COMPARISON OF VARIOUS TYPES OF PIR MOTION SENSORS FOR NODEMCU ESP32 CAM IMAGE CAPTURING DEVICES

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Abstract

Abstract:Videos and images can be used as observations or evidence of a crime. The most widely used device for recording video in an office or home is CCTV (Closed Circuit Television). The cost of installing the cheapest CCTV in Indonesia is 1,300,000 thousand Rupiah.The development of the microcontroller has been equipped with a camera module. Lilygo TTGO, NodeMCU ESP 32 CAM, Raspberry Pi, are the choices of microcontrollers with camera extensions. Using the ESP32 CAM Node MCU to record images is a cheaper option compared to using CCTV (Closed Circuit Television). The input data for the ESP32 CAM NodeMCU to detect human movement is the PIR Motion sensor module.In searches on various marketplaces, there are around 20 types of PIR Motion. Each type has a different range and delay time specifications. In this study, 6 PIR Motion sensors available on the Indonesian marketplace were tested with the types HC-SR505, HC-SR501, SR602, AM312, D203s, PIR 507. The test was carried out by assembling six PIR Motions on one PCB (Printed Circuit Board) to get data at the same time. The testing tool uses Arduino Uno by utilizing the Serial Monitor service on the Arduino IDE application. The results of the PIR sensor range test show that the HC-SR501 type has the farthest range while the HC-SR505 successfully captures images.

Keywords: ESP32 CAM, PIR Motion, Image Capture

Abstrak

Video dan gambar dapat digunakan sebagai bukti atau pengamatan dalam kasus kriminal. Perangkat yang paling umum digunakan untuk merekam video di kantor atau rumah adalah CCTV (Closed Circuit Television). Biaya pemasangan CCTV termurah di Indonesia sekitar 1.300.000 Rupiah. Perkembangan mikrocontroller kini telah dilengkapi dengan modul kamera. Lilygo TTGO, NodeMCU ESP32 CAM, dan Raspberry Pi adalah beberapa pilihan mikrocontroller dengan ekstensi kamera. Penggunaan ESP32 CAM NodeMCU untuk merekam gambar menjadi pilihan yang lebih murah dibandingkan dengan menggunakan CCTV. Data input untuk ESP32 CAM NodeMCU dalam mendeteksi gerakan manusia berasal dari modul sensor gerak PIR. Berdasarkan pencarian di berbagai marketplace, terdapat sekitar 20 jenis sensor PIR Motion. Setiap jenis memiliki spesifikasi jangkauan dan waktu tunda yang berbeda. Dalam penelitian ini, enam sensor PIR Motion yang tersedia di marketplace Indonesia diuji, yaitu jenis HC-SR505, HC-SR501, SR602, AM312, D203s, dan PIR 507. Pengujian dilakukan dengan merangkai enam sensor PIR pada satu PCB (Printed Circuit Board) untuk memperoleh data secara bersamaan. Alat pengujian menggunakan Arduino Uno dengan memanfaatkan layanan Serial Monitor pada aplikasi Arduino IDE. Hasil uji jangkauan sensor PIR menunjukkan bahwa tipe HC-SR501 memiliki jangkauan terjauh, sedangkan tipe HC-SR505 berhasil menangkap gambar.

Kata Kunci : CAM ESP32, Gerak PIR, Pengambilan Gambar

1. INTRODUCTION

Evidence of the thievery is difficult to obtain if it occurs in areas where CCTV is not installed, such as livestock pens and village housing. By using a tool to capture images of acts of theft, identification of the perpetrators of crime can be carried out when the action occurs. Images of perpetrators can be used as evidence for reports to the police and the time of the incident can be used as a reference for the community in protecting the environment.

There have been many monitoring devices using the ESP32 CAM which can display still images and videos. The operational method of the tool can run locally or inter-locally by implementing the Internet of Things (IoT). ESP32 CAM is equipped with OV2640 and OV7670 camera modules along with LED flash. The resulting image quality is 2 Megapixel. The ESP32 CAM module is not equipped with an Infrared LED so that taking pictures in a dark room with a distance of more than 3 meters has deficient quality and cannot even be recognized[1].

The increasing incidence of thievery has driven the need for remote monitoring and control of household appliances[2]. Remote monitoring and control systems, implementation of controlled electronic or mechatronic systems to control household devices, hereinafter referred to as Smart Homes [4]. Smart home technology has evolved from the performance the function of turning on and off remote control equipment based on Bluetooth and wireless to remote monitoring and even being able to send images over the Internet network, better known as the Internet of Things (IoT)[3].Internet of Things implementation can be used in various fields[4][5].The ESP32 CAM Node MCU module is one that supports the Smart Home System and has proven its reliability in implementing camera module operations. Implementation of NodeMCU ESP32 CAM on Internet of Things-based Smart Home shows overall test taking and sending images successfully [8]. ESP32 CAM has been used to capture images on embedded systems implemented in Face Recognition-based presence systems[6]. The use of the camera module has been used to scan a QR code in the development of a QR Code-based Smart Home tool [7]. Higher technology has been used in blood group detection systems with a scan distance of 20 centimeters[8]. Image scan results are displayed via the Telegram, WEB and TFT SPI applications[9][10][11].

Internet of things-based ESP32 CAM implementation uses several data and information delivery services. The service functions as a broker or connector so that data can be sent from the ESP32 CAM to the destination device. Blink is an application for the purposes of running an IoT-based system[12]. Telegram provides an Application Program Interface for communication purposes with IoT devices[13].*Message Queuing Telemetry Transport (MQTT) is a messaging standard for IoT that works using the subscribe method with minimal programming*[14][15][16]. The transfer delay on MQTT is 0.008634 seconds and the throughput value is 9.2 MBit/sec. So that sending images from the ESP32 CAM can run at low bandwidth and high latency [17].

Passive infrared sensors (PIR) are widely applied to microcontroller-based systems and the Internet of Things, especially in home security[18].Several PIR motion sensors can be applied to a system to carry out the function of tracking human presence within the range of the PIR sensor[19].

ESP32 CAM implementation is integrated with other modules or components to carry out certain functions and performance measurements have been carried out on these modules. In detecting humans, a passive infrared sensor (PIR) Motion body temperature sensor is used as input[20]. If a human or living creature crosses the area that the PIR Motion sensor can reach, then it can be input for the ESP32 CAM to run a program to capture and send images over the Internet network. Test results carried out at the effective range of PIR Motion show an effective distance of 0 to 5 meters and the response time test shows an average delay time of 2.7 seconds[21][22].

Testing the use of the ESP32 CAM NodeMCU has been carried out in several implementations. Implementations on Machine Learning are used for small-scale machine learning (tinyML) tasks with Ease of use platforms such as Arduino IDE, MicroPython and Tensor Flow Lite (TF) concluding that the ESP32 CAM can be used for some simple machine learning tasks and camera image capture and prepare another more powerful processor [23][24]. In image processing the pixel changes from the ESP32 CAM are used as the basis for calculations using the polynomial regression formula. Measurement accuracy at a height of 1 cm to 7 cm with a relative error value of 1.26%. For a height of 8 cm the measurement is inaccurate with a relative error value of 250.31%[10]. The use of the rainfall detection system shows that the test results run well through image processing produced by the ESP32 CAM using python software in the form of

a histogram (gray scale) which will be analyzed using the Fourier Transform.[25]. The facial recognition system found that the ESP32 CAM could not distinguish between real faces and photo faces [26][27]. The implementation of the vehicle speed measurement system produces low quality, so it is necessary to increase the quality of the camera to improve the resulting image[28].

In this research, various types of PIR Motion sensors were tested and the addition of Infrared LEDs was carried out. Testing of various types of PIR sensors was carried out to obtain range specification data from various types of PIR Motion sensors. This data can be used as a reference for the use of sensors in accordance with the conditions at which the device is used.

2. RESEARCH METHOD

To obtain data on the maximum range of various PIR Motion sensors, a research phase was carried out as contained in the figure 1.

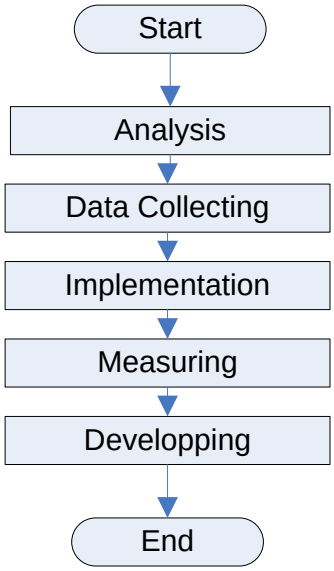

Fig 1. Research Flow

Analysis

At this stage, a needs analysis was carried out in this study. The need for consumables to support sensor testing, work tools and previous research related to the use and or measurement of PIR Motion Sensors.

Data Collection

Data collection was carried out by tracing back through a web indexing reputable international and national research articles related to PIR Motion. In collecting this data, a datasheet search of six types of PIR Motion was also carried out which would be compared. This PIR Motion data is very important for reference the wiring and operation of the PIR sensor.

Implementation

At this stage, tests were carried out on various PIR Motion sensors as well as the schematic design of the ESP32 CAM NodeMCU NodeMCU-based Crime Capture Tool. Implementation is carried out by assembling various PIR Motions on one printed board (PCB) so that tests can be run at the same time and at the same distance from the sensor and object.

Measurement

Tests and measurements were carried out to obtain research results as a reference for developing tools based on ESP 32 CAM and PIR Mition Sensors. Measurement of the maximum range distance from several PIR Motion Sensors mounted on one PCB board so that tests can be carried out at the same time and at the same sensor distance position.

Development

The design of the NodeMCU ESP32 CAM Image Capturing tool was developed. This design is a development of the results of research that has been done. The development is done to increase the ability or quality of the performance of the ESP 32 CAM in capturing images.

Assembling various PIR sensors on a PCB board. The purpose of this assembly is to carry out testing of various PIR sensors at the same time. Supporting devices in this test are an Arduino Nano as the main processor, a Ping sensor to get the distance of human objects and the addition of two lasers to ensure that the PIR sensor reading angle is directed at the human object during testing.

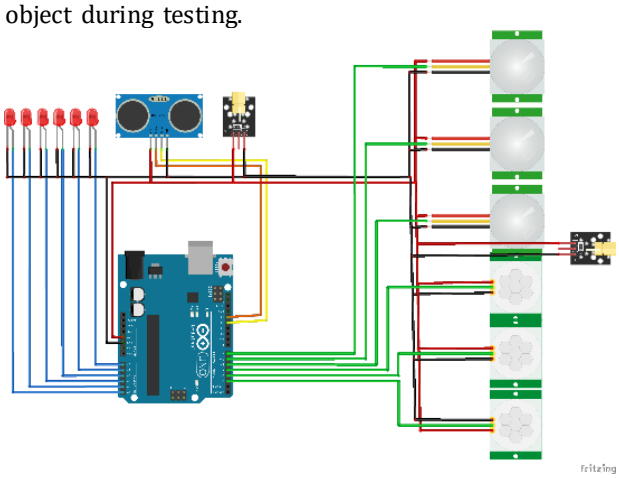

Figure 2. Circuit scheme testing various PIR sensors

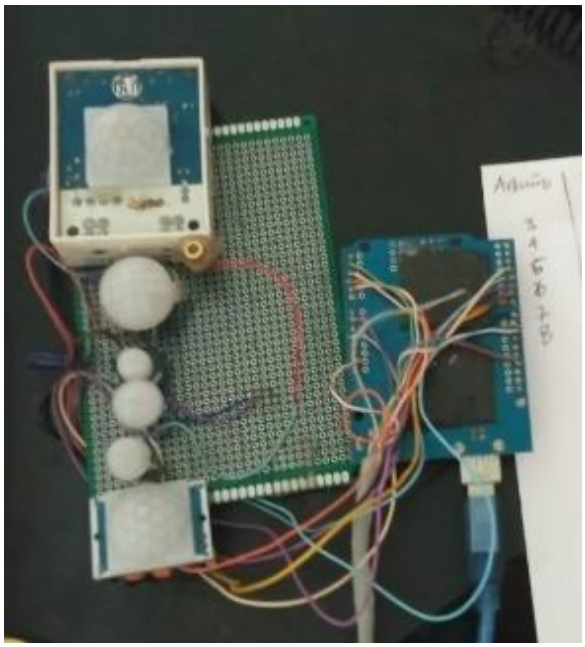

Figure 3. Various PIR Motion Sensors on a PCB

3. RESULTS AND ANALYSIS

Furthermore, testing is carried out on human objects. The test is carried out in a closed room to avoid noise from animals or other people passing by. Tests were carried out during the day using a tripod for PCB placement while human objects moved closer to the sensor. The initial distance used is 12 meters taking into account the farthest distance of the object in the implementation is 12 meters.

Figure 4. Testing various PIR Motion sensors

To get data from the readings of several PIR Motion sensors in the text, it is used with the Arduino IDE application. This test is carried out by utilizing data from the Arduino IDE serial monitor. This serial monitor can display the current time. In addition to the current time, the distance of the human object from the position of the PIR Motion sensor is also displayed. This distance data is obtained from an ultrasonic distance sensor.

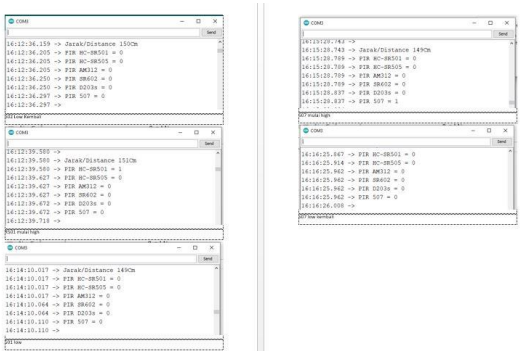

Figure 5. Test results of various PIR Motion sensors.

The test results for various sensors are stated in table 1. Table 1 is the average value of the PIR Motion Sensor test results for 100 times.

TABLE I. THE RANGE OF THE PIR MOTION SENSOR

No	PIR *Motion*	Average Distance (Meters)
1	HC-SR505	3,5
2	HC-SR501	4,2
3	SR602	3,7
4	AM312	3,2
5	D203s	2,4
6	PIR 507	2,9

The design of a series of crime image capture tools based on the NodeMCU ESP32 CAM was carried out with reference to the results of testing various PIR Motion sensors. Table 1 shows that the PIR Motion type HC-SR501 has the ability to read human objects at the furthest distance, namely 4.2 meters. Based on these data, the circuit schematic design uses the PIR Motion HC SR501. The circuit design is equipped with a 18650 lithium battery as a voltage source. Added a charger module to charge the battery and at the same time a converter from 3.7 Volt DC to 5 Volt DC. 5 Volt DC voltage is required to run NodeMCU ESP 32 Cam, Relay Module, PIR Motion Module.

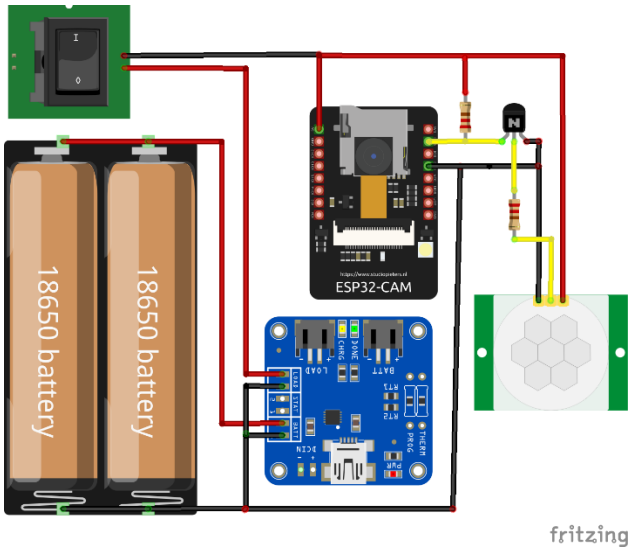

Figure 6. Network Schematic

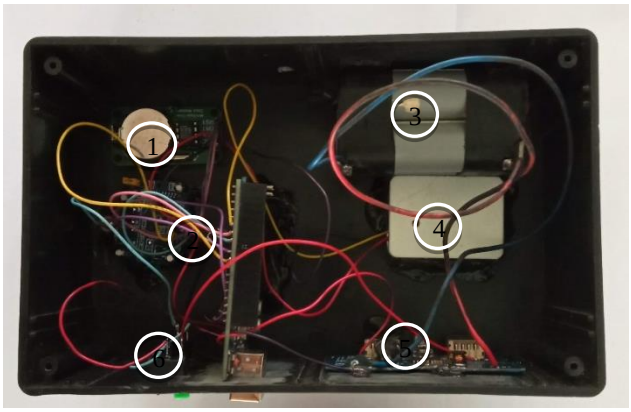

Figure7. Module placement in the box

Figure 7 shows the placement of the modules (1) Laser Module, (2) PIR Motion Sensor, (3) Battery, (4) ESP32 CAM, (5) Battery Charger, (6) Power Switch.

Figure 8. (a) Device Display, (b) Device installation

Figure 8 (a) is a view of a toolbox with a rotatable stand 180^0horizontal direction and 60^0vertical direction.

4. CONCLUSION

The results of the PIR Motion sensor test show that the best series in the reading distance category is the HC-SR01 series. A circuit scheme and design of an image capture tool box based on the NodeMCU ESP32-CAM which is capable of working in a dark room with a rechargeable battery voltage source has been designed.

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