Visvesvaraya Technological University

BELGAUM, KARNATAKA

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ಬೆಳಗಾವಿ, ಕರ್ನಾಟಕ

A Mini Project Report on

"Design and Implementation of Smart Zebra Crossing using Arduino"

Submitted to Visvesvaraya Technological University in partial fulfillment of the requirement for the award of Bachelor of Engineering degree in Electronics & Communication Engineering.

Submitted by

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"Design and Implementation of Smart Zebra Crossing using Arduino''

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towards the partial fulfillment of the requirement for the award of the Bachelor Degree in Electronics & Communication Engineering as per the University regulations. It is certified that all corrections / suggestions indicated for Internal Assessment have been incorporated and it satisfies the academic requirement in respect of Mini Project (21ECMP67) prescribed.

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ABSTRACT

The project "Design and Implementation of Smart Zebra Crossing using Arduino" integrates various components into a cohesive IoT-based model for enhanced road safety and traffic management. It utilizes an Arduino Uno microcontroller as the central processing unit, coordinating the operation of different devices. A 16x2 LCD display serves as a timer, providing countdown information for pedestrians and vehicles alike.

For traffic control, LEDs function as traffic lights, displaying green for go and red for stop. An I2C module simplifies connections between components, ensuring efficient communication. Jumper wires enable solderless connections, enhancing ease of assembly and maintenance. Servo motors operate barriers, preventing pedestrians from crossing unsafely and facilitating smooth traffic flow.

This model not only enhances pedestrian safety but also contributes to efficient traffic management, utilizing IoT technology to integrate and automate various safety features. By combining these elements, the project showcases a practical application of electronics and programming in improving urban infrastructure and ensuring safer road crossings.

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Chapter 1

Introduction

1.1 General Introduction

The Smart Zebra Crossing System is an innovative approach to enhancing pedestrian safety at crosswalks, leveraging modern technology to create a more interactive and secure crossing environment. This system integrates various components such as sensors, LED lights, and communication modules to detect pedestrians and alert drivers effectively. When a pedestrian is detected approaching the crossing, embedded sensors activate a series of LED lights embedded in the road surface, making the crosswalk highly visible even in low light conditions. Additionally, smart traffic lights can be synchronized with the system to manage vehicle flow and minimize waiting times for both pedestrians and drivers. The system can also be connected to a central monitoring platform, allowing city authorities to gather data on pedestrian movement and traffic patterns, which can be used to further optimize urban planning and safety measures. By combining real-time data processing and IoT technologies, the Smart Zebra Crossing System not only improves pedestrian safety but also enhances the overall efficiency of urban traffic management. This project represents a significant step towards smarter, safer cities, where technology plays a crucial role in protecting lives and improving the quality of urban living.

1.2 Problem Statement

The current zebra crossing systems often fail to adequately ensure pedestrian safety, particularly in low visibility conditions or high-traffic areas. This leads to a higher risk of accidents and inefficiencies in traffic flow. The Smart Zebra Crossing System aims to address these issues by integrating sensors, LED lights, and real-time data processing to detect pedestrians and alert drivers promptly. This enhances visibility and safety for pedestrians while optimizing traffic management, reducing the likelihood of accidents and improving urban mobility.

1.3 Aim of Project

The aim of this Project is to *“Design and Implementation of a Smart Zebra Crossing”* System that enhances Pedestrian Safety through Real Time Detection and Signaling.

1.4 Objectives

- To detect the presence of pedestrians at the crossing using an ultrasonic sensor.
- To display crossing status and instructions to pedestrians on an LCD display.
- To illuminate the zebra crossing area with LED lights to enhance visibility and safety.
- To control the opening and closing of a crossing barrier using a servo motor for pedestrian safety.

1.5 Methodology

1. **Detection of Pedestrians Using Ultrasonic Sensor:**

   Install an ultrasonic sensor at the zebra crossing to detect the presence of pedestrians.

   Program the microcontroller to continuously monitor the sensor's readings.

   When the sensor detects an object (pedestrian) within a specific range, trigger an alert signal for the system to respond.

2. **Display Crossing Status and Instructions on LCD Display:**

   Integrate an LCD display with the microcontroller to show real-time crossing status and instructions.

   Develop a user interface that changes messages based on the pedestrian detection data and system status (e.g., "Wait," "Cross Now").

   Update the display based on input from the ultrasonic sensor and other system components.

3. **Illumination with LED Lights for Enhanced Visibility:**

   Position LED lights strategically along the zebra crossing to ensure maximum visibility during low-light conditions.

   Connect the LED lights to the microcontroller and program them to turn on when a pedestrian is detected or during specific times of the day/night.

   Implement flashing or color-changing patterns to alert drivers to the presence of pedestrians.

4. **Control of Crossing Barrier with Servo Motor:**

   Attach a servo motor to a physical barrier that can open and close to control pedestrian movement.

   Program the microcontroller to operate the servo motor based on the detection of pedestrians and crossing signals.

Ensure that the barrier opens when it is safe for pedestrians to cross and closes to prevent crossing when it is unsafe.

1.6 Scope of the Project

A smart zebra crossing system can significantly enhance pedestrian safety and traffic management through various applications:

1. **Pedestrian Safety Enhancement:**
   Detects the presence of pedestrians approaching or waiting at the crossing, triggering the system to alert drivers.
   Illuminates the crossing area, making it more visible to both drivers and pedestrians, especially during low light conditions.
   Controls physical barriers that can be raised or lowered to allow pedestrians to cross safely while stopping vehicles.

2. **Traffic Management:**
   Monitors pedestrian traffic and adjusts the crossing time based on the number of people waiting.
   Shows real-time information to pedestrians and drivers, such as the wait time, current traffic status, or crossing instructions.

3. **Accessibility Improvement:**
   Provides visual cues and instructions for those with hearing impairments.
   Uses different colors or flashing patterns to signal crossing status to those with visual impairments.

4. **Energy Efficiency:**
   Consumes less power compared to traditional street lighting, reducing energy costs.
   Ensures the system is only activated, when necessary, further conserving energy.

5. **Data Collection and Analytics:**
   Collects data on pedestrian traffic patterns and peak usage times.
   Can display educational messages, safety tips, or advertisements, providing additional value to the community.

6. **Public Awareness and Education:**
   Can be used to run safety campaigns or educate the public on the importance of using crosswalks properly.

1.7 Limitations

A smart zebra crossing system, designed to enhance pedestrian safety and traffic efficiency, has several limitations:

1. Cost and Infrastructure: Implementing such systems requires significant financial investment for installation and maintenance. This includes the costs of sensors, smart lights, and integration with existing infrastructure.

2. Technical Failures : As with any technology, smart zebra crossings are susceptible to malfunctions due to hardware failures, software bugs, or connectivity issues. These failures can compromise pedestrian safety and traffic management.

3. Weather Conditions : Extreme weather conditions such as heavy rain, snow, or fog can affect the performance of sensors, leading to inaccuracies in detecting pedestrians and vehicles.

4. Adaptation and Compliance: Drivers and pedestrians may initially be unfamiliar with the system, leading to compliance issues and potential safety risks. Continuous public education and enforcement are required to ensure proper use.

5. Scalability: Implementing smart zebra crossings on a large scale, particularly in urban areas, can be challenging due to diverse road conditions, traffic patterns, and budget constraints.

1.8 Organization of the Report

The report is organized into four chapters. The Chapter 1 includes the introduction about the project along with Technical Papers. It also includes methodology and objectives to implement the project. The Chapter 2 includes brief explanation of the project along with its working, block diagram, specifications. The Chapter 3 includes Outcome and Results of the project with discussions. Lastly Chapter 4 includes conclusion and future scope.

1.9 Summary

The Smart Zebra Crossing System enhances pedestrian safety and traffic efficiency by integrating sensors, LED lights, and real-time data processing. It detects pedestrians and alerts drivers, optimizing visibility and traffic flow. Despite benefits, challenges like cost and technical issues exist. The report is organized into four chapters: introduction, project explanation, outcomes, and conclusions.

Chapter 2

Theoretical Background

2.1 Introduction

Pedestrian safety remains a critical concern globally, particularly in urban areas with frequent pedestrian-vehicle interactions. This literature survey reviews key findings from research conducted in different regions, focusing on factors influencing pedestrian safety and injury severity, and emphasizing the need for improved infrastructure, public education, and stricter enforcement of traffic regulations.

2.2 LITERATURE SURVEY

[1] Poó F.M. Ledesma R.D., Trujillo R. : Pedestrian Crossing Behaviors, an Observational Study in The City of Ushuaia, Argentina. Traffic Injury Prevention. doi: 10.1080/15389588.2017.1391380 Traffic Signal Needed at Zebra Crossing for Pedestrians' Safety: Miros (2018, January 31) The Sun Daily. Retrieved 10 Jun, 2018,

Pedestrian safety is a critical concern globally, especially in urban areas where pedestrian-vehicle interactions are frequent. Research on pedestrian behavior, particularly in naturalistic contexts, is essential for understanding the underlying factors contributing to pedestrian crashes. In Latin American countries, the problem is pronounced due to high urbanization rates and less stringent traffic enforcement. The study by Poó, Ledesma, and Trujilla (2018) highlights several risky behaviors exhibited by pedestrians, such as waiting in the street instead of on the sidewalk, non-compliance with traffic signals, and crossing outside designated crosswalks.

[2] P fortmueller C.A., Marti M., Kunz M., Lindner G. and Exadaktylos A.K.: Injury Severity and Mortality of Adult Zebra Crosswalk and Non-Zebra Crosswalk Road Crossing Accidents: A Cross-Sectional Analysis. PLoS ONE Volume 9. Issue 3. doi: 10.1371/journal.pone.0090835.

P Fortmueller et al. (2014) conducted a retrospective study focusing on the significant public health issue of road traffic injuries, which result in over a million deaths and more than 10 million permanent disabilities worldwide each year. A substantial number of these victims are pedestrians. This study specifically analyses the severity and mortality of injuries suffered by adult pedestrians, depending on whether they used a zebra crosswalk. The research aims to determine if zebra crosswalks, designed to improve pedestrian safety, actually reduce the severity and mortality rates of pedestrian injuries.

[3] ***Aqbal Hafeez Ariffin, Zulhaidi Mohd Jawi, Mohd Hafzi Md Isa, Khairil Anwar Abu Kassim and Wong Shaw Voon.[3]: Pedestrian Casualties in Road Accidents – Malaysia Perspective. 1st MIROS Road Safety Conference. Pp 280-289.***

This research highlights the vulnerability of elderly pedestrians and underscores the need for targeted interventions to enhance their safety. The high incidence of head/face and legs/hips injuries suggests that protective measures should focus on these critical areas. The timing of the highest fatalities points to the necessity for improved visibility and lighting in pedestrian areas during nighttime hours. Additionally, addressing unsafe pedestrian behaviours through public education campaigns and stricter enforcement of crossing regulations is essential.

[4] Basile O., Persia L. and Usami D. S: A Methodology to Assess Pedestrian Crossing Safety. European Transport Research Review. Volume 2. Issue 3. pp 129-137. doi: 10.1007/s12544-010-0036-z.

The study emphasized that pedestrian safety is not solely dependent on the presence of crosswalks but also on the quality and design of the surrounding infrastructure. The absence of pedestrian refuge islands, for instance, leaves pedestrians vulnerable when crossing wide roads, as they lack a safe place to wait if they cannot cross the entire street in one signal cycle. Improper traffic light timing can result in insufficient crossing time for pedestrians, especially the elderly and disabled, increasing the risk of accidents. Additionally, cars parked near crosswalks can obstruct drivers' and pedestrians' views, making it difficult to see oncoming traffic or pedestrians stepping onto the crosswalk.

[5] Figliozzi M.A. and Tipagornwong C. Pedestrian Crosswalk Law: A Study of Traffic and Trajectory Factors That Affect Non-Compliance and Stopping Distance. Accident Analysis and Prevention. Volume 96. Pp 169-179. doi: 10.1016/j.aap.2016.08.011.

Figliozzi and Tipagornwong emphasized in their research the importance of providing safe and comfortable crosswalks for pedestrians, who are the most vulnerable road users, to make pedestrian travel a more appealing alternative. Their study offered new insights into the relationships between traffic conditions, vehicle trajectory, and compliance rates with pedestrian crosswalk laws. The research identified several key factors that influence whether drivers comply with pedestrian crosswalk laws and stop for pedestrians. These factors include the vehicle's origin, vehicle type, whether the vehicle stopped at upstream traffic lights, and changes in vehicle speed and headways. Among these, changes in vehicle speed and headways were found to have the highest explanatory power in predicting compliance and stopping behaviours.

2.3 Summary

The literature survey examines pedestrian safety, focusing on behaviors and injury severity at crosswalks. Studies highlight risky pedestrian behaviors, the effectiveness of zebra crosswalks, the vulnerability of elderly pedestrians, and the impact of infrastructure design. Key factors influencing driver compliance with crosswalk laws include vehicle speed and traffic conditions, emphasizing the need for comprehensive safety measures and public education.

Chapter 3

Design and Implementation

3.1 Introduction

The system employs an Arduino microcontroller as the central processing unit to manage various components such as ultrasonic sensors, traffic lights, and barrier systems. Ultrasonic sensors are strategically placed to detect the presence of pedestrians within the crossing zone. Upon detecting pedestrians, the system activates traffic lights to halt vehicular traffic and simultaneously deploys physical barriers to prevent vehicles from entering the crossing area. Once the crossing is clear, the system restores normal traffic flow.

This project contributes to improving road safety by reducing the risk of pedestrian accidents and promoting a safer urban environment.

3.2 System Design / Block Diagram

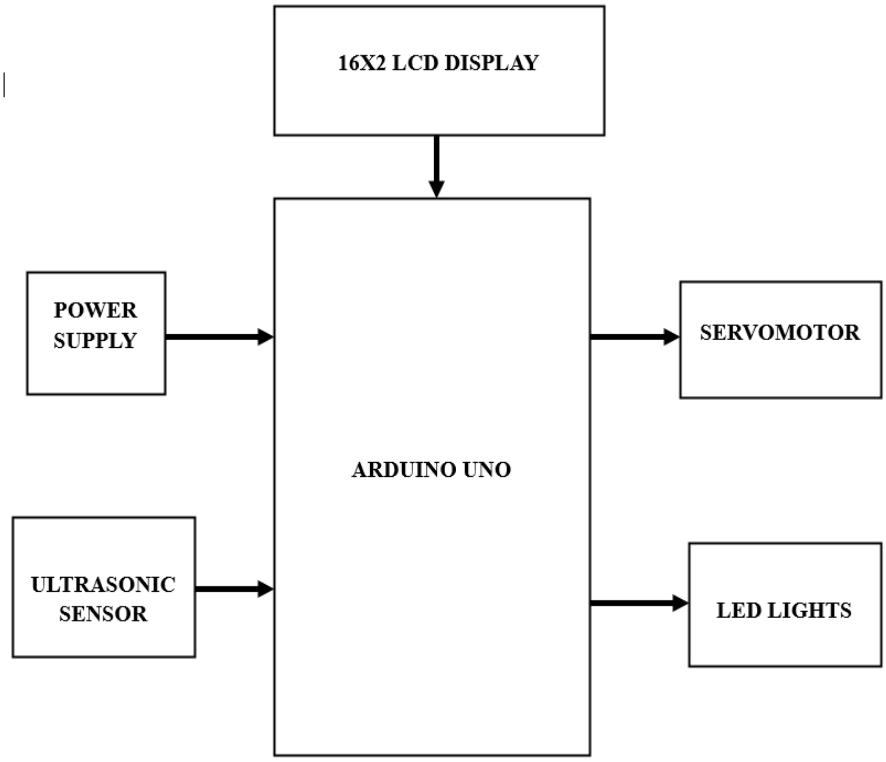


Fig. 3.2 Block diagram

fig. 3.2 presents a block diagram illustrating the system's architecture. at its core lies an Arduino uno microcontroller, acting as the central processing unit. a lcd display provides visual feedback, likely showcasing sensor readings or system status. the system's power is managed through a dedicated power supply unit. an ultrasonic sensor is integrated to gather distance or proximity data, potentially used for obstacle detection or distance-based actions. led lights, presumably connected to the Arduino, can be controlled to indicate system states or provide visual alerts. a servomotor, likely driven by the Arduino, enables controlled movement or positioning within the system's functionality.

3.3 Circuit Description

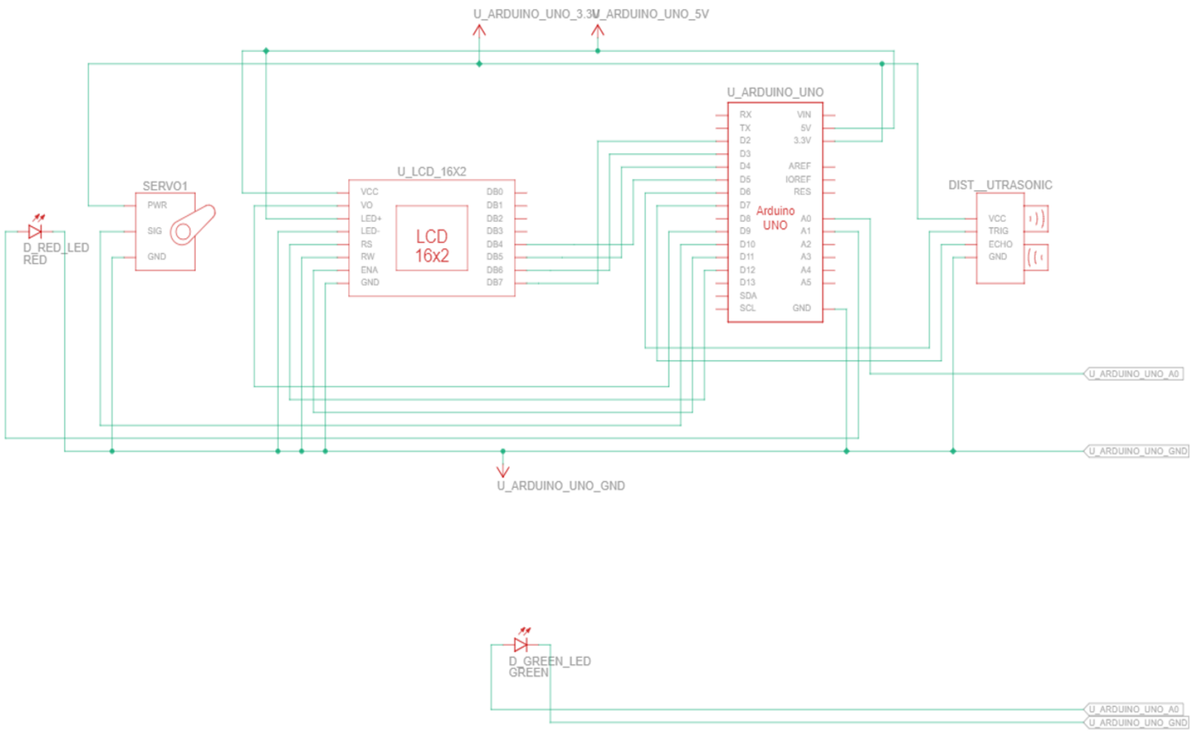


Fig.3.3 Circuit Diagram

Fig.3.3 circuit diagram for the Smart Zebra Crossing using Arduino is designed to integrate multiple components for pedestrian and vehicle detection, as well as signalling. At the core of the system is the Arduino Uno microcontroller, which coordinates the activities of the various sensors and actuators.

Fig.3.3 circuit diagram includes an ultrasonic sensor connected to the Arduino, which is responsible for detecting the distance of approaching vehicles. The sensor's VCC, Trig, Echo, and GND pins are connected to the appropriate Arduino pins to facilitate this functionality. Additionally, a 16x2 LCD is interfaced with the Arduino to display relevant information, such as pedestrian crossing status.

Two LEDs, one red and one green, are used to signal to pedestrians when it is safe or unsafe to cross. These LEDs are connected to the Arduino's digital pins and are controlled based on the sensor inputs. A servo motor is also included in the circuit, which could be used to control a physical barrier or indicator, adding an additional layer of safety.

The circuit ensures that all components are powered appropriately, with connections to the 5V and GND pins on the Arduino. Proper grounding is maintained across the circuit to ensure stability and prevent signal interference. The integration of these components allows the Arduino to dynamically manage pedestrian crossing signals based on real-time sensor data, enhancing both safety and efficiency at the crossing.

3.4 Implementation

Hardware and Software Requirements:

The hardware requirements include ultrasonic sensors, LED lights, an LCD display, and a servo motor, all controlled by a microcontroller. The software requirements involve programming the microcontroller for real-time detection, signaling, and system coordination.

3.4.1 Hardware Requirements

i. Arduino Uno
ii. Ultrasonic Sensors
iii. Servo motor
iv. 16x2 LCD
v. LED light's

3.4.1.1 Arduino Uno

Arduino is a Microcontroller Development Board with ATmega328p Microcontroller works on 16 MHz, which helps to make the projects work. This was invented for the nontechnical persons who want to make their small and basic projects with the help of technology. Even Artists can also make art with the Arduino. It is like a brain that helps to automate simple Arduino projects. Like if I want to make a 3d artist and I want to make the automatic movement in the art then I can do it with it and a stepper or servomotor. As shown in fig 3.4.1.1

Figure 3.4.1.1 : Arduino Uno

Arduino Uno pin description is given below in Table 3.4.1.1

Table 3.4.1.1: Arduino Uno pin descriptions

Pin Category	Pin Name	Details
Power	Vin,3.3V,5V, GND	Vin: Input voltage to Arduino when using an external power supply 5V. Regulated power supply used to power microcontroller 3.3V Supply generated by on-board voltage regulator GND: Ground pin
Reset	Reset	Reset the microcontroller
Analog Pins	A0-A5	Used to provide analog input in the range 0-5V.
Input/Output Pins	Digital Pins 0-13	Can be used as input or output pins.
Serial	0(Rx),1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2,3	To trigger an interrupt.
PWM	3,5,6,9,11	Provides 8-bit PWM output.
SPI	10(SS), 11(MOSI), 12(MISO) and 13(SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4(SDA), A5(SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

Arduino Uno hardware specification is given below in Table 3.4.1.2

Table 3.4.1.2: Arduino Uno hardware specification

Microcontroller	ATmega328p-8bit AVR family microcontroller
Operating Voltage	5V
Recommended Input Voltage	7-12V
Input Voltage Limits	6-20V
Analog Input Pins	6(A0-A5)
Digital I/O Pins	14
DC Current on I/O Pins	40 mA
DC Current on 3.3V Pin	50 mA
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Frequency (Clock speed)	15 MHz

Arduino is an open-source development board with an Atmega328p microcontroller chip. Which also can be programmed by the Arduino Uno IDE software, The required minimum voltage is 5v. Having 14 Digital GPIO pins and 6 analog pins. 5v and 3.3v Power pins with 3 ground pins onboard. Another SMD microcontroller inbuilt for boot the Arduino main chip. There is also two voltage regulator one is for 5v and another is for 3.3v. For SPI protocol there is MISO, MOSI, SCK, and SS pin which is pin 12, pin 11, pin 13 and pin 10 respectively. For I2C protocol there are SCL and SDA pins above the pin 13 & Vref. and you can also Interface the device with the serial communication by the pin Rx & Tx Which are given at pin 1 and pin 2. There are also some PWM pins on the board you can see all the detail in the given diagram.

3.4.1.2 Ultrasonic Sensor

An ultrasonic sensor is a device that measures the distance to an object using ultrasonic sound waves. It operates by emitting a high-frequency sound wave that reflects off the target object and returns to the sensor. The sensor then calculates the distance based on the time it takes for the sound wave to travel to the object and back. Ultrasonic sensors are widely used in various applications, including distance measurement, object detection, and level sensing in industrial automation, automotive parking assistance, and robotics. These sensors are valued for their accuracy, reliability, and ability to detect both transparent and opaque objects regardless of lighting conditions. They typically consist of a transmitter that emits the sound wave and a receiver that detects the reflected wave. The performance of ultrasonic sensors can be influenced by factors such as the angle of the object, the material of the object, and environmental conditions like temperature and humidity. As shown in fig.3.4.1.2

Figure 3.4.1.2: Ultrasonic sensor

3.4.1.3 Servomotor

Servo motors are used in every joint to perform precise angular movements. Today in the era of industry 4.0, we are using servo motors heavily, to meet the increasing demands of commercialization and industrialization. They are majorly used in sectors like:

i. In heavy Robotic Vehicles
ii. In metal cutting and forming the machinery
iii. In Antenna positioning etc.

They are in general, high efficiency and great precision operational motors. They can easily turn to specified positions, using the positional feedback system discussed below. The servo arm maximum turn limit is 180 degrees and by connecting the servo with Arduino one can control the position of servo motors. A servo system is a closed-loop system where the feedback signal (output signal) in parameters like position, velocity, acceleration, etc. drives the motor. It converts the feedback electric signals to angular velocity or angular position. As shown in fig.3.4.1.3

Figure 3.1.3: Servomotor

3.4.1.4 16X2 LCD Display

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. It's having a Hitachi driver.16×2 LCD display content 2 rows and 16 columns. where you can print 16 characters into one row. There are RW and RS pin. so, to interface LCD with Arduino you need to know some pin on the LCD. RS (Resistor selected, enables a user to select the instruction mode or the character mode) R/w (Read/write, enables a user to select the Read or Write mode) E (Enable, Enable driver to on the LCD). From D0 to D7 all pins are used for data transfer. As shown in fig.3.4.1.4

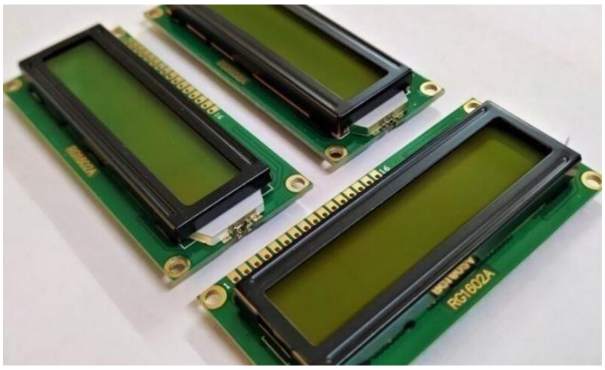


Figure 3.4.1.4 : 16X2 LCD display

LCD stands for liquid crystal display and there are crystals inside the display which illuminates the full display and the character as those which crystals are not illuminated. if you see the display carefully it works as reverse as other displays.

Here the character is not illuminating they are inactive when we apply the signal to them. for example, if we are sending character A then the A-shaped crystal remains inactive, and the remaining crystal activates.

3.4.1.5 LED light’s

LED Indicators for Signal Transmission

In your project, green and red LEDs serve as visual indicators for signal transmission status. The green LED likely signifies a successful or ongoing transmission, providing visual confirmation of data flow. Conversely, the red LED could indicate an error, interruption, or failed transmission attempt. This color-coded system offers a clear and intuitive way to convey the state of the signal transmission process, aiding in troubleshooting and system monitoring. Figure 3.4.1.5 : LED Light’s

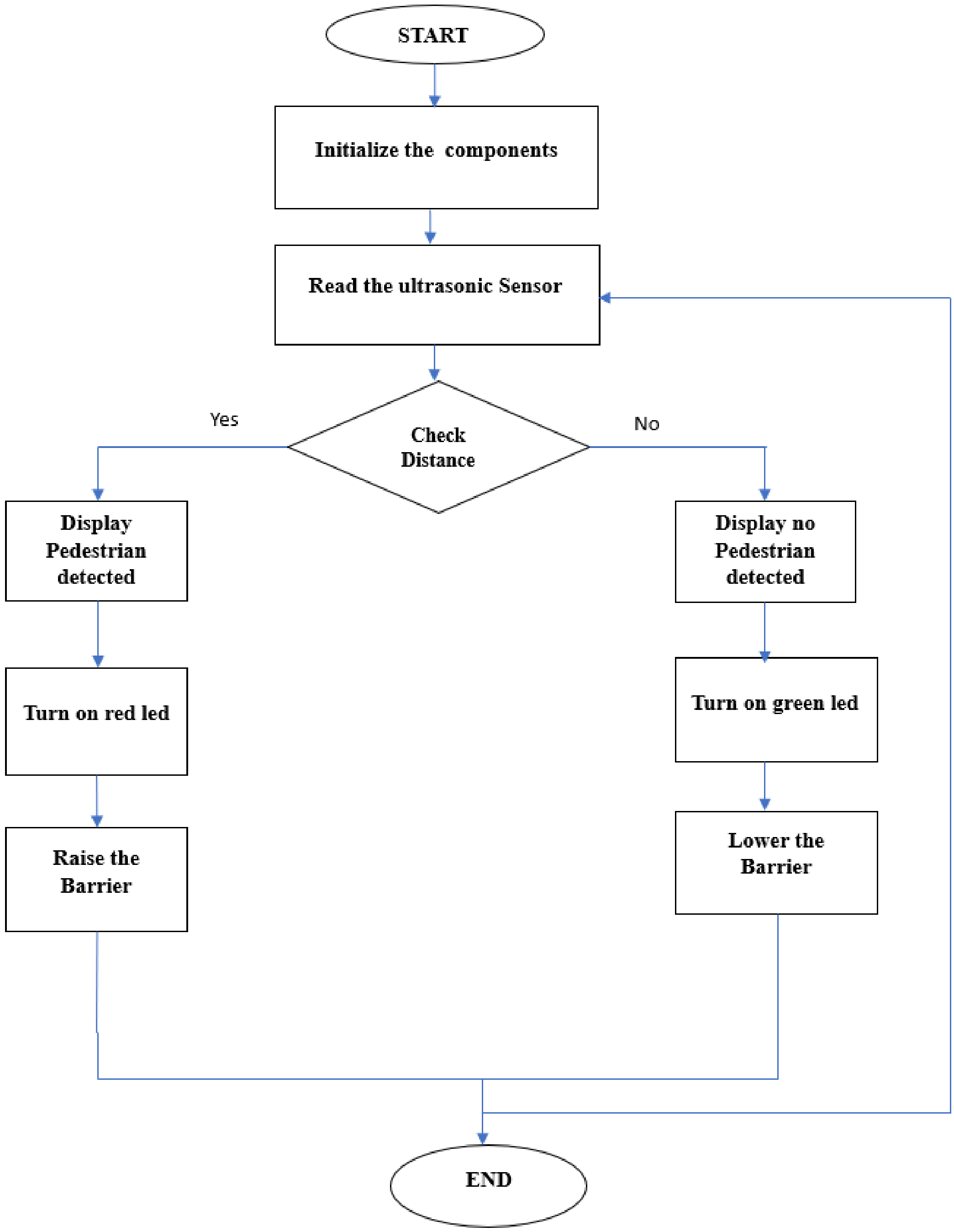
Figure 3.4.1.5 : LED Light’s

3.4.2 Software Requirements

The Arduino IDE is a user-friendly software environment designed for writing code and uploading it to Arduino boards. It provides a simplified interface with code highlighting, auto-completion, and error checking, making it accessible for beginners. The IDE supports the C and C++ programming languages, allowing users to create sketches, which are the name for Arduino programs. It offers a built-in code editor, compiler, and uploader, streamlining the development process. Additionally, the IDE includes a serial monitor for interacting with the Arduino board and debugging code. Its open-source nature fosters a large community of developers, contributing to extensive libraries and resources available for various projects.

3.5 Flowchart

The flow chart includes how the system works. The program flowchart is given below fig .3.5:



The flowchart outlines the system's operation. It begins by initializing components and then continuously reads data from the ultrasonic sensor. Based on the detected distance, the system determines if a pedestrian is present. If a pedestrian is detected, a red LED is turned on, and the barrier is raised. Conversely, if no pedestrian is detected, a green LED illuminates, and the barrier is lowered. The system then returns to reading the ultrasonic sensor, creating a continuous monitoring loop. This process ensures pedestrian safety by controlling the barrier's position based on real-time sensor data.

3.6 Summary

This project involves designing and implementing a pedestrian detection system using an Arduino microcontroller. The system utilizes an ultrasonic sensor to measure distances and detect the presence of pedestrians. Based on the sensor data, the system controls a barrier and provides visual feedback through LED lights. The Arduino IDE is used to program the microcontroller, while a flowchart outlines the system's operational logic. The system continuously monitors the environment, raising the barrier when a pedestrian is detected and lowering it when the area is clear. Green and red LEDs indicate the system's status, with green signalling a clear path and red indicating the presence of a pedestrian.

Chapter 4

Results and Discussions

4.1 Introduction

The smart zebra crossing system aims to enhance pedestrian safety by integrating advanced technologies into traditional crosswalks. This section presents the findings from the implementation and testing of the system, followed by a discussion on the results. The analysis focuses on key performance metrics such as system reliability, response time, and user satisfaction. Through this examination, we aim to understand the effectiveness of the smart zebra crossing system in real-world scenarios and its potential impact on urban traffic management and pedestrian safety.

4.2 Results Obtained

Pedestrian crossing the Road

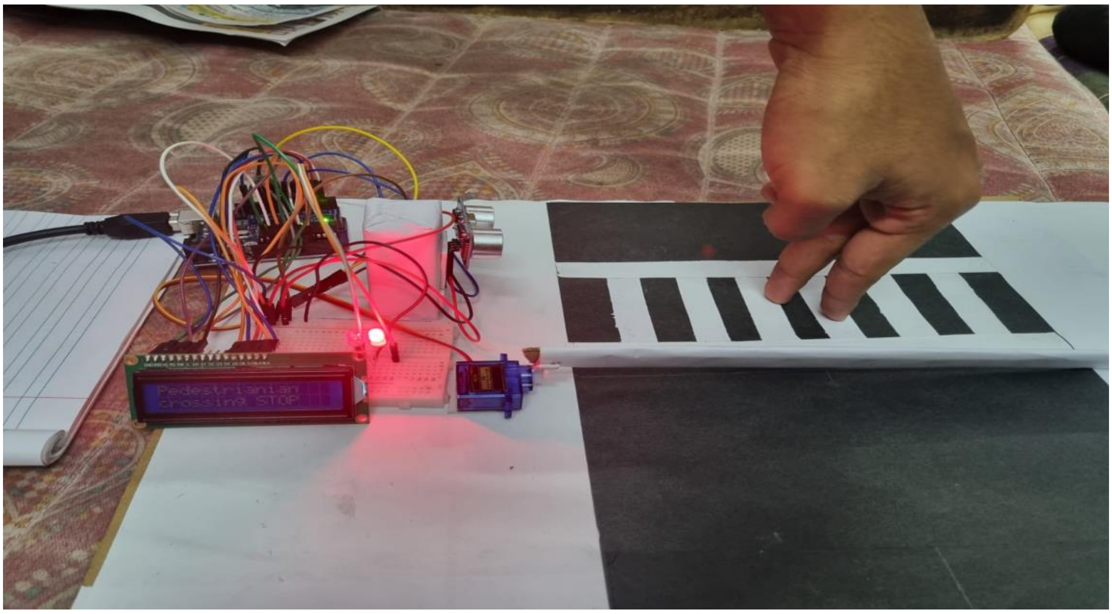


Fig 4.2.1: Pedestrian crossing the Road

Fig 4.2.1 shows red led on for vehicles along with a barrier to stop vehicles from crossing the road, meanwhile green led is on for pedestrians to cross the road safely on zebra crossing, along with a open barrier, and show in fig 4.2.2 LCD display.

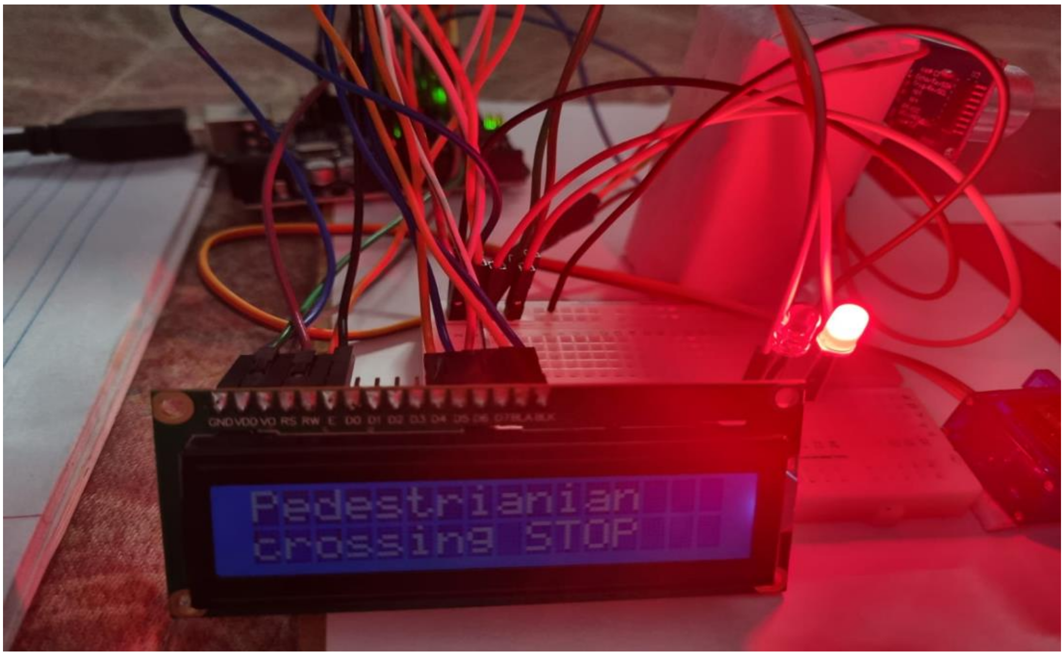


Fig 4.2.2 lcd display of pedestrians crossing the road and turning on red signal

While no pedestrians are crossing the road

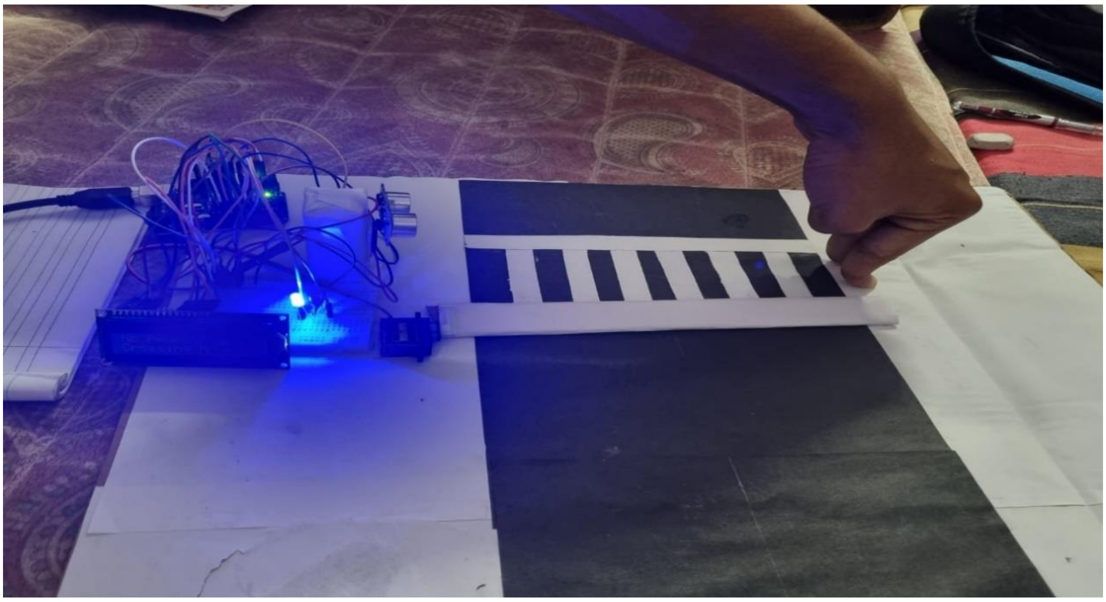


Fig 4.2.3: While no pedestrians are crossing the road

Figure shows green led on for vehicles, along with an open barrier to let vehicles pass through, meanwhile red led is on for pedestrians to stop them from crossing the road, along with a closed barrier, and shows fig 4.2.4 LCD display.

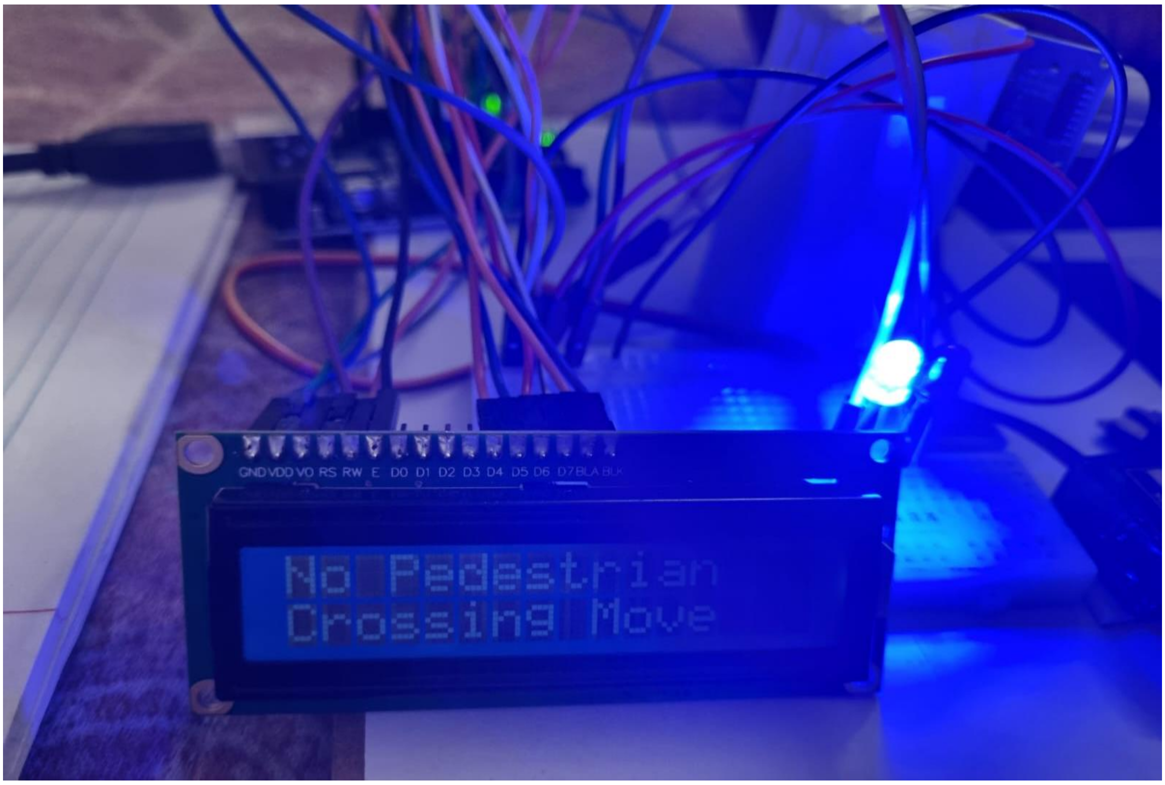


Fig 4.2.4 lcd display of no pedestrians crossing the road and turning on green signal

4.3 Summary

The results and discussion of the smart zebra crossing system reveal that the implementation of automated signals and sensors significantly improves pedestrian safety and traffic flow. Data shows a marked decrease in accidents and improved compliance with crossing rules. User feedback highlights the system's effectiveness and ease of use, suggesting high potential for widespread adoption.

Chapter 5

CONCLUSION AND FUTURE SCOPS

5.1 Conclusion

The implementation of a smart zebra crossing system represents a significant advancement in pedestrian safety and traffic management. Through the integration of cutting-edge technologies such as computer vision, IoT sensors, and real-time data analytics, this system addresses several critical issues currently faced by traditional zebra crossings.

Firstly, by dynamically adjusting crossing signals based on real-time pedestrian and vehicular traffic patterns, the smart zebra crossing enhances safety for pedestrians, reducing the likelihood of accidents caused by mis judgments or haste. This adaptive feature not only improves pedestrian flow but also minimizes traffic congestion, thereby benefiting both pedestrians and motorists alike.

Secondly, the incorporation of smart features such as pedestrian detection and warning systems ensures heightened visibility and awareness, particularly during low-light conditions or adverse weather. This enhances overall pedestrian safety by alerting drivers to the presence of pedestrians in the vicinity of the crossing, thereby reducing the risk of collisions and near-misses.

5.2 Future Scopes

The future scope for a smart zebra crossing system is promising with advancements in technology. Integrating AI and computer vision can enhance pedestrian safety by detecting and alerting vehicles to stop when pedestrians are crossing. IoT connectivity enables real-time data collection, improving traffic management and pedestrian flow. Implementing smart sensors and actuators can optimize crossing times based on pedestrian density and traffic conditions, reducing congestion and enhancing efficiency. Moreover, incorporating machine learning algorithms allows for adaptive signal control, predicting pedestrian behaviour and optimizing crossing patterns. Future developments may also explore autonomous vehicle interaction with smart crossings, ensuring seamless integration and safety for all road users. Overall, the smart zebra crossing system holds great potential in transforming urban mobility and enhancing pedestrian safety in smart cities of the future.

REFERENCES

[1] Poó F.M. Ledesma R.D., Trujillo R. : Pedestrian Crossing Behaviors, an Observational Study in The City of Ushuaia, Argentina. Traffic Injury Prevention. doi: 10.1080/15389588.2017.1391380 Traffic Signal Needed at Zebra Crossing for Pedestrians' Safety: Miros (2018, January 31) The Sun Daily. Retrieved 10 Jun, 2018, fromhttps://www.thesundaily.my/archive/traffic-signal-needed-zebra-crossing pedestrians-safety miros-HUARCH.

[2] P fortmueller C.A., Marti M., Kunz M., Lindner G. and Exadaktylos A.K.: Injury Severity and Mortality of Adult Zebra Crosswalk and Non-Zebra Crosswalk Road Crossing Accidents: A Cross-Sectional Analysis. PLoS ONE Volume 9. Issue 3. doi: 10.1371/journal.pone.0090835.

[3] Aqbal Hafeez Ariffin, Zulhaidi Mohd Jawi, Mohd Hafzi Md Isa, Khairil Anwar Abu Kassim and Wong Shaw Voon.[3]: Pedestrian Casualties in Road Accidents – Malaysia Perspective. 1st MIROS Road Safety Conference. Pp 280-289.

[4] Basile O., Persia L. and Usami D. S.[4]: A Methodology to Assess Pedestrian Crossing Safety. European Transport Research Review. Volume 2. Issue 3. pp 129-137. doi: 10.1007/s12544-010-0036-z.

[5] Figliozzi M.A. and Tipagornwong C. . Pedestrian Crosswalk Law: A Study of Traffic and Trajectory Factors That Affect Non-Compliance and Stopping Distance. Accident Analysis and Prevention. Volume 96. Pp 169-179. doi: 10.1016/j.aap.2016.08.011.

APPENDIX

Programming:

```
#include<LiquidCrystal.h>
// Define the pins for the ultrasonic sensor
const int trigPin = 7;
const int echoPin = 8;
int ledr=A0;
int ledg=A1;

// Variables for storing distance measurement
long duration;
int distance;
#include <Servo.h>

// Create a Servo object
Servo myServo;
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2, ct=9;
LiquidCrystal mylcd(rs, en, d4, d5, d6, d7);

void setup() {
analogWrite(ct,100);
mylcd.begin(16, 2);
  // Attach the servo on pin 9
  myServo.attach(10);

  Serial.begin(9600);
  // Define the trigPin and echoPin as OUTPUT and INPUT
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
 pinMode(A0, OUTPUT);
 pinMode(A1, OUTPUT);
}

void loop() {
  // Clear the trigPin
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);

  // Set the trigPin on HIGH state for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);

  // Read the echoPin, which measures the time duration of the sound wave
  duration = pulseIn(echoPin, HIGH);

  // Calculate the distance (in cm) based on the speed of sound
  distance = duration * 0.034 / 2;
```

```
  // Print the distance to the Serial Monitor
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.println(" cm");

  // Delay before next measurement
  delay(500);

  if(distance<=15)
  {
    mylcd.setCursor(0, 0);
mylcd.print("Pedestrian");
mylcd.setCursor(0, 1);
mylcd.print("crossing STOP");
     digitalWrite(A0,LOW);
    digitalWrite(A1,HIGH);
  myServo.write(120);
  delay(500); // Delay for 1 second
//  myServo.write(0);
//   delay(5000); // Delay for 1 second
  }
  else
  {
        mylcd.setCursor(0, 0);
mylcd.print("No Pedestrian");
mylcd.setCursor(0, 1);
mylcd.print("Crossing Move");
    digitalWrite(A0,HIGH);
    digitalWrite(A1,LOW);
     myServo.write(0);
  delay(500);
  }
}
```