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SmartWayFix -An Intelligent Pothole Reporting and Maintenance System

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Abstract: *Road maintenance is one of the key challenges faced by modern urban infrastructure systems. Potholes not only disrupt smooth traffic flow but also cause serious vehicle damage, accidents, and increased fuel consumption. The traditional road monitoring process is largely manual and reactive, depending on citizen complaints or routine inspections, which often leads to delayed responses and inefficient management. To address these issues, this paper introduces SmartWayFix – An Intelligent Pothole Reporting and Maintenance System, designed to automate the detection, reporting, and monitoring of road surface conditions. The system integrates the YOLO (You Only Look Once) deep learning model for real-time pothole detection and uses GPS technology for accurate location tracking. The web platform is developed using HTML, CSS, and React.js for an interactive frontend and Node.js, SQL, and Java for backend processing and data management. SmartWayFix operates through three core modules — User, Admin, and Mayor. Users can register, upload pothole reports with images, and track repair status. The admin module automates complaint handling, assigns tasks based on location and priority, and sends automated notifications to users and concerned authorities through an email automation system. The mayor module ensures transparency by enabling real-time monitoring of maintenance progress within respective areas. This system enhances accountability, reduces manual inspection time, and promotes Smart City initiatives by leveraging AI and IoT-based infrastructure monitoring for efficient, data-driven decision-making.*

Keywords: SmartWayFix, Pothole Detection, YOLO, React.js, Node.js, Java, SQL, Smart City, Road Maintenance, Web Application, Real-Time Monitoring, Automation, Email Notification System, E-Governance

I. INTRODUCTION

Urban development and population growth have led to a rapid increase in the number of vehicles on roads, resulting in heavy wear and tear of road surfaces. Among the most common road defects, potholes pose a significant risk to both vehicles and pedestrians. Poor road conditions contribute to accidents, traffic congestion, and unnecessary maintenance costs. In most cities, the process of identifying and repairing potholes relies heavily on manual inspection or delayed citizen complaints, which causes inefficiency in road maintenance and resource management. The need for an automated, intelligent, and transparent system for monitoring road conditions has become crucial in the era of smart cities. With advancements in computer vision, IoT, and cloud computing, it is now possible to detect and report potholes efficiently with minimal human intervention. The proposed system, SmartWayFix, provides a modern solution to automate pothole detection and maintenance through an intelligent, web-based application that connects users, administrators, and local authorities on a single platform. The SmartWayFix system employs YOLO (You Only Look Once) — an advanced object detection algorithm — to automatically identify potholes from road images captured through cameras or sensors. Once detected, the pothole data, along with its GPS coordinates, is uploaded to a centralized database. The frontend, developed using HTML, CSS, and React.js, offers a user-friendly interface where users can log in, register complaints, and track repair progress. The backend, implemented with Node.js, SQL, and Java, manages database connectivity, data processing, and workflow automation.

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The system consists of three integrated modules:

1. User Module: Allows citizens to report potholes, attach images, and view complaint progress.
2. Admin Module: Handles complaint management, assigns maintenance tasks based on area and priority, and sends automated email notifications to users and authorities.
3. Mayor Module: Provides monitoring access to mayors or area officials, enabling them to oversee ongoing maintenance and ensure accountability.

By connecting all stakeholders — citizens, administrators, and government officials — SmartWayFix ensures a transparent and responsive communication system for urban road maintenance. Additionally, the integration of automated email alerts and real-time progress tracking makes the entire process efficient and traceable.

The project aligns with Smart City and Digital India objectives by utilizing technology to improve public infrastructure management. The system reduces manual effort, enhances transparency, and helps authorities make data-driven maintenance decisions, ultimately improving urban mobility and public safety.

II. LITERATURE REVIEW

1. Bhavana N. et al. (2024) – POT-YOLO: Real-Time Road Pothole Detection

Bhavana N. et al. (2024) proposed POT-YOLO, a real-time pothole detection system that integrates the YOLOv8 deep learning model with edge segmentation techniques to enhance detection precision. The system effectively identifies potholes in real-time by improving edge accuracy, which helps in differentiating potholes from other road irregularities. This approach demonstrates a significant improvement in the accuracy of pothole boundary detection compared to traditional methods. However, the model demands high computational resources, and its performance tends to degrade under poor lighting conditions or in the presence of image noise, which limits its efficiency in diverse real-world scenarios.

2. Younis Matouq, D. Manasreh, and Munir D. Nazzal (2024) – AI-Driven Approach for Automated Real-Time Pothole Detection, Localization, and Area Estimation

Younis Matouq, D. Manasreh, and Munir D. Nazzal (2024) developed an AI-driven system designed to automatically detect, locate, and estimate the area of potholes in real-time. The system utilizes image-based data from cameras integrated with GPS modules and employs the YOLOv8 deep learning model to achieve precise detection and localization. The proposed approach achieved high detection accuracy and provided valuable spatial information about pothole distribution, which can aid in road maintenance planning. Despite its effectiveness, the system faces challenges during rainy or unclear weather conditions and requires high-quality datasets as well as GPU-enabled hardware, which can limit its scalability and cost-efficiency.

3. A. Lincy, Dhanarajan G., Sanjay Kumar S., and Gobinath B. (2023) – Road Pothole Detection System

In 2023, A. Lincy, Dhanarajan G., Sanjay Kumar S., and Gobinath B. introduced a Road Pothole Detection System that leverages the YOLOv7 deep learning algorithm in combination with live camera input to identify potholes on road surfaces. The model demonstrated a 94.5% accuracy rate in detecting potholes and included a driver warning mechanism to reduce road accidents caused by sudden encounters with damaged surfaces. This real-time alert feature contributes to enhanced road safety and preventive maintenance. However, the system's performance decreases in adverse weather conditions such as rain or fog and depends on the availability of high-performance GPUs, which may restrict its deployment in low-resource environments.

4. S. Nashikkar et al. (2022) – Road Pit Notifier

S. Nashikkar et al. (2022) presented the Road Pit Notifier, a system that combines IoT sensors and GPS technology installed in vehicles to detect and report potholes automatically. When a pothole is detected, the system sends real-time notifications to local authorities, enabling faster road repair responses. This IoT-based solution enhances road monitoring efficiency and supports smart city initiatives by promoting data-driven maintenance operations. However,

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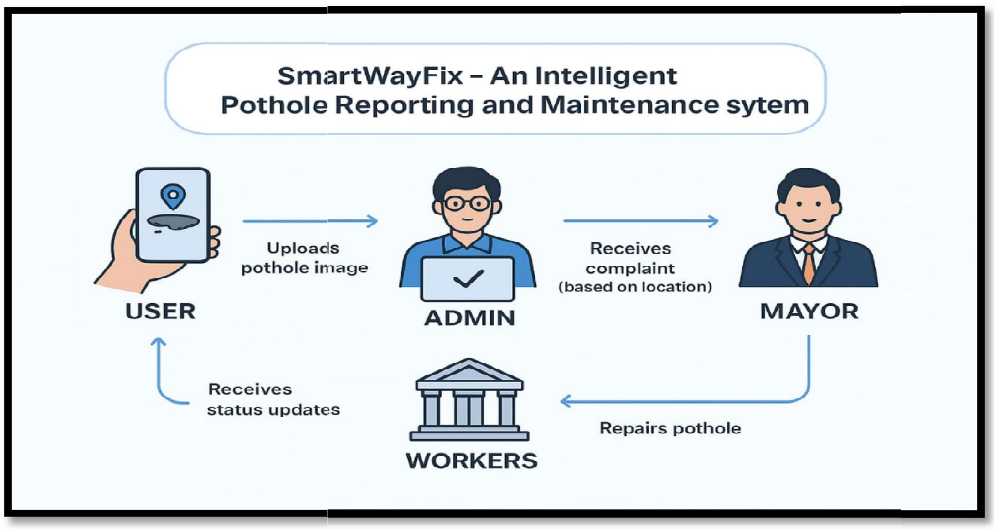
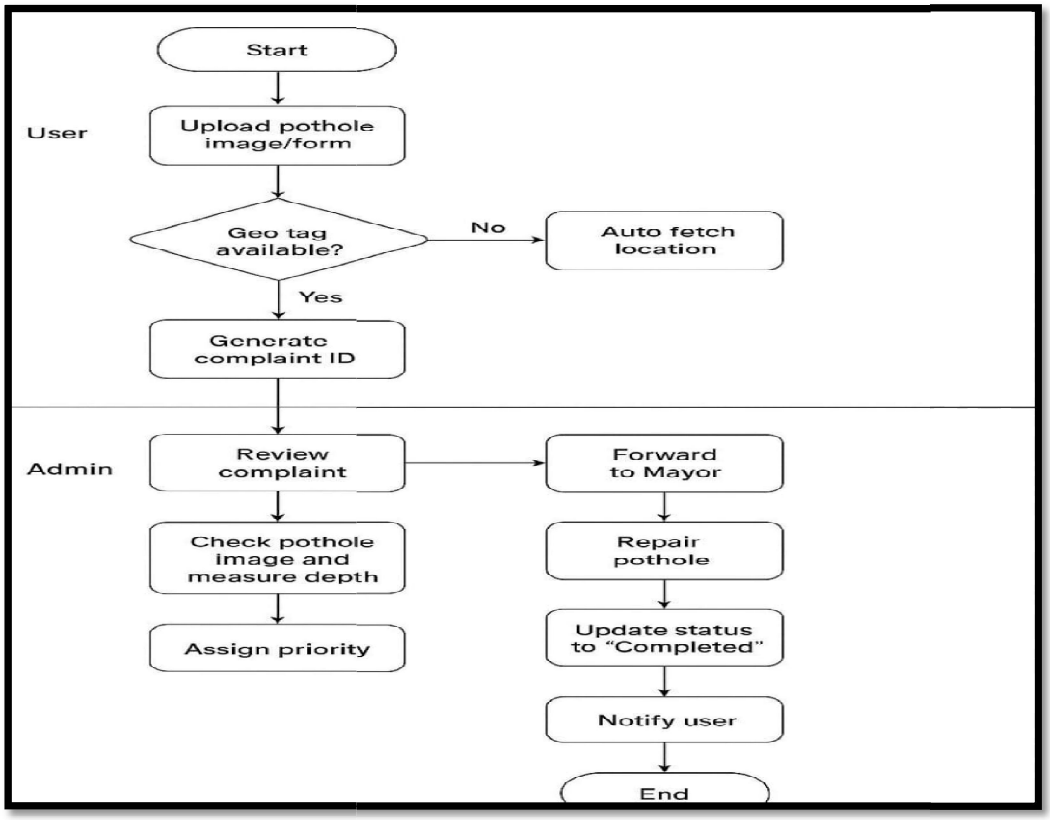
the system's success heavily depends on IoT connectivity, widespread adoption by vehicles, and timely responses from authorities, which can affect its overall impact and coverage.

III. ARCHITECTURE DIAGRAM



IV. ACTIVITY DIAGRAM



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V. METHODOLOGY

The proposed system introduces an intelligent pothole detection and reporting framework that combines computer vision, deep learning, and GPS-based localization to identify and report road surface damages in real time. The complete workflow involves five major phases: data collection, preprocessing, model development, detection and localization, and reporting.

In the data collection phase, road surface images and videos are gathered through cameras installed on vehicles or mobile devices while driving across various road conditions. These images are collected under different environments such as daylight, night, and rainy conditions to ensure the model performs well under all scenarios.

The captured images are then sent for preprocessing, where they are resized, noise is removed, and augmentation techniques such as flipping, rotation, and brightness adjustment are applied. This step helps improve the clarity and consistency of the data before feeding it to the model.

The YOLOv8 deep learning model is used for the detection process due to its capability to perform real-time and accurate object detection. The model is trained using an annotated dataset containing images where potholes are manually labelled. This allows the algorithm to learn the distinguishing features of potholes, such as edges, shapes, and texture irregularities. After training, the system can identify potholes from live video feeds and mark them on the screen.

Once the pothole is detected, the GPS module automatically attaches the geographical coordinates of the pothole location. These coordinates, along with the image and detection details, are stored in a centralized cloud database. This information is made available on a web-based dashboard where administrators or municipal authorities can monitor and prioritize repairs.

Finally, the system sends automated alerts or notifications to relevant authorities, enabling faster response and maintenance actions. After the repair work is completed, the system updates the status of the reported pothole. This method ensures a cost-effective, scalable, and efficient solution for improving road quality and public safety.

VI. CONCLUSION

From the review of existing literature, it is evident that recent advancements in pothole detection have largely relied on deep learning and computer vision techniques, especially YOLO-based models such as YOLOv7 and YOLOv8. These systems have shown promising results in achieving real-time detection with high accuracy, improving edge segmentation, and providing location-based insights using GPS integration. Additionally, IoT-based approaches have contributed to automated reporting and faster maintenance responses, highlighting their potential in smart infrastructure management.

However, most studies still face common limitations such as dependency on high-end hardware (GPU-enabled systems), reduced accuracy under poor lighting or adverse weather conditions, and the need for large, high-quality datasets. Hence, there remains a research gap in developing a cost-effective, efficient, and weather-resilient pothole detection system that can perform accurately in varied environmental and resource-constrained conditions. Addressing these challenges can significantly enhance road safety and enable smarter, data-driven maintenance strategies

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