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IOT- Based Potholes and Speed Breaker Detection

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ABSTRACT

Due to the rise in automobiles, climate change, and population density, there are now an alarmingly large number of potholes in the world. Understanding the physical features of potholes and their surroundings, such as the surfaces they appear on, the size and depth of common potholes, and the kinds of wear and tear that might result in pothole formation, is usually necessary for their identification. It would also require familiarity with technologies like deep learning and machine learning techniques that are frequently used for pothole identification. Poor road conditions are one of the major causes for road accidents. Developing countries in particular are witnessing increased accident rates due to these poor road conditions. Potholes, deep ridges, missing pitches, improper speed breakers, poorly constructed manhole covers and slabs all combine to greatly increase the probability of serious accidents thus transforming roads into obstacle courses. In this study we have developed a model to detect unwanted potholes, deep ridges and speed breakers using computer vision and machine learning tools. We have developed a customized dataset (called Bumpy) that we use to train our machine learning algorithms. In this paper we propose a method where we use the Tensorflow pre-trained model to detect the potholes, deep ridges and speed breakers. Our experimental results demonstrate high accuracy although there are many obstacles on the road.

General Terms

This paper presents an IoT-based system that uses deep learning and computer vision techniques (YOLOv4/YOLOv5 and OpenCV) to detect potholes and speed breakers in real time. The system processes road images and videos using a trained CNN model, identifies anomalies, and sends GPS-tagged alerts to a cloud platform, helping improve road safety and maintenance efficiency.

Computer Vision: Core technology used for image-based detection of road anomalies like potholes and speed breakers.

Machine Learning: Refers to the training of algorithms (e.g., CNNs, YOLOv4) to classify and detect patterns in road imagery.

Algorithms Covers the detection pipeline including YOLO object detection, preprocessing steps, and alerting mechanisms.

Pattern Recognition: Relates to identifying visual features and distinguishing between normal roads, potholes, and speed breakers.

Internet of Things (IoT): Involves the use of edge devices (e.g., Raspberry Pi, GPS modules) and cloud connectivity for real-time monitoring and alerting.

Keywords

Pothole Detection , Speed Breaker detection , Machine learning algorithms, Convolutional neural network , Road safety .

1.INTRODUCTION

Roads have been an essential aspect of human society for thousands of years, serving as a crucial means of transportation. The construction and maintenance of roads can be traced back to 6000 BC, and the presence of well-developed roads has always been a sign of advanced civilization. With time, the nature of roads has evolved, and our dependence on them has increased significantly. As a result, it is crucial to maintain roads effectively to prevent accidents and minimize transportation delays. Due to infrastructure and resource limitations many developing countries suffer from poor road conditions. In turn poor road conditions are one of the major causes of accidents, property damages and sometimes loss of life. With increasing vehicular traffic many developing countries are witnessing increased accident rates. Potholes, deep ridges, missing pitches, improper speed breakers, poorly constructed manhole covers and slabs all combine to transform roads

into obstacle courses thus greatly increasing the probability of serious accidents. The scope of this project pothole detection is to create a pothole detection system that utilizes the YOLOv5 Tiny object detection algorithm and OpenCV for detection of potholes from a video stream or image. This system is designed to accurately identify potholes and draw bounding boxes around them, providing a means for government authorities to monitor road conditions and take appropriate measures to repair them.

2. Literature Survey

1) Paper Name: Speed Breaker Detection and Mapping using IoT. Author: Rahul Ramakrishnan; Ayusha Pendse; Chetna Sharma; Priya Chimurkar. With increasing road accidents due to improper and non-standard speed breakers, it is the need of the hour to address this issue appropriately, and due to this although speed breakers are built for safety, they are posing to be more of a danger. This is mainly due to building illegal speed breakers and not maintaining existing ones. The existing solutions are largely dependent on the user or the surrounding, both of which do not provide immediate accuracy and dependability. This paper presents a self-improving system with minimal user involvement and aims to cover nearly all the drawbacks of the current solutions. It suggests speed breaker detection by measuring the difference in the height between the road level and the vehicle.

2) Paper Name: Detection of Potholes and Speed Breaker on Road Author: Gurpreet Singh; Rajeev Kumar; Poonam Kashtriya. In this paper, earlier potholes detection systems that have been developed and introduces a worthwhile solution to recognize humps, potholes and speed breakers on road surface and give up-to-date signals to drivers to avoid vehicle damages or accidents, by giving him earlier warnings. To identify of humps, speed breaker and potholes, ultrasonic sensors are used and also to estimate their height and depth, respectively. In our proposed system, we are using global positioning system receiver (GPS receiver) for identification of geographical location coordinates of the detected potholes and speed breaker.

3. Proposed System

The proposed system for pothole detection using YOLOv4 Tiny and OpenCV is an algorithmic approach that utilizes deep learning and computer vision techniques. The system consists of two main components: the first component uses YOLOv4 Tiny, a state-of-the-art object detection algorithm, to identify potholes from the input images.

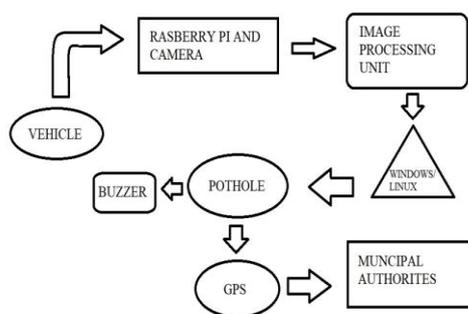


Figure1: Block diagram of proposed system

The proposed system is designed to detect potholes and speed breakers using an IoT-based, image-processing approach. As illustrated in Figure 1, the system comprises several key components integrated to operate in real-time. A camera module, interfaced with a Raspberry Pi, is mounted on a

moving vehicle to continuously capture road surface images or video. These images are passed to the image processing unit, which leverages deep learning algorithms (such as YOLOv4 or YOLOv5) to detect anomalies like potholes and speed breakers. Once a pothole is detected, two parallel actions are triggered: A buzzer is activated in the vehicle to immediately alert the driver of the detected hazard. The system retrieves the current location of the vehicle using a GPS module. This GPS-tagged information is then sent to a cloud platform or centralized server.

4. Algorithm for Proposed System

The entire system process is explained below in detail by step by step process.

Data Collection: Collect images/videos of roads with and without potholes and speed breakers.

Use vehicle-mounted cameras or publicly available datasets.

Label the data:

Class 1: Normal Road

Class 2: Pothole

Class 3: Speed Breaker

Data Preprocessing: Resize images to a fixed dimension (e.g., 224×224 pixels).

Convert images to grayscale or RGB format.

Normalize pixel values between [0,1] for better training.

Augment data (flipping, rotation, contrast changes) to improve model generalization.

CNN Model Architecture: Input Layer: Accepts preprocessed images.

Convolutional Layers: Extracts spatial features from images using filters.

Pooling Layers (Max Pooling): Reduces dimensionality while retaining important features.

Flatten Layer: Converts feature maps into a 1D vector.

Fully Connected Layers (Dense Layers):

Uses activation functions like ReLU and Softmax for classification.

Output Layer:

Outputs probability scores for "Normal Road," "Pothole," or "Speed Breaker."

Training the Model: Split data into training (80%) and testing (20%) sets.

Use Cross-Entropy Loss Function for classification.

Optimize using Adam Optimizer with an appropriate learning rate.

Train for multiple epochs until convergence.

Real-Time Detection System: Deploy the trained CNN model on an Edge Device (Raspberry Pi, Jetson Nano, etc.).

Process live video feeds to detect potholes and speed breakers.

If detected, fetch GPS coordinates and send alerts via an IoT-based system.

IoT-Based Alert System: When a pothole/speed breaker is detected:

Capture its GPS location using a GPS module.

Send data to a cloud server (Firebase, AWS, or Thingspeak).

5. Results



Figure: Result of proposed system

Explanation of the Results

The uploaded image showcases the real-time detection of potholes and speed breakers on a road using a Raspberry Pi-based IoT system. The detection results are overlaid on the image, highlighting key road surface irregularities.

Key Observations from the Image, Detection Labels & Confidence Scores: A pothole is detected with a confidence score of 0.45 (i.e., 45% confidence). The green bounding box accurately highlights the pothole area. Speed Breaker (Red Box, Label: "speed_breaker 0.86") A speed breaker is detected with a high confidence score of 0.86 (i.e., 86% confidence). The red bounding box covers the speed breaker on the road.

Real-Time Processing FPS: The Frames Per Second (FPS) is 10.9, indicating the system is processing approximately 11 frames per second. This suggests a decent performance level for real-time road condition monitoring.

Practical Significance: Accurate detection of road hazards helps in preventing accidents and improving road safety. Authorities can use this data to schedule road maintenance and repairs efficiently. It is particularly useful for autonomous vehicles or driver assistance systems. **Hardware & Software Used:** The system likely uses Raspberry Pi with a camera module to capture road conditions. AI-based computer vision algorithms (such as YOLO, SSD, or OpenCV-based models) are used to classify and localize road irregularities.

Discussion

The proposed system of implementation in a CNN-based pothole and speed breaker detection system combined with IoT technology presents a promising approach for improving road safety and infrastructure maintenance. This section discusses the system's performance, challenges, advantages, and future improvements.

Future Scope

The proposed system can be enhanced by integrating real-time cloud analytics for large-scale road monitoring, expanding detection to include other road anomalies like cracks or faded lane markings. Future versions could

incorporate AI-based severity analysis, automated report generation for municipal authorities, and mobile app integration for public reporting. Additionally, deploying the system on autonomous vehicles can further support smart city initiatives and traffic safety enhancements. The development of an IoT-based pothole and speed breaker detection system using CNN offers significant potential for further enhancements and widespread implementation. Future research and advancements in technology can address the existing limitations and improve the system's accuracy, efficiency, and scalability. Below are some key areas for future work: Edge AI and Model Optimization, Crowdsourcing and Community Participation, AI-based Predictive Maintenance for Smart Cities.

6. REFERENCES

- [1] A. Arab, K. Yu, J. Yi, and D. Song, "Motion planning for aggressive autonomous vehicle maneuvers," in IEEE International Conference on Automation Science and Engineering (CASE), Fort Worth, TX, USA, Aug. 2016.
- [2] Pandey, A., & Singh, D. K. (2019). Real-time pothole detection and alert system using deep learning. In 2019 International Conference on Computer Communication and Informatics (ICCCI) (pp. 1-6). IEEE.
- [3] G. Singal, A. Goswami, S. Gupta, T. Choudhury "PITFREE: Potholes Detection on Indian Roads Using Mobile sensors" IEEE 8th International Advance Computing Conference (IACC), 14th-15th dec. 2018.
- [4] Tang, Q., & Li, Z. (2021). Pothole detection in road surface images using transfer learning and deep convolutional neural networks. Journal of Ambient Intelligence and Humanized Computing, 1-9
- [5] Hassan, M. R., Ali, M. E., Hossain, M. J., & Shatabda, S. (2021). A comprehensive review of deep learning based pothole detection and classification systems. Journal of Intelligent & Fuzzy Systems, 1-17.
- [6] Immanuel, R. R., & Sangeetha, S. K. B. (2023). Implementation of an Automatic EEG Feature Extraction with Gated Recurrent Neural Network for Emotion Recognition. In Computer Vision and Machine Intelligence Paradigms for SDGs: Select Proceedings of ICRTAC-CVMIP 2021 (pp. 133-150). Singapore: Springer Nature Singapore.