Automated Speed Breaker Identification with Driver Alert and Dynamic Zebra Marking

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Abstract:

Unmarked or poorly visible speed breakers pose a significant risk to road safety, leading to sudden braking, vehicle damage, and accidents. To address these challenges, this paper proposes a system for automatic detection of speed breakers, dynamic alignment of zebra lines, and a real-time driver warning mechanism. The proposed system utilizes advanced sensors, including AVR Microcontroller, to accurately detect the presence, height, and location of speed breakers. Once detected, the system dynamically aligns zebra markings directly onto the speed breakers using automated painting systems or augmented reality overlays, ensuring high visibility under various weather and lighting conditions. Additionally, the system generates real-time warnings for oncoming drivers through in-vehicle notifications, enabling timely response and safe breaking. This integrated approach not only enhances the visibility of speed breakers but also minimizes the risks associated with unmarked obstacles. The system is designed for adaptability, allowing its implementation in both conventional and autonomous vehicles. Extensive testing demonstrates its superior performance in terms of detection accuracy, rapid response, and operational efficiency compared to existing methods. This innovation has the potential to transform traffic management systems, improve road safety, and reduce accident rates.

Keywords: Arduino nano, L298n motor driver , Motor ,Ultrasonic sensors , LCD display, E18-D80NK Mini Adjustable Infrared Sensor Switch 3-80cm, Arduino IDE, Embedded C

1. Introduction:

Speed-breakers (speed humps/speed bumps/sleeping policeman) are traffic calming devices commonly installed to reduce speed related accidents. Speed-breakers are designed to be driven over at a predetermined comfortable speed, while causing exceeding discomfort at higher speeds. The reduction in average vehicular speed significantly improves the safety of people in the neighboring areas[1]. For example, a before and after study in Ghana

found that speed humps reduced casualty crash frequencies by 37.5%, fatal crashes by 46% and pedestrian crashes by 72%. This traffic calming technique is of special value in developing countries because “stop”, “yield” and “speed limit” signs do not work due to shortage of traffic enforcement resources. As a result, speed-breakers are ubiquitous in many developing countries, including India, Chile, Egypt, Ghana and Pakistan. Even though there is evidence that speed-breakers reduce speed related accidents, they have also been known to cause accidents and injuries. When an automobile approaches a speed-breaker at a speed greater than a threshold velocity, the risk of accident or injury to the passengers becomes substantial[2]. For example, a motorcyclist who hit a speed hump in Isleworth in 2001 was ejected from the bike and suffered serious injuries (paralysis). In another incident, a 20 year old female was killed in Pune, India in 2012 after her motorbike went over a speed-breaker at a high speed [6]. Motorcycles and scooters are specially vulnerable because inconspicuous speed-breakers can throw them off balance. Additionally, passengers of large vehicles like buses, trucks and tempos are also vulnerable to speedbreaker induced injuries. In authors provided case details of patients who suffered back and neck injuries that occurred when their transport bus crossed a speed hump[3].

2. Literature review:

A method for detecting vehicle braking and road bumps was proposed in. They used machine learning techniques to detect road anomalies and braking events from accelerometer and magnetometer data. The method will not always work because magnetometer is not present in all phones, is susceptible to magnetic interference and increases battery consumption. In addition, the performance of this algorithm was not evaluated for various different types of speed-breakers, vehicles and drivers. A method for detecting speed bumps and braking events was also proposed[4]. This work did not differentiate between potholes and speed-breakers, and labeled them both as speed bumps. Just like requires magnetometer for reorientation, requires GPS for reorientation, increasing overall complexity and battery consumption.

1. Recently, mobile phone crowd-sourcing based pothole detection has also gained significant attention. In this work, the mobile phone had to be placed a certain way on the dashboard to avoid reorientation complexity. Authors of attempted to solve the pothole detection problem without taking

into account accelerometer reorientation. In another work, authors of proposed a fixed threshold based pothole detection algorithm that may not work with different types of phones or cars because of the difference in overall sensitivity to variations along vehicle's z-axis.

2. Speed Breaker Detection and Mapping using IoT. Author: Rahul Ramakrishnan; Ayusha Pendse; Chetna Sharma; Priya Chimurkar. With increasing road accidents due to improper and non-standard speed breakers, it is the need of the hour to address this issue appropriately, and due to this although speed breakers are built for safety, they are posing to be more of a danger. This is mainly due to building illegal speed breakers and not maintaining existing ones. The existing solutions are largely dependent on the user or the surrounding, both of which do not provide immediate accuracy and dependability. This paper presents a self-improving system with minimal user involvement and aims to cover nearly all the drawbacks of the current solutions. It suggests speed breaker detection by measuring the difference in the height between the road level and the vehicle. In this approach, GPS coordinates are stored in an online database system that is available to the public through a portal. When the vehicle is at a predefined distance away from the speed breaker, the user is notified resulting in improved accuracy with every usage[5].

3. Block diagram:

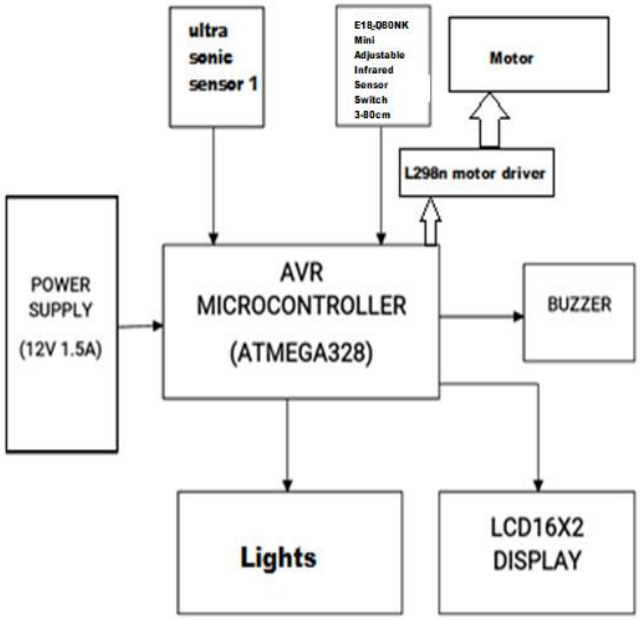

Fig.1. Block diagram of proposed system

3.1.Working process:

This work proposed an early warning system that can alert the driver in advance when the vehicle is approaching a speed-breaker. One E18-D80NK Mini Adjustable Infrared Sensor Switch 3-80cm sensor and one ultrasonic Sensor placed both sides of vehicle. When E18-D80NK sensor activated that means vehicle wants to cross speed breakers then sensor will be active and come up. Red LED will be ON for vehicles and Green LED will be ON for speed breakers.

Lights will be automatically on at near of speed breakers. ultrasonic Sensor is used for obstacle detection and vehicle slowdown speed also controlled[6].

4.Objective:

- To create a system that can identify speed breakers (also known as speed bumps or humps) on the road.
- To implement a robust warning system that alerts the autonomous vehicle's control system when lanes or speed breakers are detected.
- To develop interfaces to seamlessly integrate the lane and speed breaker detection system with the vehicle's autonomous control system.
- Automatic speed control and lightning system on speed breakers.

5.Existing system:

After analyzing the system, the following observations were made about the current state: Pedestrians tend to disregard the right of way on zebra crossings, resulting in potentially hazardous situations. Pedestrians are frequently hit by vehicles on zebra crossings, especially during peak hours when vehicular traffic is heavier. Additionally, many drivers tend to blame pedestrians for incidents on zebra crossings, while pedestrians accuse motorists of marginalizing them[7].

6.Proposed system:

Safety is a necessary part of man's life. Due to the accident cases reported daily on the major roads in all parts of the developed and developing countries, more attention is needed for research in the designing an efficient car driving aiding system. It is expected that if such a device is designed and incorporated into our cars as a road safety device, it will reduce the incidence of accidents on our roads and various premises, with subsequent reduction in loss of life and property. When it comes to the use of a motor vehicle, accidents that have occurred over the years tell us that something needs to be done about them from an engineering point of view. Now it is suffice to say that the implementation of certain highway safety means such as speed restrictions, among others, alone has done a lot in reducing the rates of these accidents. To develop interfaces to seamlessly integrate the lane and speed breaker detection system with the vehicle's autonomous control system. Automatic speed control and lightning system on speed breakers[8].

7. Hardware description:

7.1. Arduino nano:

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike

most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package[9].

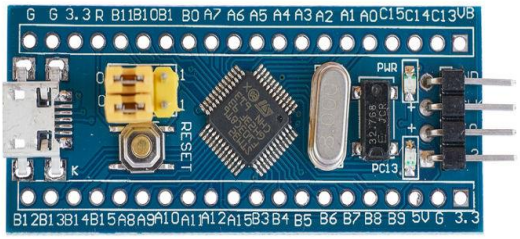

Fig.2. Arduino nano controller

The micro-USB connector is not soldered to the board very well and is easily broken.Pins:- these pins are used to make connections with sensors and module.Common pins on arduinoboads are 5V, 3.3V, GND, Digital, PWM, Analog, AREF. RX and TX LED:- first of all RX and TX is short term for receive and transmit respectively.When ever there is data transfer while uploading code or communicating with bluetooth module etc these LED glow.

7.2.L293d H-Bridge Serial Motor Driver:

This dual bidirectional motor driver is based on L293d chip. It contains two 'H bridges' which are high voltage and high current full bridge drivers that can drive two DC motors. L293 motor driver can independently control two motors of up to 2A each in both directions. L293 IC amplifies an output current as the current from the microcontroller is not enough to drive the DC motor directly so L293 chip is used for this purpose. It contains two enable inputs pins which can be directly control from Arduino to enable or disable the device independently of the input signal. PWM signal are send from Arduino to motor driver to change the speed of motors by varying the PWM signals:

Fig.3. L293d motor driver

7.3. Sealed Lead Acid Batteries:

12V 1.3AH Sealed Lead Acid Battery The 'Online' range of sealed lead acid batteries are maintenance free, valve regulated and leak proof ideally suited to all 'standby applications' There will be no loss in power output over the battery life. Low self-discharge of about 2-3% per month

compared with 20-30% for more common battery systems[11]. Quality construction with no compromise on materials to ensure a long service life. Low internal resistance means a high discharge rate. Wide operating temperature range operating between -15° C to +50 ° C when fully charged.

Fig. 4.Lead Acid Rechargeable battery

This high performance Panasonic battery is specially designed as your back up when the mains power is lost or you experience a blackout. The high quality rechargeable sealed lead acid battery ensures that no electrolyte leakages occurs from the case or terminals. This battery has a long running time of 6 to 9 years and is optimally usable in standby parallel operation. With AGM technology, you can be sure that the battery is sealed and maintenance free. The plates are rigidly mounted to withstand extensive shock and vibration.

7.4.BO motor:

A BO motor is a small, lightweight, and inexpensive DC motor that runs on batteries. BO stands for "battery operated". BO motors provide efficient and reliable power Good torque and RPM: BO motors provide good torque and RPM at lower operating voltages Easy to install: BO motors are easy to install and have mounting holes on the body [12].

Fig.5. B.O motors

7.5. I2C Module for 16x2 (1602) Character LCD:

I2C Module has a inbuilt PCF8574 I2C chip that converts I2C serial data to parallel data for the LCD display. These modules are currently supplied with a default I2C address of either 0x27 or 0x3F. To determine which version you have check the black I2C adaptor board on the underside of the module. If there a 3 sets of pads labelled A0, A1, & A2 then the default address will be 0x3F. If there are no pads the default address will be 0x27. The module has a contrast adjustment pot on the underside of the

display. This may require adjusting for the screen to display text correctly.

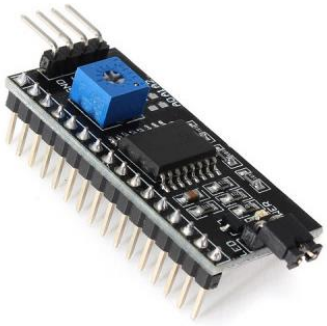

Fig.6. I2C module

7.8. The E18-D80NK Mini Adjustable Infrared Sensor

The E18-D80NK Mini Adjustable Infrared Sensor Switch 3-80cm is a set of transmitter and receiver in one of the photoelectric switch sensor. The detection distance can be adjusted according to the demand. The sensor has a detection range of 3-80cm. The Adjustable Infrared Sensor Switch is small, easy to use, inexpensive, easy to assemble and can be widely used in a robot to avoid obstacles, interactive media, industrial assembly lines, and many other occasions[13].

The switching signal output differs in accordance with the obstacles. It remains high when no obstacles and remains low when there are obstacles. There is a bright light behind the probe to detect the scope of 3cm – 80cm.

Fig.7. E18 IR sensor

7.9. **HC-SR04**-Ultrasonic sensor

Finder is a very popular sensor that is found in many applications where it requires measuring distance and detecting objects. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The HC-SR04 ultrasonic sensor uses sonar to determine the distance to an object like bats or dolphins do. This Ultrasonic Sensor module is a transmitter, a receiver, and a control circuit in one single pack!! It has very handy and compact construction. It offers excellent range accuracy and stable readings in an easy-to-use package. Its operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). The Trigger and the Echo pins are the I/O pins of this module and hence they can be connected to the I/O pins of the microcontroller/Arduino. When

the receiver detects the return wave the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor. Ultrasonic Ranging Module HC-SR04 provides 2cm-400cm non-contact distance sensing capabilities, Ranging accuracy up to 3mm. This Ultrasonic Sensor can be attached to your project using a mounting bracket, so buy it now at Robu.in we have a very good quality Acrylic Mounting Bracket for this HC-SR04 Ultrasonic Module.

Fig.8. Ultrasonic sensor

8 .Software Description (ARDUINO IDE):

Arduino IDE is an open source software that is mainly used for writing and compiling the code into the Arduino Module. It is an official Arduino software, making code compilation too easy that even a common person with no prior technical knowledge can get their feet wet with the learning process. It is easily available for operating systems like MAC, Windows, Linux and runs on the Java Platform that comes with inbuilt functions and commands that play a vital role for debugging, editing and compiling the code in the environment. A range of Arduino modules available including Arduino Uno, Arduino Mega, Arduino Leonardo, Arduino Micro and many more, each of them contains a microcontroller on the board that is actually programmed and accepts the information in the form of code. The main code, also known as a sketch, created on the IDE platform will ultimately generate a Hex File which is then transferred and uploaded in the controller on the board. The IDE environment mainly contains two basic parts: Editor and Compiler where former is used for writing the required code and later is used for compiling and uploading the code into the given Arduino Module. This environment supports both C and C++ languages.

9. Applications:

- Zebra crossing applications
- Smart roads applications

- Smart cities applications
- Smart speed breakers
- Smart Zebra crossing with speed breaker

10. Advantages:

- To make the driver aware of the speed breaker well before time.
- To avoid any possible accidents, damages to the suspension, tyres, etc.
- Develop the system further, to detect potholes[14]
- The driver will be aware of the speed breakers beforehand, thus providing him sufficient time to control the vehicle. • Decline in causalities caused by improper speed breakers.
- Automatically control the vehicle speed in case the driver fails to do so[15].
- Improved Safety:

• High accuracy in detecting lane markings reduces the risk of lane departure accidents.

• Early detection of speed breakers allows for timely speed adjustments, preventing sudden jolts and potential vehicle damage.

Enhanced Reliability:

•Real-time data processing ensures timely and reliable lane and speed breaker detection

11. Conclusion:

Speed breakers plays important role on roads to minimize vehicles speed to avoid accidents at zebra crossing places. Because of normal speed breakers all vehicles slow down even no people on zebra crossing. So that unnecessarily so much traffic stuck on roads because of normal speed breakers. To solve this issue, we need automatic speed breakers that will come up when needed. System has to identify people on zebra crossing and speed breaker should come up. This kind of speed breaker mechanism will save time of travel passengers by avoiding unnecessary speed breaker stops or slowdowns. The entire project controlled by Arduino microcontroller. Proposed project title is zebra crossing with automatic speed breaker using Arduino[16] . One E18-D80NK Mini Adjustable Infrared Sensor Switch 3-80cm sensor and one ultrasonic Sensor placed both sides of vehicle. When E18-D80NK sensor activated that means vehicle wants to cross speed breakers then sensor will be active and come up. Red LED will be ON for vehicles and Green LED will be ON for speed breakers. Lights will be automatically on at near of speed breakers. ultrasonic Sensor is used for obstacle detection and vehicle slowdown speed also controlled.

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