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Pothole Detection

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Abstract –

The goal of our project is to design a Pothole detection System which assists the driver in avoiding potholes on the roads, by giving the driver prior warnings. For example, it can be like a buzzer or series of LED, if the driver is approaching a pothole driver may be warned regarding the pothole on the road. In this paper, we propose a simple and robust design of a portable and affordable device that can warn the driver about the detected pothole. The hardware system installed in a moving vehicle can automatically detect and report potholes via image-processing of Raspberry-Pi microcontroller. The reported images of the pothole and its location are stored and viewed through the GOOGLE API.

Index Terms—Pothole Detection, Hardware system, Raspberry-Pi microcontroller, GOOGLE API

I. INTRODUCTION

Innovation in the field of internet of things which mainly consists of sensors has drastically changed over the past few decades. Smart transportation has become one of the dimensions going through the travelers for a safe and sound journey.

With vehicles rapidly getting smarter to get into the limelight overnight, sophisticated sensors were installed, allowing the vehicle to profile the road surface under the wheels and identify different road distresses and upgrade the car to that level. However, vehicles are still vulnerable to damages caused by these road distresses like bumps, patches, and especially potholes.

According to ATS Euromaster, a tire service provider, initial impact by these potholes on the wheels can cause cracks, lumps in the tire, suspension control in the wheels can be damaged, and this can make the drivers lose their control over the vehicles and being involved in an accident.

Several types of research and technologies have been developed using a variety of concepts and approaches for detecting and reporting of these potholes on the road. These already existing potholes can be categorized into three methods, namely, i) Vibration-based methods, ii) Reconstruction-based methods, and iii) Vision-based methods.

From the above, the vibration-based method, one of which uses a Smartphone accelerometer sensor. It was able to detect potholes from a speed of 15kph to 40kph for a pothole with a depth of 8.7cm using the Gaussian Model for abnormal event detection. But this kind of design needs a smartphone, which makes the design an expensive one to be taken into consideration for our Model.

The reconstruction-based method uses ultrasonic sensors and the accelerometers for 3D reconstruction methods. But these may not be reliable all the time as many of the engineers nowadays, became a camera-based

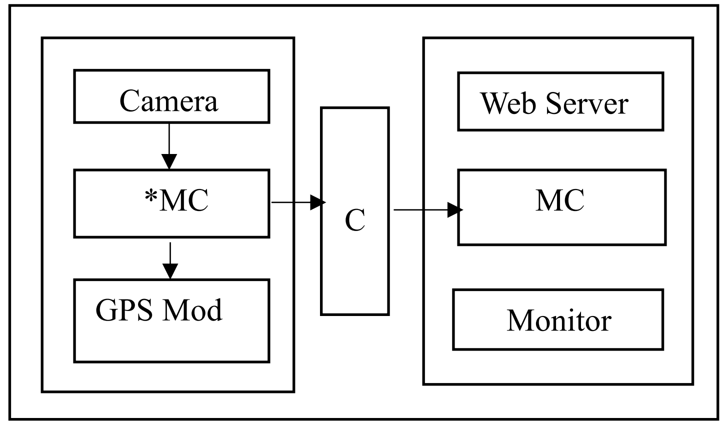
which gives reliable and handy images of the potholes. Although these mobiles provide reliable results, it is not handy since they incorporate Smartphones, or even laptops or computers, in the design. Hence, this study aims to provide a simple and yet robust design of a portable and affordable system that deals with simultaneous smart detection (via image processing using Raspberry Pi microcontroller) and reporting (through a webserver) of potholes without using Smartphones. For image-detection, Raspberry Pi microcontroller was used because of its compatibility and robustness in image-processing. But for our study, no smartphone is needed, as a GPS-module can work out our of sending the pothole reports to the API. However, a stable wifi connection is required or the mobile network for the automation of reporting to take effect.

II.PROPOSED MODEL

This part discusses the following: A). Overview of the System, B). The process for the automatic detection of the pothole, C). The automatic reporting, D). System Integration, and E). Interfaces.

A)OVERVIEW OF THE SYSTEM

The main theme of our system detects potholes on the road using a camera installed on the vehicle and send back the location and the images of the pothole to the webserver which is the GOOGLE API in our case. The below figure shows the system process between the vehicle and the database of the webserver. Our system has a camera, a microcomputer, and a GPS module.



*MC and C here indicate microcomputer and cloud, respectively.

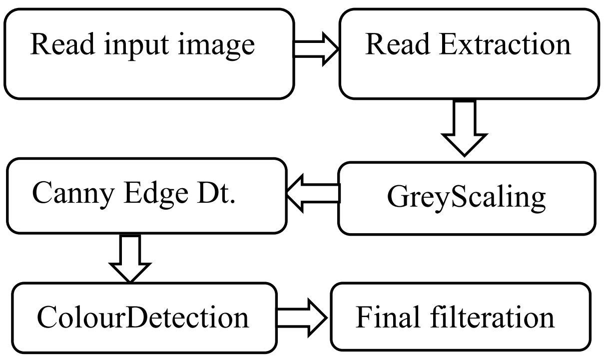
B)AUTOMATIC DETECTION OF POTHOLE

The position and location of the camera module played an important role in properly detecting the potholes. The camera module was placed securely in the upper portion of the car, behind the rear mirror, to obtain a good range and to acquire reliable and accurate results. It was vital for the camera to be as stable and secure as possible since changes in its position could cause potholes to be undetected. This system detects the pothole based on image processing. First, before to detecting process, we don’t need an RGB scale. Because the pothole region is dark, most of the asphalt pavement is gray and white. The system can detect the pothole with the grayscale image. Fig. 1 shows after and before preprocessing, which the RGB image and the grayscale image. It makes drop out unnecessary data. Potholes then would be detected based on its color and area using Canny edge detection, and finally, contour detection and final filtering.

(a) (b)

Fig. 1 a)Part of ROI image, b) Greyscale of (a)

The image processing scheme will be as follows.



C) REPORTING OF POTHOLES

Another key element of the system is the automatic reporting system. The main component of this setup consists of the Raspberry-Pi microcomputer, GPS module, portable wifi device, and a webserver. If a pothole was detected, the same microcomputer would connect to the Internet to send the image and the location of the said pothole to the main database. Another LED was placed in the system to indicate if the report was sent. A specific computer with another microcomputer connected into it in the main server would receive and collect all data coming from the microcomputer. GPS module was to locate the occurrence of the detected pothole coming from different road pavements. Upon detection of the pothole, the microcomputer would connect to the geosynchronous satellites using the preinstalled antenna in the module. The receiving end of the module would obtain the coordinates of where the pothole was detected and would be saved in the microcomputer.

D) SYSTEM INTEGRATION

The main process of the system focuses on the automatic detection of potholes and as well as the reporting of its specific location to the main server. The design of the whole system would be concerned with the integration of the various schemes. The process of the system is shown in Figure 3.

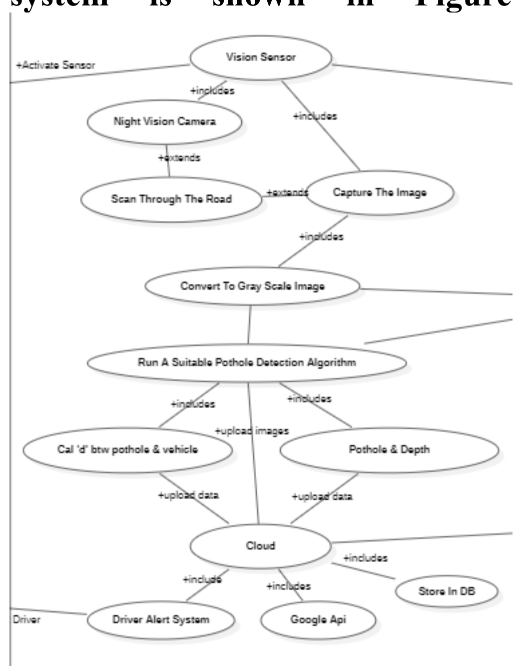


Fig 3. Case Diagram for pothole detection

E) INTERFACES

Two interfaces were used in the system. One interface was used for the automatic detection scheme, and the other was for the automatic pothole reporting system. The interface would help to interpret the data gathered accordingly and conveniently. It would also be useful for the motorist in order to identify whether the system is working properly. The interface used for the automatic detection scheme only contained an LED to alert the driver whether a pothole was detected or not. For the reporting system, a web server would be connected to a Dropbox account that would store all reports to give a proper visualization of the collected data to the user. The below figure shows sample results from the ideal setup and non-ideal setup.

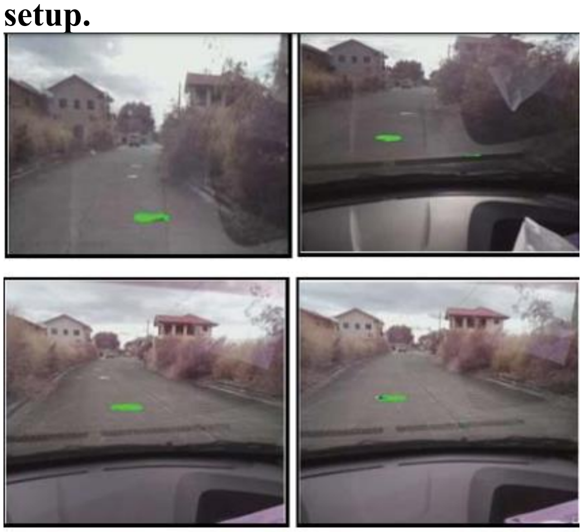


Fig. 5. Sample results from the ideal set-ups

Fig. 6. Sample results from the non-ideal set-ups

III) TESTING MATERIAL

IV) CONCLUSION

The smart detection and reporting of pothole system was able to operate successfully. The camera was efficiently used for the detection of potholes where several algorithms like erosion, dilation, Canny edge detection, and contouring were used for image processing. In general, the response time of the image-processing scheme was relatively fast. The deployment of automatic detection system did not use any laptop, desktop nor Smartphones and therefore proved to be portable since only the Raspberry Pi microcomputer, along with its modules, were used on the vehicle. This shows that the system was able to detect potholes and report them properly along with correct details about the pothole locations.