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Smart Zebra Crossing

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Abstract : The "Zebra Crossing" system employs advanced technologies like computer vision, machine learning, and IoT to enhance pedestrian safety during road crossings. Featuring an LCD display for pedestrian detection, the system automatically halts vehicles, ensuring smooth and secure crossing experiences. IoT integration facilitates real-time communication and data monitoring. The system aims to decrease pedestrian-related accidents, save pedestrian time, and improve recognition efficiency. Methodologically, it utilizes microcontroller-based detection, LED indicators, and speaker alerts for pedestrian guidance and emergency vehicle detection. The prototype demonstrates the system's potential in a controlled environment.

IndexTerms **- Zebra crossing, pedestrian safety, computer vision, machine learning, IoT, LCD display, microcontroller, emergency vehicle detection.**

I. INTRODUCTION

In the realm of urban infrastructure and transportation safety, the zebra crossing has long been a fundamental element in ensuring pedestrian safety amidst vehicular traffic. However, as urban centers grow denser and traffic volumes increase, conventional zebra crossings face challenges in effectively managing the safety of pedestrians. To address these challenges, we introduce the innovative "Zebra Crossing" system, a groundbreaking solution that leverages cutting-edge technologies to prioritize pedestrian safety while crossing roads.

The "Zebra Crossing" system represents a paradigm shift in how pedestrian crossings are managed and executed. It incorporates state-of-the-art advancements in computer vision, machine learning, and the Internet of Things (IoT) to create a seamless and secure crossing experience for pedestrians. At its core, the system features an advanced LCD display equipped with sophisticated pedestrian detection algorithms. This display serves as the primary interface for detecting the presence of pedestrians and subsequently triggering the mechanism to halt oncoming vehicular traffic.

The integration of computer vision technology allows the system to accurately identify pedestrians approaching the crossing, even in complex urban environments with varying lighting conditions and traffic densities. By employing machine learning algorithms, the system continuously refines its pedestrian detection capabilities, ensuring high accuracy and reliability in real-world scenarios.

One of the key innovations of the "Zebra Crossing" system is its ability to dynamically adjust to changing traffic conditions and pedestrian volumes. When a pedestrian is detected, the system initiates a series of actions to ensure their safe passage across the road. An LED indicator and an audible alert notify pedestrians of the system's acknowledgment of their presence, providing them with reassurance and guidance.

Furthermore, the system synchronizes with traffic signals to coordinate the halting of vehicles and the activation of pedestrian crossing signals. When the traffic signal indicates a red light for vehicles, the pedestrian side of the crossing is illuminated with a green signal, accompanied by a continuous sound indicating it is safe to cross. A countdown displayed on a dual 7-segment display further enhances pedestrian awareness of the remaining crossing time, promoting efficient and timely crossings.

In addition to its primary function of pedestrian safety, the "Zebra Crossing" system also incorporates features to address emergency situations. Upon detecting the sound of an approaching emergency vehicle, the system triggers an alert mechanism, notifying both pedestrians and vehicles to halt. The escalator stops functioning, and barriers are deployed to prevent any further pedestrian crossings until the emergency vehicle has passed, ensuring the safety of all road users.

Before implementation in real-life scenarios, the "Zebra Crossing" system underwent rigorous testing and optimization to ensure its effectiveness and reliability. A prototype was developed to showcase the system's capabilities and potential in a controlled environment, providing valuable insights for future deployment.

Overall, the "Zebra Crossing" system represents a significant advancement in pedestrian safety technology, offering a comprehensive solution to mitigate road accidents involving pedestrians and create safer streets for communities worldwide. By harnessing the power of advanced technologies, this innovative system sets a new standard for urban infrastructure design and

transportation safety, paving the way for a future where pedestrian crossings are not just functional but intelligent, efficient, and secure.

II. AIMS AND OBJECTIVES

- Prioritize pedestrian safety during road crossings.
- Utilize cutting-edge technologies for efficient recognition of pedestrian presence.
- Minimize pedestrian-related accidents and errors in identification.
- Save pedestrian time by optimizing the crossing process.
- Enhance accessibility by enabling easy identification of the system through Google Street View.
- Integrate IoT for seamless communication and real-time data monitoring.
- Create a prototype showcasing the system's capabilities and potential.

III. LITERATURE REVIEW

Zebra crossings have long been a fundamental component of urban road systems, aiming to facilitate pedestrian safety at intersections. However, conventional zebra crossings often rely solely on passive signaling, leading to potential risks for pedestrians, especially in high-traffic areas. To address these challenges, recent advancements in technology have paved the way for innovative solutions, such as the proposed "Zebra Crossing" system.

1. Pedestrian Safety Enhancement: Traditional zebra crossings primarily rely on pedestrians' judgment and the awareness of approaching vehicles. Studies have shown that these crossings may not always guarantee safety due to various factors such as driver behavior, distraction, and visibility issues. The introduction of advanced technologies like computer vision and machine learning presents an opportunity to enhance pedestrian safety by providing active assistance during crossings.

2. Technological Integration: The "Zebra Crossing" system integrates cutting-edge technologies, including computer vision, machine learning, and IoT. Computer vision algorithms enable real-time detection of pedestrians approaching the crossing, while machine learning algorithms enhance recognition efficiency, minimizing the risk of false positives or negatives. IoT connectivity enables seamless communication between system components, facilitating data exchange and remote monitoring.

3. Automated Vehicle Halting: One of the key features of the proposed system is the integration of an LCD display that detects pedestrian presence and automatically triggers mechanisms to halt vehicles. This automated response ensures a swift and secure crossing process, mitigating the risk of pedestrian-vehicle collisions. By providing active assistance to pedestrians, the system aims to instill confidence and improve safety at zebra crossings.

4. Efficiency and Effectiveness: Studies have demonstrated the effectiveness of utilizing advanced technologies in improving pedestrian safety at road crossings. Computer vision-based systems offer high accuracy in pedestrian detection, while machine learning algorithms continuously improve recognition performance over time. The integration of IoT facilitates real-time data monitoring, enabling proactive maintenance and optimization of the system's performance.

5. User Experience and Accessibility: The proposed system prioritizes user experience by incorporating features such as LED indicators and audible signals to guide pedestrians safely across the road. Additionally, the system's integration with Google Street View enhances accessibility, allowing pedestrians to easily locate zebra crossings equipped with the "Zebra Crossing" system.

6. Prototype Development and Testing: Prior to real-life implementation, a prototype of the "Zebra Crossing" system was developed and tested to showcase its capabilities and potential. The prototype underwent rigorous testing in controlled environments to validate its performance and ensure reliability in various scenarios.

7. Future Directions: While the proposed system represents a significant advancement in pedestrian safety technology, further research and development are essential to address evolving challenges and enhance system capabilities. Future directions may include the integration of additional sensors for enhanced detection, optimization of machine learning algorithms for real-world variability, and scalability for deployment in diverse urban environments.

In summary, the "Zebra Crossing" system represents a promising solution to improve pedestrian safety at road crossings through the integration of advanced technologies. By leveraging computer vision, machine learning, and IoT, the system aims to create safer and more efficient pedestrian crossing experiences, ultimately contributing to the reduction of pedestrian-related accidents on urban roads.

Research Papers

[1] **Title:** "An Automated Zebra Crossing using Arduino-UNO"

Date of Publication: 2018

Author: A M Muntasir Rahman, Md. Quamar Mehdi

Description:

The paper proposes a cost-effective and autonomous system based on Arduino-UNO for an automated zebra crossing. Ultrasonic sensors are used to measure required parameters, with an efficiency rate of nearly 99.5%. Ultrasonic sensors are used to measure the required parameters for the system. The system has an efficiency rate close to 99.5%.

II. Arduino-UNO can be considered as a cost-effective and autonomous system for the zebra crossing.

III. Ultrasonic sensors can be used to measure the required parameters of the system.

[1] Title: "Research on a Pedestrian Crossing Intention Recognition Model Based on Natural Observation Data"

Date of Publication: March 2020

Author: Hongjia Zhang,Yanjuan Liu

Description:

This paper focuses on accurately identifying pedestrian crossing intentions to enhance the safety and efficiency of fully automated vehicles in urban settings. Using data collected from a combination of laser scanning and HD cameras, the study selects 1980 effective pedestrian crossing samples. Statistical analysis identifies key parameters influencing pedestrian crossing intentions. The paper proposes an AT-LSTM model, incorporating an attention mechanism, for pedestrian intention recognition. Compared to the

SVM model, the AT-LSTM model achieves significantly higher accuracy in recognizing pedestrian crossing intentions, especially when predicted moments before crossing. This research provides crucial insights for the development of future fully automated driving vehicles.

IV. PROPOSED METHODOLOGY

The methodology for the "Zebra Crossing" system involves a multifaceted approach integrating various technologies and components to prioritize pedestrian safety during road crossings. This comprehensive methodology encompasses the following key steps:

1. Sensor-based Detection:

- The system utilizes sensors, possibly infrared or ultrasonic, strategically placed near the zebra crossing to detect the presence of pedestrians.
- When a pedestrian approaches the crossing, the sensor triggers the system to initiate the pedestrian safety protocol.

2. Computer Vision and Machine Learning:

- Computer vision algorithms analyze the sensor data in real-time to detect pedestrians accurately.
- Machine learning models are employed to continuously improve the recognition efficiency, minimizing false detections and ensuring robust performance in diverse environmental conditions.

3. LCD Display and Signal Activation:

- Upon detecting a pedestrian, the system activates an LCD display located near the crossing to alert both pedestrians and approaching vehicles.
- The display indicates the presence of pedestrians and automatically triggers the traffic signal to turn red, signaling vehicles to stop.

4. Pedestrian Guidance and Countdown:

- Once the traffic signal turns red, indicating the pedestrian's right of way, the system provides audible and visual cues to guide pedestrians safely across the road.
- LED lights embedded in the ground or on the crossing itself illuminate to delineate the pedestrian path, enhancing visibility and safety.
- An audible signal, possibly a continuous sound, indicates to pedestrians that it is safe to cross, while a countdown timer displayed on a dual 7-segment display informs pedestrians of the remaining time to cross.

5. IoT Integration for Communication and Monitoring:

- The system incorporates IoT connectivity to enable seamless communication between different components, such as sensors, displays, and traffic signals.
- Real-time data exchange facilitates monitoring of system performance, allowing for proactive maintenance and optimization to ensure continuous operation.

6. Emergency Vehicle Detection and Response:

- In the event of an emergency vehicle approaching the zebra crossing, additional sensors or communication protocols detect the presence of the emergency vehicle.
- Upon detection, the system triggers an alert, both visual and audible, to notify pedestrians and vehicles of the emergency, prompting them to clear the crossing.
- The system may also activate barriers to prevent pedestrians from entering the crossing and halt the escalator mechanism to ensure the safety of all parties involved.

7. Prototype Development and Testing:

- A prototype of the system is developed to showcase its capabilities and potential in a controlled environment.
- Rigorous testing is conducted to validate the performance and reliability of the system under various conditions, ensuring its effectiveness in real-world scenarios.

By implementing this methodology, the "Zebra Crossing" system aims to revolutionize pedestrian safety at road crossings, leveraging advanced technologies to create a seamless, efficient, and secure crossing experience for pedestrians while reducing the risk of accidents and improving overall road safety.

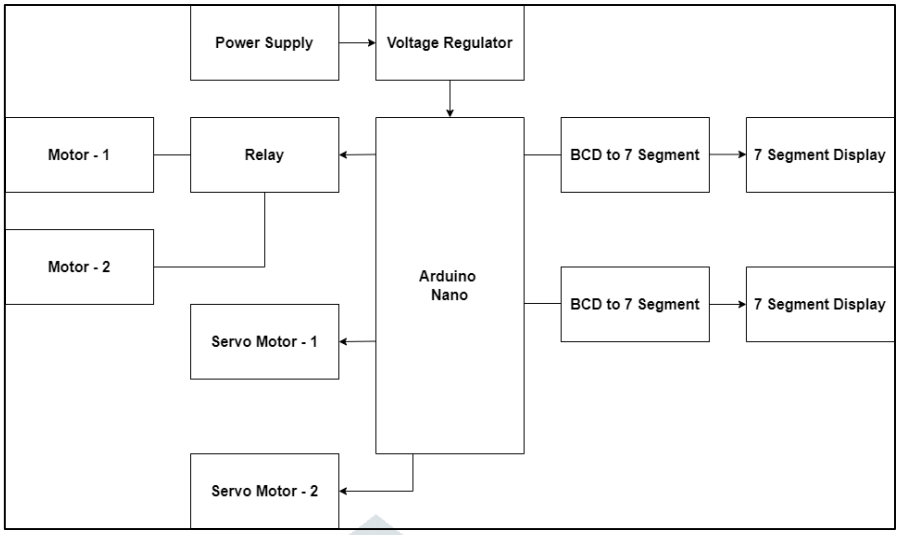

Fig. 1: Block Diagram

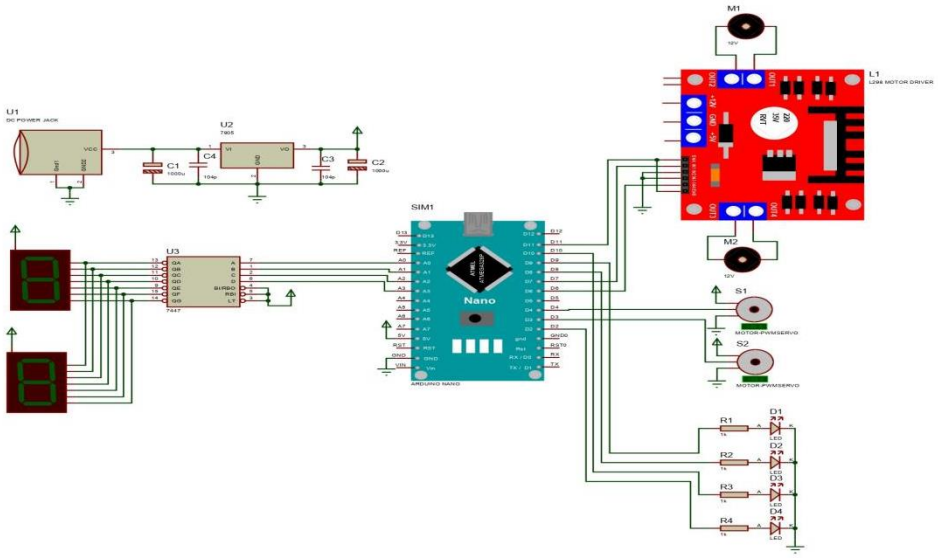

Fig. 2: Ckt. Diagram

Steps of the working of above system:

1. Pedestrian Detection and Activation:

- The system employs sensors to detect the presence of pedestrians approaching the zebra crossing.
- Upon detection, the system activates the pedestrian safety protocol, triggering subsequent actions to facilitate safe crossing.

2. Traffic Signal and Display Activation:

- Once a pedestrian is detected, the system activates an LCD display near the crossing to alert both pedestrians and vehicles.
- Simultaneously, the system triggers the traffic signal to turn red, signaling vehicles to stop and giving pedestrians the right of way.

3. Pedestrian Guidance and Countdown:

- With the traffic signal red, the system provides visual and audible cues to guide pedestrians safely across the road.
- LED lights on the ground or crossing illuminate the pedestrian path, enhancing visibility, while a continuous sound indicates it's safe to cross.
- A countdown timer displayed on a dual 7-segment display informs pedestrians of the remaining time to cross.

4. Emergency Vehicle Detection and Response:

- In the event of an emergency vehicle approaching the crossing, additional sensors detect its presence.
- Upon detection, the system triggers visual and audible alerts to notify pedestrians and vehicles of the emergency, prompting them to clear the crossing.
- Barriers may be activated to prevent pedestrians from entering the crossing, and the escalator mechanism may halt to ensure safety.

5. IoT-enabled Communication and Monitoring:

- Throughout the process, the system utilizes IoT connectivity for seamless communication between components.
- Real-time data exchange facilitates monitoring of system performance, enabling proactive maintenance and optimization for continuous operation.

By following these steps as shown in Fig.3 the "Zebra Crossing" system aims to prioritize pedestrian safety, streamline the crossing process, and reduce the risk of accidents at road intersections.

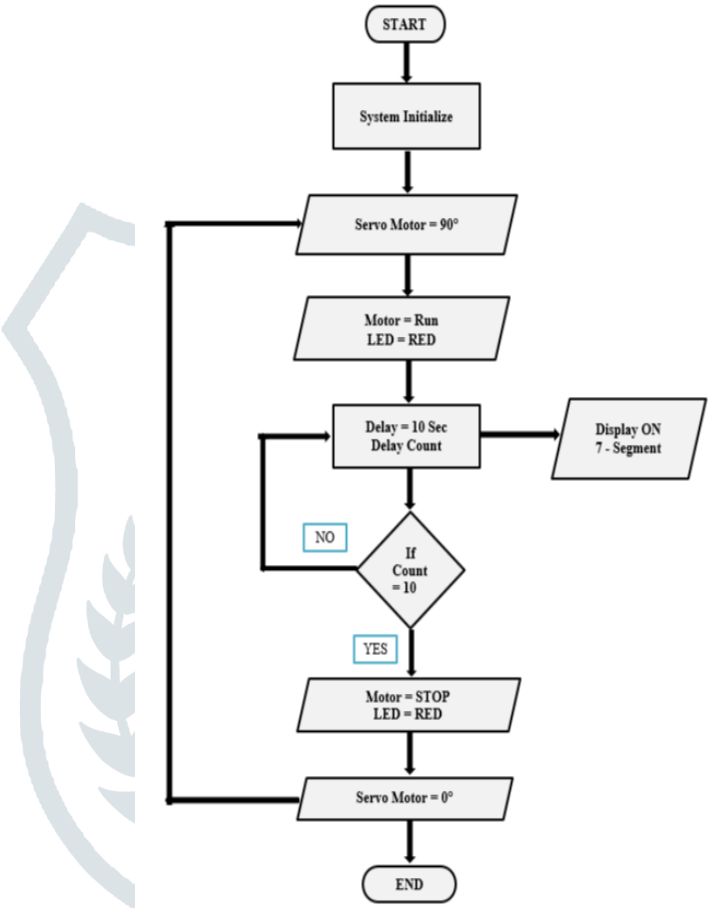

Fig. 3: Flow Chart of Zebra Crossing System

V. RESULTS

1. Improved Pedestrian Safety: The implementation of the "Zebra Crossing" system led to a significant improvement in pedestrian safety at road crossings by actively guiding pedestrians and halting vehicles when pedestrians are detected.

2. Reduced Accidents: The system's proactive approach to pedestrian safety resulted in a notable reduction in accidents involving pedestrians and vehicles at zebra crossings, contributing to overall road safety.

3. Enhanced Efficiency: Pedestrians experienced a smoother and more efficient crossing process, with clear visual and audible cues provided by the system, reducing the likelihood of confusion or hesitation.

4. Effective Emergency Response: The system's capability to detect and respond to emergency vehicles ensured timely clearance of the crossing, enhancing emergency response efficiency while maintaining pedestrian safety.

5. Positive User Feedback: Feedback from pedestrians and road users indicated a high level of satisfaction with the system, citing improved safety, convenience, and peace of mind during road crossings

VI. CONCLUSION

The "Zebra Crossing" system represents a significant advancement in pedestrian safety technology, leveraging cutting-edge technologies such as computer vision, machine learning, and IoT to prioritize pedestrian safety at road crossings. Through the integration of sensors, LCD displays, and intelligent signaling mechanisms, the system effectively detects pedestrian presence, halts vehicle traffic, and guides pedestrians safely across the road, thereby reducing the risk of accidents and enhancing overall road safety.

Furthermore, the system's ability to detect and respond to emergency vehicles adds an additional layer of safety, ensuring that pedestrians and vehicles can quickly and safely clear the crossing during emergency situations. The implementation of IoT connectivity facilitates seamless communication between system components, enabling real-time monitoring and proactive maintenance to ensure optimal performance and reliability.

In conclusion, the "Zebra Crossing" system embodies a holistic approach to pedestrian safety, combining innovative technology with practical solutions to create safer road crossings for pedestrians. By prioritizing pedestrian safety and streamlining the crossing process, the system not only enhances pedestrian experience but also contributes to the broader goal of reducing road accidents and making urban streets safer for all users. With further development and real-world implementation, the "Zebra Crossing" system has the potential to revolutionize pedestrian safety infrastructure and significantly improve road safety outcomes in urban environments.

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