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ROAD POTHOLE DETECTION USING DEEP LEARNING

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ABSTRACT:

Potholes are a common problem in roads and highways around the world, which can cause severe damage to vehicles and create safety hazards for drivers. In recent years, deep learning algorithms have been increasingly used for automated pothole detection. This research offers a deep learning based algorithm that can detect potholes early using photos and videos, reducing the likelihood of an accident. This model is basically based Faster Region-based Convolutional Neural Network(F-RCNN) and You Only Look Once Version 3(YOLO V3). It also discuss the challenges in detecting potholes, such as variable lighting conditions and noise in the data, and how these challenges have been addressed in previous research. Finally, we provide a comparative analysis of the performance of different deep learning algorithms for pothole detection based on accuracy. There are various pothole identification models that combine the accelerometer with machine learning techniques, but there are fewer pothole detection models that use simply machine learning techniques to detect potholes. The findings of this study suggest that deep learning algorithms can provide accurate and efficient pothole detection solutions that can help road authorities to maintain and repair roads, reduce vehicle damage, and enhance road safety.

Keywords: Road Side Potholes Detection,Reduce Accidents and Improve Road Safety.

Introduction:

Potholes are a hollow structural damage to the road that can cause serious traffic accidents and reduce road efficiency. Manual road condition assessment is a difficult task because it is a time-consuming and labor-intensive process. India has the world's second-largest road network. As a result, the road network is critical to Indian economic development and social functioning. According to the report, the Road Transport sector GDP grew at a close to 10% annual average rate over the last ten years, compared to a 6% annual GDP growth rate overall. And according to government of India statistics, from 2013 to 2016, potholes claimed 11,836 lives and injured 36,421 people. Pothole problems are difficult to resolve because floods, disasters, heavy rainfall, and other natural disasters occur almost every year in almost every location. The government of India is currently constructing roads at a rapid pace. However, road maintenance is a difficult task due to poor drainage and overloaded vehicles. The most important step in maintaining road conditions is detecting potholes with high accuracy. Several studies have been conducted in recent years to detect potholes in the road automatically

What is the roadside potholes?

Roadside potholes are holes or depressions that form near the edge of a road or on the shoulder. They occur due to water damage, traffic pressure, and erosion, especially where drainage is poor. These potholes can damage vehicles, pose risks to pedestrians and cyclists, and worsen over time if not repaired. Regular maintenance and good drainage help prevent them

What is the use of roadside potholes?

The use of roadside pothole detection is to identify potholes near the edges of roads early, so they can be repaired quickly. This improves road safety, reduces vehicle damage, and helps in efficient road maintenance..

Methodology:

There are several methods currently employed for pothole detection, each with distinct advantages and limitations that affect their suitability in road maintenance and infrastructure management. The traditional approach relies on manual inspection, where inspectors visually identify potholes during routine checks, but this method is prone to human error and inconsistency. laser scanners to detect road anomalies including potholes, offering precise measurements but at a high cost to deploy and maintain. Image processing techniques, such as edge detection and thresholding applied to road surface images , can identify certain types of potholes but may struggle with complex road conditions. Machine learning techniques like Support Vector Machines and traditional neural networks use annotated datasets to classify road images but they may not capture all pothole variations effectively. Deep learning, particularly Convolutional Neural Networks (CNNs), represents a state-of-the-art approach by automatically learning hierarchical features from road images showing promising results in detecting various pothole types across different conditions.

Laser Scanners (LIDAR) method

The Laser Scanners (LIDAR) method for pothole detection uses Light Detection and Ranging (LIDAR) technology to capture highly accurate 3D measurements of road surfaces and identify potholes and other surface anomalies. LIDAR is a remote sensing technology that uses laser pulses to measure distances to the surface of objects, creating detailed, high-resolution models of the environment.
For example, Laser scanners (also referred to as LIDAR scanners) are widely used in various fields, including pothole detection, mapping, archaeology, construction.

How Does laser scanners work?

Laser scanners work using a technology called LIDAR (Light Detection and Ranging), which is based on laser beams to measure distances and create detailed 3D models of objects or environments. Here's a breakdown of how laser scanners (or LIDAR scanners)

Typical work activities

- Laser Emission: Emitting laser pulses toward the target area.
- Laser Reflection: Pulses bounce back to the scanner after hitting the surface.
- Distance Calculation: Measuring the return time to calculate the distance.
- Point Cloud Generation: Accumulating data to create a 3D model of the area.
- Data Processing: Cleaning, filtering, and converting raw data into useful models.
- Visualization and Analysis: Creating 3D models and performing analysis for decision-making.
- Reporting and Action: Generating reports and using data to plan repairs or other actions.

Analog Method:

The analog method of pothole detection relies on manual observation and basic tools to identify and measure road damage. While these methods have been effective in the past, they are now considered outdated compared to modern, automated techniques such as LIDAR, machine learning, and sensor-based detection systems. However, these traditional methods may still be useful in areas with limited access to high-tech infrastructure or where low-tech solutions are sufficient for road condition assessments..

Persistence and Trends Method:
The roadside potholes detection persistence and trends method refers to a technique for monitoring and analyzing pothole occurrences and their development over time. This method focuses on detecting potholes persistently and identifying trends in their appearance, growth, and repair patterns on roads over a given period. Understanding persistence and trends helps road maintenance authorities plan repairs, allocate resources, and improve road safety.

Objective:

1. To develop an automated pothole detection system using deep learning.
2. To utilize Faster R-CNN and YOLOv3 for accurate and real-time detection.
3. To analyze and address challenges such as variable lighting and noisy data.
4. To compare the performance of different deep learning models based on accuracy.
5. To provide a vision-based solution over traditional sensor-based methods.
6. To enhance road safety, reduce vehicle damage, and support efficient road maintenance.

Results

The results of roadside potholes detection provide valuable insights that enhance road maintenance strategies, ensuring that roads are kept safe and functional. These results help municipalities improve road conditions, reduce costs, and prioritize repairs in an efficient and data-driven manner. By leveraging modern detection technologies and analyzing pothole data, authorities can make informed decisions that benefit both drivers and infrastructure management.

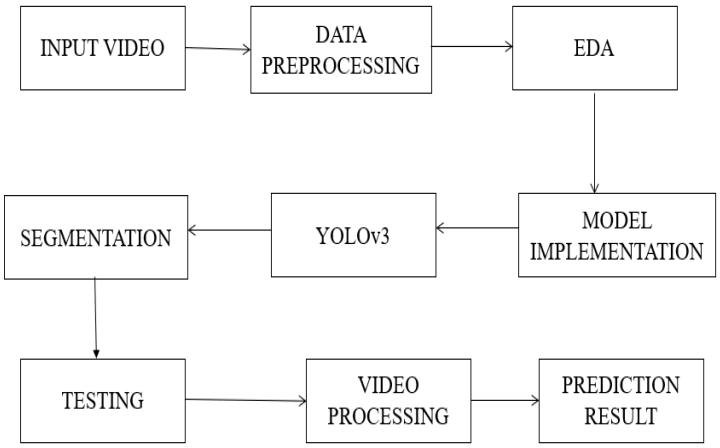

Fig 1 Block Diagram

Conclusion

In conclusion, the development of pothole detection using deep learning for pothole detection represents a significant advancement with profound implications for road maintenance and safety. By leveraging sophisticated algorithms trained on diverse datasets, these systems offer the promise of more efficient and proactive infrastructure management. Early and accurate detection of potholes not only enhances road safety by facilitating timely repairs but also optimizes resource allocation and reduces operational costs associated with maintenance. Despite challenges such as ensuring robust performance under various environmental conditions and minimizing false positives, ongoing advancements in technology and methodologies continue to improve the reliability and scalability of these systems. The potential benefits extend beyond immediate road safety improvements to include broader impacts on urban planning, transportation efficiency, and sustainable development. Moving forward, continued research, collaboration across disciplines, and partnerships between technology developers, governments, and communities will be essential to realize the full potential of deep learning pothole detection systems.

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