the image sending time testing from the three providers, namely Telkomsel, Indosat and Tri, it was found that the Telkomsel provider had the best delivery time speed, followed by Indosat and Tri. With an average value (mean) from Telkomsel providers for 25.2 seconds, Indosat providers for 27.4 seconds and Tri providers for 28.6 seconds.

4. Telegram Notification Distance Testing

a. Near Field Notification Testing

Testing the short distance of Telegram bot notifications is carried out to ensure the difference in delivery time of incoming message notifications to Telegram bots with different location points on smartphones which is carried out in stages within 5 meters with a total test distance of 50 meters. By testing the distance of the Telegram bot notification from the distance of the tool to the smartphone as a recipient of Telegram messages as far as 50 meters, the incoming data for Telegram bot notifications is obtained between the Arduino IDE serial monitor connected to the tool and the smartphone as the recipient of the Telegram bot notification using the Telkomsel provider shown in Table 10 as following.

Table 1. Short Range Telegram Bot Entrance Trial

Telegram bot incoming notification				
No.	Distance between the device and the	Smartphone internet speed (Telkomsel)	Time sent time series	Time Received Telegram
1	2 Meter	13.11 Mbps	09.37 WIB	09.37 WIB
2	10 Meter	11.31 Mbps	09.38 WIB	09.38 WIB
3	15 Meter	7.69 Mbps	09.39 WIB	09.39 WIB
4	20 Meter	8.06 Mbps	09.43 WIB	09.43 WIB
5	25 Meter	8.57 Mbps	09.45 WIB	09.45 WIB
6	30 Meter	9.00 Mbps	12.55.WIB	12.55 WIB
7	35 Meter	11.30 Mbps	12.56 WIB	15.56 WIB
8	40 Meter	11.88 Mbps	12.57 WIB	12.57 WIB
9	45 Meter	10.57 Mbps	12.59 WIB	12.59 WIB
10	50 Meter	7.12 Mbps	12.04 WIB	12.05 WIB

Based on Table 1, is the acceptance data from the results of 10 times testing the time of receiving Telegram bot notifications using the Telkomsel provider. From the data that has been obtained, it can be concluded that the time the Arduino IDE Serial Monitor is sent is the same as the time it is received by the Telegram bot. So that for sending Telegram bot notifications received by smartphones, it is confirmed that they are in accordance with the sending data on the device.

b. Remote Notification Testing

Remote Telegram bot notification distance testing was carried out to ensure the difference in delivery time of incoming message notifications to Telegram bots with 4 different location points on smartphones which was carried out in stages with testing tools placed at the UNILA Electronics Laboratory. The locations for receiving Telegram Notifications are Arum Lestari 3 Housing, the UNILA Library, Kos Tri Putra and the Lampung Museum. Figure 14 shows the location of receiving Telegram bot remote notifications.

Figure 14. Telegram Bot Notification Location

Based on Figure 14, the location for receiving Telegram bot notifications is shown in Table 2 as follows:

Table 2 Remote Locations of Telegram bot Notification Reception.

No.	LOCATION	Distance from Unila Electronics Lab
1	Housing Area Arum Lestari 3	2.516 Meter
2	House of Tri Putra	676 Meter
3	Lib Unila	277 Meter
4	Museum Lampung	1.252 Meter

Remote Telegram bot Notification testing was carried out 10 times at each predetermined location from the Lab. Electronics which is where the security system tools are tested are shown in the following experiments:

Perumahan Arum Lestari 3
Table 3 Testing Notifications at Location 1

Notification trial at the Arum Lestari housing location 3			
No.	Smartphone internet speed (Telkomsel)	Time sent time series	Time Received Telegram
1	35 Mbps	10.05	10.05
2	35 Mbps	10.05	10.05
3	35 Mbps	10.06	10.06
4	35 Mbps	10.06	10.06
5	35 Mbps	10.07	10.07
6	35 Mbps	10.07	10.07
7	36 Mbps	10.08	10.08
8	36 Mbps	10.08	10.08
9	36 Mbps	10.08	10.08
10	36 Mbps	10.09	10.09

Based on the remote notification sending trials conducted at different locations, it can be concluded that the time sent from the Arduino IDE serial monitor is the same as the time received by the Telegram platform, which means that Telegram notifications are sent in Real Time.

Figures 15 to 17 below are the results of the VC 0706 camera capture sent to the Telegram bot with an image quality of 320 x 240 pixels.

Figure 15. Telegram Bot Image Sending Results "/jepret".

Figure 16. Results Sending Images Bot Telegram Sensor PIR 1 Active.

Figure 17. Results Sending Images Bot Telegram Sensor PIR 2 Active.

IV. CONCLUSIONS

A security system has been realized for filter cloth objects at the Lampung Museum with Passive Infra Red (PIR) sensor input and output in the form of a Buzzer and image capture from Camera VC0706 using Internet of Things (IoT) technology. Based on the trial sending images from the security system tool to the Telegram bot, the image quality is 640 x 480 pixels with an average (mean) value from the Telkomsel provider for 25.2 seconds, the Indosat provider for 27.4 seconds and the Tri provider for 28.6 seconds. From this data, it is found that Telkomsel providers have better speeds than Indosat and Tri providers. Thus, it is obtained from testing using 3 different image qualities that will affect the length of time it takes to send image data to the Telegram bot.

V. ACKNOWLEDGMENT

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VI. REFERENCES

[1] T. A. Ahmad, "Strategi Pemanfaatan Museum Sebagai Media Pembelajaran Pada Materi

Zaman Prasejarah", *Jurnal Paramita*. Volume 20 No.1, 2010.

[2] A. Syarif, "Identifikasi Kain Tapis Lampung Menggunakan Ekstraksi Fitur Edge Detection (CANNY) dan Klasifikasi Probability Neural Network (PNN)", Bandar Lampung. Program Studi Ilmu Komputer Universitas Lampung, 2021.

[3] P. Wibowo, Perancangan Sistem Keamanan Rumah Menggunakan Sensor PIR Berbasis Mikrokontroler. Medan. Universitas Pembangunan Panca Budi, 2018.

[4] S. A. Umam, Sistem Keamanan Ruangan Berbasis WEB Menggunakan Webcam dan Sensor PIR. Jember. Universitas Jember, 2016.

[5] P. R. Ananda, Perancangan dan Pembuatan Sistem Keamanan Rumah Berbasis Smartphone. Padang. Universitas Negeri Padang, 2021.

[6] Ruuhwan, Pendeteksi Gerakan Menggunakan Sensor PIR untuk Sistem Keamanan di Ruang Kamar Berbasis SMS. Tasikmalaya. Teknik Informatika, Universitas Perjuangan Tasikmalaya, Indonesia, 2020.

[7] R. A. Gae, Rancang Bangun Sistem Pemantauan dan Notifikasi Otomatis Pada Keamanan Rumah Menggunakan Teknologi Wireless Sensor Network Berbasis Website. Pontianak. Jurusan Sistem Komputer; Fakultas MIPA Universitas Tanjungpura. 2019.