Volume 9, Issue 6, June – 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

Automatic Zebra Crossing Using Raspberry PI

Kaumudi Tanajirao Patil[1]
U.G, Student
Department of Electronics &Telecommunication
Engineering College, NMCOE, Peth, India

Dhanashree Anandrao Salunkhe[2]
U.G, Student
Department of Electronics& Telecommunication
Engineering College, NMCOE, Peth, India

S. T. Chaus[3]
Associate Professor
Department of Telecommunication
Engineering College, NMCOE, Peth, India

Abstract:- The Automatic Zebra Crossing project enhances pedestrian safety and convenience at zebra crossings using an Atmega8 microcontroller board, a time display, and Progisp software. The project features a pair of automatic gates positioned at both ends of the zebra crossing, closing whenever the traffic signal turns red to stop vehicles. This closure effectively restricts pedestrian movement beyond the zebra crossing area, ensuring enhanced safety. The system works like an automatic stairway, with the gates being opened or closed depending on the condition of the traffic signal. As the central control device, the Atmega8 microcontroller board processes inputs from the traffic signal and generates control signals to open and close the gates. The time display tells pedestrians how much time is left until they can cross in real time. The Atmega8 microcontroller is programmed using the Progisp software, allowing the construction of the control logic and synchronization with the traffic signal. The software enables the microcontroller to work seamlessly with the gate motors and the time display. The Automatic Zebra Crossing system dramatically improves pedestrian safety by keeping people inside the crossing area when the light is red. This system uses gates for straying, lowering accident rates, and optimizing traffic flow. The project documentation outlines the software implementation with Progisp and explains the hardware setup. This setup involves an Atmega8 microcontroller board, gate motors, and a time display. The code integrates a control logic for synchronization.

➢ ***Hardware Requirement:***

- ***Raspberry Pi- Pico***
- ***Mobile Wi-fi Module***
- ***Power Supply Unit***
- ***Motor Unit***
- ***Relay Unit***

➢ ***Software Requirement:***

- ***Python***
- ***PC***
- ***Web page***

I. INTRODUCTION

The "Automatic Zebra Crossing Project" utilizes the Raspberry PIand Raspberry PI software to enhance pedestrian safety at busy intersections and zebra crossings. The project implements an automatic zebra crossing system with automated gates and a time display to provide valuable information to pedestrians.

The project comprises the Raspberry PI microcontroller and automated gates on both sides of the zebra crossing. The Raspberry PI serves as the central control unit, processing inputs from traffic signals and pedestrian presence sensors to coordinate the system's functionality.

When the traffic signal turns red, the system activates the automated gates on both sides of the zebra crossing, acting as physical barriers to prevent pedestrians from crossing during the red-light phase. This encourages pedestrians to wait safely on the zebra crossing.

The project integrates a time display module that reveals the remaining time until the traffic light turns green. This aids pedestrians in making informed decisions about when to cross

Inspired by an automatic staircase, the system uses a motion detection mechanism for smooth pedestrian movement. As the traffic signal turns green, the gates open automatically, ensuring a safe road crossing for pedestrians.

The Raspberry PI software is crucial for programming the Raspberry PI, ensuring efficient and reliable operation. By leveraging the Raspberry PI platform, the project provides a cost-effective solution to improve pedestrian safety.

The project documentation encompasses the hardware setup, including the Atmega8 microcontroller board, gate motors, and time display, along with the software implementation using Progisp. The code includes the control logic for synchronizing the gate operation with the traffic signal. Additionally, the documentation provides guidelines for system calibration, testing procedures, and potential future enhancement

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

II. RELATED WORKS

A. Literature Survey

In 1930, the United Kingdom installed the first zebra crossing on Slough High Street, which feature white stripes resembling a zebra's coat and offered pedestrian priority over vehicular traffic as per the Road Traffic Act of 1934, Section 18. To address the declining effectiveness of Belisha beacons due to increasing car traffic and low usage by drivers and pedestrians, the Ministry of Transport experimented with various designs to improve visibility and utilization. This led to the well-known black and white stripes being implemented across 1,000 test locations in the UK, with credit given to George Charlesworth, a traffic engineer, and physicist, for creating the zebra markings.

➢ *Time Display Systems:*

Time display systems play a crucial role in the automatic zebra crossing project, providing pedestrians with information about the remaining time for crossing.

- "Design and Implementation of a Countdown Timer for Pedestrian Crossings" by Smith et al. (2016): This study presents the design and implementation of a countdown timer system for pedestrian crossings. The system utilizes LED displays to inform pedestrians about the remaining time to cross the road safely.
- "Evaluation of Different Time Display Systems for Pedestrian Crossings" by Johnson et al. (2018): The authors evaluate different time display systems, including digital displays, audio signals, and tactile indicators, to determine their effectiveness in assisting pedestrians during the crossing.

Pfortmueller (2014) conducted a retrospective study to analyse the severity and mortality of injuries sustained by adult pedestrians based on their use of zebra crosswalks. The study found that accidents on zebra crosswalks were more prevalent compared to non-zebra crosswalk accidents. However, the severity of injuries in non-zebra crosswalk accidents was significantly higher than in zebra crosswalk accidents. Accidents involving large vehicles were also associated with a higher risk of severe injury. The study highlights the need for further prospective research, including a detailed assessment of motor vehicle types and speed. It is crucial to address these findings to reduce the number of road traffic injuries and fatalities worldwide.

The increasing number of pedestrian accidents requires urgent attention. Careless crossing is a primary reason behind these accidents, which can result from inadequate time to cross safely, crossing at excessive speeds, or encountering unexpected factors. To address this issue effectively, one alternative is to incorporate zebra crossing speed into roadway design and operation.

Road traffic crashes often stem from a mix of factors including road design, vehicle conditions, and the behaviour of road users. We've investigated the primary causes of pedestrian fatalities and examined the safety impact of road measures such as traffic lights, roundabouts, and refuge islands at pedestrian crossings. Post-implementation results reveal these measures significantly reduce pedestrian-related accidents. Thus, advanced safety measures like vehicle and infrastructure modifications, protective systems, training, and behavioural knowledge enhancement prove to be key in decreasing the occurrence and severity of accidents involving vulnerable road users (Mako and Szakonyi, 2016).

B. Hardware Setup

The component selection analysis is based on specific parts required for the smart crossing zebra project:

➢ *Servo Motor*

Fig 1. Servo Motor

The servo motor produces torque and speed based on the applied current and voltage. It operates as a closed-loop system, receiving commands from a servo controller and delivering precise torque and velocity through a feedback mechanism. Servo motors are electronic actuators that control angular or linear position, as well as velocity and acceleration. For this project, a micro servo motor was chosen due to its suitability within the project's scope.

➢ *Jump Wire*

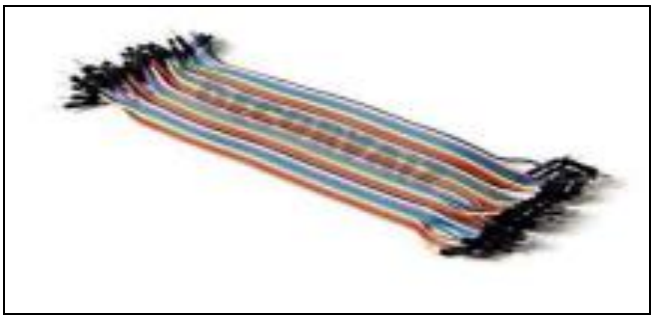

Fig 2 Jump Wire

A jump wire, also known as a jumper or DuPont wire, is an electrical wire with connectors or pins at each end. It is used to interconnect components in a breadboard or test circuit without the need for soldering. These wires are inserted into slots on a breadboard or circuit board to establish connections. Although jumper wires come in various colors, the colors do not hold specific meanings. However, they can be used advantageously to differentiate between types of connections, such as ground or power.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

➤ *LED (Light-Emitting Diode)*

Fig 3 LED (Light-Emitting Diode)

LEDs, or light-emitting diodes, are semiconductor light sources that shine when current flows through them. They hold numerous advantages over traditional incandescent light sources: they consume less power, last longer, are more durable, smaller in size, and switch faster. In this project, we employ LEDs as traffic signals for drivers and pedestrians alike. Red LEDs command a stop, while green LED. The emitted light color depends on the energy electrons need to traverse the semiconductor's band gap. To create white light, we can use multiple semiconductors or a phosphor layer on the semiconductor device.

➤ *BO Motor*

Fig 4 BO Motor

The BO motor is a lightweight DC-geared motor that provides good torque and RPM at lower voltages. It can run at approximately 200 RPM when powered by a single Li-Ion cell, making it perfect for battery-operated lightweight robots. The motor requires minimum or no lubrication due to its inherent lubricity, making it easy to maintain. It is an ideal choice for DIY enthusiasts and can be easily installed in mobile robot cars, especially in 2WD platforms.

➤ *Raspberry PI*

Fig 5 Raspberry PI

The Raspberry PI Raspberry Pi (/paɪ/) is a series of small single-board computers (SBCs) developed in the United Kingdom by the Raspberry Pi Foundation in association with Broadcom. A Raspberry Pi Zero with smaller size and reduced input/output (I/O) and general-purpose input/output (GPIO) capabilities was released in November 2015 for $5 USD.

➤ *LCD*

Fig 6 LCD Display

LCD (Liquid Crystal Display) is a flat panel display that utilizes liquid crystals in its primary operation. It finds a case for consumers and businesses, commonly appearing in smartphones, televisions, computer monitors, and instrument panels. LCDs represented a significant technological leap over the technologies they replaced, such as light-emitting diode (LED) and gas-plasma displays. They enabled much thinner displays of cathode ray tube (CRT) technology and consumed far less power as they operated by blocking light rather than emitting it. While LEDs emit light, LCDs use a backlight to produce images through liquid crystals. Liquid crystal display, or LCD, derives its name from a combination of two states of matter: solid and liquid. It employs liquid crystals to generate a visible image. These super-thin technology display screens find widespread use in laptop computer screens, TVs, cell phones, and portable video games, offering a much slimmer profile than cathode ray tube (CRT) technology.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

- *Motor Diver*

Fig 7 Motor Diver

Motor drivers serve a vital function in many motor-related projects. They amplify control and power, ensuring effective motor movement control. Acting as a bridge between the microcontroller or control system and the motor, they transform low-power signals into high-power outputs. Motor drivers come with speed and direction control, current sensing, and protection features such as overcurrent and overtemperature. They vary in type, including brushed DC, brushless DC, and stepper motor drivers, each crafted for specific motor needs. Robotics, automation, and automotive industries rely on motor drivers for their high precision in motor control and energy efficiency, which are essential for the success of their projects.

- *Adapter 12 V*

Fig 8 Adapter 12 V

The 12V adapter transforms wall outlet AC power into 12-volt DC power, offering a low-voltage DC supply for electronics like routers, modems, speakers, and other small appliances. Its compact, cylindrical design features a plug for device power input. Some adapters come with switchable tips for different devices. It's crucial to match the adapter's voltage and polarity with the device's

III. PROPOSED WORK

A. *Methodology*

Creating an automatic zebra crossing project using Raspberry PIand time display involves building a system that detects traffic signals, controls the opening and closing of gates, and implements an automatic mechanism to guide pedestrians safely across the road. Below is a general methodology to get you started:

- *Components Needed :-*

- Raspberry PI board
- Traffic signal module (to detect the red light)
- Servo motors (to control the gates)
- LED display module (for time display)
- Breadboard and jumper wires
- Power supply (battery or adapter)
- Step-by-Step Methodology:

- *Setup Hardware:*

Connect the Raspberry PI to your computer and install the Raspberry software. Assemble the hardware components on the breadboard and connect them to the Raspberry PI according to their specifications and pin configurations.

- *Traffic Signal Detection:*

Interface the traffic signal module with the Raspberry PI to detect the red light. Use digital inputs to read the state of the traffic signal (e.g., red light).

- *Control Gates with Servo Motors:*

Connect servo motors to the gates on both sides of the zebra crossing. Write code to control the servo motors to open and close the gates.

- *Implementing Time Display:*

Connect an LED display module to the Raspberry PI board to display the time countdown for pedestrian crossing. You can use either a 7-segment display or a dot matrix display to show the time remaining for pedestrians to cross the road safely.

- *Coding the Raspberry:*

Write the Raspberry PI to integrate all the components. Use the inputs from the traffic signal and ultrasonic sensors to determine the appropriate times for the gates to open and close. Implement a timer to display the time remaining for pedestrians to cross the road.

- *Testing and Debugging:*

Upload the code to the Raspberry PIand test the system. Debug and make necessary adjustments to ensure smooth functionality.

- *Safety Considerations:*

Pay attention to safety measures and ensure the gates do not close while pedestrians are still crossing. Implement failsafe mechanisms to prevent accidents.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

➢ *Documentation:*
Document the project, including circuit diagrams, code explanations, and any modifications made.

B. Algorithm

➢ *Step 1: Set up the Hardware*

- Connect two servo motors to the Raspberry PI. These will control the gates.
- Connect sensors to detect the traffic signal status and presence of pedestrians on the zebra crossing. Make sure all the connections are properly wired and secure.

➢ *Step 2: Define Pin Assignments*

- *Assign Pins for the Servo Motors and Sensors. For example:*

✓ Gate 1 servo: Pin 2
✓ Gate 2 servo: Pin 3
✓ Traffic signal sensor: Pin 4
✓ Pedestrian presence sensor: Pin 5

➢ *Step 3: Initialize Libraries*
Include the necessary libraries for servo motor control and sensor input/output.

➢ *Step 4: Set Up the Initial Configuration*

- Set the initial positions of the servo motors to keep the gates open.
- Configure the sensor inputs and outputs.

➢ *Step 5: Implement the Loop*
In the main loop of your Raspberry PI code, continuously check the status of the traffic signal and the presence of pedestrians.

➢ *Step 6: Check Traffic Signal Status*

- Read the input from the traffic signal sensor.
- If the red light is detected, proceed to the next step. Otherwise, continue looping.

➢ *Step 7: Close the Gates*

- Activate the servo motors connected to the gates to close them, preventing pedestrians from crossing.
- Set the positions of the servo motors to close the gates.

➢ *Step 8: Wait for Pedestrian Presence*

- Continuously monitor the input from the pedestrian presence sensor.
- If a pedestrian is detected, proceed to the next step. Otherwise, continue looping.

➢ *Step 9: Open the Gates*

- Deactivate the servo motors to open the gates and allow pedestrians to cross.
- Set the positions of the servo motors to open the gates.

➢ *Step 10: Wait for Pedestrian Clearance*

- Continue monitoring the input from the pedestrian presence sensor.
- If no pedestrians are detected, proceed to the next step. Otherwise, continue looping.

➢ *Step 11: Close the Gates Again*

- Activate the servo motors to close the gates and prevent more pedestrians from crossing.
- Set the positions of the servo motors to close the gates.

➢ *Step 12: Repeat the Process*

- Return to Step 6 and continue the loop to monitor the traffic signal and pedestrian presence.

➢ *Block Diagram*

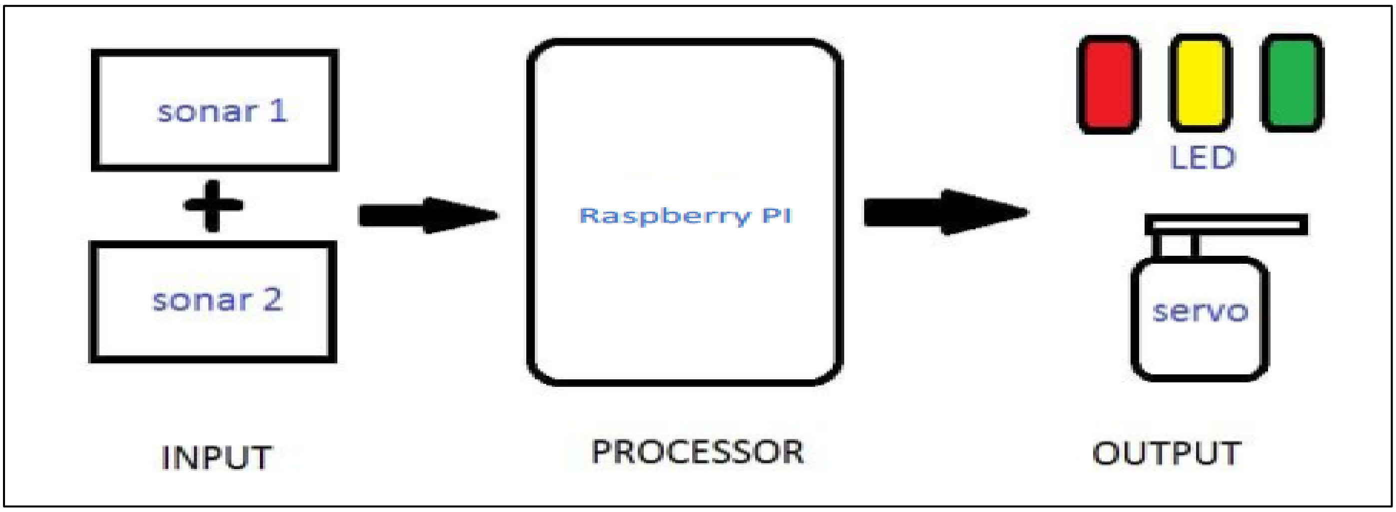

Fig 9 Project Block Diagram

➢ *Flowchart*

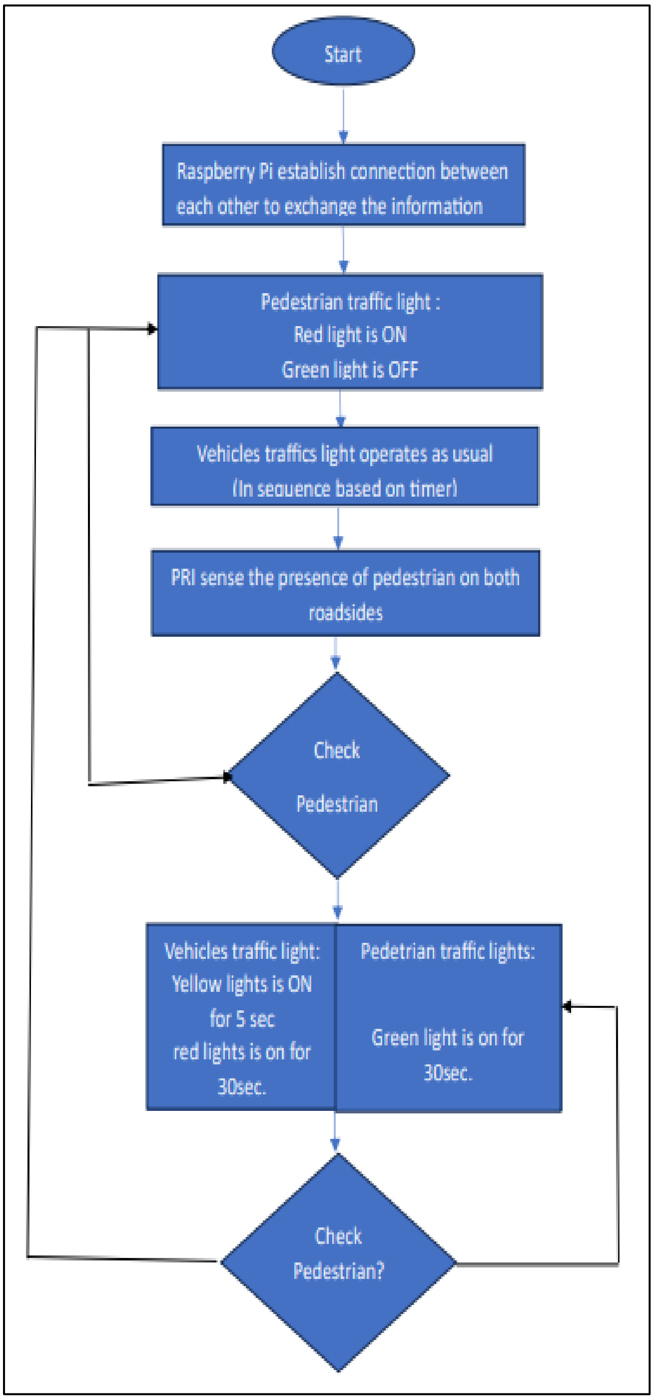

Fig 10 Project Flowchart.

IV. IMPLEMENTATION AND TESTING

➢ *Implementation*

The proposed system needed proper scaling before implementation in a real-life scenario to ensure perfect output in a controlled environment. For showcasing the capabilities and potential of the system, a prototype model was developed using a miniature version. The computational device chosen for the prototype was Raspberry PI, which offers open-source hardware with various easy-to-implement functionalities.

The system's input and output components included two HC-SR04 Ultrasonic Sensors, one SG90 Micro Servo, several LED lights, male-female jumper wires, and a standard breadboard. The Raspberry PI board, with 32KB of flash memory, was selected due to its easy trackability and compatibility with the open-source IDE used for implementing software instructions onto its SRAM. The IDE can be conveniently downloaded from the Raspberry PI.cc website, making manipulation of the system more accessible when using Raspberry PI as the computational device.

The Raspberry PI board features 14 advanced input/output pins (with 6 of them usable as PWM outputs), 6 simple inputs, a USB connection, an energy jack, and a reset button. These components provide all the necessary elements to develop a simple system. Powering the Raspberry PI can be achieved through a USB link connected to a PC or laptop, or by using an AC-to-DC connector to plug it into a battery.

➢ *Future Enhancement*

- The system incorporates advanced sensors, such as infrared or ultrasonic sensors, to detect pedestrians waiting to cross, thereby improving efficiency and preventing unnecessary gate closures.
- The project integrates with the traffic light system to ensure better synchronization between the gates and the traffic signals, resulting in smoother traffic flow and minimized waiting time for pedestrians.
- A mechanism is implemented to adjust the gate's opening and closing speed, accommodating different pedestrian flow rates and providing a more comfortable and user-friendly experience.
- An emergency stop button or switch is included, allowing pedestrians to halt the gate operation if needed, especially in situations compromising pedestrian safety or in case of malfunctions.
- A smart control system is developed, which analyses real-time traffic conditions, such as vehicle and pedestrian density, to optimize gate operation using machine learning algorithms or external data sources.
- Audio/visual signals, such as warning lights or sound alerts, are integrated to provide additional cues for pedestrians and drivers, enhancing safety and awareness of the gate operation.
- Accessibility features are incorporated to cater to individuals with disabilities, ensuring that the zebra crossing is accessible to a wider range of pedestrians. These features may include audible signals or tactile feedback systems.
- The system implements a data logging system to record the number of crossings, gate usage patterns, and pedestrian waiting times. This data can be used for analysis and optimization of the system's performance.
- A mobile application is developed, enabling pedestrians to request gate operation or provide feedback on the system, enhancing user engagement and facilitating communication and updates.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

➢ *Output Below are the Final Results.*

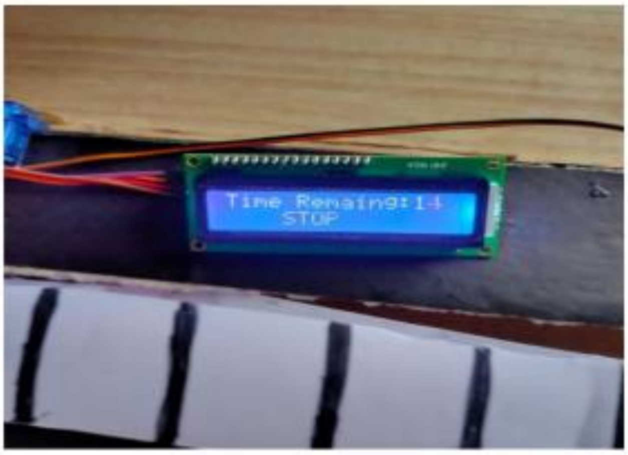

Fig 11 LCD Indicating Time to Stop Pedestrian

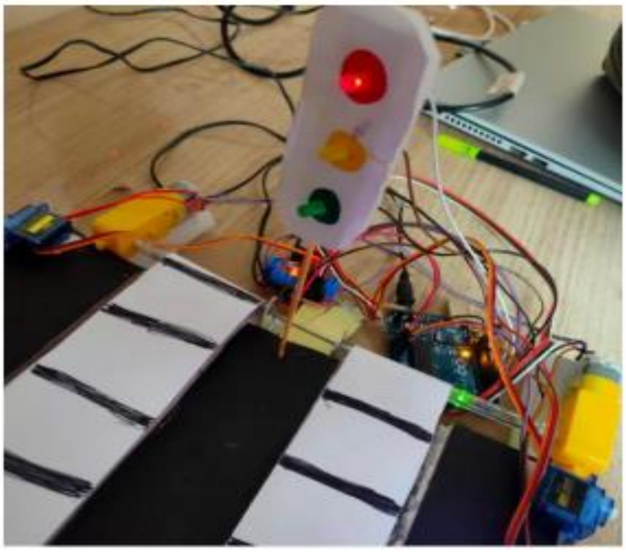

Fig 12 Signal is Red for Pedestrian.

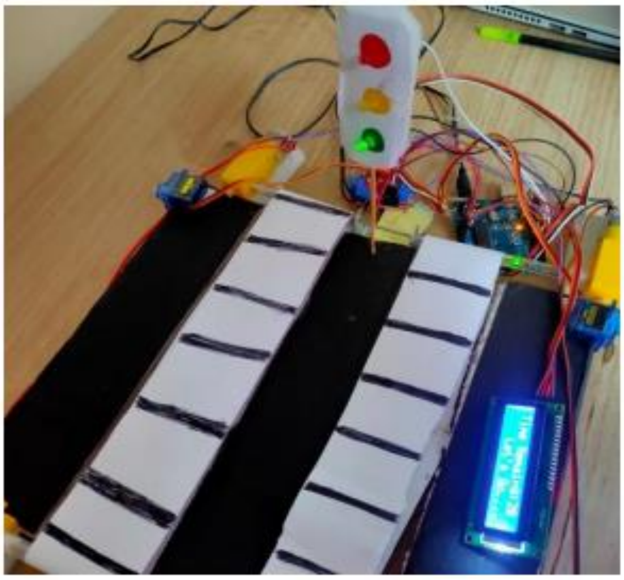

Fig 13 Signal is Green for Pedestrian

Fig 14 LCD show Time Remaining for Pedestrian to Cross Road.

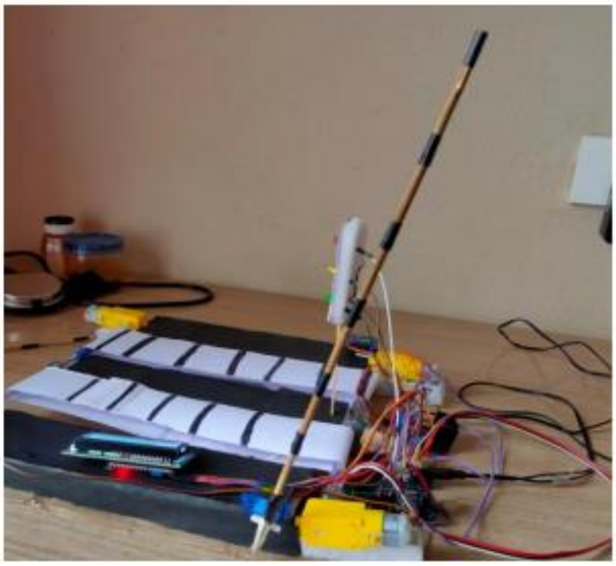

Fig 15 Now the Gate is Open for Road Cross

V. CONCLUSION

The Raspberry PI-based automatic zebra crossing project demonstrates an innovative approach to enhance by leveraging technology for a safer urban environment. It is part of a larger city initiative, showcasing the potential of integrating mechatronic systems with IoT technology to create a Smart Zebra Crossing. The prototype consists of three subsystems: manual, automated, and Blynk App-controlled, providing flexibility and usability in different scenarios.

The system seamlessly integrates the instrumentation system, the actuation system, and the human-machine interface. Intensive programming efforts have optimized the prototype's performance, ensuring it effectively responds to real-world scenarios.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24JUN240

The microcontroller chosen for the project is NodeMCU ESP8266, which offers cost-effective and energy-efficient solutions while providing seamless Wi-Fi and Bluetooth connectivity. The project implementation draws heavily from mechatronics principles, and the developer has conducted significant online research to devise effective prototype design and mechanics. Programming complexity has honed the developer's coding skills, contributing to valuable hands-on experience.

By integrating IoT and mechatronics concepts, the project showcases the synergy between hardware and software, providing valuable insights into smart city infrastructure. The primary concern of the automatic zebra crossing is pedestrian safety, aiming to create safer and more efficient road-crossing experiences for pedestrians. The project highlights the potential of combining emerging technologies to tackle urban challenges and improve the quality of life.

Implementing a mechatronic-based automated system is a promising step toward building cities with innovative and adaptive infrastructure. We expect continuous improvements and refinements in the prototype design, reflecting the iterative nature of modern technology projects. The Raspberry PI-based solution is scalable and adaptable for various pedestrian crossings in urban environments.

REFERENCES

[1]. R. Methorst, R. Eenink, J. Cardoso, K. Machata and J. Malasek, "Single unprotected road user crashes: Europe we have a problem!", *Transp. Res. Procedia*, vol. 14, pp. 2297-2305, Jan. 2016.

[2]. D. R. Green, J. Ward and N. Wyper, "Solar-powered wireless crosswalk warning system", Jan. 2008.

[3]. *Road Traffic Injuries, 2020,* [online] Available: https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries.

[4]. A. H. Ariffin, Z. Mohd Jawi, M. Md Isa, K. Abu Kassim and S. Wong, "Pedestrian casualties in road accidents-Malaysia perspective", *Proc. MIROS Road Saf. Conf.*, pp. 280-289, 2010.

[5]. C. Bastien, R. Wellings and B. Burnett, "An evidence based method to calculate pedestrian crossing speeds in vehicle collisions (PCSC)", *Accident Anal. Prevention*, vol. 118, pp. 66-76, Sep. 2018.

[6]. B. Hoe Goh, K. Subramaniam, Y. Tuck Wai and A. Ali Mohamed, "Pedestrian crossing speed: The case of Malaysia", *Int. J. Traffic Transp. Eng.*, vol. 2, pp. 323-332, Dec. 2012.

[7]. D. Muley, W. Alhajyaseen, M. Kharbeche and M. Al-Salem, "Pedestrians’ speed analysis at signalized crosswalks", *Procedia Comput. Sci.*, vol. 130, pp. 567-574, Jan. 2018.

[8]. S. Movahed, S. P. Azad and H. Zakeri, "A safe pedestrian walkway; creation a safe public space based on pedestrian safety", *Procedia Social Behav. Sci.*, vol. 35, pp. 572-585, Jan. 2012.