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Smart Zebra Crossing with Smart Street-Light

Mayur M. Gaikwad, Saba I. Pathan, Shreya B. Jadhav
Department of Electronics & Telecommunication Engineering,
Nanasaheb Mahadik College of Engineering, peth , India.

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Abstract:
This research presents a prototype of a smart street and zebra crossing system using Arduino, designed to improve road safety and energy efficiency. The system integrates multiple sensors and actuators such as Light Dependent Resistors (LDRs), Infrared (IR) sensors, DC motors, servo motors, seven-segment displays, and LED traffic lights. The LDR sensor automates street lighting based on ambient light levels, conserving energy. The IR sensor detects pedestrians and activates DC motors to deploy sliding zebra crossings and servo motors to operate safety barriers, preventing accidents. A seven-segment display shows traffic countdown timers, while LEDs display traffic signal status. The system is cost-effective, scalable, and suitable for urban infrastructure upgrades.
An automatic zebra crossing is an essential technology for enhancing pedestrian safety on busy roads. In today's world in every 4 minute an accident happens. This system is designed to reduce these accidents that happen while crossing the road. This project proposes a smart zebra crossing system that utilizes DC and Servo motors, an Arduino UNO microcontroller, and ICs without the use of sensors. Arduino UNO controls all the components, DC Motor controls the zebra lines for sliding, Servo Motor controls the gates, LCD is used to display the time, Traffic LED is used to show the traffic signal, Buzzer is used to provide real-time alertness to the pedestrian. The traffic lights' timing is programed to ensure that pedestrians have enough time to CROS safely, while vehicles are stopped at the crossing. The system provides a safe and efficient crossing experience for pedestrians, reducing the risk of accidents on busy roads.
Keywords:-Arduino UNO, IR Sensor, Motor Driver Shield, DC Motor, Servo Motor, Buzzer, 7 Segment, Traffic LED light, Switch.

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Introduction:

Pedestrian safety at zebra crossings is a critical aspect of civic business operation. Traditional zebra crossings calculate on static markings and homemade control, which can occasionally fail to adequately cover climbers, especially in busy areas or for periods of high business. To address these challenges, an innovative approach using ultramodern electronics and colonization can significantly enhance the effectiveness and safety of zebra crossings. The Smart Street Project utilizes an Arduino Unomicro-controller to automate the control of rambler and business signals, integrating colorful electronic factors to produce a responsive and user-friendly system. This system aims to ameliorate rambler safety, optimize business inflow, and give clear, real-time information to both climbers and motorists. This design not only demonstrates the practical operation of electronics and microcontroller technology in enhancing civic structure but also serves as a step towards smarter and safer megacity planning. The integration of these factors through Arduino programming showcases how technology can be abused to address everyday challenges in business operation and rambling safety. Smart road is the troop of sliding the zebras lines and automatic gates or walls operate according to the business signal. When the signal is red, gate across the road is unrestricted and gate along with the path is open and also the sliding zebra lines slide through which people can cross the road and vehicles have to stay till the signal turns into the green. When the signal is green, the roadside gate will be open and the gate along with the path will be closed and sliding also stops, so vehicles can go in the forward direction and people have to stay till the signal turns green. Everyone can be distributed as climbers. A rambler is a person traveling on the bottom, whether walking or running. In some communities, those traveling using bits buses such as skates, skateboards, and scooters, as well as wheelchair druggies are also included as climbers. In the civic environment, climbers are one of the most important rudiments that work civic conditioning by fulfilling the inner space of metropolises for colorful purposes such as work, business, shopping, sightseeing and so on. Pedestrians not only calculate solely on the routes handed. Pedestrian movement is unlimited and delicate to control. Each rambler has different

situations and capacities. This depends on the person's physical factors, including gender, age, and abidance independently. The type of rambler crossing that is used all over the world is zebra crossing. The effectiveness of zebra crossing affecting the road business smooth in avoiding the undesirable events occurs on the carriageway. Therefore, the provision of rambler installations is important as one of the measures to ameliorate and produce social relations among the community as well as to control the quality of the terrain. In addition, it also helps in generating and stimulating profitable conditioning of a megacity.

This is because the megacity is a center of attention. Hence, the megacity that can attract guests is a fleetly developing municipality. The Malaysian Institute of Road Safety Research(MIROS) was established in 2007 as an agency under the Ministry of Transport Malaysia to serve as a central depository of knowledge and information on road safety. The findings deduced from exploration and confirmation-based intervention programs give the base for the expression of new strategies, legislation, programs, and enforcement measures, governing road safety at the public position. Basically engaged in exploration, MIROS collaborates almost with original and transnational government agencies and private bodies to foster the cause of road safety. For instance, the 20th ASEAN Transport Ministers Meeting(ATM) on 27 November 2014 in Mandalay, Myanmar blazoned the appointment of the Malaysian Institute of Road Safety Research(MIROS) as the ASEAN Road Safety center ARSC). The places of this center are to help and guide the ASEAN countries to reach an advanced position of road safety performance on road safety issues which includes road business laws and regulations, data operation, morals development, road safety mindfulness and education programs and also to estimate and validate road safety performance for member countries, combine and harmonize indigenous comparisons to represent indigenous road safety conditioners has conducted an observation on rovers and motorists' get at the signalized and signalized zebra crossings. Findings from the observation set up that around 74 of the motorists do not give way to rovers at zebra crossings, especially stun-inked junctions. For signalized junctions, only 8.2 of them defied the business rules (run red light) at the zebra crossing. Meanwhile, 95.4 of rovers used the crosswalk properly stun-signed junctions and 83.1 at signalized junctions. The MIROS president, Tan Sri Lee Lam Thye has linked a need to equip zebra crossings with business signals to ensure that approaching vehicles stop for rovers crossing the road. Processes or a dereliction points system were recommended to be executed to the motorists who haven't given the right of way to rovers at crossings (The Sun Daily, 2018). According to the Road Transport Act 1987, duty of rovers to act up with business directions subdued to a police officer in outfit or a business warden in outfit is for the time being engaged in regulating vehicular business on a road; any rambler who proceeds across or along the trace in violation of a direction to stop given by the officer in the prosecution of his duty, either to rovers or to rovers and other business, shall be lowered of an offense and shall on conviction be exceeding five hundred ringgits in agreement to Part III Section 75. Thus, we used Ultrasonic and one IR detector in this design. Some useful parameters are used to calculate the need and frequency of an active and activated and inactive rambler crossing. To construct and operate the device inexpensively and effectively. Dimension detectors are used for understanding the number of people who need to cross at a specific time. In addition to other important parameters, such as time, road characteristics, etc., the Arduino bias calculates this dimension. We need to use 3 detectors in this design. The rambler crossing bar is observed by 2 detectors, and 1 detector operates for the specific distance. When people and vehicles are placed face to face, voice is incorporated and blazoned. Also, they stopped and did not cross the road. The primary points of our case study on a named subject are to demonstrate that rambling safety must be the top priority. To learn the studies and views of people on the use of road crossing safety equipment and systems. To produce an innovative road system.

Objectives:

•Enhanced Safety: By automating the zebra crossing, the project aims to reduce the likelihood of accidents and improve safety for pedestrians, especially in high-traffic areas.

•Improved Traffic Management: The system helps in coordinating traffic flow more effectively by controlling pedestrian and vehicle signals in a synchronized manner.

•Real-Time Information: Providing real-time updates through visual and auditory signals to keep both pedestrians and drivers informed about crossing times and signal statuses.

•Reduce Accidents: Reduce accidents at crossings by providing real-time alerts(e.g., sound alarms, emergency switches and traffic light) to both drivers and pedestrians.

•Conserve Energy: Conserve energy through the intelligent control of streetlights that adjust brightness based on the presence of pedestrians and vehicles.

•Integrate with Smart City: Integrate with smart city infrastructure by using IoT sensors and microcontrollers for real-time monitoring and automation.

•Emergency Support: Provide emergency support via manual switches for disabled or elderly pedestrians requiring additional crossing time.

Literature Review:

This section reviews key studies addressing solar panel performance, with a focus on dust accumulation and automated cleaning solutions.

1. SMART ZEBRA CROSS

Ahmad, Aneziatun Aqmal Puteh, and Rusatika Abdullah (2022) in their seminal paper "Smart Zebra Cross" (IJ SRT) These study Achievements at exploring the motion sensor and LEDs light along the crosswalk in smart zebra crossing and several conclusions, a modern and user-friendly of smart zebra cross prototype has been built to give the road users a sense of its function and operation.

2. SMART AND INTELLIGENT ZEBRA CROSSING WITH TRAFFIC LIGHTS USING ARDUINO

SRIKANTH, S., et al. (2015) explored the "Smart and Intelligent Zebra Crossing with Traffic Lights Using Arduino" (Journal, vol 15.2). In the proposed automated zebra crossing system, one would have a very hard time outsmarting it to get the benefit of the system towards him/her. The automation of this particular system relies entirely upon the characteristics of the road and area, which in the upgraded versions will be estimated automatically as well.

3. DESIGN OF INTELLIGENT PEDESTRIAN AND VEHICLES GUIDANCE SYSTEMS FOR ZEBRA CROSSING BASED ON MILLIMETER WAVE RADAR

Go, Peng, et al. (2020) in "Design of Intelligent Pedestrian and Vehicles Guidance System for Zebra Crossing Based on Millimeter Wave Radar" (Journal of Physics: Conference Series. Vol. 1646. No. 1. IOP Publishing) The intelligent pedestrian and vehicle guidance system proposed in this paper adopts a separate structure, which is light and portable.

4. AN INTELLIGENT STREETLIGHT SYSTEM BASED ON PIEZOELECTRIC GENERATOR WITH NOTICEABLE ZEBRA CROSSING POINT AND BUS STAND

Kabir, AM Tamil, et al. (2019) in their paper "An Intelligent Streetlight System Based on Piezoelectric Generator with Noticeable Zebra Crossing Point and Bus Stand" (International Conference on Advances in Science, Engineering and Robotics Technology (INSERT)) From this project, we have not depended only on the grid connection as sometimes it is not available due to lack of electricity, so piezoelectric material plays an important role by providing a renewable source of energy.

5. PEDESTRIAN SAFER IoT-BASED SMART CROSSING SYSTEM WITH OBJECT TRACKING

Pathak, Abhijit, et al. (2020) in "Pedestrian Safer IoT Based Smart Crossing System with Object Tracking" (International Journal of Recent Technology and Engineering 9.1) It was found that 62.16 of the total pedestrian crossing were using overpasses, 19.37 were using zebra-crossing and the remaining 18.27 were traveling illegally. It is significant that approximately 82 of pedestrians use legal facilities.

Methodology:

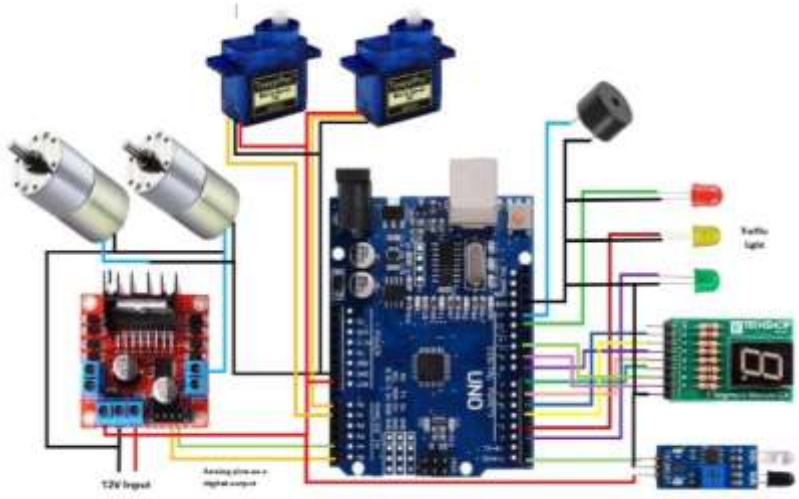

Fig. circuit diagram of proposed project

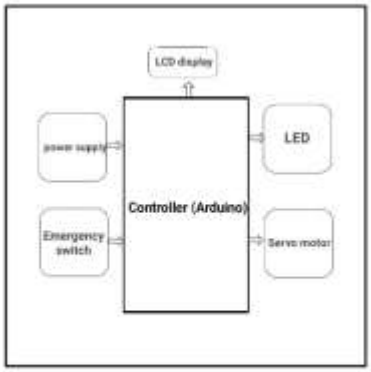

Fig. block diagram of proposed work

- **Working of Proposed Project:**

This circuit is designed to:
Automatically detect pedestrians at a zebra crossing using IR sensors. Control traffic lights and barricades (servo motors).
Display countdown on a 7-segment display.
Operate streetlights based on vehicle or human presence.

1. Pedestrian Detection and Zebra Crossing Operation:
IR Sensor:
Continuously checks for pedestrians near the zebra crossing.
When a pedestrian is detected, it sends a HIGH signal to Arduino.
Arduino Action:
When the IR sensor detects a pedestrian:

1. Traffic Light Control:
The red LED turns ON to stop vehicles.
The green LED for pedestrians turns ON.
The yellow LED blinks briefly to warn vehicles before turning red.
2. Servo Motors (2 units):
They act as road barriers.
Move down to block vehicles during pedestrian crossing.

After crossing, they move up to allow traffic.

3. Buzzer sounds to alert pedestrians it is safe to cross.
Also acts as a warning for vehicles.

4. 7-Segment Display:
Displays a countdown (e.g., 10 to 0 seconds) for the pedestrian to cross.
Each second, the number reduces by 1.

5. After Countdown:
Green LED (vehicles) turns ON again.
Red LED (vehicles) turns OFF.
Barriers lift up using servo motors.
Buzzer stops.

1. Smart Street Light System:

IR Sensor / Motion Detector:

When a vehicle or person is detected at night:
Arduino turns ON the street light (can be white LED or relay-driven light).
If no motion is detected for a few seconds:
Arduino turns OFF the light to save energy.
Note: In some models, an LDR (Light Dependent Resistor) is used to ensure this works only at night.

Power System:
A 12V input supplies power to:
L298N Motor Driver for DC motors (if used for other purposes).

Arduino Uno, which regulates voltage for:
Sensors
LEDs
Buzzer
7-segment display
Servos.

Hardware Components:

1. Arduino UNO:

fig. Arduino uno

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful

board used in various projects. Arduino.cc developed the Arduino UNO board.Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc.

2. Motor Driver Module

Fig. Motor driver module

A motor driver module is an electronic circuit that acts as an interface between a microcontroller or control system and an electric motor, allowing precise control over the motor's speed and direction by amplifying low-power control signals from the microcontroller to a level strong enough to power the motor; essentially, it is the "bridge" that lets you effectively manage a motor using a small control signal.

3. Servo Motor

Fig. Servo Motor

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. In this project we used servo motor for open and close the barriers.

4. DC Motor:

Fig. DC motor

DC Motor is an electrical machine which, when provided with direct current electrical energy, converts it into mechanical energy. It is based on electromagnetic induction, where a conductor carrying current (normally a coil of wire) placed in a magnetic field experiences force to rotate. This rotation is used to perform mechanical work. In this project we used DC motor for rotating sliders of zebra crossing.

5. 7- Segment Display

Fig. 7 seg. Display

The purpose of a seven-segment display in a traffic light system is to provide clear, numerical visual information to drivers, pedestrians, or both. It enhances the effectiveness and safety of traffic management by offering real-time countdowns or status indicators. 1.Countdown Timer for Signals Displays the remaining time (in seconds) before the light changes from red to green or green to yellow. Helps drivers anticipate when to stop or proceed, reducing sudden braking or acceleration. Pedestrians can also judge when it's safe to cross. 2. Improved Traffic Flow With a visible countdown, drivers are less likely to hesitate, improving overall traffic efficiency. Reduces idling time and helps prevent traffic jams at intersections. 3. Pedestrian Safety Countdown displays for pedestrian lights help people decide whether they have enough time to cross the road. Reduces mid-crossing panic or rushing.

6. Emergency S/W:

Fig. switch

This is an electronic device; the IR sensor can determine an object's heat as well as sense the motion. IR is invisible to the human eye since its wavelength is longer than the visible light. Everything that emits heat has a temperature that emits infrared radiation. There are two types of active and passive infrared sensors available. Both active infrared sensors emit and detect infrared. Light emitting diode (LED) and receiver. IR sensors act as proximity sensors. The purpose of an IR (Infrared) sensor in a smart zebra crossing is to detect the presence or movement of pedestrians near or on the crossing, enabling the system to respond intelligently to ensure safety and improve traffic management.

7. Buzzer:

Fig. Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell and siren.

Result:

Fig. Result of project

Conclusion:

Automatic zebra crossings represent a significant advancement in traffic management, offering enhanced safety and improved traffic flow. The integration of microcontrollers, sensors, and actuators has enabled the development of sophisticated systems that respond dynamically to real-time conditions. However, challenges remain in terms of technical implementation, cost, and public acceptance. Ongoing research and technological advancements will continue to shape the future of automatic zebra crossings, making them a critical component of modern urban infrastructure.