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Automatic Pothole Detector

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Abstract- This paper aims at proposing a automatic pothole detection system, which forewarn the driver to avoid potholes on the roads by giving prior warnings by displaying on an application. The idea is to build a robot vehicle that is capable of detecting the potholes and transferring this information of it's dimension and locationto the application through navigation system on an application. By sharing the information about potholes on the application, the probability of accidents or collision can be reduced. Here, I propose a pothole detection model, which can detect the potholes with a minimum depth of 15 meters and share the information. This idea can be extended to design vehicles capable of detecting the humps or other irregularities on the roads and for the updation of google map. The application illustrated in this work can be effectively used to reduce the problem of increasing accidents caused due to potholes.

1. Introduction-

In recent years, a lot of research has been done in the area of automated vehicles and automatic highway systems. All this research has a common goal: to make driving safer and easier. It is important to find out solutions to reduce the number of accidents. One of the major reasons for road accidents is potholes according to the survey conducted by the Automobile Association. Vehicles tend to lose balance when they come across a pothole on roads or on highways. Whenever a driver slows down the vehicle to avoid the effect due to potholes, there are chances of collisions with the vehicle following it or loosing its balance in the process. So information sharing about the dimensions and location of potholes plays a very important role in avoiding the effects of potholes. Here, we establish an application for information sharing. Another problem is, during night times, potholes are not easily detectable by human eye. This problem is eliminated here by using ultrasonic sensors, which give the output independent of light intensity. By making automatic pothole detecting system, it is possible to reduce the possibility of accidents. To test this model, we have used the following approaches:

I. To develop a model which would gather the dimensions and location of the potholes.

II. Sharing the information on the application and giving a prior warning to drivers.

III. Controlling the speed of the vehicle based on the information displayed on the application.

IV. Maintenance of potholes by the sharing the information with the government agencies.

The main objective of this work is to detect potholes with a minimum depth of 15 m and share the information to on an application. The remainder of this paper is as follows: Section 2 discusses some of the related projects. Section 3 provides the technical details about the components used. The proposed model is presented in the section 4. Section 5 presents the results. And section 6 presents the conclusion of the proposed work and further research work.

2. Related Projects-

Several researchers have worked to detect the potholes using different methods. Pothole detection using accelerometers gives the output based on the vibration. Here, cameras were used for detecting the potholes with the help of image processing algorithms . Detection of pavement distress was achieved using 3D laser scanning technology by Chang. Damage detection in roadways with ground penetrating radar was proposed in which illustrates the use of radar technology. A paper by C.Koch and I Brilakis used a method of vision tracking for detecting the pothole. Jin Lin and Yayu Liu proposed a pothole detection model based on histogram texture measure using image processing.

In this paper, ultrasonic sensors used to provide light intensity and surrounding temperature. One of advantage this model is that it is cheaper than the above mentioned methods. Real time pothole detection using Android smart phones was proposed by ArtisMednis and FPGA (Field Programmable Gate Array) based system for pothole detection on Indian roads was proposed by Shonil Vijay, which used low cost FPGA. Pothole detection using digital image processing was proposed by Hussain Z, which used the image processing algorithms to extract the information about the pothole. In our project, we have used NXP LPC 1768 microcontroller with ARM Cortex-M3 core processor. The existing systems used GPS system for location recognition and GSM for communications. Here, we have used Zigbee modules for communication, which can transmit and receive data within 100 m. Since, we have used Zigbee so there is no need of a mobile network, which is required in the case of GSM system.

3. Technichal components of the proposed system-

- An ultrasonic sensor- It is an electronic device that emits and/or detects ultrasonic radiation in order to sense the objects in front of it. The range and angle of detection depends on the ultrasonic sensor specifications. Value sensed by ultrasonic sensor is independent of surrounding light and temperature. For this work, we are using the LV-MaxSonar-EZ0 ultrasonic sensor to detect objects from 0 to 254 inches and provides sonar range information from 6 inches out to 254. Objects from 0 to 6 inches typically range as 6-inches and are said to be in blind range. We are taking digital voltage output from the sensor.

- IR Sensor - Sensors are basically electronic devices which are used to sense the changes that occur in their surroundings. The change may be in color, temperature, moisture, sound, heat etc. They sense the change and work accordingly. In IR sensor the there is emitter and detector. Emitter emits the IR rays and detector detects it.The IR sensor basically consists of three components:

1. IR LED (emitter)
2. Photodiode (detector)
3. Op-Amp

- Motor driver L293d - A motor driver translates the input to higher voltage while maintaining the promised current output, thereby acting as a current amplifier. This current is used to drive the motors, which usually require a larger current for their operation compared to the other peripherals. The motor driver uses L293D to drive 3 DC motors. It is a quadruple H-bridge and can provide bidirectional drive currents of up to 600 mA. D

- A tachometer (revolution-counter, tach, rev-counter, RPM gauge) – It is an instrument measuring the rotation speed of a shaft or disk, as in a motor or other machine.[1] The device usually displays the revolutions per minute (RPM) on a calibrated analogue dial, but digital displays are increasingly common. Tachometers or revolution counters on cars, aircraft, and other vehicles show the rate of rotation of the engine's crankshaft, and typically have markings indicating a safe range of rotation speeds. This can assist the driver in selecting appropriate throttle and gear settings for the driving conditions.

- Audrino Uno - The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.[1] The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable.[4] It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

- Audrino Mega - The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

4. Proposed Model-

For the purpose of illustration, we have taken a vehicle robot having 4 ultrasonic sensors having an angle of projection of half of the angle of beam and a frequency range of 65kHz to 300 kHz.

If we make all the ultrasonic sensors work at the same time, it will affect the results. So, to avoid this, we will operate these sensors at a time interval of 20 microseconds.

Since, the speed of this vehicle is too slow for this time interval to make any subsequent change in the output. The block diagram of proposed model is illustrated below-

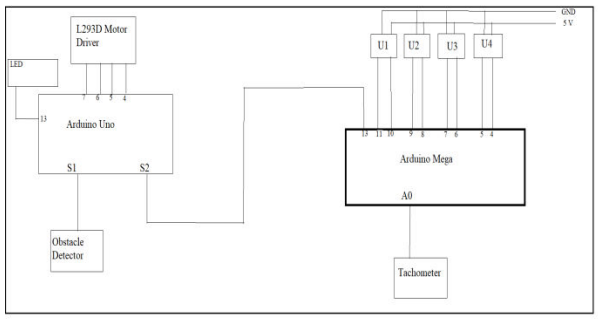

Fig. 1- Block diagram of proposed model.

Each pothole will have varying width and depth. The effect of potholes on the vehicle depends on the ground clearance of the vehicle and vehicle suspension. Ultrasonic sensors are used to detect the depth of potholes. Ultrasonic sensors work on a principle similar to radar or sonar.An ultrasonic sensor generates high frequency sound waves and waits for the waves reflected back from the object. The sensor calculates the time interval between sending the signal and receiving the echo to determine the distance to an object.The ultrasonic sensor is attached in a suitable place depending on the structure and dimension of the vehicle.The ultrasonic sensors will detect the depth of the potholes and since, the distance of the vehicle from the road is 4 cm, so, whenever the distance measured by sensors will be greater then 4 cm, it will be considered as a pothole. The width of the ultrasonic sensor is approximately 2 cm, so, if the pothole is detected by only one sensor, its width is considered as 2 cm. If, the pothole is detected by two consecutive sensors, its width is considered as 2*2= 4 cm, and so on.

Tachometer is used, which will send the signal to the micro processor after every 2 cm. After receiving the signal, the micro controller will then send the signal to the ultrasonic sensors, which will operate at a time interval of 20 micro seconds. A value is loaded in the controller to automatically stop the robot. Whenever, that value is reached, the controller will send the signal to another controller i.e Arduino Uno, which controls the motor driver and the vehicle will get stop.Motor drivers are connected to the PWM pins of the microcontroller and are used to control the current flow to the motors.

We are using IR Sensor for obstacle detection. Whenever, the vehicle passes over the pothole, it gets deviated from its original path. So, whenever the value of IR Sensor becomes greater then the pre determined value, it will send a signal to the controller and a signal is sent to the motor driver by the micro controller.

The information is then uploaded in an application using navigation system with the help of Global Positioning System (GPS). The driver may log in to the application and can get the information about the potholes in the roads.

The working model is shown below-

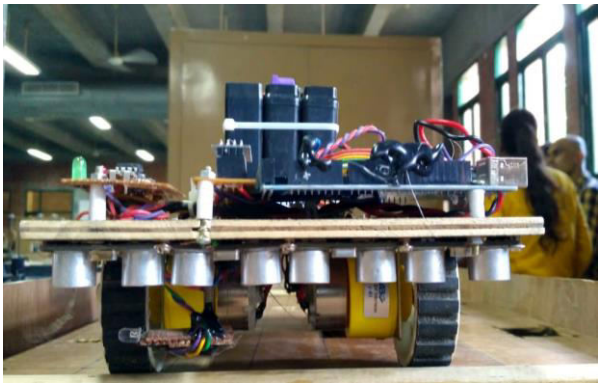

Fig. 2- Front view of vehicle robot.

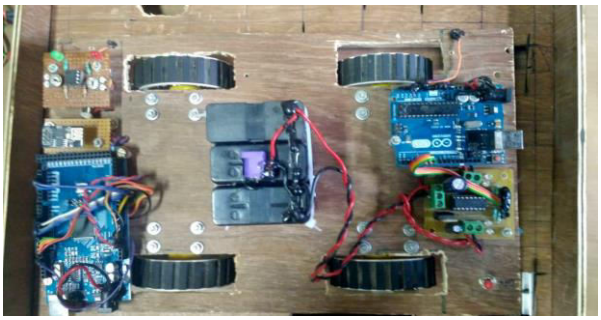

Fig. 3- Top view of vehicle robot.

5. Experimental results-

The tests were conducted in an indoor environment using artificial pothole arrangement. The working of the system was tested several times successfully and the reading of one of the test is presented here. Ultrasonic sensor gives the analog output values. To test the working of the model, we have set a threshold value of 3670. But in real time scenario we cannot generalize the threshold value. Depending on the vehicle dimension and suspension, the threshold value can be set by vehicle manufacturers. Based on the sensor value, distance from thesensor to the road surface is calculated and decision is taken by the microcontroller about the condition of the road.

Distance from starting point	Sensor 1	Sensor 2	Sensor 3	Decision taken by micro controller
0	7	9	5	Pothole
2	4	4	4	Clear
4	8	4	4	Pothole
6	4	9	5	Pothole
8	8	8	8	Pothole
10	4	4	4	Clear
12	8	6	9	Pothole

6. Conclusion-

Here, we establish an automatic pothole detection system model for information sharing. During night times and rainy season, potholes are not easily detectable by human eye. This problem is eliminated here by using ultrasonic sensors, which give the output independent of light intensity. By making pothole detecting vehicles and shairing the information to an application, it is possible to reduce the possibility of accidents. Dangerous road surface conditions are major distractionsfor safe and comfortable transportation.Both drivers and roadmaintainers are interested in fixing them as soon as possible. So, automatics pothole detection system helps them in this.

7. Acknowledgement-

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