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Conflict Avoidance and Landslide Update of Vehicles in Deep Curves

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Abstract:
This project aims to reduce accidents on curved roadways, especially in hairpin bends and narrow roads. It uses IR sensors connected to an Arduino Uno microcontroller to detect vehicles and alert drivers via an LCD display. Motor-operated gates control traffic flow, allowing safe passage when conditions are clear. The system also monitors landslides and heavy rainfall using accelerometer and rain sensors. If hazardous conditions are detected, the system warns drivers and closes gates until the road is safe. By improving vehicle detection, collision avoidance, and traffic management, this system enhances safety on challenging, high-risk road segments.

Keywords: hairpin curves, Accidents, Deep curves, Machine learning.

1. Introduction

Traffic accidents, especially in areas with poor road conditions and careless driving, are a major concern in our society. Curved road segments, particularly hairpin bends in narrow, hilly, and ghat sections, are especially prone to crashes due to reduced visibility and difficult navigation. These turns are designed to navigate steep slopes safely but come with the drawback of sharp angles, lower speed limits, and higher accident risks. Moreover, the threat of landslides, particularly in regions prone to heavy rainfall, further exacerbates these dangers.

The **"Conflict Avoidance and Landslide Update System for Vehicles in Deep Curves"** addresses these issues by integrating advanced technologies like Arduino Uno, IR sensors, rain sensors, ADXL sensors, LCD displays, and Zigbee communication. This system provides real-time assistance to drivers in hazardous areas by detecting obstacles and monitoring road conditions. IR sensors detect vehicles on the curve, triggering warnings on an LCD display for drivers on the opposite side, alerting them of approaching vehicles.

Additionally, the system uses ADXL sensors to monitor vehicle dynamics and detect potential landslide conditions, while rain sensors detect more rainfall, which leads to slippery roads and landslides. Upon detecting these hazards, the system triggers automatic warnings and closes gates to prevent vehicles from entering dangerous zones.

Leveraging IoT technology, the system connects devices to share data in real-time, improving communication between vehicles and infrastructure. This system helps prevent accidents by offering dynamic traffic management and ensuring better coordination in areas with high accident risks.

By combining vehicle detection, environmental monitoring, and automated traffic control, the system enhances safety, reduces congestion, and offers an effective solution to the challenges posed by hairpin curves and mountainous roads.

2. OBJECTIVES

- Develop a real-time conflict avoidance system using Arduino Uno and IR sensors to identify obstacles and potential conflicts on the road, especially in deep curves.
- Implement an ADXL sensor to monitor Land slide and provide drivers with information on vehicle tilt and lateral acceleration in real-time.
- Detection of vehicles in curves and automating the vehicle operations.
- Utilize an LCD display to present visual warnings and updates to the driver regarding road conditions and potential conflicts.
- Establish a Zigbee communication network between vehicles to exchange critical information about road conditions, obstacles, and potential landslide risks.
- Ensure compatibility with existing vehicle systems and navigation devices, making it easy to retrofit vehicles with this system.

3. REQUIREMENT SPECIFICATION

Hardware requirements:

- Arduino UNO
- IR Sensor
- ADXL Sensor
- Rain Sensor
- LCD Display
- Zigbee Communicator
- Buzzer
- Motor Gates

Software Requirements:

- Arduino IDE
- Python

4. METHODOLOGY

Project consists two model's hub model and vehicle model. Hub model consists of IR sensor for vehicle detection in hair pin curve, accelerometer for landslide detection, rain sensor for identification of percentage of rain in hilly areas and Zigbee for communication which vehicle model as in the block diagram shown in the Fig 1. Vehicle model consists of Zigbee to communicate with hub model, LCD display as in the block diagram shown in Fig 2.

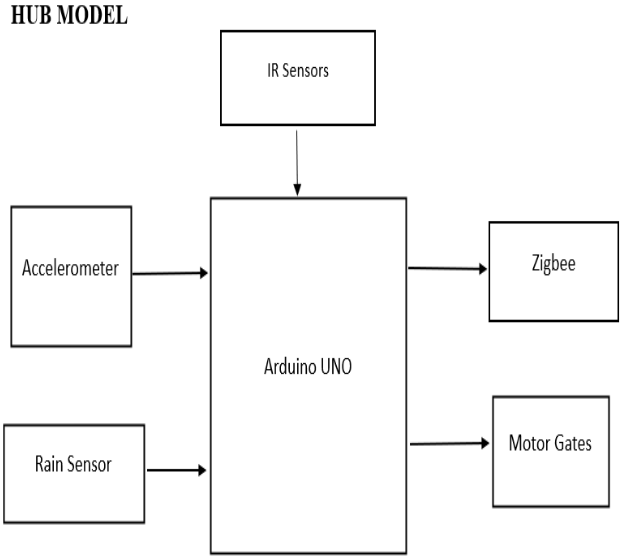

FIG 1: HUB MODEL

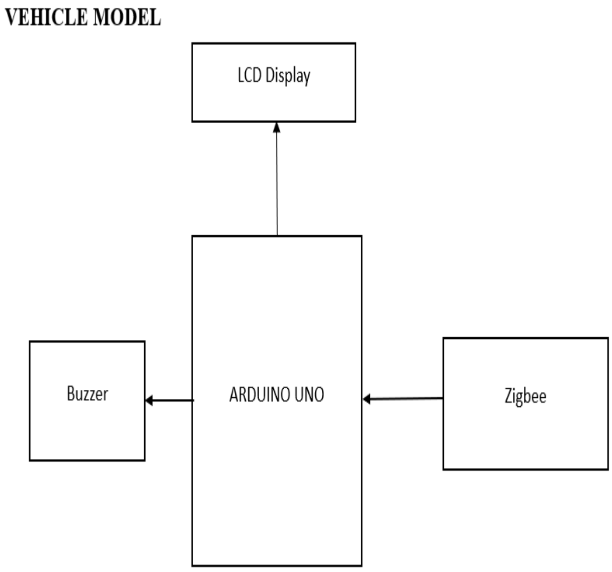

FIG 2: VEHICLE MODEL

This section explains the vehicle detection and classification process using the YOLO (You Only Look Once) algorithm. As shown in Fig 3, the workflow begins with data acquisition, followed by data annotation to label vehicles in the frames. Then, YOLO configuration is set up, and the algorithm is trained with the annotated data. Once trained, YOLO detects and classifies vehicles based on type or size, updating the system with results. This step-by-step process ensures accurate detection and classification, enabling timely alerts for drivers.

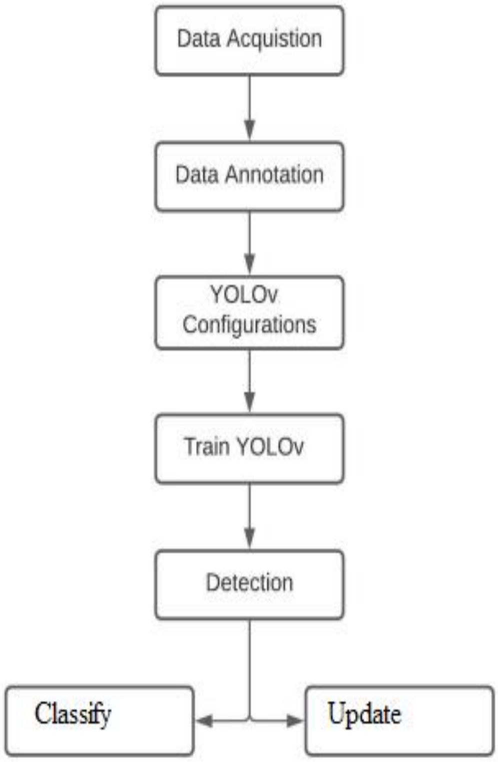

FIG 3: WORKFLOW OF YOLO

The system uses a night vision camera and object detection algorithms like YOLO or R-CNN to detect approaching vehicles. It extracts the vehicle's height and classifies it as either a Light Motor Vehicle (LMV) or a Heavy Motor Vehicle (HMV) using an SVM classifier. The system then sends output signals to an LED display, alerting drivers to the type of approaching vehicle. The LED display shows different states: no vehicle (Fig 4), LMV detected (Fig 5), and HMV detected (Fig 6). This system enhances safety by providing real-time alerts, especially in areas with low visibility, reducing accident risks.

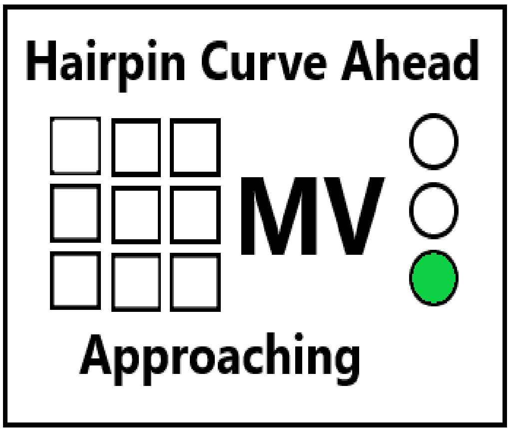

FIG 4: DEFAULT STATE OF LED BOARD (WHEN NO VEHICLE IS DETECTED).

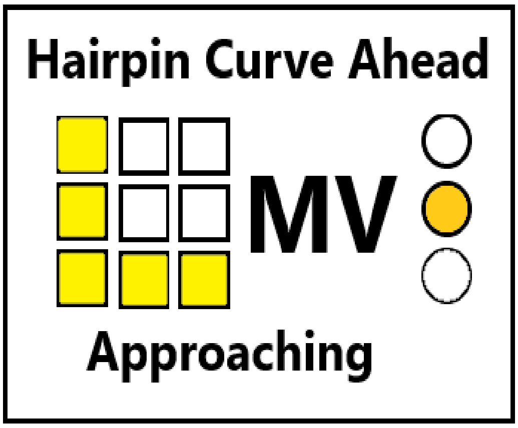

FIG 5: STATE OF THE LED BOARD WHEN A LMV (LIGHT MOTOR VEHICLE) IS DETECTED.

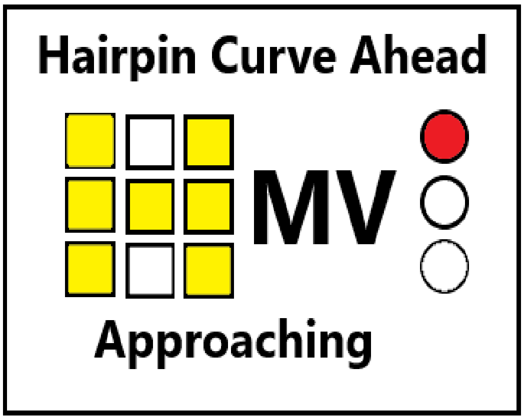

FIG 6: STATE OF THE LED BOARD WHEN HMV (HEAVY MOTOR VEHICLE) IS DETECTED.

5. IMPLEMENTATION

Testing:

Testing is the process of evaluating a system or its parts to verify whether it meets the established requirements. It involves executing the system to detect any inconsistencies, errors, or missing requirements when compared to the specified expectations.

- **Testing Principle:**

Before designing effective test cases, software developers must understand the basic principle of software testing. All tests should be directly aligned with the customer's requirements, ensuring that each test checks the system's conformity to the anticipated user results and needs.

UNIT TESTING

Unit testing is a process in software development where the smallest testable components of an application, known as units, are tested individually to confirm their proper functionality. This type of testing is typically automated, although it can also be done manually. The primary purpose of unit testing is to isolate each section of the program and ensure that each part works correctly according to the specified requirements. Test cases and outcomes are usually documented, as shown in Table I, which demonstrates vehicle detection results.

TABLE I.

VEHICLE DETECTION

Sl # Test Case: -	UTC-3
Name of Test: -	Vehicle Detection
Items being tested: -	Different Mask images
Sample Input: -	Image or video
Expected output: -	Vehicle should be detected
Actual output: -	Same as Expected
Remarks: -	Test Passed

INTEGRATION TESTING:

Integration Testing is a phase in software testing where individual units are combined and tested together as a complete system. The objective is to recognize any problems in the interactions between the integrated components. Tools like test stubs and test drivers are commonly utilized during this phase. The focus of integration testing is to verify that the different parts of the application work together smoothly. The process concludes with tests of the entire system, preferably in conditions that mirror real-world use cases. The test cases for integration testing and their corresponding results are shown, with Table II presenting the findings for landslide detection.

TABLE II.

LANDSLIDE DETECTION

Sl # Test Case: -	ITC-3
Name of Test: -	Landslide Detection
Item being tested: -	Different inputs accelerometer
Sample Input: -	Vibration input
Expected output: -	Landslide should be detected
Actual output: -	Functioned Properly
Remarks: -	Pass.

SYSTEM TESTING:

System testing refers to the action of testing a fully integrated system to assess whether it meets the specified requirements. It falls under black-box testing, meaning it doesn’t require any understanding of the internal workings or logic of the system. The importance of system testing includes the following points:

- **First Comprehensive Evaluation:** System testing is typically the first phase where the complete application is tested as a unified entity.

- **Thorough Verification:** This type of testing ensures that the software meets both its functional and technical specifications.
- **Realistic Testing Environment:** It is carried out in an environment that closely mirrors the production setting where the application will eventually be used.
- **Validation of Requirements and Architecture:** System testing helps confirm that the application fulfils the business needs while also validating the software architecture.

Table III illustrates the signal operations based on the detected vehicles.

TABLE III.

SIGNAL OPERATION ACCORDING TO VEHICLE DETECTED

Sl # Test Case : -	STC-2
Name of Test: -	Signal Operation according to vehicle detected
Item being tested: -	Input different type of vehicle images and check
Sample Input: -	Capture image and send Signal to hardware
Expected output: -	Signal LED's should operate according to vehicle detected
Actual output: -	Traffic signal Status operated according to vehicle detected
Remarks: -	Pass.

VI. RESULTS

The result of the project between referred papers is shown in the comparison table IV.

TABLE IV.

COMPARISON TABLE

Paper	Methodology	Limitation	Proposed method
Harshada Targe et al., [1]	The use of CCTV and LCD screens rather than Mirror.	During night, driver can only be able to view headlight of the vehicle in the big LCD screen than the type and size of the vehicle.	This project aims to detect type and size of the vehicle.
Aravinda B et al., [2]	Use of ultrasonic sensors to trigger signal of approaching vehicle.	Waiting time is more in case of small vehicle approaching. Signal is triggered even for object.	Waiting time will be less as this project gives the priority to the heavy vehicle to move on.
Anuradha A et al., [3]	Use of IR sensors to calculate the speed of the approaching vehicle and given priority to high-	Fails in case of both vehicles approaching with same speed.	As the heavy vehicle moving in the downward direction will be given first priority as they will

	speed vehicle.		be in high speed.

PROJECT IMAGE

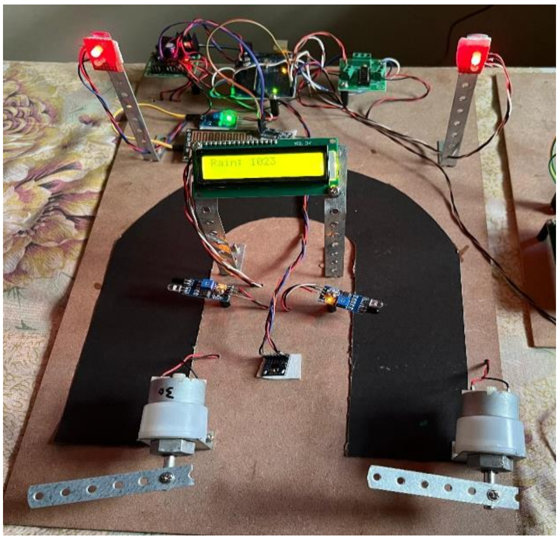

FIG 7: PROJECT MODEL

VII.CONCLUSION

The "Conflict Avoidance and Landslide Update System for Vehicles in Deep Curves" is designed to improve road safety and prevent accidents by using a combination of Arduino Uno, IR sensors, ADXL sensors, LCD displays, and Zigbee communication. The system provides real-time assistance to drivers navigating challenging terrains, with the aim of reducing collisions and optimizing traffic flow in areas prone to deep curves and landslides.

In the current setup, convex mirrors help drivers observe oncoming vehicles at curves, but this method is ineffective at night. The proposed solution involves placing sensors on both sides of hairpin curves, which work well even in low-light conditions. These sensors detect vehicles approaching within 10 meters of the curve and send signals to warn drivers, improving safety.

Additionally, the project examines the environmental impact of landslides and provides a platform for analysing and presenting results. The system is specifically designed to reduce traffic congestion and facilitate smoother vehicle movement in hilly areas. By incorporating advanced cameras and sophisticated calculations, it offers a real-time solution for avoiding collisions and managing traffic. Ultimately, this system enhances road safety, prevents accidents, and provides a more efficient driving experience in challenging terrains, saving lives in the process.

VIII.REFERENCE

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