# ROAD HEALTH MONITORING SYSTEM


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***Abstract— The purpose of our project is to create a pothole detecting system that helps drivers avoid potholes on the road by providing them with warnings in advance. These warnings can take the form of a buzzer or a series of LED lights. This can be utilised on a four-wheeler, particularly by ambulance drivers so that they can quickly save a great number of lives. Road surface quality needs to be regularly evaluated and maintained as necessary. The economy of the nation is significantly boosted by well-maintained roadways. Due to the heavy use of road transportation, there are numerous chances that potholes on the roads can cause accidents. Every driver in India must navigate potholes, which are most common during the rainy season.But each of the methods currently in use has some downsides, such as high setup costs, a risk of being discovered, or a lack of night vision capabilities. As a result, we have developed a project that might most easily assist people. The major goal is to locate and warn of potholes, ideally without human assistance. We are utilising object identification API and AI-enabled cameras to detect potholes in order to accomplish our goal. The driver can use the information gathered to prevent collisions.***



**Keywords—** ***Pothole, Buzzer, LED, Road, Accident, Vehicle, AI, ML, Camera.***


## I. Introduction

What feature do the majority of large cities share? They will all likely invest substantial sums of money in various smart city projects. Innovation has not been absent from road infrastructure. In the upcoming years, almost one-third of Pittsburgh's crossings will have smart traffic lights installed; these sensors monitor traffic volume and modify stop-and-go times according to the amount of cars present. Wait times at crossings have decreased by 41% since the project's beginning, and car emissions have decreased by 21%. Contrary to popular belief, when travelling on a road you are unfamiliar with, the search for the most convenient route may not always match to the search for the quickest route.

Initially, hundreds of thousands of dollars are spent "patching" and fixing damaged road segments. Also, driving on uneven ground uses more fuel and necessitates maintenance more frequently. We shouldn't forget that potholes on the road are frequently one of the factors contributing to collisions, which can result in injuries and occasionally fatalities. At the very least, the subpar condition of the road lane aggravates and discomforts drivers. Road maintenance is difficult because there are so many variables that can cause harm. Both organic and artificial ones are included. The cost of road repair projects strongly relates to how quickly they respond to damage. With the assistance of static sensors or human monitoring, it is nearly difficult to assure quality management of roads. Such systems need money that could be utilized for repairs because the roads are so long. The idea of the Internet of Things is becoming more and more well-known every year. The fundamental idea behind this theory is that when sensors share data, the yields of earlier fishing techniques fall..

## II. Literature Review

### *A. Background*

Both organic and artificial ones are included. The cost of road repair projects strongly relates to how quickly they respond to damage. With the assistance of static sensors or human monitoring, it is nearly difficult to assure quality management of roads. Such systems need money that could be utilized for repairs because the roads are so long. [1]The idea of the Internet of Things is becoming more and more well-known every year. The fundamental idea behind this theory is that when sensors share data, the yields of earlier fishing techniques fall.[2]

### *B. Basic Terminologies*

The suggested system employs the YOLO v4 algorithm to detect potholes in real-time, and it does so with the aid of a very straightforward and user-friendly GUI that gives you two options: "Start" and "Stop". When the "Start" option is chosen, the camera turns on and potholes are detected in real time. Now, while the YOLO v4 algorithm is running in the background, the camera is still recording. When a pothole is found, a bounding box is predicted to be around it. The bounding box is made up of a Box Label and a Predicted Accuracy Percentage, where Accuracy Percentage is the percentage of pothole detection accuracy. The console output reflects the number of potholes that are found in each image. The system exits the GUI as soon as you choose the "Stop" option, stopping the detection process in its tracks.

### C. Existing Systems

When conducting routine field surveys, inspectors of the municipal corporation in developing nations frequently identify pavement potholes. This traditional approach can aid in obtaining a precise assessment of potholes, but it also has a low productivity for both data collecting and data processing. One pavement inspector can only inspect less than 10 km every day, which is the cause.[3]The automation of pothole identification becomes a critical requirement for transportation authorities due to the increasing number of road sections that must be routinely evaluated. The simplest approach might be to compile participant-taken images of road damage and hazards and upload them to a central server.[4]

## III. PLAN OF PROJECT

### A. Proposed System Architecture

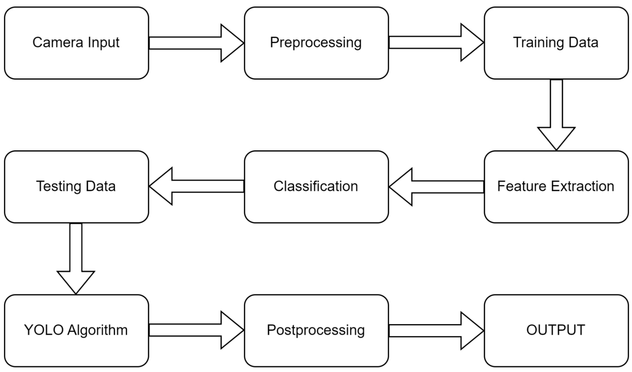



Fig 3.1 System Architecture

#### 1) Dataset:

In order to develop a "Road Health Monitoring System" software project that uses only software to detect potholes, a relevant and accurate dataset is necessary. Here are some potential sources and characteristics of a dataset that could be used for this purpose:

Mobile sensors: Mobile sensors on vehicles can be used to collect data on road conditions, such as vibration and roughness, which can indicate the presence of potholes. This data can be collected from a large number of vehicles in different locations to provide a comprehensive view of road conditions.

Street view images: Potholes can be visually detected in street view photographs taken with on-board cameras or in satellite imagery. Based on color, shape, and texture, machine learning algorithms can be trained to recognise potholes in these pictures.

Crowdsourced data: Data can also be collected through crowdsourcing platforms, where drivers or other road users report the location and severity of potholes they encounter while traveling. This data can be supplemented with additional information such as weather and traffic conditions to improve the accuracy of pothole detection.

Historical data: Historical data on road conditions and maintenance can be used to predict the likelihood of potholes developing in certain areas. This data can be collected from government agencies and other organizations responsible for maintaining roads.

Simulated data: Simulated data can be used to train machine learning models to detect potholes in a controlled environment. This data can be generated using 3D modelling software or video game engines to simulate different road conditions and pothole sizes.

In order to ensure the accuracy and reliability of the dataset, it should be labelled or annotated with information such as the location and severity of potholes. It is also important to ensure that the dataset is representative of the road conditions in the target area and includes a diverse range of road types and traffic conditions.

Overall, the development of a high-quality dataset is essential for the accurate and effective detection of potholes using software in the "Road Health Monitoring System" project.

#### 2) Pre-processing Data:

Cleaning and converting raw data into a format that may be used for more research is part of pre-processing, a crucial stage in data analysis.Pre-processing is a crucial step in guaranteeing the accuracy and quality of the data used for pothole identification and other road health monitoring tasks in the context of the "Road Health Monitoring System" software.Here are some of the pre-processing steps involved in the RHMS software:

Data collection: The first step in pre-processing is data collection. To provide a complete picture of the state of the roads, the RHMS software gathers information from a variety of sources, including sensors, cameras, and mobile devices.The collected data is usually in raw format and needs to be cleaned and processed before analysis.

Data cleaning: After data collection, the next step is to clean the data.Data cleaning entails deleting useless or redundant information, fixing mistakes, and adding missing data.
In the case of RHMS, this step is essential to ensure that the data used for pothole detection and other road health monitoring tasks is accurate and complete.

Data integration: RHMS software collects data from multiple sources, and the collected data needs to be integrated into a single dataset. This step involves merging data from different sources and ensuring that the data is consistent and compatible with the analysis tools.

Data transformation:The process of transforming unprocessed data into a form suitable for analysis is known as data transformation.In the case of RHMS, this step involves converting data into a format that is compatible with machine learning algorithms and other analysis tools.

Data reduction: Data reduction is the process of reducing the amount of data by eliminating redundant or unnecessary data. This stage is crucial for RHMS since it can assist decrease the amount of data that needs to be analysed, increasing the software's effectiveness and speed.

Data normalization: Data normalization is the process of scaling data to a common range to make it easier to compare and analyse. In the case of RHMS, this step can help ensure that data from different sources is consistent and compatible with the analysis tools.

### B. Methodology

After the dataset has been obtained for a pothole detecting system, the suggested approach annotation for each image is carried out explicitly. The annotated data are split into training and testing samples before being sent to deep learning models like the YOLO family and SSD for specific model training. Utilizing testing data, the weights collected during training aid in assessing the model's effectiveness. The custom weights are then converted into real-time detection on the OAK-D and Raspberry Pi acting as the host computer using the OpenVino IR protocol.

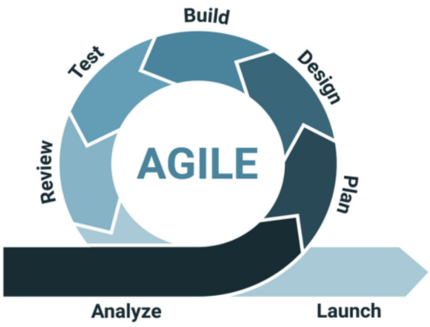



Fig. 3.2 Agile Lifecycle

Other methodologies that fall under the Agile umbrella include:

- Feature Driven Development (FDD)– One of the additional approaches that fall under the Agile umbrella is a straightforward and incremental paradigm that, as the name says, prioritises features. It goes through several checks and iterations. This system requires extensive planning and design expertise.

- Lean software development – Agile methodology is combined with the principles and practises of lean manufacturing to create lean software. Concentrate on making the most of your time while wasting as little money as possible.

- Scrum – Scrum is a methodology that focuses on managing software development in complicated knowledge work, research, and cutting-edge technology while emphasising collaboration, iteration, and responsibility.

## IV. Project Analysis

A software-based pothole detection system would typically use image processing techniques to examine photos or videos taken by cameras mounted on cars or drones. The essential steps in such a project are as follows:

Data collection: You will need to collect a large number of images or video footage of roads with potholes. You can capture these yourself or use publicly available datasets.
Image processing: Once you have the data, you will need to process it to detect potholes. This can be done using computer vision techniques such as edge detection, thresholding, and segmentation. The goal is to isolate the potholes in the image or video.

Feature extraction: After the potholes have been detected, you will need to extract relevant features from the images or video. This may include the size, shape, depth, and location of the potholes.

Classification: Once the features have been extracted, you will need to classify the potholes as either minor or major based on their severity. Machine learning algorithms like decision trees, support vector machines, or neural networks can be used for this.

Alert generation: Finally, the system should be able to generate alerts when potholes are detected. These alerts can be sent to the driver, maintenance crew, or city officials.
The project will require skills in programming, image processing, machine learning, and software engineering. The software can be developed using open-source libraries such as OpenCV, TensorFlow, or PyTorch.

It's crucial to remember that while a software-only approach to spotting potholes may be successful, it may not be as accurate as a system that uses both software and hardware. For example, a system that combines camera data with sensor data from the vehicle can provide more accurate information about the location and severity of potholes.
Overall, a pothole detection system using software can be a valuable tool for improving road safety and reducing maintenance costs

### A. Algorithms:

This study suggests using the YOLOv4 algorithm for object detection and pothole detection. On a dataset of pothole photos, we assess the proposed model's performance and compare it to other well-liked object detection techniques. Our findings show that YOLOv4 performs better than other models in terms of precision and effectiveness, making it a potential method for pothole identification in practical applications. The collection of pothole photos, which consists of diverse sizes and shapes of potholes under varied lighting and weather circumstances, is used to train the proposed YOLOv4-based pothole detection model. Future study might involve putting the suggested model to the test on a bigger dataset and seeing how well it performs in practical situations.

## V. Project Design

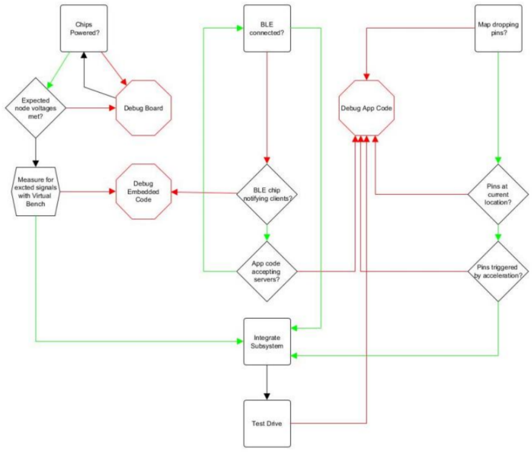



Fig 5.1 State Transition Diagram

The project is divided into two parts. These parts are considered as follows:

i. Machine Learning Model
ii. Flask Application

*Machine Learning Model:*
Similar to computer software, a machine learning model uses data or experience to identify patterns or behaviors. Machine learning is the study of various algorithms that could create a model automatically through use and past data.Similar to computer software, a machine learning model uses data or experience to identify patterns or behaviors.The learning algorithm scans the training data for patterns and then generates a machine learning (ML) model that captures those patterns. To determine if there is a pothole or not, we will utilize the YOLO v4 Algorithm for detecting the Gradient Boosting Classification.

*Flask Application:*
Flask is a straightforward WSGI web application framework. It is designed to make getting started quick and easy, with the ability to scale up to complex projects. It began as a simple Werkzeug and Jinja wrapper but has since developed into one of the most well-liked Python web application frameworks.

### A. *Activity Diagram*

The Activity Diagram plays an essential part in our design. It shows the inflow of conditioning and the connections between different tasks in a visual manner which is essential for understanding our design methodology. In this section, we will offer a complete explanation of the exertion Diagram, including its end, symbols, and significance. By doing so, we hope to give a clear and terse understanding of our design methodology and the way involved. The illustration and explanation will help the anthology grasp our approach and results more thoroughly.

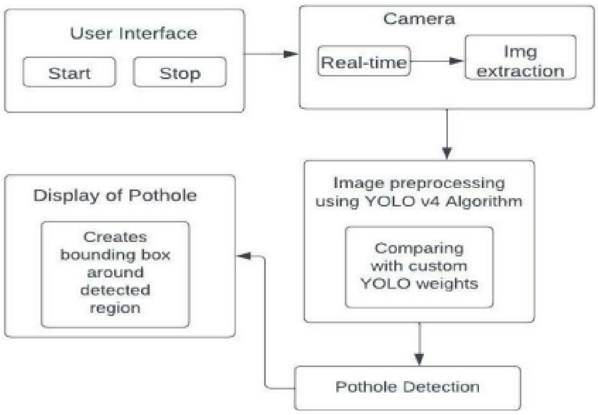
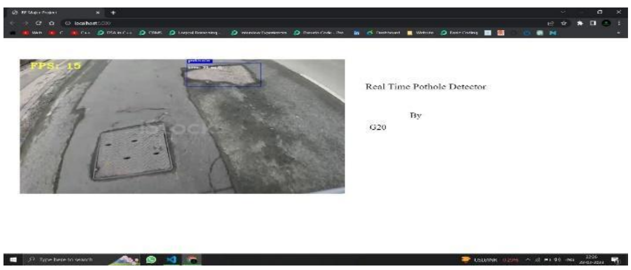



Fig 5.2 Activity Diagram

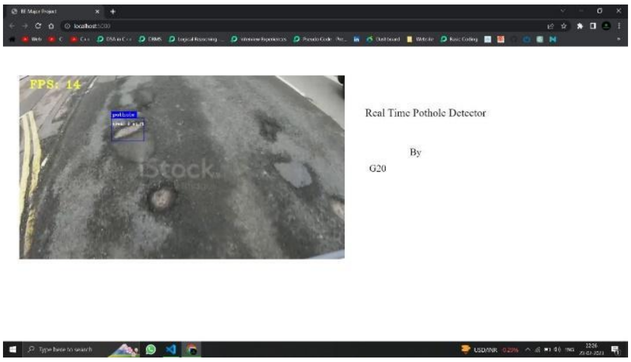
Real-time potholes detection using the YOLO v4 algorithm is made possible by a very straightforward and user-friendly GUI that gives you the choice between two options, "Start" and "Stop". When the "Start" option is chosen, the camera turns on and potholes are detected in real time. Now, while the YOLO v4 algorithm is running in the background, the camera is still recording.When a pothole is found, a bounding box is predicted to be around it. The bounding box is made up of a Box Label and a Predicted Accuracy Percentage, where Accuracy Percentage is the percentage of pothole detection accuracy.
The console output reflects the number of potholes that are found in each image. The system exits the GUI as soon as you choose the "Stop" option, stopping the detection process in its tracks.

## VI. Results

A software-only pothole detection system could work by analyzing video or image data from cameras mounted on vehicles or drones. The system would need to use image processing techniques to identify potholes and distinguish them from other features such as shadows or cracks in the road.

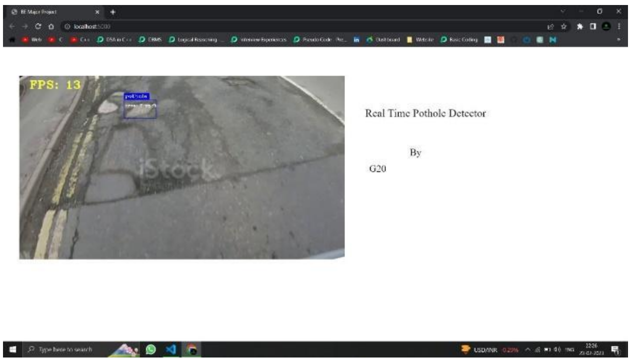



Using computer vision algorithms to spot changes in the texture or colour of the road surface, which may signify the existence of a pothole, is one method that could be used. The system might additionally classify the discovered anomalies as potholes using machine learning techniques, and it might be trained using a sizable collection of labelled pothole photos.




Once a pothole is detected, the system could alert drivers or local authorities through an app or other communication system. The system could also gather data on the location and severity of potholes, which could be used to prioritize repairs and improve road maintenance.

Overall, a software-only pothole detection system has the potential to improve road safety and reduce maintenance costs, but would require accurate and reliable image processing algorithms and a large dataset of labeled pothole images for training.




## VII. CONCLUSION

The model's primary goal is to automatically identify and report potholes on the roadways. Finding and reporting potholes doesn't take any manual work. Our pothole detection system aids society in encouraging road safety by reducing detection challenges, reducing the need for human labor, and ultimately saving time. It can be detected automatically with the aid of AI. Therefore, the number of traffic accidents may be decreased by filling potholes. The image captured along with the latitude and longitude of the pothole's position will be mailed to the appropriate government authorities. The image is visible to the authorities, who can view the position of the pothole discovered in Google Maps by clicking on the link sent via email. The suggested solution will make travelling safer and help decrease accidents. It aids municipal administration in making plans and taking action based on alerts, and the public can monitor how well municipal administration handles pothole complaints. Another benefit is the hardware model's affordability.

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