International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design and Manufacturing of Pothole Detection Cement Dispatch and Levelling Robot

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ABSTRACT:-

The project's primary goal is to design and construct a semi-automated robot that will identify potholes in the road, discharge the necessary quantity of concrete for the potholes, perform levelling operations on the discharged concrete, and fill the potholes in the road. The robot's power supply is turned ON, allowing it to drive along the road. When a pothole is identified, the ultrasonic sensor on the robot's front can feel the road's surface and transmit signals to the Arduino controller, which abruptly stops the robot's movement near the pothole and allows the robot to be discharged cement. The roller will then level the cement once the pothole has been filled.

1. Introduction

Roads have a major role in economic growth as well as provide significant social benefits. They are crucial to a country's development and growth. Roads provide access to new locations and promote social and economic advancement. For these reasons, road infrastructure is the most important public asset. Yet, a pothole might be created on a road from repetitive loading and weathering, which could have a highly negative impact on human life. We will manufacture a semi-automatic robot that can identify potholes in the road, dispense the necessary quantity of concrete to fill the hole, and level the discharged concrete using a roller attached to the robot's end. As a result, the road pothole may be filled, which might minimize the number of

accidents caused by the pothole. Many studies are being conducted to create systems that can detect and identify sensory-based gaps to solve this issue, which might enhance study outcomes. Appropriate action may be performed regarding road quality by early inquiry. We have investigated the numerous holes and drawing techniques that have been created thus far in this study. putting forward a finding strategy and properly and effectively mapping the sinkhole. By merging data from various vehicles and users of crowdsourcing, smart holes are found and mapping is done, providing more accurate access to environmental data.

Figure 1. .Pothole Image

2. Present Theory & Practice

A. Stereo Vision based technique

A stereo-based approach was presented by Yaqi Li Christos Papachristou [4] to assist in the detection of potholes. The identical workflow is as follows:

Two USB cameras are part of the system, and they are concurrently photographing the road. after gathering the necessary information. To construct the disparity map, we employ parameters from camera calibration using a checkerboard. utilizing points from a two-dimensional picture that can be projected into three dimensions using a disparity map. We fit the road surface using the bisquare weighted robust least-squares approximation using all the 3-dimensional points. It is possible to identify any point below the road surface model as a pothole location. Also, it is possible to find out each pothole's size and depth. So, these processes aid in our accurate identification of the state of the roads.

B. Deep Learning approach for pothole detection

The author describes a technique that integrates deep learning algorithms with cell phones to quickly identify potholes. A smartphone application that maps all potholes along a user's journey serves as the system's user interface (UI). The Single Shot Multi-box Detector object detection method is the deep learning technique we are employing. This technique uses a mobile camera in the background to search for potholes using Single Shot Multi-box Detector (SSD). The coordinates of potholes are promptly updated in real time in our database as soon as some unregistered potholes are discovered by SSD. A Deep Feed Forward Neural Network model also continually collects and analyses accelerometer and gyroscope measurements in order to identify unreported potholes. This dual technique offers consistent results in addition to cross-validating detection.

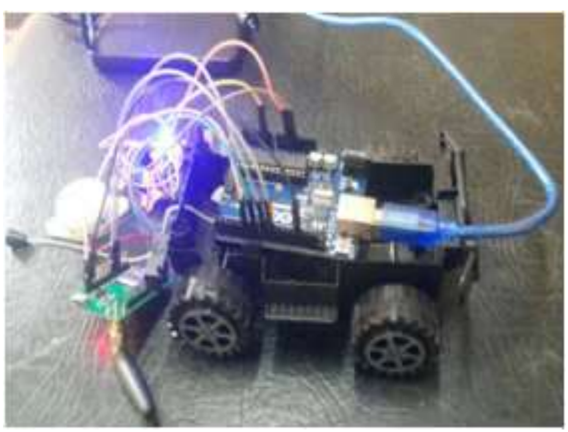


Figure 2. Pothole Detection Robot

3. Problem Statement

A pothole is a structural flaw in a road surface that develops when water from the underlying soil structure and traffic pass over the afflicted region, typically leading to flaws in asphalt pavement.

So, the goal of our research is to create a robot that will aid society in promoting road safety and in making it easier to spot potholes. We created a semi-automatic robot that can identify potholes in the road, release the necessary quantity of concrete to fill the hole, and use a roller to level the discharged concrete. Hence, the road pothole may be entirely filled, which might minimise the number of accidents caused by the pothole.

4. Need of Project

Road surface issues like potholes are particularly dangerous because they obstruct the safe, secure, and dependable flow of people, goods, and services. Access to markets and quick, efficient delivery of products and services from producers to consumers are made possible by effective road networks. A useful and dependable road network that promotes the efficient flow of people, products, and services is created with the support of early identification and treatment of potholes.

5. Aim and Objective

Aim

The purpose of this project is to design and construct a robot that can detect potholes, distribute cement, and level terrain.

Objective :

1. The project's primary goal is to develop and build a semi-automated robot. The road pothole will be found by the robot.

2. After that, pour the necessary quantity of concrete into the identified pothole.

3. The robot will then level the concrete and proceed.

6. Scope

The following describes the project's scope of work:

The creation of a robotic vehicle with rover controls (i.e. Forward movement, backward movement, etc) Programming the Sensor and Microcontroller to take action at the Cement Dispensing after receiving the signal from the Ultrasonic sensor. creating and securing the Servo Motor system to release the cement when a pothole is found to create a mechanical and electronic design capable of performing the aforementioned duties.

7. Literature Survey

1) “Design and Development of an Intelligent System for Pothole and Hump Identification on Roads” By B. G. Shivaleelavathi, Veeramma Yatnalli, Chinmayi, Yamini V. S, Spoorthi Thotad.

This article offers a straightforward method for spotting potholes and speed bumps, helping drivers and preventing accidents. Potholes are located using an image processing technique, while humps are located using ultrasonic sensors. A Raspberry Pi is utilised as the controlling device. Using Wi-Fi, the system locates potholes and broadcasts their location to the appropriate authorities so they may take the necessary action.

2) “Machine Learning Based Autonomous Road Maintenance System Using Cold Lay Asphalt” By Abhinav Sreesan, Anirudh Shankar,Vignesh Vaidyanathan, Shubhangi Kharche.

In order to provide an effective solution to the aforementioned challenge, this study presents a novel technique that can minimise the time and labour requirements by fusing ideas from image processing and machine learning with cutting-edge materials like Cold Lay Asphalt. This paper's main objective was to find and emphasize use of autonomous cars. In order to do this, the following study suggests an autonomous road repair system based on machine learning (ML-ARMS). Raspberry-Pi is used to train and operate the vehicle (Bot) in ML-ARMS. With 500 training photos, the machine learning algorithm's accuracy is determined to be 42.778%.

8. Project Methodology

- **Problem identification**: A pothole in a road surface, typically produced by asphalt pavement degradation owing to water in the underlying soil structure and vehicles traveling over the afflicted region. This pothole causes wear and tear on vehicles the treatment of this potholes is very important.
- **Research:** According to problem and necessity we are finding the best solution for Pothole Detection and cement Dispatch and Levelling process.
- **Design Calculation:** The aim is to design a model that detects the potholes on road through an ultrasonic sensor technique. In this design, we have used 4340 steel as a material for the frame of the model and EN18 for the rack and pinion. For CAD model design the CATIA software is used.
- **Model Analysis:** Analyse the Deformation and Equivalent Stress of the model in ANSYS Software.
- **Fabrication:** We will manufacture the model as per our design calculations and requirements for the detection of potholes and the Dispatching of Cement and Levelling.
- **Testing:** We will test the model on roads and see whether the model is working properly or not.

9. Prototype model

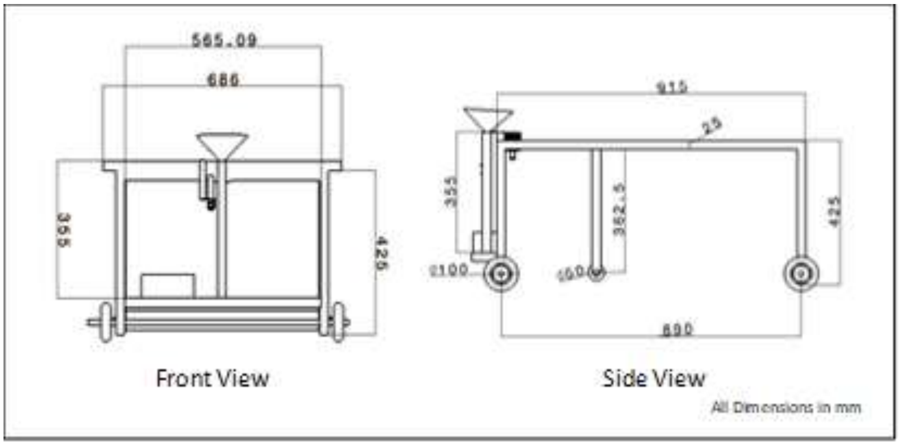


Figure 3. Model Design

10. Analysis

The actions taken during test

1 are listed below. SOLID WORKS is utilised as the modelling programme.

2. We constructed our model based on the parameter that was chosen.

3. They employed ANSYS as their analytical tool for the very next stage.

4. To do this, we first meshed our model properly.

5. We determined the equivalent stress and deformation in our model based on the required torque.

6. Consequently, we could tell that our model was secure.

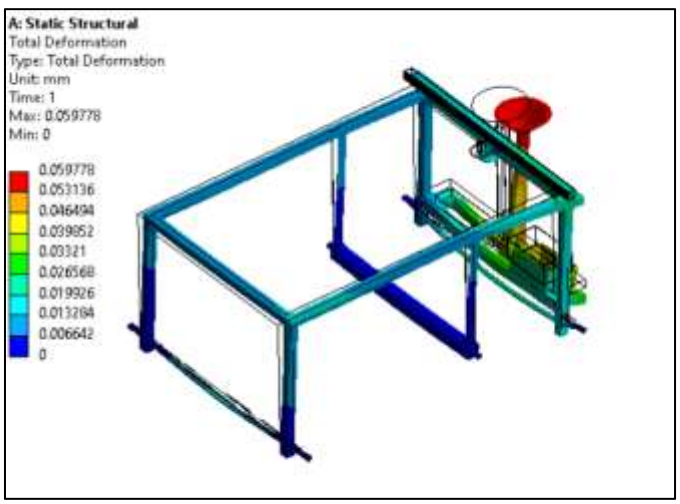


Figure 4. Total Deformation Analysis

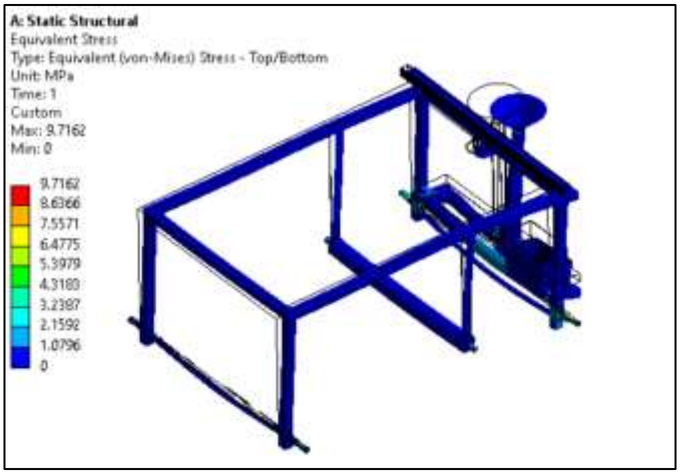


Figure 5. Equivalent Stress Analysis

11. Fabrication

List of Components using for fabrication

- ➢ Square Tube
- ➢ Rack and Pinion
- ➢ Arduino UNO
- ➢ Ultrasonic Sensor
- ➢ Servo Motor
- ➢ 2- Channel Relay
- ➢ L298 Motor Driver

1) Square Tube

Figure 6. Square Tube

To build the frame, we're employing square tubes, which are hollow square components made of mild steel. We have bought square tubes on the market in the quantities and at the prices listed below.

2) Rack and Pinion

Figure 7. Rack and Pinion

A mechanical device called a rack and pinion is used to convert rotational motion into linear motion. In steering systems for automobiles, trucks, and other vehicles, it is often utilised. A gear (the pinion) connects with a flat, toothed bar (the rack), which is attached to a steering column, in the rack and pinion system. The vehicle's wheels are moved back and forth as the pinion rotates, which also moves the rack.

For the horizontal movement of the cement distributing pipe in our model, rack and pinion is used.

3) Arduino UNO

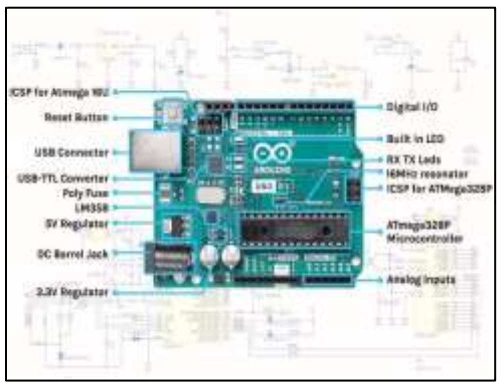


Figure 8. Arduino UNO

A microcontroller board called the Arduino UNO is based on the ATmega328 (datasheet). It contains a 16 MHz ceramic resonator, 6 analogue inputs, 14 digital input/output pins (of which 6 may be used as PWM outputs), a USB port, a power connector, an ICSP header, and a reset button. It comes with everything needed to support the microcontroller; to get started, just plug in a USB cable, an AC-to-DC converter, or a battery.

➢ Microcontroller ATmega328

➢ Operating Voltage 5V

➢ Input Voltage (recommended) 7-12V Input

➢ Voltage (limits) 6-20V

➢ Digital I/O Pins 14 (of which 6 provide PWM output)

➢ Analog Input Pins 6

➢ DC Current per I/O Pin 40 mA

➢ DC Current for 3.3V Pin 50 mA

➢ Flash Memory 32 KB (ATmega328) of which 0.5 KB used by bootloader

➢ SRAM 2 KB (ATmega328)

➢ EEPROM 1 KB (ATmega328) Clock Speed 16 MHz

4) Ultrasonic Sensor

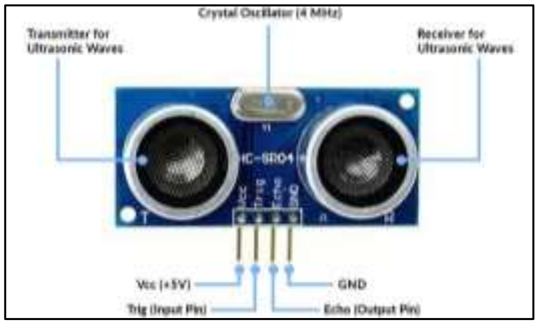


Figure 9. Ultrasonic Sensor

A device that detects the presence or vicinity of objects by using high-frequency sound waves is known as an ultrasonic sensor. Short, high-pitched sound waves are emitted, and after they hit surrounding objects and return to the emitter, the sensor picks them up. In order to calculate the distance between the sensor and the item, the sensor monitors the amount of time it takes for the sound waves to bounce back.

Applications for ultrasonic sensors include industrial automation, automotive, robotics, and security systems, among others. They frequently serve as distance gauges, obstacle detectors, and feedback systems for navigation and control systems. To find potholes, we employ ultrasonic sensors.

5) Servo motor

Figure 10. Servo Motor

There are many different types of servo motors on the market, and each has unique technology and uses. You may choose the best servo motor type for your project or plan by using the information in the two parts that follow. Most servo motors work between 4.8 and 6.5 volts, but often at 5 volts, when the voltage climbs above the torque that may be obtained. Due to their gear arrangement, almost all recreational servo motors can only rotate from 0° to 180°, so make sure your project can function with half a circle; if not, you may pick an engine that can rotate from 0° to 360° or replace the engine to produce a full circle. If your application calls for robust and long-lasting motors, you may either carry metal gears or just stay with standard plastic. Car gears can be changed easily. The engine's operating torque is the next and most crucial characteristic. Again, there are several possibilities here, but the Tower pro SG90 Motor's 2.5kg/cm torque is the most popular. The engine can pull 2.5 kilogrammes if it hangs at a distance of 1 cm thanks to its torque of 2.5 kg/cm. As a result, the engine can pull 5 kg if the load is stopped at 0.5 cm.

6) Relay

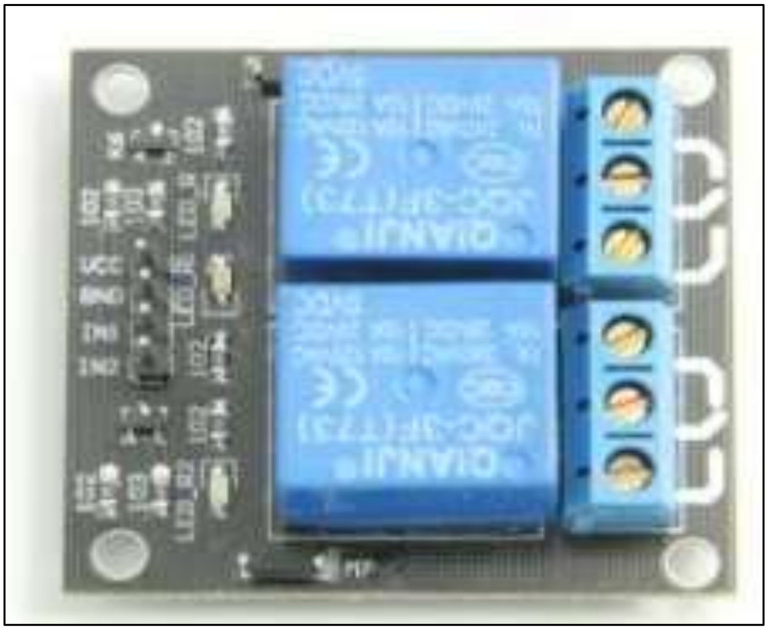


Figure 11. 2-Channal Relay

Larger loads and devices, such as AC or DC Motors, electromagnets, solenoids, and incandescent light bulbs, may be controlled by a variety of microcontrollers, including Arduino, AVR, PIC, and ARM with digital outputs. This module can control two relays since it is built to be combined with two relays. One premium QIANJI JQC-3F relay with rated loads of 7A/240VAC, 10A/125VAC, and 10A/28VDC is used as the relay shield. An individual light-emitting diode indicates the relay output condition.

7) L298 Motor Driver

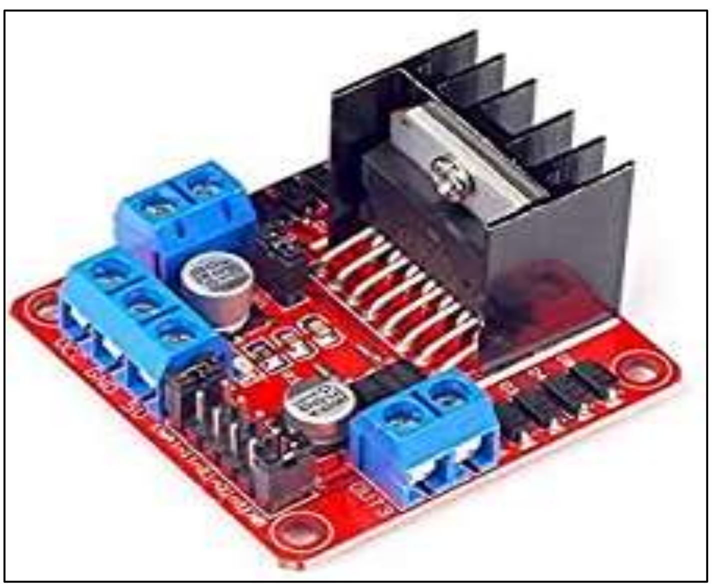
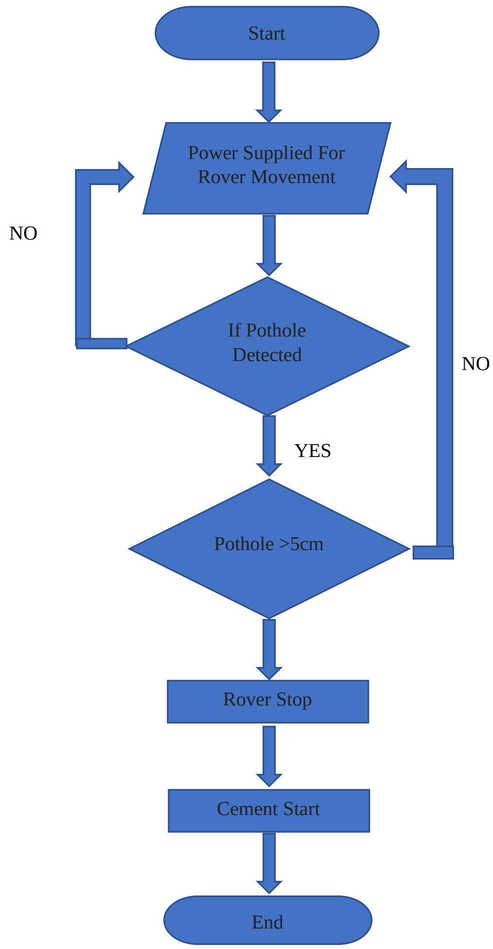


Figure 12. L298 Motor Driver

The twin H-Bridge motor driver L298N enables simultaneous speed and direction control of two DC motors. The module can run DC motors with peak currents up to 2A and voltages between 5 and 35V.

12. Working Principal



1. Start

2. Set up the system's accessories.

3. Launch the machine.

4. Verify the measurement of distance from the ultrasonic sensor.

5. A pothole is detected if the distance exceeds the reference level.

6. Turn the robot off

7. Starts of servo motors

8. Cement begins to dispense

9. Robot advances while rolling cement with a connected roller.

13. Result

The sample model was constructed in a simulated setting with real-world potholes in order to verify the functionality of our suggested approach. Two pieces made up this gearbox.

Pothole detection was first noticed, and notice of its presence was given to the appropriate blocks. The procedure of triggering the system to drop the necessary amount of concrete once a pothole is spotted was successfully completed. This is a basic prototype that can be used to successfully patch potholes in the road.

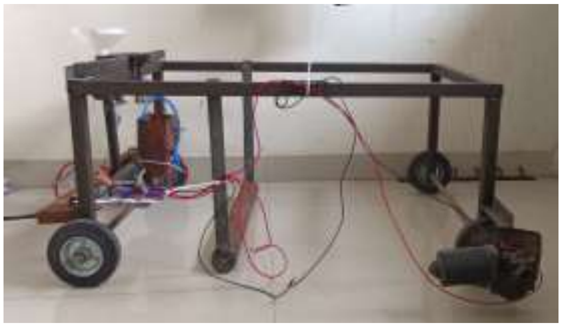


Figure 13. Fabrication Model Side View

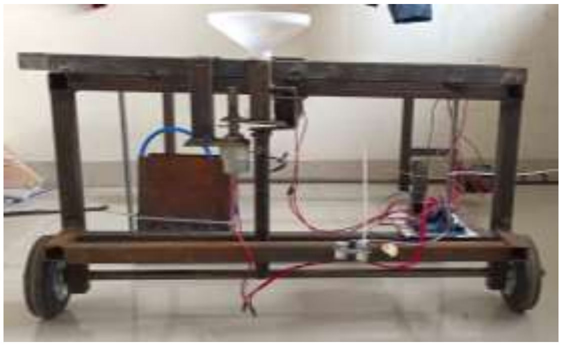


Figure 14. Fabrication Model Front View

14. Conclusion

The suggested system will find potholes on the road and upload the data to a server. Additionally, the holes are discovered, and using ultrasound, their height and depth are determined.

Accelerometers and sensors, third. As a result, our self-propelled robot aids the community by boosting road safety, minimizing potholes, and saving time by using less human energy.

As a result, by plugging the hole, traffic accidents can be decreased.

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