**FF No** **180**

**Project Synopsis**

**Introduction :**

The "Pothole Detection and Severity Analysis Portal" is designed to enhance road safety and optimize infrastructure maintenance by leveraging machine learning and advanced web technologies. The project focuses on accurately detecting potholes and assessing their severity through the analysis of images collected from various sources, including mobile devices, cameras, and drones. By training machine learning models on datasets representing different road conditions, the portal can provide real-time information on the state of roadways, complete with GPS locations. The integration of predictive analytics further enables the system to forecast potential future road conditions, helping to prioritize maintenance efforts and prevent hazardous situations before they arise.

The portal also emphasizes user engagement, allowing individuals to report potholes manually, verify automatically detected potholes, and monitor the progress of repairs. This interactive approach not only empowers users to contribute to the upkeep of their communities but also assists them in making informed decisions about their travel routes based on pothole severity. By facilitating timely maintenance and efficient resource allocation, the project aims to reduce vehicle damage, enhance road safety, and promote a more sustainable environment.

**Literature Review :**

1. Title: Potholes Detection Using Deep Learning and Area Estimation Using Image Processing

Authors:Ahmed, Khaled R. & Kharel, Subash.

Year : 2021

The literature review for this paper likely examines various methodologies for pothole detection using computer vision, beginning with traditional image processing and object detection algorithms, which often struggle with accuracy and speed. It would then shift focus to deep learning approaches, particularly Convolutional Neural Networks (CNNs), which offer improved performance across diverse road and environmental conditions. The review would highlight the effectiveness of models like YOLOv5 and Faster R-CNN, noting that Faster R-CNN with ResNet50 achieved the highest accuracy at 91.9% precision, while YOLOv5 Small (Ys) provided the fastest detection speed at 0.009 seconds per image, making it suitable for real-time applications. Additionally, the review would discuss the lower accuracy of models like MobileNetV2, which recorded a precision of 63.1%, and the slower speed of VGG16 at 0.11 seconds per image.

**Problem Statement :**

**Objectives:**

1. Accurately identify potholes in user-submitted images, ensuring high precision and recall rates in detection.
2. Implement a robust scoring system to evaluate the severity of detected potholes, facilitating effective decision-making for travelers and contractors.
3. Design an intuitive web portal that allows users to easily submit images, view pothole locations on a map, and access severity information for informed decision-making.

4. Enable the collection and processing of real-time data from users and other sources to maintain an up-to-date database of road conditions, ensuring timely and accurate information.

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| 2. Title: RUI: A Web-based Road Updates Information System using Google Maps API  Authors:Grepon, B., Margallo JC, Maserin, J., Dompol, R.  Year : 2023  The literature review for this research would examine the importance of real-time road information systems in improving transportation safety and efficiency, focusing on existing methods like GPS-based apps and news outlets, which often lack accuracy and user engagement. It would explore the advantages of web-based platforms using tools like Google Maps API for providing timely and interactive road updates. The review would highlight the use of Agile methodologies for system development, ensuring continuous improvement and user-centric design. Additionally, it would discuss the ISO/IEC 25010 quality model for evaluating software effectiveness, comparing the developed system's enhanced user participation and broader geographic applicability to similar platforms.  3. Title: A Real-time Pothole Detection Based on Deep Learning Approach  Authors:Yeoh Keng Yik, Nurul Ezaila Alias, Yusmeeraz Yusof and Suhaila Isaak  Year : 2021  This paper presents a real-time pothole detection system using the deep learning algorithm YOLOv3, aimed at improving road safety and maintenance efficiency. It discusses the rising need for robust road monitoring due to increased vehicle usage and the potential road hazards posed by climate-induced defects such as potholes. The YOLOv3 algorithm, known for its high speed and accuracy, was chosen for its capability to detect potholes in various lighting and weather conditions, using a dataset of 330 images. The system logs detected potholes along with their locations on Google Maps, offering real-time data for road maintenance authorities. The study achieved a mean Average Precision (mAP) of 65.05% and demonstrated that the model could be optimized further with a more extensive dataset and higher GPU specifications. This approach promises a scalable and efficient solution for monitoring road conditions, significantly reducing road hazard risks.  4. Title: Real-time machine learning-based approach for pothole detection  Authors:Oche Alexander Egajim,Gareth Evans,Mark Graham Griffiths, Gregory Islas  Year : 2021  This research outlines an advanced approach to pothole detection using machine learning models, enabled by data collected from mobile devices such as smartphones. The authors employ a range of machine learning techniques, including Naïve Bayes, Logistic Regression, SVM, K-Nearest Neighbours (KNN), and Random Forest, to distinguish between pothole and non-pothole road events. Their methodology utilizes a binary classification system based on the features extracted from accelerometer and gyroscope sensors within the devices. The study emphasizes the importance of real-time data collection and processing to identify potholes, leveraging common mobile devices' capabilities without requiring specialized hardware. The extracted features from the sensor data undergo pre-processing and are used to train the classifiers. The Random Forest model, particularly when optimized through random search hyperparameter tuning, demonstrated superior performance across several metrics, including accuracy, precision, recall, and F-score. This approach represents a significant improvement in using technology for infrastructure management, potentially reducing the costs associated with road damage and enhancing road safety. The paper also provides a detailed methodology and validation process, including k-fold cross-validation, to ensure the robustness and accuracy of the models developed.  5. Title: Analysis and Prediction of Pothole Formation Rate using Spatial Density Measurements and Pavement Condition Data  Authors:Abed, A., Rahman, M., Thom, N., Hargreaves, D., Li, L., & Airey, G.  Year : 2023  This paper investigates the relationship between various pavement conditions and the formation of potholes. It highlights that weather variations and different distress types (e.g., cracking, rutting) significantly affect the pothole formation rate. The study also considers the impact of the spatial density of potholes (PSD) on predicting the number of potholes formed annually. The literature review emphasizes the importance of considering both climatic conditions and road maintenance activities when predicting pothole formation.  6. Title: Assessing severity of road cracks using deep learning‑based segmentation and detection  Authors:Jongwoo Ha, Dongsoo Kim, Minsoo Kim  Year : 2022  This research paper focuses on improving the automation of road crack detection, classification, and severity assessment, essential for effective pavement management systems (PMS). The study addresses limitations in previous research by expanding the types of cracks detected to five (alligator crack, longitudinal crack, transverse crack, pothole, and patching) and integrating severity assessment into the system. The authors utilized a combination of deep learning models, specifically SqueezeNet, U-Net, and Mobilenet-SSD, to achieve high accuracy in detecting and classifying cracks while also assessing their severity. They trained two U-Nets separately for linear and area cracking to enhance segmentation performance, leading to improved accuracy in severity assessment—94.39% for linear cracks and 89.68% for area cracks. The overall system achieved 91.2% accuracy in both crack type classification and severity assessment. The research also suggests that adding depth information to the 2D images used for training could further improve the system's accuracy, especially for assessing cracks like patching and potholes. The study contributes significantly to the field by providing a comprehensive system that integrates crack detection, classification, and severity assessment, which had not been effectively combined in previous research.  **Problem Statement :**  Current methods for detecting and addressing potholes are inefficient, leading to delayed road repairs, increased safety risks, and environmental concerns. There is a need for a machine learning-based portal that can accurately detect potholes, assess their severity, and provide real-time data to users and contractors, enabling timely and efficient road maintenance.  **Objectives :**  1. Accurately identify potholes in user-submitted images, ensuring high precision and recall rates in detection.  2. Implement a robust scoring system to evaluate the severity of detected potholes, facilitating effective decision-making for travelers and contractors.   1. Design an intuitive web portal that allows users to easily submit images, view pothole locations on a map, and access severity information for informed decision-making.   4. Enable the collection and processing of real-time data from users and other sources to maintain an up-to-date database of road conditions, ensuring timely and accurate information  **System Architecture :**  IMG_256 |