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HOME SECURITY SYSTEM DEVELOPMENT USING MOTION SENSOR WITH ALARM OUTPUT BASED ON ARDUINO UNO

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Abstract: The increasing number of home burglaries highlights the need for an effective and affordable residential security system. Conventional door locks are often inadequate to prevent unauthorized access, especially when the home is left unattended. This study aims to develop a motion-based indoor security system that enhances security through real-time alerts. The system was designed using a prototype method, combining an Arduino Uno microcontroller, a Passive Infrared (PIR) motion sensor, a buzzer, and a GSM module. When motion is detected within a 5-meter range, the PIR sensor activates the buzzer and simultaneously sends an alert message to the homeowner's mobile phone via the GSM module. The circuit was tested in stages, including validation of the power supply, sensor responsiveness, and overall system integration. The results showed that the system operated reliably, with accurate motion detection and timely alert responses. The study concluded that the proposed solution is effective, low-cost, and applicable to enhance indoor or home security in everyday life.

Keywords: arduino; home security; prototype; PIR sensor.

Abstract : Meningkatnya jumlah kasus pencurian rumah menyoroti perlunya sistem keamanan hunian yang efektif dan terjangkau. Kunci pintu konvensional seringkali tidak memadai untuk mencegah akses tanpa izin, terutama ketika rumah ditinggalkan tanpa pengawasan. Penelitian ini bertujuan untuk mengembangkan sistem keamanan ruangan berbasis gerakan yang meningkatkan keamanan melalui peringatan waktu nyata. Sistem ini dirancang menggunakan metode prototipe, menggabungkan mikrokontroler Arduino Uno, sensor gerak Inframerah Pasif (PIR), buzzer, dan modul GSM. Ketika gerakan terdeteksi dalam jarak 5 meter, sensor PIR mengaktifkan buzzer dan secara bersamaan mengirimkan pesan peringatan ke ponsel pemilik rumah melalui modul GSM. Rangkaian ini diuji secara bertahap, termasuk validasi catu daya, responsivitas sensor, dan integrasi sistem secara menyeluruh. Hasilnya menunjukkan bahwa sistem beroperasi dengan andal, dengan deteksi gerakan yang akurat dan respons peringatan yang tepat waktu. Penelitian ini menyimpulkan bahwa solusi yang diusulkan efektif, berbiaya rendah, dan dapat diterapkan untuk meningkatkan keamanan ruangan atau rumah dalam kehidupan sehari-hari.

Keywords: arduino; keamanana rumah; prototype; PIR sensor.

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INTRODUCTION

As time goes by, humans are constantly striving to create things that can simplify their activities by utilizing technology. This is because technology makes everything easier . This is what drives technological development, which has resulted in many tools that simplify human activities and can even replace humans in certain functions.

Nowadays, home security system is the most important thing in daily life, such as home security system. There are many thefts in homes because the home security system is not well protected, especially the doors. Usually house doors only use conventional locks or ordinary house keys.

A microcontroller is a small (micro) device, control component, or controller. A microcontroller is a computer on a chip used to control electronic devices, emphasizing efficiency and cost-effectiveness. Literally, it can be called a small controller for an electronic system that previously required many other supporting components. Arduino Uno is a microcontroller board that supports a programming language that is very easy for users to understand, namely the C programming language.

The Arduino Uno microcontroller can be implemented in various automatic control devices, for example, the author directly implemented the Arduino Uno as the main controller for a home security system. The Arduino Uno also includes a motion sensor that can detect any movement in a particular room. The PIR (Passive Infra Red) sensor is a sensor that can detect human movement well. So the PIR sensor and Arduino Uno are very good for use as a home security system (Dewa & Kartadie, 2016).

A context diagram is a diagram that illustrates the interaction between a system and its users. Users enter data and receive information from the system, while the system processes the received data and displays it as more useful data for the user (Herlambang & Setyawati, 2019).

Simbol Context Diagram	Arti Khusus
	Sistem
	Entitas luar
	Arah aliran

Image 1. Context Diagram Symbols

A microcontroller (micro controller) in an electronic circuit functions as a controller that regulates the working process of the electronic circuit. Inside a microcontroller IC there is a CPU, timer memory, serial and parallel communication channels, input/output ports, ADC etc. Microcontrollers are used in modern electronic systems, such as: car engine management systems, computer keyboards, electronic measuring instruments (such as digital multimeters and oscilloscopes).

A microcontroller is a computer on a chip used to control electronic devices, emphasizing efficiency and cost-effectiveness. Literally, it can be called a "small controller," where an electronic system that previously required many supporting components such as TTL and CMOS ICs can be reduced/smaller and ultimately centralized and controlled by this microcontroller. Microcontrollers are used in products and devices that are automatically controlled, such as machine control systems, *remote controls* , office machines, household appliances, heavy equipment, and toys.

By reducing size, cost, and power consumption compared to designs using separate microprocessors, memory, and input/output devices, the presence of microcontrollers makes electrical control for various processes more economical. By using this microcontroller,:

1. Electronic systems will become more compact.
2. Electronic system design will be faster because most of the system is software that is easy to modify.
3. Troubleshooting is easier due to its compact system. For a microcontroller to function, it requires external components, known as a minimum system. A minimum system

requires at least a clock and reset system, although some microcontrollers already have an internal clock system, allowing the microcontroller to operate without external circuitry.

What is meant by a minimal system is a microcontroller circuit that can be used to run an application.

METHOD

This research used a prototype method, which aimed to design and build a motion sensor-based indoor security system with alarms and notifications via text messages. The prototype method was chosen because it allows for gradual system development, from design and manufacture to testing and refining the device based on the trial results.

The research stages included:

Data Collection

Information was obtained through a literature review related to home security systems, the use of Arduino Uno microcontrollers, PIR (Passive Infrared) sensors, and GSM modules. Data was also collected through observations of user needs for motion-based security systems.

System Requirements Analysis

At this stage, the main components required are identified, namely:

- Arduino Uno as the control center
- PIR sensor as a motion detector
- Buzzer as a warning sound indicator
- SIM800L GSM module as a notification message sender.

System Design

The design was carried out in the form of a system flow diagram, electronic circuit, and Arduino program listing. The circuit connects the PIR sensor to the Arduino and the output module consists of a buzzer and GSM. The system is designed to detect human movement, activate the buzzer, and send an SMS to the homeowner.

System Implementation

All components were assembled into a single system circuit. The program (sketch) was written using the C programming language and uploaded to the Arduino Uno board. The implementation was carried out physically and tested under real-world conditions.

System Testing and Evaluation

The testing was conducted in several stages:

Power supply test: to ensure the 12V DC power output from the power supply was stable. PIR sensor test: to measure the effectiveness of motion detection at a distance of up to 5 meters, with and without obstructions. Arduino Uno microcontroller test: to verify the stability of the input-output logic when the sensor is active. Overall system test: to ensure the system operates according to logic, namely detecting motion, sounding the buzzer, and sending a notification message.

RESULTS AND DISCUSSION

Power Supply Circuit Testing

A power supply is a set of electronic components designed to convert alternating current (AC) into direct current (DC) with the aim of providing power to electronic devices. To test it, you need a power measuring tool, namely a multitester. Here's how to measure power on a power supply (Yulisman et al., 2022)

1. Provide a multitester.
2. Calibrate the multitester at 50 DCV.
3. Connect the positive pin of the multitester to the positive cable of the power supply, then connect the negative pin of the multitester to the negative cable of the power supply.
4. On the analog screen of the multitester indicator, the needle will move towards the number 12 VDC.

In this power supply test, the power output was 12 VDC. The power supply circuit test revealed that the assembled circuit was correct, with the required output voltage of 12 VDC, allowing the power supply to be used as a power source for the device. The power supply test results are shown below.

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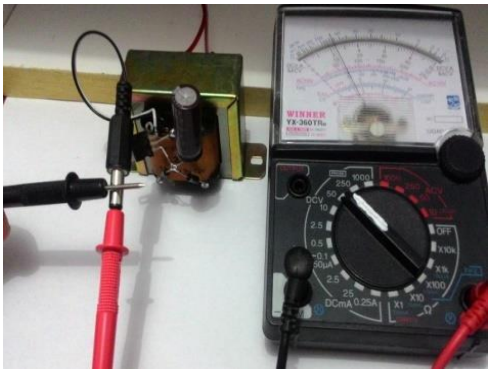

Image 1. Power Supply Testing

PIR Sensor Testing

PIR sensor or commonly called motion sensor is a sensor that works by detecting movement in front of the sensor. The PIR sensor does not emit infrared rays but instead reads infrared from every movement of living objects in front of the sensor.

In this test, the PIR sensor is connected to an Arduino Uno microcontroller that has been previously programmed to light an LED. In the design, the PIR sensor data pin is connected to pin 12 of the Arduino Uno microcontroller, while the LED output pin is connected to pin 13 of the Arduino Uno microcontroller.

Testing on the PIR sensor is divided into two stages, for the first stage of testing the PIR sensor connected to the Arduino Uno microcontroller and LED is not given any obstacles, for example, an obstacle such as a human palm. An example of testing in the first stage is as follows.

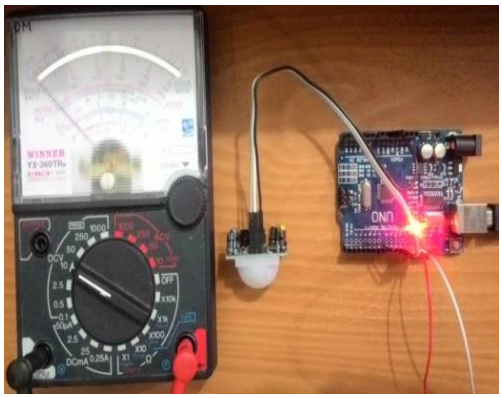

Image 2. PIR Sensor Testing Without Obstructions

In the second stage of testing, the PIR sensor circuit was given a barrier in the form of a human palm. The image from the second stage of testing is as follows.

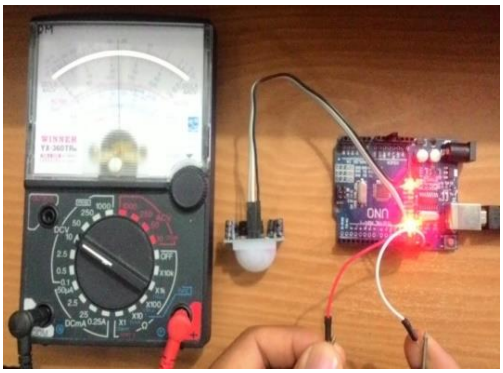

Image 3. PIR Sensor Testing With Obstacles

From the two tests displayed in the form of images, the following test results were obtained :

Table 1. Motion Sensor Testing

No	Testing	Output Voltage	Information
1	Unobstructed PIR Sensor	0 volt	LED Goes Out
2	PIR Sensor with Obstacle	4.5 Volts	LED Lights Up

The program used in testing the PIR sensor is as follows:

```
const int pirPower = 12;
const int pirIn = 13;
int led = 3;

void setup(){
pinMode( pirPower, OUTPUT);
pinMode( pirIn, INPUT);
pinMode( led, OUTPUT);
digitalWrite( led, LOW);
digitalWrite( pirPower, HIGH);
}
void loop()
{
  int value= digitalRead(pirIn);
    if (value == HIGH)
{
      digitalWrite( led, HIGH);
      delay( 1000);
```

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```
}
    else
{
    digitalWrite( led, LOW);
}
}
```

Arduino Uno R3 Circuit Testing

Arduino Uno R3 is a type of microcontroller with a program chip code of 328. The Arduino microcontroller, commonly known as Arduino, is often used by students as a C-based programming component for theses and final assignments. For testing, this Arduino circuit is connected directly to a recommended power source of 7.5 VDC to 12 VDC. This Arduino circuit is specifically programmed to light an LED connected directly to the Arduino port. This allows the circuit to be verified as working properly. Testing the Arduino circuit can be seen as shown in the following image.

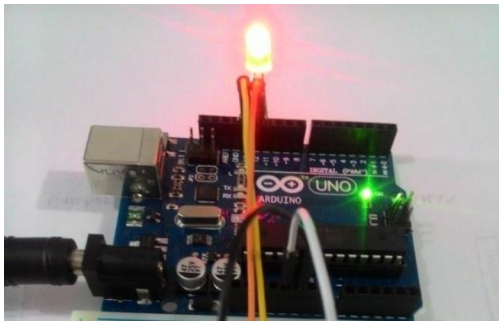

Image 4. Arduino Uno R3 Circuit

Overall Circuit Testing

Testing the overall circuit can be done after testing the circuits one by one. After that, the circuits are connected to each other, including the power supply circuit, Arduino Uno microcontroller, PIR sensor circuit and Output circuit in the form of a Buzzer . In testing the entire Arduino Uno microcontroller circuit, it is first programmed according to its needs, namely controlling the spraying of the air freshener based on the specified time. The program listing that is input into the Arduino Uno microcontroller is as follows:

```
const int pirPower = 12;
const int pirIn = 13;
int mp0 = 3;
void setup(){
pinMode( pirPower, OUTPUT);
    pinMode( pirIn, INPUT);
    pinMode( mp0, OUTPUT);
    digitalWrite( mp0, LOW);
    digitalWrite( pirPower, HIGH);
}
void loop()
{(Setianto, 2022)
 int value= digitalRead(pirIn);
  if (value == HIGH)
{
    digitalWrite( mp0, HIGH);
    delay( 1000);
    digitalWrite( mp0, HIGH);
    delay( 2000);
    digitalWrite( mp0, LOW);
    delay( 10000);
}
  else
{
    digitalWrite( mp0, LOW);
}
}
```

From the program listing above, we can see that the home security system works when a living object passes or is directly in front of the PIR sensor. In this case, the sensor will receive infrared radiation from the moving object, so the PIR sensor sends a signal 1 to the Arduino Uno microcontroller. The Arduino Uno microcontroller processes the signal into HIGH logic so that the output circuit in the form of a buzzer will sound continuously for a predetermined time.

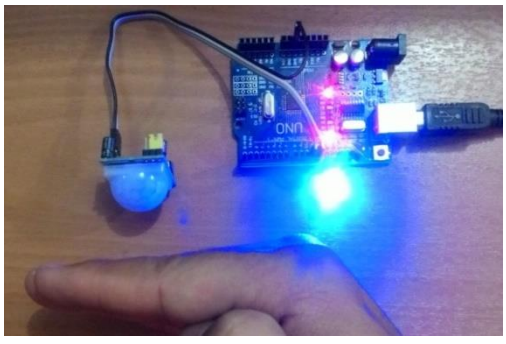

Image 5. Overall Circuit Testing 1

The image above shows that when an object (e.g., a palm) blocks the PIR sensor, the LED lights up. The LED is used to indicate whether the PIR sensor is operating.

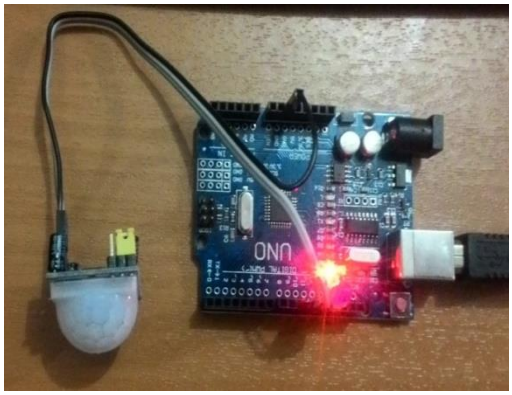

Image 6. Overall Circuit Testing 2

From the image above, we can see that when there is no object blocking the PIR sensor, the LED does not light up (is off). The LED functions as a signal or output when the sensor is operating.

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