e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 8, August 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

© 2024 IJMRSET | Volume 7, Issue 8, August 2024| DOI: 10.15680/IJMRSET.2024.0708019

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Efficient Manhole Visual Inspection System using Deep Learning in UAV Navigation

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ABSTRACT: Manhole is a covered opening in a street or public area that provides access to a utility or maintenance vault underground. Manholes are typically constructed with a cover or lid that can be removed to allow entry for inspection, maintenance, or repair of utility infrastructure such as sewers, storm drains, telecommunications, electrical, or gas systems. Manholes are often located in public areas, and their covers need to be secure to prevent accidents. Broken or missing manhole covers can pose serious safety hazards to pedestrians, cyclists, and drivers.

The increasing risk of traffic accidents due to the deterioration of manhole covers necessitates a more efficient and reliable inspection method. Manual observation, the traditional approach to monitoring manhole covers, faces challenges such as labour shortages and ethical concerns. Identifying open or broken manholes using image processing algorithms faces challenges related to variable image quality, complex backgrounds, scale changes, and dynamic environmental conditions. In response to this difficulty the aim of this project proposes an automated system architecture based on deep learning models to replace the manual examination process. The project involves the development of a deep learning model capable of analysing images of manhole covers. The model undergoes training using a diverse dataset to accurately classify covers into categories such as 'Close,' 'Open,' 'Broken,' and 'No Manhole.' Additionally, the system incorporates advanced techniques, including Convolutional Neural Networks (CNN) for image classification and You Only Look Once version 8 (YOLOv8) for accurate prediction and localization using UAV Images or CCTV Footages. The implementation of this deep learning-based architecture offers a promising avenue for enhancing urban safety and streamlining infrastructure maintenance processes.

KEYWORDS: Manhole, Drainage system**,** Broken, monitoring manhole covers, UAV Images.

I.INTRODUCTION

A manhole or an inspection chamber is a unit constructed underground to provide access to the utilities like a sewer system, drainage system, etc. Hence, with the help of a manhole, underground utilities are inspected, modified, cleaned and maintained. Sewer systems are built underground with pipes that carry waste from homes and other buildings to a place of treatment or disposal. Part of maintaining a sewer system is providing frequent inspection, cleaning and repairs. Utility crews use manholes to gain closer access to pipes or other parts of the underground system to meet those needs. Manholes are built primarily for trenchless restoration of the sewer system, drainage system inspection, cleaning of clogged lines, and maintenance purposes. If the levels are high, it suggested there is a problem nearby which requires attention. The manhole covers are composed of metal, precas and composite material and come in a variety of sizes, materials, and designs, including rectangular, circular, and square. If the depth of the manhole chamber exceeds 2.5 m, a ladder must be installed inside; if the depth is little than 1 m, a step ladder is required.

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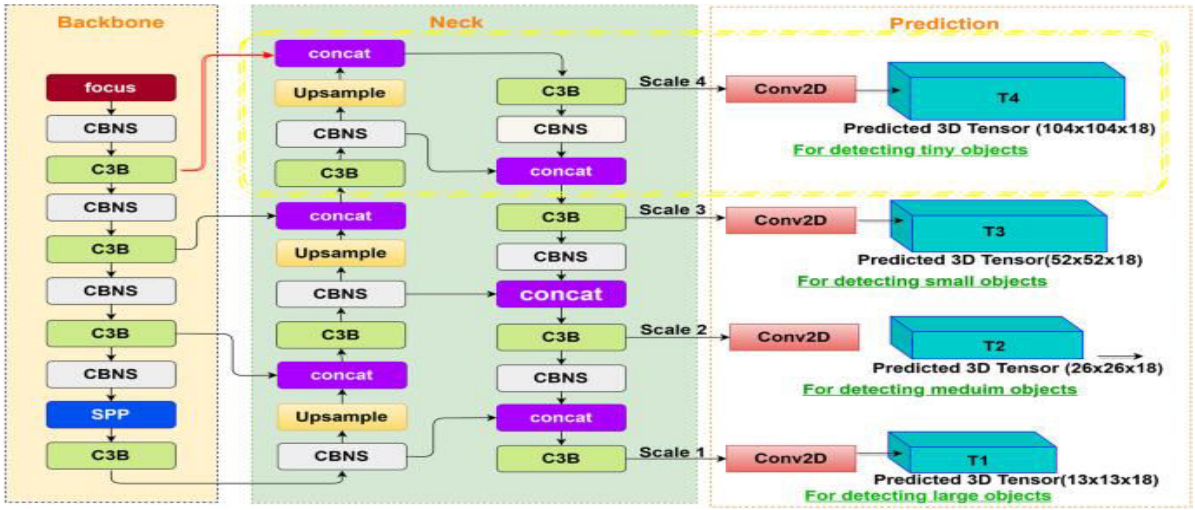
II. YOLO ALGORITHM

YOLO is an algorithm that uses neural networks to provide real-time object detection. This algorithm is popular because of its speed and accuracy. YOLO is an abbreviation for the term 'You Only Look Once'. This is an algorithm that detects and recognizes various objects in a picture (in real-time). Object detection in YOLO is done as a regression problem and provides the class probabilities of the detected images. YOLO algorithm employs convolutional neural networks (CNN) to detect objects in real-time. As the name suggests, the algorithm requires only a single forward propagation through a neural network to detect objects. YOLOv8 represents a significant milestone in computer vision, designed to enhance the efficiency and precision of object detection. Its underlying principle simplifies the process by processing an entire image through a neural network known as a convolutional neural network (CNN) in a single pass, eliminating the need for laboriously inspecting each part of the image individually. This streamlined approach, often referred to as "You Only Look Once," leads to impressive gains in both speed and efficiency.



III.EXISTING SYSTEM

The existing manual system for manhole defect prediction involves trained inspectors visually inspecting manholes for signs of damage or wear and tear. Inspectors typically use checklists or forms to document their findings, which are then manually entered into a database or spreadsheet for further analysis. This manual process is time-consuming and can be prone to errors or inconsistencies due to human error or subjective judgments. Inspectors may also miss certain defects or fail to identify trends or patterns in the data, leading to incomplete or inaccurate information. Furthermore, the manual system is often reactive rather than proactive, meaning that repairs or maintenance are only initiated after a defect has been identified, rather than being detected and addressed before the issue becomes critical. There are some existing image processing systems for manhole defect prediction. These systems use various image processing techniques such as edge detection, morphological operations, and thresholding to identify defects in manhole images. Some of the commonly used techniques are This technique is used to detect edges in an image by calculating the gradient in the x and y directions. The edges in the image can be used to identify defects in manholes.

IV.RESULT & DISCUSSION

In conclusion, the Manhole Predictor Web App developed using deep learning techniques has shown promising results for predicting the damage and defects in manholes. The system's architecture involved various stages, including dataset collection, pre-processing, segmentation, feature extraction, classification, and prediction, all working together to make accurate predictions. The feasibility study revealed that the system's implementation is possible and can improve the efficiency of manhole maintenance systems. The software testing and test cases performed demonstrated the reliability of the system and its ability to accurately predict manhole defects. The performance analysis using various metrics such

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as accuracy, precision, recall, and F1 score showed that the system's predictions are reliable and accurate. The results and discussion further showed that the Manhole Predictor Web App has the potential to improve manhole maintenance and reduce accidents caused by damaged manholes. In summary, the Manhole Predictor Web App using deep learning techniques is a promising solution for efficient manhole maintenance systems. The system can predict manhole defects accurately and in real-time, allowing for quick repairs and maintenance scheduling by municipality officers.

Fig.1.Home Page

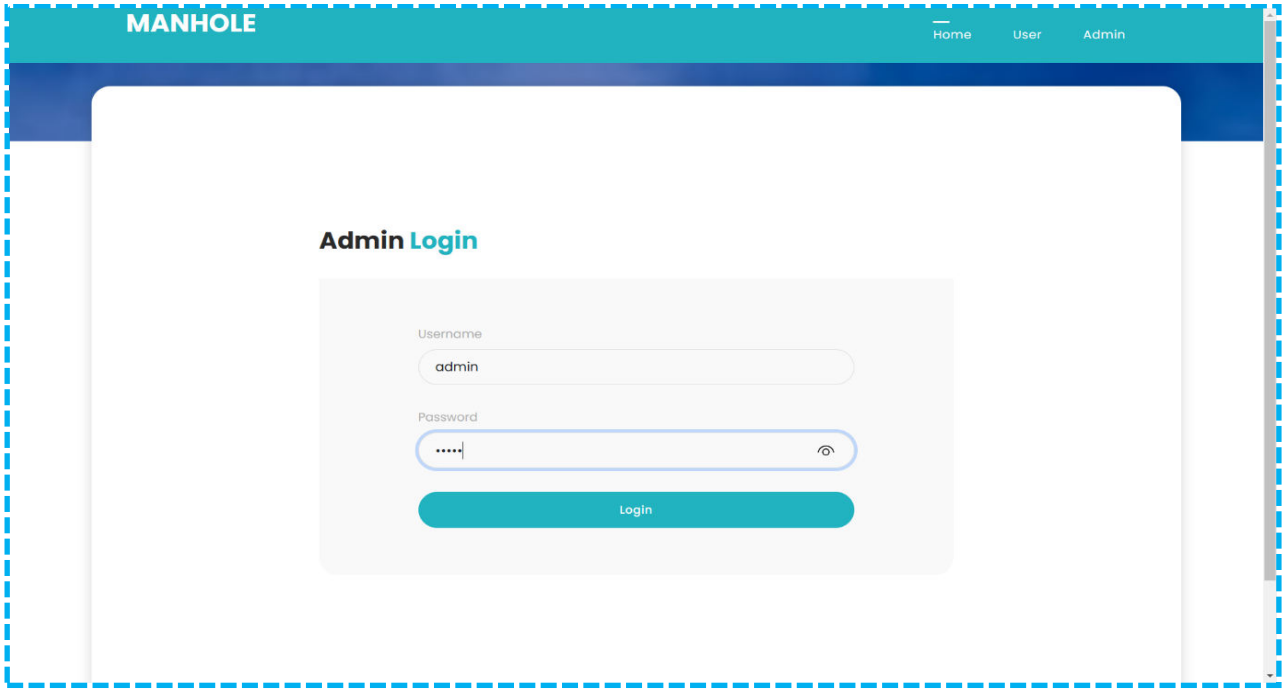

Fig.2.Admin Login

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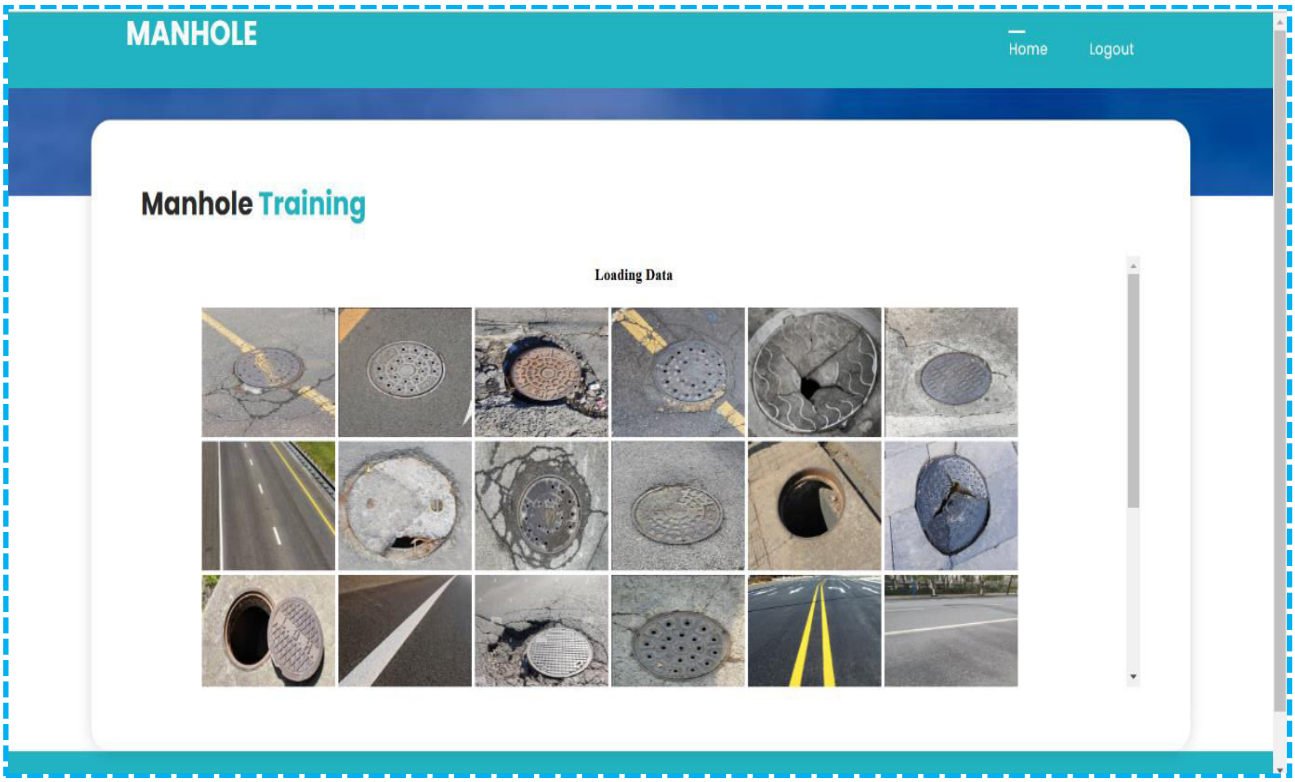

Fig.3.Manhole Training

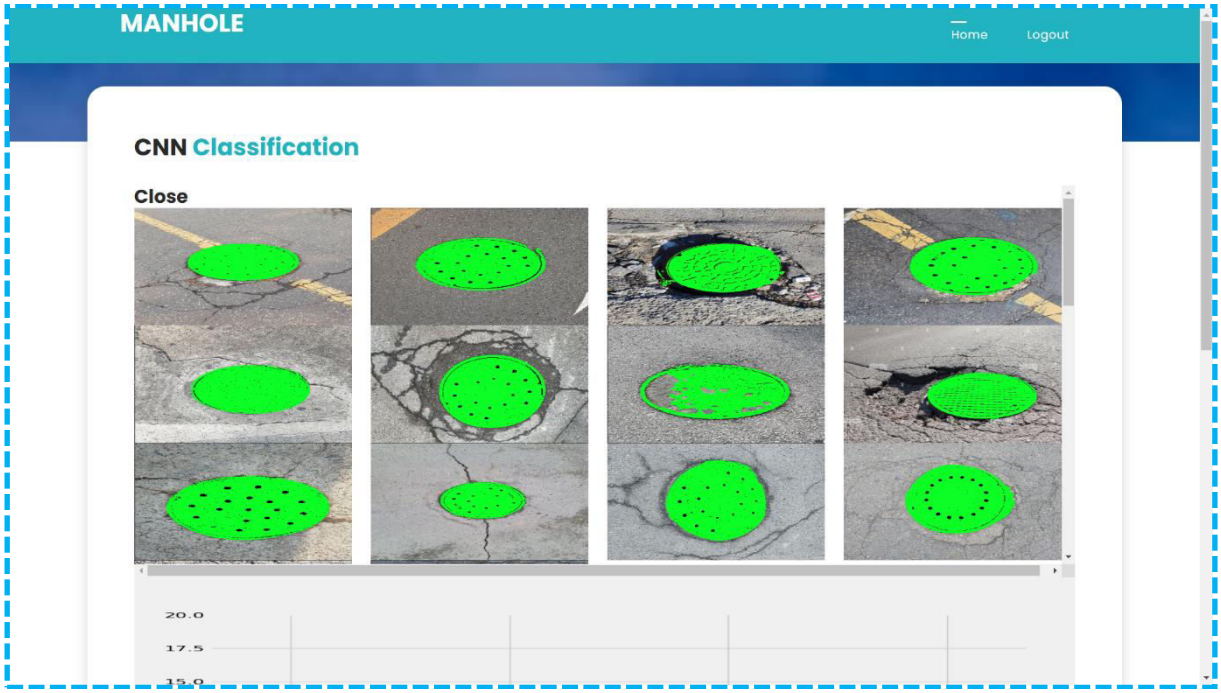

Fig.4.CNN Classification

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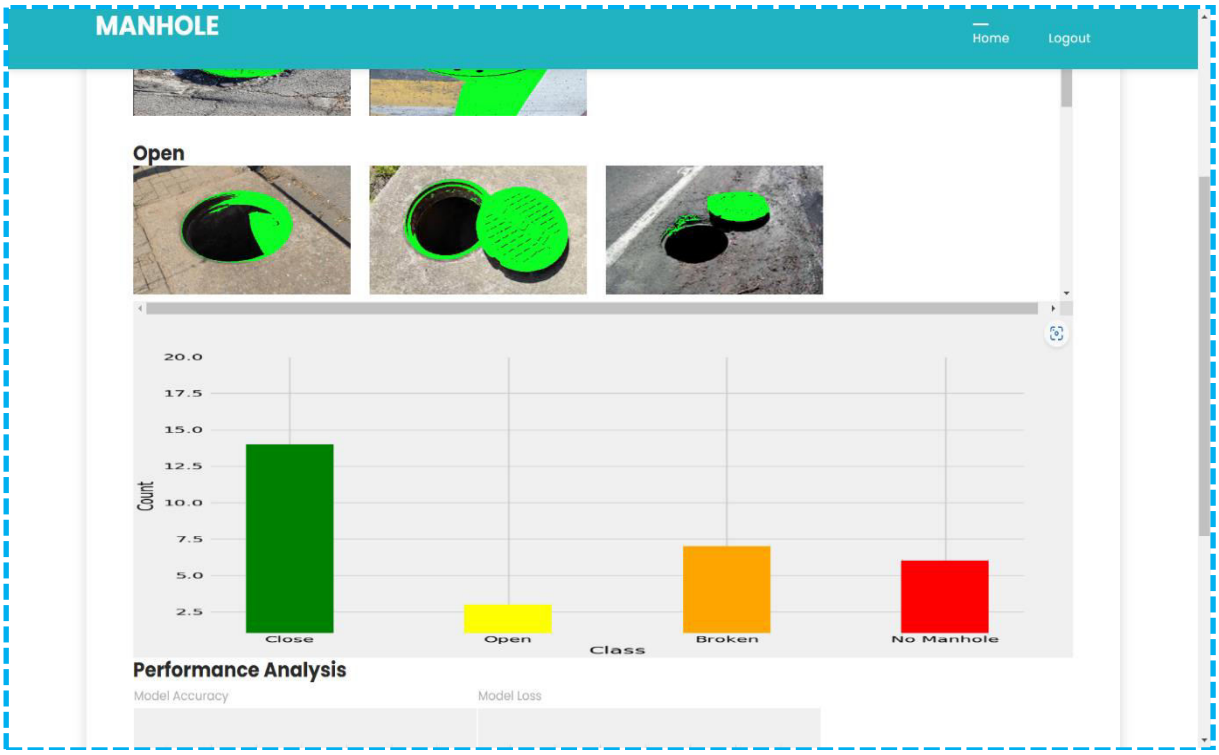

Fig.5.Performance Analysis

V.CONCLUSION

In conclusion, the Manhole Predictor Web App developed using deep learning techniques has shown promising results for predicting the damage and defects in manholes. The system's architecture involved various stages, including dataset collection, pre-processing, segmentation, feature extraction, classification, and prediction, all working together to make accurate predictions. The feasibility study revealed that the system's implementation is possible and can improve the efficiency of manhole maintenance systems. The software testing and test cases performed demonstrated the reliability of the system and its ability to accurately predict manhole defects. The performance analysis using various metrics such as accuracy, precision, recall, and F1 score showed that the system's predictions are reliable and accurate. A manhole or an inspection chamber is a unit constructed underground to provide access to the utilities like a sewer system, drainage system, etc. Hence, with the help of a manhole, underground utilities are inspected, modified, cleaned and maintained. Sewer systems are built underground with pipes that carry waste from homes and other buildings to a place of treatment or disposal. Part of maintaining a sewer system is providing frequent inspection, cleaning and repairs. Utility crews use manholes to gain closer access to pipes or other parts of the underground system to meet those needs. The results and discussion further showed that the Manhole Predictor Web App has the potential to improve manhole maintenance and reduce accidents caused by damaged manholes. In summary, the Manhole Predictor Web App using deep learning techniques is a promising solution for efficient manhole maintenance systems. The system can predict manhole defects accurately and in real-time, allowing for quick repairs and maintenance scheduling by municipality officers.

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