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Cnn And Yolo For Automated Pothole Detection In India

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Abstract

Potholes are a serious risk to both public safety and the economy, but finding them usually requires labor-intensive, time-consuming manual inspections.This research explores the deep learning prospects for automated pothole recognition using a synergistic CNN and YOLO approach. For our pothole-detecting research, we have collaborated with CNN and used YOLOv5. These results demonstrate the deep learning prospects for automated pothole detection, which might enhance road safety, minimize car damage, and save maintenance expenses. Future directions that could be explored include pothole severity rating, mobile platform integration, and transfer learning.

Keywords: CNN,YOLO,Pothole identification,deep learning

1.Introduction:

Potholes are more than just a passing annoyance for drivers. These ubiquitous road imperfections pose a significant threat to road safety, causing vehicle damage, accidents, and injuries every year. Their presence not only frustrates motorists but also creates economic burdens for individuals and communities alike.The problem of potholes stems from a complex interplay of factors, including weather conditions, ageing infrastructure, and heavy traffic loads. Traditional methods for detecting and repairing potholes often rely on manual inspections, which are notoriously slow, labor-intensive, and subjective. This reactive approach leaves countless potholes undetected and unrepaired, creating a persistent safety hazard and increasing infrastructure deterioration.

Muddy road potholes

Bituminous road potholes

However, developments in technology provide a viable solution: automatic pothole identification. Potholes can be reliably and efficiently identified from photos or sensor data by systems that make use of artificial intelligence (AI) and deep learning. Proactive pothole detection has the potential to transform road maintenance, increase safety, and save expenses.This study explores the possibilities and difficulties related to automated pothole identification. We investigate the possibilities of several techniques for artificial intelligence, including convolutional neural networks (CNN) and You Only Look Once (YOLO), to precisely detect potholes in practical situations. By conducting thorough testing and assessment, our goal is to clarify the efficacy of these methods and clear the path for everyone to enjoy safer and more comfortable roads.

This study investigates the application of CNN and YOLO for automated pothole identification. We develop a deep learning model that leverages the strengths of both YOLO and CNN to achieve accurate and efficient pothole detection in real-world scenarios.The challenges that society faces in resolving pothole issues to protect people's safety and well-being served as the impetus for this essay.

2.Literature review:

Accelerometer data is unreliable since cars have a tendency to slow down when they meet potholes, according to the literature review that was done. There are several ways to identify potholes. Furthermore, the term "pothole" was being used to refer to speed bumps, and it was impossible to identify the potholes on the muddy roads.

In this research, image data is taken as an input parameter for the models. In the data pre-processing model, photos are converted into a readable format, and images are also resized to fit into the input model. Training and testing data are separated within the dataset. Deep learning modules that have already been trained are used for the implementation. Evaluation metrics like accuracy, precision, and recall are computed

Halli Anand, Mallikarjun [2]: In this paper, pothole detection is conducted on both CNN and Yolov 3. Google-Colab is used to train pre-trained Darknet neural networks for pothole identification. Pothole identification without annotation is carried out on CNN in two stages, namely picture classification and heat-map localization, in order to assess the pothole's efficacy. The localization of potholes through a heat map based on predictions helped to build the bounding box around a pothole.

Elsevier B.V[3] This research focuses exclusively on the image-based approach for detecting pothole items. CNNs, as a subset of deep learning methods, are built on multiple layers of artificial neurons, providing a deep computational structure. Their achievements in the realm of computational intelligence are encouraging.

In this study, K.A. Vinodhini and K.R.A. Sidharth [4] The method of identifying and classifying potholes is outlined in At first, pictures that contain the recognized code are already obtained. Subsequently, the collection of data is subjected to multiple picture pre-processing techniques, including noise reduction and background removal. Subsequently, a machine learning approach is utilized to identify significant features in the photos. Ultimately, the potholes on a typical bituminous road are categorized using our suggested method.

In this work, Muhammad Haroon Asade [5] After the dataset has been gathered, an explicit annotation is made for every image. Before the annotated data is sent to deep learning models like the YOLO family and SSD for bespoke model training, it is divided into training and testing data. The weights acquired upon training are part of the model.

Ricardo Bharat, Abiodun M. Ikotun, Absalom E. Ezugwu, Laith Abualigah, Mohammad Shehab, and Raed Abu Zitar [6] made use of Android and mobile smartphones that have built-in sensors. Using these sensors, images and information will be captured and fed into the trained pothole classifier, which will then determine the state of the road by detecting any potholes observable at that current point in time and issue a warning of caution to the user of the application. The techniques used for accurate image classification involve data collection, pre-processing the data, defining a model, and training the defined model using the processed data.

In the study, doctors M. Seetha and K. Prasanna [7] Following the pre-processing of the data, a system is created to identify holes in photographs and videos so that users of the online application can submit the image or video to report issues. Faster R-CNN and YOLO V3 algorithms are used on the system.

In this study, Kaushik Goswami, Soumyadip Chattopadhyay, and Arka Kundu [8] To find potholes, the suggested approach makes use of a specially trained YOLOv7 model. It receives input from the dashcam and runs the frames through the trained model, just like the other modules. A pothole is recognized and identified, and the driver is alerted if one is found in any frame and its confidence value exceeds the confidence threshold.

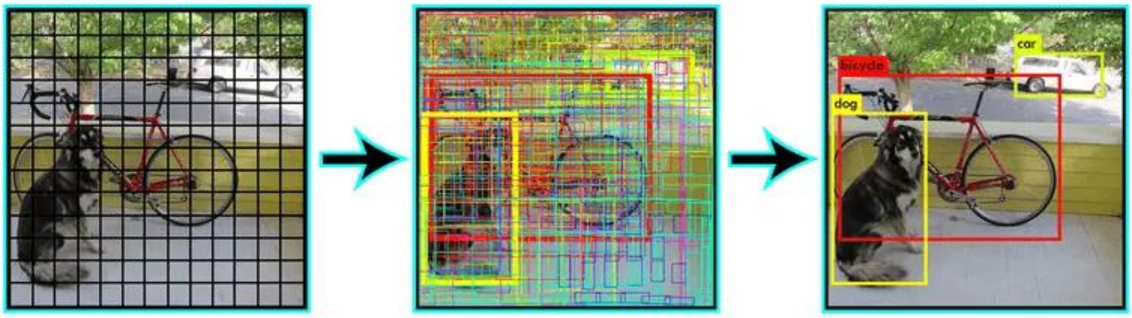
In their study, Yash Vishwakarma, Jinendra Naik, Yash Yenpure, Shreya Tundalwar, and Swati Shekapure [9] employed YOLOV5 to identify potholes in real-time. Yolo is trained on whole photos that have pothole labels. Initially, we simultaneously obtain location coordinates from the GPS module and video input in the format of the camera. This footage is sent to YOLO, which uses CNN (Convolutional Neural Network) to detect potholes in real time. Each frame is processed separately. Every frame (picture) is split up into a MxM grid, and each grid square is then given a prediction.Every grid has a confidence value assigned to it. The grid with the greatest confidence value is selected first, and the neighbors' levels of confidence are then assessed. Until the full pothole in the image is found, this procedure is continued.

Oche Alexander Egaji , Gareth Evans , Mark Graham Griffiths and Gregory Islas [10] This study focused on identifying pothole and non-pothole events. Hence, it was a binary classification problem. The initial stage of the project involved the data collection and labelling of pothole or non-pothole events. This led to the development of two bespoke Android applications (apps). The first app records the accelerometer, gyroscope, and GPS data, and the second app helps with data labelling. The raw sensor data from both apps was pre-processed, merged, cleansed, and split (training, validation, and testing) before extracting relevant features ready to train with the machine learning model.

Lei Huang, Gustavo Vejerano, and Ashith Patel [11]This project seeks to meet safety standards for autonomous decision-making via real-time pothole detection with high detection accuracy and rapid detection speed from dash camera photos. The structure of the picture dataset, the data augmentation techniques employed, the CNN model architecture, and the performance metrics assessed in our suggested solutions are all covered in the subsections that follow.

3.Proposed methodology:

The primary input that is needed to implement the YOLO method and CNN using the deep learning idea is photos.The term "You Only Look Once" (YOLO) refers to the fact that this object identification method operates in real-time and scans photos at a very high speed. We'll go over the algorithm's operation and some of its uses here. Numerous iterations of YOLO have been created, including YOLOv1, YOLOv2, YOLOv3, YOLOv4, YOLOv5, YOLOv6, and YOLOv7. Every new version builds upon the one before it, offering more features including increased precision, quicker processing, and better small object handling. Yolo is widely utilized in many different applications, including surveillance systems and self-driving cars.



Initial image Object identification Classifying objects using bounding boxes

Object Detection: YOLO accurately estimates class probabilities and bounding boxes. simultaneously since it is a single-stage object detection system.

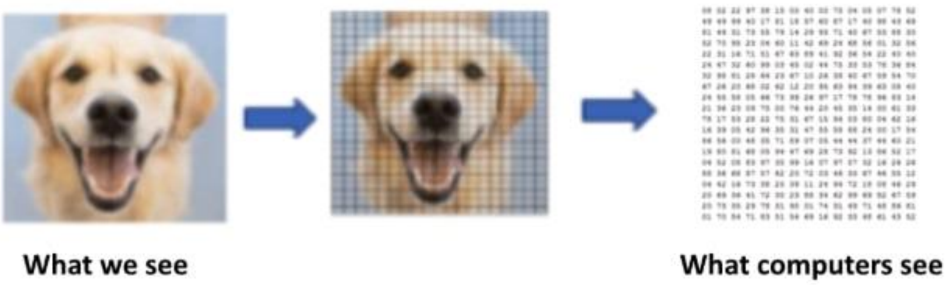
Convolutional Neural Network (CNN) backbone: YOLO uses a CNN as its backbone, just like the majority of object detectors. This network uses its convolutional layers to extract features from the input image.

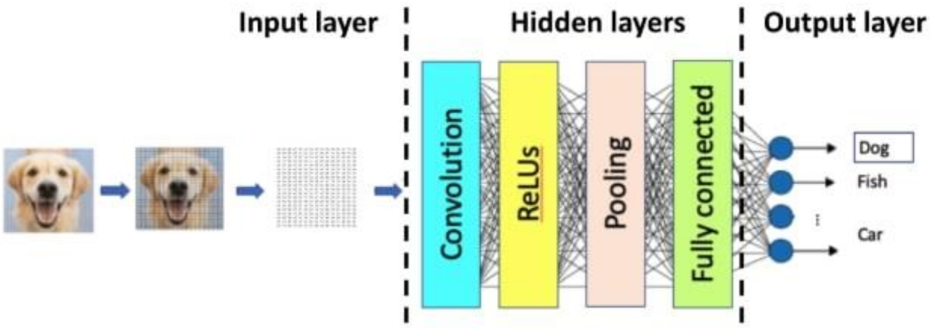
Anchor boxes: YOLO uses pre-established "anchor boxes" with varying dimensions and aspect ratios to forecast bounding boxes.

Feature maps: A grid is created using the CNN's output feature maps. The bounding boxes for the anchor boxes that best suit the items in each cell of the grid are predicted, along with object confidence.

Non-max suppression: To prevent duplicate detections, only the prediction with the greatest confidence score is retained if there is a considerable overlap between numerous predictions.

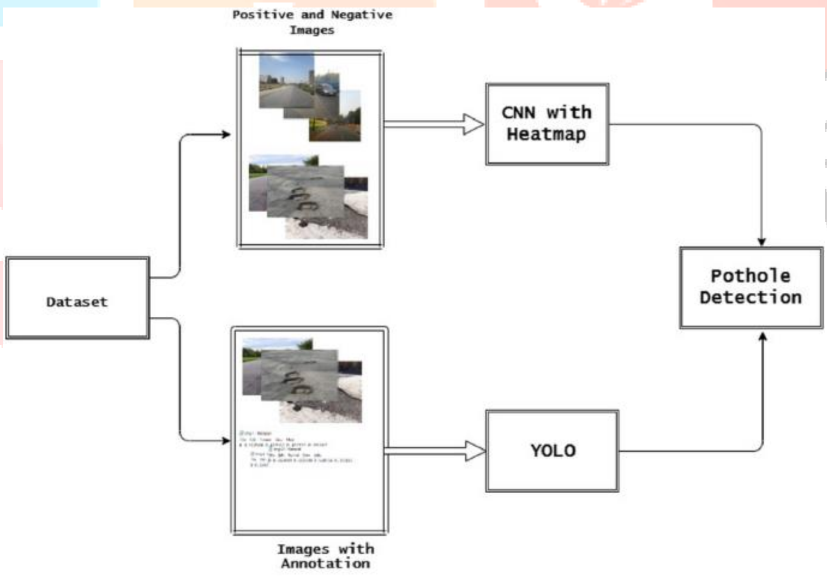
One kind of neural network is a CNN. Neural networks aim to replicate the learning process of the human brain. The neural network passes information through several layers in a manner similar to how the brain receives input, processes it, and produces some output.





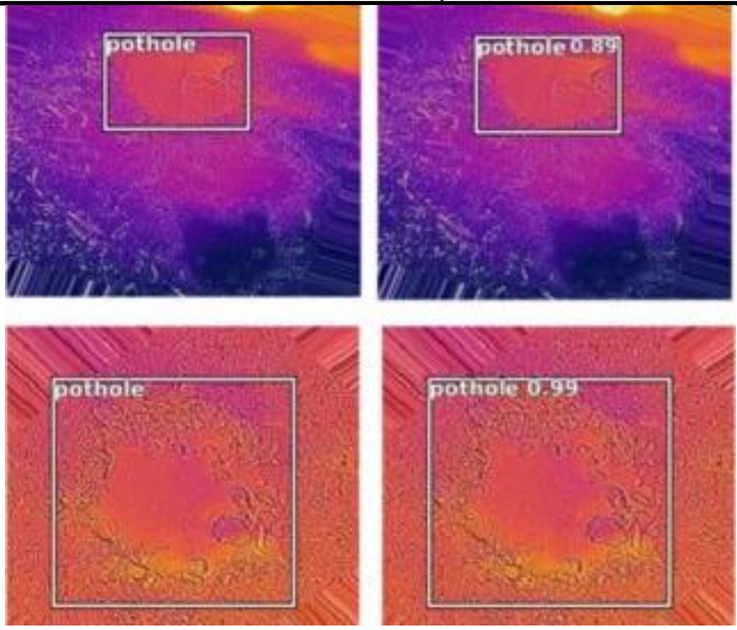
- Convolutional, ReLU, pooling, and fully connected layers are the four different types of CNN layers. To produce a classification, an image classifier runs the image through these layers.
- The convolutional layer uses filters to scan through an image and extract its information.
- All negative values are adjusted to zero and all positive values to one by the ReLU layer. Its goal is to give the model more non-linearity.
- To reduce an image's dimensions and speed up computation, pooling layers are used. The most popular method, known as max pooling, uses the highest value found in each sub-region.
- The CNN is completed by the fully connected layer. It creates the final categorization by combining and weighing all the data.

Feature extraction: By using convolutional layers and pooling operations, CNNs are highly skilled at extracting pertinent information from images. These characteristics aid in recognizing items and patterns in the picture. CNNs with numerous layers that extract more complicated information from the input image make up a deep learning architecture. Classification**:** The final CNN layers in pothole detection can be utilized to categorize the retrieved features as "background" or "pothole."



4. Experiment and results:

In this experiment, we apply the deep learning concept to CNN and the YOLOv5 version of the YOLO algorithm.The following idea was used to identify a set of between 100 and 1000 photos:. The accuracy of the features that are taken for analysis is predicted using deep learning models. The models are VGG19, InceptionResnetV2, and Resnet50. Initially, we individually chose each model and trained it with training data. Following a successful training session, the model is saved as h5.Next, each model makes a prediction, which is then tested for accuracy using a test dataset.

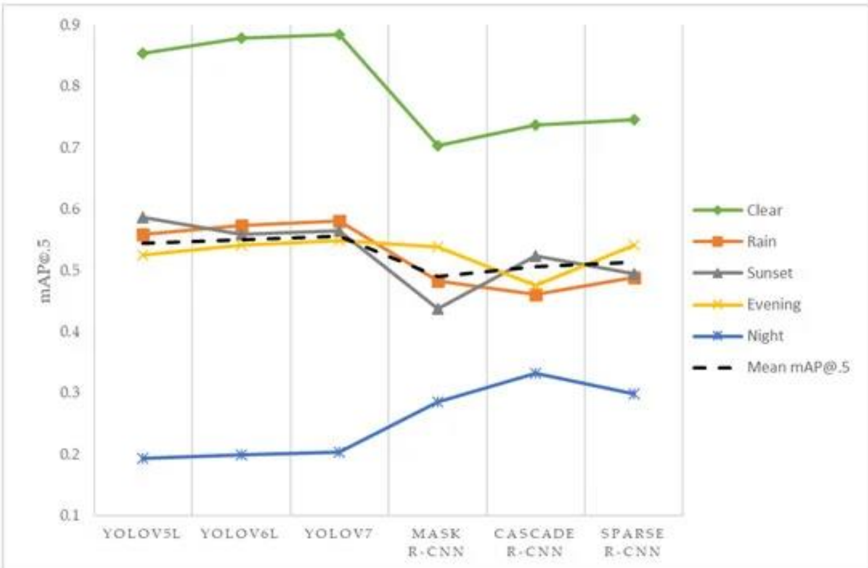


Results obtained from the Resnet50 model working

Result:

Our experiment aims to identify the potholes on the highway roads and the muddy roads, along with the condition of roads in different climatic conditions.

Data augmentation is a crucial technique in deep learning to mitigate the impact of a limited dataset size and prevent overfitting. Data augmentation makes models learn and generalize more effectively, which improves accuracy by intentionally expanding the dataset. Different data augmentation approaches were applied in the instance of YOLO and R-CNN in order to enhance the models' performance.The performance indicators that are provided allow us to make a number of inferences on the relative advantages and disadvantages of R-CNN and YOLO for the pothole detection task. The findings show that, in terms of accuracy and inference speed, YOLO models perform better than R-CNN models.



5.Conclusion:

In conclusion, this research explored the potential of combining YOLO and CNN for real-time, accurate pothole detection.

With an average detection rate of 2 ms per image, our YOLOv5-based pothole detection approach obtained good detection accuracy with mAP values higher than 93%. Potential avenues for future research could involve more technological developments that enable precise pothole identification.

References:

[1] Chemikala Saisree and Dr. Kumaran U,Pothole Detection Using Deep Learning Classification Method, Procedia Comput. Sci. 218 (2023), 2143–2152.

[2] Mallikarjuna Anandhalli,Vishwanath Baligar, Indian pothole detection based on CNN and anchor-based deep learning methods, International Journal of Information Technology (2022)

[3] Peter Klco, Dusan Koniar, Liber Hargas, and Marek Paskala, Automated Detection of Potholes Using the YOLOv5 Neural Network, 15th International Scientific Conference on Sustainable, Modern, and Safe Transport (2023).

[4] K.A. Vinodhini and K.R.A. Sidhaarth, Pothole detection in bituminous roads using CNN with transfer learning, Measurement: Sensors 31 (2024), 100940.

[5] Muhammad Haroon Asad, Saran Khaliq, Muhammad Haroon Yousaf, Muhammad Obaid Ullah, and Afaq Ahmad, Pothole Detection Using Deep Learning: A Real-Time and AI-on-the-Edge Perspective, Advances in Civil Engineering (2022), Volume 2022, Article ID 9221211, 13 pages.

[6] Ricardo Bharat, Abiodun M Ikotun, Absalom E. Ezugwu, Laith Abualigah, Mohammad Shehab, and Raed Abu Zitar A real-time automatic pothole detection system using convolutional neural networks, 3rd International Conference on Signal Processing and Machine Learning, Vol. 6, 2755–2721 (2023)

[7] Kaushik Goswami, Soumyadip Chattopadhyay, Arka Kundu, A Deep Learning-Based Approach to Detect Potholes Using YOLO v7, International Journal of Creative Research Thoughts (IJCRT), Volume 11, Issue 1, January 2023 | ISSN: 2320-2882.

[8] Yash Vishwakarma, Jinendra Naik, Yash Yenpure, Shreya Tundalwar, Swati Shekapure, Pothole Detection Using Deep Learning, International Journal of Research Publication and Reviews, Vol. 4, No. 3, pp. 1145–1151, March 2023

[9] Oche Alexander Egaji , Gareth Evans , Mark Graham Griffiths , Gregory Islas , Real-time machine learning-based approach for pothole detection,Expert Systems With Applications Vol. 184 (2021), 115562.

[10] Dr. M. Seetha and Dr. K. Prasanna, Intelligent Deep Learning-Based Pothole Detection and Alerting System, International Journal of Computational Intelligence Research ISSN 0973-1873, Volume 19, Number 1 (2023), pp. 25–35.

[11] Ashith Patel, Lei Huang, and Gustavo Vejerano, Pothole Detection from Dash Camera Images Using YOLOv5.