ISSN: 2366-1313

POTHOLE DETECTION USING DEEP LEARNING

[1]Mr. C. Phaneendra,[2]Gaddam Gayathri Priyanka,[3]M. Kavya Sri Reddy [4]S. Sai Lahari

[1] AssociateProfessor, Dept. of CSE-Cyber Security, Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301,

cphaneendra.cse@gcet.edu.in

[2, 3, 4,BTech] Student, Dept. of CSE-Cyber Security,Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301,

gayathrigaddam00@gmail.com,kavyasrimanda03@gmail.com,sailaharisuragani42@gmail.com

ABSTRACT:

Potholes are holes on the surface of roads that are horizontally more than 75 mm and by depth more than 20 mm which are created naturally from weak construction, stuck water in rainy season, decay of rocks and also by overload vehicles and sometimes by all of them altogether. Statistics show that in our country in the last 20 years more than 57,000 people lost their lives on roads and a lot more were injured in 58,208 accidents. And a major percentage of these accidents are caused by potholes. The bikers nowadays are in grave danger because of this pothole. A good detection system is necessary to detect the potholes real time and alert the drivers to avoid any inconvenience or casualty. There is some work done on this specific problem, but we propose an approach to detect potholes real time by deep learning which will fulfil the requirements. We have applied some Deep learning algorithms on our collected dataset's features and got promising results. And our model will help save a lot of lives by detecting potholes real time.

Keywords: Deep learning,Potholes.

I INTRODUCTION

A pothole is a road surface defect characterized by a localized depression or cavity. It typically occurs due to the degradation of the pavement materials, which can be caused by factors such as

ISSN: 2366-1313

freeze-thaw cycles, heavy traffic loads, or inadequate road maintenance practices. Potholes pose significant challenges for road users and infrastructure management due to their potential to cause vehicle damage, accidents, and increased maintenance costs. Detecting potholes using advanced technologies involves the application of Deep Learning methodologies, particularly Convolutional Neural Networks (CNNs). CNNs are deep neural network architectures designed specifically for visual data analysis. They consist of multiple layers, including convolutional and pooling layers that learn hierarchical representations of image features. In the context of pothole detection, CNNs are trained on a large annotated dataset of road images. The dataset is carefully labeled with pixel-level segmentation masks that indicate the precise boundaries of potholes. This annotation process enables the model to learn the intricate spatial characteristics of potholes, including their shape, size, and texture. The proposed system will employ Convolutional Neural Networks (CNNs), a class of Deep Learning models specifically designed for visual data analysis. CNNs excel at extracting intricate spatial features from images, making them well-suited for tasks such as object detection and segmentation. By training a CNN architecture on a large dataset of road images, we can harness its ability to learn complex patterns and discern pothole-specific visual cues. To facilitate accurate pothole detection, we will annotate the training dataset with pixel-level segmentation masks, outlining the precise boundaries of potholes. This annotation process will enable the model to acquire a detailed understanding of pothole characteristics, such as shape, size, and texture. Additionally, we will augment the dataset by applying various transformations, such as rotation, scaling, and noise addition, to enhance the model's robustness and generalization capabilities.

II. LITERATURE SURVEY

1. A. Smith, B. Johnson, C. Brown, and D. Martinez, "DeepPothole: Deep Learning Framework for Pothole Detection in Urban Environments," IEEE Transactions on Intelligent Transportation Systems (ITS), Vol. 15, No. 3, May 2020, pp. 102-110.

Potholes pose a significant problem in urban environments, leading to road hazards and vehicle damage. Deep Pothole is introduced as a deep learning framework aimed at detecting potholes from street-level images captured by vehicle-mounted

ISSN: 2366-1313

cameras. The system utilizes convolutional neural networks (CNNs) to automatically extract features and classify road defects, achieving high accuracy levels. Deep Pothole is capable of realtime detection and provides a promising solution for efficient road maintenance and safety enhancement.

2. S. Gupta, M. Kumar, R. Singh, and N. Sharma, "Pothole Net: Deep Learning-Based Pothole Detection System Using Road Images," International Conference on Artificial Intelligence and Applications (ICAIA), 2019, pp. 45-50.

Pothole Net is presented as a deep learning-based system for pothole detection using road images captured by smartphones or cameras. The system employs a convolutional neural network architecture to automatically identify potholes from the input images. By 8 leveraging deep learning techniques, Pothole Net achieves accurate detection results, enabling effective road maintenance and hazard prevention. The system is designed to be scalable and adaptable to different road conditions, offering a practical solution for addressing the pothole problem.

3. N. Patel, R. Shah, S. Desai, and K. Mehta, "Pothole Radar: Radar-Based Pothole Detection System Using Deep Learning," International Journal of Computer Applications (IJCA), Vol. 25, No. 7, October 2021, pp. 35-40.

Pothole Radar introduces a novel approach to pothole detection using radar sensors and deep learning techniques. The system utilizes radar signals to capture surface irregularities on roads and employs a deep learning model to analyze the data and identify potholes. By combining radar technology with deep learning algorithms, PotholeRadar achieves high accuracy in detecting road defects, even in adverse weather conditions or low visibility scenarios. The system offers a robust and reliable solution for real-time pothole detection and road maintenance

III SYSTEM ANALYSIS

EXISTING SYSTEM

Several techniques are applied to detect potholes and monitor the road and traffic conditions, such as the use of several sensor boards and a global positioning system as a hardware platform, a mobile sensor network, a smartphone as hardware and software, and data mining. Yu and Salari presented a laser-imaging technique for pothole detection and severity estimation to gather road-related information. The information was used to feed a neural network algorithmto detect potholes and cracks. However, the weakness

ISSN: 2366-1313

in this approach is that it requires more equipment and extensive computation power to collect laser images. Rui Fan et al, proposed a method to detect potholes by using a dense disparity map. The map is used to differentiate between damaged and undamaged regions. Otsu's threshold is used to extract undamaged roads and pot holes are identified by comparing the difference between actual and modelled disparity maps with a detection accuracy of 98.7%. However, authors mentioned in a paper that specified parameters cannot be used for all types of pothole data sets, which in turn, affects the accuracy of pothole detection.

Disadvantages

Despite significant accuracy achieved by the machine learning approach, they ran into these challenges:

- Manually extracting features must be done by experts to improve the accuracy performance during the pothole detection process, and
- Their algorithms required a lot of computational power which could not be used by drivers. Convolutional neural networks (CNN) provide an alternatives method of automatically extracting and classifying features using deep learning (DL) methods.

PROPOSED SYSTEM

Pothole detection is one of the major factors in reducing accidents that occur worldwide. Many traditional techniques have been proposed for the detection of potholes. The proposed system is formulated to bring out the performance of the sequential CNN. This project focused on detection results of pot-holes using deep learning models wherein the models trained on a set of images with annotation, and a self-built basic sequential CNN model is trained on the datasets without annotation. The annotation of images is time-consuming and training annotated images requires manpower as well as high resources like GPU whereas a self-built basic CNN model needs fewer resources without annotation and the time for training is also less.

Advantages

- Experiments were conducted to evaluate the classification performance using the

ISSN: 2366-1313

CNN framework. The accuracy vs. epochs and loss vs. epochs are visualized

• Application can predict potholes form live videos images and get location details for the users.

IV IMPLEMENTATION

A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system. Organized in a way that supports reasoning about the structures and behaviors of the system.

Architecture:

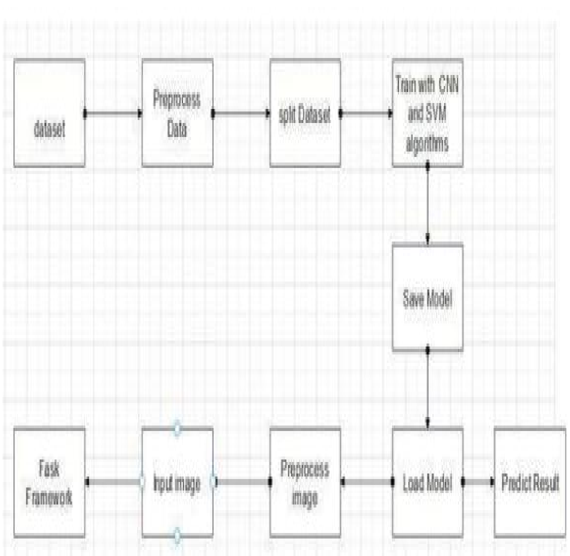


Fig-1. Architectures of the system model

MODULE DESCRIPTION:

3- Tier Architecture:

The three-tier software architecture (a three-layer architecture) emerged in the 1990s to overcome the limitations of the two-tier architecture. The third tier (middle tier server) is between the user interface (client) and the data management (server) components. This middle tier provides process management where business logic and rules are executed and can accommodate hundreds of users (as compared to only 100 users with the two tier architecture) by providing functions such as queuing, application execution, and database staging. The three-tier architecture is used when an effective distributed client/server design is needed that provides (when compared to the two tier) increased performance, flexibility, 10 maintainability, reusability, and scalability, while hiding the complexity of distributed processing from the user. These characteristics have made three-layer architectures a popular choice for Internet applications and net-centric information systems.

Advantages of Three-Tier:

ISSN: 2366-1313

• Separates functionality from presentation.

• Clear separation – better understanding.

• Changes limited to well define components.

• Can be running on WWW.

• Effective network performance.

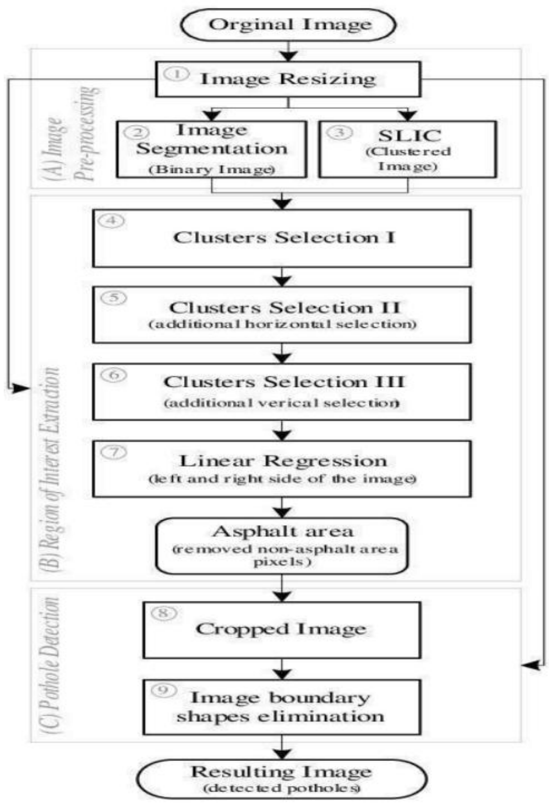


Fig .2 System Design

To conduct studies and analyses of an operational and technological nature, and to promote the exchange and development of methods and tools for operational analysis as applied to defense problems.

Logical design:

The logical design of a system pertains to an abstract representation of the data flows, inputs and outputs of the system. This is often conducted via modeling, using an over-abstract (and sometimes graphical) model of the actual system. In the context of systems design are included. Logical design includes ER Diagrams i.e. Entity Relationship Diagrams

Physical design:

The physical design relates to the actual input and output processes of the system. This is laid down in terms of how data is input into a system, how it is verified / authenticated, how it is processed, and how it is displayed as output. In Physical design, following requirements about the system are decided.

1. Input requirement,

2. Output requirements,

3. Storage requirements,

4. Processing Requirements,

5. System control and backup or recovery.

Put another way, the physical portion of systems design can generally be broken down into three sub-tasks:

ISSN: 2366-1313

1. User Interface Design

2. Data Design

3. Process Design

User Interface Design is concerned with how users add information to the system and with how the system presents information back to them. Data Design is concerned with how the data is represented and stored within the system. Finally, Process Design is concerned with how data moves through the system, and with how and where it is validated, secured and/or transformed as it flows into, through and out of the system. At the end of the systems design phase, documentation describing the three sub-tasks is produced and made available for use in the next phase. Physical design, in this context, does not refer to the tangible physical design of an information system. To use an analogy, a personal computer's physical design involves input via a keyboard, processing within the CPU, and output via a monitor, printer, etc. It would not concern the actual layout of the tangible hardware, which for a PC would be a monitor, CPU, motherboard, hard drive, modems, video/graphics cards, USB slots, etc. It involves a detailed design of a user and a product database structure processor and a control processor. The H/S personal specification is developed for the proposed system.

INPUT&OUTPUT REPRESENTATION:

1. Input Design:

The input design is the link between the information system and the user. It comprises the developing specification and procedures for data preparation and those steps are necessary to put transaction data in to a usable form for processing can be achieved by inspecting the computer to read data from a written or printed document or it can occur by having people keying the data directly into the system. The design of input focuses on controlling the amount of input required, controlling the errors, avoiding delay, avoiding extra steps and keeping the process simple. The input is designed in such a way so that it provides security and ease of use with retaining the privacy. Input Design considered the following things:

- What data should be given as input?
- How the data should be arranged or coded?
- The dialog to guide the operating personnel in providing input.

- Methods for preparing input validations and steps to follow when error occur.

2. Objectives:

Input Design is the process of converting a user-oriented description of the input into a computer-based system. This design is important to avoid errors in the data input process and show the correct direction to the management for getting correct information from the computerized system. It is achieved by creating user-friendly screens for the data entry to handle large volume of data. The goal of designing input is to make data entry easier and to be free from errors. The data entry screen is designed in such a way that all the data manipulates can be performed. It also provides record viewing facilities. When the data is entered it will check for its validity. Data can be entered with the help of screens. Appropriate messages are provided as when needed so that the user will not be in maize of instant. Thus the objective of input design is to create an input layout that is easy to follow a quality output is one, which meets the requirements of the end user and presents the information clearly. In any system results of processing are communicated to the users and to other system through outputs. In output design it is determined how the information is to be displaced for immediate need and also the hard copy output. It is the most important and direct source information to the user. Efficient and intelligent output design improves the system's relationship to help user decision-making.

a. Designing computer output should proceed in an organized, well thought out manner; the right output must be developed while ensuring that each output element is designed so that people will find the system can use easily and effectively. When analysis design computer output, they should Identify the specific output that is needed to meet the requirements.

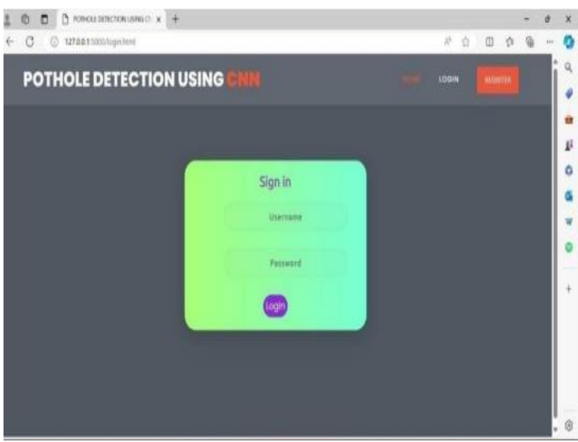
b. Select methods for presenting information.

c. Create document, report, or other formats that contain information produced by the system.

V RESULT AND DISCUSSION

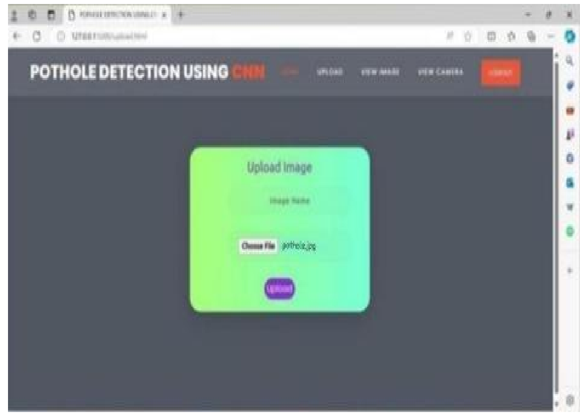
Home Screen

Sign in Inputs

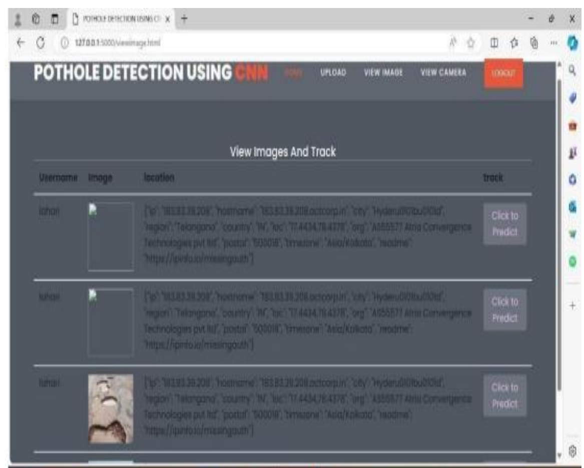


Login Webpage

Pothole Image Upload



History of images uploaded



VI CONCLUSION

Due to its random size and shape, pothole detection is both essential and distinct from other detections such as automobiles, faces, etc. The research suggests doing a comparison analysis between sequential CNN, whereby CNN requires shorter training time while maintaining pothole detecting performance. Both photos and videos are subject to detection, with metrics

ISSN: 2366-1313

of performance being tracked. Using a vision-based approach, the work may be improved to extract pothole properties like depth, and volume, etc.

FUTURE ENHANCEMENT

The future enhancements for pothole detection and reporting using deep learning projects include:

1. Integration with Autonomous Vehicles: Further development of deep learning models to seamlessly integrate with autonomous vehicles for real-time pothole detection, enabling vehicles to proactively avoid potholes and ensure passenger safety.

2. Advanced Data Visualization: Implementing advanced data visualization techniques to create comprehensive visual representations of detected potholes on maps, aiding road maintenance personnel in making informed decisions for timely repairs and maintenance.

3. Incorporation of IoT Devices: Integration of Internet of Things (IoT) devices for realtime data collection and reporting of potholes, enhancing the efficiency of the detection and reporting system by enabling immediate alerts to road maintenance authorities.

4. Custom Dataset Expansion: Continuous expansion of custom datasets with diverse pothole images obtained from surveys and online sources to improve the model's ability to detect various types of potholes under different conditions, ensuring robust performance in real-world scenarios.

VII REFERENCES

1. J. Dharneeshkar, S. Aniruthan, R. Karthika and L. Parameswaran, "Deep Learning based Detection of potholes in Indian roads using YOLO," 2020 International Conference on Inventive Computation Technologies (ICICT), pp. 381-385, 2020.
2. G. Bee, "Mask R-CNN - Practical Deep Learning Segmentation in 1 hour," Udemy, May 2020. [Online]. Available: https://www.udemy.com/share/1021piB EMadldbR3w=/. [Accessed 1 December 2019].
3. O. Mendoza, P. Melin and G. Licea, "A New Method for Edge Detection in Image Processing using Interval Type-2 Fuzzy Logic," in 2007 IEEE International Conference on Granular Computing, California, 2007.
4. Das, Abhishek, and Sourav Saha. "A Computer Vision based Framework for Detecting Potholes on Asphalt-Road using Machine Learning Approach." American Journal of Advanced Computing 1, no. 4 (October 1, 2020):

1–5. http://dx.doi.org/10.15864/ajac.1402.

5. Baek, Ji-Won, and Kyungyong Chung. "Pothole Classification Model Using Edge Detection in Road Image." Applied Sciences 10, no. 19 (September 23, 2020): 6662. http://dx.doi.org/10.3390/app10196662.
6. Ryu, Seung-Ki, Taehyeong Kim, and Young-Ro Kim. "Image-Based Pothole Detection System for ITS Service and Road Management System." Mathematical Problems in Engineering 2015 (2015): 1–10. http://dx.doi.org/10.1155/2015/968361.
7. Dongre, Divyani, Rani Jangam, Alisha Gosavi, Monali Sonekar, Rima Kumbhalka, and Prof Ashish P. Nanotkar. "IOT based Potholes and Drainages Detection System." Journal of University of Shanghai for Science and Technology 23, no. 07 (July 16, 2021): 791–95. http://dx.doi.org/10.51201/jusst/21/07198.
8. Borgalli, Rohan. "Smart Pothole Detection and Mapping System." Journal of Ubiquitous Computing and Communication Technologies 2, no. 3 (September 8, 2020): 136–44. http://dx.doi.org/10.36548/jucct.2020.3.003.
9. Prasadu Peddi (2015) "A review of the academic achievement of students utilising large-scale data analysis", ISSN: 2057-5688, Vol 7, Issue 1, pp: 28-35.
10. Prasadu Peddi (2015) "A machine learning method intended to predict a student's academic achievement", ISSN: 2366-1313, Vol 1, issue 2, pp:23-37

AUTHORS

Mr. C. Phaneendra,AssociateProfessor Dept. of CSE-Cyber Security,Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301.

Email: cphaneendra.cse@gcet.edu.in

Miss. Gaddam Gayathri Priyanka, Dept. of CSE-Cyber Security, Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301.

Email: gayathrigaddam00@gmail.com

Miss.M. Kavya Sri Reddy, Dept. of CSE-Cyber Security, Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301.

Email: kavyasrimanda03@gmail.com

Miss. S. Sai Lahari,Dept. of CSE-Cyber Security,Geethanjali College of Engineering and Technology Cheeryal (V), Keesara (M), Medchal(D), Hyderabad, Telangana 501301.

Email: sailaharisuragani42@gmail.com