

Design of an Intelligent System for Automatic Detection and Location of Potholes in Mali

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Abstract

Potholes are practically present on all roads in Mali. Malian drivers seek to locate potholes on the road when driving. And during night trips in Mali, it is very difficult to locate potholes on the road, which most often leads to fatal accidents. The objective of this article is to design an intelligent system for detecting and locating potholes and speed bumps in Mali. For pothole detection, an ultrasonic sensor was used with an Arduino microcontroller. GPS was used to locate the location of potholes and GSM (Global System for Mobile Communication) was used to transmit the location data of potholes. Detecting potholes helps reduce the number of traffic accidents in Mali and their locations will allow local and government structures to quickly repair the road. This project has enabled an improvement in human comfort in the existing system, so that the driver can be fully attentive and reassured when driving in Mali.

Keywords

Ultrasonic Sensor, GPS, GSM, Potholes, Accidents

1. Introduction

Today's automobiles have made traveling from one place to another over long or short distances easier and safer [1]. The journey in recent cars is peaceful due to the availability of air conditioning, good mileage, and availability of space for sitting and sleeping [2]. But they lack certain characteristics that offer more safety in Malian traffic such as potholes and speed bumps. The objective of this article is to design a system for detecting potholes and speed bumps.

The main concern is to pay more attention to the driver on the road [3]. No matter where you are in Mali, driving is a breathless, multi-mirror, potentially deadly affair. Roads in Mali usually have potholes; vehicle speed must be controlled to

avoid accidents. To solve the above-mentioned problems, a cost-effective solution is needed that collects the information about the severity of potholes and speed bumps and also helps drivers drive safely. With the proposed system, an attempt has been made to encourage drivers to avoid accidents caused by potholes (**Figure 1**).



Figure 1. Pothole.

2. Materials and Methods

To create the automatic pothole detection system, the ultrasonic sensor, an Arduino microcontroller, resistors, connection wires, a GPS module, and GSM were used.

➤ Ultrasonic sensor

The HC-SR04 (**Figure 2**) is an ultrasonic ranging module that provides non-contact measurement function from 2 cm to 400 cm. The ranging accuracy can reach up to 3 mm and the effective angle is $<15^\circ$. It can be powered by a 5 V power supply [3].

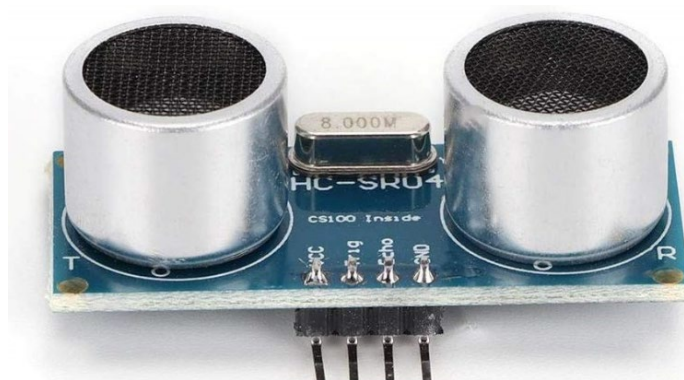


Figure 2. Ultrasonic sensor [4].

➤ Resistances

A resistor (**Figure 3**) is a two-terminal passive electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, divide voltages, bias active elements, and terminate transmission lines, among other uses [5].



Figure 3. Resistors [5].

➤ GSM

GSM (Global System for Mobile Communication) is used to transmit mobile data as well as voice services. GSM is an open, digital cellular technology used to transmit mobile and data services operating on the 850 MHz, 900 MHz, 1800 MHz and 1900 MHz frequency bands. It requires 12 V power supply. In this system, GSM (**Figure 4**) is used in pothole detection application [6].



Figure 4. GSM module [6].

➤ GPS

The Global Positioning System (GPS) is a space-based satellite routing framework that provides area and time data in all climatic conditions. The GPS receiver

can only receive vehicle location information from satellite when detecting potholes, and GPS (Figure 5) helps to trace the location of potholes [7].



Figure 5. Module GPS [6].

3. Result

This project (Figure 6) is based on vehicles equipped with a system that allows:

- To detect the presence of potholes and speed bumps or vehicles can not only avoid these places but also use GPS records and save the geographic coordinates of these areas, then send them back via a connector to a mobile (telephone, computer). This data received on these mobiles will allow, in the event of repairs by local young people or by the town hall or road management agencies, to quickly locate the faulty places on the road. It will make it easier to assess the condition of our roads.



Figure 6. Prototype.

The principle is to place the sensor at a height and inclined facing the tar on the road. The vehicles are unstable at height due to different factors: spring, weight, condition of the tires, and condition of the road, so it is necessary to give a distance interval to the sensor for the non-triggering of obstacles: potholes and speed bumps.

The interval given in this project is 100 to 150 cm. The empty vehicle is at a maximum of 150 cm and when loaded, it goes down to a minimum of 100 cm. So, the tolerance of obstacles is 50 cm between the two types: potholes and speed bumps. In this interval, no fault or obstacle is reported and the road is considered normal.

- Below 100 cm: The system triggers a pothole, locates it through the GPS and sends the GPS coordinates via SIM900 to a phone.
- Beyond 150 cm: Following the principle of the different modules, the system detects a speed bump and sends the coordinates to a phone. The user receives the SMS of the different coordinates in his phone and takes appropriate measures.
- From 100 cm to 150 cm: Nothing was reported, therefore was no presence of potholes or speed bumps.

4. Discussions

Singh *et al.* implemented a method for pothole detection and bump recognition using Lidar sensors [8]. Lidar made it possible to identify potholes and bumps and calculate their distances from vehicles, the height of the bumps or the depth of the potholes, respectively. The circuit was installed in the front or above the vehicle [8]. This method is very useful, but the use of Lidar is limited when driving at night or in clouds and is quite expensive technology [8].

The system proposed in this study is less expensive and is based on a method of detecting potholes using ultrasonic sensors (HC-SR04). The system captures geographic location coordinates of potholes and bumps. The detected data includes pothole depth, bump height and geographic location, which are stored in the database.

5. Conclusion

Detecting potholes helps reduce the number of traffic accidents in Mali and their locations will allow local and government structures to quickly repair the road. This project has enabled an improvement in human comfort in the existing system, so that the driver can be fully attentive and reassured when driving in Mali. The proposed system can be supplemented by automatic control of the intensity of the FARS and automatic windshield wipers for a considerable reduction in traffic accidents in Mali.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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