SAVITRIBAI PHULE PUNE UNIVERSITY

FINAL PROJECT REPORT ON

POTHOLE DETECTION USING ACCELEROMETER AND IMAGE PROCESSING

SUBMITTED TOWARDS THE
COMPLETION OF THE REQUIREMENTS OF

BACHELOR OF ENGINEERING (Computer Engineering)

BY

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CERTIFICATE

This is to certify that the Project Entitled

Pothole Detection using Accelerometer and Image Processing

Submitted by

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have successfully completed the project entitled ***"Pothole Detection using Accelerometer and Image Processing"*** in the fulfillment of B. E. (Computer Engineering) and this work has been carried out in presence of Prof.Mahendra Salunke.

Prof.Mahendra Salunke
Internal Guide

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Abstract

Pothole Detection System using Image Processing or using Accelerometer is not a new normal. But there is no real time application which utilizes both techniques to provide us with efficient solution. We present a system which can be useful for the drivers to determine the intensity of Pothole using both Image Processing Technology and Acceleremoter device based Algorithm. The challenge in building this system was to efficiently detect a Pothole present in roads, to analyze the severity of Pothole and to provide users with information like Road Quality and best possible route. We have used various algorithms for frequency based pothole detection like Z-THRESH, Z-DIFF, STDEV(Z), G-ZERO. We compared the results. We selected the best approach suitable for achieving the project goals. We have used a Simple Differentiation-based Edge Detection Algorithm for Image Processing. The system has been built on Map Interfaces for Android devices using Android Studio, which consists of usage of Image Processing Algorithm based Python frameworks which is a sub field of Machine Learning. It is backed by powerful DBMS. This project facilitates use of most efficient technology tools to provide a good user experience, real time application, reliability and improved efficiency.

Acknowledgments

It gives us great pleasure in presenting the The Project Report project report on ***'Pothole Detection using Accelerometer and Image Processing'****.*

I would like to take this opportunity to thank my internal guide ***Prof. Mahendra Salunke*** *for giving me all the help and guidance I needed. I am really grateful to them for their kind support. Their valuable suggestions were very helpful.*

I am also grateful to ***Prof. Archana Chaugule****, Head of Computer Engineering Department, Pimpri Chinchwad College Of Engineering and Research for her indispensable support, suggestions.*

In the end our special thanks to ***to all staff members*** *for providing various resources such as laboratory with all needed software platforms, continuous Internet connection, for Our Project.*

Sumit Bhimte
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Synopsis

1.1 PROJECT TITLE

”Pothole Detection using Accelerometer and Image Processing”

1.2 PROJECT OPTION

Final Year Project

1.3 INTERNAL GUIDE

Prof. Mahendra Salunke

1.4 SPONSORSHIP AND EXTERNAL GUIDE

No

1.5 TECHNICAL KEYWORDS (AS PER ACM KEYWORDS)

1. I. Computing Methodologies
    (a) I.4 IMAGE PROCESSING AND COMPUTER VISION
        i. I.4.1 Digitization and Image Capture
            A. Enhancement
            B. Restoration
            C. Reconstruction
            D. Segmentation
            E. Scene Analysis
            F. Image Representation

1.6 PROBLEM STATEMENT

To construct the pothole detection system using the help of accelerometer and real time pothole detection using the image processing

1.7 ABSTRACT

Pothole Detection System using Image Processing or using Accelerometer is not a new normal. But there is no real time application which utilizes both techniques to provide us with efficient solution. We present a system which can be useful for the drivers to determine the intensity of Pothole using both Image Processing Technology and Accelerometer device-based Algorithm. The challenge in building this system was to efficiently detect a Pothole present in roads, to analyze the severity of Pothole and to provide users with information like Road Quality and best possible route. We have used various algorithms for frequency-based pothole detection. We compared the results. Apart from that, we selected the best approach suitable for achieving the project goals. We have used a Simple Differentiation-based Edge Detection Algorithm for Image Processing. The system has been built on Map Interfaces for Android devices using Android Studio, which consists of usage of Image Processing Algorithm based Python frameworks which is a sub field of Machine Learning. It is backed

by powerful DBMS. This project facilitates use of most efficient technology tools to provide a good user experience, real time application, reliability and improved efficiency

1.8 GOALS AND OBJECTIVES

- Goal:
  - Detection of pothole.
  - To check the severity of pothole.
  - Road quality check
  - Implementation of optimum path algorithm
- Objectives:
  - This project aims to build the system which can detect the pothole.
  - To normalize the data which consists of different natural frequency shown by different vehicles
  - To store the data in the local database when device is not connected to internet.
  - To transmit stored data to server as soon as device gets connected to internet.
  - To transmit real time data to server as long as device is connected to internet.

1.9 RELEVANT MATHEMATICS ASSOCIATED WITH THE PROJECT

- Input: Accelerometer Readings, Video footage of front view of vehicle.
- Output: Map based to Interface to depict severity of pothole, optimum path.
- Functions : Identify Speed, Identify Pothole, Store Frequency Readings, Search Optimal Path, Road Quality Check, Colour Decision

1.10 NAMES OF CONFERENCES / JOURNALS WHERE PAPERS CAN BE PUBLISHED

- International Journal of Advance Research in Engineering, Science Technology (IJAREST)
- International Journal of Recent Technology and Engineering (IJRTE)
- International Research Journal of Engineering and Technology IRJET Journal

1.11 REVIEW OF CONFERENCE/JOURNAL PAPERS SUPPORTING PROJECT IDEA

- **A Road Quality Detection Method - HUAIJUN WANG , NA HUO, JUNHUAI LI,KAN WANG, AND ZHIXIAO WANG Shaanxi Key, Shaanxi Key Laboratory forNetwork Computing and Security Technology, School of Computer Science and En-gineering, Xi'an University of Technology, Xi'an 710048, China**

  In this research paper the acceleration sensor and gyroscope have obvious fluctuations when the vehicle passes through the larger pothole, and there is a connection between them. In this paper, we propose a novel road detection approach based on Mahalanobis-Taguchi system (MTS), leveraging smartphones for data collection and involving the correlation between characteristics. We develop an application to collect and process the data, and then classify road quality conditions.

- **Real Time Pothole Detection using Android Smartphones with Accelerometers - Artis ednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs, Leo Selavo, DigitalSignal Processing Laboratory Institute of Electronics and Computer Science**

  The paper is describing a mobile sensing system for road irregularity detection using Android OS based smart-phones. Selected data processing algorithms are discussed and their evaluation presented with true positive rate as high as 90 percent using real world data. The optimal parameters for the algorithms are determined as well as recommendations for their application.

- **A Modern Pothole Detection technique using Deep Learning - Abhishek Kumar,Chakrapani,Dhruba Jyoti Kalita, Department of Computer Science and EngineeringNational Institute of Technology, Allahabad**

  This paper proposed a deep learning-based model that can detect potholes early using images and videos which can reduce the chances of an accident. This model is basically based on Transfer Learning, Faster Region-based Convolutional Neural

Network(F-RCNN) and Inception-V2. There are many models for pothole detection that uses the accelerometer (without using images and videos) with machine learning techniques, but a less number of pothole detection models can be found which uses only machine learning techniques to detect potholes. The results of this work have shown that our proposed model outperforms other existing techniques of potholes detection.

- **Multi-lane Pothole Detection from Crowd sourced Under sampled Vehicle SensorData - Andrew Fox, Member, IEEE, B.V.K. Vijaya Kumar, Fellow, IEEE, JinzhuChen, Member, IEEE, and Fan Bai, Fellow, IEEE**
  In this paper, they investigated these issues and develop a crowdsourced system to detect and localize potholes in multi-lane environments using accelerometer data from embedded vehicle sensors. Our crowdsourced system reduces the required network bandwidth by determining road incline and bank angle information in each vehicle to filter acceleration components that do not correspond to pothole conditions. They evaluated their system on simulated and real-world data, analyze tradeoffs in the number of vehicles and the amount of bandwidth required for accurate detection, and compare the results to the simpler single lane detection scenario.

1.12 PLAN OF PROJECT EXECUTION

The plan of project execution gives idea regarding the time required for the project to complete.

Plan of Project Execution

Action plan outline	Goal
Requirement gathering	Gathered requirement for development of project
Designing	Designing for the project
Implementation	Coding of working process of project
Testing	Testing the project at different phases of development.
Deployment	Merging of different tested modules in a single unit for making it ready to use for end user
Maintenance and updating	Maintaining the developed project for the given time and also up- gradation

Chapter 2

Technical Keywords

2.1 AREA OF PROJECT

- IMAGE PROCESSING :-

  Image Processing : Image processing is a method to perform some operations on an image, in order to get an enhanced image or to extract some useful information from it. It is a type of signal processing in which input is an image and output may be image or characteristics/features associated with that image. Nowadays, image processing is among rapidly growing technologies. It forms core research area within engineering and computer science disciplines too.

2.2 TECHNICAL KEYWORDS

1. I. Computing Methodologies
   (a) I.4 IMAGE PROCESSING AND COMPUTER VISION
      i. I.4.1 Digitization and Image Capture
         A. Enhancement
         B. Restoration
         C. Reconstruction
         D. Segmentation
         E. Scene Analysis
         F. Image Representation

Chapter 3

Introduction

3.1 PROJECT IDEA

- To Design a Map based Interface System that takes Real Time Road Images and Pothole Frequency Readings as data using devices like Accelerometer and Camera in order to process the acquired data to check the existence of the pothole and to check the Severity of Potholes and Quality of Roads.

3.2 MOTIVATION OF THE PROJECT

According to data provided on official website of 'Ministry of Transport and Highways', "A total of 22,656 people lost their lives due to various reasons of which 2015 lost their lives on the roads due to Road Potholes across India in 2018". This motivated us to make a system which makes the driver aware of damaged road so that he/she can drive cautiously. And hence, people's life can be saved and also damaged can be reduced. This also can be used as a measure to depict road quality to concerned authority and common people as well.

3.3 LITERATURE SURVEY

- **A Road Quality Detection Method - HUAIJUN WANG , NA HUO, JUNHUAI LI,KAN WANG, AND ZHIXIAO WANG Shaanxi Key, Shaanxi Key Laboratory forNetwork Computing and Security Technology, School of Computer Science and En-gineering, Xi'an University of Technology, Xi'an 710048, China**

  In this research paper the acceleration sensor and gyroscope have obvious fluctuations when the vehicle passes through the larger pothole, and there is a connection between them. In this paper, we propose a novel road detection approach based on Mahalanobis-Taguchi system (MTS), leveraging smartphones for data collection and involving the correlation between characteristics. We develop an application to collect and process the data, and then classify road quality conditions.

- **Real Time Pothole Detection using Android Smartphones withhttps://www.overleaf.com/project Accelerometers - ArtisMednis, Girts Strazdins, Reinholds Zviedris, Georgijs Kanonirs, Leo Selavo, DigitalSignal Processing Laboratory Institute of Electronics and Computer Science**

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techniques, but a less number of pothole detection models can be found which uses only machine learning techniques to detect potholes. The results of this work have shown that our proposed model outperforms other existing techniques of potholes detection.

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Chapter 4

Problem Definition and Scope

4.1 PROBLEM STATEMENT

To Design a Map based Interface System that takes Real Time Road Images and Pothole Frequency Readings as data using devices like Accelerometer and Camera in order to process the acquired data to check the existence of the pothole and to check the Severity of Potholes and Quality of Roads.

4.1.1 Goals and objectives

4.2 GOALS AND OBJECTIVES

- Goal:
  - Detection of pothole.
  - To check the severity of pothole.
  - Road quality check
  - Implementation of optimum path algorithm
- Objectives:
  - This project aims to build the system which can detect the pothole.
  - To normalize the data which consists of different natural frequency shown by different vehicles
  - To store the data in the local database when device is not connected to internet.

- To transmit stored data to server as soon as device gets connected to internet.
- To transmit real time data to server as long as device is connected to internet.

4.2.1 Statement of Scope

This project aims to create a system that shows the user whether given road has any Potholes and also to provide them with vital information like Severity of Potholes, Road Quality and to provide Users with the Optimum Path.

4.3 SOFTWARE CONTEXT

The system will be used by the General Public in day to day life, for the people who want to travel through unknown roads or the for daily travellers who want to know the Quality of the Road and Optimal Path to save their time.

4.4 OUTCOME

Outcome of the project will be in the form of a Map Interface based Android Application which depicts the Quality of Road, Severity of Potholes and provides Optimal Path.

4.5 APPLICATIONS

- This system will be used by daily Travellers, Common Public, Transport Industrialists, Road Maintenance Department, Government Agencies, etc. for their convenience.

4.6 HARDWARE RESOURCES REQUIRED

- CPU Speed : 2GHz
- RAM : 8GB
- Hard Disk : 1TB
- Accelerometer Sensor
- Portable Camera

4.7 SOFTWARE RESOURCES REQUIREMENT

- Operating System : Windows 10
- Languages : OpenCV, Python
- Backend : MySql
- Support for Android Version 5.0 and Above.

Chapter 5

Project Plan

5.1 PROJECT ESTIMATES

5.1.1 Reconciled Estimates

Cost Estimate

Cost related to Camera Equipments

Time Estimates

Approximately 11 months

5.1.2 Project Resources

- Internet Services
- Accelerometer, Camera
- Windows OS based x64 Laptop/PC
- Android Device
- Testing Vehicle

5.2 RISK MANAGEMENT

5.2.1 Risk Identification

Following risks have been identified:

- Input Images can be unclear depending on Camera, Lighting Conditions of Background.
- Pothole may be recognised incorrectly by the model.
- Inappropriate images in Dataset - To overcome this risk we are trying to use well organized and clear images of potholes.
- Bad lighting conditions can affect the image processing.
- Failure of device.
- Bad weather conditions can affect the output.

Following is the questionnaire:

1. Are requirements fully understood by the software engineering team ?

Yes

2. Have customers been involved fully in the definition of requirements?

No

3. Do end-users have realistic expectations?

Yes

4. Does the software engineering team have the right mix of skills?

Yes

5. Are project requirements stable?

Yes

6. Is the number of people on the project team adequate to do the job?

Yes

5.2.2 Risk Analysis

The risks for the project can be analyzed within the constraints of time and quality

5.2.3 Overview of Risk Mitigation, Monitoring, Management

The identification of risk is central to the success and failure of the project, hence we have made a concentrated effort to minimize and even eliminate certain risk factors. Software risk could be classified into categories such as Internal risks and External risks, risks which arise from the risk factor within the organization can be defined as internal risks and the risk coming from outside is called external risk. Internal risk avoidance can be done by clear picturing of the process risk, product risk. Following are the details for each risk.

ID	Risk Description	Probability	Impact		
			Schedule	Quality	Overall
1	Input images can be unclear depending on camera, lighting conditions.	Medium	Low	High	High
2	Pothole may be recognised incorrectly by the model.	Low	Low	High	High
3	Failure in system due to failure of Equipments.	Low	Low	High	High

Table 5.1: Risk Table

Probability	Value	Description
High	Probability of occurrence is	$> 75\%$
Medium	Probability of occurrence is	$26 - 75\%$
Low	Probability of occurrence is	$< 25\%$

Table 5.2: Risk Probability definition

Impact	Value	Description
Very high	$> 10\%$	Schedule impact or Unacceptable quality
High	$5 - 10\%$	Schedule impact or Some parts of the project have low quality
Medium	$< 5\%$	Schedule impact or Barely noticeable degradation in quality Low Impact on schedule or Quality can be incorporated

Table 5.3: Risk Impact definitions

Risk ID	1
Risk Description	Hardware Limitations
Category	Development Environment.
Source	This was identified during early development and testing.
Probability	Medium
Impact	High
Response	Accept
Strategy	Good Quality Camera will overcome this
Risk Status	Occurred

Table 5.4: Risk Id 1

Risk ID	2
Risk Description	Usage of Algorithm with Low Efficiency
Category	Development Environment.
Source	This was identified during early development and testing.
Probability	Low
Impact	High
Response	Mitigate
Strategy	After studying the Algorithm and taking care of the conditions, this problem can be minimized
Risk Status	Identified

Table 5.5: Risk Id 2

Risk ID	3
Risk Description	Undeterministic reasons like power shortage or short circuit leading to failure or destruction of devices
Category	Development Environment.
Source	This was estimated during early development and testing.
Probability	Low
Impact	High
Response	Mitigate
Strategy	After studying the Algorithm and taking care of the conditions, this problem can be minimized
Risk Status	Did not occur but Estimated

Table 5.6: Risk Id 3

5.3 PROJECT SCHEDULE

5.3.1 Project Task Set

Major Tasks in the Project stages are:

- Task 1: Developing an Accelerometer based Pothole Frequency Calculator Application to acquire the Data Set.
- Task 2: Developing an Image Processing based Real Time Pothole Detector.
- Task 3: Developing an Android based Application which consists of Map Interface and is able to transmit real time Geo Coordinates along with Frequency to the Database.
- Task 4: Using Data Set to mark the concerning coordinates on the Map Interface.
- Task 5: Combining the developed modules.
- Task 6: Integration of the Camera based Application and Map interface to mark pothole coordinates as per respective Severity.
- Task 7: Develop Modules such as Prediction of Road Quality and show Optimal Path based on obtained Data.

- Task 8: Integration of all the Developed Modules into a Single Application.
- Task 9: Testing.

5.3.2 Task Diagram

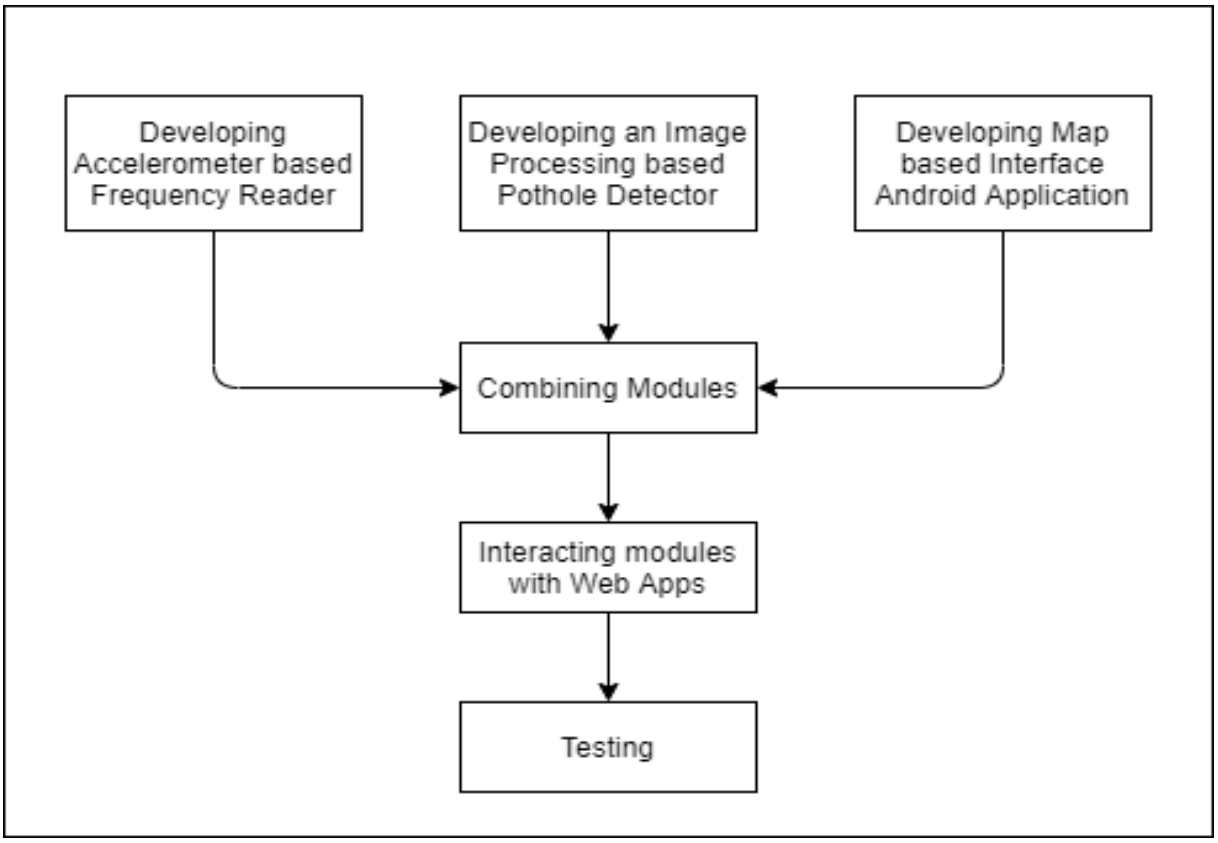


Figure 5.1: Task Network

5.4 TEAM ORGANISATION

5.4.1 Team Structure

The team structure for the project is identified. There are total 4 members in our team and roles are defined. All members are contributing in all the phases of project.

5.4.2 Management Reporting and Communication

Mechanisms for progress reporting and inter/intra team communication are identified as per assessment sheet and lab time table.

Chapter 6

Software Requirement Specification

6.1 INTRODUCTION

6.1.1 Purpose and Scope of Document

The software requirement specification of our project will have the requirements which will be a baseline of our project. The software requirement specification will incorporate functional and non-functional requirements, system architecture, data flow diagrams, UML diagrams, experimental setup requirements and performance metrics.

A software requirements specification (SRS) is a document that is created when a detailed description of all aspects of the software to be built must be specified before the project is to commence. It is important to note that a formal SRS is not always written. There are many instances in which effort expended on an SRS might be better spent in other software engineering activities.

6.1.2 Overview of responsibilities of Developer

1. To have better understanding of the problem statement.
2. To know what are the hardware and software requirements of the proposed system.
3. To have understanding of the proposed system.
4. To plan various activities with the help of planner.
5. Designing, programming, testing etc.

6.2 USAGE SCENARIO

6.2.1 Use Case

The profiles of all the users are described here.

Admin : Authorizes users and collects system generated attendance reports.

User : The user will provide his/her images and details.

System : Registers the new user into the system.

6.2.2 Use Case View

A use case diagram is a graphical representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can show the different types of users of a system and the various ways in which they interact with the system.

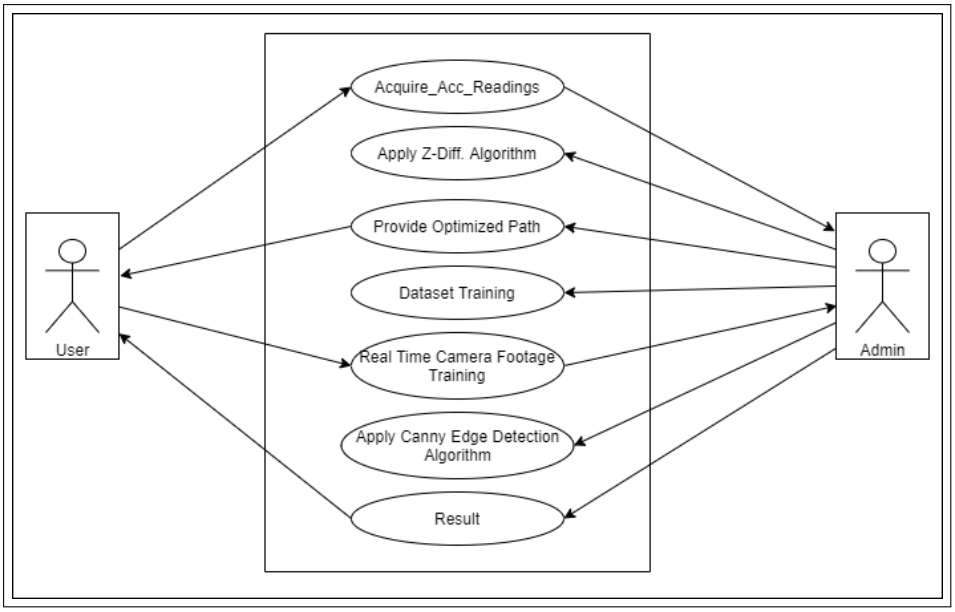


Figure 6.1: Use case diagram

6.3 DATA MODEL AND DESCRIPTION

6.3.1 Data Description

Images of the pothole will be required during the training phase. Model will be trained on these images that will be stored in the system. While analyzing the presence of pothole, the system will detect uneven surfaces using the available camera. Processing will be done on the Image and Pothole will be recognised by the system. Later Accelerometer will be used to find the severity of pothole.

6.4 FUNCTIONAL MODEL AND DESCRIPTION

Functional requirements define the internal workings of the software: The technical details, data manipulation and processing and other specific functionality that show how the use cases are to be satisfied. They are supported by non-functional requirements, which impose constraints on the design or implementation.

The functional requirement of this system application can be broadly categorized into following parts –

- Entry of data

  - Modification of data
  - Verification of data
  - View Data
  - Uploading of data

- Entry of data:
  Pothole Geo-coordinates will be required before deploying this software. Also, test images will be required for training the software based Image Processing Algorithms. Moreover pothole images and frequency fluctuations will be required at the real time usage.

- Modification of data:
  The Admin shall be able to modify, control, normalize, process the data of the acquired location coordinates, frequency fluctuations, pothole images.

- Verification of data:
  This data will be updated automatically as the users use the application. Machine Learning Algorithms will be implemented likely

- View data:-
  View data on the system.

- Uploading:
  The system shall recognize a pothole and upload the frequency changes, coordinates to check the severity of the pothole to database.

6.4.1 Description of functions

- Access Application GUI : The admin will be able to access the application GUI.

- Detect Pothole : The occurred pothole will be captured using available camera.
- Detect Frequency : When vehicle passes through a pothole frequency fluctuations will be detected.
- Transmit Coordinates : When frequency fluctuations are observed, location will be stored in Data base
- Compute Severity : Depending on the factors like amount of frequency, speed severity of Pothole will be computed.
- Provide Optimal Path : Depending on the factors like road quality, number of potholes, severity Optimal Path will be recommended to the user.

6.4.2 Activity Diagram

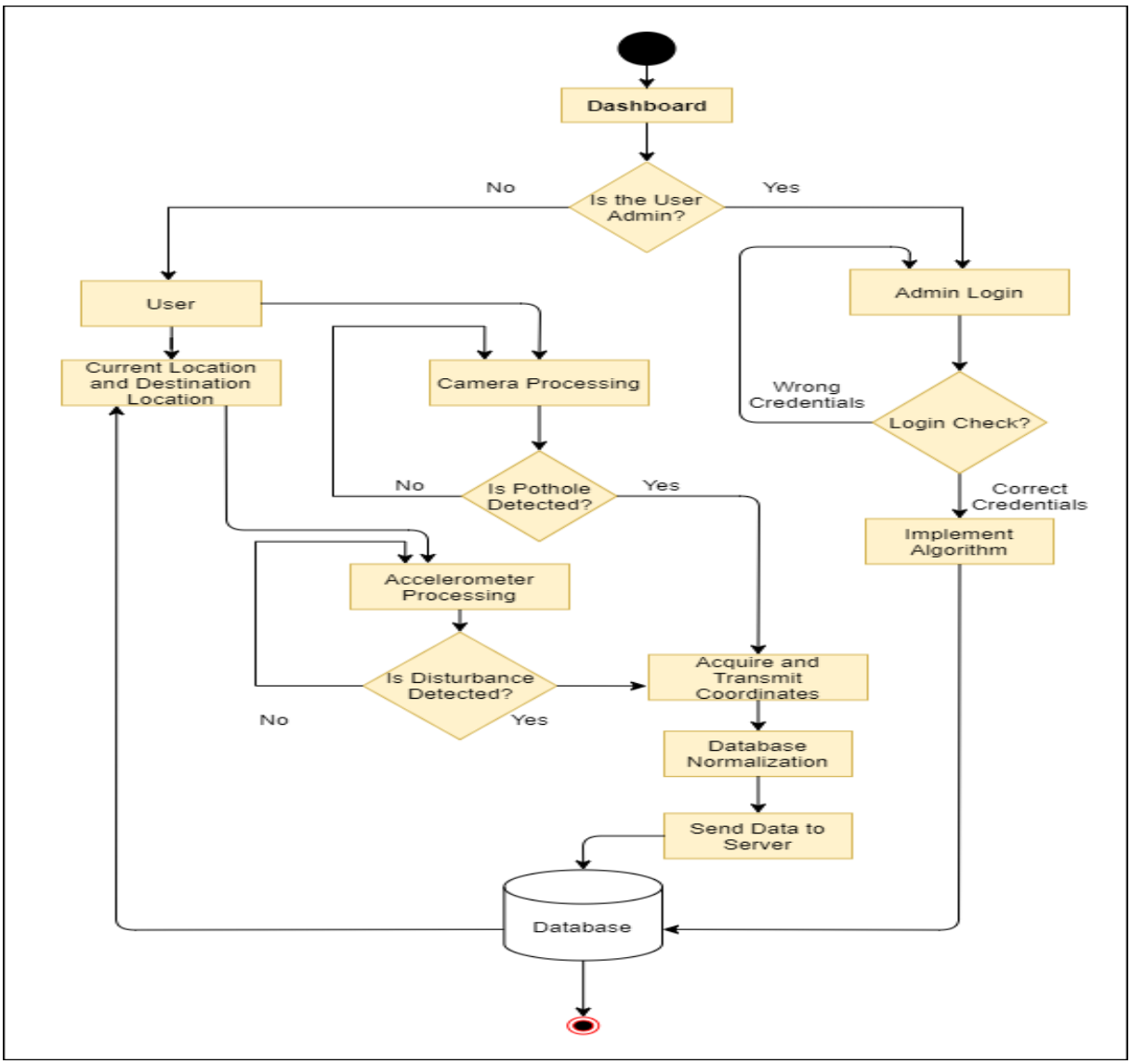


Figure 6.2: Activity Diagram

6.4.3 Non Functional Requirements:

1. Performance Requirements

- Reliability: If any exceptions occur during the execution of the software it should be caught and thereby prevent the system from crashing.
- Scalability: The system should be developed in such a way that new modules and functionalities can be added, thereby facilitating system evolution.
- Cost: The cost should be low because of free availability of software packages.

2. Security Requirements :

Records and data will be available only to authorized user.

6.4.4 State Diagram

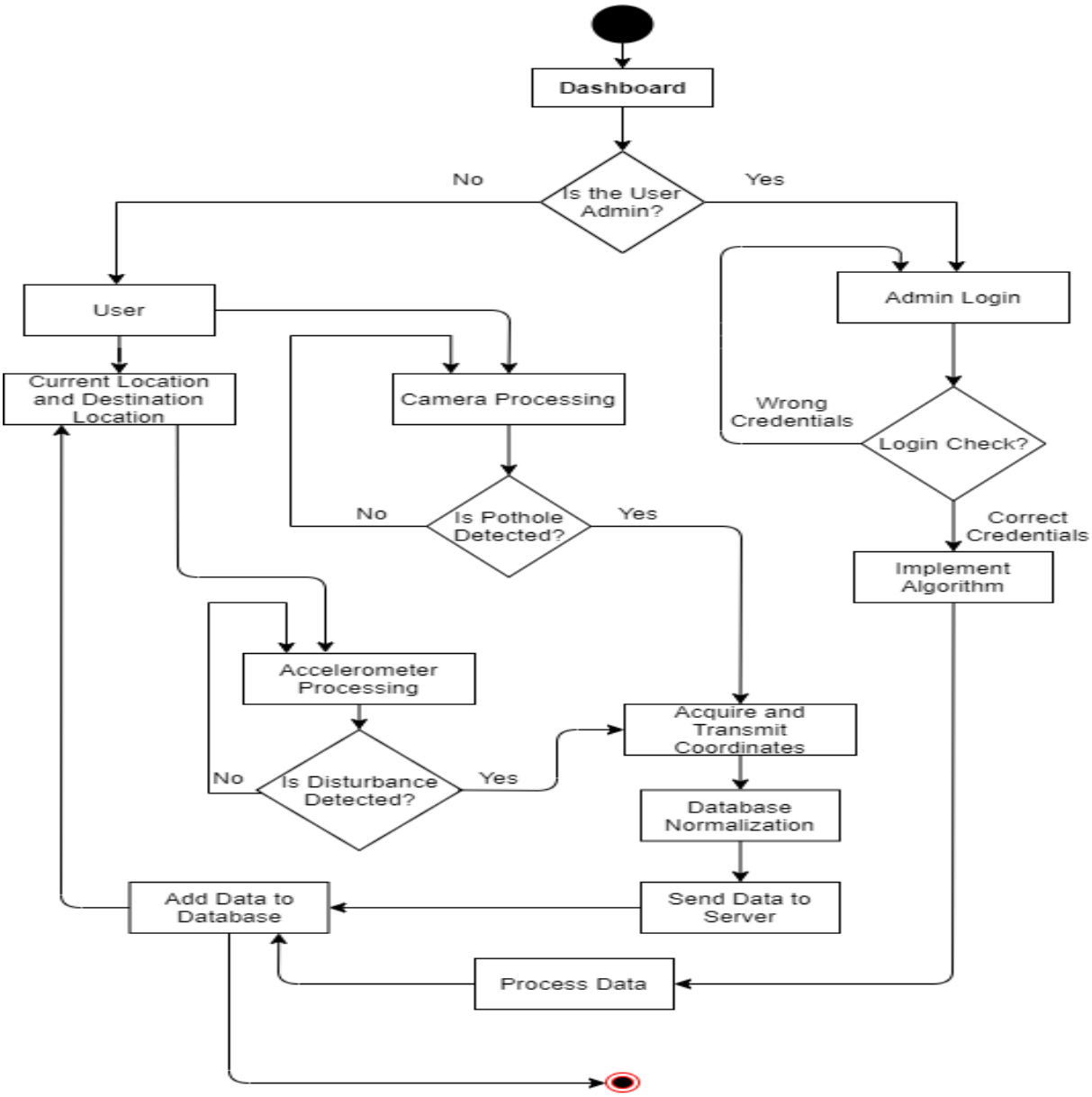


Figure 6.3: State Diagram

6.4.5 Design Constraints

The design constraints includes restrictions of the system that prevents smooth functioning of the application. This may happen if a wrong image is given as input to a system.

6.4.6 Software Interface Description

The software interface includes one component: screen.

The screen will display the result.

Chapter 7

Detailed Design Document using Appendix A and B

7.1 INTRODUCTION

This Application has four main basic modules, which gives feasibility to Face detection and recognition.

- Pothole location is stored in System by training the system using Accelerometer.
- Pothole is detected on screen using Image Processing.
- Develop an Algorithm on the system to map Accelerometer and Image Processing.
- Develop an Algorithm to provide appropriate chromatography to Pothole on Map Interface
- Provide Optimal path.

7.2 ARCHITECTURAL DESIGN

A description of the project architecture is presented.

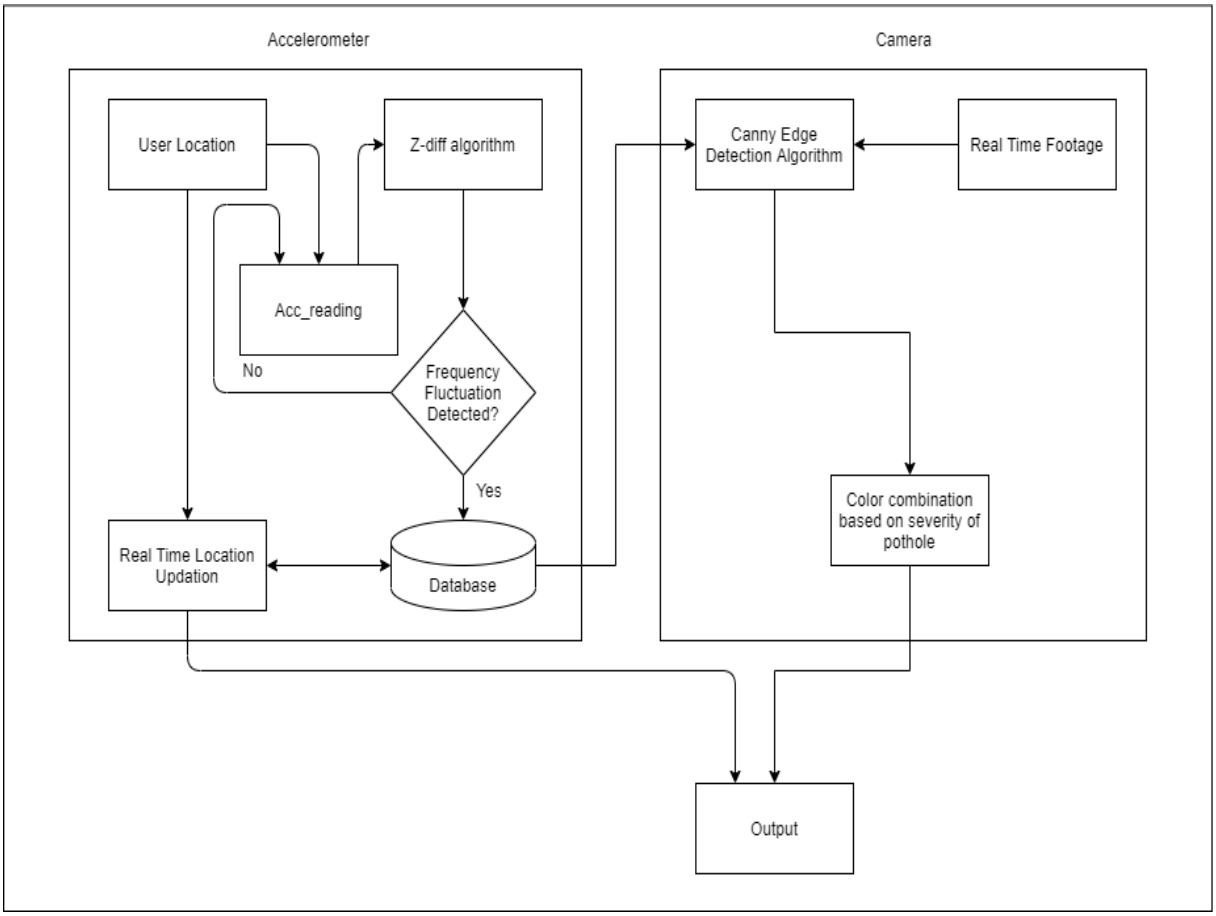


Figure 7.1: Architectural Diagram

Chapter 8

Proposed System

8.1 LOGIC FOR ACCELEROMETER

1. Data in the form of dataset from the accelerometer sensors was collected on an urban road with various potholes.

2. Consecutive measurements with difference value above specific threshold level represent events. Road Mic pothole detection methodology was used to collect reference data, where Road Mic tests were performed.

3. Research of potential event related features was performed, after acquisition of the first test data set. The emphases were put on features that do not require resource intensive signal processing techniques and therefore are suitable for implementation of real time detection using devices with limited hardware and software resources.

4. The features that classify the measurements are the values exceeding specific thresholds that identify the type of the potholes.

5. The algorithm is trained in such a way that it assumes about the information regarding Z-axis position of accelerometer is known. Additional virtual reorientation of the accelerometer is possible, as described in Neric ell.

6. We used controlled placement of the accelerometer, and eliminated the extra processing required for the virtual reorientation. This also tested on the acquired data set.

8.2 LOGIC FOR IMAGE PROCESSING

1. We have used high resolution images and videos as input for the purpose of training and building computer vision system. Images are accordingly converted into convenient resolution. We have used YOLO v4, darknet, Computer Vision i.e., OpenCV library as software aspects for this project.

2. We had a dataset consisting of 600 high resolution images, of which 30 images are used for training and remaining images are used for testing. Before providing all the images to create a model, it was necessary to process the images and convert them into suitable format.

3. YOLO framework also known as 'You Only Look Once' deals with object detection. It takes entire image/video in a single instance. It returns boundaries of the detected object in the form of coordinates. It works on the principle of probabilities; higher the obtained probability higher is the accuracy of the detected object.

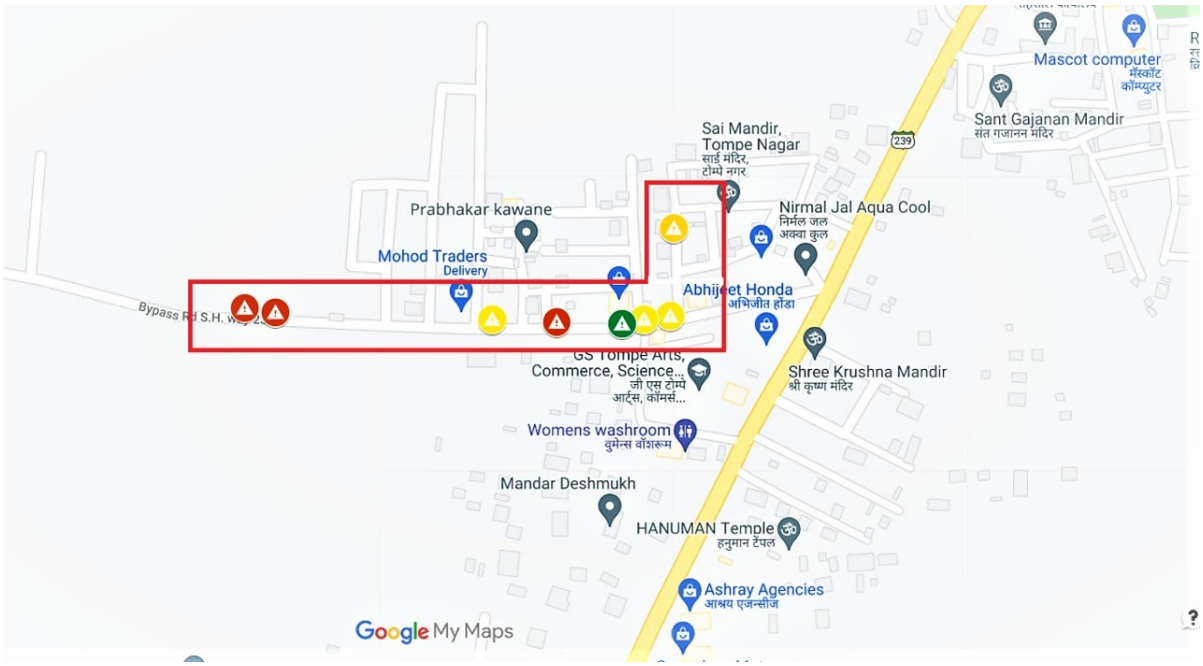
4. It is a very fast technique which can process 45 frames per second. For training, YOLO takes an image and converts it into 3 x 3 grid and checks for the probability of presence of given object (Pothole) in each grid individually.

5. Each grid is assigned values 0 or 1 according to the probability. For testing, images are passed and run-in forward propagation until we obtain output. It uses RCNN family of techniques.

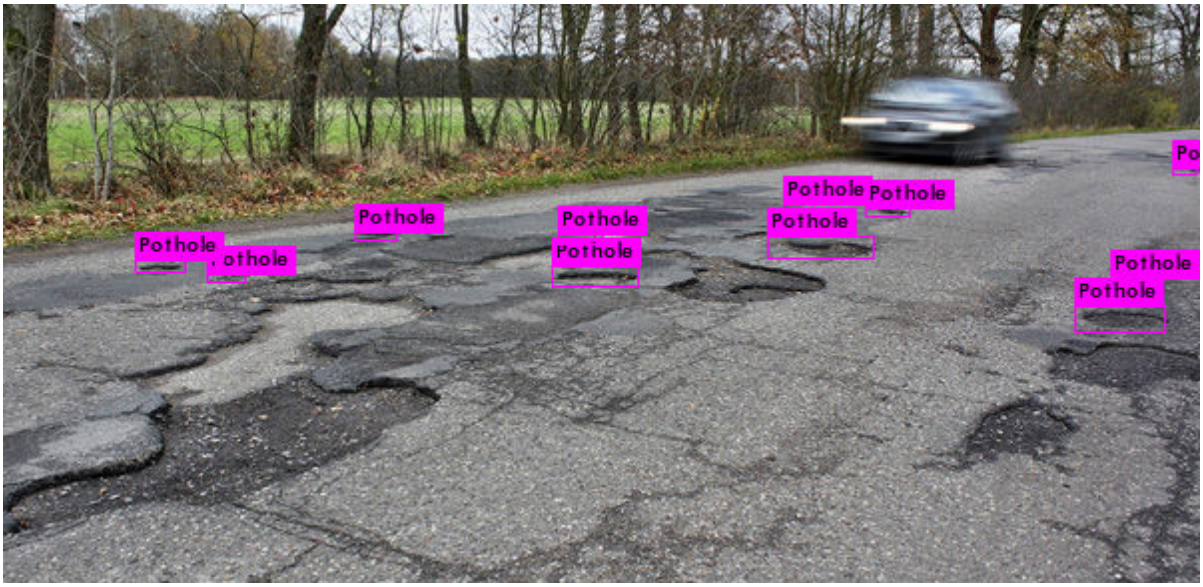
Chapter 9

Result

9.1 MAP OUTPUT



9.2 IMAGE PROCESSING OUTPUT



Chapter 10

Conclusion

In this project, we proposed a system where user can get the location of Potholes, the Quality of Road, severity of a pothole, optimal path. The system detect Potholes through Accelerometer and Camera. The frequency related data and the location coordinates are stored in database and respectively processed and updated in real time. The result is shown in the form of Map so that user can choose best possible path and avoid damage or accidents.

Chapter 11

References

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Annexure A

Plagiarism Report

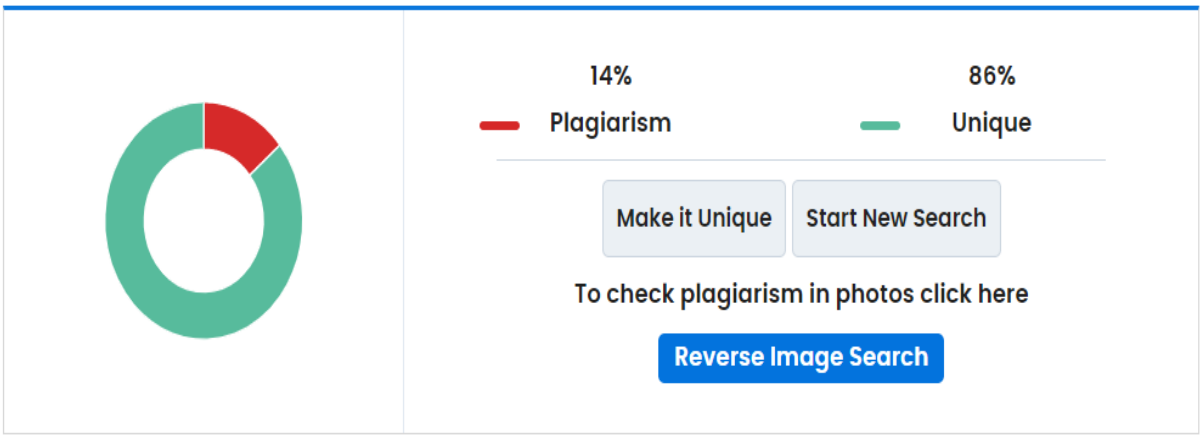

Figure A.1: Plagiarism Report

Annexure B

Laboratory Assignment on Project Analysis of Algorithmic Design

B.1 ALGORITHM

B.1.1 YOLO V4

(a) You only look once (YOLO) is a state-of-the-art, real-time object detection system.

(b) YOLO (You Only Look Once) uses deep learning and convolutional neural networks (CNN) for object detection, it stands out from its “competitors” because, as the name indicates it only needs to “see” each image once. carry out the detection, the image is divided in a grid of SxS (left image). Each one of the cells will predict N possible “bounding boxes” and the level of certainty (or probability) of each one of them (image at the center), this means SxSxN boxes are calculated.

(c) The vast majority of these boxes will have a very low probability, that’s why the algorithm proceeds to delete the boxes that are below a certain threshold of minimum probability.