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Design and Contructtion of Motion Detection Security Alarm Using Arduino Uno

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Abstract: *This research is based on Arduino Uno. The Arduino Uno microcontroller is used to control the system, while the PIR sensor is used to detect motion. This device is constructed with locally sourced components and materials of regulated standards. The system is designed to detect motion in a specified area and trigger an alarm when motion is detected. The results show that the system is effective in detecting motion and triggering the alarm. The system is simple, cost-effective, and easy to implement.*

Keywords: *Arduino Uno, Alarm, Security, PIR sensor*

1. Introduction

Due to the increasing frequency and severity of burglaries, having an alarm system with effective and dependable intrusion detection has become essential. There are more attacks on residences, workplaces, factories, banks, etc. Thanks to technological advancements, motion can now be detected by tracking changes in an object's speed or vector within the field of view. Either mechanical devices that physically interact with the field or electronic devices that quantify and measure changes in the surrounding environment can accomplish this(Moe *et al.,* 2020).

Motion detectors, also known as home security alarms, are one type of system that uses a passive infrared sensor (PIR). Passive infrared (PIR) energy is used by the most popular single-technology motion detecting sensor to identify object movement, such as a person approaching the door. It works best for detecting when the heat mass passes through the sensor's field of view (Shoewu *et al.*,2020).The concept behind the research is that heat energy is produced by everyone and takes the form of infrared rays, which are invisible to the human eye but can be detected by PIR sensors. The research main goal is to detect an intruder's motion without using any outside force. When an unusual motion occurs within five meters of the electronic motion sensor's detection range, it is detected. Using a PIR sensor, an Arduino Uno, and some provided code as a guide. The open-source microcontroller Arduino Uno serves as the foundation for the entire research. Anytime a motion occurs within its detection range, the PIR sensor picks up the presence of an intruder. It transmits the signal after detecting the infrared rays that a body emits.

2. Brief Background Review and Motivation

With increasing concerns about burglary and unauthorized access, there is a demand for affordable and easy-to-implement solutions that provide reliable motion detection capabilities.

Heinrich Hertz invented the first motion detection system, or radar, when he investigated the characteristics of waves and discovered that they could bounce off of objects and had varying speeds. Samuel Bagno created the first motion detector that doubled as a burglar alarm in the early 1950s. Bagno used the principles of radar to identify a thief or a fire by using ultrasonic waves, which are at a frequency that is inaudible to humans. Bagno's motion detector also utilized the Doppler effect, which is the variation in wave frequency caused by a moving object, such as a train making a louder sound as it approaches (Iyapo *et al*., 2018).

False alarms can be prevented because the motion sensor can distinguish between the presence of humans and animals. This solution to false alarm issues is implemented by the motion sensor utilized in this research without incurring significant costs. It's also important to have a basic motion detection alarm that is easy to operate without the need for wireless internet connections and is hard to hack into because it doesn't have any programming features. A broader range of users can utilize the circuit because it is made with easily accessible and reasonably priced components.

3. METHODOLOGY

The physical construction was done on the Arduino UNO board using mainly surface mounted components. Components used are the programming cable, PIR sensor, Arduino UNO board and buzzer.An Arduino UNO, an advanced microprocessor unit, serves as the system's central component and is responsible for system control. The device has a port that can be used to control an alarm system (buzzer), which is triggered when a PIR sensor detects motion (Fig. 1).

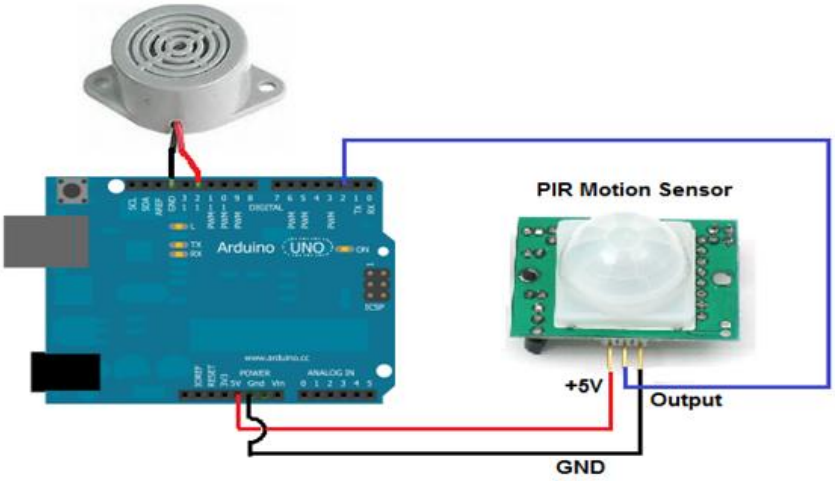

Fig1. *Circuit design*

The GND pin of the Arduino was connected to the GND pin of the Arduino, the output pin to the Arduino digital pin 2, and the PIR sensor VCC pin to the Arduino 5V pin. The Arduino digital pin 9 was linked to the buzzer's positive terminal, and the Arduino GND pin was connected to its negative terminal. To supply power to the system, the power supply was connected to the GND and Vin pins of the Arduino. The installed Arduino IDE software on the computer was used and the Arduino Uno was connected to the computer using a USB cable. The Arduino code was uploaded to the Arduino UNO. This code defines the sensor's detection threshold, alarm activation parameters, and buzzer control logic (Fig. 2).

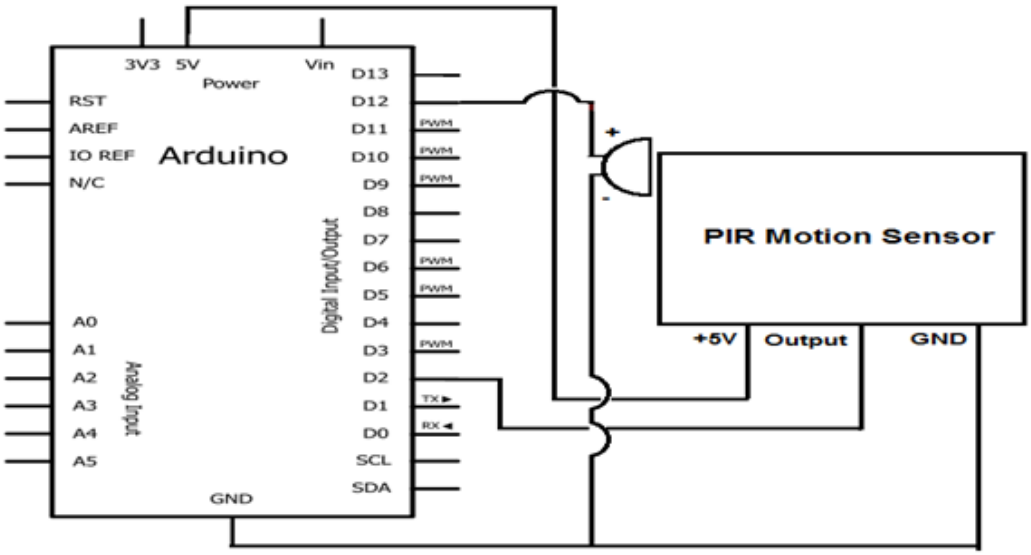

Fig2. *Circuit diagram motion detection alarm system*

4. CIRCUITRY ANALYSIS

The sensor sensitivity test was carried out by gradually moving a heat source (human hand) towards the PIR sensor while monitoring the sensor readings on the serial monitor. The distance at which the sensor detects motion consistently was recorded. The maximum detection range of the PIR sensor was measured by moving the heat source further away until the sensor stops detecting motion. The maximum detection range was recorded. The buzzer behaviour was observed when motion was detected and ensure that the alarm activates promptly and consistently upon motion detection. The duration of the alarm sound once activated was measured and verified that the alarm duration is sufficient to alert the user or initiate appropriate response.Figure 3 shows the complete construction of the system.

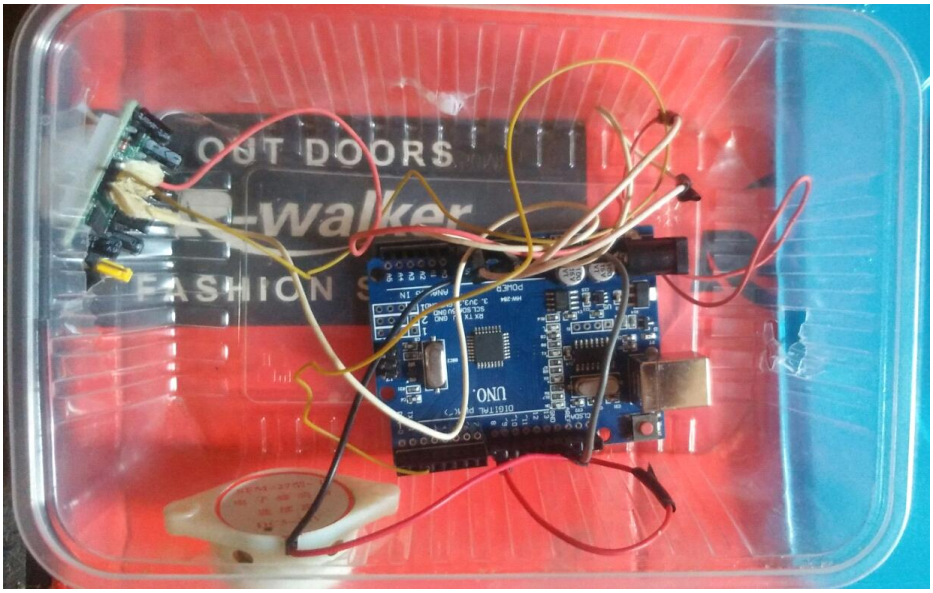

Fig3. *Casing of complete construction of the system*

A well-designed enclosure shields the electronic components from dust, moisture, and other environmental hazards, extending the system's lifespan and ensuring reliable operation. A secure enclosure deters unauthorized access to the system's components, preventing intentional damage or tampering. The choice of casing material depends on the specific requirements of the installation environment and the desired aesthetic. A lightweight, durable, and cost-effective, plastic is a versatile choice for indoor enclosures.

The enclosure was design for easy access to the system components for maintenance, troubleshooting or potential upgrades. Adequate ventilation to prevent overheating to maintain optimal operating conditions of the electronic components. Designate openings or channels for proper wire management, allowing for organized cable routing and a clean appearance.

4.1. Mode of Operation

A microcontroller board based on the ATmega328P is called the Arduino UNO. It contains a 16 MHz quartz crystal, 6 analog inputs, 14 digital input/output pins (six of which can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. An external hardware programmer is not necessary because the Arduino UNO's ATmega328P is pre-programmed with a bootloader that enables the uploading of new code. It uses the original STK500 protocol for communication. An external power supply or a USB connection can be used to power the Arduino UNO. It chooses the power source on its own. To connect the adapter, insert a 2.1 mm center-positive plug into the power jack on the board. An external supply of 6 to 20 volts can power the board. However, if the supply is less than 7V, the 5V pin might only provide 5 volts, which could cause the board to become unstable. The voltage regulator may overheat and harm the board if more than 12V is used. A voltage range of 7 to 12 volts is advised. The FTDI USB-to-serial driver chip is not used by the UNO, in contrast to all previous boards. As an alternative, it has the Atmega16U2 (or Atmega8U2 up to version R2) configured as a serial-to-USB converter. Several features allow the Arduino UNO to communicate with other microcontrollers, computers, or other Arduinos. The ATmega328 provides

UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). A serial monitor built into the Arduino Software (IDE) enables basic text data to be sent to and received from the board. When data is being transmitted via the USB-to-serial chip and USB connection to the computer, the RX and TX LEDs on the board will flash.The infrared signal is focused onto the object by the device's Fresnel lens, a unique type of filter. When a moving human body needs to be detected in a variety of situations, the passive infrared sensor can pick up the infrared light that the person or animal is emitting. This switch signal can then be applied. A pyroelectric device is PIR. The sensor's ability to produce a voltage when heating or cooling is the basis for its operation. In other words, it senses changes in the infrared radiant heat that nearby objects emit in order to detect motion. The three primary components of passive infrared detectors are thermal sensors, also known as infrared sensors, optical systems, and alarm controllers. The main component is an infrared detector, which works with the optical system to detect changes in thermal radiation in a three-dimensional defense area.

The motion detector programme was written in C++. When the PIR sensor detects motion, this code will cause the buzzer to sound.This code will continuously read the value from the PIR sensor. If the sensor detects motion, it will output a HIGH signal, which will turn the buzzer on. After a second, the buzzer will turn off. If no motion is detected, the buzzer will remain zero (O).

4.2. Testing

Initial testing of the board was carried out using continuity meter to ensure all short circuit fault are properly cleared. The sensory circuitry was tested to ascertain the level of sensitivity as expected. The device was further installed in an office to determine how effective the device can detect motion. The test result shows that the motion sensor performed adequately as expected.

Based on the analysis of the results, the overall performance of the motion detection and alarm system is satisfactory. However, it is important to note that the system may require further optimization if the false alarm rate is considered unacceptable or if a faster response time is required. Additionally, continuous monitoring and adjustments may be necessary to maintain optimal performance under varying environmental conditions.

5. CONCLUSION

The system effectively detects motion within a specified range and triggers an alarm to alert the user or initiate an appropriate response. The system's hardware and software components work together seamlessly to achieve the desired functionality.

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