ADVANCED POTHOLE REPORTING AND MANAGEMENT SYSTEM USING MACHINE LEARNING

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ABSTRACT:: Potholes have become a significant issue that affect road safety and vehicle maintenance all around the world. They frequently lead to accidents and vehicle damage. Conventional pothole reporting techniques, which rely on government agencies involving engineers and laborers to locate and fix road damages, often prove to be ineffective, causing repairs to be delayed and raising the risk for both motorists and pedestrians. According to a recent study, potholes contribute to around 4,446 accidents annually. In this project, a novel pothole reporting and management system is proposed that makes use of modern technologies such as Firebase for real-time synchronization and image processing for pothole detection. Citizens can submit pothole reports by clicking images of potholes and providing geo-location via an easy-to-use interface, with the reports automatically reviewed for accuracy. Administrators have access to an extensive dashboard for effective report management. The suggested system intends to improve pothole management efficiency, accuracy, and responsiveness by using automatic detection, real-time updates, and user-friendly features. Adopting Firebase offers many benefits over standard SQL databases, such as real-time data management, scalability, and customization. This publication describes the architecture, features, and advantages of the system, demonstrating how it may greatly enhance public safety and road maintenance operations.

INTRODUCTION:

Good road infrastructure plays a critical role in the transportation system. It enables the efficient movement of people and access to a variety of commercial and social activities (Ng et al. 2019). Roads are an essential component of the transportation and communication network that help connect people and places. Their sizes and structures depend on what they serve; for instance, highways are designed to carry heavy traffic with several lanes while urban roads are typically narrow with either one or two lanes. This means that regular maintenance is needed considering the significance of roads in daily life. However, a vast road network spread throughout the country makes it a daunting task to continuously monitor them hence it becomes difficult to predict and address pothole formations.

One of the main reasons roads deteriorate is pavement distress, which includes a variety of degradation types that are generally divided into Pavement distortion comprises deformations like rutting, which creates depressions in wheel paths from repeated heavy traffic loads and insufficient pavement thickness, corrugation, which is characterized by a washboard-like series of ridges and valleys frequently resulting from poor bonding and inadequate compaction; and shoving, which occurs when the surface is horizontally displaced as a result of heavy braking; Different types of cracking and breaking can occur in fractures. One such type is fatigue cracking, often called alligator cracking, in which repeated traffic pressures that are greater than the pavement's intended strength causes cracks to form. The causes of longitudinal cracking, which occurs parallel to the centerline, include temperature changes, inadequate construction, and reflected cracking from underlying layers.

Among these pavement failures, potholes represent one of the most severe and unpredictable types. They usually occur due to combinations of various environmental factors like temperature changes as well as precipitation together with traffic loads acting upon them. When there is cold weather, water can infiltrate into openings within the pavement, freeze and expand leading to cracking or complete breakage of the pavement. Potholes develop when these areas become more fragile due to heavier traffic during warmer periods. Also, the surface of pavements deteriorates faster as a result of freezing and thawing cycles together with mechanical stresses caused by vehicles moving over them repeatedly.

The economic and social relevance of potholes is intense. They place considerable financial responsibilities on governments for repairs and maintenance as well as vehicle owners who bear the brunt of damages to their vehicles. In fact, potholes are a significant threat to safety. Potholes contribute to around 4,446 accidents each year in accordance with recent surveys thus creating an urgent need for efficient and effective solutions to lousy road management.

Traditional approaches towards detecting and mitigating against potholes involve manual assessments by government departments, engineers, and employees. These methods are time-consuming, labour-intensive, and often inefficient with the result that there are delays in repairing them thereby increasing the risks of motorists. The study further introduces an emerging innovative way of dealing with this challenge through designing a modern system capable of making reporting easier while at the same time boosting detection activities used during repair processes.

This paper provides an overview of the architecture design characteristics, components analysis benefits offered by new software development methodology called proposed pothole reporting management system (PRMS). It shows how new technologies can be deployed to overcome drawbacks inherent in traditional ways leading to substantial advancements in road maintenance procedures public order conditions. As compared to other alternatives systems that have been developed before for managing potholes such as speed humps and cones this one is more efficient than all others since it reduces traffic jams caused by frequent road blockages.

LITERATURE SURVEY:

A research conducted by Rastogi et al. (2020) [2] focuses on examining neural network algorithms in the sense of YOLO and Faster R-CNN using VGG16 and ResNet-18 architectures for efficient pothole detection with

smartphone camera images. Instead of calling "pothole" and "normal road," it was proposed to use a better YOLOv2 architecture as a way to deal with class imbalance problem. This modified YOLOv2 outperformed other models with fewer parameters (35 million) and superior performance metrics, achieving 28 FPS, 0.87 precision, and 0.89 recall. The study proposes that this model could be used effectively in autonomous vehicles for detecting geotagged potholes in real time, suggesting green alternative routes and assisting night driving by workers.

In [3] the authors Bose et al. suggested a comprehensive system title as DRSense that aims to improve road safety through analysis of driving styles, and detection of road anomalies using data from smartphone GPS and accelerometers. DRSense classifies driving behavior as it detects acceleration, braking as well as road anomalies such as bumps and potholes. This categorization is effected by employing the Support Vector Machine (SVM) machine learning method. As an aid for driver safety, the system gives real-time warnings and instructions based on locally running Fast Dynamic Time Warping (FastDTW) algorithm. The system was experimentally evaluated extensively which shows that it has a potential to minimize accident rates in roads through earlier alerts on road conditions thereby ensuring safe driving habits.

PotAlert is designed by Nordin et al. to be an easy-to-use platform which facilitates pothole reporting and management on different gadgets. The Public Web App (PWA) allows end users to take images or mention locations in order to make the report of a pothole, get information on their status, and receive responses. This permits authorities to have access to comprehensive information for decision making including updating the statuses of potholes, assigning maintenance activities as well as visualizing trends in data. They system has login/out option, reporting of potholes, tracking complaints and progress associated with potholes as well as data visualization is among its essential components that contribute towards improving road safety through timely updates and repair works.

IMPLEMENTATION OR METHODOLOGY

The primary goal of this project is to boost road safety and streamline pothole repairs by creating a user-friendly reporting and management system. Leveraging technologies like image processing and Firebase, it enables easy, accurate reporting of potholes through an intuitive interface where users can upload images and location data. Real-time synchronization ensures that administrators have up-to-date information, accessible via a comprehensive dashboard, facilitating efficient management and prioritization of repairs.

A) Architecture

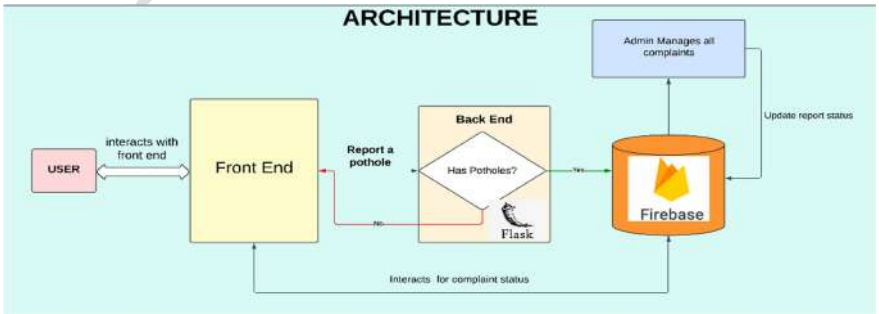

Fig 1: Architectural diagram of proposed system

The Frontend, Backend, and Database are the three primary components that make up the robust architecture of the Pothole Reporting and Management System. ReactJS helped build the frontend that allows for user login, report potholes and uploading images with ease. Flask powers the backend responsible for core logic including image detection of pot holes by machine learning technique processes as well as user authentication management. Firebase acts as the database to store users' reports, photos and geolocation information in real time. This enables quick updates and scalability to meet growing user demands.

B) Operation of the proposed system

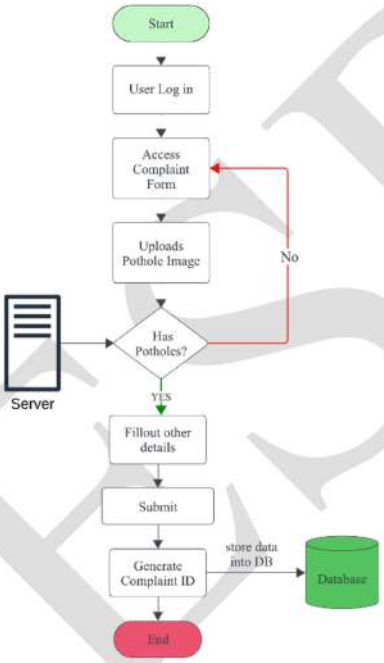

Fig 2: Flowchart of the proposed system

When a citizen comes across a pothole while driving or walking through their route, they can easily file a complaint through our project by logging in via the web interface. They will be taken to a short form designed for reporting potholes after logging in. The citizen will be able to upload an image of the pothole they came across in this form. Users can choose an existing photograph from their library or take a picture of the pothole directly from their device's camera thanks to the user-friendly image upload option.

Our backend system, which is powered by YOLOv4, will automatically analyze the image to determine the presence of potholes whenever the citizen uploads a picture of the pothole. The citizen will be informed that their submission cannot be processed further if no potholes are found. This early identification guarantees that only actual pothole reports are sent to the system for processing.

If a pothole is found in the submitted image, the citizen will then fill out the form with more information, including the pothole's location and any extra remarks or observations they would like to provide. The citizen will submit their report to the system for processing once they have completed the form.

Upon successful submission of a complaint a unique ID is generated, from which they can use to track the progress or status of their request. The citizen can track the status of their pothole report using this ID as a point of reference.

The system will then alert the appropriate authorities regarding the just registered pothole repair request. Administrators can view the request details, including the uploaded photo and location information, by logging onto the dashboard. They will confirm the report's accurateness and evaluate the pothole repair according to characteristics including the pothole's location and severity.

The citizens will be informed in a timely manner with the progress of their pothole report at every stage of the procedure. As soon as their report is received, examined, and a repair date is set, they will be notified.

FEATURES OF THE SYSTEM

A) User Authentication and Profiles

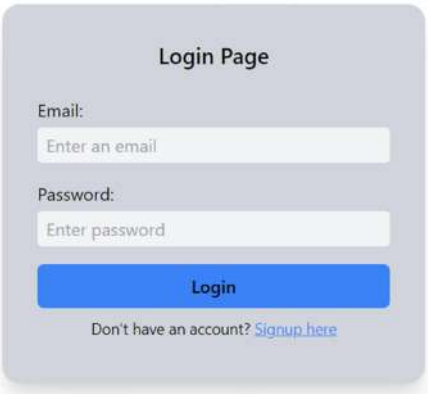

Fig 3: Login page for users

Citizens can create profiles through the system's safe user authentication mechanism. To manage their submissions, use the reporting interface, and get information on the progress of their reports, users must log in.

B) *Image Processing and Validation*

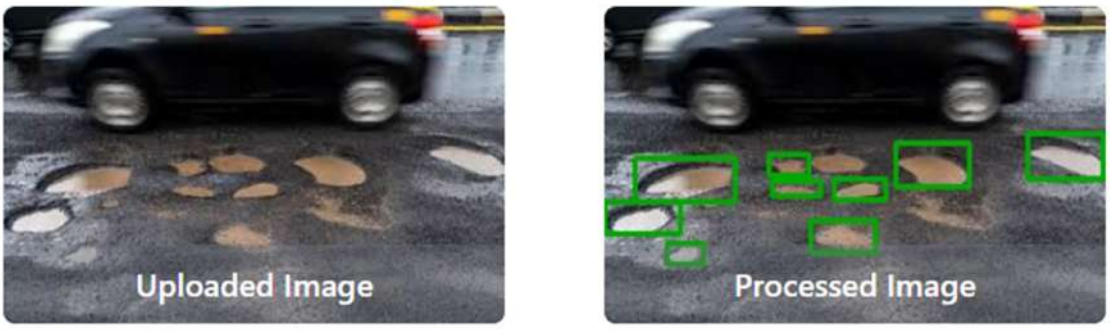

Fig 4: Whenever user selects an pothole image, the system cross verifies for potholes.

A user-friendly form makes it simple for citizens to report potholes. Images of the pothole can be uploaded by people using the form. The provided photos are processed by the backend to identify any potholes using Flask

and machine learning models. By decreasing false reports and increasing efficiency, our automated analysis guarantees quick and accurate report validation.

C) *Status Tracking*

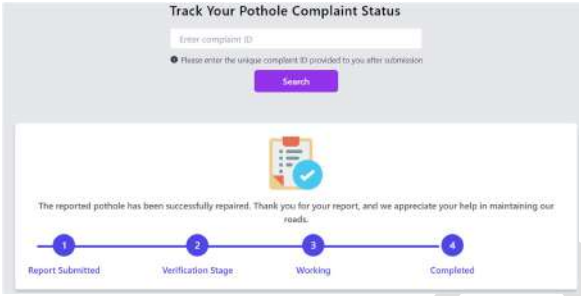

Fig 5: Status page

Upon successful submission of a complaint a unique ID is generated, from which they can use to track the progress or status of their request. They get real-time updates on the status of their report, knowing if it is being reviewed, accepted, or handled. It also provides customers with updates on the status of their contributions, which increases transparency.

D) *Administrator Dashboard:*

Fig 6: Admin dashboard to manage reports.

Every pothole that has been reported has been examined in detail by an extensive dashboard that administrators can access. Verification of reports, repair prioritization, and progress monitoring are all made possible by the dashboard's features.

CONCLUSION

The Pothole Reporting and Management System is an important step towards improving road maintenance and public safety. Thus, the system integrates ReactJS for an intuitive UI, Flask for efficient backend processing and Firebase for real-time data synchronization to provide a complete solution in reporting and controlling potholes. This makes it possible to promptly repair roads since pothole complaints are handled speedily and accurately. Among other key attributes include image processing of pothole recognition, administrator dashboard, and real-time status tracking. Other than enabling citizens report with ease this method gives government agencies the means of keeping roads well.

Looking ahead, several improvements can further enhance the functionality and user experience of such a system. Some future developments could be incorporating predictive analytics to predict potential formations of potholes as well as developing mobile apps that will make it easier for people to access these systems among others. In addition, community engagement features can be added so that they improve geo-location accuracy, multilingual support enabled by localizing to many languages among other things which may need doing in order to make the software more powerful or user-friendly. These advancements will further help keep road infrastructure intact.

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