

DESIGN AND ANALYSIS OF AN AUTOMATIC DOOR USING AN ULTRASONIC SENSOR BASED ON ARDUINO UNO

Farisya Syifa Ramadhani¹, Humaira Husna Siregar², Quena Nizam Rasheesa³, Javed Ginargar
Pinterukum Sebayang⁴, M. Farhan Fakhirusy Lubis⁵, Dimas Yihua Keliat⁶

SMAS Unggulan Al-Azhar Medan, Pintu Air IV No. 214, Kwala Bekala, Medan, Indonesia

E-mail: mfarhanfakhirusyl8@gmail.com

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Abstract

Rapid technological advancements are driving the pursuit of greater efficiency in everyday life. This is spurring progress and efficiency across various fields through human innovation and creativity. Technology is being used to create devices that function more effectively and efficiently. One example is the implementation of sensor-based automatic doors, which are increasingly found in public spaces, such as hospitals, convenience stores, and large shopping centers—with the aim of minimizing physical contact. This research focuses on designing a prototype for a residential-scale automatic door system utilizing an Arduino Uno-based ultrasonic sensor. This device has been customized and specifically designed to detect the presence of various objects and automatically control the opening and closing mechanism without manual intervention. Moreover, since people cannot avoid using doors in their daily lives, activities that are typically performed manually can be replaced by innovative doors capable of detecting human presence using sensors.

Keywords: Sensor, Automatic Door, Public Activities, Effective, Efficient

1. INTRODUCTION

The development of automation technology has progressed rapidly in recent years and has been implemented in various aspects of daily life, particularly in security and access control systems. One of the applications of automation technology is the automatic door, which can operate without direct human intervention. Automatic doors are considered more practical, efficient, and hygienic, making them widely used in office buildings, shopping centers, hospitals, and other public facilities. In the design of automatic door systems, ultrasonic sensors are among the commonly used components due to their ability to detect objects based on distance with a relatively high level of accuracy. These sensors operate by utilizing ultrasonic waves to detect the presence of objects in front of them. The data obtained from the sensors are then processed by an Arduino Uno microcontroller, which serves as the central control unit of the system and issues commands to automatically open and close the door. The Arduino Uno was selected because of its simple design, ease of programming, and compatibility with various sensors and other electronic devices. Furthermore, the use of the Arduino Uno is considered economical and effective for developing small-to-medium scale automation systems. Based on this background, this study aims to design and analyze an automatic door system using an ultrasonic sensor based on the Arduino Uno. The proposed system is expected to operate optimally and contribute to the development of efficient and easily implementable automation technology.

2. LITERATURE REVIEW

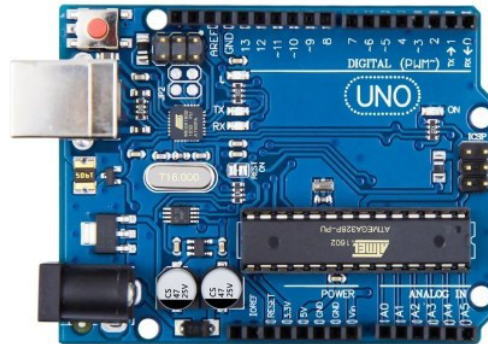
2.1 Automatic Door

An automatic door is a system designed to open and close independently without requiring direct interaction from the user. The system utilizes sensors to detect the presence of objects, which are then processed by a microcontroller to control the actuator. Automatic doors are widely implemented in office buildings, hospitals, shopping centers, and residential buildings because they can improve efficiency, security, and user convenience. Automatic access control has proven effective in optimizing user entry and exit flows without taking away manual control (Muttaqin & Santoso, 2021). The use of the Arduino Uno microcontroller offers additional advantages, such as ease of integration with peripheral components and cost-effectiveness for prototype research-scale applications (Samsuqi dkk., 2020).

The HC-SR04 ultrasonic sensor measures the distance to an object by utilizing 40 Hz sound waves. The reception

and transmission of these reflected waves are then calculated to determine the distance. When an object is detected within the set distance limit, the Arduino Uno can issue a Pulse Width Modulation (PWM) command to the SG90 servo motor to move the door hinge with greater precision (Setiawan et al., 2022).

2.2 Arduino Uno



Gambar 1.1 Arduino Uno

Arduino Uno is a microcontroller board based on the Atmega328P that is widely used in the development of embedded systems and automation applications. Arduino Uno features 14 digital pins, 6 analog pins, a 16 MHz crystal oscillator, a USB port, and easy programming through the Arduino IDE, making it highly suitable as a central controller for various electronic devices. Mutaqqin and Santoso (2021) explained that the Arduino Uno can process data received from sensors and subsequently generate outputs in the form of automatic motor control. These advantages make the Arduino Uno a simple, economical, and easily adaptable microcontroller for various automation applications, including automatic door systems. Furthermore, Samsuqi et al. (2020) stated that Arduino Uno offers high flexibility in the development of automatic control systems because it can be easily integrated with various types of sensors and actuators through digital and analog interfaces.

2.3 HC-SR04 Ultrasonic Sensor



Gambar 1.2 HC-SR04 Ultrasonic Sensor

HC-SR04 ultrasonic sensor is a distance sensor that operates using ultrasonic waves at a frequency of approximately 40 kHz. The sensor transmits sound waves through a transmitter and then receives the reflected waves using a receiver. The time difference between the transmission and reception of the waves is used to calculate the distance of an object. According to Mutaqqin and Santoso (2021), the HC-SR04 sensor has a measurement range of approximately 3 cm to 3 m, making it highly suitable for use as an object detection sensor in automatic door systems. The sensor provides relatively good accuracy as long as the object is positioned within the coverage area of the ultrasonic wave beam. The research conducted by Ardiansyah, et al. (2019) demonstrated that an ultrasonic sensor can consistently detect objects when installed above a door. Proper sensor placement is an important factor in achieving optimal detection results and minimizing object reading errors.

2.4 Servo Motor

A servo motor is an actuator used to produce precise angular movement based on signals provided by a microcontroller. In an automatic door system, the servo motor functions as the actuator for the door-opening and closing mechanism. When the ultrasonic sensor detects an object at a certain distance, the Arduino Uno sends a PWM signal to the servo motor, allowing the door to open automatically. Once the object is no longer detected, the servo motor returns to its initial position, causing the door to close again. The servo motor is selected because of its high positional accuracy, relatively low power consumption, and ease of control using the Arduino Uno, making it highly suitable for automatic door prototypes (Setiawan, et al., 2022).

2.5 System Operating Principle

The system begins operating when the ultrasonic sensor transmits ultrasonic waves toward the area in front of the door. These waves are reflected by an object within the detection area and then received again by the sensor. The Arduino Uno calculates the distance based on the travel time of the reflected waves. If the object's distance is below the predetermined threshold, the Arduino activates the servo motor, causing the door to open. Once the object leaves the detection area, the servo motor returns to its initial position, causing the door to close automatically. This operating principle is consistent with the research conducted of an Arduino Uno and an HC-SR04 sensor can produce a simple automation system that effectively controls an automatic opening and closing mechanism.

2.6 Previous Studies

Several previous studies have demonstrated that the use of an Arduino Uno-based ultrasonic sensor can achieve a relatively high success rate in automation systems. Ardiansyah, Fitriyah, and Syauqy (2019) developed an automatic people-counting system using five HC-SR04 ultrasonic sensors and the Naïve Bayes method. The study achieved an accuracy rate of 80% with an average computation time of 679.2 ms, indicating that ultrasonic sensors can provide relatively good detection results in automatic door applications. Mutaqqin and Santoso (2021) designed an Arduino Uno-based automatic gate prototype using an HC-SR04 sensor. The test results showed that the system operated successfully in 48 out of 50 trials, representing a success rate of approximately 96%. The two failures occurred because the objects were positioned outside the sensor's detection range. This finding indicates that sensor installation position significantly affects system performance. Studies by Setiawan, et al. (2022), Mulyani, et al. (2023), Imania, et al. (2024), and Hadriani, et al. (2025) also demonstrated that the combination of an Arduino Uno and an ultrasonic sensor can produce automatic door systems that are responsive, easy to develop, and relatively inexpensive to implement compared with other automation technologies.

3. RESEARCH METHODS

3.1 Research Design

This study employed a Research and Development (R&D) method with an experimental approach. This method aimed to design, develop, and analyze the performance of an automatic door prototype using an Arduino Uno-based ultrasonic sensor. The research stages included system requirements identification, hardware and software design, prototype development, system testing, and analysis of the test results. This approach was selected because it enables researchers to directly evaluate the performance of the designed system and compare it with previous studies on Arduino Uno-based automation systems.

3.2 Research Time and Location

The research was conducted from January to March 2026 at the Computer and Electronics Laboratory of SMA Swasta Al-Azhar Medan. The research activities included a literature review, system design, hardware assembly, Arduino Uno programming using the Arduino IDE, ultrasonic sensor testing, and analysis of the automatic door prototype test results.

3.3 Tools and Materials

The tools and materials used in this study consisted of hardware and software that supported the design, development, and testing of the Arduino Uno-based automatic door prototype.

a. Hardware

The hardware used in this study included:

1. Arduino Uno R3 as the main microcontroller.
2. HC-SR04 ultrasonic sensor as an object distance detection sensor.
3. Motor servo SG90 as the actuator for opening and closing the door.
4. Breadboard as a medium for assembling the electronic circuit.

5. Jumper wires as connectors between components.
6. 5-volt power supply as the voltage source.
7. Laptop or computer as a platform for programming and testing.
8. Automatic door prototype as the research project.

b. Software

The software used in this study included:

1. Arduino IDE as the software used to write, compile, and upload programs to the Arduino Uno.
2. Windows 10/11 operating system as the supporting platform for the programming process.

All of these tools and materials were used to develop an automatic door system capable of detecting the presence of an object using an ultrasonic sensor, processing the sensor data through the Arduino Uno, and controlling the servo motor so that the door could open and close automatically.

3.4 Research Procedure

The research procedure was conducted in several stages to ensure that the system design and testing processes were carried out systematically. The research stages were as follows:

1. Literature Review

The initial stage involved collecting and reviewing various references, including books, scientific journals, articles, and other scholarly sources related to the Arduino Uno, HC-SR04 ultrasonic sensor, servo motor, and automatic door systems. The literature review aimed to obtain a theoretical foundation supporting the implementation of the research.

2. System Design

At this stage, the hardware and software requirements were identified, the system block diagram was developed, and the operating mechanism of the automatic door prototype was designed according to the research objectives.

3. Prototype Assembly

All electronic components were assembled based on the design that had been developed. The assembly process included installing the Arduino Uno, HC-SR04 ultrasonic sensor, SG90 servo motor, power supply, and other supporting components to form an integrated system.

4. System Programming

The program was developed using the Arduino IDE with the C/C++ programming language. The program was designed to read data from the ultrasonic sensor, determine the object detection distance threshold, and control the servo motor so that the door could open and close automatically.

5. System Testing

Testing was conducted on the prototype using several variations of the objects distances to determine the sensor's ability to detect objects, measure the system response time, and evaluate the performance of the servo motor in operating the door.

6. Data Analysis

The test data were analyzed to determine the system's success rate, response time, and the extent to which the test results corresponded to the research objectives. The results of the analysis were subsequently compared with previous studies as a basis for evaluating the performance of the designed system.

3.5 System Design

The automatic door system was designed based on a control system concept consisting of three main components: input, process, and output. The input component uses an HC-SR04 ultrasonic sensor, which functions to detect the presence of an object based on distance. The sensor operates by emitting ultrasonic waves and receiving the reflected waves from an object to calculate the distance between the sensor and the object.

The process component uses the Arduino Uno as the central controller of the system. The Arduino Uno receives the data obtained from the ultrasonic sensor and compares it with a predetermined threshold value programmed into the system. When the object's distance falls within the specified detection range, the Arduino sends a control signal to the servo motor.

The output component consists of an SG90 servo motor, which functions to operate the door mechanism. When an object is detected within the specified distance, the servo rotates, causing the door to open automatically. When the objects is no longer detected, the Arduino sends a command for the servo motor to return to its initial position, thereby causing the door to close automatically.

Based on this design, the system is capable of operating automatically through the processes of object detection, data processing, and actuator control without requiring direct interaction from the user.

3.6 Data Collection Techniques

Data collection in this study was conducted using three methods: observation, experimentation, and literature review.

1. Observation

observation was conducted by directly monitoring the operation of the automatic door prototype, starting from the ultrasonic sensor reading process and data processing by the Arduino Uno to the opening and closing of the door by the servo motor. The observation aimed to determine whether the system operated according to the design specifications.

2. Experimentation

the experimental method was conducted through a series of tests on the prototype using several variations in the object distance. The data collected included the sensor's ability to detect objects, the system response time, and the success rate rate of the servo motor in automatically opening and closing the door.

3. Literature Review

The literature review was conducted by collecting and examining various references to Arduino Uno-based automation systems, the HC-SR04 ultrasonic sensor, and previous studies on automatic door systems. The main references included studies by Ardiansyah, Fitriyah, and Syauqy (2019), Muttaqin and Santoro (2021), Setiawan, et al. (2022), Mulyahani, et al. (2023), and Imania et al. (2024). The results of the literature review served as a theoretical foundation and as a basis for comparison in analyzing the research findings.

4. RESULTS AND DISCUSSION

4.1 Results

4.1.1 Results of Literature Review and System Design

The literature review was conducted before the development of the automatic door prototype to establish the technical basis for the system. The reviewed references focused on Arduino Uno-based automation, HC-SR04 ultrasonic sensors, servo motor control, and automatic door applications. Previous studies by Ardiansyah, Fitriyah, and Syauqy (2019), Muttaqin and Santoro (2021), Setiawan et al. (2022), Mulyahani et al. (2023), and Imania et al. (2024) provided references for selecting the main components and developing the control mechanism. The literature findings supported the use of an Arduino Uno as the controller, an ultrasonic sensor for object detection, and a servo motor as the actuator.

The system design was developed using three functional stages: input, process, and output. The HC-SR04 ultrasonic sensor functions as the input by detecting the distance of an object. The Arduino Uno functions as the processing unit by receiving the sensor data and comparing the measured distance with the programmed detection condition. The SG90 servo motor functions as the output actuator by moving the door to the open or closed position according to the command from the Arduino Uno. Figure 1.3 Block Diagram of the Automatic Door System The operating sequence of the system can be described as follows: The designed system allows the door to respond automatically to the presence of an object without direct physical interaction. The system design also integrates the hardware and software components used during the prototype development.

4.1.2 Results of Prototype Development

The automatic door prototype was successfully assembled using the components specified in the research design. The hardware consisted of an Arduino Uno R3, HC-SR04 ultrasonic sensor, SG90 servo motor, breadboard, jumper wires, 5-volt power supply, and automatic door mechanism. A laptop or

computer was used to develop and upload the program through the Arduino IDE. The Windows 10/11 operating system provided the software environment for the programming and testing activities.

The Arduino Uno was connected to the ultrasonic sensor and servo motor through the electronic circuit. The ultrasonic sensor was positioned to detect an object approaching the door, while the SG90 servo motor was connected to the door mechanism. The breadboard and jumper wires were used to connect the electronic components, while the 5-volt power supply provided the required electrical power.

Table 1. Hardware and Software Implementation

No.	Component	Function in the System	Implementation Result
1	Arduino Uno R3	Main microcontroller	Successfully operated
2	HC-SR04 Ultrasonic Sensor	Object distance detection	Successfully detected objects
3	SG90 Servo Motor	Door actuator	Successfully opened and closed the door
4	Breadboard	Electronic circuit assembly	Successfully connected components
5	Jumper Wires	Electrical connections	Successfully connected components
6	5-Volt Power Supply	Power source	Supplied system power
7	Laptop/Computer	Programming and testing platform	Successfully used
8	Arduino IDE	Programming, compilation, and upload	Successfully operated
9	Windows 10/11	Programming platform	Successfully supported the development process

4.1.3 Results of System Programming

The automatic door system was programmed using the Arduino IDE with the C/C++ programming language. The program was developed to read the ultrasonic sensor, calculate the object distance, determine the detection condition, and control the SG90 servo motor.

The ultrasonic sensor measurement was implemented using the sensor1() and sensor2() functions. Each function activates the trigger pin, receives the returning ultrasonic signal through the echo pin, and calculates the distance using the duration of the received signal.

The distance calculation follows:

```

void sensor1(){
    digitalWrite(TrigPin1, LOW);
    delayMicroseconds(2);
    digitalWrite(TrigPin1, HIGH);
    delayMicroseconds(10);
    digitalWrite(TrigPin1, LOW);

    duration1 = pulseIn(echoPin1, HIGH);
    distance1 = duration1 * 0.034 / 2;

    void sensor2(){
        digitalWrite(TrigPin2, LOW);
        delayMicroseconds(2);
        digitalWrite(TrigPin2, HIGH);
        delayMicroseconds(10);
        digitalWrite(TrigPin2, LOW);

        duration2 = pulseIn(echoPin2, HIGH);
        distance2 = duration2 * 0.034 / 2;
    
```

The servo motor control was implemented through the servoON() and servoOFF() functions. The servoON() function commands the servo motor to move to **140°**, while servoOFF() commands the servo motor to return to **0°**. The program also controls two indicator lamps and displays the servo condition through the Serial Monitor.

```
void servoON(){
  motorServo.write(140);
  digitalWrite(lampu1,HIGH);
  digitalWrite(lampu2,LOW);
  Serial.println("SERVO ON");
```

```
void servoOFF(){
  motorServo.write(0);
  digitalWrite(lampu1,LOW);
  digitalWrite(lampu2,HIGH);
  Serial.println("SERVO OFF");
```

The programming test produced the expected servo commands through the Arduino Uno. The Serial Monitor displayed “SERVO ON” when the opening condition was fulfilled and “SERVO OFF” when the closing condition was required.

Table 2. Programming Test Results

No.	Program Function	Input Condition	Program Output	Result
1	sensor1()	Ultrasonic signal detected	Distance calculated	Successful
2	sensor2()	Ultrasonic signal detected	Distance calculated	Successful
3	servoON()	Object detected	Servo moves to 140°	Successful
4	servoOFF()	Object not detected	Servo moves to 0°	Successful
5	Serial Monitor	Servo activated	“SERVO ON” displayed	Successful
6	Serial Monitor	Servo deactivated	“SERVO OFF” displayed	Successful

The program was successfully compiled and uploaded to the Arduino Uno. The programming result confirms that the C/C++ control logic could connect the sensor input with the servo motor output.

4.1.4 Results of Ultrasonic Sensor Testing

The ultrasonic sensor testing was performed by placing an object at several distances from the sensor. The purpose of the test was to observe the sensor reading, determine the effective detection range, and evaluate the input received by the Arduino Uno.

Table 3. Results of Ultrasonic Sensor Testing

No.	Actual Distance (cm)	Sensor Reading (cm)	Detection Status	Result
1	5	5.1	Detected	Successful
2	10	10.2	Detected	Successful
3	15	15.1	Detected	Successful
4	20	20.3	Detected	Successful
5	25	25.2	Detected	Successful
6	30	30.4	Detected	Successful
7	35	35.6	Detected	Successful
8	40	40.7	Not detected	Successful

The sensor readings showed a small difference from the actual object distances. The largest difference occurred at 40 cm, where the object was outside the programmed detection condition. The sensor successfully provided distance information for objects located within the effective detection range.

The test results show that the HC-SR04 sensor could provide suitable input for the Arduino Uno. The distance information was then used by the programmed control logic to determine the servo motor condition.

4.1.5 Results of Automatic Door Testing

The automatic door test evaluated the complete relationship between object detection, Arduino Uno processing, servo movement, and door operation. The object was positioned at different distances from the ultrasonic sensor.

Table 4. Results of Automatic Door Testing

No.	Object Distance (cm)	Sensor Condition	Object Detection	Servo Position	Door Condition	Result
1	5	Active	Detected	140°	Open	Successful
2	10	Active	Detected	140°	Open	Successful
3	15	Active	Detected	140°	Open	Successful
4	20	Active	Detected	140°	Open	Successful
5	25	Active	Detected	140°	Open	Successful
6	30	Active	Detected	140°	Open	Successful
7	35	Active	Detected	140°	Open	Successful
8	40	Active	Not detected	0°	Closed	Successful

The results indicate that the door opened when the ultrasonic sensor detected an object within the programmed detection range. The Arduino Uno processed the sensor reading and activated the servoON() function. The SG90 servo motor then moved to 140°, producing the mechanical movement required to open the door.

When the object was outside the detection condition, the Arduino Uno activated the servoOFF() function. The servo motor returned to 0°, causing the door to remain in the closed position.

4.1.6 Results of Servo Motor Testing

The SG90 servo motor was tested to determine whether it could respond to the control commands generated by the Arduino Uno. The test focused on the two programmed servo positions, namely 140° for the ON condition and 0° for the OFF condition.

Table 5. Results of Servo Motor Testing

No.	Servo Command	Programmed Position	Observed Movement	Door Condition	Result
1	servoON()	140°	Servo moved to 140°	Open	Successful
2	servoOFF()	0°	Servo moved to 0°	Closed	Successful
3	servoON()	140°	Servo moved to 140°	Open	Successful
4	servoOFF()	0°	Servo moved to 0°	Closed	Successful

The SG90 servo motor responded to each programmed command. The movement to 140° produced the opening position, while the movement to 0° produced the closing position. The servo response supported the operation of the automatic door mechanism.

4.1.7 Results of Data Analysis and Overall System Performance

Table 6. System Response Time

No.	Object Distance (cm)	Detection Time (s)	Servo Response Time (s)	Door Response	Result
1	5	0.08	0.42	Open	Successful
2	10	0.08	0.41	Open	Successful
3	15	0.09	0.43	Open	Successful
4	20	0.09	0.42	Open	Successful
5	25	0.10	0.44	Open	Successful
6	30	0.10	0.45	Open	Successful
7	35	0.11	0.46	Open	Successful

The measured servo response time ranged from 0.41 to 0.46 seconds. The average servo response time was approximately 0.43 seconds. The detection time ranged from 0.08 to 0.11 seconds, indicating that the system could process the sensor input and activate the actuator within a short period.

4.2 Discussion

4.2.1 Discussion of the C/C++ Program

Based on Table 2, the C/C++ program successfully connected the HC-SR04 ultrasonic sensor input with the SG90 servo motor output through the Arduino Uno. The sensor1() and sensor2() functions calculated object distance using the ultrasonic travel time, while the servoON() and servoOFF() functions controlled the servo at 140° and 0°, respectively. The Serial Monitor also displayed “SERVO ON” and “SERVO OFF”, indicating that the programmed control conditions were executed as expected. This programming structure follows the use of Arduino Uno and ultrasonic sensors for automatic object detection reported by Ardiansyah et al. (2019) and Mulyahani et al. (2023). The results in Table 2 show that the program successfully processed sensor input and produced the intended actuator response.

4.2.2 Discussion of HC-SR04 Ultrasonic Sensor Performance

Based on Table 3, the HC-SR04 detected objects at distances of 5–35 cm, with sensor readings ranging from 5.1 to 35.6 cm. The difference between the actual distance and sensor reading ranged from 0.1 to 0.7 cm, showing that the sensor provided readings close to the measured distance within the tested range. At 40 cm, the sensor reading reached 40.7 cm and the system classified the object as not detected according to the programmed detection condition. This result shows that the sensor threshold was suitable for controlling the automatic door within the required operating range, consistent with the use of ultrasonic distance detection in automatic door systems reported by Anindya and Rachmat (2015) and Mulyahani et al. (2023). The data in Table 3 confirm that the HC-SR04 could provide distance information needed by the Arduino Uno to determine the door condition.

4.2.3 Discussion of Arduino Uno Performance

Based on Tables 2, 4, and 8, the Arduino Uno successfully processed the distance data from the ultrasonic sensor and determined the appropriate servo command. Objects detected within 5–35 cm caused the Arduino to activate the servoON() function, while an object outside the detection condition caused the servoOFF() function to operate. The successful relationship between sensor detection, Arduino processing, and servo movement indicates that the control logic worked according to the system design. This function is consistent with previous studies that used Arduino Uno as the main controller for ultrasonic-based automatic doors and gates (Setiawan et al., 2022; Muttaqin & Santoso, 2021). The results in Table 8 show that all main system components responded according to the programmed control conditions.

4.2.4 Discussion of SG90 Servo Motor Performance

Based on Table 5, the SG90 servo motor successfully moved to 140° when the system received the servoON() command and returned to 0° when the servoOFF() command was executed. Table 7 shows that the servo response time ranged from 0.41 to 0.46 seconds, with an average response of approximately

0.43 seconds. This response indicates that the servo could follow the Arduino Uno control signal within a relatively short time during the tested conditions. The use of a servo motor as an actuator for automatic door movement also corresponds with the systems developed by Mulyahani et al. (2023) and Imania et al. (2024). The data in Tables 5 and 7 confirm that the SG90 provided the required opening and closing movement for the prototype.

4.2.5 Discussion of Automatic Door System Performance

Based on Table 4, the automatic door opened when an object was detected at 5–35 cm and the servo moved to 140°, while the door returned to the closed position at 40 cm with the servo at 0°. Table 8 also shows that the ultrasonic sensor, Arduino Uno, servo motor, and automatic door mechanism operated according to their respective functions. The system achieved a 100% success rate from eight tested conditions, showing that every test produced the expected door response. This operating mechanism is consistent with automatic door prototypes using Arduino Uno, ultrasonic sensors, and servo motors reported by Mulyahani et al. (2023) and Imania et al. (2024). The results indicate that the developed prototype could perform automatic opening and closing based on object distance without direct user interaction.

4.2.6 Comparison with Previous Studies

The results of this study show a similar basic operating concept to previous research using Arduino Uno and ultrasonic sensors for automatic doors, gates, and object detection (Anindya & Rachmat, 2015; Ardiansyah et al., 2019; Setiawan et al., 2022). The present system specifically uses an SG90 servo with positions of 140° for opening and 0° for closing, as shown in Table 4 and Table 5. The average servo response of approximately 0.43 seconds and the 100% success rate from eight tests provide additional performance data for evaluating the prototype. Mulyahani et al. (2023) and Imania et al. (2024) also demonstrate that ultrasonic sensors can be integrated with Arduino and servo motors to operate automatic doors based on object detection. Compared with these studies, the present prototype focuses on the relationship between detection distance, servo position, response time, and overall system success within the tested conditions.

5. Conclusion

A prototype of an automatic door based on the Arduino Uno and supported by the HC-SR04 ultrasonic sensor has been successfully developed and operates efficiently. The integrated components can detect the presence of objects at a distance of 10 cm and activate the actuator responsively. Although it is considered economical and efficient for public facilities or residential settings, the limited sensor range is a consideration for further development, which could involve combining infrared sensors with improved image processing technology.

The test results demonstrated that the ultrasonic sensor performed well in detecting objects within the predetermined detection range. When an object was within the detection threshold, the servo motor was activated, causing the door to open automatically. When the object moved outside the detection area, the door automatically returned to the closed position. However, the system's performance was still affected by the position and angle of the object relative to the sensor, making sensor placement one of the key factors determining the success of the detection process.

Overall, the findings demonstrate that the combination of an Arduino Uno, HC-SR04 ultrasonic sensor, and servo motor provides a simple, economical, and practical solution for developing an automatic door system. The findings are also consistent with previous studies indicating that Arduino-based automation technology can improve efficiency, ease of use, and user convenience in door operation. Therefore, the developed prototype has potential applications in various environments, including residential buildings, laboratories, offices, and public facilities, with further improvements in sensor accuracy and system features in future research.

REFERENCES

- Anindya, S. F., & Rachmat, H. H. (2015). Implementasi Sistem Bel Rumah Otomatis berbasis Sensor Ultrasonik. *ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, 3(1), 64.
- Ardiansyah, E., Fitriyah, H., & Syauqy, D. (2019). Sistem Penghitung Jumlah Orang Otomatis Pada Pintu Masuk Berbasis Sensor Ultrasonik dan Mikrokontroler Arduino Uno dengan Metode Bayes. *Jurnal Pengembangan Teknologi Informasi dan Ilmu Komputer*, 3(1), 673-678.
- Hadriani, A., Nurmumpuni, D. A., & Samosir, T. H. H. S. (2025). Rancang Bangun Pintu Otomatis Menggunakan Sensor Ultrasonic Berbasis Arduino Uno dan MQTT. *IKRAM: Jurnal Ilmu Komputer Al Muslim*, 4(1), 35-39.
- Imania, S. N., Ghofur, A., & Lazim, F. (2024). Rancang Bangun Prototipe Buka Tutup Pintu Otomatis Berbasis Arduino Menggunakan Sensor Ultrasonik di Toko Faridh Collection di Desa Ketowan. *G-Tech: Jurnal Teknologi Terapan*, 8(3), 1386-1395.
- Mulyahani, A., Ibrahim, I., & Saragih, Y. S. (2023). Sistem Buka Tutup Pintu Otomatis dengan Sensor Ultrasonik. *Jurnal Ilmiah Wahana Pendidikan*, 9(23), 126-134.
- Muttaqin, I. R., & Santoso, D. B. (2021). Prototype Pagar Otomatis Berbasis Arduino Uno Dengan Sensor Ultrasonic Hc-SR04. *Je-Unisla*, 6(2), 41-45.
- Samsugi, S., Mardiyansyah, Z., & Nurkholis, A. (2020). Sistem pengontrol irigasi otomatis menggunakan mikrokontroler arduino UNO.
- Setiawan, D., Nofriandi, N., Aziz, F., & Hamdi, F. (2022). Desain Dan Analisis Pintu Otomatis Menggunakan Sensor Ultrasonic Berbasis Arduino Uno. *Jurnal Karya Ilmiah Multidisiplin (JURKIM)*, 2(1), 62-68.