Signs with Smart Connectivity for Better Road Safety

Abstract:

Road traffic accident is a major problem worldwide resulting in significant morbidity and mortality. Advanced driver assistance systems are one of the salient features of intelligent systems in transportation. They improve vehicle safety by providing real-time traffic information to the driver. Road signs play an important role in road safety. To be effective, road signs must be visible at a distance that enables drivers to take the necessary actions. However, static road signs are often seen too late for a driver to respond accordingly. In this study, a system for alerting drivers about road signs has been developed and tested using a smart mobile phone.

Introduction:

Road traffic accidents (RTA) are defined as accidents that occurred or originated on a way or street open to public traffic. These collisions result in injury or death between automobiles or humans. RTA is a major problem worldwide resulting in significant morbidity and mortality. According to the World Health Organization road safety report of 2018, the number of road traffic deaths increased to 1.35 million in 2016. According to the report, 93% of global road accidents occurred in low- and middle-income countries, which account for 60% of the world's vehicles.

Road signs provide information to drivers to help them operate their vehicles safely. To be effective, road signs must be visible and legible at a sufficient distance to allow drivers to take appropriate actions. However, static road signs are frequently missed by drivers making it difficult for them to respond in time.

The purpose of this study was to develop a system that uses a smartphone to notify drivers about road signs ahead. The development of the smartphone application was motivated by the fact that smartphones are widely used nowadays.

Related Works:

A review of the literature on road safety revealed several approaches that are being used to avoid accidents. According to the review, the related approaches are divided into three themes: road sign colour and shape recognition, vehicle-to-roadside infrastructure communication, and vehicle-to-vehicle communication.

1.Road Signs Colour and Shape Recognition:

Several studies on road safety have been conducted using a device onboard a vehicle to detect and recognize signs. García-Garrido et al. developed a traffic sign recognition system that uses a vision camera mounted on a vehicle. Based on the colours and shapes of the road signs, the system detected and recognized them. The studies by Farhat et al. and Hechri et al. found a recognition of road signs with an average accuracy of about 95.53% and 92.8%, respectively. However, recognizing road signs based on colours and images presents numerous challenges. These include lighting conditions that vary naturally with the time of day and weather conditions; images that have been buffed by a moving vehicle's vibration; fading of paint on the sign; and occlusion of the sign by obstacles such as a tree, street lamp, or buildings.

2.Vehicle-to-Roadside Infrastructure Communication:

Other approaches have used mobile devices on a vehicle and communication infrastructure on the road. The study by Rajale et al. developed a road sign notification system based on the global positioning system (GPS) and wireless radio frequency identification (RFID) technology. A database of road signs and their locations was created. RFID transmitters were placed at the locations of road signs, and a receiver was placed in the vehicle. Using the system, drivers

were alerted about the next road signs at some predetermined specific distance before the road signs were encountered. However, the use of RFID transmitters in two-way traffic could be limited, in the sense that their signals might be detected by vehicles travelling in the opposite direction. Thus, this situation can be misleading the drivers. Also, the devices are expensive and require a constant power supply and regular maintenance.

3.Vehicle-to-Vehicle Communication (V2V):

The approach of V2V communication is used to interchange reliable information between automobiles on a network. In this approach, the broadcast information can include a warning while travelling on a similar road. The V2V wireless technology works as an automated system to control and properly inform drivers by exchanging accurate information. However, the most challenging issues with this approach were the connectivity between V2V and vehicle infrastructure (V2I), mobility that allows vehicle area network (VAN) to change its topology quickly, and violation of driver privacy and security. Another challenge is the variation in the broadcast information offered by different types of vehicle manufacturers.

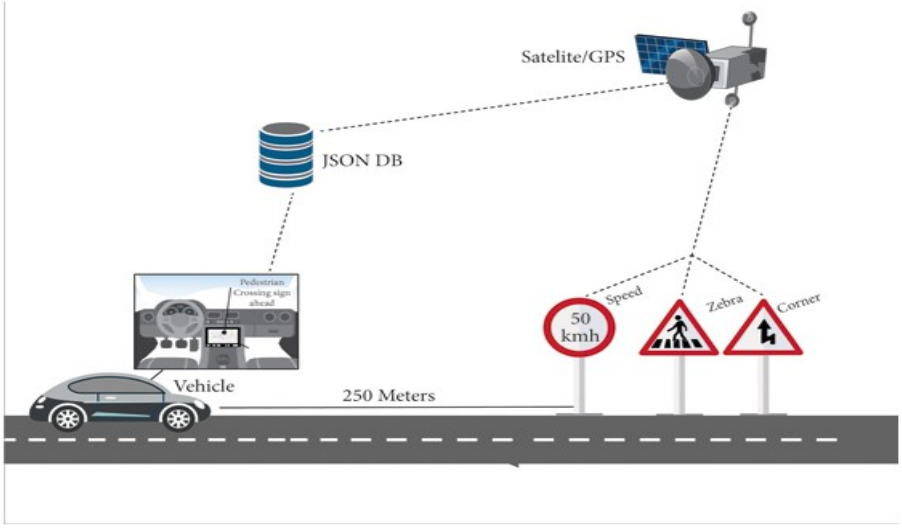
Proposed Solution:

In present Systems the road signs and the speed limits are Static. But the road signs can be changed in some cases. We can consider some cases when there are some road diversions due to heavy traffic or due to accidents then we can change the road signs accordingly if they are digitalized. This project proposes a system which has digital sign boards on which the signs can be changed dynamically. If there is rainfall then the roads will be slippery and the speed limit would be decreased. There is a web app through which you can enter the data of the road diversions, accident prone areas and the information sign boards can be entered through web app. This data is retrieved and displayed on the sign boards accordingly.

System Design:

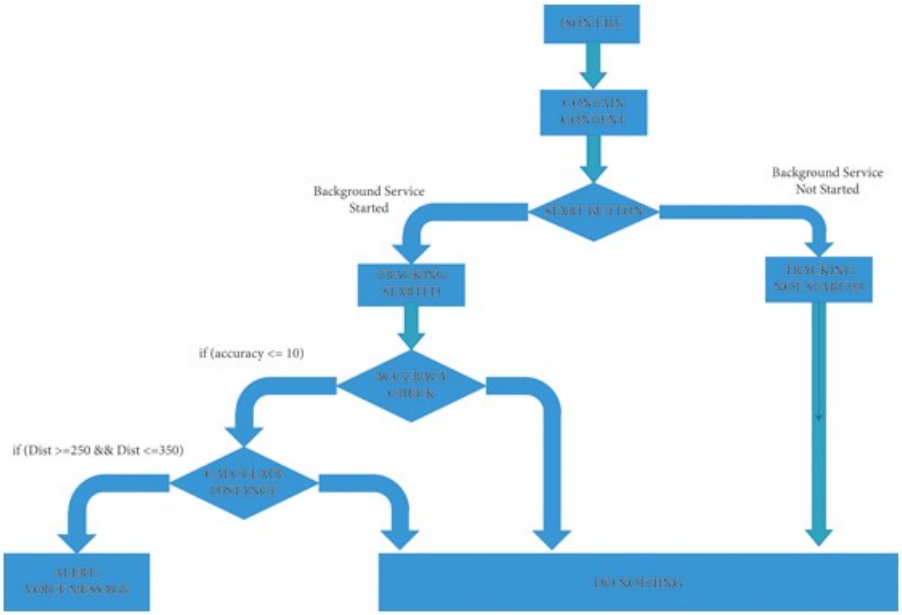
1.Architectural Design:

The system is made up of a mobile application, a database server, a satellite, and road signs. The JSON determines the distances between road signs using satellite and GPS data. The Haversine formula will calculate the distance required to reach the sign. When the calculated distance is found to be within the proposed range, a voice alert will be sent to the vehicle driver to take the necessary action on time.



2.Data Flow Diagram:

Road sign information is contained in a JSON file string. When the application is started from the main activity, a background tracking activity continuously communicates with GPS satellites and provides the vehicle's current location in decimal degrees. Following the start of the background service, the tracking activity begins, and the accuracy of the coordinates broadcasted is evaluated. This technique improves the accuracy of location estimates and distance calculations during navigation. When the coordinates are released, the first condition is to verify if the accuracy is less than 10 meters. We consider any accuracy that exceeds that limit to be erroneous. If these conditions are met, the function uses the Haversine formula to calculate distance. Using a for loop, the Haversine formula will calculate the distance in meters between the current vehicle position and an upcoming road sign stored in the JSON file. When the distance to the road sign is determined to be within a close range of 250 meters, the driver will receive a voice alert.



3.Database Design:

The JSON data structure was used during the system's development. It presents data in array and object formats that are readable by humans. The JSON array consists of nine column lists of longitude, latitude, signal, alerts, audio, direction, position, visibility, and alpha. The longitude and latitude contain the road sign coordinates. The signal, alert, and audio columns store the relevant alert notifications. The direction, position, visibility, and alpha store the destination route, road sign names, and visibility. By using a for loop, these values are instantly accessed, and notifications are delivered to the driver.

System Requirements:

1.Hardware Requirements:

- NodeMcu ESP8266

2.Software Requirements:

- Arduino IDE
- Embedded C

Conclusion:

Road accidents cannot be eliminated but can be reduced by enhancing the safety of the drivers. This study developed a smart mobile-based application that uses in-built sensors to alert drivers with voice and image notifications. The application provides a voice alert to a needed action that enhances the driver's attention. The smartphone is used to avoid the need for onboard devices to detect and recognize road signs, sensors on road infrastructure, and the use of WLAN. We have used the Haversine formula for measuring and estimating the distance between two pairs of coordinates. According to the experimental results, the proposed methodology has the benefits of high accuracy within a user radius of 10 meters, minimum bandwidth, and low-cost application. All notifications are released in a close range of 250 meters before the actual signs. Furthermore, the system administrator can monitor the system by using a cloud dashboard. The dashboard provides reports such as the number of requests made by users, errors, and traffic responses. Moreover, the system is secured to avoid unauthorized access to sensitive information. The security key was generated and added to the manifest file of the application and only requests made with the API key authenticate each user of the system. This research has generated information that can be utilized by future works in developing similar systems.

References:

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