Detection of Potholes and Obstacles on the Road

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***Abstract*— Nowadays, many automobile companies in other countries have implemented 'driverless cars'. These cars are capable of sensing its environment and navigating without human input. We are proposing a system which can be useful in driverless vehicles and also for the cars which are not automated. Since the potholes are major cause for accidents and damage of the vehicles, we have limited our scope to detect potholes and obstacles. This paper aims at proposing a versatile Pothole Detection System which assists the driver in avoiding potholes on the roads by giving prior warnings, these can be buzzers or alert messages. The basic idea of this system is to detect the pothole at a distance from which driver is driving the vehicle, to alert the driver if pothole is arriving in the way to take an appropriate action. And in driverless cars this system will generate signals with the help of which we can control the speed of the car or can abruptly stop the car. This paper presents a detailed description of the system based on image processing developed to process and analyze the dataset captured using the camera mounted on the car that gives high efficiency and accuracy compared to the conventional methods of pothole detection .**

***Index Terms*— Pothole detection, Image processing, filtering, texture extraction.**

I. INTRODUCTION

Most of the Indian rural and sub urban roads are not ideal for driving due to faded lanes, irregular potholes, improper and invisible road signs. This has led to many accidents causing loss of lives and severe damage to vehicles. All these reasons demand that it is important to collect information of such bad road conditions and through a series of processing and analyzing the obtained information, appropriate conclusions are derived which in turn, warn the driver. In the information gathering phase, a vehicle with a camera mounted on its front end travels along the road, thereby capturing images of the road. Henceforth in the analyzing phase, this data will be processed by an algorithm to detect potholes along the path travelled earlier by the vehicle. It is this algorithm which will determine the reliability of the pothole detection by the system in place.

One of the increasing problems the roads are facing is bad road conditions. Because of many reasons like potholes and other obstacles on the road difficult to drive upon Unexpected hurdles on road may cause more accidents. Because of these reasons it is very important to get the information of such bad road conditions.

To overcome all these problems, we propose design of 'Pothole/ obstacle detection and alarming System with distance of Pothole/ obstacle' which assists the driver in avoiding pot-holes on the roads, by giving him prior warnings. Warnings can be like buzzer if the driver is approaching a pothole, or driver may be warned in advanced regarding what road has how many potholes.

This system is divided into two subsystems. First is sensing subsystem which senses the potholes encountered by it, it captures images of the potholes by the camera mounted on the vehicle. This camera captured data is sent to PC for processing, which does its processing in openCV platform. Also the distance of the pothole or obstacle is also displayed on PC. Second subsystem is further divided into two parts. First is, as soon as a pothole is discovered by the first subsystem then an alarm is sent in the form of ringing the buzzer. Second part of second subsystem is the vehicle reaction on potholes. Here depending on the pothole or obstacle the vehicle will slow down or stop.

II. EXISTING SYSTEMS

Many techniques have been proposed in the past to detect these problems using image processing methods. But there has been little work specifically carried out for detecting such

issues of Indian roads. Existing methods for detection and estimation of potholes usually use sophisticated equipment and impose computationally intensive tasks. Some systems require expensive equipment, additional filtering and training phase. Another such systems require high cost laser scanners, while others are not reliable when a surface vibrates, such as bridge expansion joints. Vision based approach relies on image processing analysis. Existing methods are based on texture extraction and comparison, which requires additional filtering methods and a set of training data.
The major drawbacks of the systems that are mentioned below are either they are too expensive or they have an additional hardware device which needs to be worn by the user.
We review some existing systems related to our system.

1) Karuppuswamy[1] in his project used a vision based approach which calculates the histogram of the road environment. Based on the histogram; the vehicle could detect exact location of simulated potholes of circular size and diameter more than 2 feet. But this approach has been tried only on simulated potholes. Also this approach involves vision sensors with high response time.

2) Ruzbeh Homji[2] in his intelligent pothole repair vehicle uses a mechanical arrangement consisting of a wheel attached to a spring. When the wheel passes through pothole; the deflection in the spring is measured by an optical shaft encoder. Depending on the reading the depth of the pothole can be predicted. But the mechanical approach used in this system is hardly useful on high speed vehicles

3) Matthies[3] proposes an entirely different approach of recognizing potholes. This approach is based on thermal signature of a pothole in the night time; considering the fact that at night time temperature in the pothole remains warmer than surrounding.

4) Another approach used by *Kasun De Zoysa* [4] is based on the vibration measurement using accelerometer. In this approach the sensor measures the vibration caused while passing through a pothole and not on distributing the data. Hence the results are used by a limited set of users.

III. System Design

Figure 1 represents the basic block diagram of Pothole Detection System. It consists following modules:

A. *Image Capturing Module*

Camera is used for capturing live image of the potholes or obstacles in front of the vehicle. The captured image is transferred to processing block for further processing.

B. *Processing Module*

Processing system consists OpenCv platform. OpenCV (Open Source Computer Vision Library) is a library of programming functions mainly aimed at real-time computer vision.
Video input obtained from camera is divided into frames. Each image frame is compared with previous frame using image processing algorithm. If any undesired change occurs in frame then signal is generated and transfer to alarming and control system.

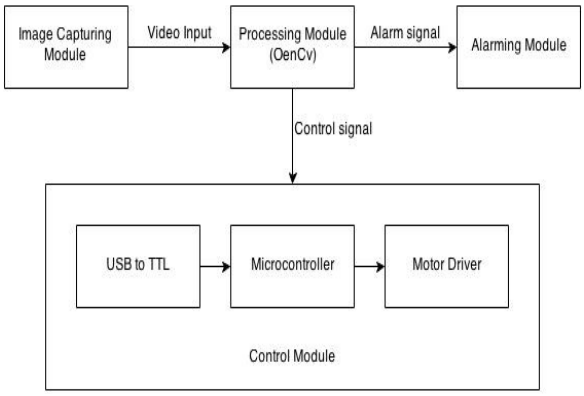

Fig 1-Block Diagram

C. *Image Capturing Module*

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E. *Alarming Module*

The speaker output is the alarm for the pothole or obstacle detection, which is the part of the second subsystem. This alerts the driver of the coming danger and he can take necessary precautions from that.

F. *Control System*

Signal obtained from processing system is transfer to control system which consist three modules USB to TTL converter, microcontroller and motor driver.

G. *USB to TTL Converter*

This is a simple to use USB to Serial TTL Converter based on the CP2102 converter IC from Silicon Laboratories. When connected to a USB port this converter sets up a virtual serial port which can be used and interfaced just like any normal serial port. You can use this board with all our development boards to do serial communication through USB. Since it shows up a virtual serial port on a computer, you can easily write softwares in most programming languages to control

external hardware devices - robots, development boards, microcontrollers, etc from computers.

H. *Microcontroller*

The microcontroller drives the motors of the base vehicle. Also it is connected to PC via USB to TTL so the data received from PC is also used for processing inside the microcontroller. As the pothole is detected, together with alarm the microcontroller drives the motor to stop if an obstacle is detected or slows down when pothole is detected.

I. *Motor Driver*

To make the vehicle move, motor driver setup is provided which contains a motor diver IC L293D, which drives two motors. Also there is broad on which it is mounted. Motor works on 12V supply. And the IC works on 5V.

IV. METHODOLOGY AND IMPLEMENTATION

Each pothole is detected on the basis of three distinctive characteristics:
1. There are shadows (low-illuminated areas) that are darker than the surrounding healthy pavement;
2. The shape is approximately an ellipse because of perspective and
3. The texture of the material inside the pothole is grainier and coarser than the surrounding healthy pavement.
These distinctive visual characteristics of a pothole were utilized for the detection method, which is basically divided into
(1) Image segmentation,
(2) Shape extraction, and
(3) Texture extraction and comparison**.**

A. Image Segmentation

To separate the distress areas described by the darker shadows, image segmentation is performed by means of histogram shape-based thresholding, namely the triangle algorithm. To reduce interference of the high peaks in the histogram, a one-dimensional median filter is applied before computing the threshold for image binarization.

In computer vision, image segmentation is the process of partitioning a digital image into multiple segments (sets of pixels, also known as super pixels). The goal of segmentation is to simplify and/or change the representation of an image into something that is more meaningful and easier to analyze. Image segmentation is typically used to locate objects and boundaries (lines, curves, etc.) in images. More precisely, image segmentation is the process of assigning a label to every pixel in an image such that pixels with the same label share certain visual characteristics. [5]
The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. [5]

B. Shape Extraction

In shape extraction the binary image, regions with holes are filled and small artifacts (such as short cracks) and regions connected to the boundary of the image are removed. Obviously, at this stage the binary image can still contain long and big cracks because such cracks also create dark shadows. These potential distress regions are identified as no-pothole regions within the downstream texture comparison procedure.

C. Texture Extraction and Comparison

To distinguish between false candidates such as big cracks, spot shadows, stains on the pavement, and actual potholes, the texture from inside the potential pothole is compared with the texture from the outside healthy region. Standard deviation of gray-level intensity values is used as a statistical measure. To emphasize texture, three spot filters of the Leung-Malik filter bank and one spot filter of the Schmid filter bank are applied to the original gray-level image. Subsequently, standard deviation values of the filter responses are used to set up feature vectors for both inside (fi) and outside (fo) texture. If the ratio r = |fi|/|fo|, with the length |fi| of the feature vector fi from inside the pothole region and the length |fo| of the feature vector fo from outside the pothole, is smaller than 1.0, then the inner region is grainier and coarser than the outside region. In this case, a pothole is said to have been detected.

V. CONCLUSION

Pothole detection system is a system that aims at warning the driver about the uneven roads and potholes in its path. We study the different ways in which goal of the system can be achieved. Various choices for implementing the System have been studied. These choices were also compared to each other on various criterions. We have specified the High level design choices of the Subsystems and justified the corresponding selections.
The module and design for this project is conceptualized and the hardware and software requirements for development and usage have been analyzed and documented successfully.

D. Advantages

1. Early warning system makes the driver aware of the pothole/obstacles**.**
2. Distance value measured will help the user, when to apply brakes.
3. Also if sudden obstacle comes, the vehicle comes to halt.

E. Limitations

1. Every system has its limitations or we may say some conditions under which the system may not give its best performance. For our system to work at its best there should be sufficient light in the environment.
2. System sometimes get stuck while processing the image, so some buffer time should be taken into account.

VI. FUTURE SCOPE

Our system can be used in night time by changing the algorithm used for image processing and also by using night vision camera

Future work will focus on estimation of potholes when the road has several cracks. And it will also take the images of backside of the vehicle so that the driver will get to know while applying the brakes.

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VII. REFERENCES

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