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A GPS-ENABLED REAL-TIME POTHOLE AND SPEED BREAKER DETECTION AND NOTIFICATION SYSTEM (POSDANS) USING ANDROID SMARTPHONE

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Abstract

One of the basic amenities expected of a progressive society is good road network. Unfortunately, this road network for the most part has resulted to large number of deaths as a result of road accidents, not so much for high speed of the drivers as it has been for bad sections of the road popularly known as potholes that come about as a result of wear and tear of the surface tar. Statistics abound and grows by the day to the fact that potholes is arguably a large contributor to the total number of road accidents. Previous researches have focused on responsive solutions instead of preventive. In this work, A GPS app on an android phone was used to capture the coordinates of the potholes on a chosen route using goggle map. First, a drive-through on the chosen route was done from origin to destination while coordinates were taken as documented in the data collection section. Then an in-house prototype android application software was developed using MIT APP Inventor to carry out the experiment, taking into cognizance the pothole coordinates. Another drive-through was carried out with the software installed on an android phone to locate any potholes on the choosen route. The result of the experiment showed an accuracy of about 97.3% in pothole notification. Our proposed system is capable of reducing the present high rate of road accidents due to potholes to its barest minimum.

Keywords: *GPS-enabled, Real-time, Pothole, Speed Breaker, Android Smartphone*

Introduction

Potholes are bowl-shaped openings in the road that can be up to 10 inches deep and are caused by the wear-and-tear and weathering of the roads. They occur when the top layer of the road, the asphalt, has worn away and exposed the concrete base. Once a pothole forms, it can grow to several feet, with rain water accelerating the process and creating a trap for vehicles, making one of the top causes of car accidents. Potholes put a huge strain on a car's suspension and shocks (which absorb most of the impact of bumps and potholes). It can cause expensive damage to your car and cause you to make an unexpected appointment with the auto mechanic. They can also cause an impact similar to that of a 35-mph car accident, if deep enough. [1]

All motorists have a responsibility to look out for road hazards, such as potholes, speed breakers etc and drive carefully to prevent road accidents.

In Sokoto state, Nigeria, ten (10) people died in an auto crash involving two J5 buses in a particular day because the driver of the vehicles had attempted to dodge potholes and suddenly lost control [2].

The Guardian.com [3] once titled an article as "More deadly than terrorism: potholes responsible for killing 10 people a day in India". It further states that almost 4,000 people died as a result of badly maintained roads in 2017.

In India, it has been reported that over 9,300 people have been killed and nearly 25,000 were injured in road accidents as a result of potholes [4]. The Supreme Court parliament of India claims that the increasing accidents due to potholes on roads are much more than deaths due to terror attacks. Below is a compiled data of persons killed due to potholes on road accidents in India.

The current Google Map Assistant can guide you effectively from a chosen location to a specified destination, telling you appropriately with a voice, the correct turns to take till you arrive at your destination. But Google Map Assistant and the likes cannot tell you when you are approaching a dangerous spot, for example, approaching a speed breaker or terrible pothole at night when you are on high speed. This scenario could and has led to several *accidents on highways. This limitation informed the motivation behind this research.*

In this work, an android app was developed with MITApp Inventor armed with the gathered dataset. The developed app is able to signal the driver of a vehicle of potential bad spot or speed breaker ahead so that necessary caution of either speed reduction or increased alertness by the driver can be done. The developed application is also capable of data update. It makes possible the entry of new collected data or updating of old ones in cases of road repair. There could be instances where a previously bad spot has been fixed, this can be appropriately updated through the application by the designated administrator in order to prevent false alarm. A previously bad spot with "UNSAFE" status can later be updated to a "SAFE" status after repair has been done.

Our proposed system will reduce the accident figures to the barest minimum by providing a quick notification of potholes ahead in order to increase driver's consciousness to take caution.

Related Works

The value of an alert notification systems in the world cannot be overemphasized as evidenced in some existing works.

In [5], the authors simulated an automatic accident detection and ambulance rescue with intelligent traffic light system. The idea behind their scheme was to implement a solution which would mechanically control the traffic lights in favour of the ambulance against other vehicles in cases of emergency in order to reduce arrival time. The controller unit identifies the location of the accident spot through sensor systems in the vehicle which determines whether an accident has occurred and this guides the ambulance favourably to the spot. Vibration sensor, fire sensor, a PIC controller, GSM module, GPS module, MAX232 chip are amongst the core hardware used in PROTEUS software for the simulation.

In [6], the authors developed a car accident and notification system using smartphone. The proposed system called car accident detection and notification system (CADANS) consists of two phases; the detection phase that identifies the occurrence of an accident and the notification phase that informs an emergency center for fast response and recovery. The detection phase relies on the information extracted from smartphone accelerometer sensor, GPS receiver and built-in microphone to determine the occurrence of a car accident. The notification phase uses SMS to notify the contacts of the driver/passenger, such as family members or an emergency center, about the accident and the location of the accident.

In [7], the authors presented an accident detection and smart rescue system using android smartphone with real-time location tracking. The purpose of their work was to reduce the response time of emergency services in situations like traffic accidents or other emergencies such as fire, theft/robberies and medical emergencies. The authors utilized onboard sensors of a smartphone to detect vehicular accidents and report it to the nearest emergency responder available and provide real time location tracking for emergency victims in order to increase the chances of survival and also help save emergency services time and resources.

In [8], the authors developed an accident detection and alert system. Their work deals with accident detection that occurs due to carelessness of the person who is driving the vehicle. They introduced an accident alerting system that utilizes an arduino board, a GPS module, a GSM module and a vibrator sensor to sense when an accident has taken place. Once the accident occurs, the system will send information containing the place of event to an already registered mobile number.

In [9], the authors developed a traffic violation and management software architecture which is organized into two modules: the traffic sign detection and recognition (TSDR) module and the traffic violation management (TVM) module. The TDSR module is used to detect vertical signs present along the road and is aimed at alerting drivers in certain dangerous situations, such as "speeding", "No Passing Zone", "Intersections", "Stop Signs", "Yield Signs"; "Dangerous Turns", "Steep Slopes", or "Road Works". On the other side, the TVM module is intended to manage traffic violations when they take place. The module was limited to three signs: "Speed Limit", "Stop Sign" and "Forbidden Turning".

Methodology

A certain road with several potholes and speed breakers was selected. The distance covered by this road was about 10 kilometers. With a car, we drove along the road from origin to destination. We stopped the vehicle wherever we find a pothole and then datalog the GPS coordinates of the bad spots. We then measured about 100 meters to and from the bad spot and took the GPS coordinates of these spots. This was done to give us a threshold distance from which danger warning should be given by our solution before one approaches the bad spot.

An android app was developed with MITApp Inventor that armed with the gathered dataset is able to signal the driver of a vehicle of potential bad spot or speed breaker ahead so that necessary caution on speed reduction or increased alertness by the driver can be done. This is especially very critical at night time when visibility is low. The software application can also be used for easy data update. This platform makes possible the entry of new collected data or updating of old ones in cases of road repair. There could be instances where a previously bad spot has been fixed, this can be appropriately updated through the application by the designated administrator in order to prevent false alarm. A previously bad spot with "UNSAFE" status can later be updated to a "SAFE" status after repair has been done. Datasets collected during this research are shown under the data collection section below.

Data collection

With the use of a smartphone enabled with a GPS sensor and an installed GPS application, we were able to capture and record coordinates of the pothole or speed breaker section along a selected area of road. The screenshots of the data capture of the individual pothole spots are shown in the figures 1, Pictures of the potholes were also taken with the camera of the smartphone as show in the figure 2. Coordinates for 14 potholes along the selected road were captured and recorded alongside the signal accuracy of the GPS receiver in meters. The captured coordinates are shown in Table 1, showing the latitude, longitude, signal accuracy and status of the data collected.

Table 1. GPS coordinates of potholes

S/N	Latitude	Longitude	Signal (Meters)	Accuracy	Status
POT HOLE 1	6.502719	4.768088	3		UNSAFE
POT HOLE 2	6.502905	4.768876	5		UNSAFE

POT HOLE 3	6.503465	4.769870	3	UNSAFE
POT HOLE 4	6.503510	4.770022	2	UNSAFE
POT HOLE 5	6.503546	4.770126	2	UNSAFE
POT HOLE 6	6.503735	4.770472	2	UNSAFE
POT HOLE 7	6.503962	4.770756	4	UNSAFE
POT HOLE 8	6.504241	4.771979	3	UNSAFE
POT HOLE 9	6.504535	4.775347	4	UNSAFE
POT HOLE 10	6.505046	4.777024	2	UNSAFE
POT HOLE 11	6.505097	4.777215	2	UNSAFE
POT HOLE 12	6.505532	4.779345	2	UNSAFE
POT HOLE 13	6.506853	4.786193	3	UNSAFE
POT HOLE 14	6.503861	4.781655	2	UNSAFE

Figure 1. Screenshots of the GPS readings for various potholes

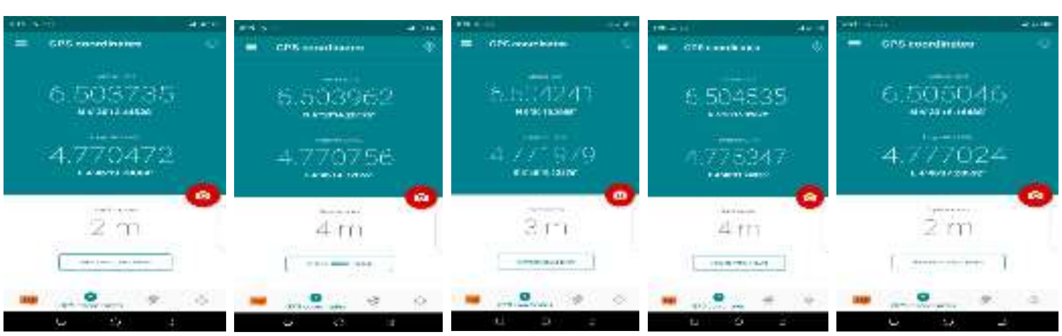

Figure 2. Photo of some of the pothole spots captured

Experiment and Result

Figure 3 shows the chosen route on google map used for this research. First, a drive-through on the chosen route was done from origin to destination while coordinates were taken as documented in the data collection section.

Figure 3. Map showing the route covered in the research

An in-house software was developed taking into cognizance the pothole coordinates. Another drive-through was carried out with the software installed on an android phone. The trigger distance was first set at 10 meters. This was to ascertain how sensitive the application is. Another drive-through was done with the trigger threshold set at 100 meters. This is to allow enough notice to a driver to make adjustment. Our solution was able to detect pothole or speed breakers ahead and notify the driver in time for increased consciousness and speed adjustment in order to avert any possible accident. In instances where a pothole has been repaired and patched adequately, the coordinate can always be updated as SAFE in order to prevent false notification in the future. Figure 4 is a screen short of the mobile application showing the pothole alert system. Figure 5 is the snapshots of the prototype software readings of the potholes sports while the vehicle is on the move.

Figure 4: Screen capture of the mobile application showing the pothole alert system.

Figure 5. Snapshots of the prototype software readings at different potholes sports.

As shown in the snapshots above, the software was capturing the real-time coordinates of the driver, when the experimental distance threshold was set at 0.06 miles (100 meters), showing the street address, the speed of the vehicle, the altitude and finally, the distance to the nearest pothole or speed breaker. When the distance between the current position and the closest pothole was below 0.06 miles which is less than the experimental threshold, a notification was triggered. An audio alert was chosen for the notification as against a visual notifier because the essence is to keep the driver's eyes on the road as much as possible. The mobile application can notify either through a pre-recorded warning sound or a pre-programmed text like "SLOW DOWN! POTHOLE AHEAD." read out aloud by a text-to-speech module.

Conclusion

Our solution was able to alert a driver of a vehicle of an impending pothole ahead along a route thereby increasing driver's consciousness and reducing the possibility of an accident to the barest minimum. An Android app was built. Unlike previous solutions with special hardware for alerting, our solution makes use of a smartphone that is readily available to every user and this makes it an economical solution. Our solution is rather preventive than curative.

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