SMART ZEBRA CROSSING

A course project report submitted in partial fulfilment of the requirement

of

SMART SYSTEM DESIGN

by

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ABSTRACT

The main aim of the Smart Zebra Cross project is to foster inclusivity and improve the overall well-being of pedestrians in society. By enhancing pedestrian safety and convenience, the project aims to create a more accessible and pedestrian-friendly environment. The integration of features such as physical barriers and an escalator-like effect aims to cater to individuals with diverse needs, including those with mobility challenges or carrying heavy loads. The Smart Zebra Cross system intends to promote a sense of security and equality by ensuring that all pedestrians, regardless of their physical abilities, can navigate road crossings safely and with ease. By prioritizing pedestrian well-being, the project contributes to building a more inclusive and supportive community for everyone. This project focuses on the development of a Smart Zebra Cross system using Arduino and various electronic components. The system incorporates servo motors, LEDs, and gear motors to enhance pedestrian safety and convenience at road crossings. The project aims to deploy physical barriers using servo motors, indicated by red LEDs, to prevent pedestrian access during potentially hazardous situations. Additionally, the system utilizes gear motors to create an escalator-like effect, assisting pedestrians in crossing the road comfortably. The implementation involves defining pin assignments, setting up the required components, and controlling their operations using Arduino programming. The Smart Zebra Cross system presents a promising solution to improve pedestrian safety and convenience, especially in high-traffic areas.

CONTENTS

CHAPTER 1

INTRODUCTION

1.1 About the project

Pedestrian safety and convenience are crucial factors in urban environments, especially at busy road crossings. To address the challenges faced by pedestrians, this project introduces a Smart Zebra Cross system that leverages advanced technologies and intelligent mechanisms. The system aims to enhance safety and convenience by incorporating servo motors, LEDs, and gear motors into the design. The primary objective of the project is to create a comprehensive solution for pedestrian safety at road crossings. By deploying physical barriers using servo motors and indicating their activation through red LEDs, the system provides a clear indication to pedestrians and drivers alike. Additionally, the integration of gear motors enables the creation of an escalator-like effect, making it easier and more comfortable for pedestrians to navigate the crossing. The development of the Smart Zebra Cross system involves the utilization of Arduino programming and various electronic components. The pin assignments are defined to establish connections with the servo motors, LEDs, and gear motors. Through the implementation of the code, the system controls the operations of these components to ensure the desired functionality. The Smart Zebra Cross project presents a promising solution to improve pedestrian safety and convenience, particularly in high-traffic areas where traditional zebra crossings may fall short. By incorporating advanced technologies and intelligent mechanisms, this system aims to provide a safer and more efficient crossing experience for pedestrians. The following sections will discuss the details of the system's implementation, including the pin assignments, component setup, and the control logic for deploying barriers and activating the escalator-like effect.

1.2 OBJECTIVES

The objectives of the program project are centred around enhancing pedestrian safety, improving convenience, showcasing effective control of electronic components, creating scalability and adaptability, promoting advanced technologies, and fostering innovation in road crossing solutions.

CHAPTER 2

PROJECT DESCRIPTION

2.1 BLOCK DIAGRAM OF THE PROJECT

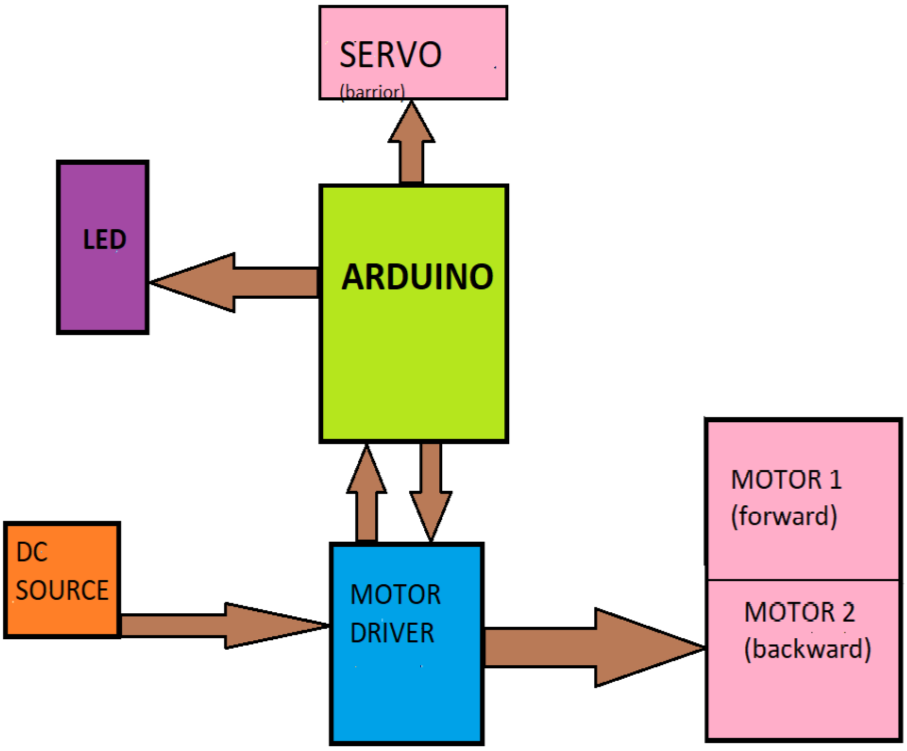


Fig.2.1 Block Diagram

2.2 DESCRIPTION OF BLOCK DIAGRAM

As shown in the diagram of the Smart Zebra Cross project consists of servo motors, red LEDs, gear motors, and control logic. When the red LEDs are activated, the servo motor swiftly deploys physical barriers to prevent pedestrian access. Simultaneously, the gear motors rotate in opposite directions, creating an escalator-like effect that assists pedestrians in crossing the road more comfortably and conveniently as shown in fig.2.

2.3 HARDWARE DESCRIPTION

2.3.1 Arduino UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial

following new features: 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

- ATmega328
- Microcontroller Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Input Voltage (limits) 6-20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB of which 0.5 KB used by bootloader
- SRAM 2 KB (ATmega328)
- EEPROM 1 KB (ATmega328)

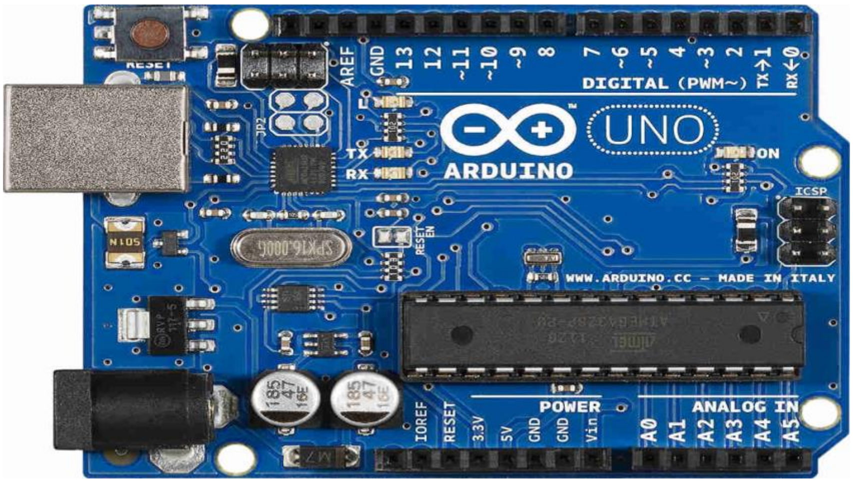


Fig. 2.2 Arduino Uno

Application:

- Xoscillo, an open-source oscilloscope.
- Arduinome, a MIDI controller device that mimics the Monome4 .
- OBDuino, a trip computer that uses the on-board diagnostics interface found in most cars.
- Gameduino, an Arduino shield to create retro 2D video games.
- ArduinoPhone, a do-it-yourself cell phone.
- Water quality testing platform.
- Automatic titration system based on Arduino and stepper motor.
- Lowcost data glove for virtual reality applications.
- Impedance sensor system to detect bovine milk adulteration.
- Homemade CNC using Arduino and DC motors with close loop control by Homo faciens.
- DC motor control using Arduino and H-Bridge.

2.3.2 SERVO MOTOR

A servo motor is a type of rotary actuator that is used to precisely control the position, speed, and acceleration of a mechanical system. It is widely used in various applications, including robotics, industrial automation, aerospace, and automotive industries. Here are some key characteristics and features of servo motors:

- Working Principle: Servo motors work based on feedback control. They consist of a small DC motor, a gear train, and a position feedback device such as an encoder or a potentiometer. The position feedback allows the motor to accurately move to the desired position and maintain that position.
- Precision and Accuracy: Servo motors are known for their high precision and accuracy. They can achieve very fine movements and position control, often within a fraction of a degree or even less.
- Closed-Loop Control: The position feedback from the encoder or potentiometer is continuously compared with the desired position, and any difference (error) is used to

adjust the motor's speed and direction until the error is minimized. This closed-loop control system allows for precise position control and correction.

- Torque and Speed: Servo motors are designed to provide high torque at relatively low speeds. They can deliver precise torque control and maintain constant speed under varying loads.
- Servo Drive: Servo motors are usually used in conjunction with a servo drive or amplifier. The servo drive receives control signals and power from a control system (such as a microcontroller or PLC) and amplifies the signals to provide the necessary power and control to the motor.
- Control Signals: Servo motors typically use pulse width modulation (PWM) signals for control. The control signals specify the desired position or speed, and the servo drive adjusts the motor accordingly. Common control protocols include Pulse and Direction (P&D) and the more advanced and widely used position control protocol called Pulse Position Modulation (PPM) or Serial Peripheral Interface (SPI).
- Size and Types: Servo motors come in various sizes and power ratings, ranging from small motors used in hobby projects to large industrial-grade motors. They can be classified based on their construction, such as brushed or brushless servo motors.

Servo motors are valued for their precise positioning, high control accuracy, and ability to handle dynamic loads. They are commonly used in applications that require precise motion control, such as robotic arms, CNC machines, 3D printers, camera gimbals, and automated manufacturing systems.

Features:

- High efficiency.
- High output power relative to their size.
- More constant torque at higher speed.
- Closed-loop control.
- Quiet operation.
- Highly reliable.
- High ratio of torque to inertia.
- High acceleration.

Fig. 2.3 SERVO MOTOR

2.3.3 GEAR MOTOR

Gear motors find wide applications in industries such as robotics, industrial automation, automotive systems, packaging machinery, medical equipment, and many more. They provide the necessary torque, speed control, and compactness required for precise and controlled motion in various mechanical systems.

FIG 2.4 GEAR MOTOR

A gear motor, also known as a geared motor, is a combination of an electric motor and a gearbox. It integrates the motor and gears into a single compact unit, providing both rotational power from the motor and mechanical speed reduction from the gearbox. Gear motors are widely used in various applications that require controlled and precise motion. Here are some key aspects and features of gear motors:

- Speed Reduction: The primary function of a gear motor is to reduce the output speed of the motor while increasing the torque. The gearbox contains a set of gears with different sizes and configurations that mesh together to transfer power from the motor to the output shaft at a lower speed but with higher torque.
- Torque Increase: By using gears, gear motors can significantly increase the torque output compared to a motor without a gearbox. The gear reduction mechanism allows the motor

to generate higher torque, enabling it to handle heavier loads or perform tasks that require more force.

- Speed Control: Gear motors provide precise control over rotational speed. By selecting different gear ratios, the output speed can be adjusted according to the specific requirements of the application. This allows for fine-tuning of the motor's speed to match the desired speed for the task at hand.
- Direction Control: Gear motors can easily reverse the direction of rotation by changing the input polarity or by using specific control signals. This feature is useful in applications that require bidirectional motion, such as conveyor systems or robotic arms.
- Compact Design: The integration of the motor and gearbox into a single unit result in a compact and space-saving design. This makes gear motors suitable for applications with limited space or where a compact form factor is desired.
- Efficiency: Gear motors can offer high efficiency in power transmission. The gear system minimizes power losses and ensures efficient transfer of rotational power from the motor to the output shaft. Modern gear motors are designed to optimize efficiency and minimize energy consumption.
- Noise and Vibration Reduction: The gear mechanism helps to dampen noise and vibrations generated by the motor, resulting in smoother and quieter operation. This can be advantageous in applications where noise reduction is important or where excessive vibrations could affect the performance or lifespan of the system.
- Protection and Durability: Gear motors are often designed with built-in protection features such as overload protection, thermal protection, and ingress protection (IP) ratings.

2.3.4 LM35 LIGHT EMITTING DIODE

Description:

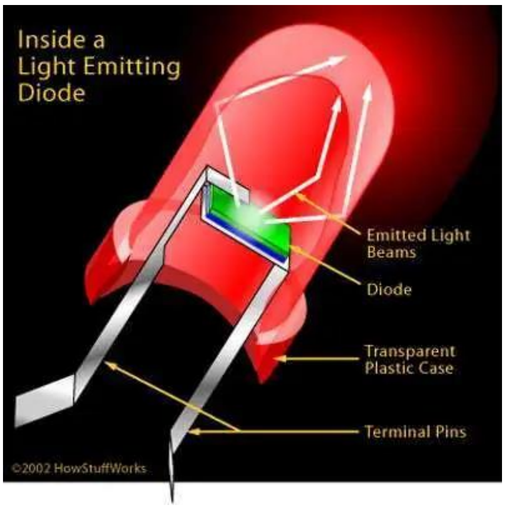


FIG 2.5 LIGHT EMITTING DIODE

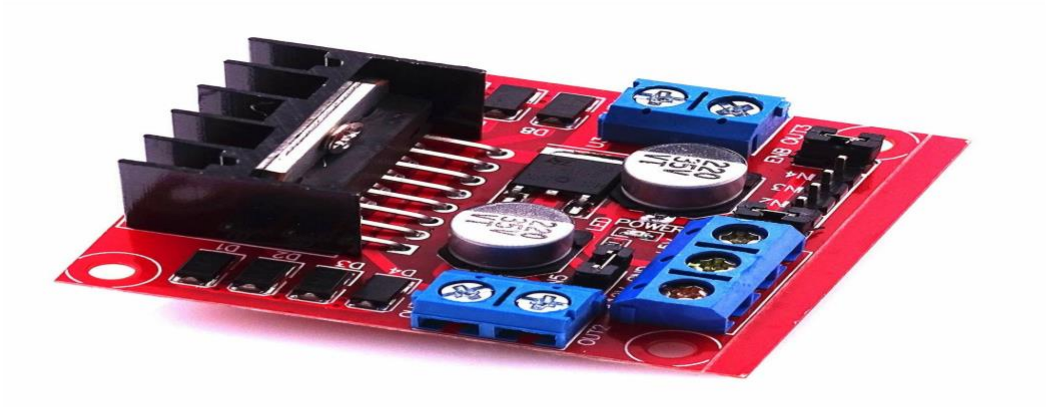
A light-emitting diode (LED) is a semiconductor device that emits light when an electric current passes through it. LEDs have gained significant popularity and become widely used as a lighting technology due to their energy efficiency, long lifespan, compact size, and versatility. Here is a description of the key aspects and features of LEDs:

- Working Principle: LEDs operate based on the phenomenon of electroluminescence. When a voltage is applied across the LED's semiconductor material, electrons and holes recombine, releasing energy in the form of photons (light). The specific semiconductor materials used in an LED determine the color of the emitted light.

- Energy Efficiency: LEDs are highly energy-efficient compared to traditional incandescent or fluorescent lights. They convert a larger portion of electrical energy into visible light, minimizing energy wastage as heat. This efficiency helps reduce energy consumption and lowers electricity costs.
- Long Lifespan: LEDs have an exceptionally long lifespan compared to traditional lighting sources. They can last tens of thousands of hours, providing reliable illumination for extended periods without the need for frequent replacements. This longevity reduces maintenance costs and the inconvenience of frequent bulb changes.
- Compact Size: LEDs are compact and can be made in various small form factors, allowing for versatile applications. They are available in a range of sizes, from miniature surface-mount LEDs used in electronics to high-power LEDs used in lighting fixtures.
- Instantaneous Switching and Dimming: LEDs can switch on and off instantly without any warm-up time. They also offer smooth and precise dimming capabilities, allowing for flexible control of light intensity. This rapid response and dimming capability are advantageous for creating dynamic lighting effects and achieving energy savings through intelligent lighting systems.
- Colour Options: LEDs are available in a wide range of colours, including red, green, blue, yellow, amber, and white. The colour of the emitted light is determined by the specific materials used in the LED's semiconductor structure. This versatility allows for creative lighting design and enables applications where colour variation is required.
- Environmental Friendliness: LEDs are considered environmentally friendly lighting solutions. They contain no hazardous substances like mercury, which is commonly found in fluorescent lamps. LEDs also produce minimal ultraviolet (UV) or infrared (IR) radiation, reducing potential harm to people or sensitive materials.
- Durability and Shock Resistance: LEDs are solid-state devices without any fragile components like filaments or glass enclosures. This solid-state construction makes them highly durable and resistant to shocks, vibrations, and harsh environmental conditions. This durability is advantageous for applications that require robust lighting solutions, such as outdoor lighting or automotive lighting.
- Directional Light Output: LEDs emit light in a specific direction, providing focused illumination without the need for reflectors or diffusers. This directional light output allows for efficient light distribution and reduces light wastage in applications where precise lighting control is desired.
- Rapid Technological Advancements: LED technology continues to advance rapidly, leading to improvements in efficiency, brightness, color rendering, and cost-effectiveness. These advancements have made LEDs even more attractive for various applications, ranging from residential and commercial lighting to automotive lighting, signage, display screens, and beyond.

LEDs have revolutionized the lighting industry and continue to find innovative applications in diverse fields. Their energy efficiency, long lifespan, compact size, and versatility make them a preferred choice for lighting solutions in both residential and commercial settings.

2.3.5 MOTOR DRIVER



The L298N 2A motor driver is a popular integrated circuit (IC) commonly used to control and drive DC motors. It is designed to provide bidirectional control for two motors, allowing forward and reverse movement. The motor driver can handle a maximum current of 2A per channel, making it suitable for driving medium-sized motors. The L298N motor driver module typically consists of the L298N IC, along with necessary supporting components such as diodes, capacitors, and connectors. It features two H-bridge circuits that enable independent control of the motor direction and speed. The motor driver can be easily interfaced with microcontrollers, Arduino boards, or other control systems. It requires external power supply connections to provide the necessary voltage for driving the motors. The module usually includes input pins for control signals, allowing users to determine the motor direction and adjust the speed using pulse width modulation (PWM) signals. The L298N motor driver is widely used in various applications, including robotics, automation systems, electric vehicles, and other projects that require precise motor control. Its robust design, high current handling capability, and ease of use make it a popular choice for hobbyists, engineers, and DIY enthusiasts working with DC motors**.**

2.4 SOFTWARE DESCRIPTION

The software used here is ARDUINO SOFTWARE:

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Writing Sketches:

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

NB:

Versions of the Arduino Software (IDE) prior to 1.0 saved sketches with the extension pde. It is possible to open these files with version 1.0, you will be prompted to save the sketch with the ino extension on save.

Verify

Checks your code for errors compiling it.

Upload

Compiles your code and uploads it to the configured board. See uploading below for details.

Note: If you are using an external programmer with your board, you can hold down the "shift" key on your computer when using this icon. The text will change to "Upload using Programmer"

New

Creates a new sketch.

Open

Presents a menu of all the sketches in your sketchbook. Clicking one will open it within the current window overwriting its content.

Note: due to a bug in Java, this menu doesn't scroll; if you need to open a sketch late in the list, use the File | Sketchbook menu instead.

Save

Saves your sketch.

Serial Monitor

Opens the serial monitor.

Additional commands are found within the five menus: File, Edit, Sketch, Tools,and help.

Programming on arduinouno:

sketch_jun1 | Arduino 1.8.19 (Windows Store 1.8.57.0)

File Edit Sketch Tools Help

sketch_jun1 §

```
// Define pin assignments
#include<Servo.h>

#define GREEN_LED_PIN 2
#define RED_LED_PIN 3
#define MOTOR1_PIN1 6
#define MOTOR1_PIN2 7
#define MOTOR2_PIN1 8
#define MOTOR2_PIN2 10
Servo myservo;
// Define servo positions
#define SERVO_UP 90
#define SERVO_DOWN 0

// Define motor speeds
#define MOTOR_SPEED 200 // Adjust speed as per your requirements

void setup() {
  // Set pin modes
  myservo.attach(9);

  pinMode(GREEN_LED_PIN, OUTPUT);
  pinMode(RED_LED_PIN, OUTPUT);
  pinMode(MOTOR1_PIN1, OUTPUT);
  pinMode(MOTOR1_PIN2, OUTPUT);
  pinMode(MOTOR2_PIN1, OUTPUT);
  pinMode(MOTOR2_PIN2, OUTPUT);

  // Initially, keep servo up and turn off LEDs

  digitalWrite(GREEN_LED_PIN, LOW);
  digitalWrite(RED_LED_PIN, LOW);
   myservo.write(0);
  // Stop motors initially
  digitalWrite(MOTOR1_PIN1, LOW);
  digitalWrite(MOTOR1_PIN2, LOW);
  digitalWrite(MOTOR2_PIN1, LOW);
  digitalWrite(MOTOR2_PIN2, LOW);
```

Fig.2.6 Software IDE

In order for the Arduino-Uno board to be able to interact with the application used in this project certain program (code) needs to be uploaded to the Arduino-Uno. Arduino Company provides user friendly software which allows writing any code for any function wanted to be performed by the Arduino-Uno and upload it to the board. Refer to appendix A for the full source code of the Arduino-Uno board.

CHAPTER 3

PROJECT IMPLIMENTATION

3.1 WORKING

In the Smart Zebra Cross project, each component plays a specific role to ensure the functionality of the system:

1. Servo Motor: The servo motor is responsible for deploying the physical barriers when the red LEDs are activated. It moves the barriers into position to prevent pedestrian access during hazardous situations.
2. Red LEDs: The red LEDs serve as indicators for activating the barriers. When the red LEDs are turned on, it signals the servo motor to deploy the barriers and indicate to pedestrians and drivers that it is not safe to cross.
3. Gear Motors: The gear motors create an escalator-like effect to assist pedestrians in crossing the road more comfortably. When both the red LEDs and power supply are activated, the gear motors rotate in opposite directions, providing an inclined surface for pedestrians to traverse.
4. Power Supply: The power supply provides the necessary electrical energy to drive the servo motor and gear motors, ensuring their proper functioning.
5. Motor Driver: Although not explicitly mentioned in the given code, a motor driver is typically used to control the operation of the gear motors. The motor driver facilitates the proper control and power distribution to the gear motors, ensuring they rotate in the desired directions.
6. Arduino (not mentioned in the code): The Arduino microcontroller is likely used to control and coordinate the operation of the components. It receives input signals from the red LEDs, triggers the servo motor and gear motors, and controls the timing and sequence of their movements.

By working together, these components enable the Smart Zebra Cross system to deploy barriers, create an escalator-like effect, and enhance pedestrian safety and convenience at road crossings.

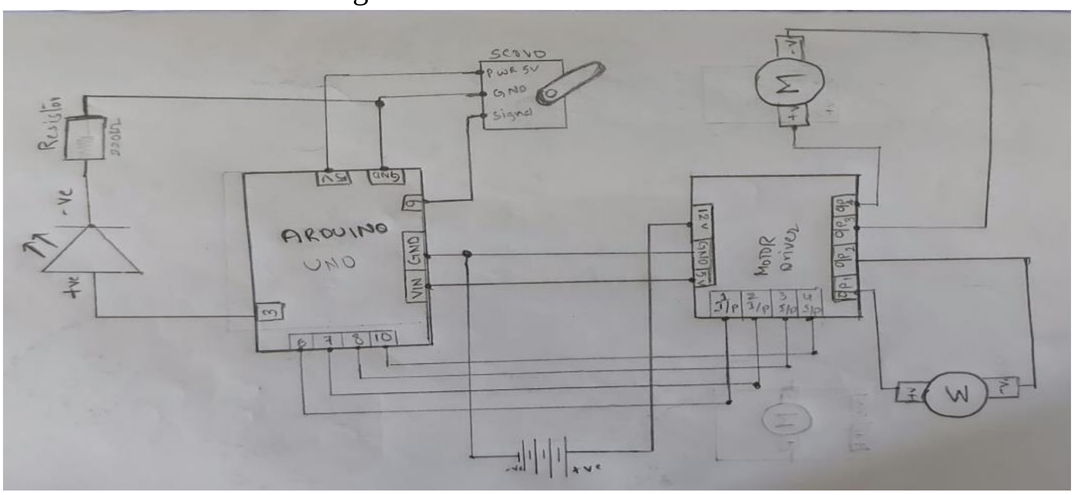
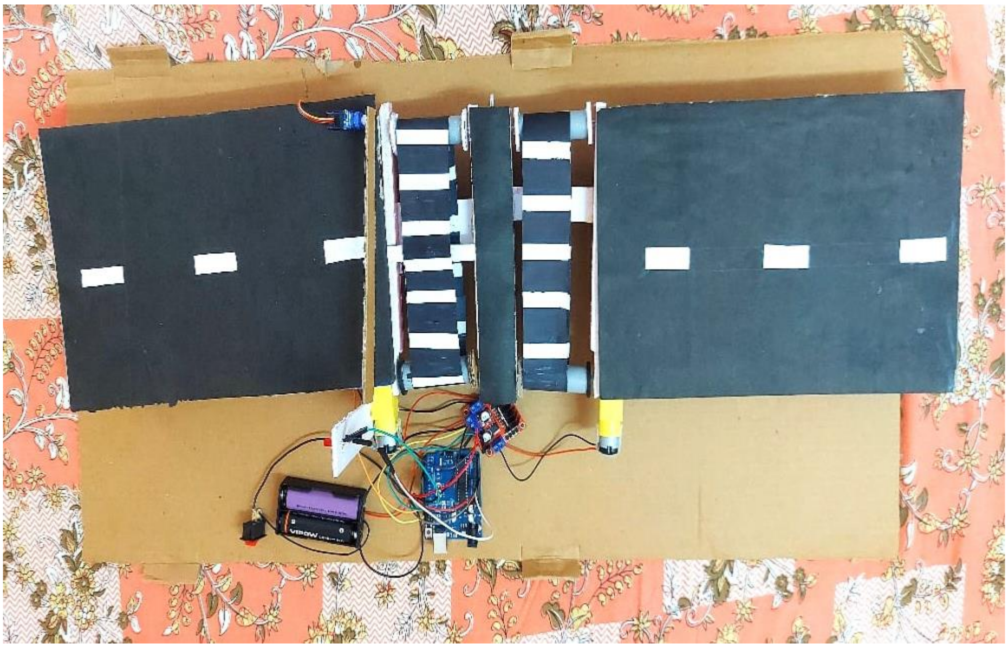


Fig.3.1 Schematic diagram

3.2 RESULTS

The experimental result is as shown in below fig. 3.2



3.2 Experimental result

The implementation of a smart zebra crossing system can yield several positive results and benefits. Some of the potential outcomes of deploying a smart zebra crossing include:

- Enhanced Safety: The deployment of physical barriers when the red LEDs are activated provides an additional layer of safety, preventing pedestrians from crossing during potentially hazardous situations.
- Improved Visibility: The red LEDs serve as clear visual indicators, alerting both pedestrians and drivers to the presence of barriers and indicating when it is unsafe to cross.
- Increased Convenience: The escalator-like effect created by the gear motors offers a more comfortable and efficient crossing experience for pedestrians, particularly for those with mobility challenges or carrying heavy loads.
- Inclusivity: The system caters to the needs of a diverse range of pedestrians, including those with disabilities or reduced mobility, by providing an accessible and user-friendly crossing solution.
- Scalability: The Smart Zebra Cross system can be implemented in various locations and environments, making it a scalable solution that can be tailored to specific crossing requirements.
- Technological Integration: By incorporating advanced technologies such as servo motors, LEDs, and gear motors, the project showcases the potential of integrating these technologies to improve pedestrian safety and demonstrates the application of technology in solving real-world challenges.

3.3 ADVANTAGES

- Reduced number of accidents due to their improved visibility.

- The ability to deeply manage urban traffic, reducing traffic jams and pollution.
- They are adaptable to different types of streets and traffic situations.
- They can be remotely and dynamically managed.

3.4 DISADVANTAGES

- Drivers do not always stop as expected. ...
- Blind or partially sighted people find zebra crossings harder to use than traffic light crossings.
- Can sometimes create vehicle congestion where pedestrian volumes are high.

CHAPTER 4

CONCLUSION

4.1 CONCLUSION

In conclusion, the Smart Zebra Cross project presents a innovative solution for enhancing pedestrian safety and convenience at road crossings. By integrating servo motors, red LEDs, and gear motors, the system effectively deploys physical barriers and creates an escalator-like effect to assist pedestrians. This project offers numerous benefits, including improved safety, increased visibility, enhanced convenience, inclusivity, scalability, and the utilization of advanced technologies. The Smart Zebra Cross demonstrates the potential of integrating intelligent mechanisms and advanced control systems to address pedestrian safety concerns in urban areas. However, further development and testing are required to refine the design, optimize control logic, and ensure its effectiveness in real-world scenarios. With its potential to improve the pedestrian crossing experience, the Smart Zebra Cross represents a significant step towards creating safer and more efficient road crossings for pedestrians.

4.2 FUTURE SCOPE

The future scope for the Smart Zebra Cross project includes integrating advanced detection systems, intelligent traffic integration, adaptive and contextual functionality, accessibility enhancements, smart city integration, data analytics, and energy efficiency. By incorporating technologies such as computer vision, LiDAR, and adaptive algorithms, the system can improve accuracy and responsiveness. Integration with intelligent traffic management systems and smart city infrastructure will optimize traffic flow and coordination. Accessibility features, data analytics, and energy-efficient solutions will enhance inclusivity, inform decision-making, and reduce environmental impact. These future developments aim to further enhance pedestrian safety, optimize traffic management, and create smarter and more sustainable road crossings.

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