VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A Project Report on

"Identifying Location of Pothole Using Computer Vision"

Submitted in partial fulfillment for the requirements as prescribed for the award of degree of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

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CERTIFICATE

It is Certified that the project work entitled **"IDENTIFYING LOCATION OF POTHOLE USING COMPUTER VISION"**, is a bonafide work carried out by **AFIFA MAHEEN (1AT19CS007), ARVIND KUMAR (1AT19CS018), ASHITHA V SHETTY (1AT19CS020) and KAVYA J K (1AT19CS045),** bonafide student of **Atria Institute of Technology,** in partial fulfilment for the award of Bachelor of Engineering in **Computer Science & Engineering of Visvesvaraya Technological University, Belgaum** during the academic year 2022-2023. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies requirement in respect of project work prescribed for the said degree.

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DECLARATION

AFIFA MAHEEN (1AT19CS007), ARVIND KUMAR (1AT19CS018), ASHITHA V SHETTY (1AT19CS020) and KAVYA J K (1AT19CS055) students of VIII semester B.E in Computer Science & Engineering at Atria Institute of Technology, hereby declare that the project work entitled "**IDENTIFYING LOCATION OF POTHOLE USING COMPUTER VISION**" has been carried out under the supervision of Prof. Sathisha G, Assistant Professor, Dept. of CS&E, Atria Institute of Technology and submitted in partial fulfillment of the course requirements for the award of degree in B.E in Computer Science & Engineering of Visvesvaraya Technological University, Belagavi during the year 2022-2023. We further declare that the report has not been submitted to any other University for the awardof any other degree.

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Place: Bangalore

Date:

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Last but not the least, the project would not have been a success without the support of our **parents** and **friends**. Our sincere thanks should be rendered to everyone who helped us in all possible ways.

ABSTRACT

On the road, there are a lot of potholes. Serious accidents may result from this. Over 3597 persons per year pass away as a result of these potholes. Potholes can result in damage including flat tyres and damaged wheels, car collisions, and serious accidents; this has grown to be a frightening issue in modern times. The study on this topic entails finding potholes in the road and keeping track of the coordinates of that particular location in a database. Creating a device that is integrated into the vehicle is frequently used to accomplish this. The device scans with its ultrasonic sensor when a pothole approaches, alerting the driver in advance. Through this effort, we are attempting to address and identify such potholes. This project's objective would be to develop a device that can detect potholes was made exclusively to find potholes. For real-time object recognition, this model was created utilizing the "You Only Look Once" method. YOLO v4 is being used by a pretrained algorithm to find the pothole. Sequential CNN (Convolution Neural Network) Methodology had previously been employed, however after a comparison study, we discovered that YOLO offered better real-time outcomes. The model has a GUI (Graphical User Interface) such that we can use the beginning and ending buttons to emulate it. Such a system uses an optic for retrieve photos from a live camera that identify potholes when it’s engaged. Similar to real-time object detection systems, Potholes will be displayed in real time. With the boxed-off pothole highlighted. Our accuracy with this approach ranges between 80 and 85 percent. Additionally, when a pothole is confirmed, add a system that enables the detector to determine the pothole's location using the coordinates of that position are recorded by the GPS (Global Positioning System) and maintained in a database.

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INTRODUCTION

1.1 OVERVIEW

Extensive research has previously been conducted on obstacle detection, with various approaches for avoiding different types of obstructions in various environments being tested. However, the mainattention has been on autonomous agents avoiding obstructions, which has only included extruding obstructions. As a result, the detection method turned out to be extremely system-specific and unfit for wider application. Although the comfort of the ride is influenced by the condition of the road, road transport has historically been very straightforward and economical. People who commute by car frequently express their frustration with potholes in the road. Potholes created by heavy vehicle traffic and excessive rainfall are to blame for accidents and fatalities. As a result, drivers are increasingly concerned about potholes since they run the danger of collisions and vehicle damage. Unexpected road bumps and ditches may cause more crashes. So that the trip is more comfortable and there are no possible problems, the potholes must be fixed. In order to identify potholes, the suggested solution uses the YOLO (You Only Look Once) v4 Algorithm. To evaluate this model, we used the following techniques:

1. Construct a model that can identify the obstacles in its route.
2. Emphasising the potholes to draw attention to them.

The outcomes are significantly influenced by the subjectivity and experience of assessors, and manually reviewing and evaluating visual pavement data is a time-consuming and expensiveoperation. The main goal of this system is to identify potholes in the road using deep learning techniques, which automate the process of spotting potholes and make it simple for users to recognize when they are approaching one.

1.2 INTRODUCTION TO DOMAIN

Deep learning, commonly referred to as deep structured learning, is one of several machine learning techniques built on representation learning and artificial neural networks. Unsupervised, semi- supervised, and supervised learning are all possible.

Deep-learning architectures, such as deep neural networks, deep belief networks, deep reinforcementlearning, recurrent neural networks, and convolutional neural networks, have been used in a varietyof applications, such as computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, material inspection, and board game programmes, and have sometimes outperformed human performance. The information processing and distributed communication nodes in biological systems served as the inspiration for artificial neural networks (ANNs). ANNs and biological brains differ in a number of ways. In particular, artificial neural networks frequently have a static, symbolic nature, whereas the biological brains of the majority of living things have a dynamic, malleable, analogue nature. The usage of several network layers is indicated by the term "deep" in deep learning. Early research shown that anetwork with a nonpolynomial activation function and one hidden layer of unbounded breadth can be a universal classifier but a linear perceptron cannot. more recent form, known as deep learning, focuses on an unbounded number of layers with bounded sizes, allowing for practical application and optimised implementation while maintaining theoretical universality under benign circumstances. For the sake of efficiency, trainability, and understandability, deep learning also allows the layers to be heterogeneous and deviate greatly from biologically informed connectionist models, hence the "structured" aspect.

1.2.1 DEFINITION

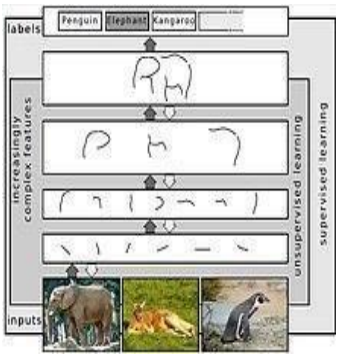

Figure 1.1 shows how deep learning represents pictures using various abstraction layers.

A family of machine learning techniques known as "deep learning" uses numerous layers to graduallyextract higher-level features from the input's raw data. In image processing, for instance, lower layersmight recognize borders, while higher layers might identify things that are important to people, likenumbers, letters, or faces.

1.1.2 OVERVIEW

However, they can also include propositional formulas or latent variables organized layer-wise in deep generative models, such as the nodes in deep belief networks and deep Boltzmann machines. The majority of contemporary deep learning models are based on artificial neural networks,specifically convolutional neural networks (CNNs).

Each degree of deep learning learns how to change the incoming data into a tad more abstract and composite representation. In an application for image recognition, the initial input could be a matrix of pixels; the first representational layer could abstract the pixels and encode edges; the second layercould compose and encode arrangements of edges; the third layer could encode a nose and eyes; andthe fourth layer could recognize that the image contains a face. Importantly, a deep learning processcan figure out on its own which features to best place in which level. This does not entirely do awaywith the necessity for hand-tuning; for instance, different layer counts and sizes can offer varied levels of abstraction. The "deep" part of "deep learning" refers to the number of layers through which the data is changed. More specifically, deep learning systems have a significant depth of credit assignment paths (CAP).The series of conversions from input to output is known as the CAP. CAPs define the relationships that might exist between input and output. Given that the output layer is also parameterized, the depthof the CAPs for a feedforward neural network equals the depth of the network plus one. The CAP depth for recurrent neural networks, in which a signal may pass through a layer more than once, is theoretically limitless. Although there isn't a depth cutoff that distinguishes deep learning from shallow learning in all cases, most researchers concur that deep learning requires CAP depths greaterthan 2. It has been demonstrated that CAP of depth 2 is a universal approximator, capable of simulating any function. Beyond that, adding more layers does not improve the network's ability to approximate functions.

Additional layers aid in effectively learning the features because deep models(CAP > 2) are able to extract better features than shallow models.

A greedy layer-by-layer strategy can be used to build deep learning architectures. Deep learning aidsin detaching these abstractions and identifying the elements that enhance performance.

Deep learning techniques avoid feature engineering for supervised learning tasks by converting the data into compact intermediate representations similar to primary components and resulting in layered structures that eliminate representational redundancy.

Deep learning algorithms can be applied to unsupervised learning tasks. This is an important benefit because unlabeled data are more abundant than the labeled data. Examples of deep structures that can be trained in an unsupervised manner are neural history compressors and deep belief networks.

CHAPTER 2

PROBLEM STATEMENT

- Road accidents and car damage are frequently caused by potholes in the poor state of the roads.
- Almost every city in the nation has recently seen a rise in big and little potholes on the roads due to increased pollution and vehicle traffic.
- In 2017, about 10 people died every day as a result of potholes, totaling 3597 fatalities nationwide, an increase of more than 50% from 2016.
- This is a significant issue in many wealthy nations as well. The government authorises a sizable sum of money to repair potholes, but because they are not promptly found, accidents and other catastrophes result from their failure to be repaired.

CHAPTER 3

LITERATURE SURVEY

A project report's literature survey or review outlines the numerous studies and analyses that have been conducted in the area of interest as well as the findings that have already been published, all while taking into account the project's varied constraints and scope. The primary goal of a literaturereview is to analyse the project's background in order to identify any weaknesses in the current system and provide recommendations for how to remedy any outstanding issues. Therefore, the following topics not only present the project's history but also expose the issues and shortcomings that prompted the development of this project.

A scientific paper's text that incorporates the most recent information, including important discoveries, as well as theoretical and methodological contributions to a given subject is called a literature survey. Reviews of the literature rely on secondary sources and do not present brand-new or unique experimental research. A literature review typically comes before the methodology and findings sectional, however this is not always the case. A literature review is most frequently connected with academic-oriented material, such as a thesis, dissertation, or peer-reviewed journal article. In a search proposal or prospectus, which must be authorised before a student can start working on a dissertation or thesis, literature evaluations are also frequent. Its primary objectives areto place the current study within the context of the body of literature and to give the reader specific context. Reviews of the literature serve as the foundation for study in almost every academic subject.The following are included in a literature review:

- Already existing theories that are widely acknowledged about the subject.
- Books on the subject, both general and specialised.
- Field research is often done from earliest to latest.
- The difficulties being experienced and ongoing work, if any.

The existing work on the specified project is described in the literature review. The issue related to the current system is addressed, and the user is provided with clear instructions on how to handle theissue and offer a solution.

Goals of Literature Review

- Acquiring knowledge of the ideas' definitions.
- Access to the most recent theories, methods, and approaches.
- Identifying research areas based on the body of available data
- Focus on your area of expertise; even when words are used in another field, they typically meanthe same thing. By removing digressions, the quality of the literature review is improved. Don't forget to explain any exclusions.

The following system is taken into account before developing our application:

1. Title: An Artificial Intelligence Method for Asphalt Pavement Pothole Detection Using Least Squares Support Vector Machine and Neural Network with Steerable Filter-Based Feature Extraction.

Author: Nhat-Duc Hoang

Abstract:

An artificial intelligence (AI) model is developed in this work for spotting potholes on asphalt pavement surfaces. To extract features from digital images, image processing techniques including the Gaussian filter, steerable filter, and integral projection are used. To train and test the predictive performance of two machine learning algorithms, including the least squares support vector machine(LS-SVM) and the artificial neural network (ANN), 200 image samples were gathered as a data set.Both LS-SVM and ANN are effective approaches for pothole identification, according to experimental findings from a recurrent subsampling process with 20 runs, with classificationaccuracy rates more than 85%. Additionally, the LS-SVM has the best area under the curve (0.96) and classification accuracy rate (roughly 89%). As a result, the suggested AI method combined withLS-SVM has a great deal of potential to help transportation authorities and road inspectors with thetask of identifying pavement potholes.

Methodology:

Artificial neural network (ANN) and least squares support vector machine (LS-SVM)**.**

Limitations:

In this study, accuracy was insufficient for effective pothole detection.

2. Title: Detecting a pothole using deep convolutional neural network models for an adaptive shock observing in a vehicle driving.

Author: Kwang Eun An; Sung Won Lee; Seung-Ki Ryu; Dongmahn Seo.

Abstract:

One of the biggest threats to driving a car is a pothole. It causes an accident by abruptly twisting thesteering wheel, applying extreme pressure on a tyre or turning the car hard by making a late discovery. Finding the location of a pothole on the pavement is essential. Finding a pothole gets increasingly difficult in contemporary life as the amount of pavement grows. Several approaches recommend using sensors to find potholes. However, these techniques need to be installed on the vehicle in order to gather pavement data. In the meantime, alternative approaches use smartphone sensors to save deployment costs and gain the benefit of sensitive sensors without requiring a difficult installation on the car. This makes a technique for identifying a pothole in a pavement using a smartphone camera and an artificial neural network effective. In this study, we examine how well a deep convolutional neural network-based image classification technique performs while detecting potholes.

Methodology:

To find a pothole in the pavement, use Inception_v4, Inception_ResNet_v2, ResNet_v2_152, andMobileNet_v1.

Limitation:

The models' training takes more time.

3. Title: Real-Time Road Pothole Mapping Based on Vibration Analysis in Smart City

Author: Dong Chen; Nengcheng Chen; Xiang Zhang; Yuhang Guan.

Abstract:

Smart cities cannot exist without vehicle-road collaboration, and pothole detection is a key component of this partnership. Road potholes can now more accurately be detected thanks to advances in surveying and mapping technology. The potholes in the road, however, cannot be mapped in time since the legacy detection methods lack the serviceability and real-time observation capability. We suggested a reflectometry technique to realise real-time pothole monitoring with vibration signal analysis and

spatio-temporal trajectory fusion in order to address this important problem. For validation, we continued to develop a number of prototype devices. These prototype devices operate with edge signal processing and spatio-temporal information fusion, measuring the acceleration signal installed on the wheel steering lever. Through the narrow band Internet of Things,observation results and spatiotemporal data are quickly transmitted to the sensing server. Results andanalysis proved that this technology, which depends on repeated trajectory data from the vehicle, successfully enables the potholes monitoring in real-time through light and a swiftly deployable platform. The outcomes showed that this strategy was not constrained by the kind of vehicle, the speed, or the state of the engine. The suggested strategy produced accurate, reliable, and real-time pothole observation results in the road experiment. Based on spatio-temporal trajectory fusion, the system lowers costs and boosts sensing effectiveness over conventional approaches, and pothole information can be prompted in real-time. This invention offers strategic investigation and consideration for addressing road potholes in real-time sensing.

Methodology:

IoT with Data mining Techniques

Limitation:

• In this work, accuracy is insufficient for effective pothole detection.

• Training the models takes more time.

4. Title: Pothole and Plain Road Classification Using Adaptive Mutation Dipper Throated Optimization and Transfer Learning for Self Driving Cars.

Author: Amel Ali Alhussan; Doaa Sami Khafaga; El-Sayed M. El-Kenawy

Abstract:

An essential component of adopting traffic intelligence is the self-driving car. The comfort and safetyof self-driving cars' rides are significantly impacted by the quality of the road in front of them. The presence of potholes on the road may cause a number of issues, such as automotive damage and thepossibility of crashes. As a result, self-driving cars have to be able to modify their driving style in response to the immediate identification of potholes in the road.

This issue is addressed using a variety of techniques, including contacting the appropriate authorities, using vibration-based sensors,and 3D laser imaging. These solutions were, however, constrained by factors including high setup costs and the risk of detection. Therefore, it is essential to accurately and quickly automate the process of identifying potholes. This research presents a unique approach for feature selection and random forest (RF) classifier optimisation based on adaptive mutation and dipper throated optimisation (AMDTO). In order to improve the performance of the optimised model, we also suggest a brand-new adaptive technique for dataset balancing known as optimised hashing SMOTE.Prior to building the proposed model, data on potholes in various environments and weather situations were gathered. Experiments demonstrating the suggested method's accuracy in classifyingroad potholes demonstrate its efficacy. Three machine learning classifiers and eleven featureselection methods, including WOA, GWO, and PSO, were used in the trials to gauge the effectiveness of the suggested approach. The proposed method, AMDTO+RF, outperformed the other approaches, WOA+RF, GWO+RF, PSO+RF, and transfer learning approaches, AlexNet, VGG-19, GoogLeNet, and ResNet-50, in terms of accuracy in classifying potholes (99.795% vs. 97.5%, 98.6%, 87.3%, and 90.4%, respectively). In order to investigate the importance and stabilityof the suggested approach, a comprehensive statistical analysis is also carried out on the recorded results.

Methodology:

For feature selection and Random Forest (RF) classifier optimisation, use adaptive mutation anddipper throated optimisation (AMDTO).

Limitation:

Training the models takes more time.

5. Title: Detection of Asphalt Pavement Potholes and Cracks Based on the Unmanned Aerial Vehicle Multispectral Imagery

Author: Yifan Pan; Xianfeng Zhang; Guido Cervone; Liping Yang

Abstract:

Asphalt roads are the fundamental building block of a land transportation system, and as they are used, their quality will deteriorate due to the ageing and wear and tear of the road surface. In the end,some road pavement distresses, like the most typical potholes and

cracks, may be visible on the roadsurface. Currently, some new types of remote sensing data, such as digital images, light detection and ranging, and radar, are widely used to detect pavement distresses without damaging the pavement in order to increase the effectiveness of pavement inspection. Remote sensing applications frequently employ multispectral imaging to display the spatial and spectral characteristics of objects. .In our study, machine learning algorithms such as support vector machine, artificial neural network,and random forest were used to separate the normal pavement from pavement damages (such as cracks and potholes) using the multispectral pavement images captured by unmanned aerial vehicle(UAV). This study compares the performance of various data sources and models and discusses theresults. It shows that a UAV remote sensing system provides a new tool for tracking the status of asphalt roads and may be used to assist maintenance decisions.

Methodology:

- IOT with random forest, artificial neural network, and support vector machine.

Limitation:

- Training the models takes more time.

CHAPTER 4

SYSTEM REQUIREMENTS SPECIFICATION

The System Requirement Specification (SRS) is a primary report that underpins the product advancement process. It describes the needs of a framework and depicts its most important feature. An SRS is essentially an organization's written assessment of a client's or potential customer's framework requirements and conditions at a certain point in time (usually) prior to any real configuration or enhancement activity. It's a two-way security strategy that ensures both the client and the organization understand the other's requirements from that point of view at anymoment.The SRS examines the item but not the endeavor that developed it; hence, the SRS serves as a foundation for eventual development of the completed item. The SRS may need to bemodified, but it allows an organization to progress with creation assessment. Simply said, determining the programming need is the first step in the product enhancement process.

The SRS entails decoding the consumers' ideas - the information - into a formal archive the output of the preparatory stage. As a result, the stage's output is a set of formally stated needs that are ideally complete and consistent, but the data has none of these features.

4.1 FUNCTIONAL REQUIREMENTS

This section explains the system's functional requirements for those needs provided in natural language.

1. Develop a desktop application.
2. Using the camera, capture the image.
3. The system will read and preprocess frames.
4. Using the YOLOv4 model, the system will detect potholes.
5. The application should identify potholes on roadways quickly.

4.2 NON-FUNCTIONAL REQUIREMENTS

These are non-functional requirements, in other words, constraints within which the system mustoperate.

4.2.1 CPU- INTEL CORE i5

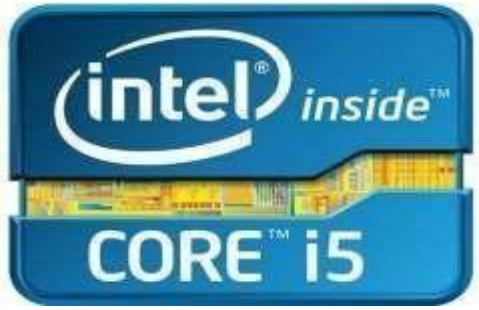

Fig 4.2.1 INTEL CORE i5

Intel Core is a brand name applied by Intel to refer to a spectrum of mid-range to high-end consumer and business microprocessors. The current Core processor lineup in 2015 featured theIntel Core i7, Intel Core i5, and Intel Core i3. 5th generation Intel® CoreTM i5 CPUs enable newbreakthroughs like Intel® Real SenseTM technology, bringing to your devices features like gesture control, 3D captures and editing, and unique picture and video capabilities. With Intel® Turbo Boost Technology 2.0, you can enjoy wonderful graphics, built-in security, and an automated burst of computing power when you need it.

4.2.2 RAM

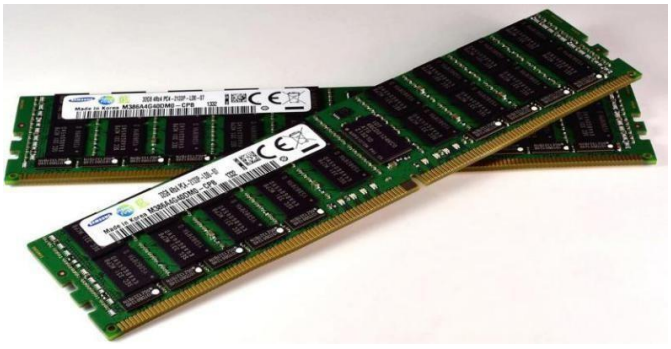

Fig 4.2.2 RAM 8 GB

When you run a programme on your computer, it is loaded into the available RAM memory. It has a very rapid memory. The more programmes you run, the more RAM is consumed. When you have loaded enough apps to utilise all of your free available physical RAM, the operating system will create a swap-file on your hard drive. This file acts as an extra copy for any other programmes you run.

The issue is that hard drives are far slower to read and write from than RAM memory. As an outcome, your computer will run significantly slower at that moment. Despite the fact that currentgeneration SSD hard drives are far quicker than classic spinning drives, it continues to be advantageous to have enough RAM accessible. If you're using Windows and want to know howmuch RAM that you're consuming, right-click on the task bar, then pick launch "Task Manager,"and on the "performance" tab, you'll notice a green bar that says "Memory."

4.2.2 HARD DISK

Fig 4.2.3 Hard Disk Drive

A hard disc drive (HDD), also known as a hard disc, hard drive, or fixed disc, is a data storage device that uses one or more rigid ("hard") fast spinning discs (platters) covered with magnetic material to store and retrieve digital information. The platters are linked together by magnetic heads mounted on a moving actuator arm that read and write information to the platter surfaces. Data is accessed randomly, which means each of the blocks of data can be recorded or retrievedin any sequence rather than sequentially. Even when turned off, an HDD keeps its data.

4.3 HARDWARE REQUIREMENTS

Processor: intel i3 processor and above.

Processor Speed: 2.44gHz or above.

Input device: Keyboard, Mouse,

RAM: 8 GB or above.

Storage Space: 50 GB or above.

Internet Connectivity: 20kbs or above required

4.2.3 PYTHON

Python is a high-level, interpreted general-purpose programming language. Python, developed by Guido van Rossum and initially released in 1991, has a design philosophy that emphasizes code readability, particularly through the use of large whitespace. It includes structures that allowfor straightforward programming on both local and big sizes. Van Rossum managed the languageassociation until his retirement in July 2018.Python has a dynamic type system as well as automated memory management. . It features a big and extensive standard library and supports several programming paradigms, including object-oriented, imperative, functional, andprocedural. Python translators are available for a wide variety of operating systems. Thereference Python implementation, CPython, is open source software[30] has a community-based development mechanism, as do practically all of Python's other representations. Guido van Rossum at Centrum Wiskunde & Informatica (CWI) in the Netherlands invented Python in the late 1980s as a replacement to the ABC language (itself inspired by SETL, capableof exception handling, and connecting with the Amoeba operating system). It went into effect inDecember 1989. Van Rossum's lengthy impact on Python is reflected in the title bestowed to himby the Python community: Benevolent Dictator For Life (BDFL), a position from which he resigned on July 12, 2018.

Python 2.0 was launched on October 16, 2000, with numerous significant enhancements, including a cycle-detecting garbage collector and Unicode support.

On December 3, 2008, Python 3.0 was released. It was a substantial language redesign that was not totally backward-compatible. Many of its major features were backported to Python versions

2.6.x and 2.7.x. The 2to3 tool, included in Python 3 releases, automates (at least partially) the translation of Python 2 code to Python 3.

Python 2.7's end-of-life date was originally set in 2015, but was later pushed back to 2020 due to issues that a significant corpus of old code would be difficult to transfer to Python 3. Google revealed in January 2017 that it was working on a Python 2.7 to Go transcompiler to improve performance under concurrent workloads.

4.2.4 JAVASCRIPT

JavaScript (abbreviated JS) is a lightweight, interpreted object-oriented programming language featuring first-class functions. It is primarily recognised as an internet scripting language, although it is also used in numerous non-browser applications. It is a prototype-based multi- paradigm scripting language that supports object-oriented, imperative, and functional programming approaches. JavaScript is used to design how web pages behave when an occurrence happens on the client side of the internet. JavaScript is a straightforward yet powerfulprogramming language that is widely used to control the behaviour of web pages. Contrary to common perception, JavaScript is not "Interpreted Java". In a word, JavaScript is a dynamic programming language that allows for prototype-based object creation. The fundamental syntaxis meant to be comparable to both Java and C++ in order to limit the number of new concepts required to learn the language. If statements, for and while loops, and switch and try... catch blocks all operate the same (or nearly so) as in these languages.

In contrast to the syntactic class declarations observed in compiled languages such as C++ and Java, objects in JavaScript are produced dynamically by attaching methods and properties to otherwise empty objects at run time. Once constructed, an object can be used

as a blueprint (or prototype) to make similar items.

Dynamic JavaScript features include runtime object generation, variable parameter lists, functionvariables, dynamic script creation (via eval), object introspection (via for... in), and source coderecovery (JavaScript programmes can decompile function bodies back into their source text).

JavaScript (abbreviated JS) is a lightweight, interpreted, object-oriented language with first-classfunctions. It is known as the scripting language for websites, although it is also used in many non-browser applications. It is a multi-paradigm, prototype-based scripting language that supports object-oriented, imperative, and functional programming techniques.

CHAPTER 5

SYSTEM DESIGN AND ANALYSIS

The process of establishing the architecture, components, modules, interfaces, and data for a system in order to meet given criteria is known as system design. The application of systems theory to product development might be viewed as systems design.

5.1 EXISTING SYSTEM

The primary goal of this project is to create a system that can detect potholes in photos. This pothole detection might be done in real time. A deep learning method was employed for this. A convolutional neural network (CNN)-based model has been developed that uses thermal photographs of potholes and non-pothole roads as input. After training the model on this data, the machine predicts whether the input image is of a pothole or not. Convolutional neural networks have been employed in many domains, including radiology, for tasks such as classification, object identification, segmentation, and so on. Furthermore, we employed pretrained neural network models based on residual networks to get superior outcomes for the specified challenge. However, we did not employ the pre-trained models alone.

First, we fine-tuned these models for the specific issue by training the model for a few epochs onthe pre-computed weights. The model was then trained utilizing recommended practices such ascyclic differential learning rates and test time data augmentation, after we eliminated pre- computed weights of the final layers. The outcomes of various models are then compared. A comparison of the suggested study with previously existing studies was also performed to see whether the proposed model based on convolutional neural networks on thermal pictures is economical and practicable.

5.1 PROPOSED SYSTEM

Improving road safety is a critical problem in Indian telecom services (ITC).

The YOLO Algorithm is used to detect potholes in this suggested model, which is based on machine learningand image processing. This device will assist in detecting potholes on the road and informing thedriver. The motivation here is to use technology to better serve mankind**.**

5.1.1 YOLOv4

In the proposed system, the YOLO V4 algorithm is employed. "You Only Look Once" is an abbreviation that stands for "You Only Look Once." It is a cutting-edge, real-time object recognition system created by Joseph Redmon that can discriminate between many things in a single frame. YOLO has an entirely new detecting method than previous technologies. Itprocesses the entire image using a single neural network. This network divides the picture into regions and predicts bounding boxes and probabilities for each region. These bounding boxes areweighted using the anticipated probability. YOLOv4's AP and FPS enhancements are working great. YOLOv4 optimizes real-time object recognition and training on a single CPU. On a TeslaV100, YOLOv4 achieved state-of-the-art performance with 43.5 percent speed (AP) at 65 framesper second (FPS) on the COCO dataset.

The graphics below depict the fundamental principle of YOLO. The input picture is divided intoS x S grid cells, with each grid cell expecting the item that is centered in that grid cell.

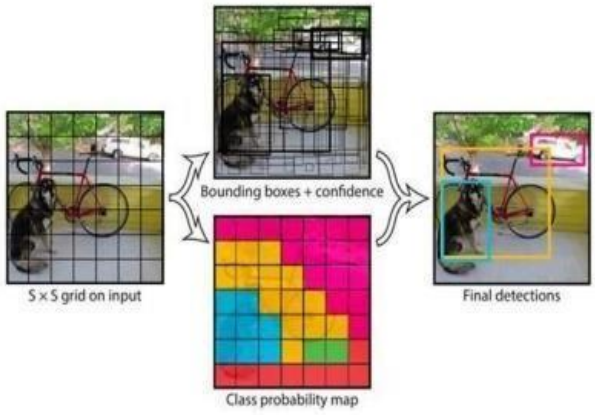

Fig 5.1 S X S Grid

In each grid cell, bounding boxes and confidence ratings are anticipated. These confidence ratings show the model's assumption that the box contains an object as well as its accuracy inforecasting the box.

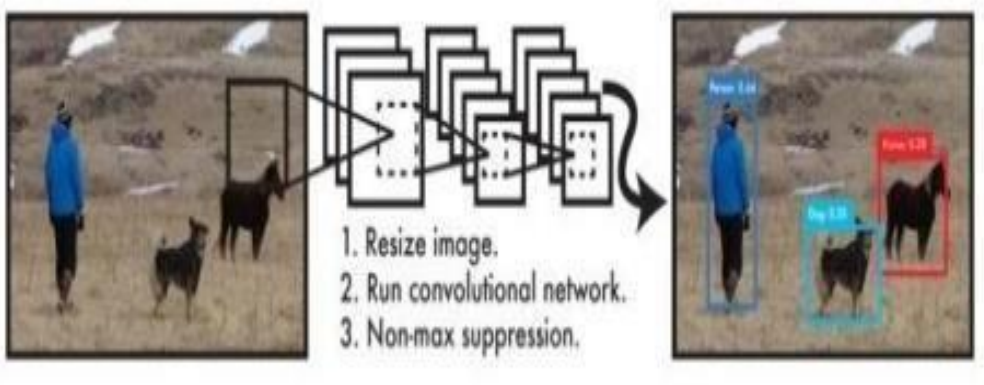

Fig 5.2 YOLO Concept

Steps for Yolov4 Training:

- We will train the YOLOv4-Tiny model with a fixed resolution of 416416.
- We will next do dynamic resolution training with the YOLOv4-Tiny model and a base resolution of 416416. On the test set, this experiment should yield a greater map than the fixed- resolution training. We will confirm this after we analyses the results.
- Next, we will train a dynamic resolution model with a base resolution of 6086608 using the YOLOv4 model. This should give us a greater map on the test set than the little models.
- Finally, we will train the YOLOv4 model using a fixed-resolution picture resolution of 60860.

5.2.2 BLOCK DIAGRAM

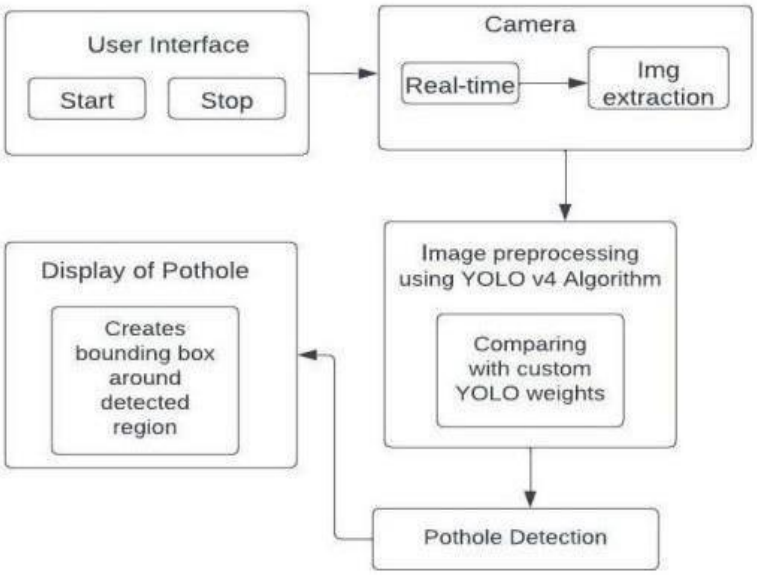

Fig 5.3 Block Diagram

Figure -2 depicts the system block diagram. The suggested system operates with a very basic anduser-friendly GUI that gives you two options, "Start" and "Stop," and allows you to identify potholes in real time using the YOLO v4 algorithm. When the "Start" option is selected, the camera turns on and detects potholes in real time. Now, the camera continues to record while the YOLO v4 algorithm operates in the background. The relevant information for identifying potholes is recorded. Throughout the live recording, pictures are retrieved and a detecting procedure is carried out. The YOLO v4 algorithm processes these photos one by one.

It compares the data from the photos to the yolo weights. When a pothole is discovered, it predictsa bounding box around it. The bounding box is made up of a Box Label and a Predicted AccuracyPercentage, where Accuracy Percentage relates to the percentage of how correctly a pothole is recognized. The number of potholes detected in each picture is displayed in the console output. When you pick the "Stop" option, the system quits the GUI and so the detection process comes to a halt.

5.2.2 FLOW CHART

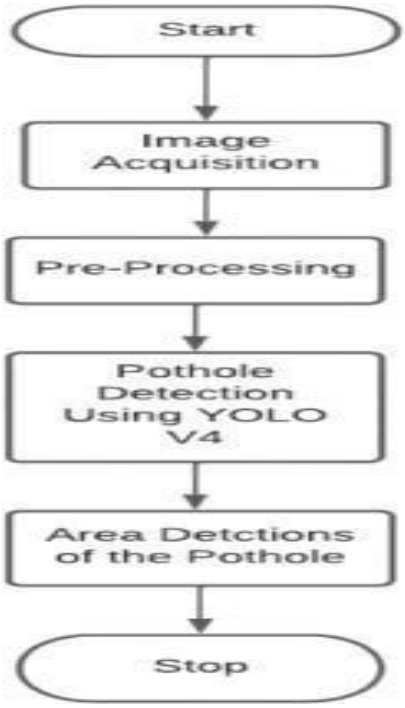

Fig 5.4 Flow Chart

To acquire the required result from this model, we have to first submit the image/video into the code. So, to enhance and make it useable, we connected our model to a live camera to detect potholes in real time. The following is the system flow: When the device boots up, the camera turns on and the Yolo V4 algorithm detects potholes in real time. Potholes are detected by extracting pictures from live video and processing them. This network divides the picture into regions and predicts bounding boxes and probabilities for each region. These bounding boxes areweighted using the anticipated probability.

5.2.3 DATA FLOW DIAGRAM

A Data flow diagram (DFD) is a graphical illustration of the "flow" of facts through an information machine, modelling its procedure aspects. A DFD is often used as a preliminary stepto create an outline of the machine without going into superb detail, which could later be elaborated. DFDs also can be used for the visualization of data

processing. A DFD is likewise known as facts drift graph or a bubble chart. A method is a change that takes input facts and produces output facts. DFDs may be used to model numerous factors of a machine or business enterprise together with the modern-day nation, the desired future state, or the effect of proposed modifications.

Level: 0 describes the overall process of the project. We are user's road images and trained as input. By using the deep learning algorithm, it will efficiently detects potholes in input image.

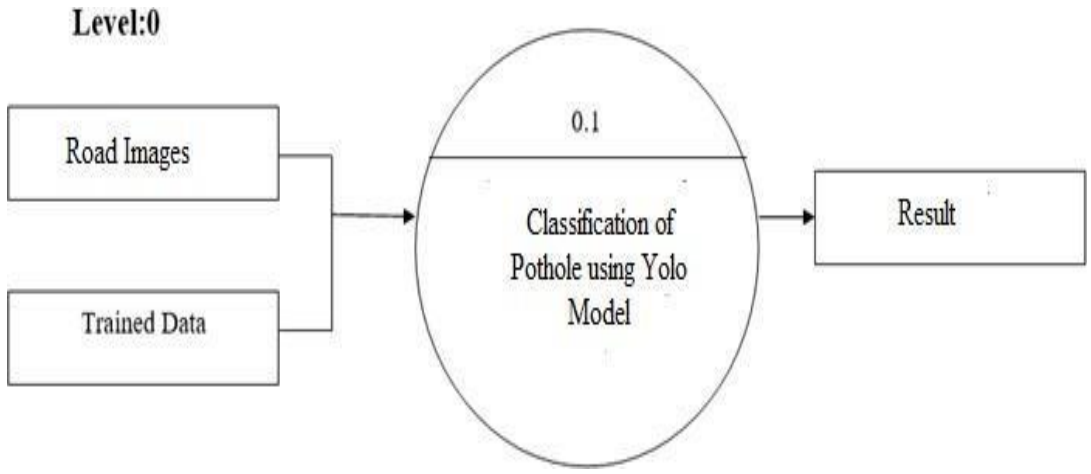

Fig 5.5: DFD of Level 0

Level: 1 describes the first step of the project. We are passing images as input system willpreprocess and extract image features.

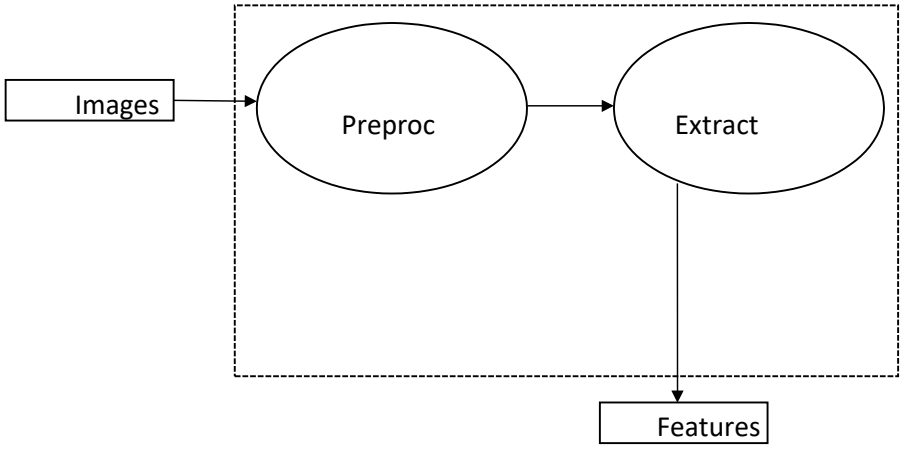

Fig 5.6 DFD of Level 1

Level: 2 describes the final step of the project. We are passing images as input system will readthe road image and detect potholes using YOLOv2.

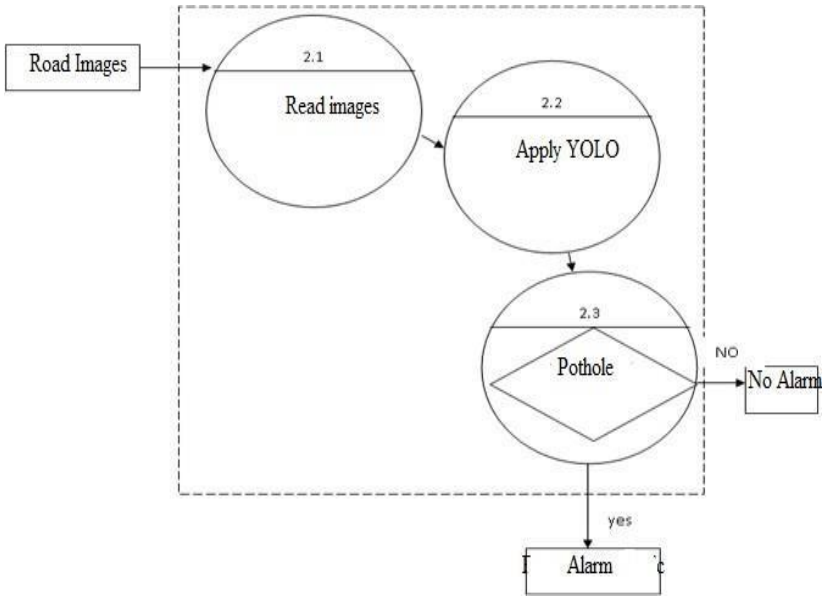

Fig 5.7 DFD of Level 2

5.2.4 USE CASE DIAGRAM

Use case diagram is a visible representation of the purposeful necessities of a machine or software program utility, depicting the interactions between its numerous actors (customers, structures, or different entities) and the particular approaches in which they interact with the machine to achieve their desires. it's miles a type of behavioral diagram that gives a excessive- level view of the device's capability, depicting the gadget's diverse use instances and the actors that participate in those use instances. Use case diagrams are often used for the duration of the early stages of software development to seize and speak requirements and to facilitate collaboration among stakeholders which include commercial enterprise analysts, developers, and testers. They can also be used to assist validate gadget necessities and to pick out ability layout troubles early inside the development technique. Use case diagrams are normally createdthe usage of specialized modelling tools or drawing software. The use case diagram allows to visualize the system's capability from a excessive-stage perspective, offering a short assessmentof the gadget's skills and interactions with the outdoor world. Use case diagrams are an vital

device for software program improvement teams to become aware of and analyse the requirements of a system, prioritize the functions, and layout and check the software program.

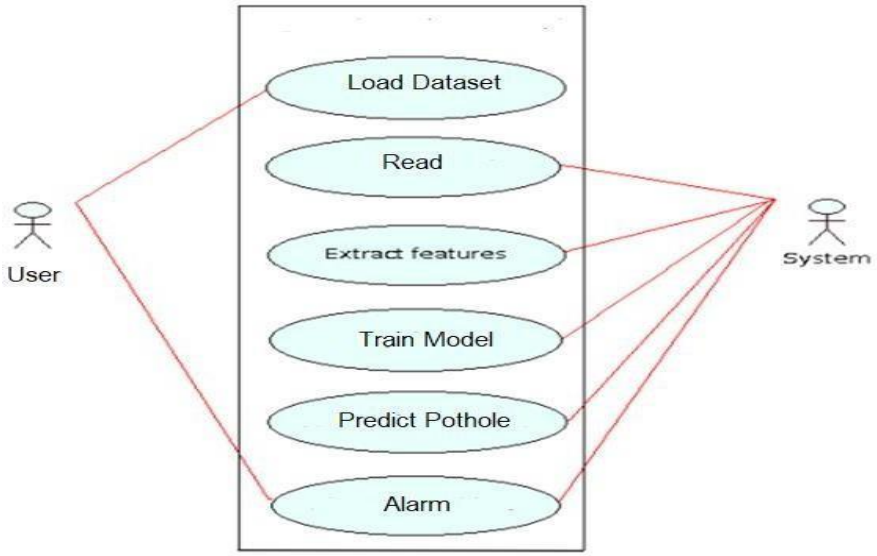

Fig 5.8 Use case Diagram

5.2.5 SEQUENCE DIAGRAM

A series diagram is a type of interaction diagram that indicates how objects interact with each different in a particular state of affairs of a use case or a enterprise process. it is used to visualise the sequence of information exchanged among items in a device over the years. collection diagrams are typically used during the design and implementation section of software development to specify and model machine behaviour and interactions between gadgets. Series diagrams consist of a fixed of gadgets and the messages which might be exchanged between them. The items are represented as vertical lifelines, and the messages exchanged between them are represented as horizontal arrows.A sequence diagram is a type ofinteraction diagram in the Unified Modeling Language (UML) that illustrates how objects in asystem interact with one another over time. It shows the sequence of messages or events that are passed between objects to achieve some task or goal. In the context of user behavior, it's possible that a sequence diagram could be used to represent the interactions between users and a system or application. For example, the diagram might show how a user logs in, navigates through different pages or screens, performs certain actions or tasks, and eventually logs out.

Each of these interactions could be represented as a sequence of messages or events in the diagram. As for the concept of active and inactive stages of users, it's possible that these termsrefer to different states or modes of user behavior. For example, an active user might be someone who is currently logged in and actively using the system or application, while an inactive user might be someone who has not logged in for a certain period of time or has not interacted with the system in a significant way. In the context of a sequence diagram, it's possible that different interactions or messages could be associated with different stages of userbehavior. For example, certain messages might only be sent or received when a user is in an active state, while others might only be relevant when a user is in an inactive state. The diagram could help to visualize these different stages and how they relate to the overall system or application.

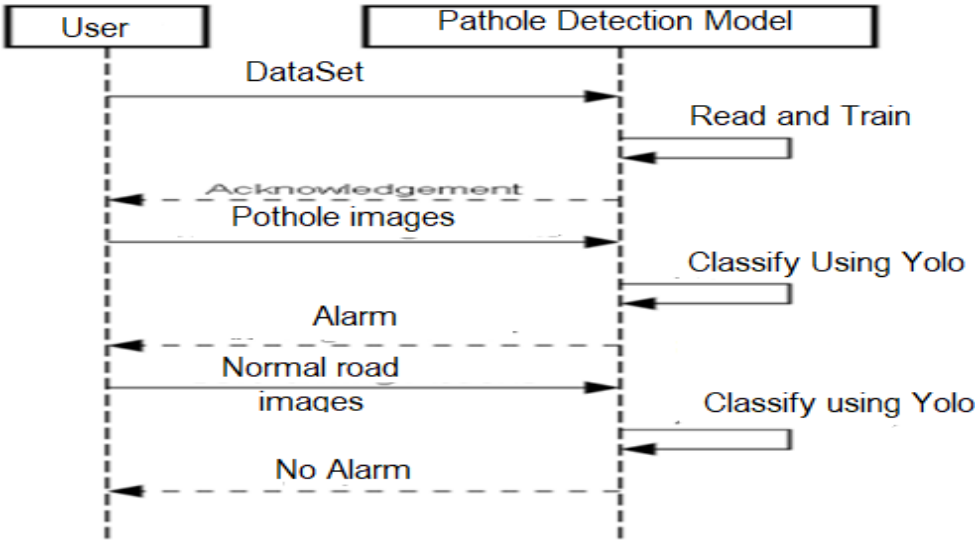

Fig 5.9 Sequence diagram represents active and inactive stages of every user.

5.2.6 ACTIVITY DIAGRAM

An activity diagram is a type of UML (Unified Modelling Language) diagram used to model themanagement flow in a machine or business procedure. It is a graphical depiction of the steps andsports involved in a process, indicating the sequence in which they occur as well as the circumstances that impact them.

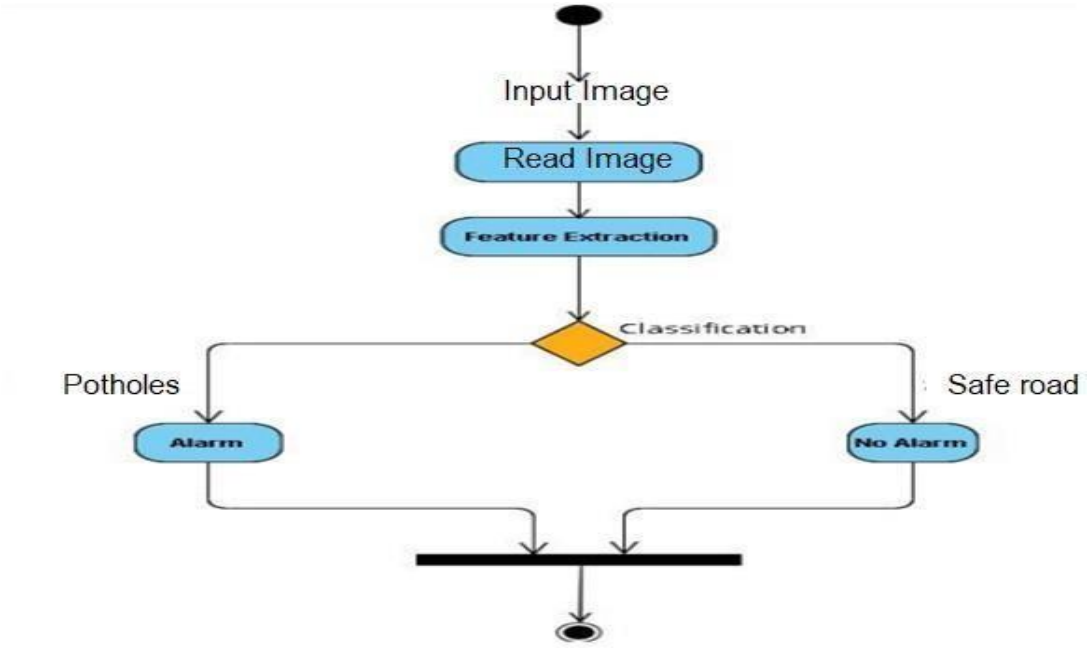

Fig 5.10 Activity Diagram

Activity diagrams are commonly used during the design and assessment stages of software development to capture and communicate the behavior of a systemor approach. They may be used to simulate a wide variety of procedures, such as software techniques, enterprise methods, and workflow techniques. Edges reflect the float of control among the nodes, whereas nodes represent the start, quit, or intermediate factors. Branching, merging, looping, and concurrent execution are examples of activities, which indicate the particular actions or motions that occur in the procedure. Activity diagrams may be used to identify and optimize a procedure's overall performance, as well as to detect possible difficultiesand bottlenecks. builders, testers, and quit-customers.

CHAPTER 6

SOFTWARE DESCRIPTION

Software can be defined as a set of programs and applications that are designed to perform specific tasks on a computer system. These programs can be broadly classified into two categories: system software and application software. System software includes programs thatare essential for the operation of a computer system, such as operating systems, device drivers, and utility applications. Operating systems are responsible for managing computer resources, such as memory and processing power, and provide a platform for running other software. Device drivers are software programs that facilitate communication between hardware devicesand the operating system. Utility programs are used to perform various system maintenance tasks, such as disk cleanup and system optimization. Application software, on the other hand, includes programs designed to perform specific tasks for end-users, such as word processors, spreadsheets, and email clients. These programs are typically designed to be user-friendly andprovide a simple interface for users to interact with. Some key features of software include:

- Functionality: Software is designed to perform specific tasks, and its functionality istypically defined by the needs of the user.
- Usability: Software should be easy to use and navigate, with a user-friendly interface that allows users to perform their tasks effectively.
- Performance: Software should be designed to operate efficiently, with minimal lag ordelays in executing instructions.
- Security: Software must be designed to be secure, with features such as data encryptionand access controls to protect sensitive data.
- Scalability: Software should be designed to be scalable, with the ability to handle increasing numbers of users or data volume over time.

6.1 VS CODE

Visual Studio (VS Code) is an integrated development environment (IDE) created by Microsoft.It is a popular tool used by developers to create a variety of applications, including desktop applications, mobile apps, web applications, and cloud-based solutions.

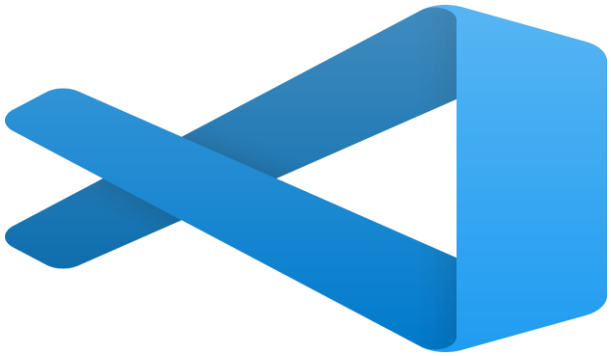

Fig 6.1: Visual Studio

VS Code offers a wide range of features and tools for developers to write, test, and debug code,as well as manage projects, source control, and collaboration. It supports several programminglanguages, including C#, C++, F#, Visual Basic, and Python. The IDE includes a code editor with advanced features such as IntelliSense, code refactoring, and code navigation, which helpdevelopers write code faster and more efficiently. It also includes a debugger that allows developers to debug their code and identify and fix errors. Visual Studio has a rich set of features for building user interfaces, including drag-and-drop designers for Windows forms, WPF, and ASP.NET web applications. It also provides tools for building mobile applications for Android, iOS, and Windows Phone. In addition, Visual Studio supports agile developmentmethodologies, with features such as sprint planning, backlog management, and project tracking. It also integrates with several popular source control systems, including Git and TFS,and provides tools for continuous integration and delivery. Overall, Visual Studio is a powerfuland feature-rich IDE that provides a comprehensive development environment for developers to build applications for Windows, web, and cloud services. Its extensive documentation, active

community, and support for multiple programming languages make it a popular choice for developers worldwide.

6.2 PYTHON

Python is a popular choice for data analysis and scientific computing due to its powerful libraries like NumPy, Pandas, and SciPy. It is also widely used for web development, with frameworks like Django and Flask that make it easy to build web applications. Overall, Pythonis a versatile and easy-to-learn programming language that is widely used in various domains. Its readability, modularity, and extensive library support make it a popular choice for developers worldwide.

Fig 6.2 Python

In addition to its extensive standard library, Python also has a vast ecosystem of third-party libraries and tools that can be easily installed and used for a wide range of purposes. For example, NumPy and pandas are popular libraries for data analysis and manipulation, while TensorFlow and PyTorch are popular for machine learning and artificial intelligence. Django and Flask are popular web frameworks for building web applications, and Pygame is a popularlibrary for game development. Python is also a cross-platform language, meaning that it can beused on multiple operating systems, including Windows, macOS, and various Linux distributions. This makes it easy for developers to write code on one platform and deploy it onanother without having to worry about platform-specific issues. Overall, Python's ease of use, flexibility, and vast ecosystem of tools and libraries make it a popular choice for a wide range of applications, from scientific computing to web development to machine learning and beyond.

6.2.1 FEATURES AND PHILOSOPHY

Python is a computer language that supports several paradigms. Object-oriented and structuredprogramming are fully supported, and many of its features allow functional and aspect-oriented programming (through meta programming and metaobjects (magic methods)). Many more paradigms, such as design by contract and logic programming, are supported through extensions.

Python manages memory via dynamic typing and a mix of reference counting and a cycle-detecting garbage collector. It also has dynamic name resolution (late binding), which binds method and variable names while the programme is being executed.

Python's architecture encourages functional programming in the Lisp tradition. It features methods like filter(), map(), and reduce(), as well as list comprehensions, dictionaries, and sets and generator expressions.

The standard library has two modules (itertools and functools) that implement functional toolsborrowed from Haskell and Standard ML.

The language's core philosophy is summarized in the document The Zen of Python (PEP 20),which includes aphorisms such as:

Beautiful is better than ugly

Explicit is better than implicit

Simple is better than complex

Complex is better than complicated

6.2.2 READABILITY COUNTS

Python was meant to be highly extendable rather than having all of its features built into its core. Because of its small modularity, it is very popular for adding programmable interfaces toexisting systems. Van Rossum's concept of a compact core language with a huge standard library and an easily expandable interpreter arose from his disappointment with ABC, which advocated the opposite approach.

While providing coding approach options, the Python ideology discourages flamboyant syntax(such as Perl's) in favour of a simpler, less-cluttered language. According to Alex Martelli, "todescribe something as 'clever' is not considered a compliment in the Python culture." Python's philosophy of language design rejects the Perl "there is more than one way to do it" approach in favour of "there should be one—and preferably only one—obvious way to do it."

Python's developers work hard to prevent premature optimisation, and they reject fixes to non- critical areas of the CPython reference implementation that offer marginal performance benefitsat the expense of clarity. When performance is vital, a Python writer can transfer time-sensitivefunctions to extension modules written in languages like C, or utilise PyPy, a just-in-time compiler.

CPython, which converts a Python script into C and makes direct C-level API calls into the Python interpreter, is also available.

Python's developers prioritise making the language enjoyable to use. This is reflectedin the language's name, which is a nod to the British comedy group Monty Python, as well as in the language's whimsical approach to tutorials and reference materials, such as examples that use spam and eggs (from a famous Monty Python joke) instead of the normal foo and bar.The termpythonic, which can refer to a variety of programming styles, is a popular neologism in the Python community. Pythonic code is code that employs Python idioms well, is natural or displays proficiency in the language, and adheres to Python's minimalist philosophy and emphasis on readability. Unpythonic code, on the other hand, is difficult to understand or readslike a clumsy transcription from another

programming language.

Pythonists, Pythonistas, and Pythoneers are terms used to describe Python users and fans, particularly those who are considered competent or experienced.

6.2.3 SEMANTICS AND SYNTAX

Python is designed to be a simple language. Its formatting is clean, and it frequently employs English terms where other languages use punctuation. It does not utilise curly brackets to delimit blocks, and semicolons following statements are optional, unlike many other languages.There are fewer syntactic exceptions and special situations in it than in C or Pascal.

6.2.4 INDENTATION

Python delimits blocks via whitespace indentation rather than curly brackets or keywords. Indentation increases after particular statements; indentation decreases at the conclusion of thecurrent block. As a result, the visual organisation of the programme perfectly mirrors.

6.2.5 METHODS

Methods on objects are functions associated to the object's class; the syntax instance.method(argument) provides syntactic sugar for Class.method(instance, argument) for conventional methods and functions. In contrast to the implicit self (or this) argument in certain other object-oriented programming languages (e.g., C++, Java, Objective-C, or Ruby), Python methods include an explicit self parameter to access instance data.

6.2.6 TYPING

Python employs duck typing, resulting in typed objects but untyped variable names. At build time, type constraints are not verified; rather, operations on an object may fail, indicating that the provided object is not of a proper type. Despite being dynamically typed, Python is stronglytyped, prohibiting non-well-defined actions (such as adding a number to a string) rather than quietly attempting to make sense of them.

Classes, which are often used in object-oriented programming, allow Python programmers to design their own kinds. Calling the class (for example, SpamClass() or EggsClass()) creates new instances of the class, and the classes are instances of the metaclass type (itself an instanceof itself), allowing metaprogramming and reflection.

Python has two types of classes prior to version 3.0: old-style and new-style. The only difference between the two forms is whether the class object is inherited directly or indirectly (all new-style classes inherit from object and are instances of type). Both types of classes are supported in Python 2 versions beginning with Python 2.2. Python 3.0 did away with legacy classes.

The long-term goal is to provide progressive typing, and starting with Python 3.5, the syntax ofthe language allows for the specification of static types, however they are not verified in the default implementation, CPython. Compile-time type checking is supported by mypy, an experimental optional static type checker.

6.2.7 LIBRARIES

Python's huge standard library, which is frequently accepted as one of its greatest features, provides tools suitable for a wide range of applications. Many standard formats and protocols,such as MIME and HTTP, are supported for Internet-facing applications. It includes modules for constructing graphical user interfaces, connecting to relational databases, producing pseudorandom numbers, decimal arithmetic with arbitraryprecision, manipulating regular expressions, and unit testing.

Some parts of the standard library are specified (for example, the Web Server Gateway Interface(WSGI) implementation wsgiref adheres to PEP 333), but the majority of modules are not. Theyare defined by their code, internal documentation, and (if provided) test suites. However, because the majority of the standard library is written in cross-platform Python, only a few modules require modification or rewriting for variant implementations.

The Python Package Index (PyPI), the official repository for third-party Python software,

has approximately 130,000 packages with a wide range of capabilities as of March 2018. It includes:

• Graphical user interfaces

• Web frameworks Multimedia

• Databases Networking

• Test frameworksAutomation

• Web scraping Documentation

• System administration

• Scientific computing

• Text processing

• Image processing.

6.2.7 DEVELOPMENT ENVIRONMENTS

Most Python implementations (including CPython) have a read-eval-print loop (REPL), allowing them to work as a command line interpreter in which the user enters instructions sequentially and receives instantaneous responses.

Other shells, like as IDLE and IPython, include additional features such as auto-completion, session state preservation, and syntax highlighting.

There are Web browser-based IDEs, SageMath (intended for developing science and math- related Python programmes), PythonAnywhere, a browser-based IDE and hosting environment, and Canopy IDE, a commercial Python IDE emphasising scientific computing, in addition to standard desktop integrated development environments.

6.2.8 IMPLEMENTATIONS

Python's standard implementation is CPython. It is written in C and adheres to the C89 standardwhile including a few C99 capabilities. It converts Python programmed into bytecode, which is subsequently processed by its virtual machine. CPython has a huge standard library developed in a combination of C and native Python. It is available for a variety of channels, including Windows and the majority of recent Unix-like systems. One of its first concerns wasplatform portability.

6.3 TKINTER

Tkinter is a widely used Python library for creating graphical user interfaces (GUIs) based on the Tk GUI toolkit, which was originally developed for the Tcl scripting language. It provides a set of Python modules that enable developers to create GUIs for desktop applications in Python. Tkinter offers a wide range of widgets, including buttons, labels, text boxes, and menus, which are customizable, allowing developers to control their appearance and behavior. It also provides support for event-driven programming, allowing the GUI to respond to user input andother events. One of the key advantages of Tkinter is its cross-platform compatibility. It works on many different platforms, including Windows, macOS, and Linux, making it an excellent choice for developing cross-platform applications. Tkinter is also easy to learn and use, with asmaller learning curve compared to other GUI libraries. Its integration with Python and availability in most Python installations make it a popular choice for developers who already use Python. Tkinter provides several layout managers, including pack, grid, and place, that make it easy to create complex GUI layouts. It also offers standard dialogs, such as message boxes, file dialogs, and color pickers, that can be used to interact with the user.Tkinter can be easily integrated with other Python libraries, such as NumPy, SciPy, and matplotlib, making ita powerful tool for scientific computing and data analysis. Overall, while other GUI libraries may have more features and better performance, Tkinter's simplicity, cross-platform compatibility, and ease of use make it a popular choice for beginners and experienced developers alike. It is a good choice for creating simple desktop applications and quick prototyping.

CHAPTER 7

IMPLEMENTATION

Improving road safety is a critical problem in Indian telecom services (ITC). The YOLO Algorithmis used to detect potholes in this suggested model, which is based on machine learning and imageprocessing. This device will assist in detecting potholes on the road and informing the driver. The motivation here is to use technology to better serve mankind.

During the execution phase, the project team develops the product or service and presents final product to customer

There are 3 execution phases

1. Build Deliverables:

We have completed the first two phases of this project. We begin by reviewing the requirementsof the project.

2. Monitor and Control:

This is the part of the execution phase because we must follow several steps to ensure the projectmeets the requirements such as

- **Time management**: During the time management process, we control the amount of time ourteam members spend working on each activity and monitor the stakeholdersat the end of the project.
- **Change management**: if a change in the project's scope of work we must formally request the change and get the changes approved.
- **Risk Management**: This involves handling the potential disadvantages and drawbacks that mayarise during a project.

3. Review: This helps you document the results of our project review, at the end of the executionproject phase.

- This is conducted at the end of the initiation, planning and execution phases within a project.
- Project is currently delivering to schedule.
- Risks have been controlled and mitigated.
- Changes were properly managed
- Project is on task.

2 Months	Studying about Literature survey
1 Month	Analyzing Problems and Problem formation
3 Months	Designing and implementation
2 Months	Testing

7.1 PRE-PROCESSING OF DATA

Data preprocessing is an important stage in the data mining process that entails modifying, deleting, or adding data before it is used to assure or improve performance. The saying garbage in, trash out" is especially applicable in data mining and machine learning projects. Because our YOLO v4 Model is pretrained, we had to enter a few photographs or videos as data, however withthe real-time detection system, images are automatically pulled from live camera recordings and analyzed using the YOLO v4 Algorithm.

7.2 DEEP LEARNING APPROACH

The YOLO V4 algorithm is employed in the proposed system. "You Only Look Once" is an abbreviation for "You Only Look Once." It is a cutting-edge, real-time object recognition system invented by Joseph Redmon that can recognize many things in a single

frame. YOLO detects using an entirely new method than previous technologies. It processes the entire image using a single neural network. This network divides the picture into regions and predicts bounding boxes and probabilities for each. The anticipated probabilities are used to weight these bounding boxes.

7.3 GUI FOR SIMULATION

We created a basic GUI (Graphical User Interface) using Tkinter to enable and disable the simulation of pothole detection. When you switch on the system, the camera begins to capture images, and you can see the pothole. If the pothole is identified, you will be able to halt the simulation by clicking on the stop button. Figure 6 shows the graphical user interface.

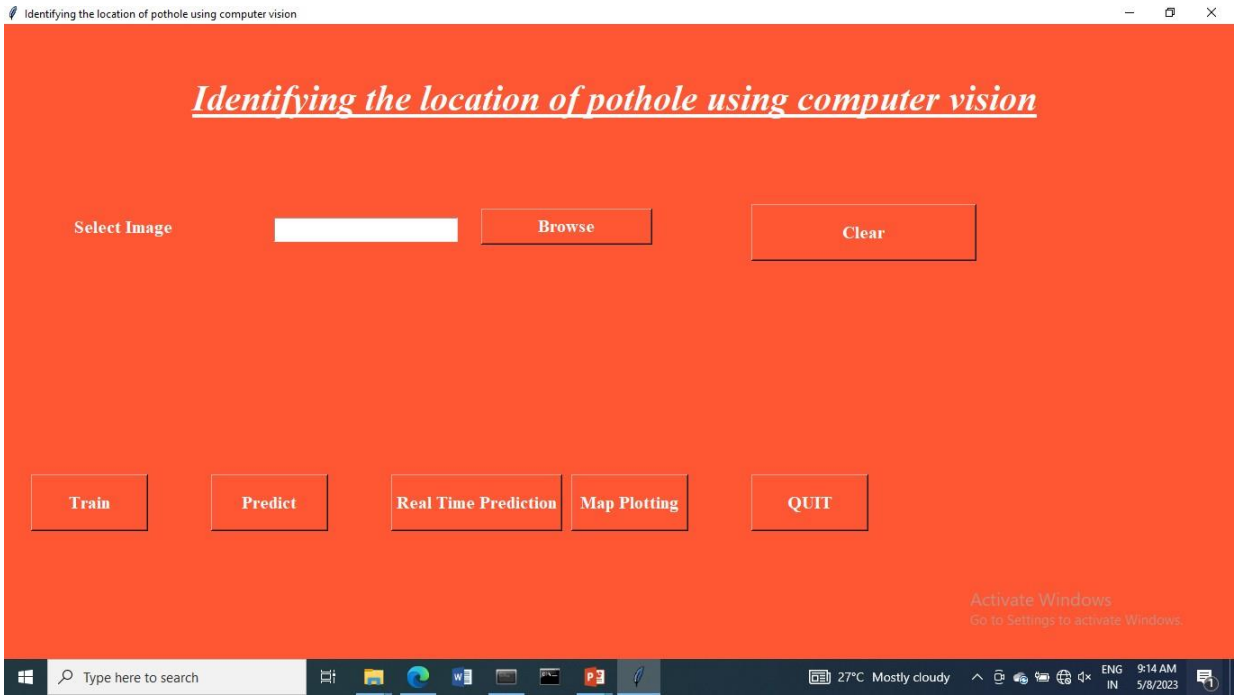

Fig 7.1 GUI

7.4 WORKING AND OUTPUT OF THE WEB APPLICATION

1. The coordinates are transmitted to the Web Application.
2. Markers are then placed on the map based on the coordinates.
3. The starting and ending points can be specified. We've chosen Hebbal as the starting place andAtria Institute of Technology as the goal.
4. This technique allows us to determine the number of potholes along the path and the distancesbetween them.

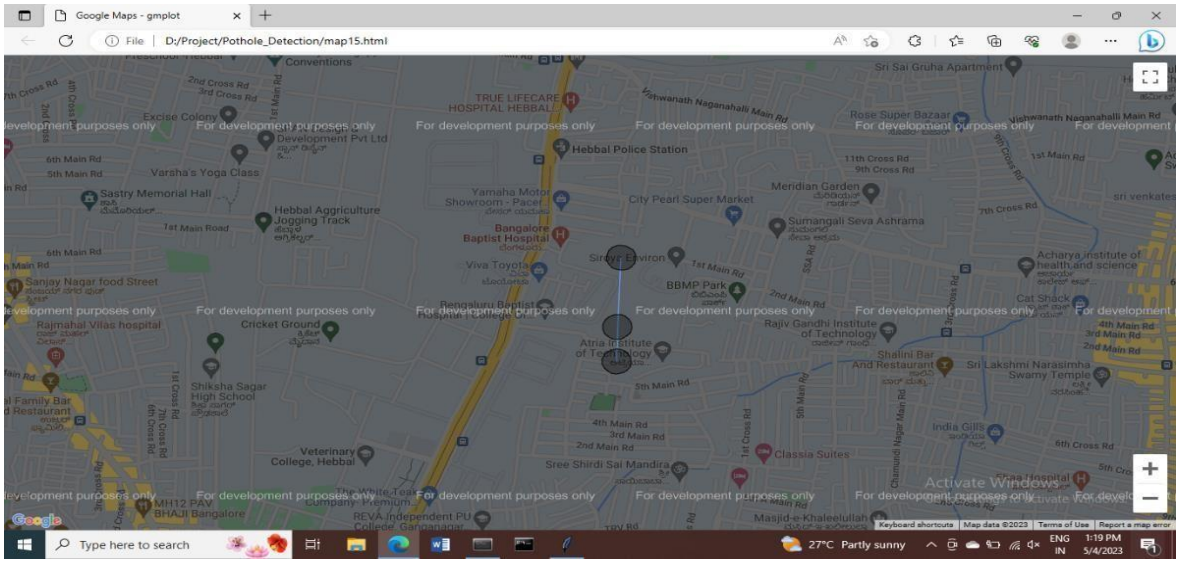

Fig 7.2 The Path between the Start and Destination is Marked.

CHAPTER 8

SYSTEM TESTING

Software testing is a critical process in the software development lifecycle that ensures that software applications meet the desired quality and performance standards. Testing is essential because software applications are complex, and it is difficult to develop error-free code that worksas intended in all scenarios. Testing helps to identify and correct defects and errors in the software,improving its overall quality and reliability. There are different types of testing, each with its ownobjectives and methods. One of the essential types of testing is system testing. System testing is the process of evaluating the entire and integrated software system to determine its overall performance and capability. It is carried out after integration testing and is designed to ensure thatthe software system meets its intended requirements and performs as expected. The primary goal of system testing is to identify and correct any defects or issues in the software system, improving its overall quality and reliability.

During system testing, various tests are conducted on the software system as a whole. These testsinclude functional testing, performance testing, load testing, stress testing, and security testing. The software system is evaluated to ensure that it meets the user's requirements, operates correctlyunder normal and peak loads, and provides error-free operation. System testing is usually performed in production-like environments, which include the same hardware and software configurations that will be used in the final deployment of the software. This helps to ensure that any issues or defects that arise during system testing are identified and resolved before the softwareis released to end-users. System testing is typically performed by professional testers or independent test teams, rather than the development team.

This is because testing requires a different skill set than software development, and testers are trained to identify and correct defects in software. System testing is an essential part of the softwaredevelopment lifecycle because it helps to ensure the overall quality and performance of the software system. It is a critical step that ensures that the software

meets the user's requirements and performs as intended, improving user satisfaction and reducing the risk of software failure. Regenerate response Send a message.

8.1 TYPES OF TESTING

It provides an overview of various software testing techniques that are commonly used to ensure that software systems meet the required quality and functional specifications.

The different types of testing covered in this section are:

8.1.1 UNIT TESTING

Unit testing is a software testing technique where individual units or components of a software application are tested independently to ensure they are working as expected. The purpose of unit testing is to validate that the internal logic of the software is functioning correctly, and that the input and output of the software are valid. In unit testing, all decision branches and internal code flow should be verified. This technique is considered invasive because it requires knowledge of the internal structure of the code being tested. Unit tests are performed at the code level and are used to test specific business processes, applications, or system configurations. The goal of unit testing is to ensure that each specific path of a business system performs appropriately to the documented specifications and contains fully defined inputs and expected outcomes.

8.1.2 INTEGRATION TESTING

Integration testing is the process of testing the interaction between different software componentsor modules. It is conducted after unit testing and is aimed at ensuring that the individualcomponents of the software work together as expected. Integration tests verify that the componentscan communicate with each other and that the integration of the components is accurate and consistent. This type of testing focuses on the outputs of the system, and it is designed to identifyproblems that may arise from the combination of the components. It is usually conducted after unittesting and before system testing. Integration testing is essential for ensuring that the software components work together correctly and that the software system as a whole functions as intended.

8.1.3 FUNCTIONAL TESTING

Functional testing is a type of software testing that focuses on verifying whether the application isperforming as expected based on its functional requirements. In functional testing, the software istested against specific requirements and features to ensure that it meets the business and technicalrequirements, system documentation, and user manuals. Functional testing involves testing the input, functions, output, and systems/processes of the software. It verifies that the application is accepting valid inputs, rejecting invalid inputs, and exercising identified functions. It also tests thedifferent types of application output and ensures that the interfacing systems or processes are invoked as required. Functional tests can be focused on specific requirements, key features, or specific test cases. The testing should consider the business process flows, data fields, predefined methods, and successive processes. Additionally, before completing functional testing, additional tests are identified, and the effectiveness of current tests is evaluated to ensure that the software meets the specified requirements.

8.1.4 MACHINE TESTING

System testing is a level of software testing that verifies the behavior and performance of a complete system or software application in a real-world environment. This type of testing is conducted after integration testing and before acceptance testing. The main goal of system testingis to evaluate whether the complete software system meets the specified requirements and works as expected. During system testing, the software is tested as a whole, including all its components,features, and interfaces. It focuses on testing the entire system's functionality, including system behavior, performance, security, and usability. System testing is often conducted in a controlled environment that simulates the real-world environment in which the software will be used. System testing can be categorized into two types: functional testing and non-functional testing. Functional testing verifies the functional requirements of the software, while non-functional testing verifies the non-functional aspects of the software, such as performance, reliability, scalability, and security.

8.1.5 WHITE BOX TESTING

White box testing is also known as structural testing, clear box testing, or glass box testing. It involves testing the internal workings of a software application, including its code, structure, and internal design, as well as its purpose. It is often used to test specific areas of the software that arenot accessible from a black box testing perspective. White box testing can help identify defects inthe software's internal logic, code quality, and other factors that may impact its performance and functionality.

8.1.6 BLACK BOX TESTING

Black box testing is commonly used to test the functionality and usability of the software system from an end-user perspective. In the context of pothole detection using YOLO, black box testing can be used to test the accuracy and reliability of the pothole detection algorithm from an externalperspective without any knowledge of the internal workings of the YOLO module. It can involvecreating various test scenarios and inputs to verify that the YOLO algorithm can correctly detect potholes in different environments and lighting conditions. The outputs can then be compared with the expected results to determine the accuracy and effectiveness of the algorithm.

8.1.7 ACCEPTANCE TESTING

User acceptability testing is an important aspect of any endeavour and demands significant engagement from the stop person. It also guarantees that the machine satisfies functional requirements.

8.2 TEST CASES

Test Case#	TC01
Test Name	User input format
Test Description	To test input image
Input	Road frame captured through camera
Expected Output	Display the frame in the monitor
Actual Output	Displayed the frame
Test Result	Success

Test Case#	TC01
Test Name	User input format
Test Description	To test input image
Input	No road image
Expected Output	Show idle state
Actual Output	Showed idle state
Test Result	Success

Test Case#	UTC03
Test Name	Preprocess
Test Description	To test image is resized or not
Input	Road images
Expected Output	Resize the image to train model
Actual Output	Image resized
Test Result	Success

Test Case#	UTC04
Test Name	Pothole Detection
Test Description	To detect pothole from input frame
Input	Road image
Expected Output	It Should detect pothole
Actual Output	It detected the pothole
Test Result	Success

Test Case#	UTC05
Test Name	Test case for importing valid python libraries
Test Description	To test whether an algorithm to implement congestion nodes works without sklearn and keras models
Input	Import all valid libraries sklearn, tensorflow, and keras libraries
Expected Output	An error should be thrown specifying "error importing libraries sklearn, tensorflow and keras libraries"
Actual Output	An error is thrown
Test Result	Success

CHAPTER 9

RESULTS

Data preprocessing is an essential step in the data mining process that involves manipulating, removing, or adding data before it is used to ensure or improve performance. In the suggested system,the YOLO V4 algorithm is used for real-time object detection. The YOLO algorithm is a state-of- the-art technique that uses a single neural network to process the entire image and predict boundingboxes and probabilities for each region.

To simulate the detection of potholes, a simple GUI using Tkinter was created, which allows the userto turn on and off the simulation of pothole detection. When the system is turned on, the camera starts capturing and detecting potholes in real-time. The user can see if the pothole is detected or notand turn off the simulation by clicking on the stop button.

The output of the web application involves feeding the coordinates to the web application and populating the map with markers. The user can set the starting and destination points, and the application provides insight into the number of potholes along the path and at what distances theyare present. Overall, the system aims to improve road safety by detecting and alerting drivers to potholes in real-time. Several studies have shown that computer vision algorithms can accurately detect and locate potholes in images or videos of roads. These algorithms use various techniques such as edge detection, textureanalysis, and machine learning to identify potholes based on their shape, size, and depth.The results of these studies suggest that computer vision can be a reliable and efficient tool for pothole detection, which can help authorities to prioritize and plan road maintenance activities. However, the accuracy of these algorithms may vary depending on factorssuch as lighting conditions, road surface, and camera quality. Therefore, furtherresearch and development are needed to improve the performance of these algorithms andmake them more robust and reliable

8.1 SNAPSHOTS

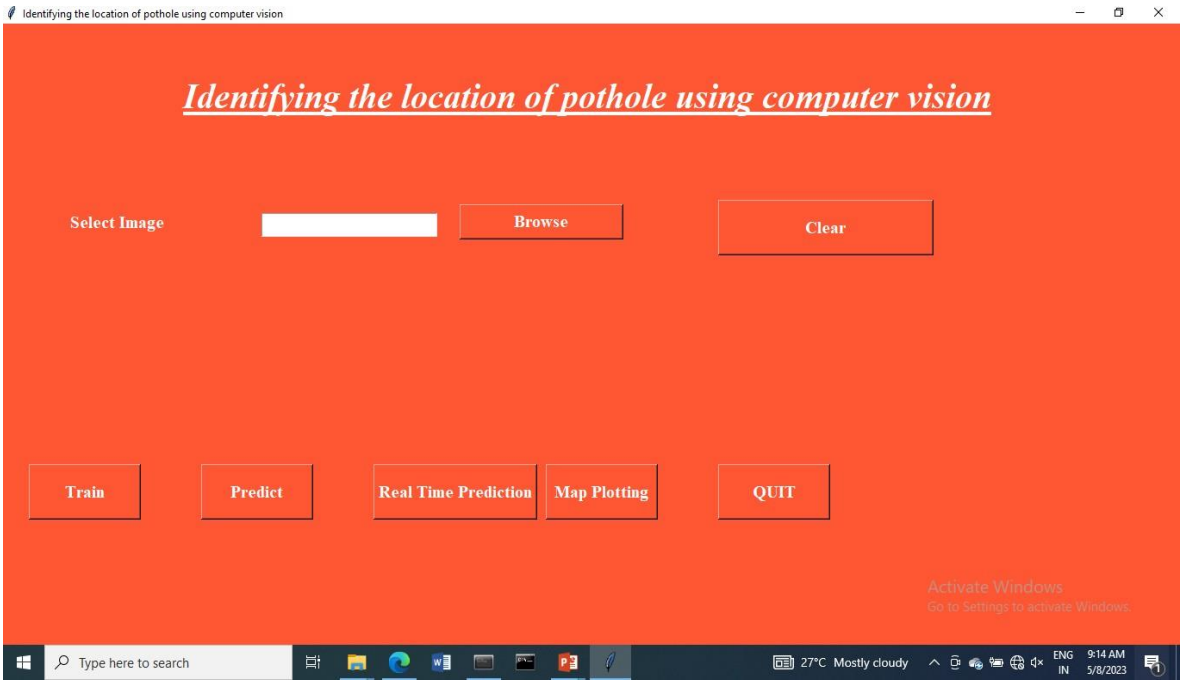

Fig 9.1 GUI

Fig 9.2 Pothole Percentage (presence) of 100% (for static images)

Fig 9.3 Pothole Percentage (absence) of 100 %(for static images)

Fig 9.4 Result image of Detected pothole with accuracy achieved: 67% and 39%

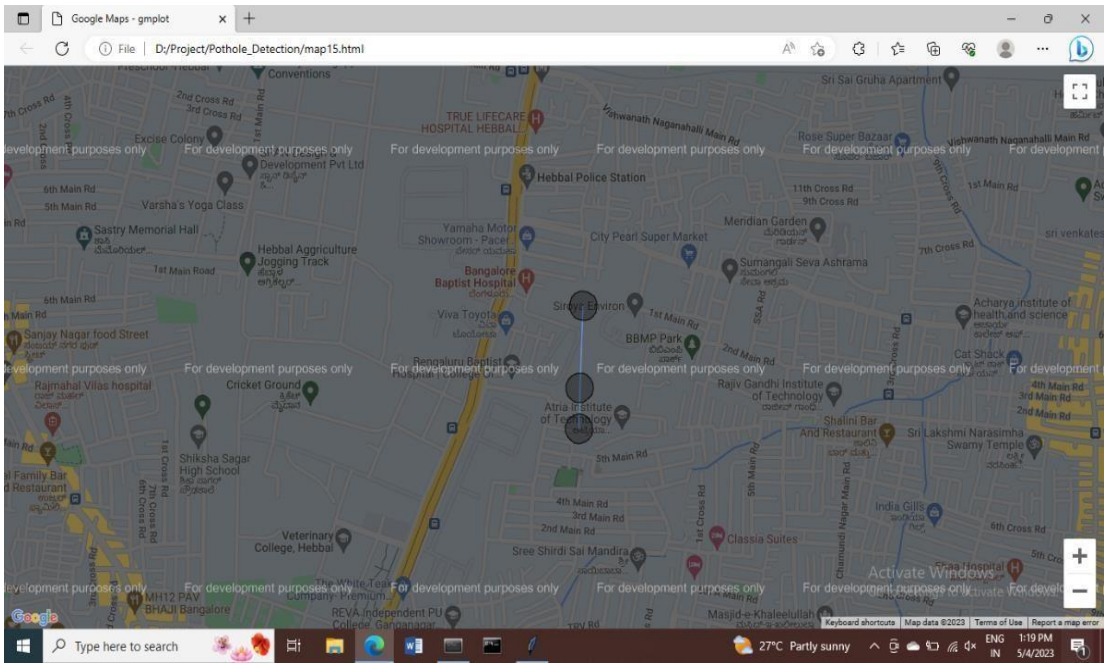

Fig 9.5 The Path between the Start and Destination is Marked.

CHAPTER 10

APPLICATIONS AND FUTURE WORKS

10.1 APPLICATIONS

- This project can be used for performing multi-tasks.
- Further this robot can be extended to perform stealth and ability to man ever in in accessible areas.
- Various sensors like PIR, IR, gas sensor, color sensor, metal detector etc. make this vehicle more effective.
- In military application, this robot can be used to detect the presence of human being.
- It can be used in rescue operation where human reach is not possible.
- This camouflage robot can be utilised in the tracking systems.
- Army Robot is an autonomous robot comprising of wi-fi camera which can Be used as a spy(surveillance purpose).
- Robot can further be equipped with speaker or recorder to interact with survivor and assure themof nearby help.

10.2 FUTURE WORKS

The proposed system provides a helping hand to our security forces in detection of intruders. The robot can also be used in high altitude areas where human cannot survive. Moreover, the camouflaging feature makes it difficult to detect the robot by naked human eye. There is scope to improve the system by configuring it with multicolor camouflaging. It can also be incorporated withthe Amazon Kindle which is basically predominant for readers allowing them not strain their eyes in any lighting conditions. Displaying an opposite side image on it makes it camouflaged and with the help of its zero reflecting screen it can be more predominant. One of the main challenges is to improve the accuracy and reliability of the algorithms under different lighting conditions, weather conditions, and road surfaces. This can be achieved by developing more advanced computer vision techniques, such as deep learning, which can learn from large datasets and adapt to different environments.

Another area of future work is to develop real-time pothole detection systems that can be integratedinto vehicles or mobile devices. This can help drivers to avoid potholes and reduce the risk of accidents and vehicle damage. Additionally, such systems can provide real-time data on the locationand severity of potholes, which can be used by authorities to prioritize and plan road maintenance activities.

Finally, there is a need to develop cost-effective and scalable solutions for pothole detection using computer vision. This can involve the use of low-cost cameras or sensors, cloud-based processing, and crowdsourcing of data. By making pothole detection more accessible and affordable, we can improve road safety and maintenance in a more sustainable and equitable way.

Pothole detection using YOLOv4 is an exciting area of research with numerous possibilities forfuture enhancements. Here are some potential directions for future work: Real-time detection: Currently, YOLOv4 can detect potholes with high accuracy, but the detection is not in real- time. Future work can focus on optimizing the algorithm to reduce the detection time. Improvedaccuracy: Although YOLOv4 has high accuracy, there is always room for improvement. Researchers can explore different ways to enhance the accuracy of pothole detection, such as by improving the training data or modifying the network architecture.

Detection of different types of potholes: YOLOv4 is primarily designed to detect potholes of a specific shape and size. Future work can focus on detecting different types of potholes, such as those with irregularshapes or different depths.

Integration with autonomous vehicles: Pothole detection can be a critical component of autonomous driving systems. Future work can focus on integrating pothole detection with autonomous vehicles to enhance safety and reduce vehicle damage.

Detection of other road defects: YOLOv4 can also be used to detect other road defects, suchas cracks, bumps, or uneven surfaces. Future work can explore how YOLOv4 can be modifiedto detect these defects.

Mobile application: Researchers can develop a mobile application that utilizes YOLOv4 to detect potholes. This application can be useful for drivers and city officials to identify and reportpotholes in real-time.

CHAPTER 11

CONCLUSION

In this project we have discussed the pothole detection system using YOLO V4 Algorithm. Decision of using YOLO V4 was great because the biggest advantage of using YOLO is its superb speed – it's incredibly fast and can process 45 frames per second. YOLO also understands generalized object representation. It is one of the best object detection algorithms, with a performance that is comparable to that of the R-CNN algorithms. The system provides several benefits and can operate with less manpower. Hence, we have successfully completed the training and testing of our model using YOLO V4. The system successfully detects the potholes with a good accuracy of approx.98%.the conclusion for pothole detection using computer vision is that it is a promising technology that can help improve road safety and maintenance. By using computer visionalgorithms to analyze images or videos of roads, potholes can be detected and located accurately, allowing authorities to take action and repair them promptly. This technologyhas the potential to save lives, reduce vehicle damage, and improve the overall quality ofroads. However, further research and development are needed tomake it more accurate and reliable, and to overcome challenges such as varying lighting conditions and road surfaces.

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APPENDIX

Acceptance Confirmation of Implementation Paper

5/10/23, 5:28 PM Gmail - IDENTIFYING LOCATION OF POTHOLE USING COMPUTER VISION

Gmail AFIFA maheen <afifamaheen8@gmail.com>

IDENTIFYING LOCATION OF POTHOLE USING COMPUTER VISION
1 message

prof prince <conferenceiccet@gmail.com> Tue, Apr 4, 2023 at 9:14 AM
To: ASHITHA V SHETTY <ashithavshetty@gmail.com>, afifamaheen8@gmail.com, kr.arvind027@gmail.com, kavyajkajjer@gmail.com, sathisha@atria.edu

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