

IDENTIFICATION OF ROAD ABNORMALITIES USING CONVOLUTIONAL NEURAL NETWORK

Submitted in Partial fulfillment of the Requirements for the Award of

Bachelor of Engineering in Electronics and Communication.

By

Anos S(38130012)

Arikaran C(38130013)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ENGINEERING**

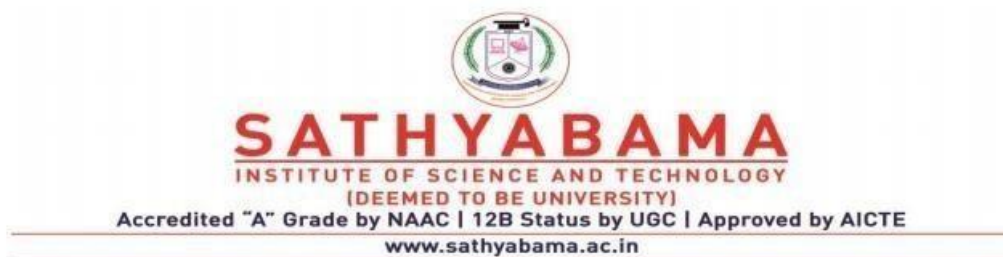
SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

May 2022



DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **ANOS S** (Reg. No. 38130012) and **ARIKARAN C** (Reg. No. 38130013) who carried out the project entitled **"IDENTIFICATION OF ROAD ABNORMALITIES USING CONVOLUTIONAL NEURAL NETWORK"** under our supervision from December 2021 to May 2022

Internal Guide

Dr.S.Lakshmi

Dr. T. RAVI, M.E., Ph.D.,

Head of the Department

Submitted for Viva voce Examination held on_____

Internal Examiner

External Examiner

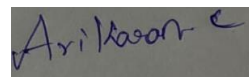
DECLARATION

We **ANOS S** (38130012) and **ARIKARAN C** (38130013) hereby declare that the Project Report entitled **“IDENTIFICATION OF ROAD ABNORMALITIES USING CONVOLUTIONAL NEURAL NETWORK ”** done by us under the guidance of **Dr.S.LAKSHMI** at Sathyabama Institute of Science and Technology, **Chennai- 600119** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electronics and Communication Engineering.

1.



2.



DATE: 02.05.2022

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. Nandhita, Dean, School of Electronics and communication Engineering** and **Dr. T. RAVI, Head of the Department, Dept. of Electronics and communication Engineering** for providing us necessary support and details at the right time during the progressive reviews.

We would also like to express our sincere and deep sense of gratitude to our internal guide **Dr.S.LAKSHMI** for her valuable guidance and suggestions during the progressive reviews for our project.

ABSTRACT

Most people prefer to use automotive - as it is the common and comfortable means of transportation. But most of the time the drivers face difficulties in driving and even meet accidents due to bad road conditions. This includes potholes, hump, uneven road surfaces, broken concrete, exposed rebar, sinkholes, and road cracks. If a driver hits a large pothole, it could burst the tyre or damage the axle causing the vehicle to veer into another lane, colliding with another vehicle. Uneven road surfaces can cause a driver to lose control of their vehicle, leading to a crash or rollover accident injuring the driver, passengers, and pedestrians. Monitoring road conditions and maintenance is a huge process. Therefore, making people alert while driving with a device especially at night times is important. The proposed project work is based on edge analysis algorithm where any abnormalities (potholes, jumps, uneven roads) has to be calculated to monitor the images using web camera and the analysis has to be done with the dataset that has been provided inside the software, then it will analyze them and made audio alert to the driver while driving using power supply from raspberry pi module. Identification of road abnormalities at the earliest time can facilitate the drivers to note them. A voice alarm is given to the drivers rather than messages or buzzers to assist the drivers to precisely hear and alert them. The main goal of the project is aimed at designing and developing a system that detects road conditions using convolutional neural network.

TABLE OF CONTENTS

CHAPTER NO.	TITLE	PAGE NO
		iii
	ABSTRACT	vii
	LIST OF TABLES	viii
	LIST OF FIGURES	10
1	INTRODUCTION	11
	1.1 IMAGE PREPROCESSING	12
	1.2 DATASET	12
	1.3 CONVOLUTIONAL NEURAL NETWORK	13
2	LITERATURE SURVEY	15
	2.1 EXISTING SYSTEM	16
	2.2 PROPOSED SYSTEM	17
3	SYSTEM DESIGN	17
	3.1 GENERAL	17
	3.2 SOFTWARE ARCHITECTURE DIAGRAM	18
	3.3 DEVELOPMENT ENVIRONMENT	26
	3.4 FUNCTIONAL REQUIREMENT	26
	3.5 NONFUNCTIONAL REQUIREMENT	27
	3.6 DESIGN OF THE ENTIRE SYSTEM	28
	3.6.1 USE CASE DIAGRAM	29
	3.6.2 ACTIVITY DIAGRAM	30
4	PROJECT DESCRIPTION	30
	4.1 METHODOLOGIES	30
	4.2 MODULES DESCRIPTION	30

	4.2.1 DATASET CREATION	30
	4.2.2 IMAGE ACQUISITION	30
	4.2.3 IMAGEPREPROCESSING	31
	4.2.4 ALGORITHM	32
	RESULTS AND DISCUSSION	34
5	5.1 UNIT TESTING	34
	5.2 MODULE TESTING	34
	5.3 TRAINED OUTPUT	35
	5.4 REAL TIME OUTPUT	36
	CONCLUSION AND SCOPE FOR	39
6	FUTUREWORK	
	6.1 CONCLUSION	39
	6.2 SCOPE FOR FUTURE WORK	39
	REFERENCES	40

LIST OF TABLES

TABLE NO	TITLE	PAGE NO
3.1	HARDWARE REQUIREMENTS	27
5.1	UNIT TESTING TABLE	34
5.2	OUTPUT TESTING TABLE	35

LIST OF FIGURES

FIGURE NO	TITLE	PAGENO
2.1	BLOCK DIAGRAM	16
3.1	ARCHITECTURE DIAGRAM	17
3.2	PUTTY LOGIN WINDOW	23
3.3	RASPBERRY PI DISPLAY	24
3.4	SCREEN OF MOBAXTERM	25
3.5	SCREEN OF MOBAXTERM	25
3.7	USE CASE DIAGRAM	28
3.8	ACTIVITY DIAGRAM	29
4.1	ROAD IMAGE	31
4.2	EDGE REMOVED IMAGE	31
4.3	SOBEL IMAGE	33
5.1	OUTPUT NORMAL IMAGE	35
5.2	OUTPUT ABNORMALITIES IMAGE	36
5.3	OUTPUT IMAGE	37
5.4	OUTPUT ABNORMALITIES IMAGE	38

CHAPTER 1

INTRODUCTION

Innovation always helps the developing world to expand and grow technologically. Many problems can be solved by inventing new technologies. India, the second most populous country in the world and a fast growing economy, is known to have a gigantic network of roads. Today within the World the general public value it more highly because it is the common and cozy means of transportation. Road transport means moving people and goods to different locations. In more simple terms, it is the medium between two destinations that are crafted and cemented so that the power driven vehicles can travel . However, most of the roads in India are narrow and congested with poor surface quality and road maintenance needs are not satisfactorily met.

In India, driving is a breath-holding, multi-mirror involving, potentially life-threatening affair. Whether you're driving a car, riding a motorcycle, or handling a bicycle, we wish for a smooth ride. But there are no guarantees. Roads aren't always consistently level. In fact, the majority of roads, highway and urban, are studded with potholes, which can make for a bumpy ride. Most of the time we tend to face difficulties and even accidents that occur due to road Abnormalities. This includes potholes, hump, uneven road surfaces, broken concrete, exposed rebar, sinkholes and road crack.

Although the roads have a period of up to twenty five years most roads don't last that long because of extreme environments and potholes. Potholes square measure holes within the route that change in size and form. They're fashioned because of serious rains and movement of serious vehicles conjointly becomes a serious reason for traumatic accidents and loss of human lives. They're caused by the growth and contraction of groundwater when the water has entered into the bottom beneath the pavement. A hollow could also be a depression throughout a level, sometimes asphalt pavement, wherever traffic has removed broken items of

the pavement. It's sometimes the result of water at intervals the underlying soil structure and traffic passing over the affected space. Water initially weakens the underlying soil; traffic then fatigues and breaks the poorly supported asphalt surface at intervals the affected space. continued traffic action ejects each asphalt and so the underlying soil material to create a hole at intervals the pavement.

Though speed bumps are effective if they are not clearly visible their use is often debatable as they will injure vehicles if traversed at too nice a speed and slow emergency vehicles. Poorly-designed speed bumps that stand too tall or with too-sharp association in nursing angle are generally unquiet for drivers, and will be hard to navigate for vehicles with low ground clearance, even at really low speeds.

Driving on an Associate on change lanes between uneven surfaces is enough to cause an automotive accident. The shift in surface height will cause Associate in nursing surprising modification in tire direction, tire harm, a blowout, and even shaft harm. Any of those circumstances, notwithstanding they solely have an effect on the motive force for a flash, will cause associate in a nursing accident, injury and damage.

The first and foremost step to be taken is to sight the road abnormalities like potholes at the earliest and give attention to the drivers and also the passengers. This can function as a protection primarily based device for each driver and additionally used for road observation authorities. Identification of road abnormalities at the earliest time can facilitate the drivers to note them. A voice alarm is given to the drivers rather than messages or buzzers to assist the drivers to recisely hear and alert them.

1.1 Image Processing with deep learning

Machine can be taught to mimic the same way human brains interpret images and analyze images and its features in depth than humans. Artificial Intelligence with image Processing has many application and lay foundation to modern technologies such as face recognition in mobile phones and other applications to ensure high level security, detecting and recognizing objects and patterns in images and videos, and so on. Today, image processing is widely used in medical visualization, biometrics, self-driving vehicles, gaming, surveillance, law

enforcement, and many other domains. Object detection which is used to detect objects in an image, Pattern recognition classifies objects, their positions and understand the hidden pattern in an image.

1.2 Dataset

The dataset was collected from the various website. It includes 10,000 road images as well as a trained and validated folder. The data set curators created an automated system using Google Net and Alex Net for achieving an accuracy of 80%.

1.3 Convolutional Neural Network (ConvNet/CNN)

A Convolutional Neural Network (ConvNet/CNN) is a Deep Learning algorithm which can take in an image, assign parameters (learnable weights and biases) to objects in the image and be able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. The architecture of a ConvNet is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex. Individual neurons respond to stimuli only in a restricted region of the visual field known as the Receptive Field. An CNN consists of the following:

1. The input layer which is a grayscale image
2. The Output layer which is a binary or multi-class labels
3. Hidden layers consisting of convolution layers, ReLU (rectified linear unit) layers, the pooling layers, and a fully connected NeuralNetwork.

CHAPTER 2

LITERATURE SURVEY

Artis ,Mednis,Strazdins, Girts & Zviedris, Reinholds & Kanonirs, Georgijs & Selavo, Leo have described a mobile sensing tool for street irregularity detection the use of Android OS-based totally on definite smartphones. The decided-on statistics processing algorithms are noted and their evaluation provided with the right terrific rate as immoderate as 90% of the usage of real-global statistics. The maximum green parameters for the algorithms are determined in addition to pointers for their application. The evaluation assessments caused the maximum green setup for each determined set of policies and the general performance assessment within the context of diverse avenues of irregularity training presentations right terrific costs as immoderate as 90%.

Aditya Anand, Rushiraj Gawande, Prathamesh Jadhav, Rima Shahapurkar, Anjali Devi, and NikhilKumar, have described an approach to build a system which reduces the number of accidents due to driver's negligence of over speeding. In this paper they have developed a speed limiter using image processing technique and by using mobile acceloremoters they have developed pothole detection.

B. Kang and S. Choi proposes two methods for detecting the potholes: one is using 2D LiDAR and the other is Vision based method. In the LIDAR process there are four steps involved where 2D LiDAR were installed in which a camera is also associated to capture the potholes on the road. LIDAR stands for light detection and ranging. It is a method of remote sensing that uses light to measure the distance of the objects. This method is applied here to detect the distance of the potholes on the road. In the second method filtering of the data is carried out. Image filtering and customization improves the quality of images and the detection and the processing techniques would be fast and accurate.

E. J. Reddy, P. N. Reddy, G. Maithreyi, M. B. C. Balaji, S. K. Dash and K. A. Kumari have Designed a method to detect potholes without any processing

mechanism. A depth based approach is adopted to detect the pothole. The depth is calculated by the distance, time and speed that is measured by the sensors applied in this system. These data are then stored in NodeMCU where it is connected to the server. Arduino IDE servers as a platform here to implement this process. Finally the data that is stored in the server is sent to the authorized person via mail.

Mircea Strutu, G. Stamatescu and D. Popescu have proposed method the pothole detection is done using accelerometer readings. A mobile system that is placed on the vehicle that consists of a video camera, accelerometer, GPS module and local computer connected to Wi-Fi. When the device detects the potholes it captures the images and stores them in the local computer. Then these data are then transferred to the main server part where there are primary and secondary point routers to enhance the data communication. This system has accelerometer reading, distance, location and images for the storage and processing purposes.

Hason hamodi johni,imzakim abdulkareem alwan describes a automated system (Automatic Pavement Distress Distinguish-APDD) has ability to discover distresses of road by using computer vision techniques (CV), only the computational sources supplied using smartphone device. Wherefore, APDD system depend on the image processing is embedded in a smartphone and computer programming, ability of the distinguishing of the famous pavement distresses.

Paweł Aksamit and Marek Szmechta have described a great approach. alternatively, then dedicated hardware observed out in several vehicles, it uses phones of an enormous large variety of individual, anonymous automobile drivers. Thousands of citizens use their Internetrelated molecular phones for navigation. When GPS is on, turning on an accelerometer does not raise battery utilization, considerably as present-day accelerometers want the only 1/10 electricity GPS uses. An enormous large variety of independent reasserts of information gives large scale and coverage of the device and compensates for a lower amount of information from each statistic delivered on account of uncontrollable and random conditions in which measurements are done. The device can find spot damages

with an accuracy of 10 – 20 m, which is bigger than sufficient to seek out and repair them

Shigeharu, Miyata describes the machine learning with local binary pattern recognition, image processing with HSV, detect only the speed-limit sign in an image of scenery using a single process focusing on the local patterns of speed limit sign. This study describes a method for using a camera to automatically recognize the speed limits on speed-limit sign

X.Yu and Ehsan Salari., They introduced an inexperienced and extra moderately priced method for pavement distress inspection with the useful resource of the usage of laser imaging. After the pavement pics are captured, regions just like potholes are represented with the useful resource of the use of a matrix of square tiles, and the anticipated shape of the pothole is determined. The vertical, horizontal distress measures, the general kind of distress tiles, and the depth index facts are calculated supplying access to a three-layer feed-in advance neural network for pothole severity and crack type classification. The proposed assessment set of guidelines can enhance the pavement image, extracting the pothole from the background, and analyzing its severity. To validate the system, actual pavement snapshots had been taken from the pavements of every on-toll avenue and close-by roads. The experimental effects established that the proposed model works well for pothole and crack detection.

Z. Zhang, X. Ai, C. K. Chan and N. Dahnoun describes a pothole is detected using stereo vision cameras that are fitted in a vehicle. The difference between the potholes and other objects on the road are analyzed after capturing the images. Then the surface of the road and humps are categorized based on their shape, size, height and other parameters which are associated with it.

2.1 EXISTING SYSTEM

One of the existing system uses asphalt roads and exported to the MATLAB environment for processing. An extensive data processing algorithm analyses the image and the parameters like, pothole area, length, and width are estimated .Explains the use of ultrasonic and accelerometer sensors to detect the potholes ahead the vehicles and alert the vehicle user about the potholes via GSM SIM900A

so the user can take precautionary measures .Multiple digital image processing technologies, including: image preprocessing, binarization, thinning, three-dimensional reconstruction, error analysis and compensation are used in the series of image analysis and processing sure to avoid the accident.

2.2 PROPOSED SYSTEM

From the above survey, it is found that the Identification of Road abnormalities system gives an early warning of road abnormalities like potholes, uneven humps on the road, to the driver to prevent sudden road accidents and saving lives. By inferring ideas from the survey, the proposed system gives an instant audio alert to the driver if the road abnormalities are detected on the road.

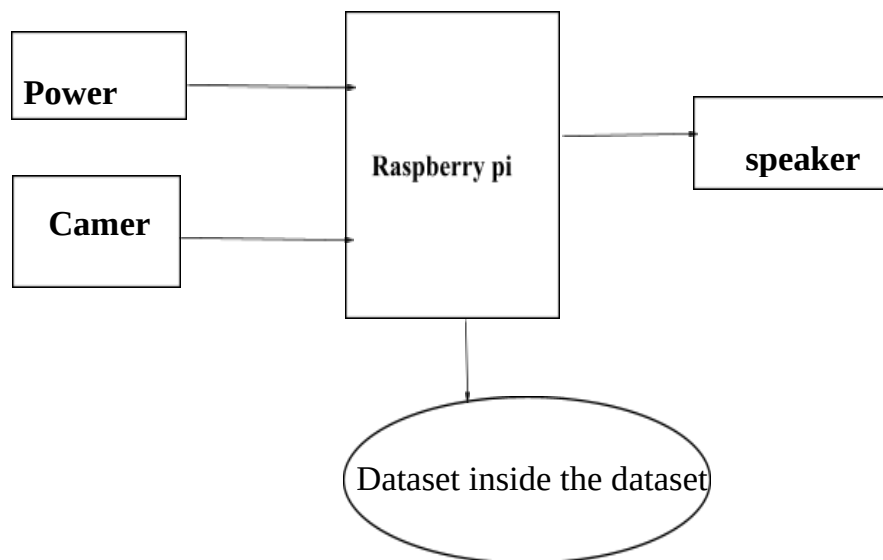


Fig 2.1 Block Diagram

The Block diagram consists of the following components: a power supply, a camera, and a raspberry pi module Fig. 2.1. shows the block diagram of the proposed system. The system frame is placed inside the vehicle and when the vehicle is ignited the power module gets initiated. Raspberry Pi here acts as a mini computer where the information is shared from the system to the controller via VNC viewer software. VNC stands for Virtual Network Computing. It is a graphical desktop sharing system which uses Remote Frame Buffer protocol (RFB) to remotely control another computer.

CHAPTER 3

SYSTEM DESIGN

3.1 GENERAL

System Design deals with the various UML [Unified Modelling Language] diagrams for the implementation of project. Design is very important part of development of an application and it represents the meaning of the model that is to be built. Software design is a process through which the requirements are translated into representation of the software. Design is the place where quality is rendered in software engineering. Design is the means to accurately translate customer requirements into finished product.

3.2 SYSTEM ARCHITECTURE DIAGRAM

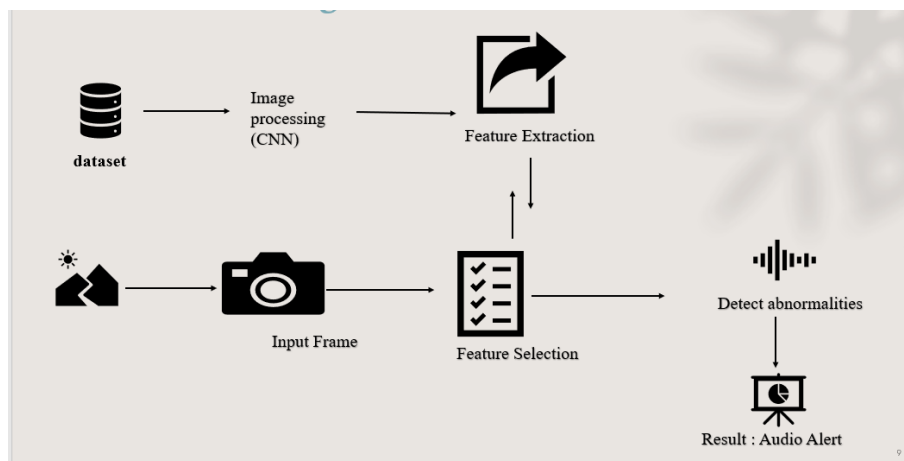


Fig 3.1 Architecture Diagram

3.3 DEVELOPMENT ENVIRONMENT

Fundamental Concepts of Convolutional Neural Network

Convolutional neural network (or CNN) is a special type of multilayer neural network or deep learning architecture inspired by the visual system of living beings. The CNN is very much suitable for different fields of computer vision and natural language processing. The main focus of this chapter is an elaborate discussion of all the basic components of CNN. It also gives a general view of foundation of CNN, recent advancements of CNN and some major application areas.

Among different deep learning architecture, a special type of multilayer neural network for spatial data is Convolutional Neural Network (or CNN or ConvNet.). The architecture of CNN is inspired by the visual perception of living beings. Though it has become popular after the record breaking performance of AlexNet in 2012 but it was actually initiated in 1980.

After 2022 the CNN got the pace to take over different fields of computer vision, natural language processing and many more.

The foundation of convolutional neural network started from the discovery of Hubel and Wiesel in 1959. According to them, cells of animal visual cortex recognize light in the small receptive field. In 1980, inspired by this work, Kuniyiko Fukusima proposed neocognitron.

Training by backpropagation algorithm helped LeNet-5 in recognizing visual patterns from raw images directly without using any separate feature engineering. But in those days despite of several merits, the performance of CNN in complex problems was lacked by the limited training data, lack of innovation in algorithm and insufficient computing power. Recently we have large labeled datasets, innovative algorithms and powerful GPU machines. In 2012, with these up-gradation, a large deep CNN, called AlexNet, designed by Krizhevsky et al[20] showed excellent performance on the ILSVRC[36]. The success of AlexNet paved the way to invent

different CNN models[41] as well as to apply those models in different fields of computer vision and natural language processing.

A traditional convolutional neural network is made up of single or multiple blocks and pooling layers, followed by one or multiple fully connected (FC) layers and an output layer. The convolutional layer is the core building block of a CNN. This layer aims to learn feature representations of the input. The convolutional layer is composed of several learnable convolution kernels or filters which are used to compute different feature maps. Each unit of feature map is connected to a receptive field in the previous layer. The new feature map is produced by convolving the input with the kernels and applying elementwise non-linear activation function on the convolved result. The parameter sharing property of convolutional layer reduces the model complexity. Pooling or sub-sampling layer takes a small region of the con-

convolutional output as input and down samples it to produce a single output. There are different sub-sampling techniques as example max pooling, min pooling, average pooling, etc.

feedforward neural network. The FC layer takes input from the pooling or convolutional layer and generates signal output of CNN. In case of image classification, a CNN can be viewed as a combination of two parts: feature extraction part and classification part.

convolution and pooling layers perform feature extraction. As an example of dog's image, different convolution layers from lower level to higher level detect various features such as two eyes, long ears, four legs, etc for further recognition. On top of this features, the FC layers are added as

classifier, and a probability is assigned for the input image being a dog. Beside the layer design, the improvement of CNN depends on several different aspects such as activation function, normalization method, loss function, regularization, optimization and processing speed, etc.

After the success of AlexNet, CNN got huge popularity in three major fields namely image classification object detection and segmentation, and many advance models

of CNN has been proposed in those areas in successive years. Major application areas that apply CNN to achieve state-of-the-art performance includes image class segmentation, human pose estimation, text detection, visual saliency detection, action recognition, scene labelling, visual question answering, speech and natural language processing, etc. Though current CNN models work very well for various applications, it is yet to know why and how it works essentially. So, more on investigating the fundamental principles of

CNNs are required.

Foundation of Convolutional Neural Network

In 1959, two neurophysiologists David Hubel and Torsten Wiesel experimented and later published their paper, entitled "Single neurons in cat's striate cortex" described that the neurons inside the brain of a cat are organized in layered form.

These layers learn how to recognize visual patterns by first extracting the local features and then combining the extracted features for higher level representation. Later on, this concept is essentially become one of the core principle of Deep Learning.

Inspired by the work of Hubel and Wiesel, in 1980, Kunihiko Fukushima proposed Neocognitron, which is a self-organizing Neural Network, containing multiple layers, capable of recognizing visual patterns hierarchically through learning and this architecture became the

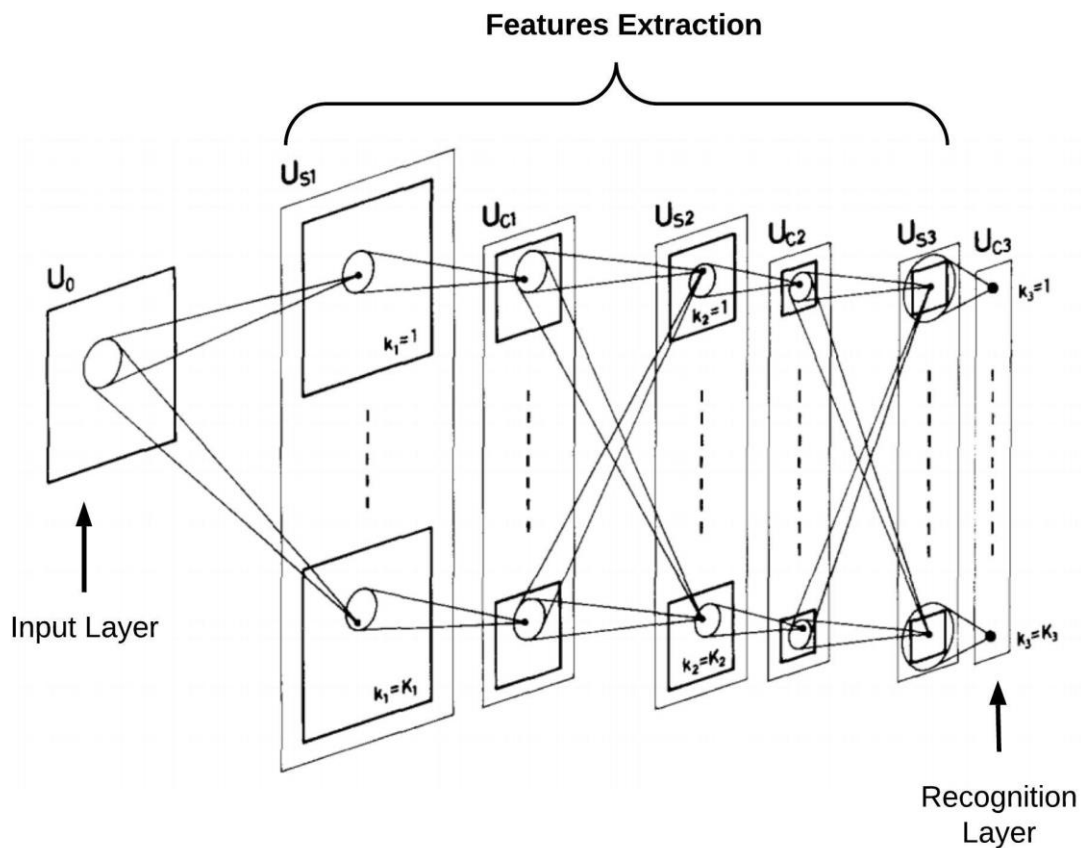
Neocognitron was done by LeCun et. In 1989 by developing a modern framework of CNN, called LeNet-5, which successfully recognized the MNIST handwritten digits dataset. LeNet-5 was trained using error back-propagation algorithm and it can be recognize visual patterns directly

from raw input images, without using any separated feature engineering mechanism.

After discovering because of several limitation like lack of large training data, lack of innovation in algorithm and inadequate computing power, CNN did not performs well in various complex problems. But nowadays, in the era of Big Data we have

large labeled datasets, more innovative algorithms and especially powerful GPU machines. With these type of up-gradation,

In 2012, Krizhevsky et al. designed AlexNet, which achieved a fantastic accuracy on the ImageNet Large Scale Visual Recognition Challenge (ILSVRC). The victory of AlexNet paved the way to invent several CNN models as well as to apply those models in different field of computer vision and natural language processing.



HARDWARE REQUIREMENTS:

The hardware requirements may serve as the basis for a contract for the implementation of the system and should therefore be a complete and consistent specification of the whole system. They are used by software engineers as the starting point for the system design. It shows what the system does and not how it should be implemented.

Table 3.1 Hardware Requirements

COMPONENT	SPECIFICATION
PROCESSOR	AMD PRO A4-4350B R4,5COMPUTE CORES 2C
RAM	4 GB RAM
MONITOR	15" COLOR
HARD DISK	10 GB
PROCESSOR SPEED	MINIMUM 500MHZ

Raspberry pi:

Raspberry Pi is a small computer; hence operating system (OS) should be installed. As the Raspberry doesn't have hard drive, OS is installed in the external memory. For that, memory card (SD card) is used for the installation of operating system and all the required software and supporting files are stored in the same SD card.

There are different types of operating system but we preferred to talk about NOOBS (New Out of the Box Software) as it is suitable for the beginners. We can either buy a preinstalled SD card or empty SD card. In pre-installed SD card, NOOBS is already

copied and ready to boot. The detail description of installation of operating system in a blank SD card in step wise is given in Appendix B.

SOFTWARE REQUIREMENTS

The Software requirements should include both a definition and a specification of requirements. It is a set of what the system should do rather than how it should do it. The software requirements provide a basis for creating the software requirements specification. It is useful in estimating cost, planning team activities, performing tasks and tracking the team and tracking the team's progress throughout the development activity.

- 1.RASPIAN OS
- 2.PuTTY
- 3.MOBXTERM
- 4.VNCVIEWER

PuTTY

This is the primary software need to be installed. It can be downloaded in the provided link as follow, [Download Putty](#). As, it is downloaded, it needs to be installed following some few normal steps of installation. For Configuration, double click the icon of Putty after the completion of installation and enter the IP address of Raspberry Pi

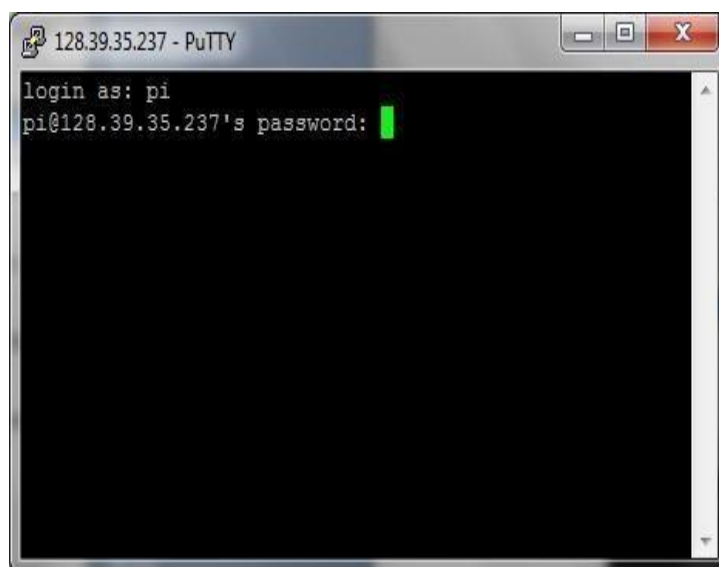


Fig 3.2 PuTTY login windows

In this window, username and password of the Raspberry Pi should be entered. The default username for a Raspberry Pi is pi. Press enter after entering correct username and password and you will see the windows where you should enter the text "lesson" as shown in Figure..

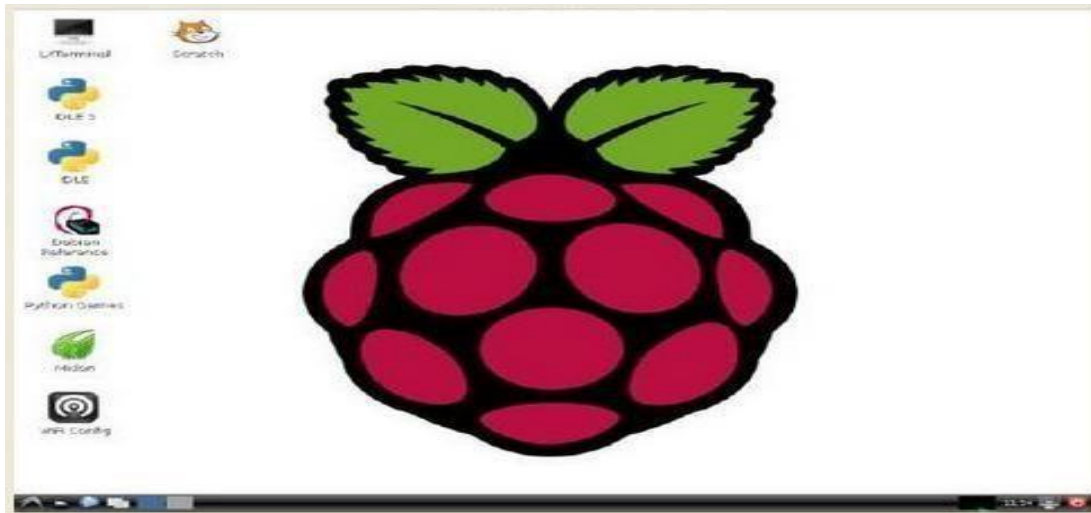


Fig 3.3 Raspberry Pi on Desktop

Raspbian OS

Raspberry Pi OS (formerly Raspbian) is a Debian-based operating system for Raspberry Pi. Since 2015, it has been officially provided by the Raspberry Pi Foundation as the primary operating system for the Raspberry Pi family of compact single-board computers. The first version of Raspbian was created by Mike Thompson and Peter Green as an independent project.

Raspberry Pi OS is highly optimized for the Raspberry Pi line of compact single-board computers with ARM CPUs. It runs on every Raspberry Pi except the Pico microcontroller. Raspberry Pi OS uses a modified LXDE as its desktop environment with the Open box stacking window manager, along with a unique theme. The distribution is shipped with a copy of the algebra program Wolfram Mathematica and a version of Minecraft called Minecraft: Pi Edition (note that Minecraft: Pi Edition is no longer installed as of the Debian bullseye update) as well as a lightweight version of the Chromium web browser.

User Interface

Raspberry Pi OS's desktop environment, PIXEL, looks similar to many common desktops, such as macOS, Microsoft Windows, and is based on LXDE. The menu bar is positioned at the top and contains an application menu and shortcuts to

Terminal, Chromium, and File Manager. On the right is a Bluetooth menu, a Wi-Fi menu, volume control, and a digital clock.

Mobaxterm:

MobaXterm is your ultimate toolbox for remote computing. In a single Windows application, it provides loads of functions that are tailored for programmers, webmasters, IT administrators and pretty much all users who need to handle their remote jobs in a more simple fashion.

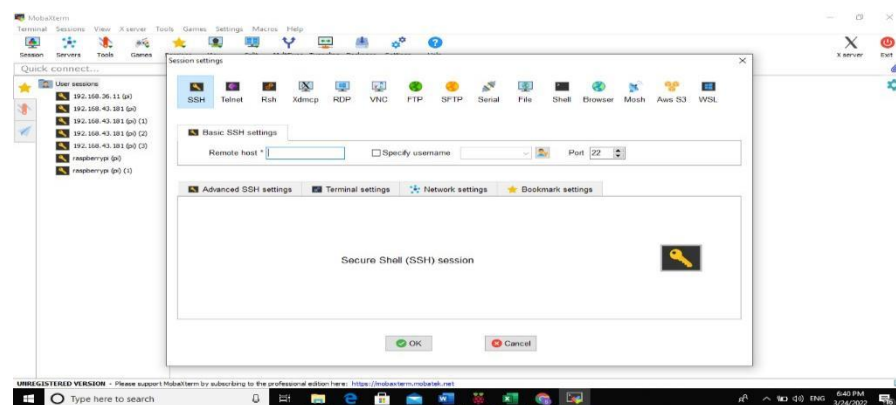


Fig 3.4 screen of mobaxterm

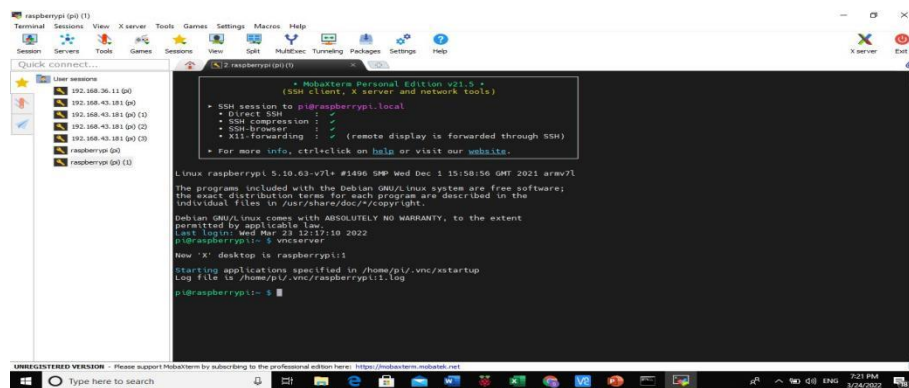


Fig 3.5 screen of mobaxterm

VNC VIEWER

VNC Viewer is a graphical desktop sharing software. Which is used to share the desktop screen and remotely control and be able to access as like a normal system. This software can be used to share the screen of a desktop or any mobile devices. VNC viewer shares the keyboard and mouse for accessing the device to send and receive data from one device to another. Real VNC is best suitable for Raspberry Pi controllers. After dumping the code in the controller, it can

be accessed just by obtaining its IP address. On booting the controller and connecting with VNC viewer will allow the user to control Raspberry Pi for obtaining the output as programmed.

3.4 FUNCTIONAL REQUIREMENTS

Functional requirements describe the system functionality, while the non-functional requirements describe system properties and constraints. Functional requirements capture the intended behavior of the system. This behavior may be expressed as services, tasks, or the functions the system is required to perform. This lays out important concepts and discusses capturing functional requirements in such a way they can drive architectural decisions and be used to validate the architecture. Features may be additional functionality, or differ from basic functionality along some quality attribute. In the proposed system, concert assesses the compliance of a workflow by analyzing the five established elements required to check for the rule adherence in workflows: activities, data, location, resources, and time limits. A rule describes which activities may, must or must not be performed on what objects by which roles. In addition, a rule can further prescribe the order of activities .

3.5 NON-FUNCTIONAL REQUIREMENTS:

1. Security

System needs to control the user access and session

It needs to store the data in a secure location and stored in a secure format

It requires a secure communication channel for the data.

2. Performance

Performance is generally perceived as a time expectation. This is one of the most important considerations especially when the project is in the architecture phase.

3. Reliability

It is necessary to ensure and notify about the system transactions and processing as simple as keep a system log will increase the time and effort to get it

done from the very beginning. Data should be transferred in a reliable way and using trustful protocols.

4. Maintainability

Well-done system is meant to be up and running for long time. Therefore, it will regularly need preventive and corrective maintenance. Maintenance might signify scalability to grow and improve the system features and functionalities.

5. Usability

End user satisfaction and acceptance is one of the key pillars that support a project success. Considering the user experience requirements from the project conception is a win bet, and it will especially save a lot of time at the project release, as the user will not ask for changes or even worst misunderstandings.

6. Documentation

All projects require a minimum of documentation at different levels. In many cases the users might even need training on it, so keeping good documentation practices and standards will do this task spread along the project development; but as well this must be established since the project planning to include this task in the list.

3.6 DESIGN OF THE ENTIRE SYSTEM

3.6.1 USE CASE DIAGRAM

The client/user feeds the image of the road into the system and the image is sent to the server after the pre-processing steps. The preprocessed image is then sent to the model and it recognizes and predicts the result if the abnormalities present on the road

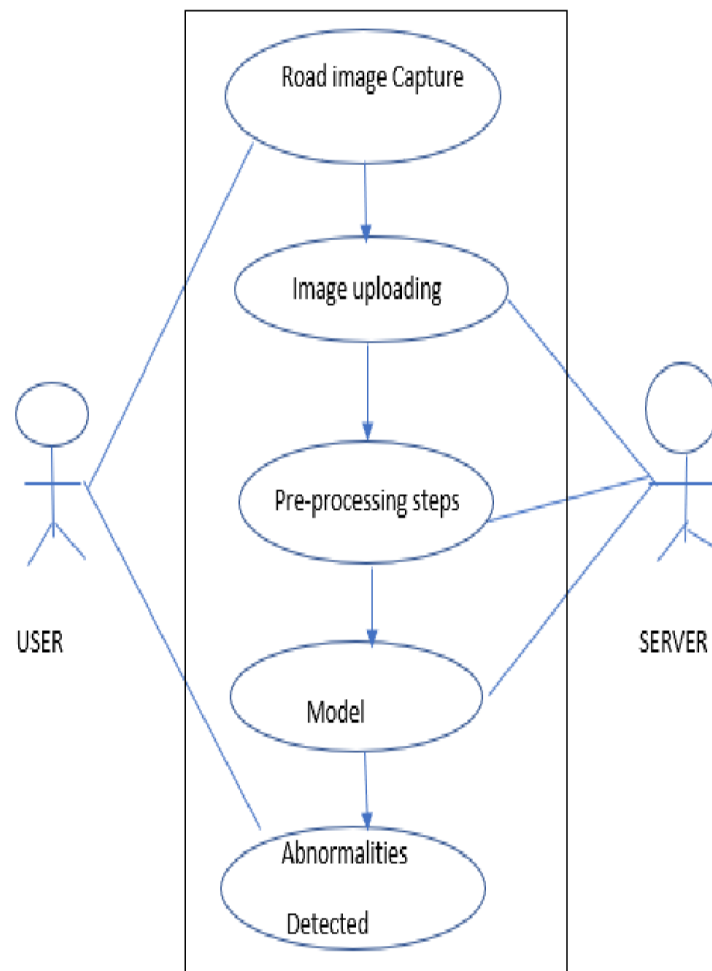


Fig 3.7 Use Case Diagram

3.6.2 ACTIVITY DIAGRAM

The flow of activity starts from image scanning in the android application, The scanned image is then uploaded to the server where the preprocessing takes place

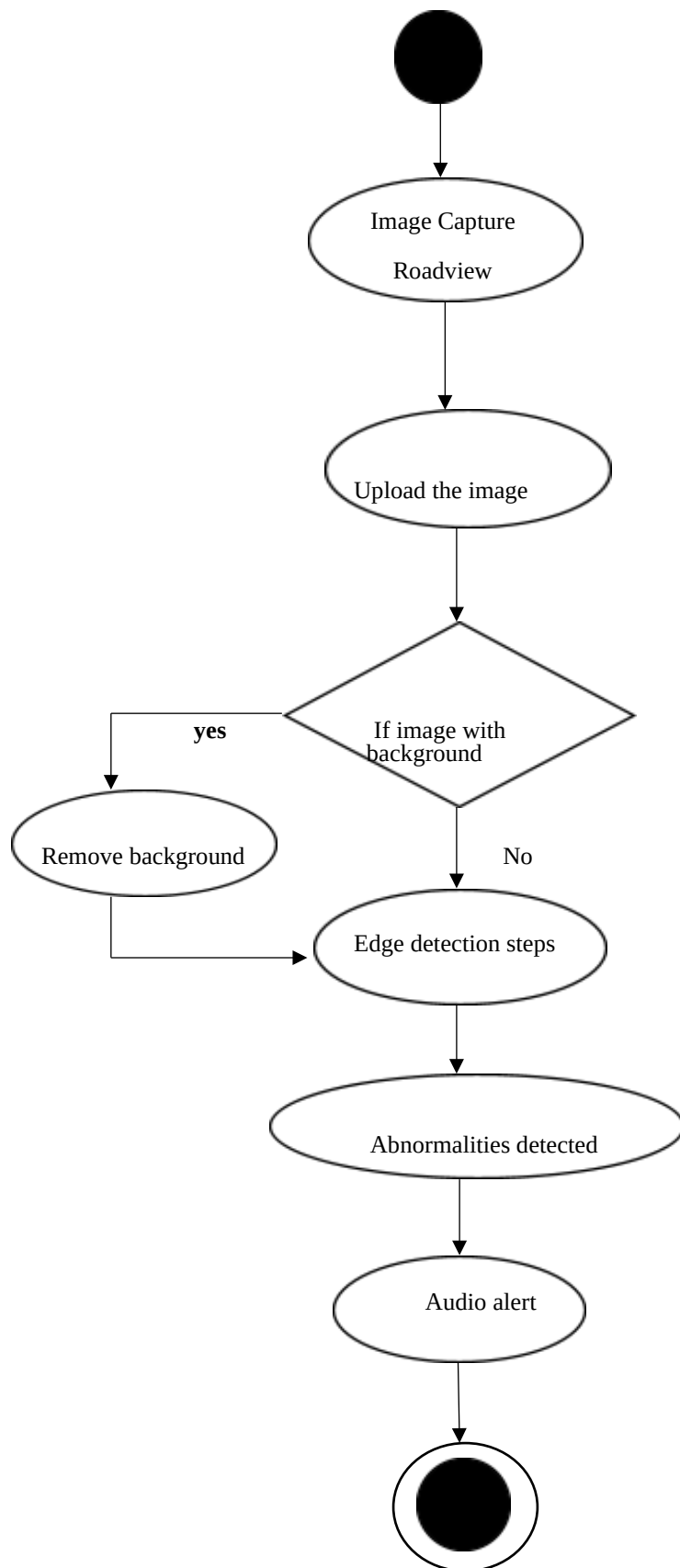


Fig 3.8 Activity Diagram

CHAPTER 4

PROJECT DESCRIPTION

4.1 METHODOLOGIES

4.1.1 MODULES

1. Dataset Creation
2. Image acquisition
3. Image pre-processing
4. Image Analysis using Algorithm

4.2 MODULES DESCRIPTIONS

4.2.1 DATASET CREATION

One of the best way to improve the data. Custom Dataset created with the help of sample images which then augmented using data augmentation techniques to add more data to the dataset. Optimum method to reduce 155 classes into 10 and 15 classes by segregating into two different Train and Test.

4.2.2 IMAGE ACQUISITION

The initial process is to collect the data from the public repository. It takes the images as input for further processing. We have taken most popular image domains so that we can take any formats like .bmp, .jpg, .gif as input to our process. The image is captured, scanned and converted into a manageable entity. This process is known as image acquisition. During a test-phase, we acquire a series of color images using a digital scanner so as to acquire a single image. The color images were digitized to produce RGB digital color images.



Fig 4.1 Road Image

4.2.3 IMAGE PREPROCESSING

In general, any digital image processing algorithm consists of three stages Input, processor and output.

In the input stage image is captured by a camera. It sent to a particular system to focus on a pixel of image that's gives, its output as a processed image.

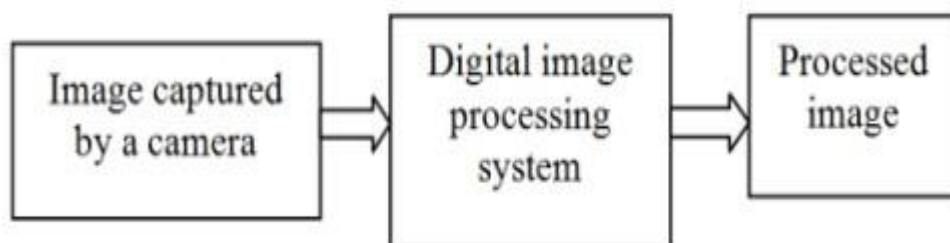


Fig 4.2 GENERAL BLOCK DIAGRAM OF IMAGE PROCESSING

4.2.4 ALGORITHM

Cannon edge detection Algorithm:

1. It is a multi-stage algorithm.
2. *Noise Reduction*

Since edge detection is susceptible to noise in the image, first step is to remove the noise in the image with a 5x5 Gaussian filter. We have already seen this in previous chapters.

3. Finding Intensity Gradient of the Image

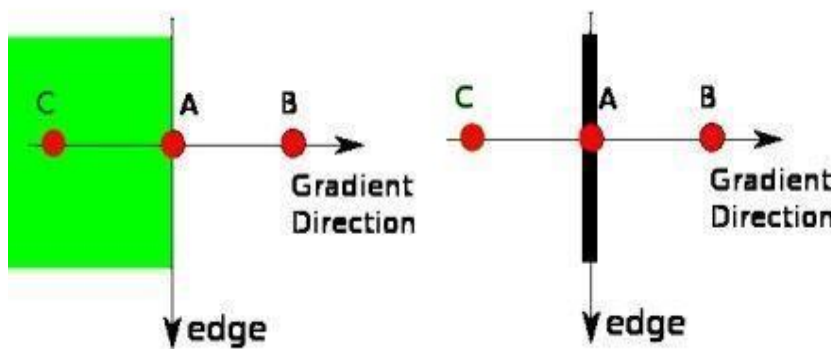
Smoothened image is then filtered with a Sobel kernel in both horizontal and vertical direction to get first derivative in horizontal direction (G_x) and vertical direction (G_y). From these two images, we can find edge gradient and direction for each pixel as follows:

$$\text{Edge_Gradient}(G) = \sqrt{G_x^2 + G_y^2} \quad \text{Angle}(\theta) = \tan^{-1}(G_y/G_x)$$

Gradient direction is always perpendicular to edges. It is rounded to one of four angles representing vertical, horizontal and two diagonal directions.

4. Non-maximum Suppression

After getting gradient magnitude and direction, a full scan of image is done to remove any unwanted pixels which may not constitute the edge. For this, at every pixel, pixel is checked if it is a local maximum in its neighborhood in the direction of gradient. Check the image below:



Point A is on the edge (in vertical direction). Gradient direction is normal to the edge. Point B and C are in gradient directions. So point A is checked with point B and C to see if it forms a local maximum. If so, it is considered for next stage, otherwise, it is suppressed (put to zero).

In short, the result you get is a binary image with "thin edges".

5. Hysteresis Thresholding

This stage decides which are all edges are really edges and which are not. For this, we need two threshold values, minVal and maxVal. Any edges with intensity gradient more than maxVal are sure to be edges and those below minVal are sure to be non-edges, so discarded. Those who lie between these two thresholds are classified edges or non-edges based on their connectivity. If they are connected to "sure-edge" pixels, they are considered to be part of edges. Otherwise, they are also discarded.



Fig 4.3 Edge Removed Image

SOBEL EDGE DETECTION ALGORITHM:

Sobel Edge detection is a widely used algorithm of edge detection in image processing. Along with Canny and Prewitt, Sobel is one of the most popular edge detection algorithms used in today's technology. When using Sobel Edge Detection, the image is processed in the X and Y directions separately first, and then combined together to form a new image which represents the sum of the X and Y edges of the image. However, these images can be processed separately as well. This will be covered later in this document. When using a Sobel Edge Detector, it is first best to convert the image from an RGB scale to a Grayscale image. Then from there, we will use what is called kernel convolution. A kernel is a 3 x 3 matrix consisting of differently (or symmetrically) weighted indexes. This will represent the filter that we will be implementing for an edge detection.



Fig 4.4 Sobel Image

CHAPTER 5

RESULTS AND DISCUSSIONS

5.1 UNIT TESTING

In the unit testing we test each module individually and integrate with the overall system. Unit testing focuses verification efforts on the smallest unit of software design in the module. This is also known as module testing. The module of the system is tested separately. This testing is carried out during programming stage itself. In the testing step each module is found to work satisfactorily as regard to expected output from the module. There are some validation checks for fields also. For example, the validation check is done for varying the user input given by the user which validity of the data entered. It is very easy to find error debut the system.

Table 5.1: Unit Testing Table

Function Name	Tests Results
Uploading Image	Tested for uploading different types and sizes of images.
Detect abnormalities	Tested for different images of road view by analysis of algorithm.

5.2 MODULE TESTING

After performance of the validation testing, the next step is output testing. The output displayed or generated by the system under consideration is tested by asking the user about the format required by system

Table 5.2: Output Testing Table

Functionality to be tested	Input	Tests Results
Working of Choose File option	User convenience to access images stored	Different folders where images are stored can be uploaded

5.3 TRAINED OUTPUT

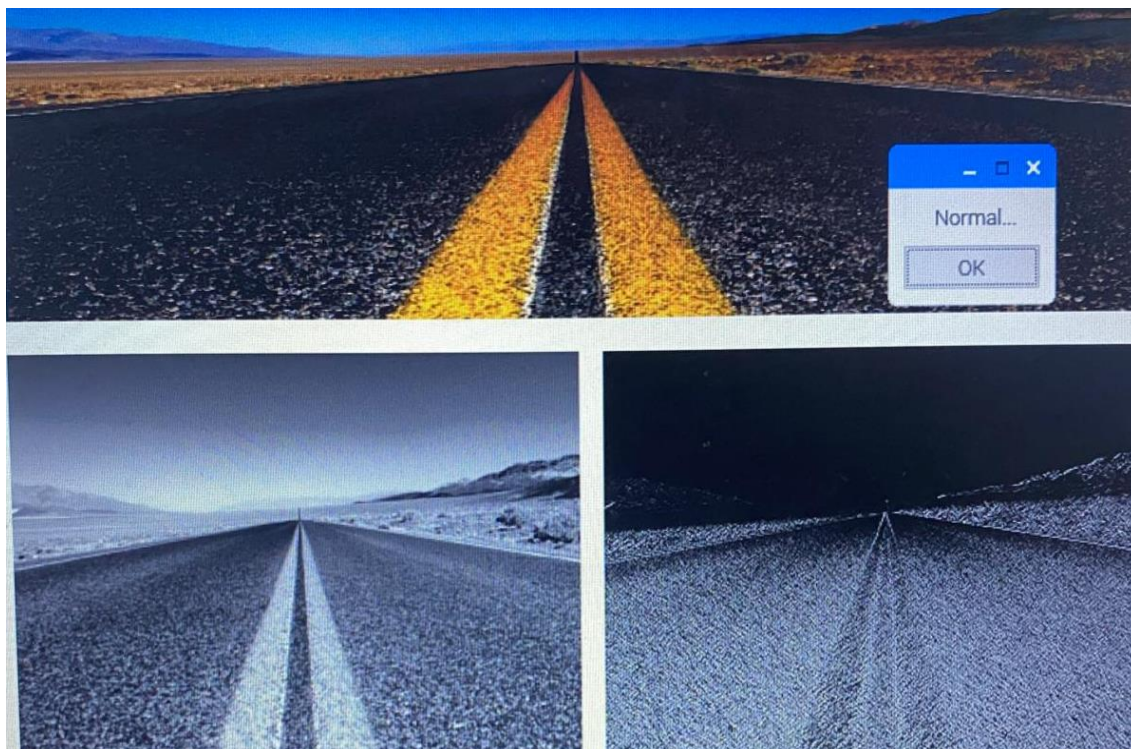
**Fig 5.1 Output Normal**

Figure 5.1 depicts the output as normal from the trained images in dataset creation by comparing the images extract from canvy and sobel algorithm.

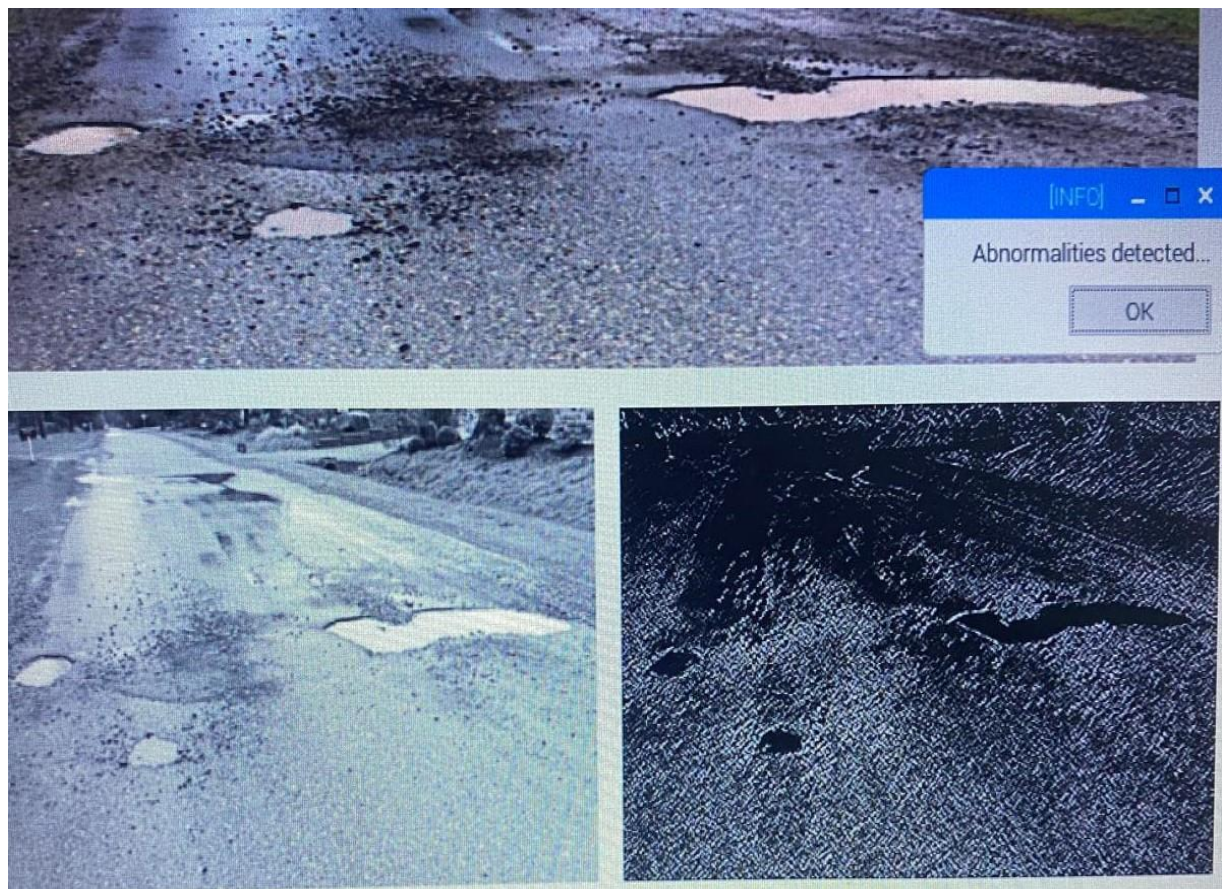
TRAINED OUTPUT:

Fig 5.2 Output Abnormalities Detected

Figure 5.2 depicts the output from the trained images in dataset creation by comparing the images extract from canvy and sobel algorithms

5.4 REAL TIME OUTPUT

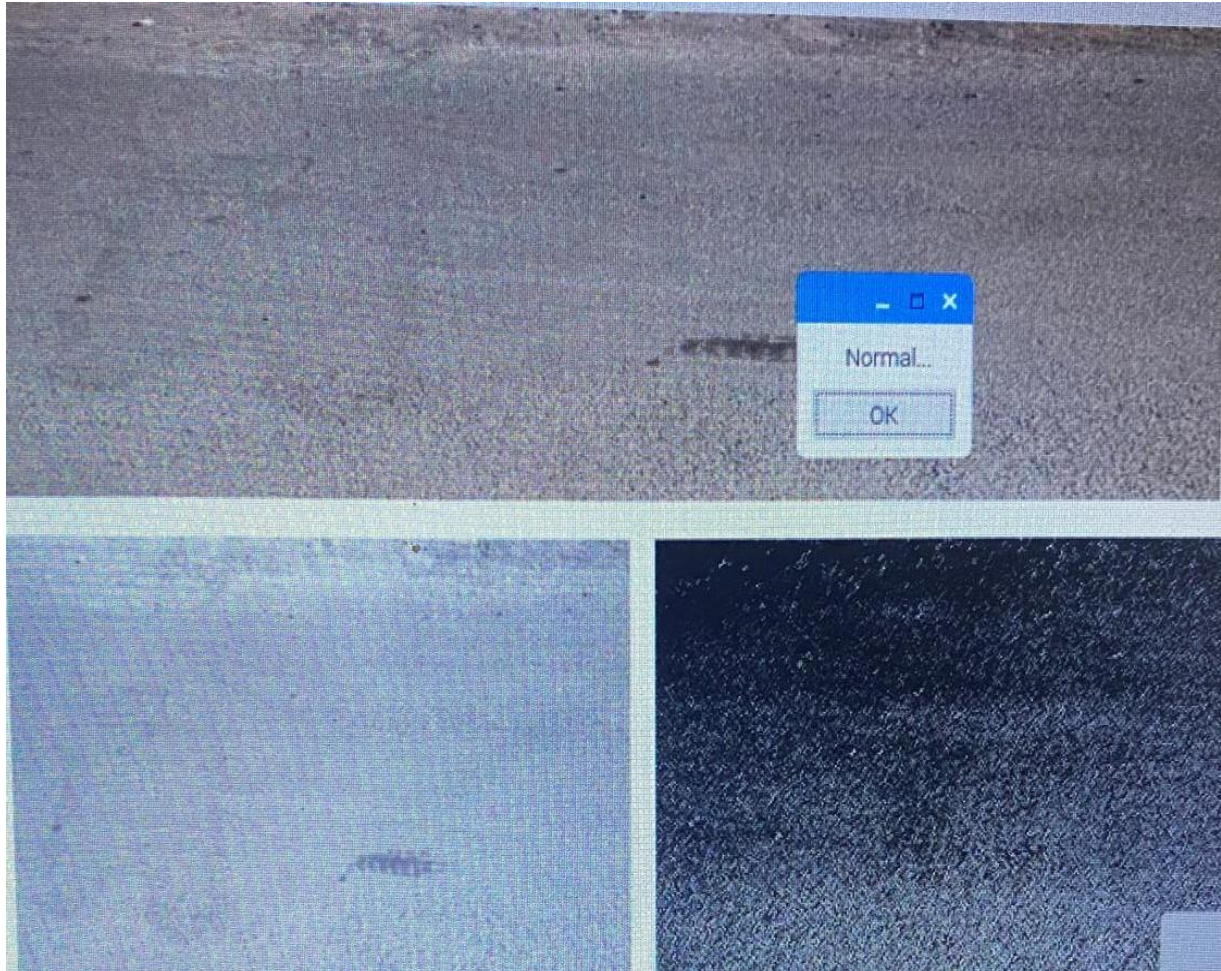


Fig 5.3 Output Real Time

Figure 5.3 depicts the images of the road output from the real time images in dataset creation by comparing the images extract from canvy and sobel algorithms .

REAL TIME OUTPUT:

Fig 5.4 Output abnormalities detected

Figure 5.4 depicts the images of the road output from the real time images in dataset creation by comparing the images extract from canvy and sobel algorithms .

CHAPTER 6

CONCLUSIONS AND SCOPE FOR FUTURE WORK

6.1 CONCLUSIONS

As roads are the common mode of transportation, it is very important to be safe while driving. But road maintenance is a very critical task and includes numerous manpower. Road abnormalities are a major cause of accidents all over the world. After taking a survey on road abnormalities and analyzing them, providing an alert to the driver in advance about the road conditions and the abnormalities would be a better idea to avoid road accidents. The proposed system is designed to give an instant audio alert to the driver indicating the potholes and other road abnormalities like humps speed breakers on the road. Implementing the system by fitting the setup in the vehicle.

6.2 SCOPE FOR FUTURE WORK

This system can be implemented in real time for the detection of road abnormalities with an audio alert to aid the drivers by using High quality camera and sensors that can detect them in a high range of distance. This design can also be used in vehicles which have an inbuilt controller and camera in it, which would be easy to alert the driver at an instance. The road abnormalities like potholes, humps and speed breakers etc can also be uploaded in Google map which is a frequently used software by many people .This project can yield a accuracy of 90% when it will be implemented in real time.

REFERENCES

- [1] Artis & Strazdins, Georgijs & Selavo, Girts & Zviedris, Reinholds & Kanonirs, Leo." *Real Time Pothole Detection Using Android Smartphones with Accelerometers*",2011.

- [2] Anand, A., Gawande, R., Jadhav, P., Shahapurkar, R., Devi, A., and Kumar, N., "*Intelligent Vehicle Speed Controlling and Pothole Detection System*",2020.

- [3] Byeong-ho & Choi ,Kang, Su-il. *Pothole detection system using 2D LiDAR and camera*.2017

- [4] Balaji ,Govindula , Reddy, Etukala & Reddy, Padhuri & Maithreyi, , M. & Dash, Santanu & Kakumani, Aruna. "*Development and Analysis of Pothole detection and Alert based on NodeMCU*",2020.

- [5] M. Strutu, G. Stamatescu and D. Popescu, "*A mobile sensor network based road surface monitoring system*," *2013 17th International Conference on System Theory, Control and Computing (ICSTCC)*, 2013, pp. 630-634, doi: 10.1109/ICSTCC.2013.6689030.

- [6] Aksamit P and M. Szmechta, "*Distributed, mobile, social system for road surface defects detection*,"2011.

- [7] Miyata, Shigeharu. "Automatic Recognition of Speed Limits on Speed- Limit Signs by Using Machine Learning". *Journal of Imaging*,2017.

- [8] Alwan, Imzahim &Joni, Hasan & Ghazwan, Adnan. "Automatic Pavement Distress Distinguish System for Smartphone Android-based Devices". *Journal of Advanced Research in Dynamical and Control Systems*,2018.

[9] Miyata, Shigeharu. "Automatic Recognition of Speed Limits on Speed- Limit Signs by Using Machine Learning". *Journal of Imaging*,2017.

[10] Z. Zhang, X. Ai, C. K. Chan and N. Dahnoun, "An efficient algorithm for pothole detection using stereo vision," *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*,2014.