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Development of Home Security System Using Motion Sensor and Magnetic Sensor with ESP-32 Cam Based on Telegram

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ABSTRACT

A home security system is very important for the comfort of home residents in terms of securing valuables. Security using conventional locks alone is not enough. This tool uses a motion sensor and magnetic sensor and ESP32-Cam. The research design uses the ADDIE development model and uses experimental methods. From the results of the motion sensor measurements, the motion sensor works at a distance of 1-7 meters, but at a distance of 6-7 meters the response speed of the motion sensor slows down and it can take pictures if the motion sensor detects movement while the magnetic sensor The new 2.3 cm can detect open doors and can send notification messages to Telegram, but access to streaming can be accessed at any time.
Keywords : ESP32-Cam, Security System, Motion Sensor, Sensor Magnet, Telegram

ABSTRAK

Sistem keamanan rumah merupakan hal yang sangat penting bagi kenyamanan penghuni rumah dalam hal mengamankan barang berharga.keamanan menggunakan kunci konvensional saja tidak cukup. Alat ini menggunakan sensor gerak dan sensor magnet dan ESP32-Cam. Perancangan penelitian menggunakan model pengembangan ADDIE dan menggunakan metode eksperimen, Dari hasil pengukuran sensor gerak bahwa sensor gerak bekerja pada jarak 1-7 meter namun pada jarak 6-7 meter kecepatan respon sensor gerak melambat dan dapat mengambil gambar jika sensor gerak terdeteksi gerakan sementara sensor magnet bekerja 2.3 cm baru dapat mendeteksi pintu terbuka dan dapat mengirim pesan pemberitahuan ke telegram, namun untuk mengakses streaming bisa diakses kapan pun.

Kata kunci : ESP32-Cam, Sistem Keamanan, Sensor Gerak,Sensor Magnet,Telegram

I. INTRODUCTION

security systems are essential for protecting important or valuable items such as houses, buildings, offices, and more, especially in areas prone to theft or criminal activity. Everyone desires a comfortable and safe home, and homeowners pay great attention to their home security. The rising incidence of burglary makes many homeowners anxious, especially when they are away for an extended period. Often, home security systems rely solely on locks used to secure doors. Conventional home security features like padlocks and bars are merely additions to standard locks. Since thieves are professionals who can operate quietly in vacant homes without raising suspicion from neighbors, traditional home security measures are often insufficient to make homeowners feel safe. The typical design of house keys is also easily replicated, allowing criminals to unlock doors, especially when homes are unoccupied.

Current innovations are closely linked to the advancements in smartphone communication technology, also known as mobile technology. The Internet of Things (IoT) is a developing field where we can connect smartphones, lights, sensors, and actuators to the internet for control and communication with humans and other objects. By utilizing IoT technology such as the ESP32-CAM, IoT can be applied to devices for smart homes. The Internet of Things can connect objects via the internet, allowing for remote monitoring and control through online networks.

According to research conducted by Rio Wahyudi and Edidas in 2022, titled "Design and Implementation of a Home Security System Based on the Internet of Things Using ESP32-CAM," the study found that the ESP32-CAM can capture images when PIR sensors detect motion. If the flame sensor is activated, the relay and buzzer will activate to send notifications; the MQ6 sensor only sends notifications, while the magnetic sensor triggers the buzzer and sends notifications. Additionally, research by Ardiansyah M., Aldi Febryan, Adriani, and Rahmania in 2023, titled "Design and Development of a Home Security System Based on Telegram Using ESP32-CAM," showed that the home security device can directly connect to Telegram by linking the ESP32-CAM to a programmed Wi-Fi network and can send images when motion is detected within a maximum distance of 6 meters by activating the ESP32-CAM and PIR sensor through the Telegram app. Research by Riklan Kango, Mohamad Ilyas Abas, and Hasto Finanto in 2022 concluded that the device can be powered on according to a predetermined schedule and can operate manually as instructed.

II. RESEARCH METHODE

This research utilizes an experimental research method. Experimental research can be defined as a systematic method aimed at establishing relationships that involve causal effects (Sukardi, 2011:179). The study develops a home security device using motion sensors and magnetic sensors with the ESP32-CAM based on Telegram. This device is designed for home security so that users can monitor the condition of their home when it is left unattended by the owner.

A. Desain Model

The design model used in this research follows the ADDIE model, which consists of five stages: analysis, design, development, implementation, and evaluation.

a. Analysis

In this stage, the primary focus is analyzing the required materials and equipment, identifying problems, and conducting task analysis

b. Design:

During the design phase, the task is to create a prototype for a home security device using motion sensors and magnetic sensors integrated with the **ESP32-Cam**, according to the planned specifications.

c. Development:

In this stage, the focus is on enhancing the device. Initially, the device was unable to stream when motion was detected. The researchers developed a prototype with **IP camera access** so users can stream video and monitor the house remotely whenever needed.

d. Implementation:

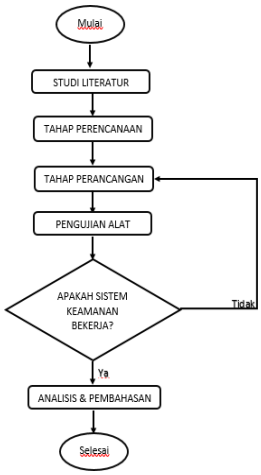
At the implementation stage, the prototype is tested to ensure that it functions properly and fulfills its intended role and purpose.

e. Evaluation:

The final stage evaluates whether the home security system meets the expected outcomes and functions as intended.

B. Research Procedur

This diagram is created to help researchers easily follow the research steps according to the defined structure. The flowchart of the research process can be seen in Figure 1.



Gambar 1 Flowchart alur Penelitian

In Figure 1, the research flow carried out by the researcher from start to finish is explained. The explanation of the Research Flowchart is as follows:

1. Literature Study

The first step involves gathering information needed to develop a home security system. Information is collected from journals, articles, books, and other sources.

2.Planning Stag

In this stage, the researcher plans the research by identifying the problem and determining the desired outcomes of the study.

3. Design Stage

After planning, the next step is the design stage, which involves creating both the software and hardware designs for the system.

4. Device Testing

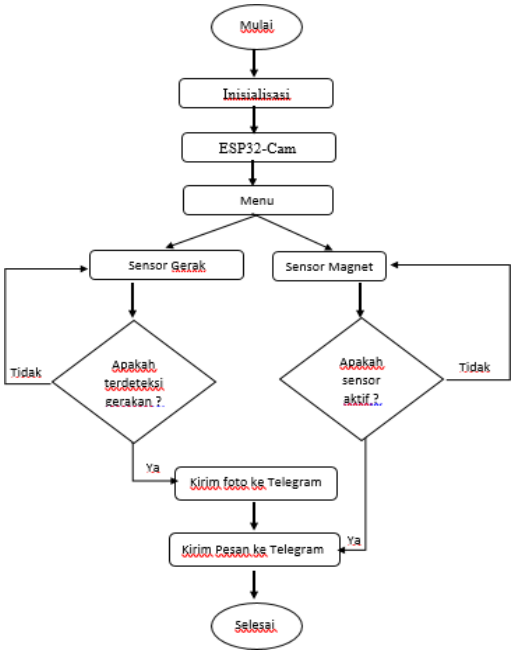
Once the design is complete, the device is tested in the form of a prototype.

5. Analysis & Discussion

After testing, the system is analyzed to assess its feasibility. This includes testing the motion sensor's detection range, the magnetic sensor's ability to notify when a door opens, access to video streaming, the flashlight's ability to capture images triggered by motion sensors or commands, and the overall performance of the system.

C. Overview of the Working

Home security can be seen in Figure 2 below:



Gambar 2 Sistem kerja alat

In the working system of the home security device, the ESP32-Cam connected to the internet will operate automatically. When the motion sensor detects movement, the sensor activates, and the captured image will be sent to a Telegram bot. A notification message will also be sent to Telegram, indicating that motion has been detected. The magnetic sensor will function when the door is opened. However, the magnetic sensor cannot send images; it will only send a message to Telegram notifying that the door is open. If the user is concerned about the condition of their home, they can monitor it through the IP address of the server displayed during programming. This IP can be accessed via a smartphone, allowing the user to log into the web server and check the home status remotely.

III. RESULTS AND DISCUSSION

The results of the design of the miniature home security system using a motion sensor, magnetic sensor, and ESP32-Cam can be seen in Figure 3.

Gambar 3 Hasil Perancangan keseluruhan

a. Design Results of the Telegram Bot Application Page

On the Telegram bot page, several menus are available, one of which allows users to activate and deactivate the sensors. Additionally, the menu provides access to the streaming page for monitoring home security in real-time. he layout of these menus ensures ease of use, enabling quick interaction with the security system via Telegram. The menu interface is shown in Figure 4.

Gambar 4 Halaman bot telegram

b. Measurement and Testing Results of Motion Sensor, Magnetic Sensor, and ESP32-Cam

1. Results of Motion Sensor Measurements The measurements of the motion sensor (PIR sensor) involved evaluating the voltage supply, input voltage, and the detection range for objects, specifically human beings

Nama	Sumber Tegangan (Volt)	Tegangan Input (Volt)	Keterangan
Sensor Gerak	0	0	OFF
	3.3	2.0	ON

"The measurement results in Table 1 can be explained that when the motion sensor is supplied with a voltage of 3.3 Volts, the input pin of the sensor has a voltage of 2.0 Volts. If the sensor detects motion, the input voltage of the sensor is 0 Volts. Conversely, if the sensor does not detect motion, the input

voltage of the sensor is 2.0 Volts."

Tabel 2 Hasil pengukuran jarak sensor gerak

Nama	**Jarak (Meter)**	**Logika**	**Keterangan**
Sensor Gerak	0.5	1	Terdeteksi gerakan
	1	1	Terdeteksi gerakan
	2	1	Terdeteksi gerakan
	3	1	Terdeteksi gerakan
	4	1	Terdeteksi gerakan
	5	1	Terdeteksi gerakan
	6	1	Terdeteksi gerakan namun respon sensor gerak melambat
	7	1	Terdeteksi gerakan namun respon sensor gerak melambat
	8	0	Tidak terdeteksi gerakan

The measurement results of the motion sensor distance can be seen in Table 4.2. It can be explained that when the distance of the detected object is up to 7 meters, the response of the motion sensor slows down at a distance of 6-7 meters. If the distance of the object exceeds 7 meters, the sensor is unable to detect any motion.

2. Measurement results of the magnetic sensor

Tabel 3 Hasil pengukuran tegangan sensor magnet

Nama	**Tegangan (Volt)**	**Keterangan**
Sensor magnet	0	OFF
	3.2	ON

The measurement results of the magnetic sensor can be seen in Table 3. The measured voltage is the input voltage of the sensor, with a measurement result of 3.2 volts.

Tabel 4 Hasil pengukuran sensor magnet

Nama	**Jarak (*Centimeter*)**	**Logika**	**Keterangan**
	1	0	Tidak Terdeteksi
	1,5	0	Tidak Terdeteksi
	2	0	Tidak

			Terdeteksi
Sensor Magnet	2,3	1	Terdeteksi
	3	1	Terdeteksi
	3,5	1	Terdeteksi
	4	1	Terdeteksi

The measurement results of the magnetic sensor can be seen in Table 4. At a distance of 1-2.2 cm, the sensor detects that the door is closed, which means the door is in a secure state. If the distance of the magnetic sensor exceeds 2.2 or 2.3 cm, the sensor detects that the door is in an insecure state or open. Notifications about the door being open or insecure will be automatically sent to the Telegram bot in the form of a message alert.

3. Pengujian sensor gerak,sensor magnet dan ESP32-Cam

Tabel 5 Pengujian sensor gerak,sensor magnet dan ESP32-Cam

Nama	**Waktu**	**Jarak**	**Logika**	**Hasil ESP32-Cam**	**Ketera ngan**
	07.25 Detik	0.5 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi Gerakan
	05.59 Detik	1 Meter	1	ESP32-Cam Berhasil mengirim	Terdeteksi Gerakan

				gambar dan pesan ke telegram.	
	05.77 Detik	2 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi Gerakan
	04.65 Detik	3 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi Gerakan
	03.79 Detik	4 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi Gerakan
Sensor Gerak	04.46 Detik	5 Meter	1	ESP32-Cam Berhasil mengirim gambar dan	Terdeteksi Gerakan

				pesan ke telegram.	
	04.88 Detik	6 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi gerakan namun respon sensor gerak melambat
	05.19 Detik	7 Meter	1	ESP32-Cam Berhasil mengirim gambar dan pesan ke telegram.	Terdeteksi gerakan namun respon sensor gerak melambat
	0 Detik	8 Meter	0	ESP32-Cam tidak mengirim gambar dan pesan ke telegram.	Tidak terdeteksi gerakan

	0 Detik	1 cm	0	Tidak mengirim pemberitahuan ke telegram	Pintu Tertutup
	0	1,5	0	Tidak	Pintu

	Detik	cm		mengirim pemberitahuan ke telegram	Tertutup
	0 Detik	2 cm	0	Tidak mengirim pemberitahuan ke telegram	Pintu Tertutup
Sensor Magnet	1 Detik	2,3 cm	1	Mengirim pemberitahuan ke telegram	Pintu Terbuka
	1 Detik	3 cm	1	Mengirim pemberitahuan ke telegram	Pintu Terbu ka
	1 Detik	3,5 cm	1	Mengirim pemberitahuan ke telegram	Pintu Terbu ka
	1 Detik	4 cm	1	Mengirim pemberitahuan ke telegram	Pintu Terbu ka

The testing results of the motion sensor, magnetic sensor, and ESP32-Cam in Table 5 can be explained as follows: the motion sensor can detect movement or objects up to 7 meters. When the motion sensor is active or in a logic state of 1, it can take pictures and send notification messages to Telegram. Meanwhile, the magnetic sensor can only detect if the door is open when the distance between the sensor and the magnet is 2.3 cm. If the magnetic sensor detects that the door is open or in a logic state of 1, a notification message about the open door is sent to Telegram.

4. Testing the Number of Responses of ESP32-Cam When the Motion Sensor Detects

   In this test, the number of images successfully taken by the ESP32-Cam and sent to Telegram when the motion sensor detects movement will be counted. A delay will be applied to the motion sensor to prevent too many images or notification messages from being sent when the motion sensor detects movement. The results of the test can be seen in Table 6.

Pengujian ke-	**Waktu (Menit)**	**Jumlah gambar yang berhasil diambil ESP32-Cam**	**Delay (Detik)**	**Sensor Gerak**
1	1	2	30	Aktif
2	2	4	30	Aktif
3	3	5	30	Aktif
4	4	6	30	Aktif
5	5	8	30	Aktif

Tabel 6 Hasil pengujian jumlah respon ESP32-Cam ketika sensor gerak mendeteks

The results of the test in Table 6 can be explained as follows: the motion sensor was given a delay of 30 seconds. In the first test, within 1 minute, 2 images and notifications were sent to Telegram. In the second test, within 2 minutes, 4 images and notifications were successfully sent to Telegram. In the third test, within 3 minutes, the ESP32-Cam successfully captured 5 images and notifications. In the fourth test, within 4 minutes, the ESP32-Cam successfully captured 6 images and notifications. In the fifth test, within 5 minutes, the ESP32-Cam successfully captured images 8 times.

5. Functional Testing of the Telegram Bot Menu

Gambar 5 Hasil respon mengambil gambar di bot telegram

If taking a picture using the bot is successful, the response can be seen in Image 5. However, if taking a picture is unsuccessful or fails, the response will be as shown in Image 6

Gambar 6 Pengujian respon mengambil gambar jika gagal

Gambar 7 Pengujian perintah mengambil gambar dengan lampu flash

Image 7 shows the response when attempting to take a picture using the flash. The resulting reply or response is as shown in Image 7.

Gambar 8 Pengujian perintah mengambil gambar tanpa lampu flash

Image 8 shows the response when attempting to take a picture without the flash. The resulting reply or response is as shown in Image 8.

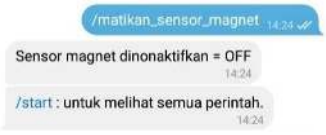
Gambar 9 Pengujian perintah mengambil gambar menggunakan sensor gerak

Gambar 10 Pengujian perintah mengambil gambar tanpa sensor gerak

Image 9 and 10 show the test results of the response when turning the motion sensor on/off,

along with the replies when the sensor is successfully turned on or off.

Gambar 11 Pengujian perintah aktifkan sensor magnet



Gambar 12 Pengujian perintah matikan sensor magnet

Images 11 and 12 show the test results of the response when turning the magnetic sensor

on/off, along with the replies when the sensor is successfully turned on or off.

Gambar 13 Pengujian perintah reset

Image 13 explains that the reset command is used when the commands do not respond properly. The reset button is used to restart the ESP32-Cam, allowing commands that are unresponsive to function again. After going through the reset process, all commands will respond once more.

D. Analysis of Test Results

The analysis of the tests conducted is to determine the feasibility of the developed device to function effectively when used.

Tabel 7 Analisis hasil pengujian sistem keamanan

No	Pengujian	Proses	Hasil yang diharapkan	Hasil pengujian
1	Pengujian jarak sensor gerak dapat mendeteksi gerakan	Pengukuran dilakukan dengan jarak 0.5-7 meter	Saat terdeteksi gerakan ESP32-Cam mengirim	Berhasil

	n	dari objek	pesan dan gambar ke bot telegram	
2	Pengujian jarak sensor magnet agar dapat pemberit ahuan pintu terbuka	Pengukuran dilakukan dengan jarak 1-4 cm dari medan magnet	Saat terdeteksi pintu terbuka ESP32-Cam mengirim pemberit ahuan ke bot telegram	Berhasil
3	Akses Streaming	Dilakukan pengujian akses streaming melalui	Akses Streaming menampilkan gambar dan led Flash	Berhasil

		alamat IP	dapat diatur	

4	Lampu Flash untuk mengam bil mengam bar dengan sensor gerak atau menggun akan perintah	Dilakuka n pengujia n fungsi perintah menghid upkan lampu flash	Pada saat terdeteksi gerakan dan mengam bil gambar lampu flash hidup	Berhasil
5	Pengujia n jumlah respon ESP32-Cam ketika sensor gerak mendete ksi geraka	Pengujia n dilakuka n dengan waktu 1-5 menit	Saat terdeteksi gerakan ESP32-Cam mengam bil gambar 2 kali setiap 1 menit	Pada pengujian 1 dan 2 sesuai yang diharapkan, namun pada pengujian 3,4 dan 5 terjadi keterlambatan respon sebanyak 1-2 kali pengambila n

	n			gambar
6	Pengujian keseluruhan sistem	Melakukan pengujian keseluruhan sistem	Sistem berjalan dengan baik	Sedikit mengalami gangguan respon tapi tetap berkerja dengan baik

E. DISCUSSION

The device was built using a DC voltage source of 5 Volts, which operates the ESP32-Cam effectively. However, when measuring the voltage of the ESP32-Cam using a multimeter, a voltage of 4.9 Volts was recorded. After measuring the ESP32-Cam, the next step was to measure the voltage source of the motion sensor, which was measured at 3.3 Volts with an input voltage of 2.0 Volts. The measurement of the magnetic sensor's voltage with a multimeter showed 3.2 Volts.The discussion based on the results tested in Table 4.6 can be explained as follows: when an object passes in front of the motion sensor at a distance of 1-7 meters, the sensor sends notifications and captures images using the ESP32-Cam to alert the user to be more vigilant against potential threats. When the object exceeds a distance of 7 meters, the sensor fails to operate or detect the object.

Furthermore, after testing the magnetic sensor to understand its operational system, it can be explained that the sensor works when it passes through a magnetic field at a distance of 2.4 cm, at which point it will send a notification via the ESP32-Cam to the Telegram bot that the door is open. However, when the magnetic sensor has not passed through the magnetic field at a distance of 2.3 cm, there is no notification in the Telegram bot, and the sensor remains inactive.

The motion sensor will limit the number of images taken by the ESP32-Cam, which has a delay of 30 seconds to prevent excessive image capture when the motion sensor detects movement and to save the memory of the mobile phone. The test results showed that with a time of 5 minutes, there were 8 image captures. To access streaming via the ESP32-Cam, users can enter the available IP address on the Telegram bot. The streaming page includes a LED flash menu, allowing users to adjust the lighting for streaming as needed. This research is a development of previous studies, and it has the advantage of being able to access streaming or check the status of the home when the sensor is active, allowing users to monitor their home conditions

VI. CONCLUSION

Based on the results of the design and testing of the prototype that has been conducted, the following conclusions can be drawn:

1. The results of the design for the development of a home security system using a motion sensor and magnetic sensor with ESP32-Cam based on Telegram have been proven to allow real-time monitoring of the home via an IP address. Users can capture images if they observe anything suspicious, which greatly assists them in being aware of potential crimes or theft.

2. The testing results of the prototype for the development of the home security system using a motion sensor and magnetic sensor with ESP32-Cam based on Telegram have shown that the motion sensor has a detection range of up to 7 meters. When the motion sensor detects movement, the ESP32-Cam will automatically send an image and notification message with a delay of 30 seconds to prevent an excessive number of incoming messages and to save memory. Meanwhile, the magnetic sensor has a detection range of 2.3 cm and can also send notification messages.

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