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Deep Learning-based Approach for Road Pothole Detection

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ABSTRACT: Potholes, a common road defect, pose serious threats to both vehicle operators and pedestrians. This research focuses on developing a robust and efficient pothole detection system utilizing YOLOv7, an advanced object detection algorithm based on deep learning. The system involves training the YOLOv7 model on a curated dataset comprising diverse road conditions and pothole instances. The model is optimized to accurately identify and localize potholes in real-time video streams. The approach leverages the power of convolutional neural networks (CNNs) to extract meaningful features from road images, enabling precise detection of potholes under varying environmental conditions. The YOLOv7-based pothole detection system demonstrates superior performance in terms of both accuracy and speed, making it suitable for deployment in real-world scenarios. Evaluation of the model on benchmark datasets and field tests validates its efficacy. The results indicate a high detection rate and a low false positive rate, showcasing the system's reliability in identifying and alerting authorities to potential road hazards. This research contributes to the enhancement of smart city initiatives and road safety by providing an efficient and automated solution for pothole detection. The YOLOv7-based system offers a practical and scalable approach to monitoring and maintaining road infrastructure, ultimately contributing to safer and more sustainable urban environments.

KEYWORDS: Deep leaning, Object Detection

I. INTRODUCTION

Road safety is one of the most critical aspects of ensuring the well-being of individuals and preserving lives. Regular monitoring and timely repair of roadway pavements are essential to maintaining the quality of road surfaces. Well-maintained roads not only improve safety but also contribute significantly to the country's economy. As per the World Health Organization, authorities are increasingly concerned about asphalt pavement distresses to prevent adverse situations. Pavements are vulnerable to traffic loads, weather conditions, aging, substandard construction materials, and poor drainage systems. These factors contribute to significant pavement failures, such as cracks and potholes. Potholes, characterized as concave depressions on the road surface, are a primary concern due to their potential to cause accidents, uncomfortable driving experiences, and vehicle damage. Each year, over one lakh lives are lost on Indian roads, with a considerable proportion of accidents attributed to potholes. The problem intensifies during the rainy season when water obscures potholes, making them harder to detect and avoid. If potholes can be identified in real-time, drivers can be alerted to their presence, enabling them to avoid these hazards and reduce the likelihood of accidents. Potholes result from cumulative surface damage caused by environmental factors and vehicular loads. They often lead to issues such as damaged car wheels (including dents in rims), suspension problems, deflated tires, wheel alignment issues, and undercarriage damage.

This highlights the need for an effective system to identify and classify potholes in road pavements. Consequently, this work focuses on developing a pothole detection system that assists drivers by providing timely warnings, thereby enhancing road safety and mitigating potential risks.

II. RELATED WORK

Madhumathy P et al. [1] proposed a system for detecting humps and potholes, storing the information in a database, and sending alerts based on the recorded data. Gurusamy P et al. [2] utilized a Pi camera attached to vehicles to detect road pits through image processing techniques, which provided timely information to municipal offices.

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R.M. Sahu et al. [3] developed a system employing ultrasonic sensors to detect potholes and measure their depth and height. The system also captured the geographical coordinates of potholes and humps using a GPS receiver. K. Mohanprakash et al. [4] designed a detection system using ultrasonic sensors to measure pothole dimensions and relay the data, along with GPS coordinates, to the municipal corporation via GSM, aiming to prevent accidents and improve road conditions.

Rajeshwari Sundar et al. [5] introduced an intelligent traffic control system to facilitate the smooth passage of emergency vehicles, incorporating RFID technology to identify unsuitable pavement paths. J. Lin et al. [6] proposed a texture-based measure extracted from image histograms to identify potholes using a non-linear support vector machine and developed an algorithm for pothole recognition on pavements.

S.S. Rode et al. [7] presented a solution involving distance sensors for detecting potholes and humps. The system used GPS to fetch the locations of detected road hazards, which were then transmitted via GSM to map the affected areas. Kshitij Pawar et al. [8] leveraged smartphone sensors for cost-effective pothole detection, acquiring data directly from these devices.

Hyunwoo Song et al. [9] proposed a practical and cost-effective method for pothole recognition using smartphone sensor data, employing Inception V3 and transfer learning to facilitate flexible implementation. Koch et al. [10] explored vision-based tracking for pothole detection in road surveys, using video sequences and kernel-based tracking, with MATLAB's image processing toolbox for data analysis.

Each of these studies focuses on specific aspects of detection and notification systems, often prioritizing unique scenarios over achieving high accuracy and reduced complexity. However, in real-time applications, a reliable model capable of high-accuracy detection, low processing time, and adaptability to diverse climatic conditions and lighting is essential.

III. METHODOLOGY

Figure 1 shows the methodology followed in this work.

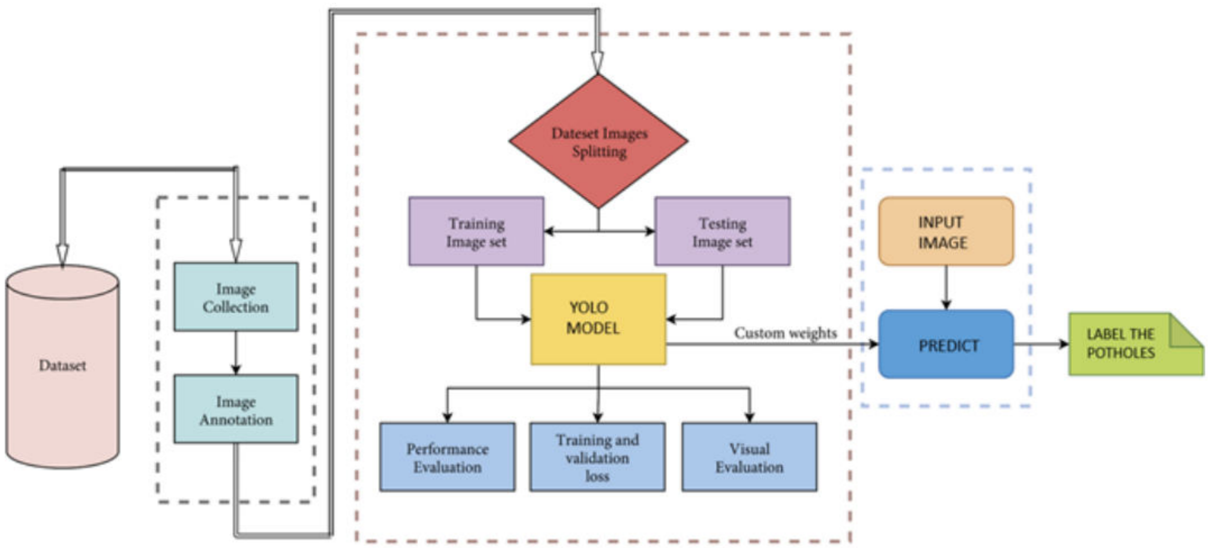

Figure 1

Step 1: Data Splitting
The dataset, which contains images of road surfaces annotated with pothole locations, is divided into two subsets: the training set and the testing set. The training set is used to teach the model, while the testing set is reserved to evaluate the model's performance on unseen data.

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Step 2: Preparation of Annotations
Each image in the dataset is annotated with bounding boxes around potholes. These annotations specify the location (coordinates) of the potholes within the image. This annotated data is crucial for the supervised training of the YOLOv7[11] model.

Step 3: Model Initialization
YOLOv7 is initialized with pre-trained weights from a large dataset. These weights are learned from a diverse set of images. This pre-training helps the model capture general features and patterns useful for object detection tasks.

Step 4: Transfer Learning
The initialized YOLOv7 model is then fine-tuned on the pothole dataset. During this phase, the model learns to detect potholes specifically, adapting its weights to the characteristics of the pothole images in the training set. This process is known as transfer learning.

Step 5: Training
The fine-tuned model is trained using the training dataset. The training process involves adjusting the model's parameters (weights) based on the error (the difference between predicted and actual bounding box locations) using optimization algorithms like stochastic gradient descent (SGD). This step is crucial for the model to learn to identify potholes accurately.

Step 6: Testing/Evaluation
After training, the model is evaluated using the testing dataset. The model's performance is assessed by comparing its predictions with the ground truth annotations. Evaluation metrics such as precision, recall, and F1 score are commonly used to quantify the model's accuracy in identifying potholes.

Step 7: Validation
In addition to testing, it is essential to validate the model's performance on real-world images that were not part of the training or testing sets. This step helps ensure that the model generalizes well to unseen data and performs effectively in practical scenarios.

Step 8: Hyperparameter Tuning
Throughout the process, hyperparameters (configuration settings) may need to be adjusted. This can include learning rates, batch sizes, and other parameters that affect the training process. Fine-tuning these hyperparameters can enhance the model's performance.

Step 9: Iterative Improvement
If the model's performance is not satisfactory, the process may be iteratively repeated. This could involve collecting more data, adjusting the model architecture, or experimenting with different training strategies to enhance performance.

Step 10: Deployment Considerations
Once a satisfactory model is obtained, considerations for deployment arise. This includes addressing any limitations identified during testing and validation, ensuring real-time performance on target platforms, and addressing ethical and privacy considerations.

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IV. EXPERIMENTAL RESULTS AND CONCLUSION

Figure 2 and 3 shows the trained model ouputs using YOLO v7.

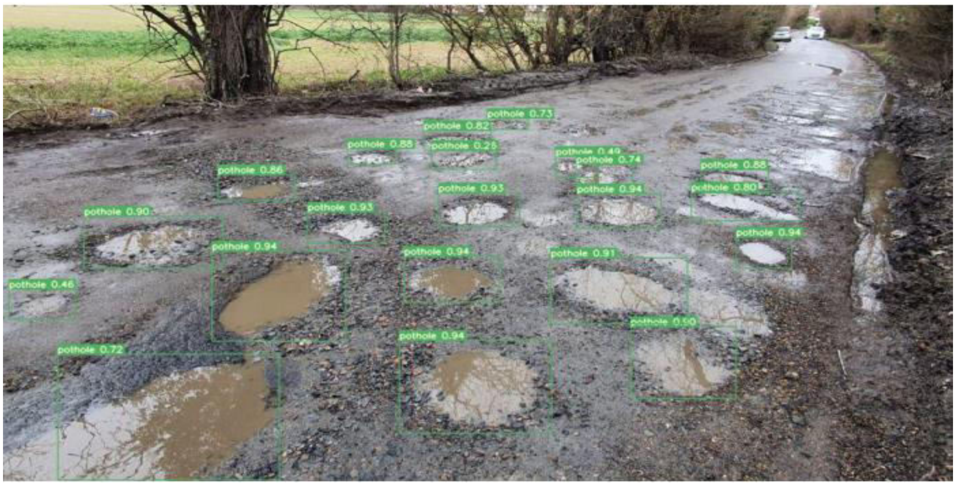

Figure 2

Pothole detection using YOLOv7 (You Only Look Once version 7) is a promising and effective approach for addressing the challenges associated with road maintenance and safety. YOLOv7, being an advanced object detection algorithm, offers real-time and accurate identification of potholes from images or video streams. This technology has the potential to revolutionize the way we monitor and manage road infrastructure, helping to enhance road safety and reduce maintenance costs.

The success of pothole detection using YOLOv7 lies in its ability to efficiently process images, accurately locate potholes, and provide real-time information to relevant authorities. This can enable prompt repairs and preventive measures, leading to safer roads for drivers and pedestrians.

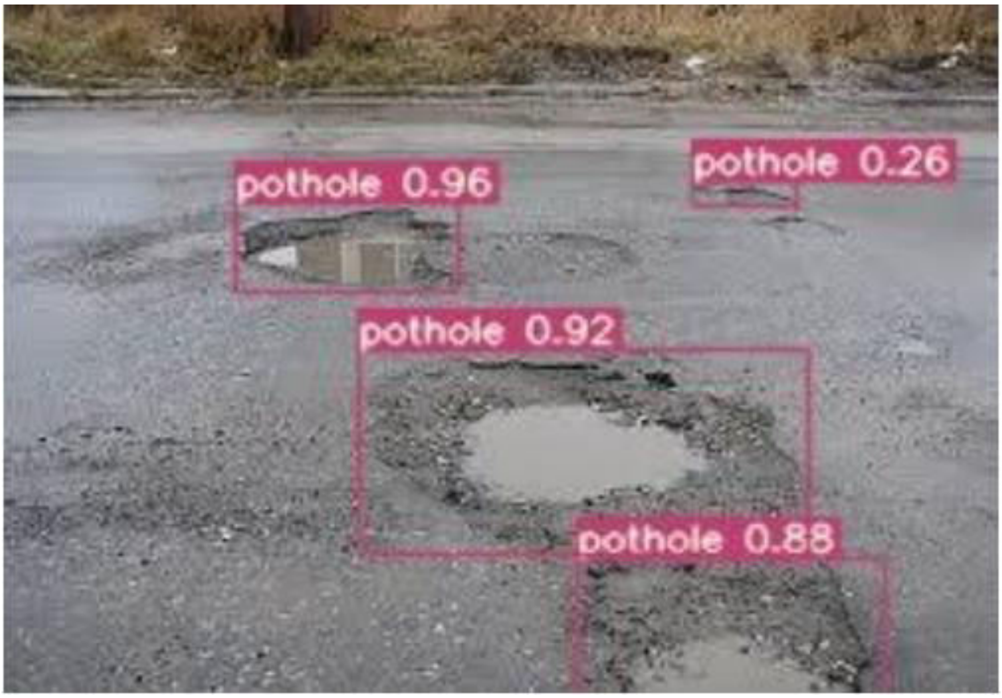

Figure 3

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REFERENCES

[1] Madhumathy p, .Saurabh Singh, Shivamshukla, Unnikrishnan, Dayanandasagar .,2017. Detection of humps and potholes on roads and notifying the same to the drivers,International Journal of Management and Applied Science, Volume-3, pp294- 326

[2] P. Gurusamy, M.Anusha, N.Devipriya, P.Harini,MDAsrarUl Haque.,2020. Speed Control of Vehicle by Detection of Potholes and Humps. International Journal of Broadband Cellular Communication Vol 6, p2.

[3] Prof.R.M.Sahu, MayankKher , NurulHasan, Laxmi Pancha.,2018.Automatic Detection of Potholes and Humps on Roads to Aid Driver.International Journal of Engineering Science and Innovative Technology Volume 7,p334-338 .

[4] K.mohanprakash, S.brindha, S.gowri, K.latha maheswari.,2023.Implementation of vehicle speed limiting and pothole identification using ultrasonic sensor.International Journal of Management and Applied Science .Volume-9,Issue-1.

[5] R. Sundar, S. Hebbar, and V. Golla.,2017 Implementing intelligent traffic control system for congestion control, ambulance clearance, and stolen vehicle detection, International Journal of Recent Contributions from Engineering Science & IT IEEE vol. 15, no. 2, pp. 1109–1113.

[6] R. Sundar, S. Hebbar, and V. Golla.,2017 Implementing intelligent traffic control system for congestion control, ambulance clearance, and stolen vehicle detection, International Journal of Recent Contributions from Engineering Science & IT IEEE vol. 15, no. 2, pp. 1109–1113.

[7] S. S. Rode, S. Vijay, P. Goyal, P. Kulkarni, and K. Arya.,2010 ., Pothole detection and warning system: Infrastructure support and system design,International Journal of Computer Trends and Technology in Proc. Int. Conf. Electron. Computer. Technol., pp. 286–290.

[8] KshitijPawar, Siddhi Jagtap and Smita Bhoir.,2020.,Efficient pothole detection using smartphone sensors.ITM Web of Conferences 32, pp 118-128.

[9] Hyunwoo Song, KihoonBaek and Yungcheol Byun.,2020., Pothole Detection using Machine Learning, Conference: Advanced Science and Technology , pp 544– 547.

[10] C. Koch and I. Brilakis, 2017., Improving Pothole Recognition through Vision Tracking for Automated Pavement Accessment,International Workshop on Intelligent Computing in Engineering, pp 603-617

[11] Chien-Yao Wang , Alexey Bochkovskiy, and Hong-Yuan Mark Liao Institute of Information Science, Academia Sinica, Taiwan, YOLOv7: Trainable bag-of-freebies sets new state-of-the-art for real-time object detectors