Smart Railway Crossing Signal System

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Candidate's Declaration

It is declared hereby that this project paper or any part of it has not been submitted to anywhere else for the award of any degree.

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Abstract

As Human safety is major goal for Railways. The intention of this of paper to achieve automatic control at the level crossing when the arrival/departure of the train takes place replacing the manual gate control. The railway gate automatically is closed when a train passes through railway crossing. The detection of arrival and departure of train is done by using two IR sensors. The gate opening and closing is to be done using servo motors/DC motors which is controlling by Arduino Uno. Buzzer is used to indicate the closing of gate for the people who are trying to cross the gate. This system helps in avoiding the increased number of the accidents at level crossing in Bangladesh. The hardware is supported by the Arduino C programming. The proposed system is more reliable and cost efficient

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CHAPTER I

INTRODUCTION

1.1 Automatic Railway Gate Control Using Arduino

Level crossing is that area where the rail line intersects with the road which is used by transportation or other vehicles. To prevent accidents a system named “Level Crossing” has been developed. But in early days all the level crossings are operated by humans. So human interference was mandatory. But, manual control is not errors free. The railway gate or level crossing is opened or closed by a gateman who was informed from the nearest railway station about the arrival of a train. There’re also many level crossings in India which are unmanned. So they are potentially dangerous for road users. In India we must develop a prototype to be implemented to automatically control railway gate upon arrival as well as departure of train. The project should not be too much expensive but must be reliable. So we used Arduino Uno R3 which is quite reliable as well as affordable. We started to develop our project based upon 8051 microcontroller which is also cheaper than Arduino. But in terms of reliability and implementation of future featured we upgraded to andiron Uno.

1.2 What Is Level Crossing?

A level crossing is an intersection where a railway line crosses a road or path at the same level, as opposed to the railway line crossing over or under using a bridge or tunnel. The term also applies when a light rail line with separate right-of-way or reserved track crosses a road in the same fashion. Other names include railway level crossing, grade crossing, and road through railroad, railroad crossing, train crossing, and RXR.

1.3 History of Level Crossing

The history of level crossings depends on the location, but often early level crossings had a flagman in a nearby booth that would, on the approach of a train, wave a red flag or lantern to stop all traffic and clear the tracks. Gated crossings became commonplace in many areas, as they protected the railway from people trespassing and livestock, and they protected the users of the crossing when closed by the signalman/gateman. In the second quarter of the 20th century, manual or electrical closable gates that barricaded the roadway

started to be introduced, intended to be a complete barrier against intrusion of any road traffic onto the railway. Automatic crossings are now commonplace in some countries as motor vehicles replaced horse-drawn vehicles and the need for animal protection diminished with time. Full, half or no barrier crossings superseded gated crossings, although crossings of older types can still be found in places. New technology is advancing to create new ways of protecting the railway from users of a level crossing, with one of the most recent being obstacle detection scanners fitted to some crossings in Europe. In rural regions with sparse traffic, the least expensive type of level crossing to operate is one without flagmen or gates, with only a warning sign posted. This type has been common across North America and in many developing countries. Some international rules have helped to harmonize level crossing. A majority of the level crossings in India were manually regulated. Signals and barriers are installed at all crossings while manual crossings are additionally required to have the hand red and green signal flags. But Indian Railways aims at elimination of all unmanned crossings and replacing it with manned crossings. The Automatic Railway crossing using Arduino Project makes use of an Arduino UNO to manage the whole circuit. A DC motors are acquainted with open and shut the railway gates. The foremost objective is to shut the railway gates when the train approaches it, so on block vehicles from going across the track.

CHAPTER II

Design And Fabrication

2.1 Block Diagram

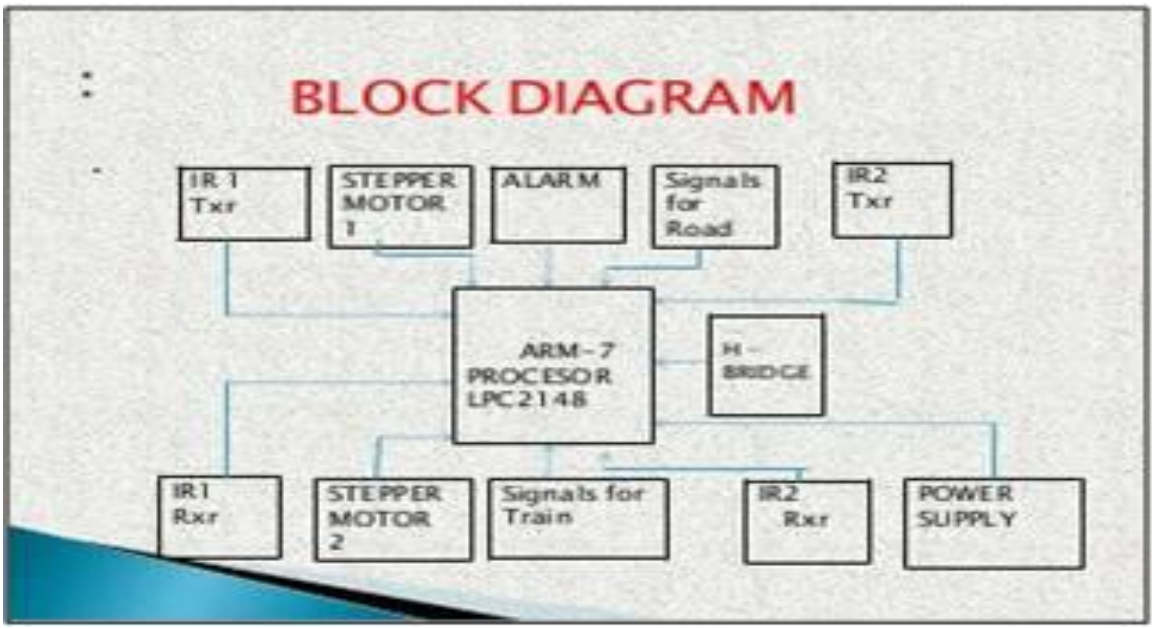


Fig 2.1: Block Diagram.

2.2 Flow Chart

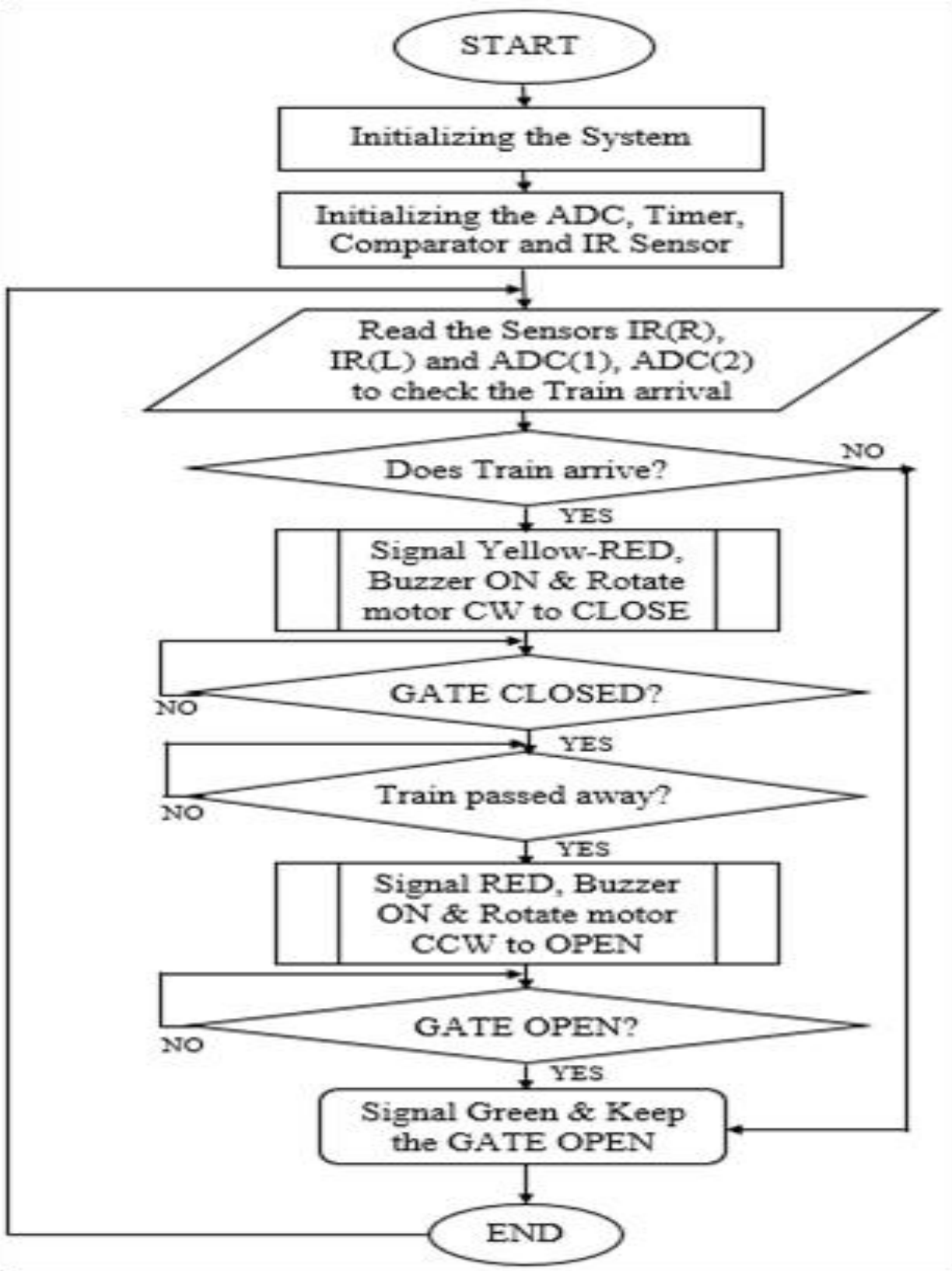


Fig 2.2: Flow Chart.

2.3 Schematic of the project

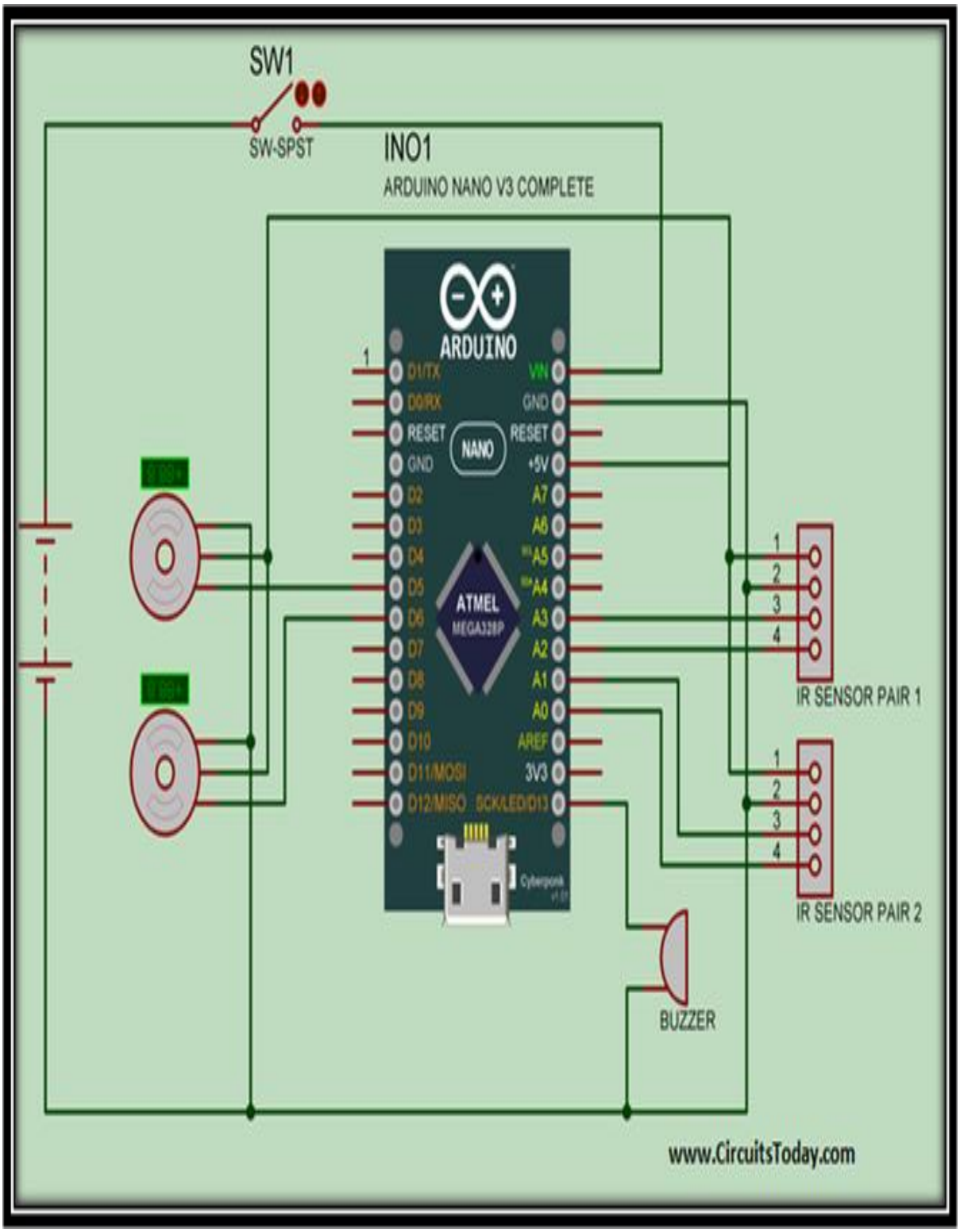


Fig 2.3: Schematic Of The Project .

2.4 Required Components

- Cable and connectors
- Bread board
- Signal led
- Model rail set
- 12v power supply
- Servo motor
- IR sensor
- Arduino Uno micro controller

CHAPTER III

Description of components

3.1 Cable and connectors

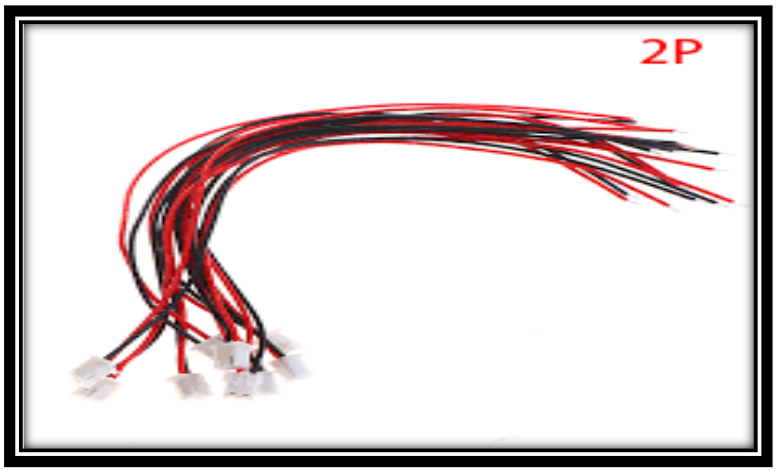


Fig 3.1: Cables.

A cable connector is the component that you attach to the end of a cable so that it can plug into a port or an interface of an electronic system. The majority of connectors are either male or female gender; the males have one or more exposed pins and the female contains holes for those male pins to insert into.

3.2 Bread board

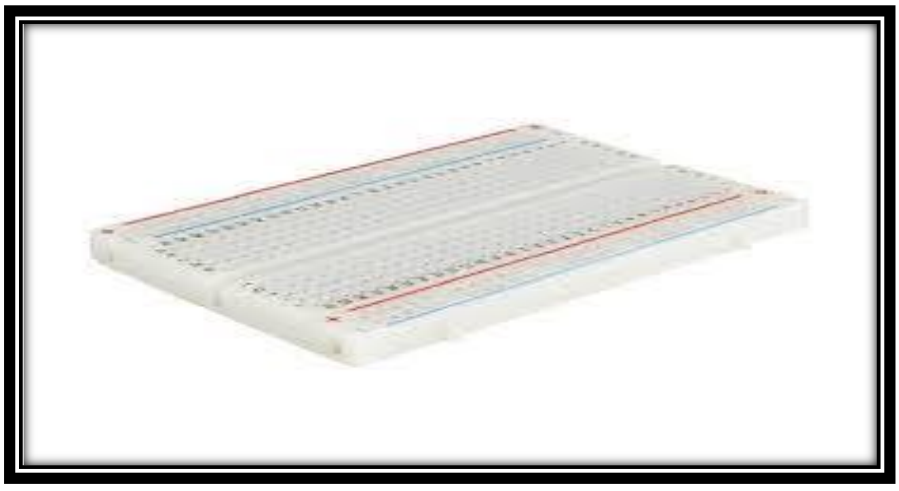


Fig 3.2: Bread Board.

A breadboard, solder less breadboard, proto board, or terminal array board is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike strip board, breadboards do not require soldering or destruction to tracks and are hence reusable.

3.3 Signal led



Fig 3.3: Signal Led.

This is surface mounted Light Emitting Diode (LED) based signal lighting unit with transparent cover of UV painted in matte (dull) finish, to prevent reflection of sunlight or headlight of loco. LED based signal lighting unit is the replacement of the hitherto used signal lamp.

3.4 Model rail set



Fig 3.4: Model Rail Set.

3.5 12v power supply



Fig 3.5: 12V Power Supply.

12V power supplies (or 12VDC power supplies) are one of the most common power supplies in use today. In general, a 12VDC output is obtained from a 120VAC or 240VAC input using a combination of transformers, diodes and transistors.

3.6 Servo motor



Fig 3.6: 12V Servo Motor.

Brushed DC motors rotate continuously when DC voltage is applied to their terminals. The stepper motor is known by its property to convert a train of input pulses(typically square wave pulses) into a precisely defined increment in the shaft position. Each pulse moves the shaft through a fixed angle. Stepper motors effectively have multiple "toothed" electromagnets arranged around a central gear-shaped piece of iron. The electromagnets are energized by an external driver circuit or a micro controller. To make the motor shaft turn, first, one electromagnet is given power, which magnetically attracts the gear's teeth. When the gear's teeth are aligned to thefirst electromagnet, they are slightly offset from the next electromagnet. This means that when the next electromagnet is turned on and the first is turned off, the gear rotates slightly to align with the next one. From there the process is repeated. Each of those rotations is called a "step", with an integer number of steps making a full rotation. In that way, the motor can be turned by a precise angle. The circular arrangement of electromagnets is divided into groups, each group called a phase, and there is an equal number of electromagnets per group. The number of groups is chosen by the designer of the stepper motor. The electromagnets of each group are interleaved with the electromagnets of other groups to form a uniform pattern of arrangement. For example, if the stepper motor has two groups identified as A or B, and ten electromagnets in total, then the grouping pattern would be ABABABABAB. Electromagnets within the same group are all energized together. Because of this, stepper motors with more phases typically have more wires (or leads)

3.7 IR sensor

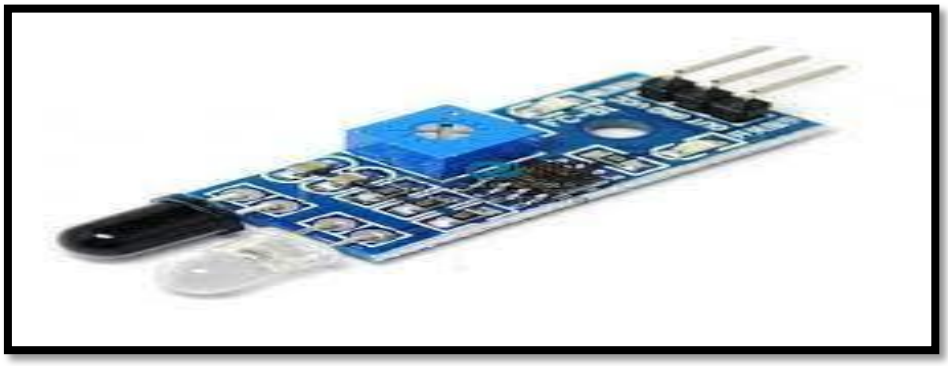


Fig 3.7: IR Sensor.

IR sensor is an electronic device that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the infrared spectrum, all the objects radiate some form of thermal radiation.

3.8 IR LED



Fig 3.8: IR Led.

IR LED emits light, in the range of Infrared frequency. IR light is invisible to us as its wavelength (700nm – 1mm) is much higher than the visible Light range. Everything which produce heat, emits infrared like for example our human body. Infrared have the sameproperties as visible light, like it can be focused, reflected and polarised like visible light.

3.9.1 Photodiode



Fig 3.9.1: Photodiode .

Photodiode is considered as Light dependent Resistor (LDR), means it has very High resistance in absence of light and become low when light falls on it. Photodiode is a semiconductor which has a P-N junction, operated in Reverse Bias, means it start conducting the current in reverse direction when Light falls on it, and the amount of current flow is proportional to the amount of Light. This property makes it useful for IR detection.

3.9.2 IR sensor Module

- Components
- R pair (IR LED and Photodiode)
- IC LM358
- Resistor 100, 10k, 330 ohm
- Variable resistor – 10k
- LED

3.9.3 Circuit Diagram of IR Sensor module

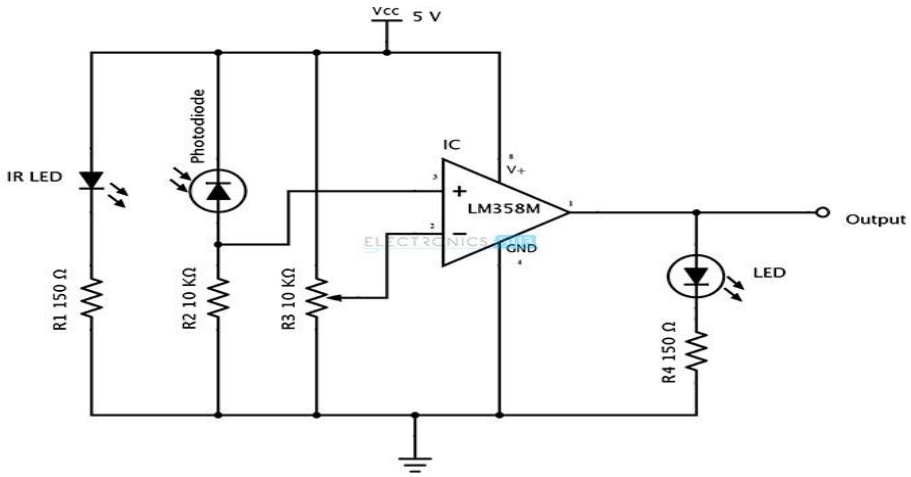


Fig 3.9.2: Circuit Diagram Of Sensor Module.

3.9.4 Working method

When we turn ON the circuit there is no IR radiation towards photodiode and the Output of the comparator is LOW. When we take some object (not black) in front of IR pair, then IR emitted by IR LED is reflected by the object and absorbed by the photodiode. Now when reflected IR Falls on Photodiode, the voltage across photodiode drops, and the voltage across series resistor R2 increases. When the voltage at Resistor R2 (which is connected to the non-inverting end of comparator) gets higher than the voltage at inverting end, then the output becomes HIGH and LED turns ON. Voltage at inverting end, which is also called Threshold Voltage, can be set by rotating the variable resistor's knob. Higher the voltage at inverting end (-), less sensitive the sensor and Lower the voltage at inverting end (-), more sensitive the sensor

3.9.5 Arduino Uno micro controller

Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.[1]

3.9.6 Arduino Uno micro controller

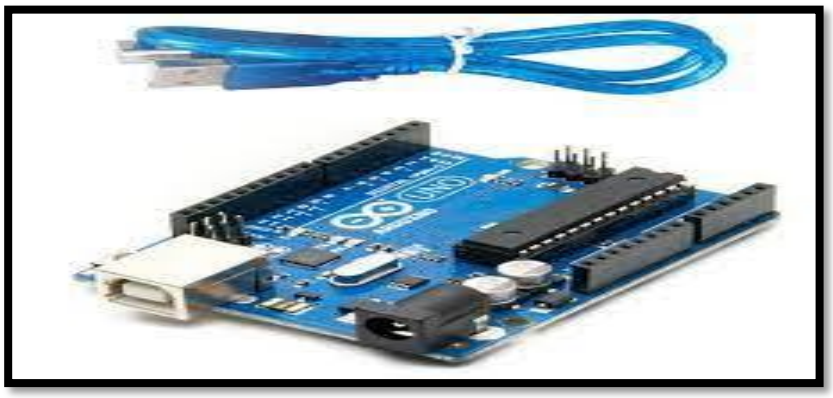


Fig 3.9.3 Arduino Uno Micro Controller.

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website.Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform.[3] The ATmega328 on the Arduino Uno comes preprogrammed with a bootloader that allows to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The Uno also differs from

all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 programmed as a USB-to-serial converter.

3.9.7 Technical Specifications

- Microcontroller: ATmega328P
- Operating Voltage: 5v
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 Ma
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB used by bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- Clock Speed: 16 MHz
- Length: 68.6 mm
- Width: 53.4 mm
- Weight: 25 g

3.9.8 PINS

General Pin functions

- LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

• VIN: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board
- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.

- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

3.9.9 Special Pin Functions

Each of the 14 digital pins and 6 Analog pins on the Uno can be used as an input or output, using pinMode(),digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller. The Uno has 6 analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin and the analog Reference() function. In addition, some pins have specialized functions:

• Serial: pins 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to- TTL Serial chip.

• External Interrupts: pins 2 and 3. These pins can be configured to trigger an

interrupt on a low value, a rising or falling edge, or a change in value.

• PWM(Pulse Width Modulation) 3, 5, 6, 9, 10, and 11 Can provide 8-bit PWM output with the analog Write() function.

• SPI(Serial Peripheral Interface): 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.

• TWI(Two Wire Interface): A4 or SDA pin and A5 or SCL pin. Support TWI

communication using the Wire library.

• AREF(Analog Reference: Reference voltage for the analog inputs.

3.9.10 Communication

The Arduino/Genuino Uno has a number of facilities for communicating with a computer, another Arduino/Genuino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).A SoftwareSerial library allows serial communication on any of the Uno's digital pins.

3.9.11 Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino/Genuino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset thechip.[7] This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened

CHAPTER IV

Description of components

4.1 Software

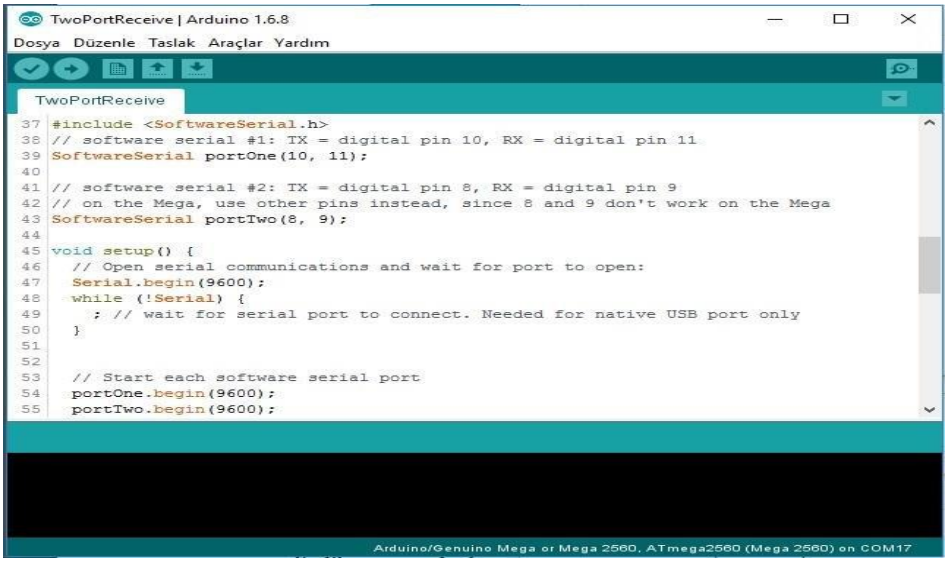


Fig 4.1: Aurdino IDE Interface.

Audrino IDE is used to develop the prototype of the software.Audrino IDE is available at the official website of audrino. This is open source. So any one can develop anything according to their choices.

4.2 Circuit Diagram Of prototype

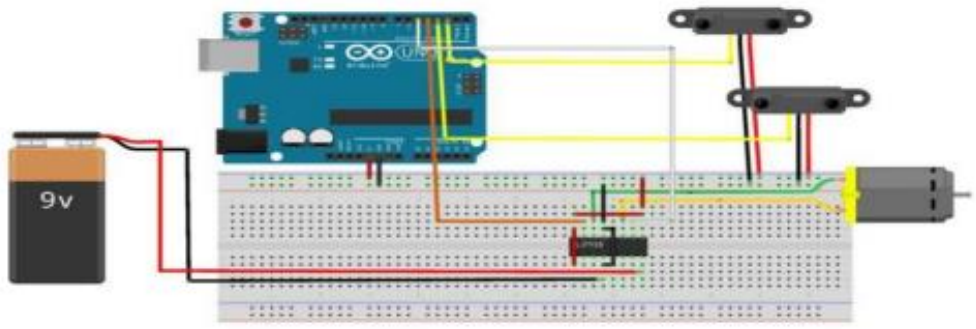


Fig 4.2: Circuit Diagram Of Prototype.

4.3 Working Principal

The working principle of the prototype is quite simple. Two IR sensors are placed at the bpth sides of railway crossing. They are placed 1Km. apart from level crossing. The arrival and departure of train is sensed by the sensors and transmitted to the audrino uno. There’s a loop

that keeps running in the audrino that always checks the ir sensor output. If the ir sensor outputs the signal, the audrino instructs the L293D to close the gate using Stepper motor and play the buzzers to alert the road users. The stepper motor exactly rotated at 90 degrees and the railway gate gets closed. After passing the train the departure is sensed
by the another IR sensor which is placed at the opposite side of the other other IR sensor. When the departure is sensed by another IR sensor the audrino gets the acknowledgement signal to open the gate via L293D module.
Same process happens if the train is coming from another side. The delay between sensed signal and closing of gate is kept small here (500 ms).But in real ife the delay is kept more.

CHAPTER V

Possibilities

5.1 Possible Obstacles

Though this prototype is simple to build and highly reliable but there're some obstacles too. Rather than a train if an animal or other object is placed in front of the IR sensor the alarm will and the gate will be closed which is not desirable at all.Also other natural obstacles like fog may arise problems. There're also a scope of alerting the nearest railway station about arrival and departure of
the train.

5.1 Possible solutions and future scopes

The problems indicated above can be overcome by adding some extra modules. Like we left the GSM module for future scope. After adding this module, upon arrival and departure of train, the GSM module will send an SMS to registered phone number for acknowledgement and safety. Also adding a pair of pressure sensor increases the chance of fault triggering of gate as well as alarm. After adding the pressure sensor, the audrino closes the gate after receiving both signal from IR sensor as well as pressure sensor

CHAPTER VI

Working Procedure

6.1 Working Procedure

- First of all, we need to place the components correct position for the perfect work of the system. Two IR sensors are placed on both sides of **level crossings** and the distance between the two IR sensors is dependent on the **length of the train**. Two Servo motors are placed on both sides of the railway track. [10]

- When the train comes in front of the **IR sensor-1**. Then IR sensor-1 **detects** the arrival of the train. So, the **sensor-1** output goes **LOW(0)**. But, the other side the **IR Sensor-2** output is **HIGH (1)** because this time sensor-2 **does not detect** the train. When the Arduino gets this signal from **two sensors**, then the Arduino sends the **PWM signal** to the **servo motors**. As a result, servo motors start working and **close the gate**. At the time, the Arduino sends commands to turn on **Red LED** , it means that the **train is coming**.

- When the **train crosses the level crossing** and the train comes in front of the IR sensor-2. Then **IR sensor-2** detects the arrival of the train. So, the sensor-2 output goes **LOW(0)**. But, the other side the IR Sensor-1 output is **HIGH (1)** because this time sensor-1 does not detect the train. When the Arduino gets this signal from two sensors, then again the Arduino sends the **PWM signal** to the servo motors. As a result, **servo motors back to the first position**, and automatically open the gate. This time **Green LED** will turn on, it means that the train is gone.

- When **IR sensor 1** and **IR sensor 2** does not detect train, then the output of the sensor is **High (1)**. In this condition, the gate is open and the Green LED will turn on it means that the train does not come.

6.2 Practical Implementation of the Project

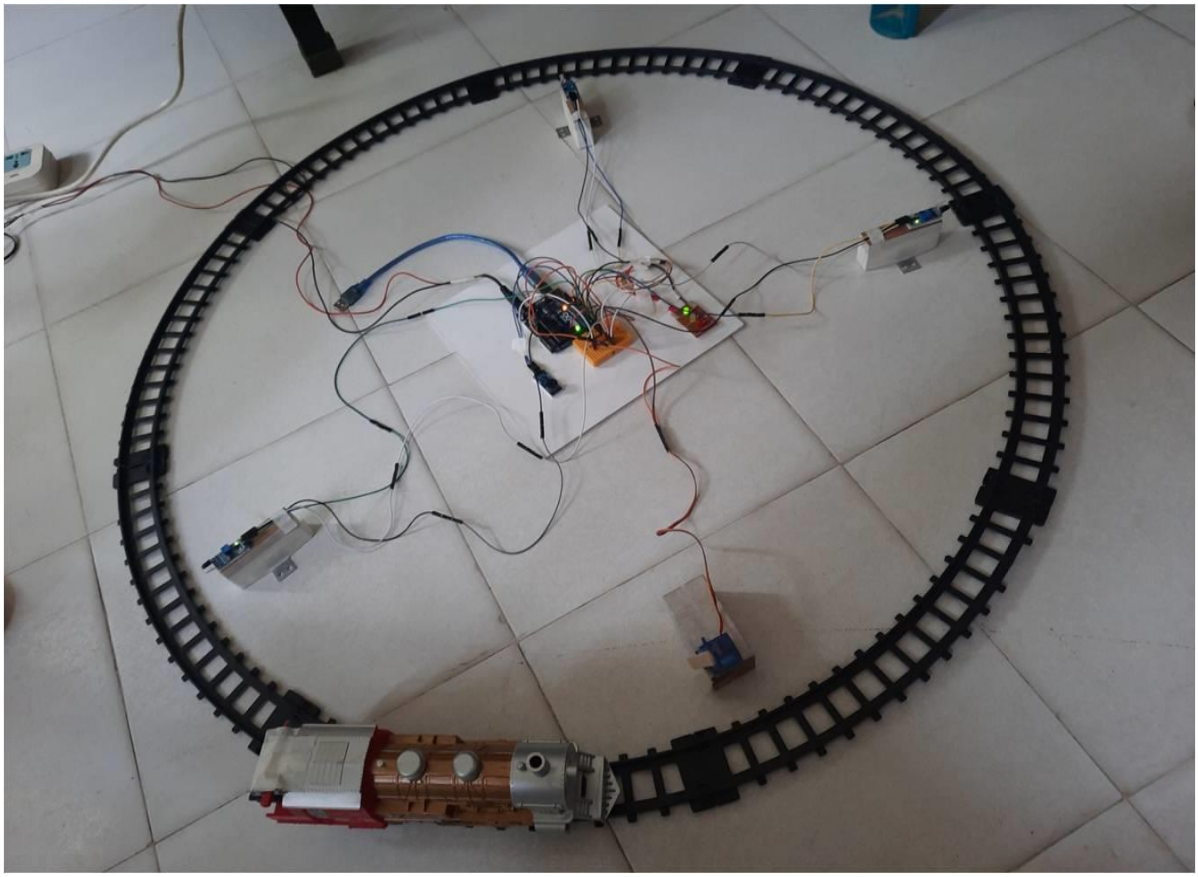


Fig 6.1: Results.

6.3 Results

- Several tests were conducted to gather information on how each of the components in the system operates tests were categorized into three groups as unit testing , integration testing and system testing.
- The aim of this project was to create a automated system for existing railway gates to minimize accidents. Furthermore, Research problem will be solved using this system. Development of this prototype proved that this is an effective and efficient method to control the railway gates instead of the manual operation. Also the system works

autonomously without any external inputs from users making it temper proof and extremely accurate when detecting oncoming trains thus avoiding deaths on the tracks.

6.4 Advantages

Advantages of automatic control system: The need of automation is due to or advantages of automatic control system are:

- It results in economy of operation.
- Elimination of human error.
- If frees human beings from mental tasks.
- Saving in energy requirements.
- Increase in efficiency.

6.5 A Disadvantages

- This system totally depends on gate keeper.
- Accuracy of this system is not good.
- Low reliability.

6.6 Application

- Railway Gate Controlling
- Parking Gate Controlling

CHAPTER VII
Limitation, Future Work & Conclusion

7.1 Limitation

Besides being ineffective in rough weather conditions the system also suffers from being insecure. Even though the IR transmission is encoded, it can be traced with the help of proper equipment and could be used to cause disturbance to the system.

7.2 Future Work

We look forward to incorporating additional features into our project in the near feature. On the first stage of the upgrade, we plan to create a web of wireless communication between the level crossing system and components (sensors, displays etc.) to ensure a seamless process. Our next upgrade will entail a cohesive obstacle detection system with the purpose of detecting obstacles at any point of the train track and a movement tracker in order to prevent the movement of a specific train through track switches in case they are in the wrong position. Our vision is also to make the system fully automated by implementing electronic braking system in the locomotives.

7.3 Conclusion

In a nutshell, this project has given us a unique experience of amalgamating the fields of electronics, communication and computer science, and has brought out a developed system that can be implemented in the real-life scenario. By implementing our system, train collisions can be predicted beforehand and necessary precautions could be taken in order to avoid any accidents. Derailments caused by excessive speeds could also be prevented as speeds of trains are always monitored in the CCS. The intuitive user interface of all three systems would allow users to combat emergency situations very easily. Automatic train detection and obstacle detection at level crossings would play a major role and guarantee a comprehensive amount of safety in the level crossings of Dhaka.

7.3 Arduino Code

```
int sensor1 = 3;
 int sensor2 = 4;
int sensor3 = 5;
int motor = 9;            // potentiometer wiper (middle terminal) connected to
analog pin 3
                          // outside leads to ground and +5V
#include <Servo.h>
 Servo myservo;
int e = 0;
int c = 0;        // variable to store the value read
int x = 0;
void setup()
{
Serial.begin(9600);    // setup serial
pinMode ( sensor1 , INPUT );
pinMode ( sensor2 , INPUT );
pinMode ( sensor3 , INPUT );
pinMode ( motor , OUTPUT );
myservo.attach(9);
}
void loop()
{
e = analogRead(sensor1);     // read the input pin
```

```
c = analogRead(sensor2);
x = analogRead(sensor3);
Serial.println(e);
Serial.println(c);
Serial.println(x);
int pos = 0;
if (e>1000 && c<1000)
{
for(pos = 0; pos <= 90; pos += 1) // goes from 0 degrees to 90 degrees
{ // in steps of 1 degree
myservo.write(pos);     // tell servo to go to position in variable 'pos'
delay(10); break;       // breaks the loop  }
}
if (x>1000)
{
for(pos = 90; pos >= 0; pos -= 1) // goes from 90 degrees to 0 degrees
{ // in steps of 1 degree
myservo.write(pos);       // tell servo to go to position in variable 'pos'
delay(10);
break;                    // breaks the loop
}
{
Serial.println(e);
Serial.println(c);
Serial.println(x);
delay(1000);  }
```

References

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