



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

[www.ijirset.com](http://www.ijirset.com)

# Implementation of Efficient Manhole Visual Inspection System Using Deep Learning in UAV Navigation

N.Nandhini, Aakash.A, David .T, Perarasan.M

Assistant Professor, Department of IT, P.S.V College of Engineering & Technology, Krishnagiri, Tamilnadu, India

UG Student, Department of IT, P.S.V College of Engineering & Technology, Krishnagiri, Tamilnadu, India

UG Student, Department of IT, P.S.V College of Engineering & Technology, Krishnagiri, Tamilnadu, India

UG Student, Department of IT, P.S.V College of Engineering & Technology, Krishnagiri, Tamilnadu, India

**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 :** Artificial Intelligence, Non tech-savvy, Image Recognition, Object Detection, Logistic Regression.

## I.INTRODUCTION

### Deep Learning Model:

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,' 'Overflow,' and 'Object detection.'

Advanced techniques, including Convolutional Neural Network (CNN) for image classification and You Only Look Once version 8 (YOLOv8) for accurate prediction and localization, are incorporated using UAV (Unmanned Aerial Vehicle) images.

### Benefits and Impact:

The implementation of this deep learning-based architecture offers a promising avenue for enhancing urban safety and streamlining infrastructure maintenance processes. By automating the inspection process, the system reduces the risk of accidents caused by damaged manholes, potentially preventing injuries or fatalities. It also saves costs for municipalities and other organizations responsible for maintaining manholes by reducing the need for manual inspections. The system's web-based interface makes it easy for maintenance personnel to access and use, improving overall usability and accessibility. Furthermore, the system can be adapted to different types of manholes and environments, making it scalable and useful for various organizations responsible for manhole maintenance.

#### Related Works:

- Previous research has explored real-time detection of road hazards using YOLOv8 [1].
- Depth-based deep learning has also been successfully applied for manhole detection in UAV navigation [2].
- Other studies have proposed deep learning-based vehicle-mounted methods for real-time manhole cover detection [3]

### II. PROBLEM DEFINITION

Manholes present several significant challenges. Firstly, they pose safety hazards to pedestrians, cyclists, and motorists if left uncovered or improperly maintained, leading to accidents and injuries. Additionally, uncapped or poorly maintained manholes can become breeding grounds for pests and bacteria, raising public health concerns. Infrastructure damage is another issue, as damaged or corroded manholes can result in collapsed road surfaces or sewer lines, necessitating costly repairs. Moreover, clogged or blocked manholes can cause flooding and drainage problems, resulting in property damage and environmental pollution. Accessibility challenges arise for individuals with disabilities when manholes lack proper accommodations, hindering their ability to navigate public spaces safely. Furthermore, open or unsecured manholes present security risks by providing unauthorized access to underground infrastructure, leading to vandalism and theft. Lastly, the maintenance burden of manholes is substantial, requiring regular inspection, cleaning, and upkeep, which can strain municipal resources. Addressing these challenges requires proactive measures such as regular maintenance, infrastructure upgrades, public awareness campaigns, and improved design and security measures.

The problem statement of the project revolves around addressing the multitude of challenges associated with manholes, particularly in urban environments. Manholes, while crucial for utility access and maintenance, present significant safety hazards, public health concerns, infrastructure damage, and accessibility issues if left unattended or improperly maintained. The lack of proper management and maintenance can lead to accidents, injuries, property damage, environmental pollution, and hindered mobility for individuals with disabilities. Additionally, the security risks posed by open or unsecured manholes further exacerbate the problem. Therefore, the project aims to develop innovative solutions and technologies to enhance the detection, management, and maintenance of manholes, ensuring public safety, health, infrastructure resilience, and accessibility in urban areas.

### III. OBJECTIVE OF THE PROJECT

The aim and objective of the project of Manhole Predictor: Web-based Efficient Manhole Maintenance System using Deep Learning include: This system that can accurately classify and predict the condition of manholes from images.

- To develop a web-based system that can predict the condition of manholes from images.
- To collect and pre-process a large dataset of manhole images for training the machine learning model.
- To segment the manhole images using RPN to identify the location of the manhole in the image.
- To extract texture features from the manhole images using GLCM to identify the texture patterns of the manhole.
- To classify the manhole images into different classes such as closed, open, broken, and missing using a trained CNN.
- To predict and locate the manhole in the image using YOLOv8.
- To develop a user-friendly web interface for the system that can be accessed from anywhere with an internet connection.
- To improve the accuracy of the system through fine-tuning of the machine learning model and testing with a diverse set of manhole images.
- To assist in the maintenance of public infrastructure by identifying the condition of manholes and aiding in their repair or replacement if necessary.

Overall, the aim and objective of this project are to develop a reliable and efficient system that can predict the condition of manholes and aid in the maintenance of public infrastructure.

### IV. SCOPE OF THE PROJECT

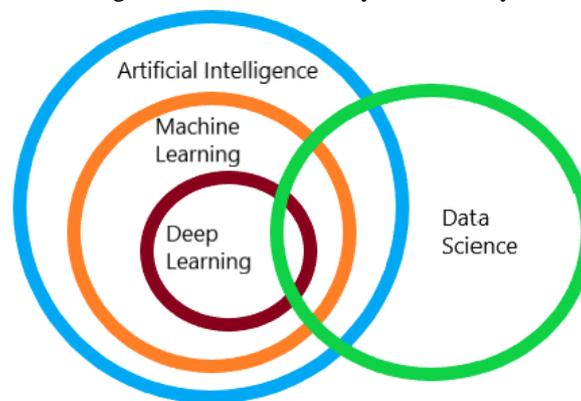
The scope of the project of Manhole Predictor: Web-based Manhole Classification includes the following:

1. Dataset Collection: The project will involve collecting a large dataset of manhole images from various sources, including public and private datasets.

2. Pre-processing: The collected images will be pre-processed by converting them from RGB to grayscale, resizing them to a standard size, removing noise, and binarizing them to make them easier to process.
3. Segmentation: Region Proposal Network (RPN) will be used to segment the manhole images and identify the location of the manhole in the image.
4. Feature Extraction: Gray-Level Co-occurrence Matrix (GLCM) technique will be used to extract texture features and identify the texture patterns of the manhole.
5. Classification: A Convolutional Neural Network (CNN) will be trained on the extracted features and classify the manhole images into different classes such as closed, open, broken, and missing.
6. Prediction and Localization: YOLOv8 will be used to predict the class of the manhole image and locate the manhole in the image.
7. Web Development: A user-friendly web interface will be developed for the system that can be accessed from anywhere with an internet connection.
8. Testing and Evaluation: The system will be tested with different manhole images and evaluated for its accuracy. The model will be fine-tuned if necessary and continued testing until the system performs well.
9. Maintenance: The system will be maintained to ensure it is up-to-date with the latest technologies and security updates.

## V. DEEP LEARNING

Deep Learning is a part of machine learning, which is a subset of Artificial Intelligence. It enables us to extract information from the layers present in its architecture. It is used in Image Recognition, Fraud Detection, News Analysis, Stock Analysis, Self-driving cars, and Healthcare like cancer image analysis, etc. By inputting more data into the network, the layers get trained very well. They can be classified into Supervised, Semi-Supervised, and Unsupervised categories. Each layer is known for extracting information specifically. For example, in Image recognition, the first layer will find the edge, lines, etc, second layer like the eye, ear, nose, etc.



*Figure 1.3 Deep Learning*

While deep learning is certainly not new, it is experiencing explosive growth because of the intersection of deeply layered neural networks and the use of GPUs to accelerate their execution. Big data has also fed this growth. Because deep learning relies on training neural networks with example data and rewarding them based on their success, the more data, the better to build these deep learning structures. Recurrent Neural Networks (RNN), Autoencoders, and Convolution Neural Networks (CNN) are examples of deep learning architectures. In computer vision, CNN remains the crux of deep learning algorithms.

## VI. CONVOLUTIONAL NEURAL NETWORKS (CNN)

In CNN, the processing of data involves breaking the images into many numbers of overlapping tiles instead of feeding entire images into our network. And then, we use a technique called a sliding window over the whole original image and save the results as a separate tiny picture tile. The Sliding window is a kind of brute force solution where we scan all around for a given image to detect the object for all possible sections, each section at a time until we get the expected object.

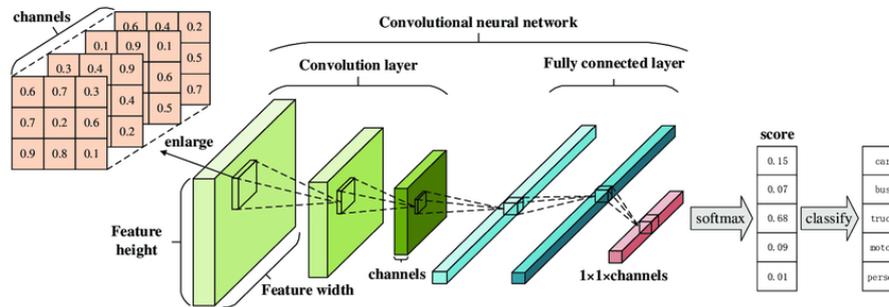


Figure 1.4 Convolutional Neural Networks

### Convolution Layer

CNN has a convolution layer that has several filters to perform the convolution operation.

### Rectified Linear Unit (ReLU)

CNN's have a ReLU layer to perform operations on elements. The output is a rectified feature map.

### Pooling Layer

The rectified feature map next feeds into a pooling layer. Pooling is a down-sampling operation that reduces the dimensions of the feature map.

The pooling layer then converts the resulting two-dimensional arrays from the pooled feature map into a single, long, continuous, linear vector by flattening it.

### Fully Connected Layer

A fully connected layer forms when the flattened matrix from the pooling layer is fed as an input, which classifies and identifies the images.

## V.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.

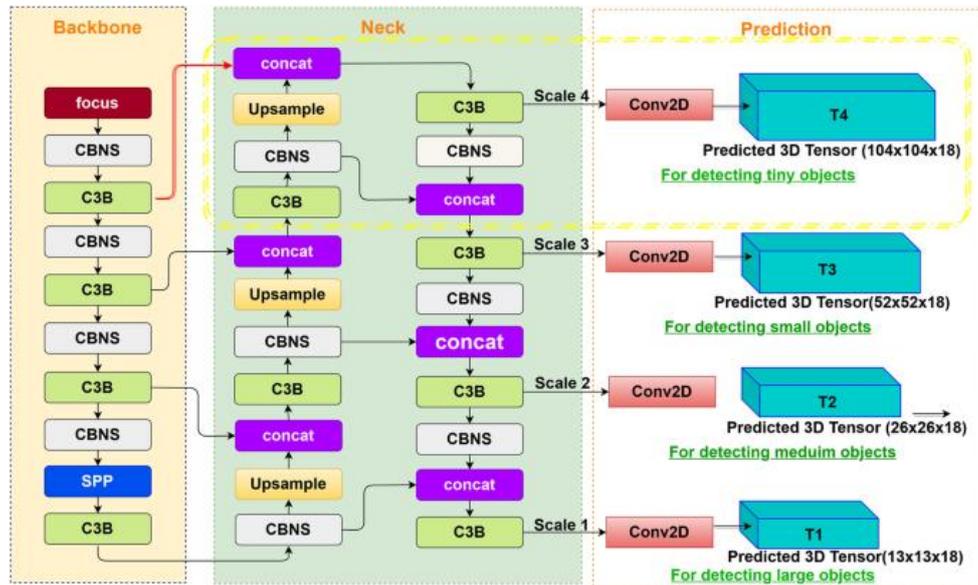


Figure 1.5 Yolo Algorithm

At its core, YOLOv8 follows a straightforward set of principles. It all starts with an input image, which can be of varying sizes, making it a versatile tool for a wide range of applications. The image then undergoes a process of feature extraction within a neural network. This network, carefully engineered and trained, excels at identifying and highlighting the most relevant features within the image, akin to a detective piecing together crucial clues at a crime scene. YOLOv8 stands out by not just detecting objects at a single scale but by simultaneously spotting them at different scales, ensuring it can identify objects both large and small effectively.

## VI.CONCLUSION

### Anchor-Free Detection

YOLOv8 switched to anchor-free detection to improve generalization. The problem with anchor-based detection is that predefined anchor boxes reduce the learning speed for custom datasets. With anchor-free detection, the model directly predicts an object's mid-point and reduces the number of bounding box predictions. This helps speed up Non-max Suppression (NMS) – a pre-processing step that discards incorrect predictions.

## REFERENCES

1. Yin, X., Li, X., Gao, Q., & Li, H. (2019). Manhole defect detection algorithm based on convolutional neural network. *Journal of Intelligent & Fuzzy Systems*, 36(6), 6071-6079.
2. Naini, H. K., Ahmadi, M., & Moini, A. (2017). Manhole detection and tracking for urban road mapping using an unmanned aerial vehicle. *Measurement*, 104, 50-58.
3. Bhat, S. S., & Sundaram, S. (2018). Manhole cover detection and classification for intelligent vehicles using deep learning. In *2018 15th International Conference on Control, Automation, Robotics and Vision (ICARCV)* (pp. 1814-1819). IEEE.
4. Kataria, K., & Patel, M. (2021). Manhole Defect Detection Using Computer Vision and Image Processing. In *2021 5th International Conference on Computing Methodologies and Communication (ICCMC)* (pp. 516-519). IEEE.
5. Kim, J. H., Lee, Y. H., Kim, J. H., & Oh, H. (2019). Automatic detection of manhole covers using a deep convolutional neural network. *Journal of Computing in Civil Engineering*, 33(1), 04018048.
6. Ding, J., Liu, X., & Wang, J. (2020). Urban Manhole Cover Detection Based on Improved YOLOv3. *Journal of Physics: Conference Series*, 1693(1), 012012.
7. Muralidharan, V., & Balasubramanian, R. (2020). Smart manhole covers monitoring system using IoT. In *2020 IEEE International Conference on Innovative Research and Development (ICIRD)* (pp. 104-107). IEEE.



8. Zhang, S., & Jiang, H. (2021). Urban Manhole Cover Detection Algorithm Based on Deep Learning. In Proceedings of the 2021 International Conference on Computer Science and Big Data Applications (pp. 67-71).
9. Sahu, S., & Sahu, N. (2021). Detection of Manhole Defects Using Deep Learning. In International Conference on Intelligent Communication and Computational Techniques (pp. 609-616). Springer, Singapore.



INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details