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(Research Article)

Arduino-Based Automatic Door Opener Design Using Ultrasonic Sensors

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Abstract. The development of microcontroller technology has made it easier to design simple, economical, and easily applied automatic systems in everyday life. One application of this technology is an automatic door opener system. This study aims to design and test an Arduino-based automatic door opener system using an HC-SR04 ultrasonic sensor as an object detector. A cardboard house is used as a prototype to simplify the system design and testing process. The designed system uses an Arduino Uno as the main controller, an HC-SR04 ultrasonic sensor as a distance detector, and a servo motor as an actuator to open and close the door. The ultrasonic sensor detects the distance of the object in front of the door, then the Arduino processes the distance data to determine whether the door will open or close automatically. Tests were conducted with several variations in object distance to determine the level of sensor accuracy and system response. The test results show that the system is able to work well at a detection distance of less than or equal to 15 cm with an average response time of around 0.8 – 1.0 seconds. The door can open automatically when the object is within a predetermined distance and closes again after the object moves away. Based on these results, the designed automatic door opening system can function according to the research objectives and is suitable for application in a door automation system prototype.

Keywords: Automatic Door; Arduino Uno; Control System; Microcontroller; Ultrasonic Sensor

1. Introduction

The development of microcontroller-based control and automation system technology is currently growing rapidly and is widely applied in everyday life. One application is in automatic door opening systems that aim to improve comfort, efficiency, and safety aspects for users. These systems are generally designed to work independently without direct physical interaction, making them highly relevant for application in homes, offices, and public facilities, especially in situations that require reduced physical contact, such as during the COVID-19 pandemic, where touching common surfaces can be a means of spreading disease. Because the door will open automatically and does not need to be opened manually, it minimizes unwanted impacts. Although research related to automatic door openers has been widely conducted, further studies are still needed regarding the design process of a simple, efficient, and easily replicated system, especially for educational purposes and small-scale prototype development. In addition, thorough system testing is very important to determine the level of sensor accuracy, system response time, and the reliability of the door opening mechanism.

Several previous studies have discussed the implementation of an automatic door system based on Arduino and ultrasonic sensors that design an automatic door system to work based on the distance of the object with test results showing that the system is able to open and close the door consistently at a distance of less than or equal to 15 cm and shows that the ultrasonic sensor is able to provide a stable response in the automatic door system with a detection success rate above 95%.

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Arduino is a microcontroller platform widely used in automation system development because it is open-source, easy to program, and supported by a large community. Arduino is also compatible with various types of sensors and actuators, making it suitable for use in research and development of automatic door system prototypes. One sensor frequently used in automatic door opening systems is an ultrasonic sensor, which is able to detect the distance of an object based on the reflection of high-frequency sound waves. Ultrasonic sensors have advantages in terms of distance measurement accuracy, relatively low cost, and ease of integration with Arduino microcontrollers. The working principle of this sensor allows the system to detect the presence of an object or person at a certain distance, then sends a signal to the Arduino to activate an actuator, such as a servo motor or DC motor, as a door mover. Meanwhile, the use of ultrasonic sensors can reduce direct physical contact, so this system is considered effective in supporting the implementation of contactless technology.

This research aims to design and test an Arduino-based automatic door opening system using an ultrasonic sensor. It is hoped that the results of this research will contribute to the development of simple, applicable, economical, and easy-to-implement automation systems, particularly in the fields of embedded systems and the Internet of Things (IoT).

2. Literature Review

This research presents an automatic door design consisting of an HC-SR04 ultrasonic sensor, an Arduino Uno microcontroller, and a servo motor as a door opening and closing actuator. The trial showed that the system is able to detect human presence and open the door according to the distance measured by the sensor. Monitoring the presence of objects or humans to control the opening and closing of automatic doors requires a sensor that is able to provide distance data reliably and accurately.

The HC-SR04 ultrasonic sensor is a digital distance sensor that is widely used in automation systems because it can measure the distance of objects within a certain range quickly and stably. This sensor works by emitting ultrasonic waves and receiving signal reflections from objects to calculate the distance based on the travel time of the sound pulse, so that it can be processed by the microcontroller directly. The integration of the ultrasonic sensor with the Arduino Uno allows distance readings to detect objects or people approaching the automatic door in real-time, then the microcontroller sends a signal to the actuator such as a servo motor or motor driver to open and close the door automatically based on the measured distance.

This kind of system design has been widely studied in various researches and prototypes, including the design of an Arduino-based automatic door and ultrasonic sensors to open the door without touching as a measure to prevent the spread of infectious diseases, which shows that the combination of ultrasonic sensors and microcontrollers can provide a responsive and efficient door opening and closing system solution.

3. Method

The research system developed in this study is an automatic door opening system based on the Arduino Uno microcontroller that works by utilizing the HC-SR04 ultrasonic sensor as an object distance detector. This system is designed to provide an automatic response in the form of opening and closing the door without physical contact, thereby increasing efficiency and user comfort.

The system's working principle begins with the HC-SR04 ultrasonic sensor, which emits ultrasonic waves and receives reflected waves from objects in front of it. The travel time of these ultrasonic waves is used to calculate the object's distance. The distance data is then processed by the Arduino Uno to determine the appropriate action, which is to move the servo motor to open or close the door.

If an object is detected at a distance less than or equal to a predetermined threshold, the system sends a PWM signal to the servo motor, causing the door to open automatically. Conversely, if the object's distance is above the threshold, the door will close. This system was tested using a prototype or miniature door as a representation of the real system. A similar approach was also applied to research on automatic door systems based on Arduino and ultrasonic sensors, as reported in several previous studies.

Hardware System Design

Hardware design was carried out to build an automatic door opening system consisting of an Arduino Uno, an HC-SR04 ultrasonic sensor, a servo motor, and a power supply. The Arduino Uno was used as the control center because it has sufficient processing capacity, is easy to program, and is widely used in the development of small-scale automation systems.

The HC-SR04 ultrasonic sensor functions as a distance detector for objects in front of the door. This sensor was chosen because of its high accuracy, wide measurement range, and easy integration with the Arduino Uno. This sensor works by utilizing a trigger pin to transmit ultrasonic waves and an echo pin to receive the reflected waves.

A servo motor is used as an actuator to drive the door opening and closing mechanism in the prototype. Using a servo motor allows precise and stable adjustment of the door movement angle, making it suitable for automatic door system applications. The servo motor is controlled by an Arduino Uno using a PWM signal.

Table 1Lock System Component Specifications.

No	Component	Specification Main	Function
1	Arduino Uno	ATmega328P microcontroller , voltage 5 V work	As controller main system and sensor data processor
2	HC-SR04 Ultrasonic Sensor	Distance measure 2 - 15 cm	Detecting distance object in front door
3	Servo Motor	Voltage 5 V work , angle rotate 0°- 180°	Moving mechanism open And closed lock the door
4	Miniature Prototype / Door	Material light (cardboard)	Implementation media And testing system
5	Jumper Cable	Male-Male / Male-Female	Connect between component
6	Supply Power	5 V DC voltage	Provide source voltage For all over series

Figure 1 Implementation of Automatic Door Lock System.

Software Design

The software design aims to organize the logic of the automatic door opening system so that it functions according to the hardware design. The software was developed using the Arduino IDE with the C programming language.

The initial stage of software design includes initializing the Arduino Uno pins used for the HC-SR04 ultrasonic sensor and servo motor. The program then regulates the process of sending a trigger signal to the ultrasonic sensor and reading the reflected signal on the echo pin to calculate the object's distance based on the ultrasonic wave travel time. The distance value obtained is compared with a predetermined threshold value. If the object's distance is smaller than or equal to the threshold, the Arduino Uno will send a PWM signal to move the servo motor to the door opening position. After the door is opened, the system provides a certain time delay before the servo motor is returned to its initial position to close the door again.

The program is designed using a loop structure so the system can continuously read distances and make decisions. This approach allows the system to respond to changing environmental conditions in real time, as applied to other Arduino-based automated system research.

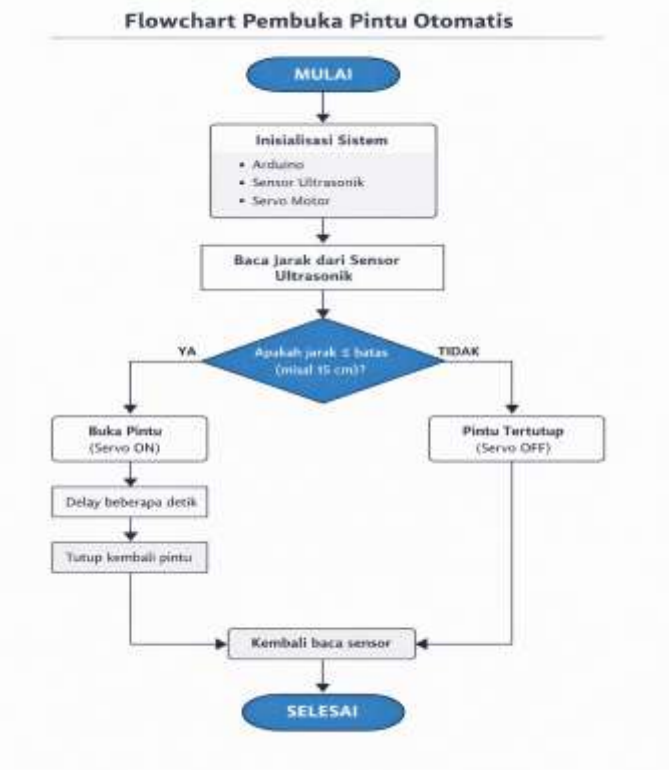

Figure 2 Flowchat.

4. Results and Discussion

In this process system , done wiring between Arduino Uno with HC-SR04 ultrasonic sensor and SG90 servo motor using breadboard and jumper cables . The HC-SR04 sensor is working For detect distance object , with GND connection to path - breadboard, VCC to breadboard + line , Trig to Arduino pin 8, and Echo to Arduino pin 9. The SG90 servo motor is connected through GND cable (brown) to path - breadboard, VCC (red) to path + breadboard, and signal (orange) to pin 6 of Arduino. With configuration this , Arduino can read distance object And move door in a way automatic . Connection process done with consider stability signal And compatibility voltage for the system Work optimally . The program code is instructions existing logic into the Arduino Uno using

Arduino IDE. Arduino IDE is the software used For create programming sketches or in other words, Arduino IDE is a medium for programming on the board you want programmed . Arduino IDE useful For edit , create , upload to the specified board , and coding a particular program . The program contains order For reading distance data from ultrasonic sensors , processing results measurement , as well as control the servo motor to open or close door based on results detection . The program also regulates pause time for the object own enough time For pass door with safe before door return closed . With this program code , system can Work in a way automatic and also optimal.

```
#include <Servo.h>

Servo servoPintu;

// Pin Sensor Ultrasonik
const int trigPin = 8;
const int echoPin = 9;

// Variabel pengukuran
long durasi;
int jarak;

void setup() {
  servoPintu.attach(6);        // Servo di pin 6

  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

  servoPintu.write(0);         // Posisi awal pintu tertutup
  Serial.begin(9600);
}

void loop() {
  // Kirim sinyal ultrasonik
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(2);
  digitalWrite(trigPin, LOW);

  // Baca pantulan
  durasi = pulseIn(echoPin, HIGH);
  jarak = durasi * 0.034 / 2;

  Serial.print("Jarak: ");
  Serial.print(jarak);
  Serial.println(" cm");

  // Logika pintu otomatis
  if (jarak <= 15) {
    servoPintu.write(5);   // Buka pintu
  } else {
    servoPintu.write(90);    // Tutup pintu
  }

  delay(500);
}
```

Figure 3 Program Code.

Based on figure 3 this code controls the automatic entrance system using Arduino Uno. The HC-SR04 ultrasonic sensor measures the distance of the object, if the object is detected within a distance of less than 15 cm, the Arduino rotates the servo motor to a 90° angle to open the door. After that the door will return to its original position (0°) if no object is detected. When read by the sensor and the door will open and close with a delay of 500 milliseconds = (0.5 seconds) The distance data is displayed on the Serial Monitor, the system works automatically and well.

Calibration Testing

Testing was conducted to ensure that the Arduino-based automatic door opener system functions according to the design specifications and has an accurate level of accuracy and stability in detecting the presence of objects. Functional testing aims to ensure that the HC-SR04 ultrasonic sensor, Arduino Uno microcontroller, servo motor, and other supporting circuits can work properly according to their respective roles. Ultrasonic sensor calibration was carried out to obtain accurate and consistent distance reading characteristics. The calibration process was carried out by measuring the distance of the object at several distance variations, namely 5 cm, 10 cm, 15 cm, and 20 cm. At each distance variation, the distance value of the sensor reading was recorded.

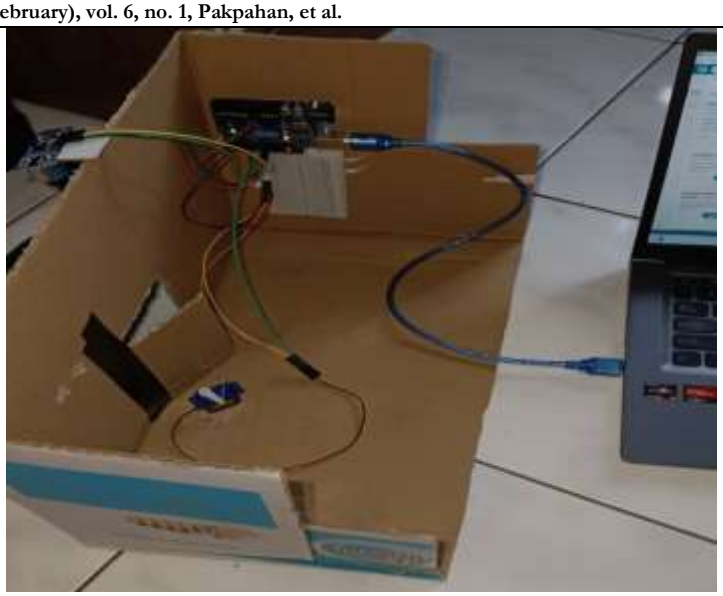

Figure 4 Device Test Circuit.

The calibration results are then used as a basis for determining the system's threshold value for automatically controlling the door opening and closing mechanism. Based on the test results, the system is configured so that the door opens when an object is detected at a distance of less than or equal to 15 cm and closes again when the object is outside that distance. With this test, the automatic door opening system is able to operate stably and in accordance with the design objectives.

Testing and Calibration Results

The results of testing and calibrating the HC-SR04 ultrasonic sensor on an Arduino-based automatic door opener system show that the sensor is able to detect the distance of objects well after the calibration process. Calibration is carried out by comparing the results of the sensor distance readings with the actual distance of the object at several variations in measurement distances. This value is used as a reference in determining the threshold to control the door opening and closing mechanism automatically. The results of testing and calibrating the HC-SR04 ultrasonic sensor on an Arduino-based automatic door opener system are shown in the table below.

Table 2 Testing and Calibration Results.

Distance Object	Object Status	Door	Time Response
2 cm	Detected	Open	1.1 seconds
5 cm	Detected	Open	1.0 seconds
10 cm	Detected	Open	1.0 seconds
14 cm	Detected	Open	1.0 seconds
15 cm	Detected	Open	1.0 seconds
16 cm	No Detected	Closed	1.0 seconds
20 cm	No Detected	Closed	1.0 seconds
25 cm	No Detected	Closed	1.0 seconds

Based on the test results, the sensor consistently produces different values at each object distance. At a distance of 0–15 cm, the object is still detected/the door is open, while at 16–25 cm, the object is no longer detected/the door is closed. This indicates that the sensor has

good sensitivity and sufficient accuracy to support the performance of an automatic door opening system.

6. Conclusion

This research successfully implemented an ultrasonic sensor-based automatic door system in a cardboard house. This system is able to detect the presence of objects within a certain distance and activates the servo motor to open and close the door automatically. The ultrasonic sensor effectively reads the distance of objects less than 15 cm, and the Arduino Uno successfully processes the sensor data and sends precise servo motor control commands. The SG90 servo motor is able to move the door at an angle according to the command, with a 500 millisecond delay for opening and closing, so that the door moves stably and safely. Test results show that the system works accurately and quickly in responding to approaching objects. Although there are several limitations in angle detection, this system has met the research objective, which is to design an effective automation solution. This research opens up opportunities for further development, such as adding security features, using more sophisticated sensors, or integration with the overall smart home system and becomes the basis for innovation in complex automatic door systems, especially in the context of embedded systems and the internet of things (IoT).

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Reference

Darmawan, E. (2023). Automatic door prototype using HC-SR04 ultrasonic sensor and servo motor. Journal of Embedded Technology and Systems, 3(1), 15–22.

Das, S. K., & Mishra, P. (2020). Design of automatic door system using servo motor and Arduino. Journal of Automation and Control Engineering, 9(4), 201–207.

Hidayat, M. R., & Hakim, L. (2022). Performance analysis of HC-SR04 ultrasonic sensor in distance detection system. Journal of Electronics and Instrumentation, 6(2), 60–67.

Hidayat, M. R., & Safitri, L. (2024). Automatic door system based on Arduino Uno using ultrasonic sensor. Journal of Information and Applied Technology (JITET), 8(2), 98–105.

Kurniawan, Y., & Susanti, L. D. (2020). Accuracy analysis of HC-SR04 ultrasonic sensor in various detection angles. Journal of Electrical and Instrumentation, 6(2), 45–50.

Mulyahani, A., Ibrahim, & Saragih, Y. (2023). Automatic door opening and closing system with ultrasonic sensor. Wahana Pendidikan Scientific Journal, 9(22), 126–134.

Nugroho, A., Riyadi, S., & Fajar, M. (2021). Implementation of Arduino Uno in door automation system. Journal of Computer Engineering, 8(1), 45–52.

Patel, S., & Mehta, R. (2024). Ultrasonic sensor-based smart automatic door system using servo motor. In Proceedings of the IEEE International Conference on Smart Systems (pp. 210–215).

Pratama, R. A., Nugroho, A., & Kurniawan, D. (2023). Design and implementation of Arduino-based automatic door using ultrasonic sensor. IEEE Access, 11, 45678–45685.

Pratama, R., & Hidayat, A. (2022). Design and construction of an Arduino Uno-based automatic door system using ultrasonic sensors. Journal of Informatics and Applied Electrical Engineering, 10(2), 85–92.

Putra, A., & Saputra, R. (2024). Design of Arduino-based automation system software. Journal of Information and Computer Technology, 11(1), 30–37.

Putra, M. R., Lestari, F., & Wijaya, H. (2022). Touchless door automation system using Arduino and proximity sensor. Journal of Electronics and Control, 8(3), 120–127.

Rahman, A., Hidayat, R., & Nugroho, A. (2023). Design and construction of an Arduino-based automatic door system using ultrasonic sensors. Journal of Computer Technology and Systems, 11(2), 85–92.

Rahman, M. L. (2021). Real-time control system using Arduino microcontroller. International Journal of Embedded Systems, 7(1), 33–40.

Sari, D. P., & Pratama, Y. A. (2024). Implementation of ultrasonic sensors in a microcontroller-based automatic door system. Journal of Informatics and Electrical Engineering, 9(1), 45–52.