# PROJECT REPORT

# IoT Sensors, Peripherals, and Processors

**[ECE3009]**

## Automatic Door Opening System

A Project Submitted

in Partial Fulfilment of the Requirements for the Degree of

**Bachelor of Technology**

in

**Computer Science and Engineering**

**Submitted to:**

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SCHOOL OF ENGINEERING AND TECHNOLOGY
BML MUNJAL UNIVERSITY GURGAON
December, 2023

## DECLARATION BY THE CANDIDATES

We hereby declare that the project entitled **"Automatic door opening system"** has been carried out to fulfill the requirements for the completion of the course **IoT Sensors, Peripherals, and Processors** offered by the 5th semester of the Bachelor of Technology programme in the Department of Computer science and engineering during the academic year - 2023-24(odd semester). This experimental work has been carried out by us and submitted to the course instructor **Dr. Rajiv Dey**. Due acknowledgment has been made in the text of the project to all other materials used. This project has been prepared in full compliance with the requirements and constraints of the prescribed curriculum.

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# Contents

## 1. ABSTRACT:

The Automatic Door Opening System, powered by an Arduino Nano and PIR sensor, revolutionizes access control. Activated by motion detection, the system utilizes a micro servo motor to seamlessly operate door mechanisms, enhancing security and user convenience. This intelligent fusion of microcontroller-based automation and motion-sensing technology serves as a pivotal model for modernizing shopping mall entrances. The system's simplicity and adaptability set the stage for future innovations in retail security, suggesting potential advancements in biometric integration and remote monitoring for a more sophisticated and user-friendly shopping experience.

## 2. INTRODUCTION:

As the complexity of security threats continues to evolve, traditional security gate systems face challenges in maintaining effectiveness. Conventional methods often struggle to adapt swiftly to emerging risks, leaving vulnerabilities that adversaries may exploit. Moreover, the increasing sophistication of intrusion techniques calls for a paradigm shift in the way we approach access control. Nano-technology offers a promising avenue to overcome these challenges, providing a platform for innovative solutions that can anticipate and respond to security breaches in real time.

Nano-scale materials and sensors possess unique properties that can be harnessed to revolutionize security measures. These materials exhibit enhanced sensitivity, enabling the detection of subtle environmental changes indicative of potential security threats. The use of nanotechnology allows for the creation of smart sensors capable of recognizing anomalies, unauthorized access attempts, or even biological markers for improved biometric authentication.

Our project focuses on achieving several key objectives with the implementation of a nano-based Automatic Door Opening System. Firstly, the system aims to provide a rapid and accurate response to security incidents, minimizing the risk of unauthorized access. Secondly, it aspires to reduce reliance on human intervention through the incorporation of autonomous decision-making processes driven by nano-sensors and artificial intelligence algorithms. Lastly, the system seeks to enhance overall user experience by streamlining the access control process while maintaining a high level of security.

By employing nano-technology, our security gate system offers a multitude of advantages. These include increased sensitivity to security threats, reduced false positives, and the ability to adapt to evolving risks. Additionally, the system's autonomous features contribute to operational efficiency, allowing security personnel to focus on strategic tasks rather than routine monitoring.

# 3. CIRCUIT DIAGRAM:

## 3.1 Components:

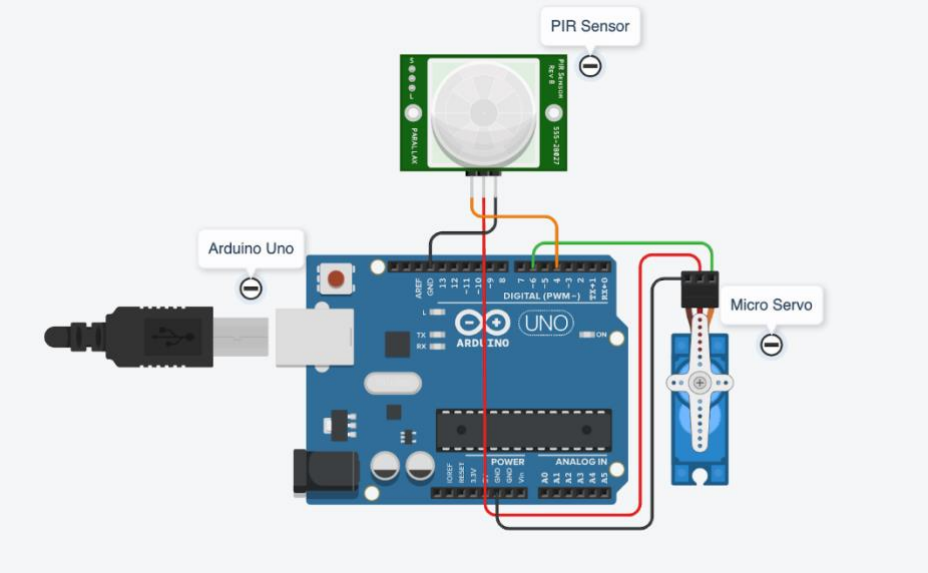



**Fig:** Circuit diagram of the system {Tinkercad}
(Note: we have used Uno due to the unavailability of Nano in Tinkercad)

### Hardware Components:

- Arduino Nano microcontroller
- PIR sensor
- Micro servo
- Jumper wires
- Breadboard

### Software Components:

- About the Arduino IDE
- AVR C Programming

The circuit diagram depicts an automatic security gate system utilizing a PIR sensor for motion detection and an Arduino Nano microcontroller for control.

# Arduino Nano Microcontroller:

The Arduino Nano is the central control unit, responsible for processing signals from the PIR sensor and sending commands to the micro servo. The main loop continuously monitors the state of the PIR sensor and triggers actions accordingly (Arduino Nano Datasheet, 2023).

## Features:

### 1. ATmega328 Microcontroller

- High-performance low-power 8-bit processor
- Achieve up to 16 MIPS for 16 MHz clock frequency
- 32 kB of which 2 KB used by the bootloader
- 2 kB internal SRAM
- 1 kB EEPROM
- 32 x 8 General Purpose Working Registers
- Real Time Counter with Separate Oscillator
- Six PWM Channels
- Programmable Serial USART
- Master/Slave SPI Serial Interface

### 2. Power

- Mini-B USB connection
- 7-15V unregulated external power supply (pin 30)
- 5V regulated external power supply (pin 27)

### 3. Sleep Modes

- Idle
- ADC Noise Reduction
- Power-save
- Power-down
- Standby
- Extended Standby

### 4. I/O

- 20 Digital
- 8 Analog
- 6 PWM Output

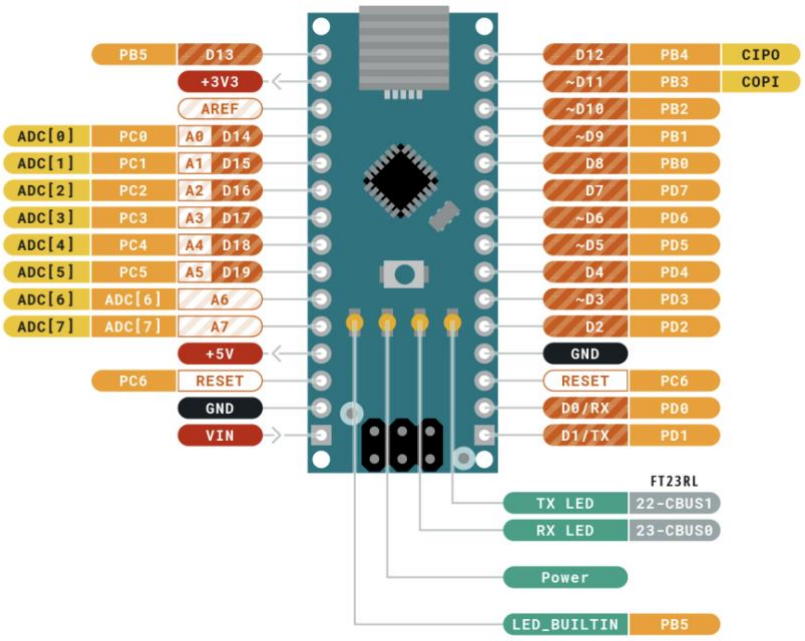



**Fig:** Representing Pinouts of Arduino nano.

### 5.1 Analog

| Pin | Function | Type | Description |
|---|---|---|---|
| 1 | +3V3 | Power | 5V USB Power |
| 2 | A0 | Analog | Analog input 0 /GPIO |
| 3 | A1 | Analog | Analog input 1 /GPIO |
| 4 | A2 | Analog | Analog input 2 /GPIO |
| 5 | A3 | Analog | Analog input 3 /GPIO |
| 6 | A4 | Analog | Analog input 4 /GPIO |
| 7 | A5 | Analog | Analog input 5 /GPIO |
| 8 | A6 | Analog | Analog input 6 /GPIO |
| 9 | A7 | Analog | Analog input 7 /GPIO |
| 10 | +5V | Power | +5V Power Rail |
| 11 | Reset | Reset | Reset |
| 12 | GND | Power | Ground |
| 12 | VIN | Power | Voltage Input |

### 5.2 Digital

| Pin | Function | Type | Description |
|---|---|---|---|
| 1 | D1/TX1 | Digital | Digital Input 1 /GPIO |
| 2 | D0/RX0 | Digital | Digital Input 0 /GPIO |
| 3 | D2 | Digital | Digital Input 2 /GPIO |
| 4 | D3 | Digital | Digital Input 3 /GPIO |
| 5 | D4 | Digital | Digital Input 4 /GPIO |
| 6 | D5 | Digital | Digital Input 5 /GPIO |
| 7 | D6 | Digital | Digital Input 6 /GPIO |
| 8 | D7 | Digital | Digital Input 7 /GPIO |
| 9 | D8 | Digital | Digital Input 8 /GPIO |
| 10 | D9 | Digital | Digital Input 9 /GPIO |
| 11 | D10 | Digital | Digital Input 10 /GPIO |
| 12 | D11 | Digital | Digital Input 11 /GPIO |
| 13 | D12 | Digital | Digital Input 12 /GPIO |
| 14 | D13 | Digital | Digital Input 13 /GPIO |
| 15 | Reset | Reset | Reset |
| 16 | GND | Power | Ground |

**Fig:** Digital and analog pins of the Arduino Nano respectively.

# PIR Sensor (Passive Infrared Sensor):

The PIR sensor is appropriately connected to the Arduino Nano, specifically to its digital pin 4 (#define PIR_PIN 4). The PIR sensor functions by detecting motion and transmitting a high signal to the connected pin when motion is detected (ada, 2023).


## Specifications of PIR Sensor:

- **Size:** The PIR sensor is rectangular in shape.
- **Output:** The sensor provides a digital pulse high (3V) when triggered (motion detected) and a digital low when idle (no motion detected).
- **Sensitivity range:** The PIR sensor can detect motion up to a range of 20 feet (6 meters) with a detection angle of 110° x 70°.
- **Power supply:** The PIR sensor requires a 5V-12V input voltage for most modules, with a 3.3V regulator. However, 5V is ideal in case the regulator has different specifications.

## How PIR sensors work:

PIR sensors, also known as Passive Infrared sensors, are used to detect motion by sensing changes in infrared radiation levels. They are commonly found in appliances and gadgets used in homes or businesses. PIR sensors consist of a pyroelectric sensor that detects levels of infrared radiation and a lens that helps focus the detection area. When a warm body, such as a human or animal, passes by, it causes a positive or negative differential change in the sensor, which is then detected as motion.

## Key points

- PIR sensors detect motion by sensing changes in infrared radiation levels.
- They consist of a pyroelectric sensor and a lens to focus the detection area.
- When a warm body passes by, it causes a differential change in the sensor, which is detected as motion.

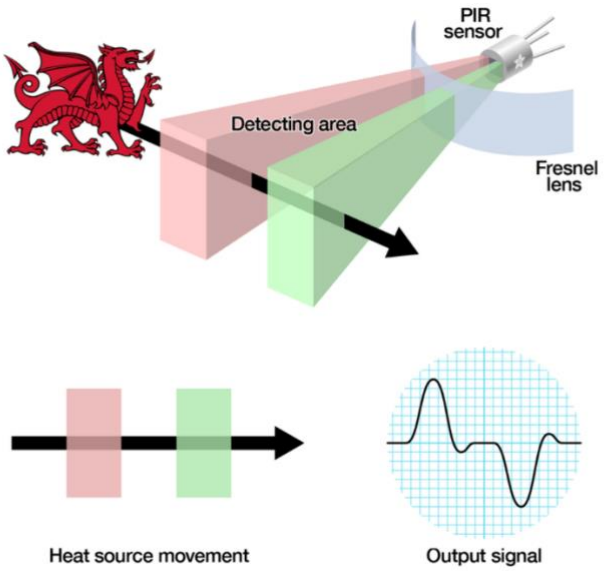
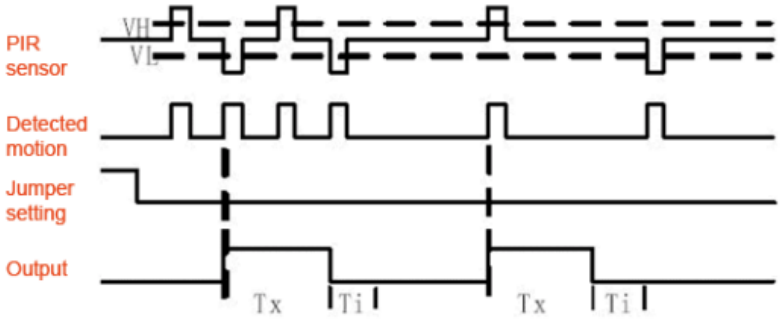


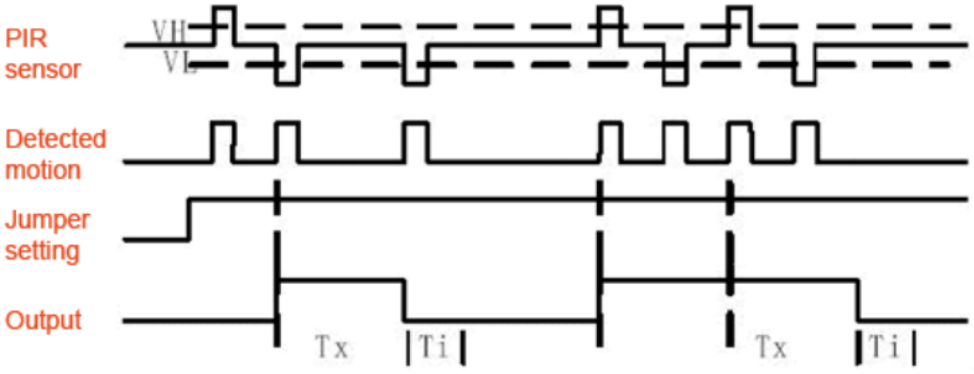

**Fig**: Representing how the PIR Sensor works.

## Retriggering:

There are a couple of options you may have with your PIR. First up we will explore the 'Retriggering' option. Once you have the LED blinking, look on the back of the PIR sensor and make sure that the jumper is placed in the L position as shown below.




Now set up the testing board again. You may notice that when connecting the PIR sensor as above, the LED does not stay on when moving in front of it but turns on and off every second or so. That is called “non-retriggering.”



Now change the jumper so that it is in the H position. If you set up the test, you will notice that now the LED stays on the entire time that something is moving. That is called "retriggering."

## Micro Servo:

A micro servo, connected to digital pin 6 (#define SERVO_PIN 6), is employed to operate the gate. When motion is detected, the servo is instructed to rotate to a position that opens the gate (180 degrees). Conversely, when no motion is detected, the servo returns to its initial position, closing the gate (0 degrees) (Servo Motor Datasheet).

**TowerPro SG90 - Micro Servo**

### Specification of the micro servo Sg90:

- Modulation: Analog
- Torque: 25.0 oz-in (1.80 kg-cm) at 4.8V
- Speed: 0.10 sec/60° at 4.8V
- Weight: 0.32 oz (9.0 g)
- Dimensions: 0.91 in (23.1 mm) x 0.48 in (12.2 mm) x 1.14 in (29.0 mm)
- Motor Type: 3-pole
- Gear Type: Plastic
- Rotation/Support: Bushing
- Rotational Range: 180°
- Pulse Cycle: ca. 20 ms
- Pulse Width: 500-2400 με

### Servo Motor Operation:

Servo motors have the capability to rotate to a specified angular position. The servo is utilized to mechanically control the gate's opening and closing.

## 3.2 Working of the System:

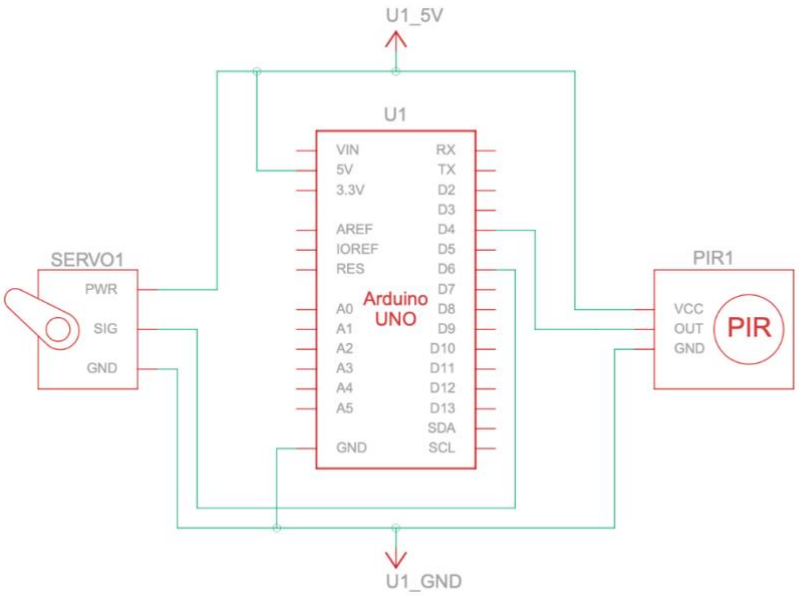



Fig: Circuit diagram of the system.

### PIR Sensor Detection:

The Passive Infrared (PIR) sensor is a motion detector that can sense changes in infrared radiation. When motion is detected, the PIR sensor outputs a high signal (logical 1).

### Arduino Signal Processing:

The Arduino board is programmed to constantly monitor the input from the PIR sensor. It checks the state of the PIR sensor pin (connected to pin 4 in this case, as defined by #define PIR_PIN 4). If the PIR sensor detects motion (high signal), the Arduino responds by executing specific actions.

### Micro Servo Control with rotateServo Function:

The rotateServo function is designed to control the rotation of the micro servo motor connected to pin 6 (defined as #define SERVO_PIN 6). The degree of rotation is determined by the input parameter to the function.

The function takes an angle in degrees and converts it into a pulse width value to control the servo motor's position. The pulse-width calculation is based on the specifics of the servo motor being used.

When motion is detected, the rotateServo function is called with an angle of 180 degrees, causing the micro servo to rotate to a position that opens the gate.

If no motion is detected, the function is called with an angle of 0 degrees, causing the micro servo to return to its initial position, closing the gate.

## Gate Open Duration:

The gate remains open for a specified duration, which is determined by the time it takes for the rotateServo function to execute the rotation from 0 to 180 degrees.

This duration can be adjusted by modifying the delay in the rotateServo function. Currently, the delay is set based on a calculated pulse Width and an additional fixed delay of 19500 microseconds.

## Gate Closure:

After the set amount of time (gate open duration), the rotateServo function is called with an angle of 0 degrees, causing the micro servo to rotate back to its initial position, closing the gate.

## 4. CODE IMPLEMENTATION:

**<avr/io.h>:**

The avr/io.h library is part of the AVR C library for Atmel microcontrollers, which includes the microcontroller-specific input/output definitions. It provides access to various register definitions for the specific microcontroller on the Arduino board. It allows you to directly manipulate the hardware registers of the microcontroller for tasks such as configuring pins and controlling peripheral devices.

**<util/delay.h>:**

The util/delay.h library provides functions for creating delays. This library is handy when precise timing is required, such as in controlling servo motors or other time-sensitive operations.

**C Code:**

```
#include <avr/io.h>
#include <util/delay.h>
#define F_CPU 16000000UL
#define SERVO_PIN 6
#define PIR_PIN 4

void rotateServo(int degrees){
  int pulseWidth=(degrees*11)+500;
  PORTD |=(1<<SERVO_PIN);
  _delay_us(pulseWidth);
  PORTD &= ~(1<<SERVO_PIN);
  _delay_us(19500);
}

int main(void) {
  DDRD |= (1<<SERVO_PIN);
  DDRD &= ~(1 << PIR_PIN);
  Serial.begin(9600);
  while(1){
    if(PIND & (1<<PIR_PIN)){
      Serial.println("Motion Detected");
      Serial.println("Welcome!");
      rotateServo(180);
    } else {
      Serial.println("Motion not Detected");
      rotateServo(0);
    }
  }
  return 0;
}
```

## 5. Photo of Hardware:

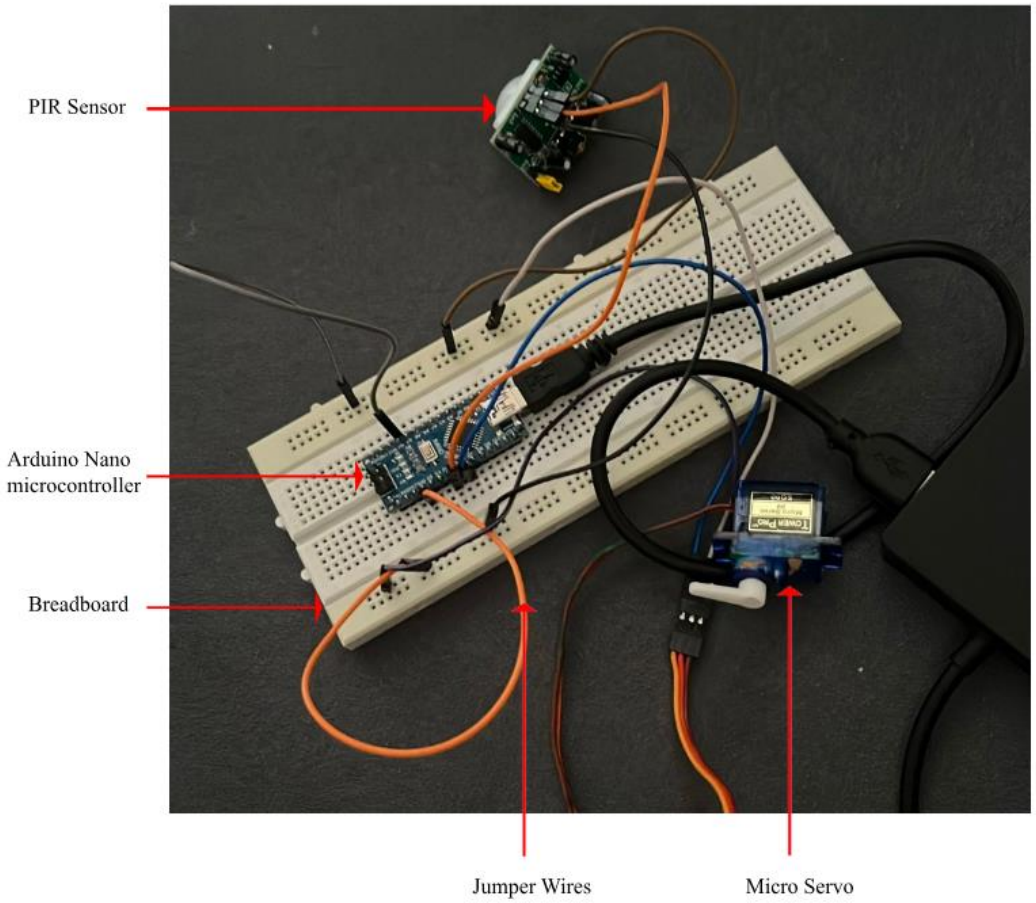
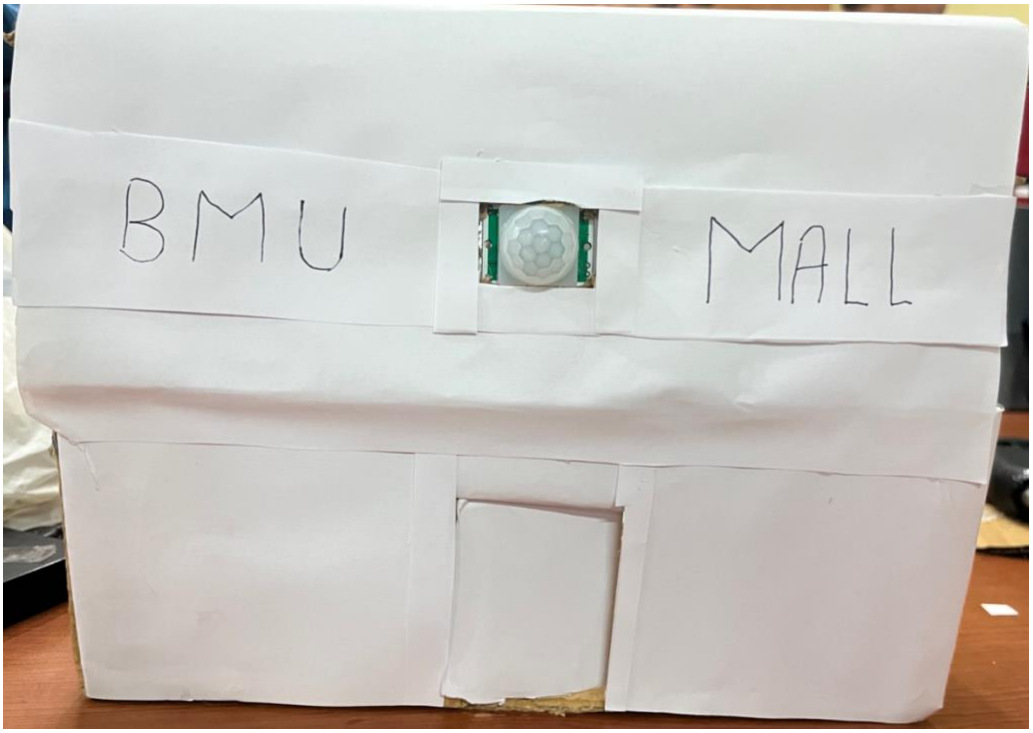



**Fig:** Photo of the hardware implementation.

## 6. RESULTS:

- If motion is detected (logical high on pin 4), the Arduino sends a signal to the micro servo to rotate to 180 degrees, presumably opening the gate.
- If no motion is detected, the Arduino sends a signal to the micro servo to rotate to 0 degrees, presumably closing the gate.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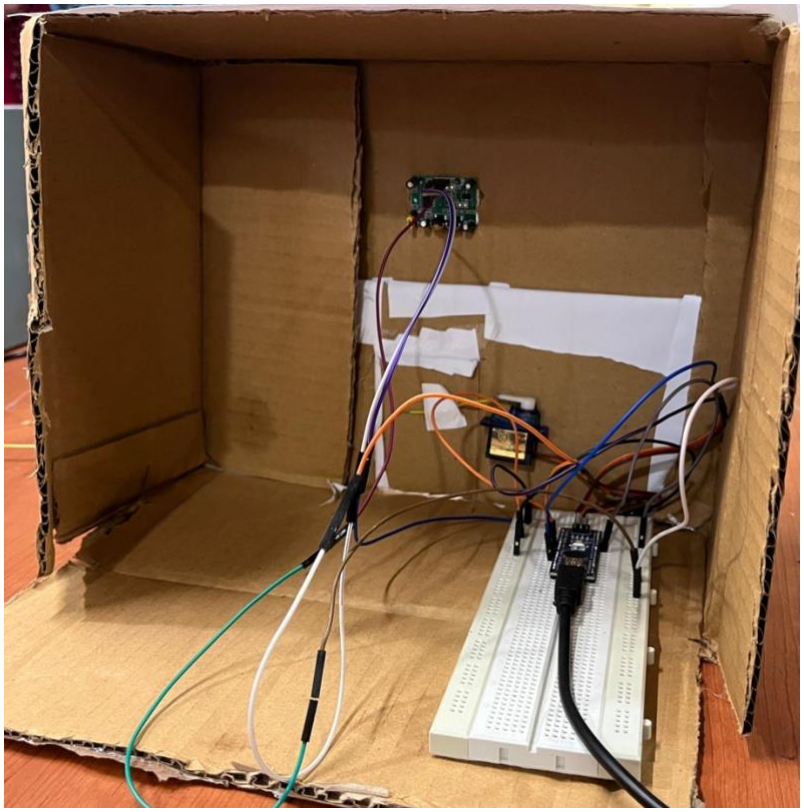

## 7. CONCLUSION:

In conclusion, the Automatic Door Opening System, driven by an Arduino Nano microcontroller and a PIR sensor, offers an efficient and responsive solution for seamless access control. Utilizing a micro servo motor for precise door operation, the system dynamically responds to detected motion. The PIR sensor serves as a dependable motion detector, initiating a series of actions upon sensing movement. Orchestrating the automated door protocol, the Arduino Nano executes code for smooth door opening and closing.

This system streamlines access control in busy shopping environments, enhancing convenience and security. The incorporation of servo motors enables customized door movements, optimizing responses to motion detection. Programmable rotation degrees provide adaptability to various door designs and operational needs.

Despite its simplicity, this Automatic Door Opening System signifies a fundamental application of microcontroller-based automation in commercial spaces. Future iterations may incorporate advanced features like biometric authentication or remote monitoring, pushing the boundaries of convenience and security in modern shopping environments. The continuous evolution of technology promises more sophisticated and adaptable solutions at the intersection of Arduino-based automation and motion sensing technologies.

## 8. References:


ada, l. (2023). *PIR Motion Sensor DataSheet.* Retrieved from PIR Motion Sensor: https://cdn-learn.adafruit.com/downloads/pdf/pir-passive-infrared-proximity-motion-sensor.pdf

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*Servo Motor Datasheet.* (n.d.). Retrieved from SG90 9 g Micro Servo : https://datasheetspdf.com/pdf-file/791970/TowerPro/SG90/1