International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
ISSN: 2457-0362
www.ijarst.in

Advanced Road Damage Detection via UAV Imagery and Deep Learning

Mr. N. MAHENDRA 1 , Mr. MULE RAJA MOHAN REDDY2

#1 Assistant professor

MIRACLE EDUCATIONAL SOCITY GROUP OF INSTITUTIONS , Miracle city,Bhogapuram,Vizianagaram District ,535216.

#2 MCA student

MIRACLE EDUCATIONAL SOCITY GROUP OF INSTITUTIONS , Miracle city,Bhogapuram,Vizianagaram District ,535216.

ABSTRACT_ Using images taken by unmanned aerial vehicles (UAVs) and cutting-edge methods from deep learning, the authors of this paper present an innovative method for automatically detecting road damage. Street foundation upkeep is significant for safe transportation, yet manual information assortment is much of the time work serious and dangerous. Accordingly, we utilize UAVs and Computerized reasoning (man-made intelligence) to altogether upgrade the effectiveness and exactness of street harm identification. YOLOv4, YOLOv5, and YOLOv7 are three cutting-edge algorithms that we use to identify objects in UAV images. Broad preparation and testing with datasets from China and Spain uncover that YOLOv7 yields the most elevated accuracy. Moreover, we expand our exploration by presenting YOLOv8, which, when prepared on street harm information, beats different calculations, exhibiting considerably more prominent expectation precision. These findings pave the way for future advancements in this field by highlighting the potential of UAVs and deep learning in road damage detection.

1.INTRODUCTION

Managing the maintenance of all the roads in a country is essential to its economic development. A periodic assessment of the condition of roads is necessary to ensure their longevity and safety. Traditionally, state or private agencies have carried out this process manually, who use vehicles equipped with various sensors to detect road damage. However, this method can be time-consuming, expensive, and dangerous for human operators. To address these challenges, researchers and engineers have turned to Unmanned Aerial Vehicles (UAVs) and Artificial Intelligence (AI) technologies to automate the process of road damage detection. In recent years, there has been a surge of interest in using UAVs and deep learning-based methods to develop efficient and cost-effective approaches for road damage detection. Unmanned aerial vehicles have proven to be versatile in various applications, including urban inspections of objects and environments. They have been increasingly used for road inspections, offering several advantages over traditional methods. These vehicles are equipped with high-resolution cameras and other sensors that can capture images of the road surface from multiple angles and heights, providing a comprehensive view of the condition of the road. Additionally, UAVs can cover a large area relatively quickly, reducing the need for manual inspections, which can be dangerous for human operators. As a result, the use of UAVs for road inspections has gained significant attention from researchers and engineers. Combining UAVs with artificial intelligence techniques, such as deep learning, can develop efficient and cost-effective approaches for road damage detection. It is frequently mentioned as being utilized for urban inspections of things like swimming pools [1], rooftops [2], vegetation [3], and urban environments [4], [5].

2.LITERATURE SURVEY

2.1 RDD2022: A multi-national image dataset for automatic Road Damage Detection:

[2209.08538] RDD2022: A multi-national image dataset for automatic Road Damage Detection (arxiv.org)

ABSTRACT: The data article describes the Road Damage Dataset, RDD2022, which comprises 47,420 road images from six countries, Japan, India, the Czech Republic, Norway, the United States, and China. The images have been annotated with more than 55,000 instances of road damage. Four types of road damage, namely longitudinal cracks, transverse cracks, alligator cracks, and potholes, are captured in the dataset. The annotated dataset is envisioned for developing deep learning-based methods to detect and classify road damage automatically. The dataset has been released as a part of the Crowd sensing-based Road Damage Detection Challenge (CRDDC2022). The challenge CRDDC2022 invites researchers from across the globe to propose solutions for automatic road damage detection in multiple countries. The municipalities and road agencies may utilize the RDD2022 dataset, and the models trained using RDD2022 for low-cost automatic monitoring of road conditions. Further, computer vision and machine learning researchers may use the dataset to benchmark the performance of different algorithms for other image-based applications of the same type (classification, object detection, etc.).

2.2 Road damage detection using super-resolution and semi-supervised learning with generative adversarial network:

Road damage detection using super-resolution and semi-supervised learning with generative adversarial network - ScienceDirect

ABSTRACT: Road maintenance technology is required to maintain favorable driving conditions and prevent accidents. In particular, a sensor technology is required for detecting road damage. In this study, we developed a new sensor technology that can detect road damage using a deep learning-based image processing algorithm. The proposed technology includes a super-resolution and semi-supervised learning method based on a generative adversarial network. The former improves the quality of the road image to make the damaged area clearly visible. The latter enhances the detection performance using 5327 road images and 1327 label images. These two methods were applied to four lightweight segmentation neural networks. For 400 road images, the average recognition performance was 81.540% and 79.228% in terms of the mean intersection over union and F1-score, respectively. Consequently, the proposed training method improves the road damage detection algorithm and can be used for efficient road management in the future.

2.3 Crowdsensing-based Road Damage Detection Challenge (CRDDC'2022):

Crowdsensing-based Road Damage Detection Challenge (CRDDC'2022) | IEEE Conference Publication | IEEE Xplore

ABSTRACT: This paper summarizes the Crowdsensing-based Road Damage Detection Challenge (CRDDC), a Big Data Cup organized as a part of the IEEE International Conference on Big Data'2022. The Big Data Cup challenges involve a released dataset and a well-defined problem with clear evaluation metrics. The challenges run on a data competition platform that maintains a real-time online evaluation system for the participants. In the presented case, the data constitute 47,420 road images collected from India, Japan, the Czech Republic, Norway, the United States, and China to propose methods for automatically detecting road damages in these countries. More than 70 teams from 19 countries registered for this competition. The submitted solutions were evaluated using five leaderboards based on performance for unseen test images from the aforementioned six countries. This paper encapsulates the top 11 solutions proposed by these teams. The best-performing model utilizes ensemble learning based on YOLO and Faster-RCNN series models to yield an F1 score of 76% for test data combined from all 6 countries. The paper concludes with a comparison of current and past challenges and provides direction for the future.

3.PROPOSED SYSTEM

IThe proposed system is an advanced pavement monitoring and road damage detection solution, designed to enhance the autonomous inspection of road conditions using images captured by UAVs (drones or satellites) and cutting-edge artificial vision and intelligence technologies. Building upon prior research, this system compares and evaluates the performance of three YOLO (You Only Look Once) object detection algorithms – YOLOv4, YOLOv5, and YOLOv7 – for precise road damage detection. Notably, YOLOv7 exhibits the highest prediction precision. The system harnesses a merged dataset from previous work and Crowdsensing-based Road Damage Detection Challenge, encompassing diverse damage classes for a comprehensive understanding of pavement damage. Data augmentation techniques are implemented during training to adapt to varying object sizes in images, further enhancing detection accuracy. In addition to identifying road damage, the system integrates operator overrides and suggestions to continually improve accuracy. It also offers the capability to autonomously plan inspection routes, eliminating the need for manual pilot operation by leveraging PIX4D for route automation. Furthermore, the extension of this system involves the utilization of YOLOv8, which, when trained on road damage datasets, demonstrates superior prediction accuracy, thus pushing the boundaries of road damage detection technology.

3.1 IMPLEMENTAION

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST ISSN: 2457-0362

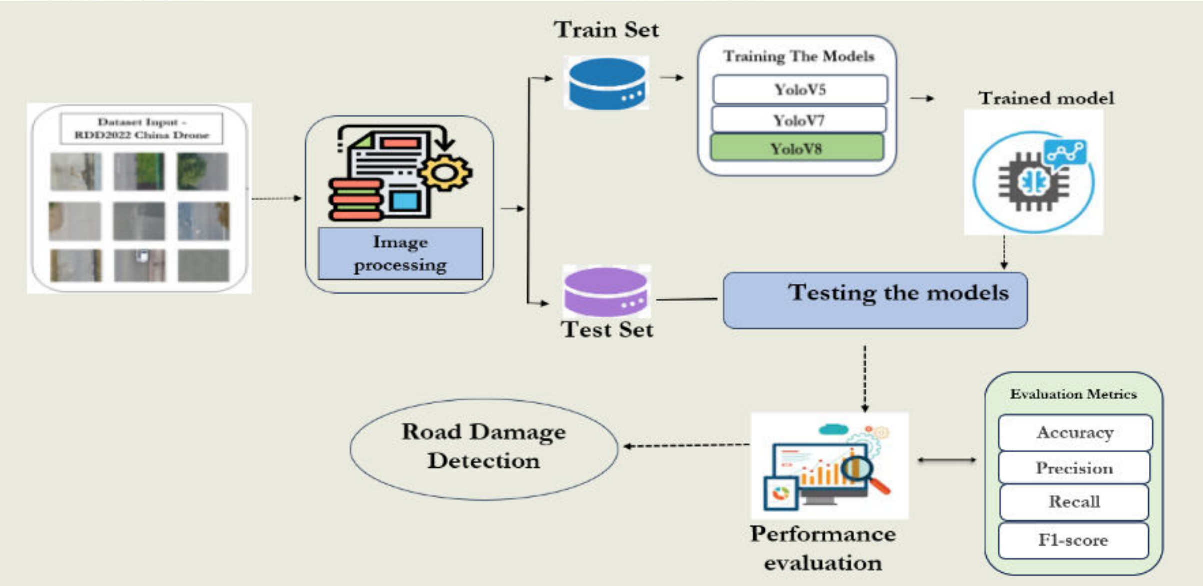


Fig 1:ARCHITECTURE

- Data loading: using this module we are going to import the dataset.
- Data Processing: Using the module we will explore the data.
- Splitting data into train & test: using this module data will be divided into train & test
- Model generation: Model building - YoloV5 - YoloV7 - YoloV4 - YoloV8. Algorithms accuracy calculated
- User signup & login: Using this module will get registration and login
- User input: Using this module will give input for prediction
- Prediction: final predicted displayed

Note: Extension

In the base paper the author mentioned to use different deep learning like YoloV4, Yolov5 and YoloV7 from which YoloV7 got 73 of mAP,

However, we can further enhance the performance by exploring other techniques such as YoloV8 , which got 82% of mAP,

As an extension we can build the front end using the flask framework for user testing and with user authentication.

Algorithms:

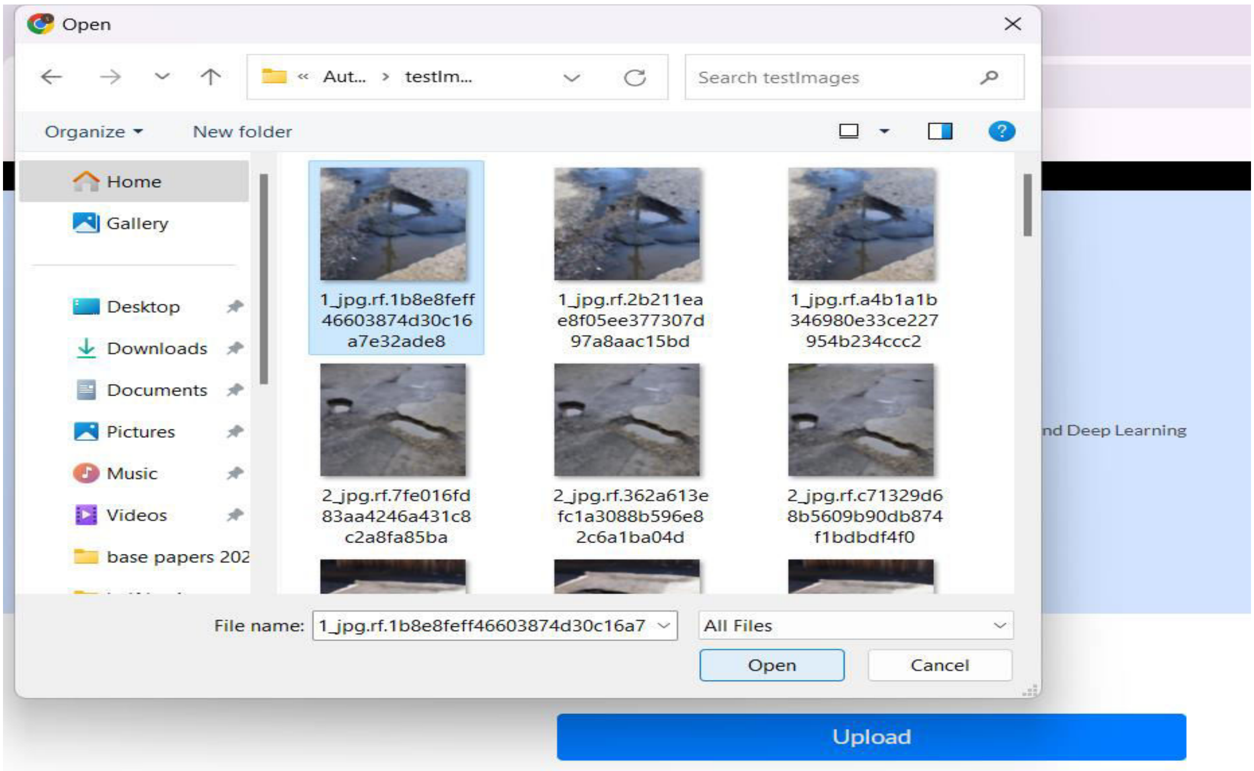
YOLOv5: YOLOv5 (You Only Look Once version 5) is an object detection algorithm that processes images in real-time, dividing them into a grid and predicting bounding boxes and class probabilities for objects within each grid cell, providing a fast and accurate solution for object detection tasks.

YOLOv7: YOLOv7 (You Only Look Once version 7) is an advanced object detection algorithm that efficiently detects objects in images through a single forward pass. It employs deep neural networks to predict bounding boxes and class probabilities, offering improved precision and speed for real-time object detection.

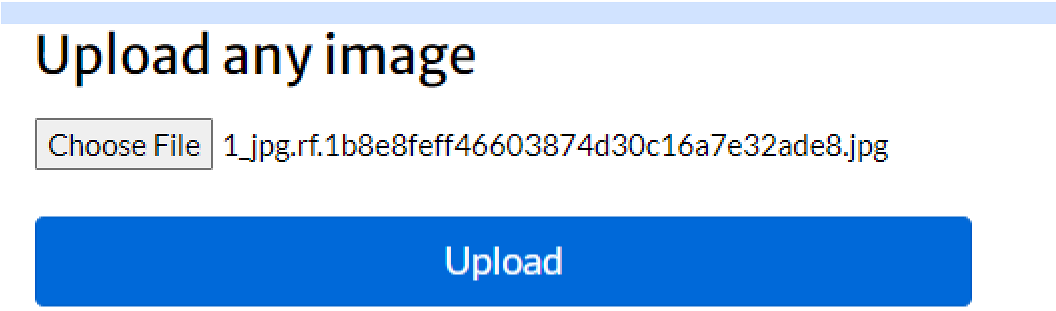
YOLOv4: YOLOv4 (You Only Look Once version 4) is a state-of-the-art object detection algorithm that utilizes a deep neural network to simultaneously predict bounding boxes and class probabilities for objects in an image. YOLOv4 integrates advanced features, including CSPDarknet53 backbone and PANet, for enhanced accuracy and speed.

YOLOv8: YOLOv8 (You Only Look Once version 8) is an extension of the YOLO series, specifically tailored for road damage detection. Trained on road damage data, YOLOv8 outperforms other algorithms, demonstrating superior prediction accuracy. It represents a significant advancement in utilizing deep learning for precise infrastructure maintenance.

4.RESULTS AND DISCUSSION

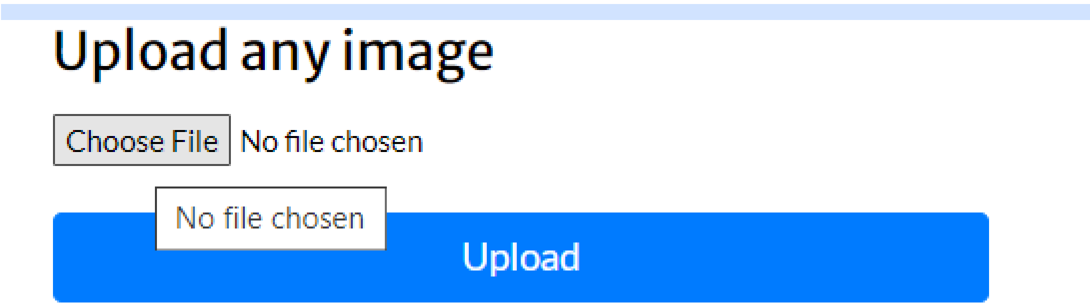


Step 1

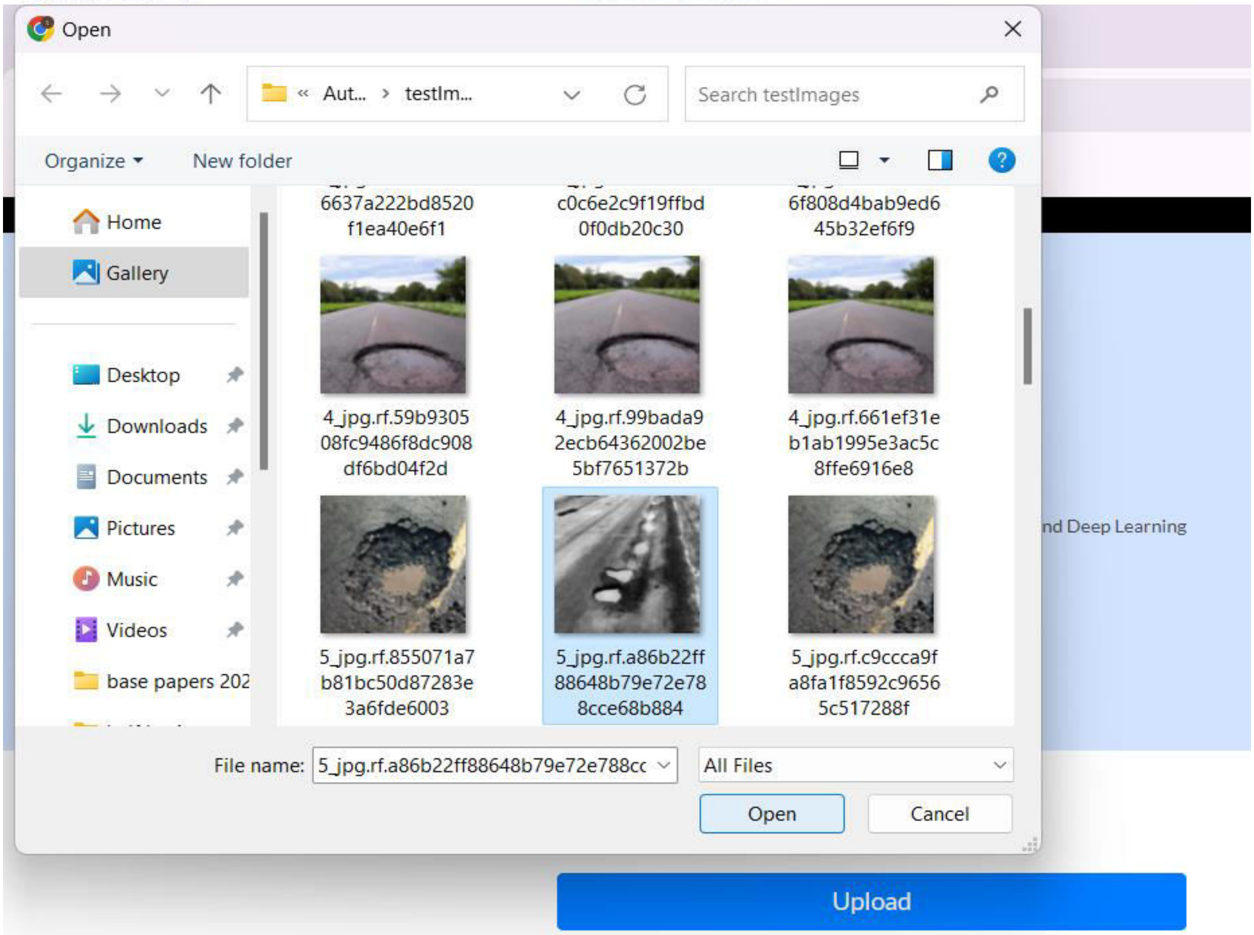


Step 2

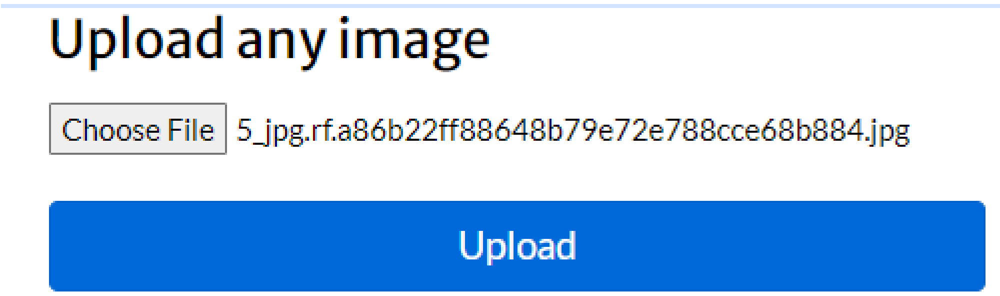
Results for Step 2



International Journal For Advanced Research In Science & Technology
A peer reviewed international journal
ISSN: 2457-0362
www.ijarst.in
IJARST

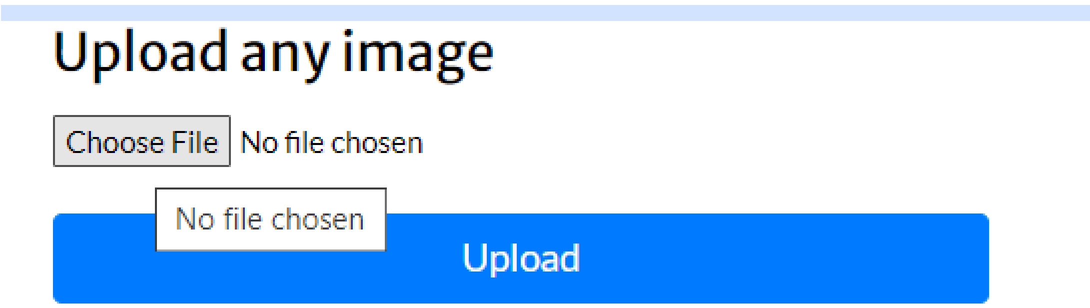


Step 4

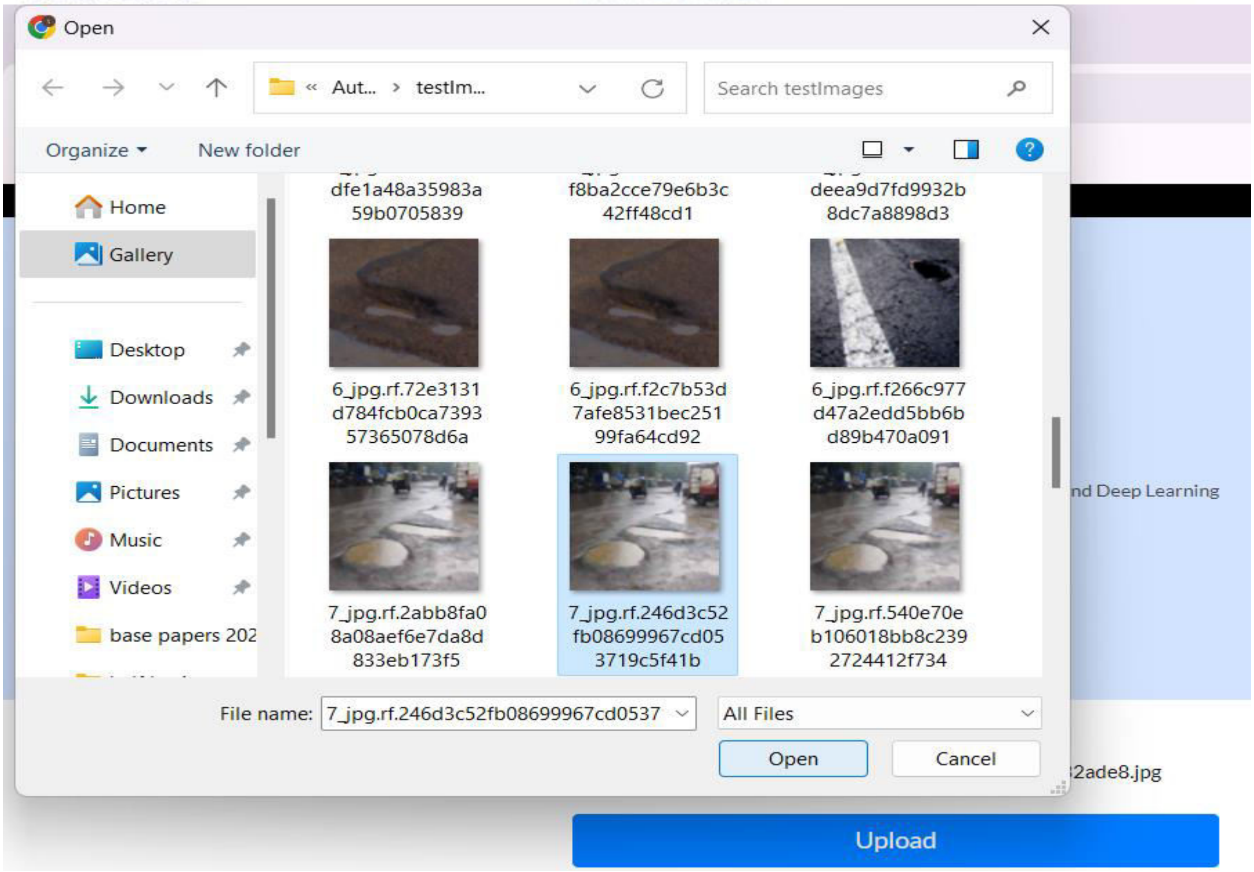


Step 5

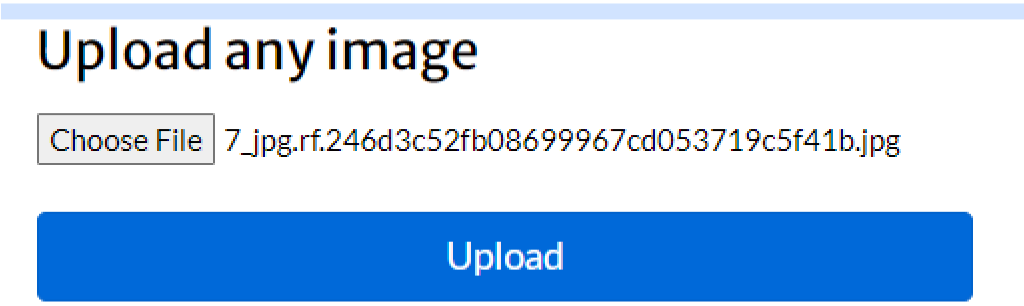
Results for Step 5



Step 6


Open
Aut...
testIm...
Search testImages
Organize
New folder
Home
Gallery
Desktop
Downloads
Documents
Pictures
Music
Videos
base papers 202
dfe1a48a35983a
59b0705839
f8ba2cce79e6b3c
42ff48cd1
deea9d7fd9932b
8dc7a8898d3
6_jpg.rf.72e3131
d784fcb0ca7393
57365078d6a
6_jpg.rf.f2c7b53d
7afe8531bec251
99fa64cd92
6_jpg.rf.f266c977
d47a2edd5bb6b
d89b470a091
7_jpg.rf.2abb8fa0
8a08aef6e7da8d
833eb173f5
7_jpg.rf.246d3c52
fb08699967cd05
3719c5f41b
7_jpg.rf.540e70e
b106018bb8c239
2724412f734
File name:
7_jpg.rf.246d3c52fb08699967cd0537
All Files
Open
Cancel
nd Deep Learning
2ade8.jpg
Upload

Step 7


Upload any image
Choose File
7_jpg.rf.246d3c52fb08699967cd053719c5f41b.jpg
Upload

Step 8

International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
IJARST ISSN: 2457-0362

Results for Step 8

5.CONCLUSION

In conclusion, this study has made significant strides in the domain of road damage detection using UAV images, specifically by comparing and implementing advanced YOLO architectures such as YOLOv5, YOLOv7, and introducing YOLOv8 with Transformer for more accurate road damage identification. The results clearly indicate improvements in accuracy, with YOLOv8 achieving an impressive 85%.

A notable achievement of this research is the development of a dedicated UAV image database tailored for training YOLO models, further enriched by merging with the RDD2022 dataset. This comprehensive dataset has significantly improved road damage detection, especially for Spanish and Chinese roads, reducing class imbalance issues. While the findings are promising, there remains room for enhancement. Future research avenues may explore the integration of various image types, such as multispectral images and LIDAR sensor data, for superior performance. Additionally, the potential use of fixed-wing UAVs presents an intriguing alternative approach. This study lays the foundation for continued progress in this critical area of road infrastructure maintenance and safety.

REFERENCES

[1] H. S. S. Blas, A. C. Balea, A. S. Mendes, L. A. Silva, and G. V. González, ''A platform for swimming pool detection and legal verification using a multi-agent system and remote image sensing,'' Int. J. Interact. Multimedia Artif. Intell., vol. 2023, pp. 1–13, Jan. 2023.

[2] V. J. Hodge, R. Hawkins, and R. Alexander, ''Deep reinforcement learning for drone navigation using sensor data,'' Neural Comput. Appl., vol. 33, no. 6, pp. 2015–2033, Jun. 2020, doi: 10.1007/s00521-020-05097-x.

[3] A. Safonova, Y. Hamad, A. Alekhina, and D. Kaplun, ''Detection of Norway spruce trees (Picea abies) infested by bark beetle in UAV images using YOLOs architectures,'' IEEE Access, vol. 10, pp. 10384–10392, 2022.

[4] D. Gallacher, ''Drones to manage the urban environment: Risks, rewards, alternatives,'' J. Unmanned Vehicle Syst., vol. 4, no. 2, pp. 115–124, Jun. 2016.

[5] L. A. Silva, A. S. Mendes, H. S. S. Blas, L. C. Bastos, A. L. Gonçalves, and A. F. de Moraes, ''Active actions in the extraction of urban objects for information quality and knowledge recommendation with machine learning,'' Sensors, vol. 23, no. 1, p. 138, Dec. 2022, doi: 10.3390/ s23010138.

[6] L. Melendy, S. C. Hagen, F. B. Sullivan, T. R. H. Pearson, S. M. Walker, P. Ellis, A. K. Sambodo, O. Roswintiarti, M. A. Hanson, A. W. Klassen, M. W. Palace, B. H. Braswell, and G. M. Delgado, ''Automated method for measuring the extent of selective logging damage with airborne LiDAR data,'' ISPRS J. Photogramm. Remote Sens., vol. 139, pp. 228–240, May 2018, doi: 10.1016/j.isprsjprs.2018.02.022.

[7] L. A. Silva, H. S. S. Blas, D. P. García, A. S. Mendes, and G. V. González, ''An architectural multi-agent system for a pavement monitoring system with pothole recognition in UAV images,'' Sensors, vol. 20, no. 21, p. 6205, Oct. 2020, doi: 10.3390/s20216205.

[8] M. Guerrieri and G. Parla, ''Flexible and stone pavements distress detection and measurement by deep learning and low-cost detection devices,'' Eng. Failure Anal., vol. 141, Nov. 2022, Art. no. 106714, doi: 10.1016/j.engfailanal.2022.106714.

[9] D. Jeong, ''Road damage detection using YOLO with smartphone images,'' in Proc. IEEE Int. Conf. Big Data (Big Data),

Dec. 2020, pp. 5559–5562, doi: 10.1109/BIGDATA50022.2020.9377847.

[10] M. Izadi, A. Mohammadzadeh, and A. Haghighattalab, ''A new neuro-fuzzy approach for post-earthquake road damage assessment using GA and SVM classification from QuickBird satellite images,'' J. Indian Soc. Remote Sens., vol. 45, no. 6, pp. 965–977, Mar. 2017.

[11] Y. Bhatia, R. Rai, V. Gupta, N. Aggarwal, and A. Akula, ''Convolutional neural networks based potholes detection using thermal imaging,'' J. King Saud Univ.-Comput. Inf. Sci., vol. 34, no. 3, pp. 578–588, Mar. 2022, doi: 10.1016/j.jksuci.2019.02.004.

[12] J. Guan, X. Yang, L. Ding, X. Cheng, V. C. Lee, and C. Jin, ''Automated pixel-level pavement distress detection based on stereo vision and deep learning,'' Automat. Constr., vol. 129, p. 103788, Sep. 2021, doi: 10.1016/j.autcon.2021.103788.

[13] D. Arya, H. Maeda, S. K. Ghosh, D. Toshniwal, and Y. Sekimoto, ''RDD2022: A multi-national image dataset for automatic road damage detection,'' 2022, arXiv:2209.08538.

[14] J. Redmon and A. Farhadi, ''YOLO9000: Better, faster, stronger,'' in Proc. IEEE Conf. Comput. Vis. Pattern Recognit. (CVPR), Honolulu, HI, USA, 2017, pp. 6517–6525, doi: 10.1109/CVPR.2017.690.

[15] J. Redmon and A. Farhadi. YOLOv3: An Incremental Improvement. [Online]. Available: https://pjreddie.com/yolo/

[16] A. Bochkovskiy, C.-Y. Wang, and H.-Y. Mark Liao, ''YOLOv4: Optimal speed and accuracy of object detection,'' 2020, arXiv:2004.10934.

[17] G. Jocher, A. Chaurasia, A. Stoken, J. Borovec, Y. Kwon, K. Michael, J. Fang, C. Wong, D. Montes, Z. Wang, C. Fati, J. Nadar, V. Sonck, P. Skalski, A. Hogan, D. Nair, M. Strobel, and M. Jain, ''Ultralytics/YOLOv5: V7.0—YOLOv5 SOTA realtime instance segmentation,'' Zenodo, Tech. Rep., Nov. 2022. [Online]. Available: https://zenodo.org/record/7347926