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Automated Pothole Filling Machine

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Abstract: ***This paper gives an overview of various methods and techniques used for pothole detection and repairing. In Indian roads, one often encounters potholes, which can be either dry or water-filled. Accordingly, to ensure safe driving, it is important detect potholes and forecast their depths in all conditions. A road network is a way of sharing and transporting goods and services locally to the community. Roads networks are also the means of communication in some parts of the world. Therefore, access to good roads improves the life quality and work of the people living in the community. Because of the poor condition of the design and development of the road network along with natural disasters like heavy rains have created many unwanted potholes on the roads which is unsafe for commuters and other road users. In addition, the lack of a proper road maintenance increases the number of potholes that jeopardizes transport and road safety.***

Keyword: Pothole detection and filling, STM32F103C6T6, IR Sensor Mod, L293D motor control, Ultrasonic sensor HC-SR04.

I. INTRODUCTION

Roads make an important contribution to economic growth of country and bring crucial social benefits. Roads include various types of injuries like crack skid resistance, pits, pothole imbalances, etc. A pothole is a plate-shaped depression in a paved area. Pothole are very dangerous on roads where their repair consumes large amount of time, funds and man power. And many road crews have no knowledge about proper materials and methods for pothole repair. Potholes formed because of heavy downpours, because of poor workmanship, poor mix design, or natural deterioration of pavement. According to a few state governments, potholes across the nation has claimed 3,597 lives in 2017, an over half ascent in the toll than a year ago. Around 30 deaths happen on daily basis because of potholes. Pothole repairs is a major reason for decrease in state funds. Potholes cause damage to car tires and impact lower part of the cars. It leads to emergency braking and steering wheel operation which leads to crashes and serious accidents. To resolve this problem many researches and developments have been caried out to help society in promoting road safety and reduce the difficulties in deciding the pothole, while also reducing the usage of human power and saving time.

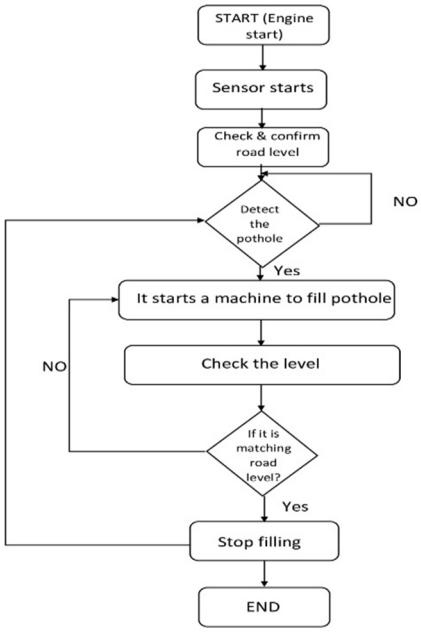
II. OVERVIEW OF THE EXISTING SYSTEMS

[1] Pothole detection is an interesting subject of research; specialists have been trying various pothole detection methods. Some of the pothole detection methods are referenced below: [1] A semi-automated robot, which will detect the pothole and discharge the required amount of concrete quantity, needed for the detected pothole and to do the levelling process on that concrete. The infra-red sensor of the robot senses the surface of the road; if the pothole will be detected, the sensor sends signal to the microcontroller, the controller suddenly stops the movement of the robot near the pothole and discharges the required concrete needed for detected pothole. Then the pothole is level by this slider crank mechanism. [2] The waste plastic which is collected from various sources and is put in a shredder and then stored in bags to drain out the moisture from them. A sensor is used to detect the pothole. Then the shredded bits are melted in a melting pot and poured in the potholes. Once the potholes are filled with this melted plastic; an air blower cools the melted plastic and hardens it. Once it is hardened, traditional road material mixture can be poured in small amount to form a layer on it. [3] The proposed model makes use of a 2D vision-based approach to detect potholes. A camera captures images of the road surface. To detect the potholes, the captured images are processed using MATLAB. This model works under uniform lighting conditions only. It is limited only to the reorganization of a pothole and does not provide any guide to the driver to avoid mishaps because of potholes. [4] The proposed model contains vehicles equipped with Wi-Fi. It gathers data about the road surface and forwards it to the Wi-Fi access point which then broadcasts this to other vehicles nearby as warnings. This system is costly as all vehicles should be then set up with Wi-Fi stations and additional number of access points have to be installed. [5]

The model uses piezoelectric sensor to measure potholes through pressure and force and the GPS linked to node MCU sends the location data along with sensor values with the help of MQTT protocol in the cloud database which then alerts the concerned authority to rectify those potholes. The system also alerts other drivers in the vicinity about nearing potholes through voice notifications through the application. The potholes which are removed from the roads are updated in the database. The system only helps in detecting potholes efficiently but the rectifying work can take longer time and hence it is an open-ended model. [6] The system uses PIC 16F877A microcontroller linked to an ultrasonic sensor, GPS receiver and GSM module to detect the pothole and alert the driver. It also posts the information about the pothole through the application to alert the other vehicles passing through that area. The model also consists of a Crime alerting system which allows users to post about 3 crime happening in an area which would alert other drivers about the crimes so they can choose a safer route to travel. The solution also works in rainy system when potholes are filled with muddy water as alerts are generated using the information stored in the database. This system seems inefficient due to dependence on humans for information as fake information can be provided and the integrity can be compromised. Also, it is not practical to avoid all the potholes in remote area only through approximate information provided about the potholes. [7] An android application that offers facilities to collect the data from sensors by recording a journey, to display the data using graphs using A Chart Engine, and to run the data through the neural network deployed. There's also a feature provided to plot the detected potholes on Google maps and email data that has been collected. It has some limitations like human errors, network providers location is not always accurate and data limitation as data is being collected by individual devices. [8] The proposed model is a line following AGV. It consists of IR sensors linked to an Arduino board which follows a white surface guided by a black line till its destination is reached.

III. SYSTEM OVERVIEW

We have implemented a pothole detection and filling machine using ultrasonic sensors for better accuracy to detect the potholes. The sensors will be located in front of the vehicle facing downwards. They will keep comparing the distance of the road surface from the sensor with the default value of distance fed into the code. When the distance exceeds the specified threshold value the LEDs will glow and a signal will be sent to the microcontroller which will stop the vehicle and send a signal to the servo motor. The vehicle carrying pothole detection and filling systems will be automated based on the principle of line following. Once the distance measured exceeds the default distance the motors stop bringing the vehicle to halt and the filling mechanism begins its work. The filling mechanism consists of a container and tubes to store and carry the filling material. The outlet of the container will be controlled using a flap operated by a servo motor which will function on getting input from the microcontroller when a pothole is detected. During the filling process the sensors will keep sensing the ground level until the default is reached and the outlet will close. The vehicle then moves forward and the flap attached at the tail of the vehicle will level the material filled inside the pothole.



Flow Chart of Automated Pothole Filling Machine

A. Components Required

1) *STM32F103C6T6*: It is an ARM 32-bit Cortex™-M3 CPU Core. The maximum frequency is 72 MHz,1.25 DMIPS/MHz (Dhrystone 2.1) performance at 0 wait state memory access. It is a Single-cycle multiplication and hardware division. Its memory is 16 or 32 Kbytes of Flash memory and 6 or 10 Kbytes of SRAM. Two 16-bit timers each with up to 4 IC/OC/PWM or pulse counter and quadrature (incremental) encoder input; 16-bit, motor control PWM timer with dead-time generation and emergency stop. 2 watchdog timers (Independent and Window), SysTick timer 24-bit down counter; 6 communication interfaces, 1 x I2C interface (SMBus/PMBus), 2 × USARTs (ISO 7816 interface, LIN, IrDA capability, modem control), 1 × SPI (18 Mbit/s), CAN interface (2.0B Active), USB 2.0 full-speed interface.
2) *IR Sensor Mod*-TCRT5000: The type of detector used is photo-transistor. The Peak operating distance is 2.5 mm. Collector current ranges from 0.2 mm – 15 mm. The typical o/p current blow test (IC) is 1 mA. Blocking filter for daylight. The wavelength of the emitter is 950 nm. Infrared sensor including the o/p of transistor o The operating voltage is 5V. The forward current of the diode is 60mA o Output data is analog/digital. The Collector current of the transistor is 100mA. Operating temperature ranges from -25°C to +85°C.
3) *L293D motor control*- Wide Supply-Voltage Range: 4.5 V to 36 V. It has separate Input-Logic Supply. It has internal ESD Protection. It has High-Noise-Immunity Inputs. It has output Current 600 mA Per Channel. It has peak Output Current 1.2 A Per Channel. It has Output Clamp Diodes for Inductive Transient Suppression. It has Operation Temperature 0°C to 70°C. It has Automatic thermal shutdown is available.
4) *Ultrasonic sensor HC-SR04*- Its operating voltage is +5V. The theoretical measuring distance is 2cm to 450cm. The practical Measuring Distance is 2cm to 80cm. Its Accuracy is 3mm. Measuring angle covered less than 15°. The operating Current is less than 15mA. The operating frequency is 40Hz.
5) *Solenoid lock*- 12V Solenoid lock has a slug with a slanted cut and a good mounting bracket. It's basically an electronic lock, designed for a basic cabinet, safe or door. When 9-12VDC is applied, the slug pulls in so it doesn't stick out and the door can be opened. It does not use any power in this state. It is very easy to install for automatic door lock systems like electric door lock with the mounting board. This solenoid in particular is nice and strong.
6) *Buzzer*- An audio signalling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

IV. SOFTWARE/ TOOLS USED

1) *Arduino IDE:* The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board.

V. CONCLUSION

Hence, we draw the conclusion that this device is quite helpful in repairing the roads efficiently compared to the manual process. Where the traditional road repairing process would take a lot of man power and time; the automated pothole filling machine would require very less manpower and therefore lesser delays in repairing the roads. The roads will be repaired using proper filling material hence making it durable.

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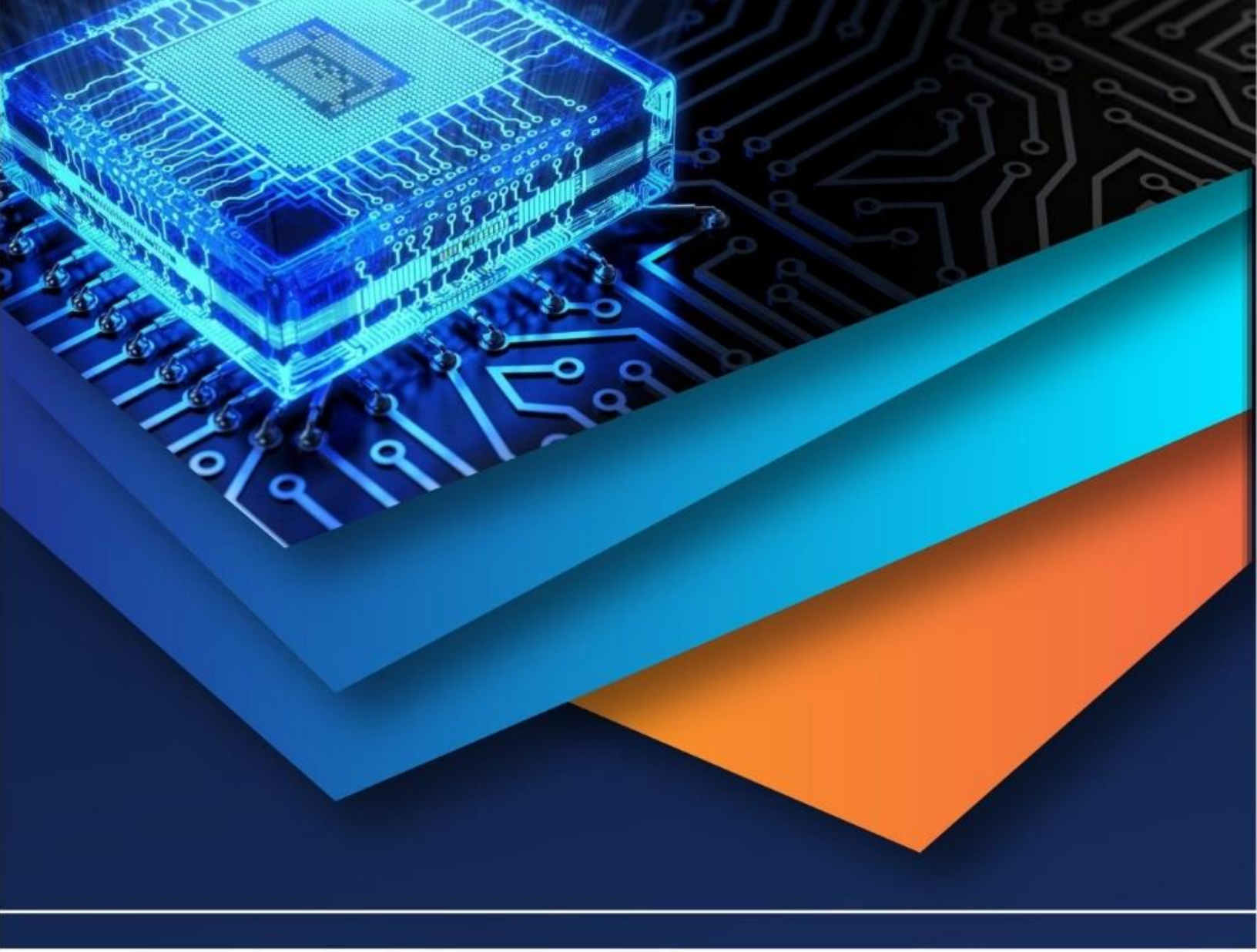

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