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Smart Home Automation Using Arduino - Automatic Door

[1]Sujal Doddi, [2]Yash Kokane, [3]Sumit Bhavsar, [4]Yash Thorat

[1 2 3 4] Department of ENTC Trinity Academy of Engineering Pune, India

ABSTRACT :

Smart ay we interact with our living spaces, making them more convenient, efficient, and secure. The concept of an automated door system is an essential component in the broader vision of smart homes. This project focuses on the development of an Automatic Door Mechanism using Arduino, with the goal of providing a seamless, hands-free, and energy- efficient solution for everyday use in homes.

The automatic door system is designed to function through a combination of sensors, motors, and an Arduino-based control unit. The system integrates infrared (IR) sensors and ultrasonic sensors for detecting the presence and proximity of individuals, automatically triggering the door to open or close without any manual effort. The ultrasonic sensor measures the distance to the user, while the infrared sensor detects motion, ensuring a precise response when someone approaches the door.

The core of the system is an Arduino microcontroller, which acts as the brain of the system. It processes the input from the sensors and controls the motors responsible for opening and closing the door. The motorized mechanism used in this project involves a DC motor or servo which moves the door smoothly along a track when triggered. The door can be either a rt Home Automation is rapidly transforming the weliding or hinged type, depending on the specific requirements of the implementation.

One of the key features of this system is its automatic locking and unlocking functionality. The door will lock when it is not in use and will automatically unlock when a person is detected, offering enhanced security for the home. In addition to security, this system contributes to energy efficiency by ensuring that the door remains closed when not in use, helping to regulate the indoor environment and reduce energy wastage.

The system is designed with flexibility in mind, allowing it to be integrated with existing home automation frameworks. Through the inclusion of IoT (Internet of Things) capabilities, the door system can be controlled remotely via a smartphone app or connected to a central home automation hub. This connectivity also enables features like remote monitoring, control, and scheduling, making the system adaptable to the user's needs and preferences.

In conclusion, the Smart Home Automation Automatic Door system is not just a solution for modernizing the way we use doors, but also a contribution to the growing trend of connected smart homes. It offers an intuitive, energy-efficient, and secure method for home access. By combining cutting-edge technology with everyday functionality, this project demonstrates the potential of automation to improve the quality of life in residential settings.

Keywords: Arduino Uno, IoT, Automation

Introduction

The rapid development of technology has led to the evolution of smart homes, where everyday devices are integrated into automated systems to improve convenience, security, and energy efficiency.

Among the key components of a smart home system, automation of basic household functions plays a crucial role in enhancing the user experience. One such essential feature is the automatic door, a system designed to provide hands- free access while improving the overall functionality of residential spaces.

This project focuses on developing an automatic door mechanism using Arduino-based control to provide seamless, automated entry and exit solutions.

In traditional homes, doors are manually opened and closed, which can be inconvenient, especially when one is carrying items or has their hands full. Moreover, conventional doors can be a point of contact for germs, posing hygiene concerns. Automatic doors, on the other hand, can help alleviate such issues by offering hands-free operation, opening only when a person is detected nearby.

This enhances convenience, particularly in situations requiring fast entry or exit. Additionally, automatic doors are an excellent solution for individuals with mobility impairments or the elderly, as they provide easier access without the need for manual effort.

The automatic door system proposed in this project utilizes a combination of infrared (IR) sensors, ultrasonic sensors, and Arduino- based controllers to automatically detect the presence of a person and operate the door accordingly. These sensors are essential in ensuring that the door responds accurately to human proximity, opening when needed and closing when not in use. The system aims to improve energy efficiency by ensuring the door remains shut when not in use, thus preventing energy wastage through open doors, especially in controlled environments like air-conditioned spaces.

Security is another significant concern addressed by the system. The door will include features such as automatic locking and unlocking upon detection of an authorized individual, providing both convenience and security. By incorporating IoT (Internet of Things) connectivity, the system can be controlled remotely via a smartphone application, enabling users to monitor and control the door's operation even when they are away from home.

Literature Review

Smart home automation has been a growing area of interest in both academic research and practical implementation, particularly in enhancing lifestyle convenience, improving security, and increasing energy efficiency.

Automatic door systems represent one of the fundamental features in the development of intelligent home environments. A variety of studies and projects have explored the use of microcontrollers, sensors, and IoT technologies to achieve automatic door functionality.

Previous research has shown that infrared (IR) sensors and ultrasonic sensors are among the most commonly used components in automatic door systems.

These sensors are effective in detecting motion and measuring distance, making them ideal for triggering the opening and closing of doors based on human presence.

For example, in a study titled "Design and Implementation of Automatic Door System Using PIR Sensor and Arduino" (Journal of Electronics and Communication), researchers demonstrated how a Passive Infrared (PIR) sensor could detect human movement and signal an Arduino microcontroller to activate a door mechanism.

This study highlighted the low cost, efficiency, and simplicity of using Arduino for smart automation projects.

Another study explored the integration of servo motors and stepper motors for smooth and controlled door operation. Servo motors offer better control in terms of angular position, making them suitable for swing doors, while stepper motors are more commonly used for sliding mechanisms. The literature suggests that choosing the right type of motor is crucial based on the door's design and required movement precision.

The inclusion of IoT in smart door systems has also been discussed extensively. In papers such as "IoT-Based Smart Door with Face Recognition" (IEEE, 2020), researchers implemented a face detection module to authorize access, combining security with automation. Though more complex, such systems show the future potential of enhancing basic automatic door mechanisms with intelligent access control.

Moreover, the energy-saving aspect of automatic doors is emphasized in various case studies conducted in commercial and hospital environments, where doors open and close only when required, reducing HVAC energy loss. These ideas are now being adapted to residential environments through home automation projects.

In conclusion, existing literature supports the feasibility and effectiveness of building an automatic door system using Arduino, sensors, and basic motors. While many implementations focus on single functionalities, there is growing interest in integrating multiple features like remote control, biometric access, and IoT connectivity. This project builds on the existing work while aiming to deliver a compact, reliable, and scalable automatic door system suitable for modern smart homes.

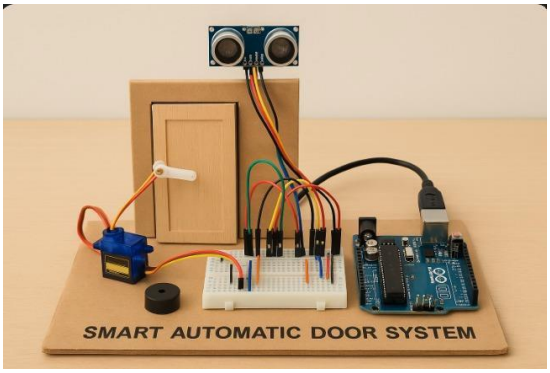
Methodology

The theory behind the smart home automation automatic door system revolves around the integration of sensors, microcontrollers, and actuators to create a responsive and intelligent mechanism. At the core of the system lies the Arduino Uno, a microcontroller that serves as the brain of the project.
It processes the input data received from various sensors and executes the corresponding output commands to operate the door. Sensors such as ultrasonic and infrared (IR) sensors are used to detect human presence or motion near the entrance. When a person approaches the door, the sensors detect movement or distance changes and send signals to the Arduino.

Upon receiving the signal, the Arduino interprets the data and decides whether to trigger the opening or closing of the door. If someone is detected within a predefined range, the Arduino sends a command to the motor— either a servo or a DC motor—causing it to move the door accordingly. The motor acts as an actuator and converts the electrical signal into mechanical motion to slide or swing the door open.

Once the person has passed, and no further motion is detected, the door automatically returns to its closed position after a short delay. The system operates in real time and ensures efficient, hands-free access, which is highly useful in modern homes, offices, or health-sensitive areas. The process is powered through a regulated power supply, and the components are connected in such a way that safety and functionality are prioritized. This concept demonstrates how basic electronic components can be combined to solve real-world problems using automation and control systems. The theory also allows for future upgrades like remote control, biometric access, or IoT integration, making it a flexible and scalable solution in the field of smart home technology.

Hardware Components



1. **Arduino Uno:**
   A microcontroller board that acts as the brain of the project. It reads sensor inputs and controls the servo motor based on programmed instructions.

2. **Ultrasonic Sensor (HC-SR04):**
   Used to detect the presence and distance of an object or person. It sends out ultrasonic waves and measures the time it takes for the echo to return.

3. **Servo Motor:**
   A motor that precisely controls angular movement. In this project, it is used to open and close the door based on signals from the Arduino.

4. **Jumper Wires:**
   Used to make electrical connections between the Arduino, sensors, and motor on the breadboard.

5. **12V Adaptor:**
   Provides the required external power supply to operate the Arduino and servo motor efficiently.

Workflow

- System Initialization:
  Arduino and all connected components (sensor, motor) are powered on and initialized.

- Sensor Detection:
  The ultrasonic sensor continuously monitors the area in front of the door for any approaching object or person.

- Distance Measurement:
  If a person/object is detected within a certain range (e.g., 0–50 cm), the sensor sends the distance data to the Arduino.

- Signal Processing:
  The Arduino processes the input data and decides whether to activate the servo motor.

- Door Opening:
  If a person is detected, Arduino sends a signal to the servo motor to rotate to a certain angle, opening the door.

- Delay Timer:
  The system waits for a few seconds (e.g., 3–5 seconds) to allow the person to pass through the door.

- Door Closing:
  After the delay, the Arduino sends another signal to the servo motor to rotate back, closing the door.

- Loop Repeats:
  The process repeats continuously, checking for new inputs and operating the door accordingly.

Result

The Smart Home Automation – Automatic Door system was successfully implemented and tested. The ultrasonic sensor accurately detected the presence of a person approaching the door, and the Arduino processed the data efficiently to control the servo motor.
The door opened and closed smoothly without manual effort, demonstrating the system's effectiveness in real-time operation. The project achieved its goal of providing a hands-free, automated door solution suitable for modern smart homes, ensuring both convenience and improved hygien

Effective Metrics

1. Accuracy of Sensor Detection
2. Response Time
3. Motor Efficiency
4. System Reliability
5. Power Consumption
6. User Experience (UX)
7. System Latency

Cost Analysis

Sr. no	**Name of component**	**Quantity**	**Cost**
1	**Arduino Uno**	**1**	**700**
2	**Ultrasonic Sensor**	**1**	**200**
3	**Servo Motor**	**1**	**400**
4	**Jumper Wires**	**7-8**	**100**
5	**12-V Adaptor**	**1**	**300**
Total Estimated cost	**1700**		

User Feedback

1. **Students' Feedback:**

i. Easy to build and understand, great for learning automation basics.

ii. Helped improve practical skills in Arduino and sensor integration.

2. **Administrators' Feedback:**

i. Effective low-cost solution suitable for real-world applications.

ii. Useful for improving hygiene and security in institutional spaces

Discussion

The Smart Home Automation – Automatic Door project presents an effective, low-cost solution for improving convenience, security, and hygiene in both residential and institutional environments. By using components such as the Arduino Uno, ultrasonic sensor, and servo motor, this system successfully automates the door mechanism based on the presence of an individual.
The project's implementation was simple yet impactful, demonstrating how basic electronics and programming knowledge can lead to practical real-world applications.

One of the major points of discussion lies in the accuracy and reliability of the ultrasonic sensor. During testing, the sensor was able to detect objects within a specific range with high accuracy. However, its performance may vary under different lighting and environmental conditions. Factors such as strong sunlight, reflective surfaces, or cluttered surroundings can influence the sensor readings, which could affect the responsiveness of the door.
Addressing such limitations would be crucial
for commercial or large-scale deployment

The servo motor used in the project also performed effectively, offering quick and smooth motion during the door's operation. However, it was found that the servo motor has limited torque, making it suitable only for lightweight doors.
For heavier doors, alternative motors such as stepper or DC motors with motor drivers may be required. Additionally, power supply management is another important area to consider. Using a stable 12V adaptor ensured the system remained consistent in its performance.

From the user perspective, both students and administrators appreciated the system's ease of use and practicality. Students gained valuable insights into sensor integration and automation, while administrators saw real-life applications of the project in offices, labs, and other smart environments.

In conclusion, the project successfully demonstrates the potential of home automation using affordable and easily accessible components.

Avdantages :

Hands-free operation:

- Enhances convenience and hygiene by automatically opening/closing the door without **physical contact.**

- Low-cost and easy to implement**:** Uses affordable components like Arduino and sensors, making it suitable for educational and real-world applications.

Limitations:

- ***Limited to lightweight doors:***

The servo motor used cannot handle heavy or full-sized doors effectively.

- ***Sensor sensitivity issues:***

The ultrasonic sensor may give inaccurate readings in certain environmental conditions (e.g., bright sunlight or reflective surfaces).

Future Direction

- Integration with IoT and mobile apps:
- The system can be enhanced by adding Wi-Fi or Bluetooth modules to enable remote control via smartphones or smart home assistants.

- Advanced security features:
- Future versions can include biometric access (fingerprint or face recognition), RFID, or keypad systems to increase safety and personalization

Conclusion

The Smart Home Automation – Automatic Door project successfully demonstrates how basic electronic components like Arduino, ultrasonic sensors, and servo motors can be used to create an efficient, hands-free door system. It provides a practical solution for enhancing convenience, hygiene, and automation in homes, offices, and institutions.

The system is affordable, easy to implement, and beneficial for learning automation concepts. With future improvements like IoT integration, biometric security, and mobile control, this project holds strong potential for advancement in the field of smart home and building automation

REFERENCES:

1. Banzi, M., & Shiloh, M. (2014). Getting Started with Arduino (3rd ed.). Maker Media, Inc.
2. John Boxall (2013). Arduino Workshop: A Hands-On Introduction with 65 Projects. No Starch Press.
3. Datasheet: HC-SR04 Ultrasonic Sensor. Retrieved from https://components101.com
4. Arduino Official Website. Retrieved from https://www.arduino.cc
5. Tutorial: How to Control a Servo Motor with Arduino. Retrieved from https://www.electronicwings.com
6. Rouse, M. (2021). Smart Home Definition. TechTarget. Retrieved from https://www.techtarget.com