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POTHOLE AND HUMP RECOGNITION USING LIDAR SENSOR

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Abstract - *This project discusses the methods that have been developed to recognize the potholes and humps on the roads. This project also provides the GPS co-ordinates to the respective authorities and to intimate the drivers about the road conditions periodically, to avoid accidents and vehicle's damage. Here, LiDAR sensor is used to identify the potholes and humps and also to calculate their distance from the vehicles, height of the humps or depth of the potholes respectively. The sensed-data includes pothole's depth, hump's height and distance of the target from the vehicle. This measured information serves as a valuable source to the vehicles, thereby alert the drivers and take precautionary measures to avoid accidents and also to send the data to the authorities to rectify the problems.*

Key Words*: *LiDAR Sensor; GPS; GSM; pothole and hump; Arduino UNO; Display unit; GP I/O

1. INTRODUCTION

In a country like India, people are often connected by means of roadways. Though most roads are well-tarred, some are in bad shape. Even in many metropolitan cities, people are often seen criticizing authorities for the poor conditions.

Many researchers have been constantly working in the improvement of road conditions, detection of potholes and many methods have been developed in the process.

Rajeshwari[1] proposed a device that locks and sends the geographical coordinates of potholes and humps using GPS transmitter. A mobile application is also implemented to provide timely messages and location of the potholes/humps.

Moazzam[2] provided a Kinect sensor (containing an RGB camera and IR sensor) based method for analysis of pavements and depth measurements. It also stressed in analysing the dimensions of the pothole. Kinect sensor was utilized because of lower costs, efficient and easy object tracking and better depth measurements.

Yu and Salari[3] developed a laser based system for detecting potholes. It contains a light source that flashed beams of laser light on to the surface, scans and captures the images and processes the scanned images using suitable algorithm that classifies it as a pothole. The algorithm has been implemented on MATLAB R2008b over a set of images and accurate results were obtained. [3]

2. METHODOLOGY

The proposed technique uses LiDAR which is a laser sensor used to detect the relative distance between the target and the sensor. The circuit will be installed at the front or on top of the vehicle and by scanning the surface; it creates a cloud of points penetrating to the ground with centimetre accuracy. In this circuit, the light sent and received is measured and is linked to a simulation software with the help of program and a micro-controller. When the sent signal is received by the sensors, the distance of the pot hole/hump and depth or height of the pot hole or hump is calculated. There were some methods proposed to detect the pothole/humps in the roadways but without the usage of LiDAR. Thus, this proposed project uses LiDAR which is more competent and accurate as the key component to address the problem of detection of potholes/humps in the roadways.

The LiDAR generates and emits laser pulses that is shipped to the surface/target to detect the time taken to return to the source. The sensor shoots rapid pulses of laser light at a surface or target and measures the amount of time taken for each of those pulses to reflect to the receiver. Pulses travel at a fixed velocity so that the instrument can calculate the distance between the object/target and itself with high precision & accuracy.

The LiDAR device is mounted on the vehicle thus can be able to calculate the pothole/hump if present between the vehicle and the target. Thus, by combining and processing all the collected data's, we can alert the driver by a buzzer alarm.

2.1. OPERATING PRINCIPLE

The principle behind the working of LiDAR is quite simple. By sending a small source of laser light at a surface and measuring the time it takes to return to its source, we can calculate the distance between the source and target. Light waves travels very fast - about 300,000 kilometres per second, 0.3 metres per nanosecond. Therefore, the equipment required to measure this needs to operate extremely fast. This has become possible only with the advancements in modern computing technology.

The distance between the source and obstacle is detected by:

Distance = (Speed of light x Time of flight)/2

3. RESULTS AND DISCUSSIONS

3.1. PROPOSED SYSTEM

- LIDAR based system for road hole detection over the road available.
- The sensory system obstacle in an efficient manner.

Figure 1: Block diagram

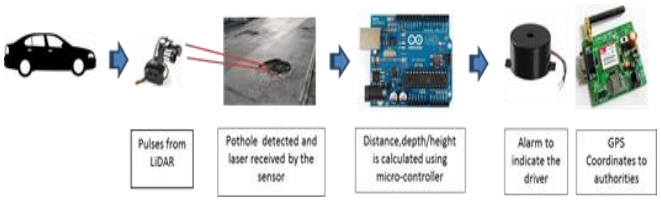

Figure 2: Functional block diagram

Initially the light signals are being sent rapidly from the LiDAR sensor. The sent signals scan the surface of the road and is reflected back to the sensor. The collected data is processed by the micro controller and is compared with the reference values that have been pre-programmed using suitable algorithm. The output is generated on the basis of processed data. Also, the geographical location coordinates of the potholes/humps is being locked and sent to the respective authorities with the help of GSM and GPS modules.

3.2. WORKING

The LiDAR sensor sends a train of laser light pulses at the object/target. It measures the time taken for each pulse to receive back to the transmitter/receiver setup. Light moves at a constant velocity so that the LiDAR sensor can calculate the distance between the target and itself with high accuracy.

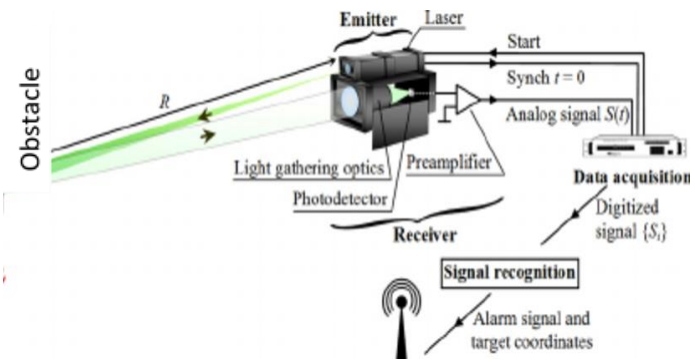

Figure 3: Working of LiDAR

By repeating this process, the instrument builds up a complex 'map' of the surface it is measuring. With airborne LiDAR other data must be collected to ensure accuracy. As the sensor is moving height, location and orientation of the instrument must be included to determine the position of the laser pulse at the time of sending and the time of return [4].

4. CONCLUSION

The proposed system of pothole and hump recognition using LiDAR senor is being executed by fixing the assembly on a vehicle and the received output in the form of alarm is given to the driver and also the GPS of that specific location is sent to the municipal authorities to take necessary actions.

5. FUTURE SCOPE

- 3-D monochromatic imaging of the surface terrain is possible in autonomous cars.
- To maintain ergonomics in the vehicle, thereby providing smoother travel experience.
- Adaptive cruise control.
- Vehicle to vehicle communications.
- High precision maps for road conditions can be updated.

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