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A project report on

HTMS SYSTEM AND STREAMLINING BID SUBMISSION

Submitted in partial fulfillment for the award of the degree of

Bachelor of Technology

in

Computer Science and Engineering

by

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SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

VIT AP UNIVERSITY

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<u>DECLARATION</u>

I here by declare that the thesis entitled “**HTMS SYSTEM AND STREAMLINING BID SUBMISSION**” submitted by me, for the award of the degree of **BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING** is a record of bonafide work carried out by me under the supervision of Mamta Arora.

I further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Abhay

Place: Amaravati

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This is to certify that the Internship titled "**HTMS SYSTEM AND STREAMLINING BID SUBMISSION**" that is being submitted by **ABHAY CHAUDHARY (19BCE7290)** is in partial fulfillment of the requirements for the award **BACHELOR OF TECHNOLOGY in COMPUTER SCIENCE AND ENGINEERING**, is a record of bonafide work done under my guidance. The contents of this Project work, in full or in parts, have neither been taken from any other source nor have been submitted to any other Institute or University for award of any degree or diploma and the same is certified.

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ABSTRACT

This project aims to design and develop a highway toll management system for Sterling Indo Tech Pvt. Ltd., a consulting firm located in India. The system will be developed using modern-day technologies to improve efficiency and accuracy in the toll collection process, as well as to provide real-time data for monitoring and analysis. The system will also include features for managing tollbooths, managing toll plaza operations, and managing toll collection data. Additionally, the project will identify a streamlined pipeline for bid submission, which will help the firm to compete effectively and efficiently for infrastructure projects. The project will also incorporate the use of data visualization tools to help the firm make informed decisions based on data analysis. Overall, this project will help the firm to improve their operations, increase efficiency, and stay competitive in the infrastructure industry.

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Place: Amaravati

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

HTMS	Highway Toll Management System
OCR	Optical Character Recognition
API	Application programming interface
SAAS	Software as a service
OS	Operating System
CI/CD	Continuous Integration and Continuous Delivery/Continuous Deployment
HTTP	Hypertext Transfer Protocol
UNIX	Uniplexed Information Computing System
NoSQL	Not Only SQL
CRUD	Create, Read, Update and Delete
RAD	Rapid Application Development
XML	Extensible Markup Language
STS	Spring Tool Suite
IDE	Integrated Development Environment
JPA	Java Persistence API
ORM	Object–Relational Mapping

Chapter 1

Introduction to Infrastructure

1.1 INFRASTRUCTURE OF HIGHWAY INDUSTRY

Infrastructure is essential for the functioning and development of a society, as it provides the necessary support for economic activity, social interaction, and the delivery of essential services. It can include transportation systems, such as roads, highways, bridges, and public transit; energy systems, such as power plants, transmission lines, and distribution networks; water and sewage systems; telecommunications systems; and educational and healthcare facilities. Building and maintaining roads, highways, bridges, and public transit systems can help to improve accessibility and connectivity within a country, which can stimulate economic growth and development.

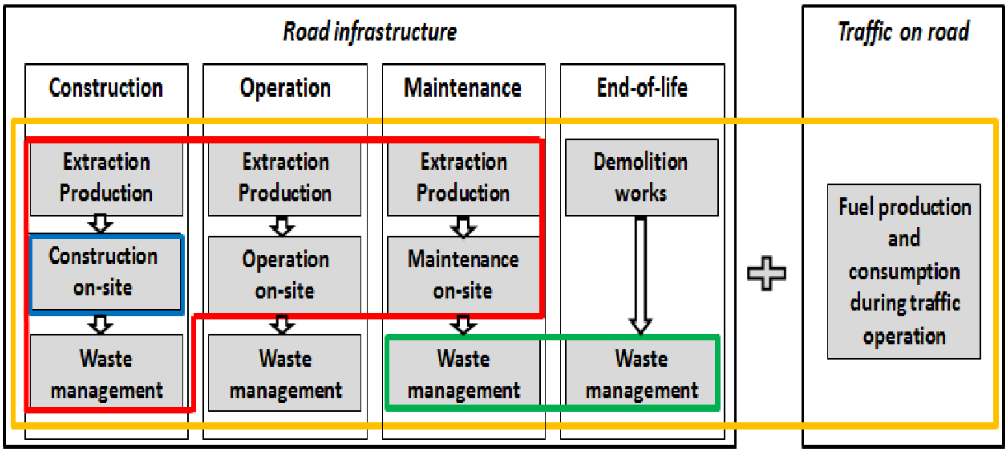


Figure 1.1: Life Cycle of a Road Infrastructure

The Indian infrastructure business is quite large, valued at billions of dollars. It includes various sectors such as transportation, energy, telecommunications, and real estate, among others. The Indian government has been investing heavily in infrastructure development in recent years, and private investment is also on the rise. The country is also seeing an increase in public-private partnerships (PPPs) in infrastructure projects. Highway infrastructure is a critical component of any country's transportation system. It plays a crucial role in connecting people, businesses, and communities, facilitating trade and commerce, and enabling the movement of goods and services across different regions. A well-developed highway infrastructure network can lead to increased economic growth, job creation, and higher standards of living for citizens.

In India, the road transportation network is the backbone of the country's economy. India has the second-largest road network in the world, covering over 5.5 million km, and it is expanding rapidly. The government has launched various initiatives, such as the Bharat Mala Pariyojana, to improve and develop highways and roads across the country. Highway infrastructure development also has a significant impact on the environment. The construction of highways can lead to deforestation, habitat destruction, and soil erosion, among other issues. Therefore, it is essential to incorporate sustainable practices and technologies in highway infrastructure development, such as the use of recycled materials and renewable energy sources. It is essential to invest in sustainable and efficient infrastructure systems that can meet the needs of the present without compromising the ability of future generations to meet their own needs.

1.2 OVERVIEW OF HIGHWAY TOLL MANAGEMENT SYSTEM (HTMS)

Highway toll management systems (HTMS) are essential for managing and monitoring the flow of traffic on highways, bridges, and other toll roads. These systems use various technologies such as automatic vehicle identification, electronic toll collection, and advanced traffic management systems to ensure efficient toll collection and traffic management. The use of HTMS can improve traffic flow, reduce congestion, and enhance the overall safety of drivers and passengers.

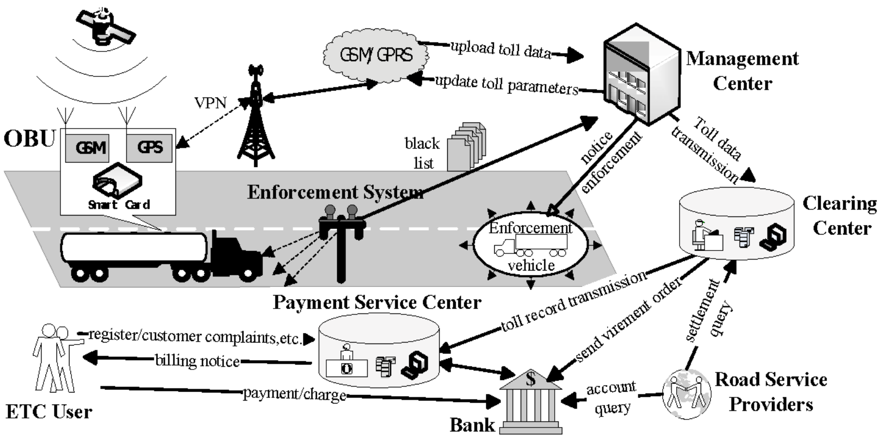


Figure 1.2: Overview of Highway Toll Management System

HTMS systems are becoming increasingly important in developing countries like India, where the demand for transportation infrastructure is rapidly increasing. India has the second-largest road network in the world, covering over 5.5 million kilometers, and is expected to continue to grow in the coming years.

The growth of the road network has created a need for efficient toll collection and traffic management systems, which can be achieved through the use of HTMS. These systems are also essential for generating revenue for the government, as toll collection is a significant source of funding for the construction and maintenance of highways and bridges. Efficient toll collection systems can ensure that tolls are collected accurately and on time, which can help to increase revenue for the government and reduce the burden on taxpayers.

There are several types of HTMS systems that are used worldwide. One of the most common types is the electronic toll collection (ETC) system, which uses electronic devices to automatically deduct toll fees from a driver's account. This system is widely used in developed countries like the United States, Canada, and Japan, where it has significantly reduced congestion and improved traffic flow. Another type of HTMS system is the automatic vehicle identification (AVI) system, which uses RFID (radio-frequency identification) technology to identify and track vehicles as they pass through toll plazas. The AVI system is widely used in developing countries like India, where it is more cost-effective and easier to implement than ETC systems. In recent years, there has been a significant shift towards the use of advanced traffic management systems (ATMS) in HTMS systems. ATMS systems use real-time data to monitor traffic flow and adjust toll rates and traffic signals accordingly. These systems can help to reduce congestion, improve safety, and reduce the environmental impact of transportation.
Overall, the use of HTMS systems is essential for managing and improving highway infrastructure, generating revenue for the government, and improving the overall safety and efficiency of transportation. With the rapid growth of the road network in India and other developing countries, the need for efficient HTMS systems will continue to increase in the coming years.

1.2.1 BENEFITS OF HIGHWAY TOLL MANAGEMENT SYSTEM

- **Increased efficiency:** A highway toll management system can increase efficiency by reducing traffic congestion, lowering wait times at toll booths, and enabling faster payment processing. This can result in faster travel times for drivers and improved overall traffic flow.
- **Cost savings:** The implementation of a highway toll management system can reduce operating costs by automating toll collection and reducing the need for manual labour. Additionally, the system can help to prevent revenue leakage by identifying and addressing instances of toll evasion.

- **Enhanced safety:** A toll management system can improve safety by reducing the need for drivers to stop and pay tolls, which can lead to fewer accidents and injuries. The system can also enable faster emergency response times by reducing traffic congestion.
- **Improved data collection and analysis:** With a highway toll management system, data can be collected and analysed in real-time, providing valuable insights into traffic patterns, toll revenues, and other key metrics. This information can be used to inform future infrastructure planning and investment decisions.
- **Environmental benefits:** A toll management system can help to reduce the environmental impact of highway travel by reducing idling times at toll booths and enabling more efficient traffic flow. Additionally, the system can facilitate the use of electric tolling, which can help to reduce emissions from vehicles.

Overall, a highway toll management system can provide a range of benefits for drivers, transportation authorities, and the environment. By increasing efficiency, reducing costs, improving safety, enabling data collection and analysis, and promoting environmental sustainability, these systems can play an important role in modernizing and improving the highway industry.

1.3 OVERVIEW OF BIDDING SYSTEM IN THE INDUSTRY

Bidding is an essential process in the highway industry for securing projects. The bidding process involves submitting a proposal for a project and competing with other consultants to win the contract. The highway industry is highly competitive, and the bidding process is complex and challenging. The success of a consultant depends on their ability to submit a competitive bid that meets the client's requirements and provides a reasonable profit margin. A well-managed bidding process can lead to the selection of the most qualified consultants at the most competitive prices.

In the highway industry, bidding is a crucial aspect of the project lifecycle. The bidding process usually begins with a request for proposal (RFP) or a request for quotation (RFQ) from the client. The RFP or RFQ typically includes details about the project, such as the scope of work, timelines, budget, and technical requirements. Consultants who are interested in bidding on the project will need to review the RFP or RFQ carefully to determine if they are capable of meeting the requirements.

The bidding process in the highway industry can be very competitive. There are often many consultants bidding on the same project, and each consultant will need to submit a competitive bid to win the contract. Consultants will need to consider factors such as labor costs, material costs, equipment costs, and overhead costs when preparing their bids. They will also need to factor in a profit margin that is sufficient to make the project financially viable.

The success of a bidding process depends on various factors, such as the quality of the bid proposal, the consultant's reputation, and the consultant's experience in similar projects. The quality of the bid proposal is critical, as it will be the primary factor that the client will consider when selecting a consultant. The proposal should include a detailed description of the work that will be performed, a breakdown of costs, a timeline, and any other relevant information that the client may need to make a decision. The reputation of the consultant is also important in the bidding process. Clients will typically prefer to work with consultants who have a good track record of completing similar projects on time and within budget. Consultants who have a history of delivering poor-quality work or failing to complete projects on time may find it challenging to win new contracts.

Experience is also critical in the bidding process. Consultants who have experience in similar projects are more likely to understand the challenges and requirements of the project, which can help them to submit a competitive bid. They will also be able to provide the client with references from previous projects, which can help to build trust and confidence in their capabilities.

The bidding process is a critical aspect of the highway industry, and consultants need to be able to submit competitive bids to win new contracts. Consultants who are successful in the bidding process will need to have a good understanding of the project requirements, be able to prepare a high-quality bid proposal, and have a good reputation and experience in similar projects. A well-managed bidding process can help to ensure that the most qualified consultants are selected at the most competitive prices.

1.3.1 BENEFIT FOR BIDDING SYSTEM IN HIGHWAY INDUSTRY FOR PROJECT

The benefits of a bidding system in the highway industry for projects include:

- **Competitive pricing:** The bidding process encourages competition among contractors, leading to better pricing for the project owner. This can result in cost savings and more efficient allocation of resources.
- **Transparency:** The bidding process is transparent, with all interested parties given equal opportunity to submit their proposals. This promotes fairness and helps to prevent corruption and favoritism.
- **Quality control:** The bidding process allows project owners to evaluate potential contractors based on their experience, expertise, and past performance. This can help to ensure that the project is completed to the required standards.
- **Time efficiency:** The bidding process streamlines the project selection process and reduces the time required to find a suitable contractor. This can help to speed up the project timeline and ensure that it is completed on schedule.
- **Risk mitigation:** The bidding process allows project owners to allocate risk to the contractor. This can help to reduce the project owner's exposure to financial and legal risks.
- **Innovation:** The bidding process encourages contractors to propose innovative solutions to project challenges, leading to more creative and efficient solutions.

To elaborate on these benefits, competitive pricing helps the project owner to save costs and allocate the available resources efficiently. Transparency ensures that the contractor selection process is fair and unbiased, which reduces the chances of corruption and favoritism. Quality control is important in the highway industry because it ensures that the final product is built to the required standard and is safe for use.

Time efficiency is also critical because highway projects can be time-sensitive, and any delay in the completion of the project can result in additional costs and inconvenience to the public. Risk mitigation is also important because highway projects can be risky, and the project owner needs to protect their interests by allocating risk to the contractor. Finally, innovation is essential because the highway industry is constantly evolving, and contractors need to be innovative to come up with new solutions to complex problems.

1.4 CHALLENGES PRESENT IN THE BID SUBMISSION PIPELINE

The process of submitting bids for highway infrastructure projects can be a complex and challenging task for many organizations. Some of the common challenges that companies may face during the bid submission pipeline include:

- **Technical challenges:** Bidding for highway projects requires a thorough understanding of technical requirements and specifications. The technical challenges can include understanding the design criteria, technical specifications, and the standards and regulations required for the project.
- **Financial challenges:** One of the primary challenges for companies bidding on highway projects is managing the financial aspect of the bid submission process. This includes preparing accurate cost estimates, developing a competitive pricing strategy, and demonstrating the financial viability of the project to potential investors.
- **Legal challenges:** Bidding for highway projects also involves navigating a complex legal framework that includes local, state, and federal regulations. Companies need to comply with various legal requirements related to bidding, procurement, and contract management.
- **Competitive challenges:** The highway infrastructure industry is highly competitive, and companies need to differentiate themselves from their competitors to win bids. They need to demonstrate their technical capabilities, experience, and financial strength to stand out in the bidding process.
- **Time and resource constraints:** Bid submission involves a significant amount of time and resources, including manpower, equipment, and materials. Companies need to manage these resources effectively to meet the project timelines and ensure timely delivery of the bid.

Overall, the bid submission pipeline can be a complex and challenging process for organizations bidding on highway infrastructure projects. Companies need to be well prepared and have the necessary resources and expertise to navigate the various technical, financial, legal, and competitive challenges.

1.5 PROJECT STATEMENT

The problem with the existing highway toll management systems is that they are often outdated and cannot cope with the increasing volume of vehicles passing through toll plazas. This results in long queues and delays, leading to frustration for the drivers and loss of revenue for the government. There is a need for a more efficient and automated system that can manage toll collection, traffic flow, and toll plaza operations in a seamless manner.

The process of submitting bids for highway construction and maintenance projects can be a complex and time-consuming process. Many factors, such as project requirements, technical specifications, financial proposals, and legal obligations, need to be taken into consideration when submitting a bid. This can lead to a lack of transparency and fairness in the bidding process, and can also result in delays and inefficiencies. There is a need to streamline the bid submission process by introducing a standardized and transparent system that can ensure a level playing field for all bidders and reduce the time and effort required for bid submission.

1.6 OBJECTIVES

- To design and develop a robust Highway Toll Management System (HTMS) that can efficiently handle toll collection, vehicle tracking, and payment processing.
- To streamline the bid submission pipeline for highway infrastructure projects, by identifying key personnel, technical requirements, and other necessary details to improve the chances of financial proposals being accepted.
- To reduce traffic congestion at toll plazas and ensure the smooth flow of traffic on highways by implementing a more efficient toll collection system.
- To ensure transparency and accountability in the toll collection process, by providing real-time data on toll revenue, traffic volume, and other relevant metrics.
- To enhance the overall user experience by providing convenient payment options, minimizing wait times, and improving the quality of service at toll plazas.

1.7 SCOPE OF THE PROJECT

The scope of the project includes the development and implementation of a highway toll management system (HTMS) along with streamlining the bid submission pipeline for highway infrastructure projects. The project aims to achieve the following:

- **Feature selection:** Identify and select the relevant features and functionalities of the HTMS that can improve the toll collection process, reduce errors, and enhance the user experience.
- **Feature identification:** Identify the key features and functionalities required for the bid submission process, such as document management, stakeholder collaboration, and proposal evaluation.
- **System design and development:** Design and develop the HTMS and the bid submission pipeline with a user-friendly interface and seamless integration with other relevant systems.
- **Testing and validation:** Test and validate the HTMS and bid submission pipeline to ensure that they meet the requirements and specifications.
- **Implementation and deployment:** Implement and deploy the HTMS and bid submission pipeline in selected highways and infrastructure projects.
- **Maintenance and support:** Provide ongoing maintenance and support for the HTMS and bid submission pipeline to ensure their continued efficiency and effectiveness.

Overall, the project's scope encompasses the development and implementation of a comprehensive system that can streamline the toll collection process and bid submission pipeline for highway infrastructure projects, resulting in improved efficiency, accuracy, and transparency. The feature selection and identification process will ensure that the system's capabilities are aligned with the needs and requirements of the users and stakeholders involved.

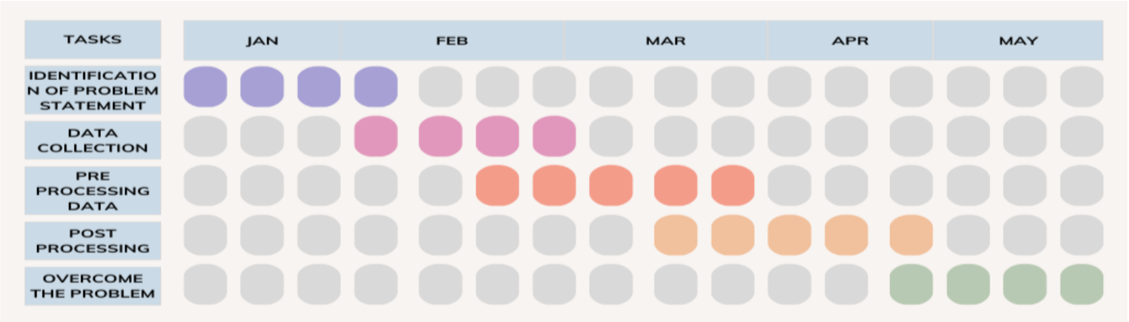


Figure 1.3: Timeline of the Project

Chapter 2

Background and Literature Survey

2.1 INTRODUCTION

Highway toll management systems are an essential part of the transportation infrastructure, helping to fund the maintenance and expansion of highways and other roads. However, the traditional toll collection methods, such as manual collection, have several drawbacks, including increased traffic congestion, higher labor costs, and increased emissions from idling vehicles. To address these issues, automated toll collection systems have been introduced, which utilize technologies such as RFID and GPS to enable fast and seamless toll collection. The implementation of an automated toll collection system requires a significant investment in hardware and software, as well as the deployment of a network of sensors and other devices along the highway. Furthermore, the system needs to be integrated with existing traffic management systems to ensure the efficient flow of vehicles and the accurate billing of tolls.

Typical VNR System consists of four modules: image acquisition, license plate extraction, character segmentation, and character recognition. The efficiency & accuracy of the system largely depends on the second module & various approaches have been used for this purpose. There are several common searching algorithms to locate vehicle license plate. Searching algorithm rely on color information. In this method a color search algorithm is used to extract the likelihood ROI in an image

Another challenge in the highway industry is the bidding process for construction projects. The bidding process involves several steps, including the announcement of the project, the submission of bids by interested parties, the evaluation of bids, and the awarding of the project to the winning bidder. The objective of the bidding process is to select the best bid based on various factors, such as the cost, quality, and timeline of the project.

However, the bidding process is not without its challenges. One major challenge is the issue of bid rigging, where companies collude to manipulate the bidding process and increase their chances of winning the project. Another challenge is the lack of transparency in the bidding process, which can lead to suspicions of favoritism or corruption. Additionally, the complex and time-consuming nature of the bidding process can result in delays and increased costs for the project.

In recent years, there have been efforts to improve the bidding process in the highway industry. One approach is the use of electronic bidding systems, which allow for the electronic submission and evaluation of bids.

Electronic bidding systems can increase transparency, reduce the risk of bid rigging, and speed up the bidding process. However, the implementation of electronic bidding systems requires significant investment in hardware and software, as well as training for the personnel involved in the bidding process.

In conclusion, the highway industry faces several challenges, including the need to implement automated toll collection systems and streamline the bidding process for construction projects. These challenges require significant investments in hardware and software, as well as the development of new processes and procedures. However, addressing these challenges can lead to significant benefits, such as increased efficiency, reduced costs, and improved transparency.

2.2 SURVEY OF THE PROJECT

The problem-solving approach for the project can be divided into several stages:

- **Problem Identification:** The first step is to identify the problem and clearly define the project scope. This includes understanding the requirements of the Highway Toll Management System (HTMS) and the bid submission process, as well as any potential challenges or limitations.
- **Research:** Once the problem has been identified, the next step is to conduct research and gather information about existing solutions and best practices. This includes reviewing literature, analyzing case studies, and consulting with experts in the field.
- **Feature Selection and Identification:** Based on the research, the project team can then identify the features and functions that will be included in the HTMS and the criteria for selecting bids. This will involve balancing the needs of stakeholders, such as the government, contractors, and the public, with technical considerations and financial constraints.
- **Design and Development:** With the features and selection criteria identified, the project team can then begin designing and developing the HTMS system and the bid submission pipeline. This will involve selecting appropriate hardware and software solutions, as well as developing the necessary algorithms and user interfaces.

- **Testing and Validation:** Once the system has been developed, it must be tested and validated to ensure that it meets the requirements and functions as intended. This will involve conducting various tests, including unit testing, integration testing, and user acceptance testing.
- **Implementation and Deployment:** Finally, the system must be implemented and deployed in a controlled manner, ensuring that it is properly integrated with existing infrastructure and that users are trained on its use. This will involve planning and coordination with various stakeholders, including government agencies, contractors, and the public.

Throughout the project, it is important to maintain open communication and collaboration with stakeholders and to continuously monitor and evaluate the system to ensure that it is meeting its objectives and addressing any issues that are.

2.3 LITERATURE SURVEY

Here is a literature survey on the topic of "Highway Toll Management System and Bid Submission Pipeline":

- "**An Intelligent Toll Collection System Using RFID Technology**" authors investigate the implementation of a RFID-based toll collection system to address issues such as traffic congestion and delays at toll plazas. The system uses RFID tags to collect tolls automatically, eliminating the need for drivers to stop and pay at toll booths.
- "**The Development of Intelligent Transportation Systems in Highway Management**" authors discuss the evolution of intelligent transportation systems (ITS) and how they can be used to improve highway management. The paper provides an overview of different ITS technologies, such as vehicle-to-vehicle communication, and how they can be used for applications such as real-time traffic monitoring and incident management.
- "**A Comparative Study of Toll Collection Systems in India**" analyze different toll collection systems used in India and compare their advantages and disadvantages. The study covers systems such as manual toll collection, electronic toll collection, and hybrid systems.

- "**An Overview of Public-Private Partnership (PPP) Models for Highway Infrastructure Development**" authors discuss different PPP models that can be used for highway infrastructure development. The paper provides a detailed analysis of the benefits and risks associated with each model, along with case studies of successful PPP projects.
- "**The Role of Information Technology in Highway Infrastructure Management**" authors investigate how information technology (IT) can be used to improve highway infrastructure management. The paper discusses various IT applications such as geographic information systems (GIS) and remote sensing, and how they can be used for tasks such as road maintenance and asset management.
- "**A Survey of Traffic Management Systems Based on Wireless Sensor Networks**" authors explore how wireless sensor networks (WSNs) can be used for traffic management. The study provides an overview of different WSN-based traffic management systems, such as traffic flow prediction and accident detection, and discusses their advantages and limitations.
- "**A Review of Bid Evaluation Methods in Public Procurement**" provide an overview of different bid evaluation methods used in public procurement. The paper analyzes the strengths and weaknesses of each method, and provides recommendations on how to choose the most appropriate method for a specific project.
- "**Intelligent Transport Systems and Road Safety**" authors investigate how intelligent transport systems (ITS) can be used to improve road safety. The paper discusses different ITS applications such as advanced driver assistance systems (ADAS) and vehicle-to-vehicle communication, and how they can be used to reduce accidents and fatalities on the road.
- "**A Review of Public-Private Partnership (PPP) Infrastructure Projects in India**" authors provide a comprehensive analysis of PPP infrastructure projects in India. The paper discusses the challenges and successes of PPP projects, and provides recommendations on how to overcome the obstacles to successful implementation.

- In their study "**The Impact of Electronic Toll Collection on Highway Safety**" authors investigate the impact of electronic toll collection (ETC) on highway safety. The paper analyzes the accident rates at toll plazas before and after the implementation of ETC systems, and concludes that ETC can significantly reduce accidents and improve highway safety.

2.4 EXISTING AND RELATED WORK

Existing and related work in the area of Electronic Toll Collection (ETC) systems includes the use of RFID (Radio-Frequency Identification) technology to track vehicles passing through toll booths. The system uses electronic tags that are placed on vehicles, which are read by scanners as the vehicles pass through the toll plaza. This technology has been implemented in many countries, including the US, Japan, and India, to improve toll collection efficiency and reduce congestion at toll plazas. In the context of bid submission, many countries have implemented online bid submission platforms such as e-procurement systems and online tendering portals.

These platforms have been implemented to streamline the bidding process, reduce the time and cost associated with the traditional paper-based bidding process, and improve transparency and efficiency in the bidding process.

These platforms allow bidders to submit bids electronically, view and download tender documents, and communicate with the tendering authority, among other features. Artificial intelligence (AI) and machine learning (ML) are increasingly being used in the field of bid submission and procurement to analyze bidding data and identify key factors that contribute to successful bids.

These technologies can help bidders to understand the bidding process better, identify the strengths and weaknesses of their bids, and improve their chances of winning contracts. AI and ML can also be used to identify patterns and trends in bidding data and predict future bidding outcomes, which can be useful for tendering authorities in assessing the quality of bids and selecting the best bidder for a contract.

Chapter 3

METHODOLOGY

3.1 INTRODUCTION

We are introducing a new method for deducting toll fares at toll plazas which is more efficient than the existed models. Automation is a technology where human interference can be reduced. Identifying vehicles automatically has been preferred because of its applications: Toll payments, ticket issuing, theft control, traffic surveillance, etc. Highways or Toll Roads are provided to control the traffic and increase the mobility of vehicles. So manual collection of toll fare results in time delay, inessential fuel consumption, traffic congestion. At present, RFID technology is implemented in the field of toll payments. The RFID tag present in the FASTAG uses an Electronic Produce Code (EPC) so that every vehicle can be uniquely identified. The EPC code is a 13-digit number that ensures that every code is unique. The RFID tag embedded in the FASTAG is a passive tag that is energized only when the beam of the scanner hits it.

So, when a vehicle comes near to the scanning device, the scanner sends RF signals and reads the information present in the tag. As the FASTAG is pre-paid with money, so it automatically deducts the corresponding toll fare. Because of the drawbacks of FASTSAG, which are previously stated, this paper provides a solution to reduce those problems by deducting the toll fares automatically using image processing. In this system, we reduce waiting time at toll plazas and make the entire process automated. The payment is proceeded by retrieving account details from the database using the vehicle's number plate details which are unique, then a notification is sent to the user's app, the amount is deducted if the user acknowledges the notification else the corresponding footage is sent to the police database. Because of this method vehicle thefts, criminal activities can also be reduced.

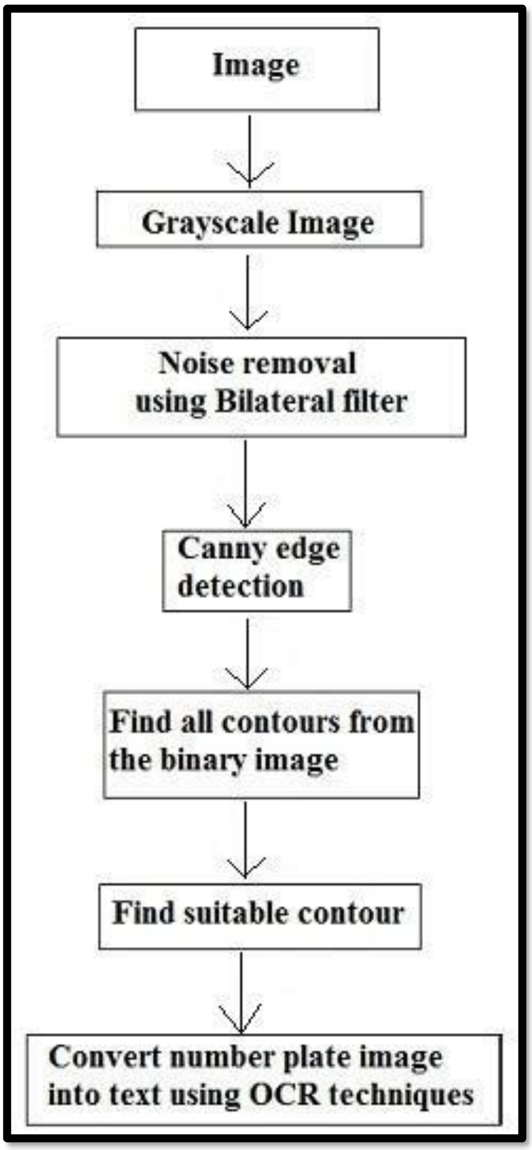


Figure 3.1: Flowchart of Image Pre-Processing

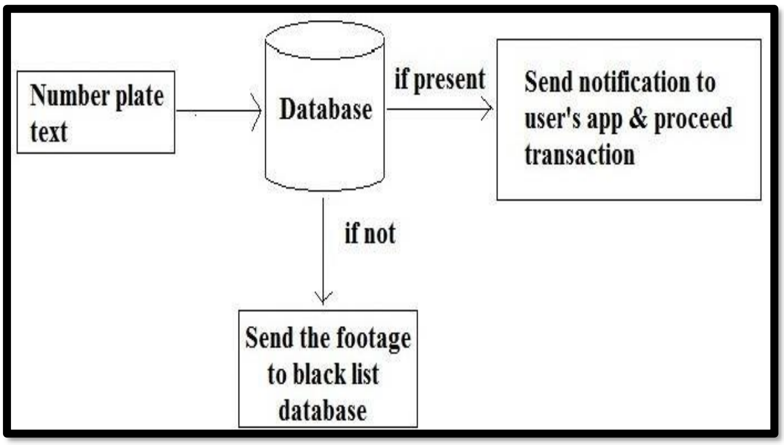


Figure 3.2: Flowchart of Server Side

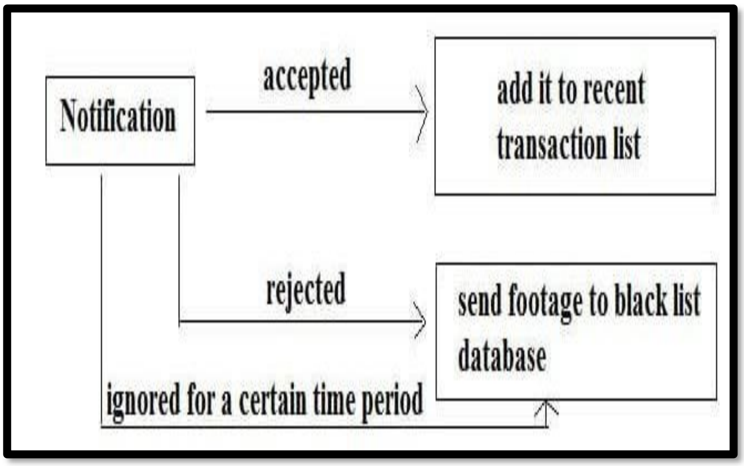


Figure 3.3: Flowchart of user side

3.2 BACKGROUND SUBSTRACTION METHOD

The technique of background subtraction is an effective means of detecting objects in video images that are in motion. However, this method has limited applicability since it assumes that the image changes occur only due to the movement of objects, meaning that the background remains stationary.

The principle behind this approach involves detecting moving objects by comparing the current frame with a reference frame, also referred to as the "background image" or "background model."

Background subtraction is commonly performed on images that are part of a video stream. Developing a reliable background subtraction algorithm poses several challenges. Firstly, it must be able to withstand variations in lighting conditions.

Secondly, it should not detect non-stationary background elements, such as moving leaves, rain, snow, and shadows cast by moving objects. Finally, its internal background model should promptly respond to changes in the background, such as the start and stop of vehicles.

3.3 OPTICAL FLOW METHOD

The concept of optical flow refers to the apparent motion pattern of objects, edges, and surfaces in a visual scene. It arises due to the relative movement between a viewer or a camera and the scene being observed. Optical flow has various applications, such as perceiving movement, identifying shapes, distances, and movements of objects in the world, and controlling locomotion. The motion can be estimated as either instantaneous image velocities or discrete image displacements, based on sequences of ordered images. To calculate motion, optical flow methods estimate the motion between two image frames captured at different times, t and t+1, at every voxel position. However, these methods are often slow and produce unsharp boundaries, resulting in many errors.

3.4 ADAPTIVE CONTRAST CHANGE DETECTION

Adaptive change detection is a technique that enhances the detection of changes in a scene by integrating both the temporal difference and background subtraction methods into a single algorithm. By combining the strengths of each method, the algorithm can compensate for the weaknesses of the other. The temporal difference method is effective in detecting continuously moving objects but fails when an object stops moving, while the background subtraction method struggles with changing backgrounds and lighting conditions. While this approach has limitations and can only be used for static backgrounds, it can still be useful to some extent.

3.5 IMAGE ACQUISITION

The initial stage of an LPR system is the acquisition phase, which involves obtaining an image through a particular acquisition method. In the proposed system, a digital camera was employed to capture the input image.

3.6 LICENSE PLATE EXTRACTION

License Plate Extraction is a key step in an LPR system, which influences the accuracy of the system significantly. This phase extracts the region of interest, i.e., the license plate, from the acquired image. The proposed approach involves histogram based analysis for detecting the location of the license plate in the image acquired.

3.7 LICENSE PLATE SEGMENTATION

License plate segmentation, also known as character isolation, is a process in license plate recognition systems where the region of interest (ROI) containing the license plate is divided into individual characters. This is an important step as it allows for the recognition and extraction of the characters on the license plate for further processing. License plate segmentation involves various techniques such as thresholding, edge detection, and connected component analysis to separate each character from the license plate image. The success of license plate segmentation greatly affects the accuracy of the license plate recognition system as a whole.

3.8 LICENSE PLATE RECOGNITION

Alter splinting the extracted License plate into individual character images, the character in each image can be identified . There are many methods used to recognize isolated characters. In this system we use Template matching was performed by using two sets of templates. One set was made up of perfect characters. Other set includes the segmented license plate characters.

A correlation function was used to compare the match between the character segment and the templates in the database. The character that retuned the highest match was output as the recognized character.

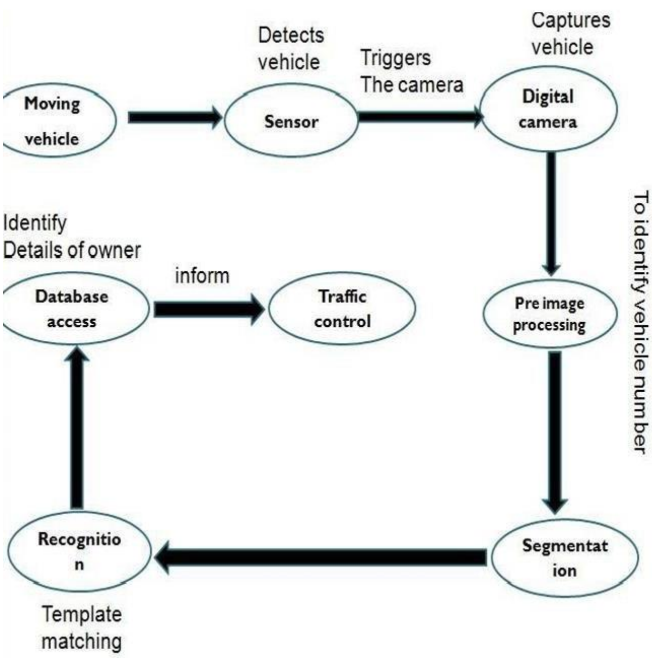


Figure 3.4: Tollgate Control System

3.9 APPLICATION OF LICENSE PLATE RECOGNITION SYSTEM

License plate recognition (LPR) systems have numerous applications in various industries and countries. Some of the common applications include electronic toll collection on highways, automatic parking attendants in banks, hotels, and airports, customer identification for personalized services in golf clubs and leisure centers, petrol station surveillance, speed limit enforcement, and security, among others. The following section elaborates on the applications of LPR systems:

3.10 APPLICATION OF HTMS SYSTEM FOR LAW ENFORCEMENT

In law enforcement, license plates are used to issue violation fines for speeding vehicles, illegal use of bus lanes, and to detect stolen or wanted vehicles. A traffic camera can capture an image of a speeding car, which can then be sent to the LPR system for processing to identify the particular vehicle. The system provides violators with an image of their vehicle along with the speeding information as proof.

3.11 APPLICATION OF HTMS SYSTEM IN PARKING

LPR systems can be used for automated parking management. For instance, pre-paid members can be automatically allowed entry into a parking lot, and non-members can be charged based on their entry and exit times. When a vehicle enters the parking lot, the system recognizes the vehicle and stores its information and entry time. When the vehicle exits, the system recognizes it again and calculates the parking fee accordingly.

Chapter 4

Digital Image Processing for the HTMS System

4.1 INTRODUCTION OF DIGITAL IMAGE PROCESSING

Digital image processing is the use of computer algorithms to create process, display digital images, Digital image processing algorithms can be used to:

- Convert signals from an image sensor into digital images
- Improve clarity, and remove noise and other artefacts
- Extract the size, scale, or number of objects in a scene
- Prepare images for display or printing
- Compress images for communication across a network

Image processing toolbox in OPEN CV which is a library in PYTHON provides a comprehensive set of reference algorithms and graphical tools for image processing, analysis, visualization and algorithms development. It can restore the noisy and degraded images, enhance image, improve intelligibility, extract features, analyze shapes and textures. It has an ability to inspect algorithms, modify the source code and to create our own custom functions. It supports engineers, scientists in the areas such as biometrics, remote sensing, microscopy semiconductor testing, image sensor design, color science and material science.

4.2 KEY FEATURES OF DIGITAL IMAGE PROCESSING

- Image analysis, including segmentation, morphology, statistics, and measurement
- Image enhancement, filtering, and deblurring
- Geometric transformations and intensity-based image registration methods
- Image transforms, including FFT, DCT, Radon, and fan-beam projection
- Large image workflows, including block processing, tiling, and multi resolution display
- Visualization apps, including Image Viewer and Video Viewer
- Multi core and GPU-enabled functions, and C-code generation

4.2.1 EXPLORATION OF DIGITAL IMAGE PROCESSING

Image Processing Toolbox supports images and video generated by a wide range of devices, including webcams, digital cameras, satellites and airborne sensors, medical imaging devices, microscopes, telescopes, and other scientific instruments Also these are functions to visualize, analyze, and process these images in many datatypes.

4.2.2 STANDARD AND SPECIALISED FILE FORMAT

OPEN CV library supports standard data and image formats including

- Windows bitmap(bmp)
- Portable image formats (p.m., pgm,ppm)
- Sun raster (sr, ras)
- JPEG (jpeg, jpg,jpeg)
- JPEG 2000(jp2)
- TIFF files (tiff,tif)
- Portable network graphics(png)

Image Processing Toolbox supports a number of specialized image file formats. For medical images, it supports DICOM files, including associated metadata.

4.2.3 IMAGE ENHANCEMENT OF DIGITAL IMAGE PROCESSING

Image enhancement techniques in Image Processing Toolbox enable to increase the signal-to-noise ratio and accentuate image features by modifying the colors or intensities of an image. The toolbox includes specialized filtering routines and a generalized multidimensional filtering function that handles integer image types, offers multiple boundary padding options, and performs convolution and correlation.

Using predefined filters and functions there is a possibility to

- Filter with morphological operators
- De-blur and sharpen
- Remove noise with linear, median, or adaptive filtering
- Perform histogram equalization

- Remap the dynamic range
- Adjust the gamma value
- Adjust contrast

Specialized filtering routines and multi-dimensional filtering techniques are also present. Predefined filters and also the functions for designing and implementing the filters are present.

4.3 IMAGE INTENSITY FOR IMAGE PROCESSING

An intensity image is a data matrix, whose values represent intensities within some range. An intensity image is represented as a single matrix, with each element of the matrix corresponding to one image pixel. The matrix can be of class double, uint8,or uintl6. While intensity images are rarely saved with a color map, a color map is still used to display them. In essence, handles intensity images are treated as indexed images.

4.3.1 RGB COLOUR OF IMAGES IN PROCESSING

An RGB image, sometimes referred to as a true color image, is stored as an m-by-n-by-3 data array that defines red, green, and blue color components for each individual pixel. RGB images do not use a palette. The color of each pixel is determined by the combination of the rod, green, and blue intensities stored in each color plane at the pixel's location. Graphics file formats store RGB images as 24-bit images, where the red, green, and blue components are 8 bits each. This yields a potential of 16 million colors.

4.4 SEGMENTATION OF IMAGE FOR PROCESSING

Image segmentation is the process of dividing an image into multiple parts. This is typically used to identify objects or other relevant information in digital images. There are many different ways to perform image segmentation, including:

- Thresholding methods such as Otsu’s method
- Color-based segmentation such as K-means clustering

4.5 TEMPLATE MATCHING OF PROCESSING

All motorized road vehicles in India are tagged with a registration or license number. The Vehicle registration plate (commonly known as number plate) number is issued by the district-level Regional Transport Office (RTO) of respective states — the main authority on road matters. The number plates are placed in the front and back of the vehicle. By law, all plates are required to be in modern Hindu-Arabic numerals with Latin letters. Other guidelines include having the plate lit up at night and the restriction of the fonts that could be used. In some states such as Sikkim, cars bearing outside plates are barred from entering restricted areas. The international vehicle registration code for India is IND.

4.6 DIMENSIONS OF STANDARD NUMBER PLATE

It was on the 8th of April 2011 when the Supreme Court of India convened the transport secretaries of Punjab, Uttar Pradesh and Delhi for the contempt of court proceedings about the non-enforcement of high security registration plates. On the 30th of November 2004, the Supreme Court clarified that all of the states need to follow the scheme. Right now, all of the North East that include Gujarat, Assam, Jammu and Kashmir, Rajasthan, Karnataka, West Bengal and Goa are the mere states right now that have complied in full. The states of Jharkhand, Bihar, Madhya Pradesh, Uttar Pradesh, Maharashtra, Odessa and Chhattisgarh did not proceed after they called tenders. Apart from these states, there are several other states that have also taken the necessary action for implementing this new scheme.

Figure 4.1: Standard Number plate

4.7 RFID TECHNOLOGY

Radio-frequency identification uses electromagnetic field to automatically identify and track tags attached to objects. An RFID system consists of a tiny radio transponder, a radio receiver and transmitter. When triggered by an electromagnetic interrogation pulse from a nearby RFID reader device, the tag transmits digital data, usually an identifying inventory number, back to the reader. This number can be used to track inventory goods. RFID tags are made out of three pieces: a microchip (an integrated circuit which stores and processes information and modulates and demodulates (RF) signals), an antenna for receiving and transmitting the signal and a substrate. The tag information is stored in a non-volatile memory. The RFID tag includes either fixed or programmable logic for processing the transmission and sensor data, respectively.

RFID tags can be either passive, active or battery-assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A battery-assisted passive tag has a small battery on board and is activated when in the presence of an RFID reader. A passive tag is cheaper and smaller because it has no battery; instead, the tag uses the radio energy transmitted by the reader. However, to operate a passive tag, it must be illuminated with a power level roughly a thousand times stronger than an active tag for signal transmission. This makes a difference in interference and in exposure to radiation. Tags may either be read-only, having a factory-assigned serial number that is used as a key into a database, or may be read/write, where object- specific data can be written into the tag by the system user. Field programmable tags may be write-once, read-multiple; "blank" tags may be written with an electronic product code by the user.

Signaling between the reader and the tag is done in several different incompatible ways, depending on the frequency band used by the tag. Tags operating on LF and HF bands are, in terms of radio wavelength, very close to the reader antenna because they are only a small percentage of a wavelength away. In this near field region, the tag is closely coupled electrically with the transmitter in the reader. The tag can modulate the field produced by the reader by changing the electrical loading the tag represents.

By switching between lower and higher relative loads, the tag produces a change that the reader can detect. At UHF and higher frequencies, the tag is more than one radio wavelength away from the reader, requiring a different approach. The tag can backscatter a signal. Active tags may contain functionally separated transmitters and receivers, and the tag need not respond on a frequency related to the reader's interrogation signal.

"Bulk reading" is a strategy for interrogating multiple tags at the same time, but lacks sufficient precision for inventory control. A group of objects, all of them RFID tagged, are read completely from one single reader position at one time. Bulk reading is a possible use of HF (ISO 18000-3), UHF (ISO 18000-6) and SHF (ISO 18000-4) RFID tags.

However, as tags respond strictly sequentially, the time needed for bulk reading grows linearly with the number of labels to be read. This means it takes at least twice as long to read twice as many labels. Due to collision effects, the time required is greater. A group of tags has to be illuminated by the interrogating signal just like a single tag. This is not a challenge concerning energy, but with respect to visibility; if any of the tags are shielded by other tags, they might not be sufficiently illuminated to return a sufficient response.

The response conditions for inductively coupled HF RFID tags and coil antennas in magnetic fields appear better than for UHF or SHF dipole fields, but then distance limits apply and may prevent success. Under operational conditions, bulk reading is not reliable. Bulk reading can be a rough guide for logistics decisions, but due to a high proportion of reading failures, it is not suitable for inventory management. However, when a single RFID tag might be seen as not guaranteeing a proper read, multiple RFID.

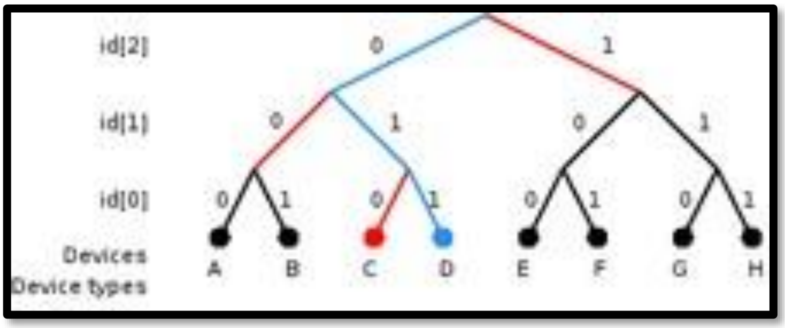


Figure 4.2: Binary tree method of identifying an RFID tag

4.8 APPLICATIONS OF RFID TECHNOLOGY

1. Access management
2. Tracking of goods
3. Tracking of persons and animals
4. Toll collection and contactless payments
5. Machine readable travel documents
6. Locating lost airport baggage
7. Tracking and billing processes
8. Monitoring the physical state of perishable goods

4.9 RFID ROLE IN FASTAG

The RFID technology uses an Electronic Produce Code (EPC) through which every vehicle can be uniquely identified. This code is different from the vehicle's registration number and exclusive to it on a global scale. Each EPC code, which is a 13-digit number, in the RFID-FASTAG is issued by GS1 India, a standards body, which ensures that each code is unique and in sync with the global standards put in place, in order for correct product identification. Which in the case of FASTAG, is a vehicle. The code needs to be standardized in order to ensure that the data coded inside is not read differently at different levels.

However, unlike barcoding, which uses a pattern of black bars and white spaces, in which the information is coded, an RFID tag uses a small electronic chip for the same which is surrounded by an antenna. Also, unlike the barcode, an RFID tag does not need to be very close to the reader or, even in the line of sight of the same. One just simply has to be within a reading distance from the scanner. A FASTAG has what is called a passive RFID chip as it does not contain its own battery.

It is energized only when the beam from the scanner strikes it. Whenever the vehicle passes through the ETC lane of the Toll Plaza, the Toll Plaza system captures the FASTAG details like (Tag ID, TID, Vehicle class, etc.) and sends it to the Acquiring bank for processing. The Acquiring bank sends a request to the NETC Mapper to validate the tag details. Once the Tag ID is validated, NETC Mapper responds with details like Vehicle class, VRN, Tag Status etc.

If the Tag ID is absent in NETC Mapper, it will respond that the Tag ID is not registered. After successful validation of Tag ID from NETC Mapper, acquirer host calculates the appropriate toll fare and initiate a debit request to NETC system. NETC System will switch the debit request to the respective issuer bank for debiting the account of the customer. Issuer host shall debit the linked tag holder account and sends a SMS alert to the tag holder. The Issuer host shall send the response message to NETC system. If the response is not sent within the defined TAT, the transaction are considered as Deemed Accepted. NETC system will notify the response to acquirer host. Acquirer host will notify to respective toll plaza system.

Figure 4.3: Fastag Image

Figure 4.4: Toll collection using Fastag

Chapter 5

Software and It's Specification for the HTMS System

5.1 INTRODUCTION

The main purpose of this project is to detect characters from number plate Image provided by a camera. An efficient algorithm is developed to detect a number plate in various luminance conditions. This algorithm extracts the number plate data from an image and provides it as an input to the stage of Car License Plate Recognition. The image of a vehicle is given as an input. The software part of the project is divided into 2 parts

1. Extract the number plate image from image
2. Convert number in the image into the string

PYTHON 3.0 is the programming language used in project for the implementation .Two main libraries used for the project implementation.

Hardware:

- Server(s) for hosting the toll management system and storing bid submission data
- Network infrastructure for communication between the toll management system and toll collection devices
- Toll collection devices (e.g. RFID readers, cameras)
- Workstations for employees to access and work on the bid submission pipeline
- Backup storage devices for data backup and recovery

Software:

- Operating system for the server(s) and workstations (e.g. Windows, Linux)
- Web server software for hosting the toll management system (e.g. Apache, IIS)
- Database management software for storing and managing bid submission data (e.g. MySQL, Oracle)
- Programming languages for toll management system development (e.g. Java, Python)
- Project management and collaboration software for bid submission pipeline (e.g. Jira, Trello)

5.2 LEXI ANALYSIS FOR IMAGE PROCESSING

A Python program is divided into a number of *logical lines*.

5.2.1 Logical Lines in Lexi Analysis

The end of a logical line is represented by the token NEWLINE. Statements cannot cross logical line boundaries except where NEWLINE is allowed by the syntax (e.g., between statements in compound statements). A logical line is constructed from one or more *physical lines* by following the explicit or implicit *line joining* rules.

5.2.2 Physical Lines in Lexi Analysis

A physical line is a sequence of characters terminated by an end-of-line sequence. In source files, any of the standard platform line termination sequences can be used - the Unix form using ASCII LF (linefeed), the Windows form using the ASCII sequence CR LF (return followed by linefeed), or the old Macintosh form using the ASCII CR (return) character. All of these forms can be used equally, regardless of platform.

When embedding Python, source code strings should be passed to Python APIs using the standard C conventions for newline characters (the \n character, representing ASCII LF, is the line terminator).

5.2.3 Comments of Lexi Analysis

A comment starts with a hash character (#) that is not part of a string literal, and ends at the end of the physical line. A comment signifies the end of the logical line unless the implicit line joining rules are invoked. Comments are ignored by the syntax; they are not tokens.

5.2.4 Encoding Declarations in Lexi Analysis

If a comment in the first or second line of the Python script matches the regular expression coding[=:] this comment is processed as an encoding declaration; the first group of this expression names the encoding of the source code file. The recommended forms of this expression

5.2.5 Indentation of Lexi Analysis in Image Processing

Leading whitespace (spaces and tabs) at the beginning of a logical line is used to compute the indentation level of the line, which in turn is used to determine the grouping of statements. Tabs are replaced (from left to right) by one to eight spaces such that the total number of characters up to and including the replacement is a multiple of eight (this is intended to be the same rule as used by Unix). The total number of spaces preceding the first non-blank character then determines the line's indentation. Indentation cannot be split over multiple physical lines using backslashes; the whitespace up to the first backslash determines the indentation.

Indentation is rejected as inconsistent if a source file mixes tabs and spaces in a way that makes the meaning dependent on the worth of a tab in spaces; a **Tab Error** is raised in that case.

5.3 OPENCV IN IMAGE PROCESSING

This filter is the simplest of all! Each output pixel is the *mean* of its kernel neighbors (all of them contribute with equal weights). The kernel is below:

$$K = \frac{1}{K_{width} \cdot K_{height}} \begin{bmatrix} 1 & 1 & 1 & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 \\ . & . & . & \dots & 1 \\ . & . & . & \dots & 1 \\ 1 & 1 & 1 & \dots & 1 \end{bmatrix}$$

5.3.1 Gaussian Filter

- Probably the most useful filter (although not the fastest). Gaussian filtering is done by convolving each point in the input array with a *Gaussian kernel* and then summing them all to produce the output array.
- Just to make the picture clearer, remember how a 1D Gaussian kernel look like?

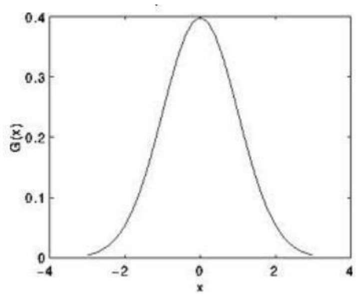


Figure 5.1: Gaussian filter

Assuming that an image is 1D, you can notice that the pixel located in the middle would have the biggest weight. The weight of its neighbors decreases as the spatial distance between them and the center pixel increases.

5.3.2 Median Filter in OpenCV

The median filter run through each element of the signal (in this case the image) and replace each pixel with the **median** of its neighboring pixels (located in a square neighborhood around the evaluated pixel).

5.3.3 Bilateral Filter

- So far, we have explained some filters which main goal is to *smooth* an input image. However, sometimes the filters do not only dissolve the noise, but also smooth away the *edges*. To avoid this (at certain extent at least), we can use a bilateral filter.
- In an analogous way as the Gaussian filter, the bilateral filter also considers the neighboring pixels with weights assigned to each of them. These weights have two components, the first of which is the same weighting used by the Gaussian filter. The second component takes into account the difference in intensity between the neighboring pixels and the evaluated one.

$$I^{\text{filtered}}(x) = \frac{1}{W_p} \sum_{x_i \in \Omega} I(x_i) f_r(\|I(x_i) - I(x)\|) g_s(\|x_i - x\|),$$

$$W_p = \sum_{x_i \in \Omega} f_r(\|I(x_i) - I(x)\|) g_s(\|x_i - x\|)$$

I^{filtered} is the filtered image;

I is the original input image to be filtered;

x are the coordinates of the current pixel to be filtered;

Ω is the window centered in x, so $x_i \in \Omega$ is another pixel;

f_r is the range kernel for smoothing differences in intensities (this function can be a Gaussian function);

g_s is the spatial (or domain) kernel for smoothing differences in coordinates (this function can be a Gaussian function).

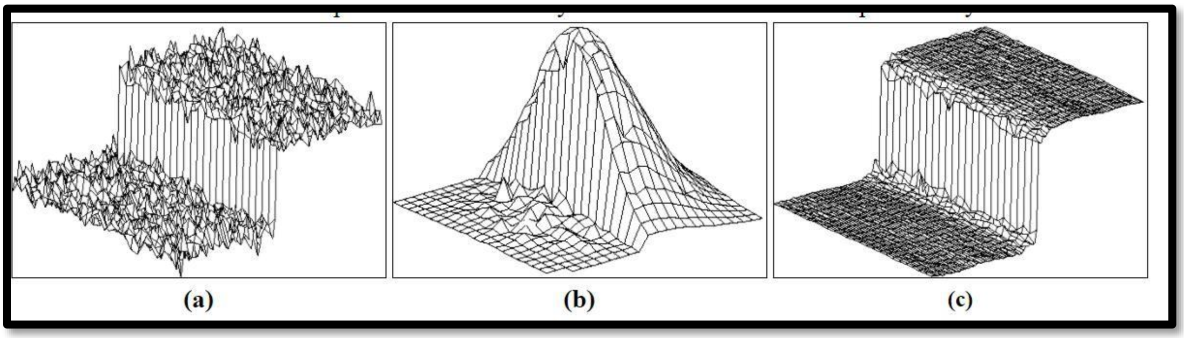


Figure 5.2: Cases in Bilateral filter

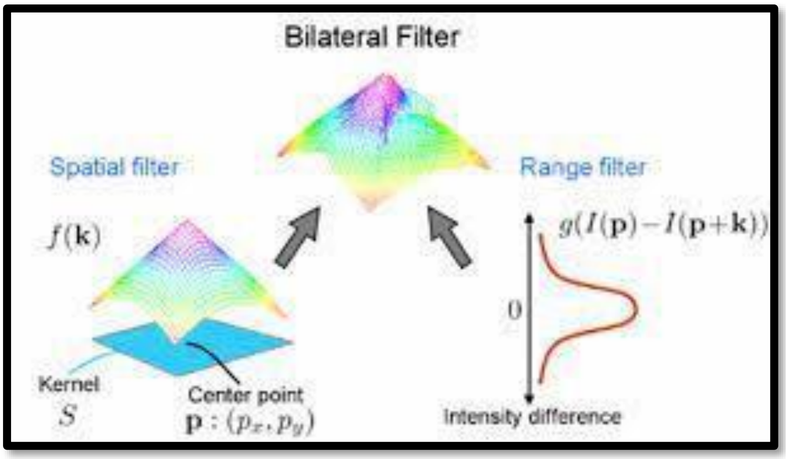


Figure 5.3: Spatial and range components of a Bilateral filter

5.3.4 Canny Edge Detection

The *Canny Edge detector* was developed by John F. Canny in 1986. Also known to many as the *optimal detector*, the Canny algorithm aims to satisfy three main criteria:

- **Low error rate:** Meaning a good detection of only existent edges.
- **Good localization:** The distance between edge pixels detected and real edge pixels have to be minimized.
- **Minimal response:** Only one detector response per edge.

Filter out any noise. The Gaussian filter is used for this purpose. An example of a Gaussian kernel of size=5 that might be used is shown below:

$$K = \frac{1}{159}\begin{bmatrix} 2 & 4 & 5 & 4 & 2 \\ 4 & 9 & 12 & 9 & 4 \\ 5 & 12 & 15 & 12 & 5 \\ 4 & 9 & 12 & 9 & 4 \\ 2 & 4 & 5 & 4 & 2 \end{bmatrix}$$

The equation for a Gaussian filter kernel of size $(2k+1) \times (2k+1)$ is given by:

$$H_{ij} = \frac{1}{2\pi\sigma^2}\exp\left(-\frac{(i-(k+1))^2+(j-(k+1))^2}{2\sigma^2}\right); 1 \le i, j \le (2k+1)$$

Figure 5.4: Original image

Figure. 5.5 Gaussian filter applied.

5.4 GRADIENT CALCULATION

The Gradient calculation step detects the edge intensity and direction by calculating the gradient of the image using edge detection operators.

When the image is smoothed, the derivatives I and Iy with respect to x and y are calculated. It can be implemented by convolving I with Sobel kernels Kx and Ky, respectively.

$$K_x = \begin{pmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{pmatrix}, K_y = \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix}.$$

Then, the magnitude G and the slope θ of the gradient are calculated as follow:

$$|G| = \sqrt{I_x^2 + I_y^2},$$

$$\theta(x, y) = arctan\left(\frac{I_y}{I_x}\right)$$

Figure 5.6: Gradient of the image

The result is almost the expected one, but we can see that some of the edges are thick, and others are thin. The Non-Max Suppression step will help us mitigate the thick ones.

5.5 NON-MAXIMUM SUPRESSION

The principle is simple: the algorithm goes through all the points on the gradient intensity matrix and finds the pixels with the maximum value in the edge directions.

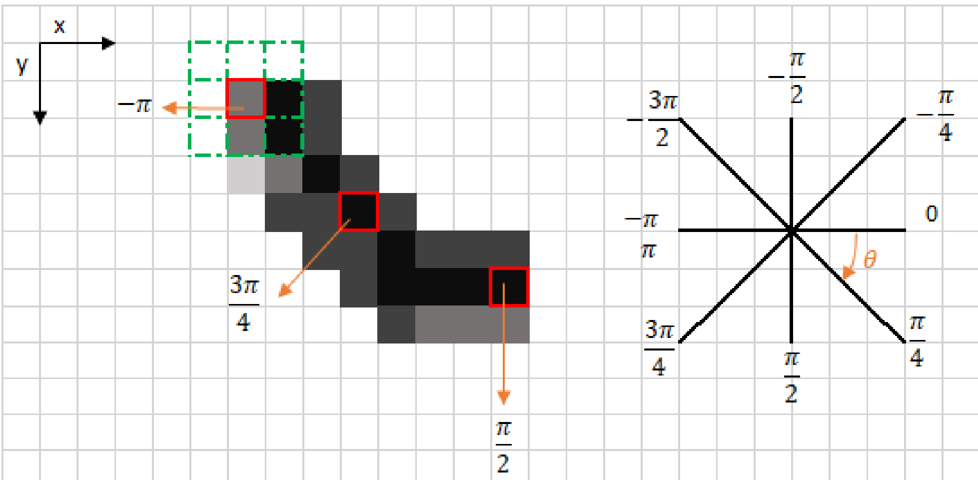


Figure 5.7: Non maximum suppression

The upper left corner red box present on the above image, represents an intensity pixel of the Gradient Intensity matrix being processed. The corresponding edge direction is represented by the orange arrow with an angle of -pi radians (+/-180 degrees).

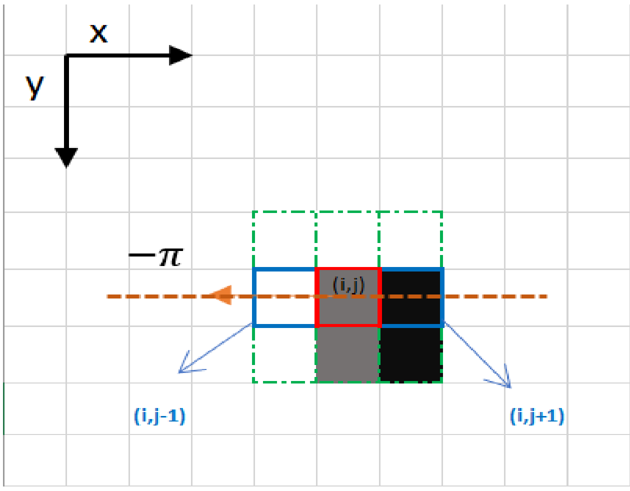


Figure 5.8: Non maximum suppression

The edge direction is the orange dotted line (horizontal from left to right). The purpose of the algorithm is to check if the pixels in the same direction are more or less intense than the ones being processed. In the example above, the pixel (i, j) is being processed, and the pixels on the same direction are highlighted in blue (i, j-1) and (i, j+1). If one those two pixels are more intense than the one being processed, then only the more intense one is kept. Pixel (i, j-1) seems to be more intense, because it is white (value of 255). Hence, the intensity value of the current pixel (i, j) is set to 0. If there are no pixels in the edge direction having more intense values, then the value of the current pixel is kept.

Figure 5.9: Non Maximum Suppressed Image

Chapter 6

PROPOSED SYSTEM AUTOMATIC NUMBER PLATE RECOGNITION SYSTEM

6.1 PROPOSED SYSTEM

The proposed system for Highway Toll Management System and Streamlining Bid Submission is a comprehensive approach to enhance the overall efficiency and accuracy of the toll management system. The system is divided into three different stages, namely number plate detection, number plate segmentation, and character recognition. Each stage is designed to achieve better accuracy in number plate recognition and streamline the entire toll management process.

To achieve better accuracy in number plate recognition, a custom YOLOv3 model was created for all the three stages. The use of YOLOv3 model ensures that the system can detect even the smallest number plates with high accuracy. In the proposed system, YOLOv5 model is used for number plate detection only. This is because YOLOv5 is better than its predecessor in detecting smaller objects while training. The YOLOv5 model provides high accuracy and speed in detecting number plates, making the system highly efficient.

After the number plate detection stage, the system moves to the number plate segmentation stage. In this stage, the system takes the region of interest and attempts to divide it into individual characters. This is sometimes referred to as character isolation. The number plate segmentation stage is crucial in ensuring that the system can accurately recognize the characters on the number plate. The use of a custom YOLOv3 model for this stage ensures that the system can accurately segment the number plate into individual characters.

Finally, after the number plate segmentation stage, the system uses Google OCR Tesseract to recognize and transform the characters on the license plate into text. Google OCR Tesseract is one of the most widely used OCR engines, and it provides high accuracy in character recognition. The use of Google OCR Tesseract in the proposed system ensures that the system can accurately recognize and transform the characters on the license plate into text.

The proposed system offers several benefits over the existing toll management systems. Firstly, it provides high accuracy in number plate recognition, ensuring that the system can accurately recognize and process the toll payments. Secondly, the use of custom YOLOv3 model in all the three stages ensures that the system can detect even the smallest number plates with high accuracy.

Thirdly, the use of Google OCR Tesseract ensures that the system can accurately recognize and transform the characters on the license plate into text, making the entire process highly efficient.

However, there is always room for improvement in any system, and the proposed system is no exception. In future work, the system can be enhanced further by incorporating machine learning algorithms that can learn and adapt to different number plate types and styles. This will make the system more versatile and efficient in recognizing number plates of different styles and types.

Another area for future work is to incorporate real-time video analysis capabilities in the proposed system. Real-time video analysis capabilities will enable the system to analyze multiple vehicles simultaneously and process toll payments in real-time, making the entire process highly efficient.

In addition, the proposed system can be further enhanced by incorporating advanced security features to prevent fraudulent activities. For example, the system can be integrated with a facial recognition system to ensure that only authorized individuals are using the toll booths. This will enhance the security of the system and prevent unauthorized individuals from accessing the toll booths.

In conclusion, the proposed Highway Toll Management System and Streamlining Bid Submission is a comprehensive approach to enhance the efficiency and accuracy of the toll management system. The system is divided into three stages, namely number plate detection, number plate segmentation, and character recognition. The use of custom YOLOv3 model and Google OCR Tesseract ensures high accuracy and efficiency in the entire toll management process. However, there is always room for improvement in any system, and the proposed system can be further enhanced by incorporating machine learning algorithms, real-time video analysis capabilities, and advanced security features..

6.2 STEPS OF PROPOSED SYSTEM

- **Acquisition of the image:** The first step in the proposed system is the acquisition of the license plate image. The image is obtained by capturing a picture of the vehicle's license plate using a camera. The camera is positioned at a certain distance and angle to capture the license plate clearly. This image is then fed into the system for further processing.

- **License Plate Detection using the YOLOv5 model:** The next step involves detecting the license plate in the acquired image. For this, the YOLOv5 object detection model is used. This model is a state-of-the-art deep learning model that can detect objects in images with high accuracy. The YOLOv5 model is trained on a large dataset of license plate images to recognize the license plate's specific features, such as its shape, size, and color. Once the license plate is detected, the system moves on to the next step.

- **Plate Segmentation: A**fter detecting the license plate, the next step is to segment the license plate from the rest of the image. The plate segmentation process involves isolating the license plate's region by removing all the unnecessary background information. This is done by applying various image processing techniques, such as thresholding, edge detection, and morphological operations, to the license plate image. The output of this process is a binary image that only contains the license plate.

- **Character Recognition of the License plate using OCR: T**he final step in the proposed system involves recognizing the characters on the license plate. For this, Optical Character Recognition (OCR) is used. OCR is a process that involves recognizing and transforming the characters on the license plate into text. In the proposed system, Google OCR Tesseract is used to perform this task. Tesseract is an open-source OCR engine that can recognize text in various languages. Once the characters are recognized, they are processed further to verify their accuracy and provide the final output.

In summary, the proposed license plate recognition system involves acquiring an image of the license plate, detecting the license plate using the YOLOv5 model, segmenting the license plate, and recognizing the characters on the license plate using OCR. This system can be useful in various applications, such as toll collection, parking management, and law enforcement, where fast and accurate license plate recognition is essential.

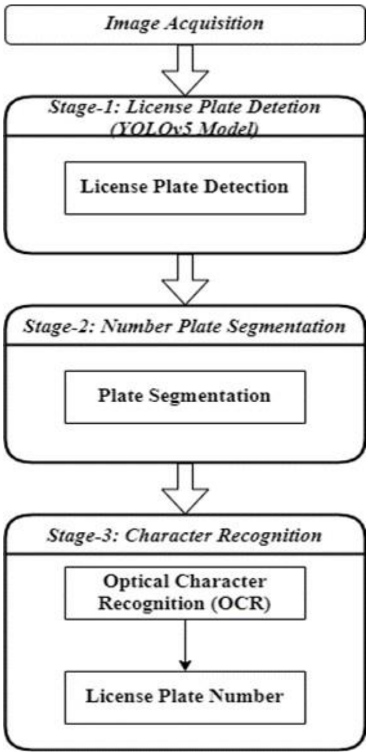


Figure 6.1: Architecture of the proposed system

6.3 STEPWISE EXPLANATION OF EACH MODULE

6.3.1 Image Acquisition

In the proposed system, the first step is to acquire images of vehicles using CCTV cameras at the toll booths and parking lots. These images serve as input for the license plate recognition system. To build the dataset for the system, the researchers used a combination of images available on the internet and images captured from mobile devices. The dataset consists of nearly 500 images of different types of vehicles such as bikes, cars, etc., with both front and rear views.

In addition to the images of vehicles, the dataset also includes images of license plates without a vehicle to train the YOLO network for license plate detection. To prepare the dataset for training, the researchers used Labeling, an open-source API that allows users to annotate images manually and create a training set in YOLO format. One important consideration while building the dataset is the size of the images. Since the images used in the dataset may have different dimensions, it is necessary to resize them to a uniform size for training. In this system, all images were resized to 640x640 for consistency. This ensures that the network is trained on images of the same size and shape, making it easier to detect license plates accurately.

Overall, the image acquisition step is crucial for the success of the license plate recognition system. By building a diverse and comprehensive dataset with annotated license plates, the researchers can train the YOLOv5 model effectively to detect license plates accurately, even in challenging lighting and environmental conditions.

Figure 6.2: Image Acquisition of the vehicle

6.3.2 License Plate Detection

The Automatic Number Plate Detection and Recognition system is a process that involves locating the number plate on a vehicle, extracting text from the image, and using local algorithms for plate separation and character recognition. In order to perform the license plate detection, we used the YOLOv5 model which is a Convolutional Neural Network (CNN) specifically designed for real-time object detection. CNNs are designed to process input images quickly while still maintaining a high level of accuracy.

The YOLOv5 Algorithm is particularly well-suited for finding specific types of objects based on a selected subject. It is capable of detecting and distinguishing between different types of objects, making it a popular choice for implementing AI programs. The algorithm is implemented using the Pytorch library, which is primarily present in Python.

We decided to use the YOLOv5s model for license plate detection because it is the smallest and lightest model with the fastest output. This is particularly important when dealing with video frames, as it ensures that the system can process frames in real-time without any significant delays. Furthermore, we evaluated the performance of different sized models of YOLOv5, and observed that larger models generally provide better accuracy at the expense of responsiveness. This tradeoff was carefully considered when selecting the YOLOv5s model for our system.

In summary, the YOLOv5 model is an excellent choice for license plate detection due to its ability to process images quickly while maintaining high accuracy levels. Its implementation using the Pytorch library in Python makes it a popular choice among AI developers. Our selection of the YOLOv5s model was based on its optimal balance between accuracy and responsiveness, ensuring that our system can process license plate data in real-time.

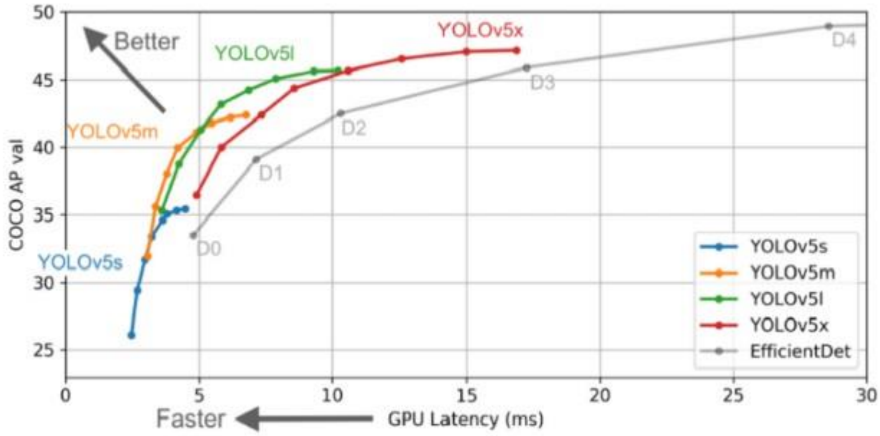


Figure 6.3: Accuracy of YOLOv5 compared to other YOLO versions

For the detection of the license plate, The YOLO algorithm uses the following steps:

1) Residual Blocks: In this technique, The whole image is converted in form of square grids and each grid has an dimension N*N. In this it will highlight the grids which have objects detected in them.

2) Bounding Box Regression: In this technique, A bounding box is formed around the objects found from the whole image. This bounding box has different attributes namely; bounding box width (bbw), bounding box height (bbh), Class c (this describes which object is what in. Here License plate) and bounding box center coordinates (bbx

,bby). Here we want to detect the license plate. In Figure 1, The green outlined bounding box along with its class Plate in green/pink represents the detected license plate from the image using YOLOv5 model.

Figure 6.4: Image after the detection of license plate using YOLOv5 Model

Proposed System has achieved the following results after training over 100 epochs.

Precision	0.629
Recall	0.943
map@0.5	0.0958
map@0.5	94% confidence as 0.417

Table 6.1: Training results of proposed system

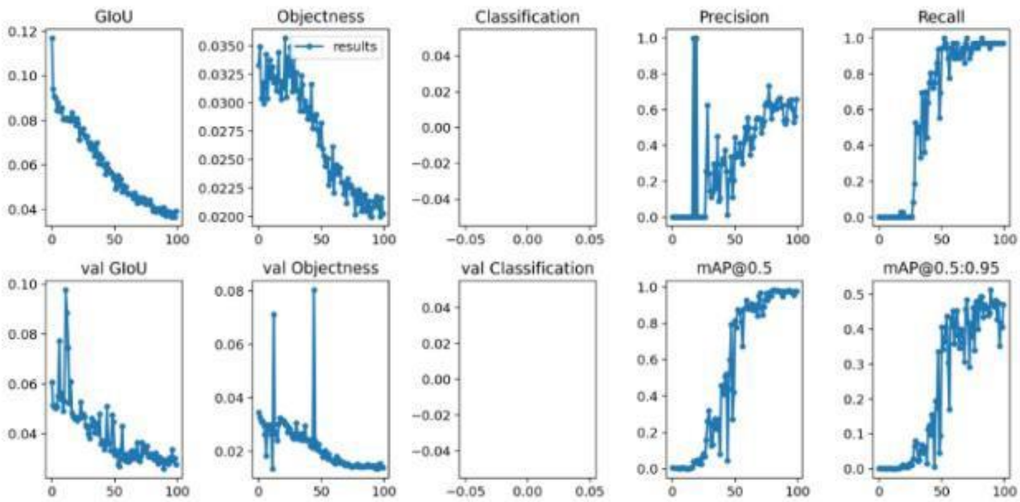


Figure 6.5: Accuracy of detection model while training

6.3.3 Plate Segmentation

Plate segmentation is the process of extracting the license plate region from the input image. Once the license plate is detected, the next step is to separate it from the rest of the image to perform character recognition on the license plate. The segmentation algorithm used here is based on the contours of the license plate region.

The contours are a curve joining all the continuous points along the boundary of the license plate region having the same color or intensity. These contours are identified using OpenCV, an open-source computer vision and machine learning software library. Once the contours of the license plate are identified, we can extract the license plate region by cropping it from the original image.

After plate segmentation, we apply OCR Tesseract on the extracted license plate region to recognize the characters on the plate. Optical Character Recognition (OCR) is a technique that is used to extract text from images. Tesseract is one of the most widely used OCR engines, which is maintained by Google. It works by identifying the character shapes on the image and then recognizing them based on their shapes and context.

The extracted license plate region is preprocessed before applying OCR Tesseract to enhance the accuracy of the character recognition. This includes techniques such as noise removal, image binarization, and character resizing. Once the preprocessing is done, the image is passed through OCR Tesseract to recognize the characters on the license plate.

In summary, plate segmentation is an important step in the identification of the license plate from the input image. The contours of the license plate are identified and used to extract the license plate region from the image. After segmentation, the extracted license plate region is preprocessed and passed through OCR Tesseract to recognize the characters on the plate.

Figure 6.6: Image of the cropped License Plate

6.3.4 Character Recognition

Character Recognition is the final step of License Plate Recognition (LPR) which involves the extraction of the characters present on the segmented license plate image. Optical Character Recognition (OCR) is a technology used to identify text characters from an image or document automatically. The OCR technology is a part of LPR systems that identifies and recognizes text characters present on the license plate.

In the proposed system, OCR Tesseract is used for character recognition. OCR Tesseract is an open-source OCR engine that is widely used for character recognition in various applications. It is a reliable OCR engine with high accuracy rates and can handle various fonts, sizes, and styles of text. Tesseract OCR engine is trained on a dataset of thousands of characters and works by comparing the extracted characters with the pre-trained set of characters to identify the text present on the license plate.

The OCR Tesseract engine takes the segmented license plate image as an input and outputs the recognized text. This recognized text is further processed to remove any extra characters and spaces to get the actual license plate number. The system then stores this number in a database for future use.

Moreover, the system is also trained to recognize regional language number plates. For instance, in India, each state has its regional language and has license plates in the respective regional languages. Therefore, the system is also trained to recognize Marathi language number plates. For this, the system uses Google Translate API to translate Marathi language words to English. However, as the dataset for Marathi number plates is relatively small, the accuracy of recognition is not high. It is expected that with the availability of more Marathi number plate datasets, the accuracy of recognition will improve.

In summary, Character Recognition is an essential part of LPR systems that involves the extraction and recognition of characters present on the segmented license plate image. OCR Tesseract is an efficient and reliable OCR engine that is widely used for character recognition in LPR systems. The proposed system can also recognize regional language number plates, and the accuracy can be improved with the availability of more datasets.

Segmented License plate	Character Recognition of License
	MH02LA7975
	M H 2 0 E E 7 5 9 8

Table 6.2: Output after performing Optical Character Recognition (OCR)

Chapter 7

Bid Submission Pipeline

7.1 METADATA AND DESCRIPTIVE STATISTICS

We have collected the data of the firm for the last two financial years: FY 2020-2021 and FY 2021-2022. The dataset is mainly focused on the financials of the key, non-key positions and other expenses made by the firm for various projects and bids made in the last two FY's.

This dataset will be analyzed over different parameters like monthly, quarterly and yearly basis in order to look for any seasonality effect if present any. In the process of Data collection, its cleaning and analysis Microsoft Excel will be used.

7.2 INFORMATION REGARDING THE EXCEL MASTER SHEET OF DATASET

Information regarding the Excel Master Sheet for various columns and their other relevant values :

Index	Column Name	Description	Types of Variables	Datatype of Variable
1	Organisation	It contains information about various organisation under which the firm bid	Categorical Data	String
2	Team Leader cum Highway Engineer	Bid price of Key Personnel	Numerical Data	Integer
3	Sr. Bridge Design Engineer	Bid price of Key Personnel	Numerical Data	Integer
4	Highway Maintenance cum Resident Engineer	Bid price of Key Personnel	Numerical Data	Integer
5	Senior Pavement Specialist	Bid price of Key Personnel	Numerical Data	Integer
6	Senior Quantity cum Material Expert	Bid price of Key Personnel	Numerical Data	Integer
7	Road Safety Expert	Bid price of Key Personnel	Numerical Data	Integer
8	Traffic Planner	Bid price of Key Personnel	Numerical Data	Integer
9	Survey Engineer	Bid price of Non-Key	Numerical Data	Integer

10	Assistant Highway Engineer	Bid price of Non-Key Personnel	Numerical Data	Integer
11	CAD Expert	Bid price of Non-Key Personnel	Numerical Data	Integer
12	Environmental Engineer	Bid price of Non-Key Personnel	Numerical Data	Integer
13	Assistant Bridge Engineer	Bid price of Non-Key Personnel	Numerical Data	Integer
14	Assistant Quality cum Material Engineer	Bid price of Non-Key Personnel	Numerical Data	Integer
15	Electrical Engineer	Bid price of Non-Key Personnel	Numerical Data	Integer
16	HTMS/Toll Expert	Bid price of Non-Key Personnel	Numerical Data	Integer
17	Quantity Surveyor	Bid price of Non-Key Personnel	Numerical Data	Integer
18	Horticulture cum landscaping Expert	Bid price of Non-Key Personnel	Numerical Data	Integer
19	Lane Size	Information whether the lane is 2/4/6	Categorical Data	Integer
20	Total Km	Total Length of Km	Numerical Data	Float
21	Design Man Month	Number of Design Man Month	Numerical Data	Integer
22	Total Month	Number of Total Man Month	Numerical Data	Integer
23	Bid Cost Before GST	Information regarding the cumulative cost for the project before GST	Numerical Data	Float
24	Bid Cost after GST (18%)	Information regarding the cumulative cost for the project after GST	Numerical Data	Float
25	Cost Per Km	Information regarding Cost Per Km	Numerical Data	Float
26	Bid Successful	Information regarding whether the bid is successful or not	Categorical Data	String

Table 7.1: Column Information of Data recorded in Master sheet.

$$\text{Cost Per Km} = \frac{\left(\frac{\text{Bid Cost after GST (18\%)}}{\text{Total Month}}\right)}{\text{Total Km}}$$

All the data has been sorted and filtered from various bids made by the firm in the last two financial years: FY 2020-2021 and FY 2021-2022. There are different sheets from every bid made and the Custom Excel Master Datasheet was made with the key personnel and non-key personnel with other information like Total Km, Design Man Month, Total Month, Bid Cost Before GST, Bid Cost after GST (18%), Cost Per Km and Bid Successful.

7.3 DATA STATISTICS DESCRIPTION

Employing Google Collab's df.describe() function to find the description of the data in the Data Frame. The description contains this information for each column are count (the number of not-empty values), mean (the average value), std (the standard deviation), min (the minimum value), 25% (the 25% percentile), 50% (the 50% percentile), 75% (the 75% percentile) and max (the maximum value).

Index	Team Leader cum Highway Engineer	Sr. Bridge Design Engineer	Highway Maintenance cum Resident Engineer	Senior Pavement Specialist	Senior Quantity cum Material Expert	Road Safety Expert	Traffic Planner
Mean	254867.64	152355.76	139795.08	123628.04	135391.30	145413.79	215000.00
Std	135220.98	41082.57	40083.38	38778.95	58082.11	98946.69	110746.13
Min	40000.00	35000.00	30000.00	30000.00	18000.00	30000.00	120000.00
25%	150000.00	130000.00	120000.00	110000.00	120000.00	62500.00	121250.00
50%	220000.00	145000.00	130000.00	124630.00	130000.00	120000.00	165000.00
75%	325000.00	157500.00	180000.00	138000.00	161000.00	180000.00	300000.00
Max	600000.00	250000.00	200000.00	195000.00	240000.00	400000.00	400000.00

Table 7.2: Description of the Key Personnel

Index	Lane Size	Total Km	Design Man Month	Total Month	Bid Cost Before GST	Bid Cost after GST (18%)	Cost Per Km
Mean	3.38	108.29	19.67	52.80	3.250759e+07	3.835895e+07	18083.37
Std	1.39	82.78	14.21	36.39	2.790715e+07	3.293044e+07	25810.26
Min	1.39	82.78	14.21	36.39	2.790715e+07	3.293044e+07	25810.26
25%	2.00	51.91	12.00	24.00	1.489727e+07	1.757878e+07	2812.82
50%	4.00	90.00	12.00	36.00	1.932825e+07	2.280733e+07	10404.81
75%	4.00	148.00	24.00	84.00	4.000000e+07	4.720000e+07	22099.77
Max	6.00	372.510	48.00	120.00	1.235520e+08	1.457914e+08	168195.18

Table 7.3: Description of various Information

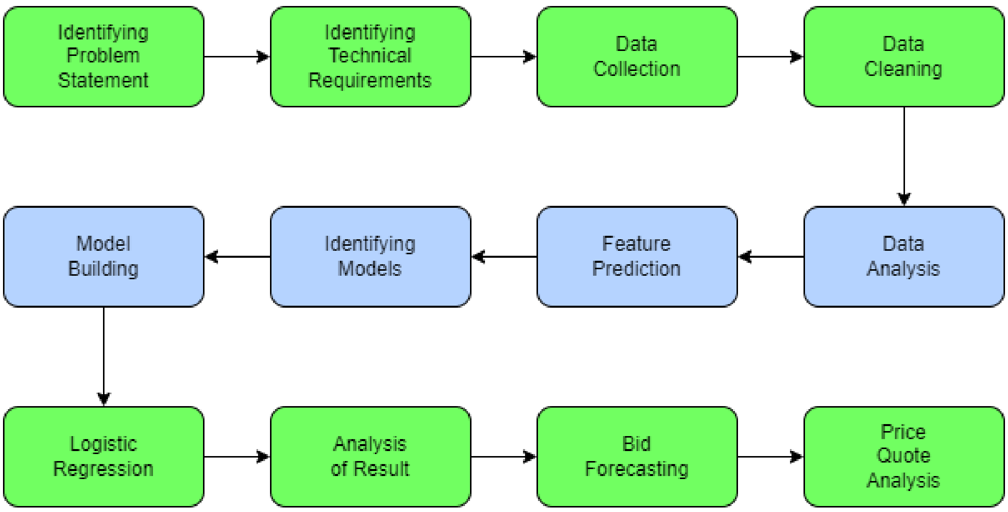


Figure 7.1: Architecture Diagram for the Project

7.4 DATA CLEANING

The process of cleaning data entails numerous processes, including determining if the data is consistent, looking for outliers, and handling any missing values that may be present in the dataset.

7.4.1 Consistency of Data

The major goal of this method is to determine whether the data adheres to the standards and is not logically inconsistent. Several metrics, including sum, average, median, and others, may be used in Excel to carry out this operation and assess the integrity of the data. The Excel keyboard shortcuts "Ctrl+" and "Ctrl+shift+" are used to validate data for the range of columns and rows, respectively. We discovered that the formulas were reliable. Nothing was wrong.

7.4.2 Replacing Missing Values

We searched for the percentage distribution of missing values in each column by the command df.isnull().mean() and replace the NaN values with df.fillna(0).

7.4.3 Outlier's Detection

If a datapoint significantly deviates from the average value of the relevant statistical group, it is said to be an outlier.

7.4.4 Scaling

It is a technique that requires fiddling with the values to make them similar to other dataset variables so they may be used for analysis. By removing the variable's mean value and then dividing the result by the variable's standard deviation, we can use the standardization method to scale the data down to the same scale.

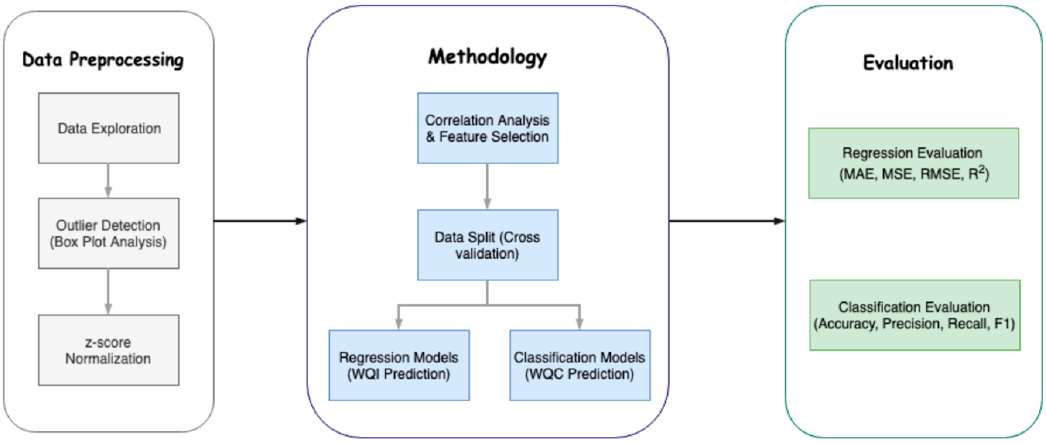


Figure 7.2: Architecture Diagram for the Data Preparation and Evaluation

7.5 ANALYSIS PROCESS

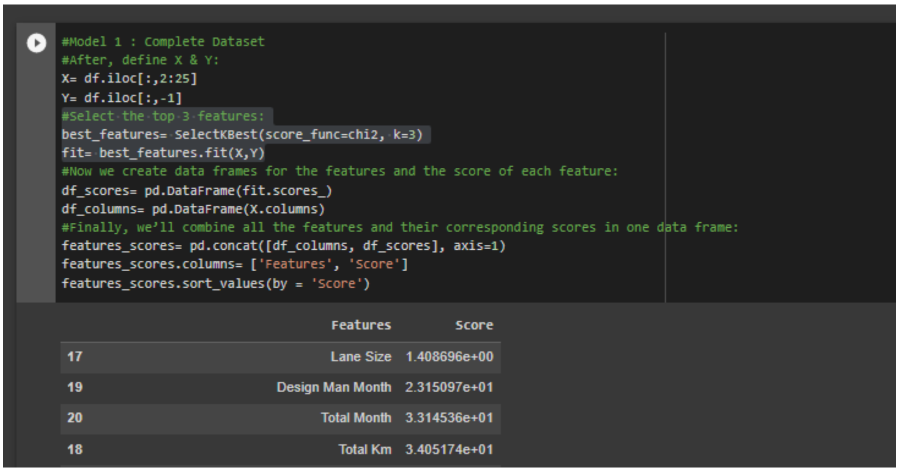
For a bid to be successful both the technical and financial region of the company given are analyzed with their weightage to be 80 and 20 percent respectively. Analyzing the financials of the bid would immensely boost up the bid success rate. Google Collaboratory and Microsoft Excel products are essential for dataset analysis tasks including data collecting, data cleaning, sorting, and analysis. With the use of trend analysis, the problem statements are mostly resolved. In order to find patterns and predict future trends, prediction model essentially involves gathering data throughout time from a variety of bids and comparing it to earlier bids. In other words, bid trend analysis enables us to forecast potential future successful bids by using previous events as a guide. We discover which fields of the bid brought in the most effective through feature selection.

7.5.1 Feature Selection

In this stage, we pick a few qualities that are most helpful in achieving the desired result. As a result, we only choose the columns in our dataset that have the highest correlation with the predicted variable, rather than training the model using all of the columns in our dataset. Run a chi-squared statistical test and choose the top 3 attributes that are most associated with floods using the SelectKBest library. SelectKBest is a feature selection library in Python's scikit-learn machine learning package. The library selects the top k features with the highest importance score based on univariate statistical tests, such as ANOVA or chi squared. Both classification and regression issues may be solved with it. The library works by fitting the model to the training data and scoring each feature based on the test statistic.

The k best features are then selected and returned as a new dataset. This process helps to reduce the dimensionality of the data, which can improve model performance and reduce overfitting. SelectKBest is a simple and efficient way to select the most key features for a given machine learning task. Here, we see that the top 3 characteristics most closely associated with the desired result are Cost Per Km, Team Leader cum Highway Engineer and Survey Engineer.

Then we build the models and evaluate the model’s performance.



```
#Model 1 : Complete Dataset
#After, define X & Y:
X= df.iloc[:,2:25]
Y= df.iloc[:,-1]
#Select the top 3 features:
best_features= SelectKBest(score_func=chi2, k=3)
fit= best_features.fit(X,Y)
#Now we create data frames for the features and the score of each feature:
df_scores= pd.DataFrame(fit.scores_)
df_columns= pd.DataFrame(X.columns)
#Finally, we'll combine all the features and their corresponding scores in one data frame:
features_scores= pd.concat([df_columns, df_scores], axis=1)
features_scores.columns= ['Features', 'Score']
features_scores.sort_values(by = 'Score')
```

	Features	Score
17	Lane Size	1.408696e+00
19	Design Man Month	2.315097e+01
20	Total Month	3.314536e+01
18	Total Km	3.405174e+01

Figure 7.3: Code Snippet of Model 1 for Feature Selection

7.6 MODEL BUILDING USING LOGISTIC REGRESSION

1. Logistic Regression is a machine learning algorithm used for binary classification problems.
2. The steps involved in building a logistic regression model include data preprocessing, splitting the data, feature selection, model fitting, model evaluation, model optimization, and prediction.
3. Data preprocessing involves cleaning and preparing the data.
4. The data is split into a training set and a test set for model fitting and evaluation.
5. Feature selection involves identifying the most important features for the model.
6. The model is fit to the training data using an optimization algorithm and evaluated on the test set.
7. Logistic Regression has strengths and weaknesses and may not be suitable for all scenarios.

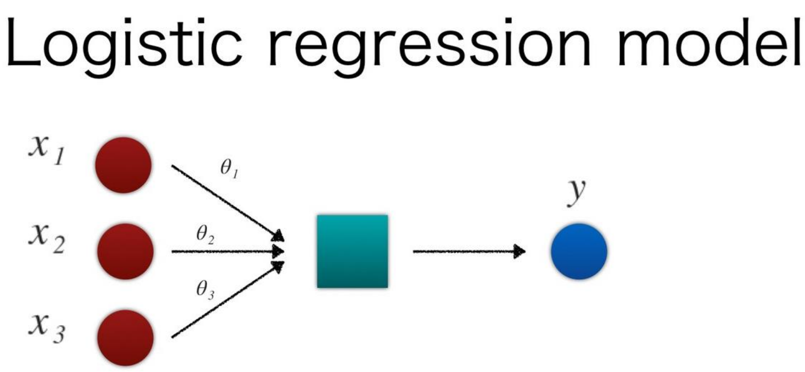


Figure 7.4: Logistic Regression Model

7.7 CLASSIFICATION REPORT

An assessment report known as a classification report is used to assess the performance of machine learning models. The performance of the model is measured by a score called accuracy. It is preferable if it is higher. Recall gauges a model's ability to foretell genuine positive values with accuracy. The precision ratio is the total of true positives divided by the total of false positives. Precision and recall are combined into one statistic called F-score. Its value should ideally be as near to 1 as possible. The dataset's support is the number of instances of each type that really occur.

F-score, also known as F1-score, is a commonly used evaluation metric in machine learning that measures the harmonic mean of precision and recall. It supplies a way to balance the importance of precision and recall in classification tasks, where both the false positives (FP) and false negatives (FN) are important. The formula for the F-score is:

$$\text{F-score} = \frac{2*(precision*recall)}{(precision+recall)}$$

Where, precision = TP / (TP + FP) and recall = TP / (TP + FN). The terms TP, FP, and FN refer to the number of true positives, false positives, and false negatives, respectively. The F-score ranges from 0 to 1, where 1 indicates perfect precision and recall, and 0 indicates deficient performance.

7.7.1 Curve

By measuring the true positive and false positive rates, the receiver operating characteristic (ROC) curve is used to show the sensitivity and specificity of the logistic regression model. The area under the curve (AUC), whose value ranges from 0 to 1, may be calculated from the ROC curve. You'll recall that for our predictive modelling, the closer to 1, the better.

ROC (Receiver Operating Characteristic) curve is a graphical representation of the performance of a binary classification model. It plots the true positive rate (TPR) against the false positive rate (FPR) for different classification thresholds. The TPR indicates the percentage of real positives that the model properly detects and is often referred to as sensitivity or recall. The FPR, on the other hand, measures the proportion of actual negatives that are incorrectly classified as positives. The ROC curve helps to visualize the trade-off between TPR and FPR at different thresholds and provides a way to compare the performance of different models.

The area under the ROC curve (AUC) is a commonly used metric for model performance, where an AUC of 1 indicates perfect classification, and 0.5 indicates random classification. In general, a model with a higher AUC is considered better than a model with a lower AUC.

7.7.2 Pareto Analysis

The problem statement calls for a thorough examination of the firm's offers. As a result, we want to create a Pareto chart to identify the kind of bids that were most effective with the least amount of leakage. We establish a pivot table with bids and key persons in order to generate a pareto chart.

7.8 BID FORECAST

In order to make data-driven business choices, bid forecasting essentially refers to the process of determining whether a certain bid would be successful over the course of time. Bar charts will be used for this.

XG Boost for Bid Forecast

1. Boost is a machine learning algorithm that can be used for bid prediction in online auctions.
2. Data preparation involves cleaning and transforming the bid data into a format suitable for XGBoost.
3. Model selection involves selecting the appropriate hyperparameters, such as the learning rate and the number of trees, for the XGBoost model.
4. Model training involves building a sequence of decision trees that are trained to predict the bid values.
5. Bid prediction involves applying the trained XGBoost model to new bid data to obtain predicted bid values.

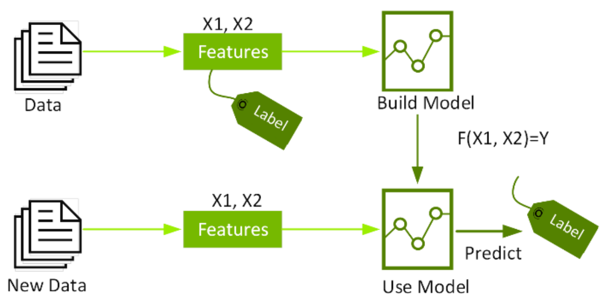


Figure 7.5: Framework for XG Boost

7.9 PROPHET FOR BID FORECAST

1. Prophet is a time series forecasting model developed by Facebook that can be used for bid acceptance prediction in online auctions.
2. Data preparation involves cleaning and transforming the bid data into a format suitable for Prophet, which may involve aggregating the data to a suitable level of granularity.
3. Model fitting involves specifying the historical bid data and any relevant features to train the Prophet model on the bid acceptance prediction task.
4. Model validation involves comparing the forecasted values with the actual bid data and calculating performance metrics such as Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE).
5. Bid acceptance prediction involves applying the trained Prophet model to new bid data to obtain forecasted bid acceptance rates.

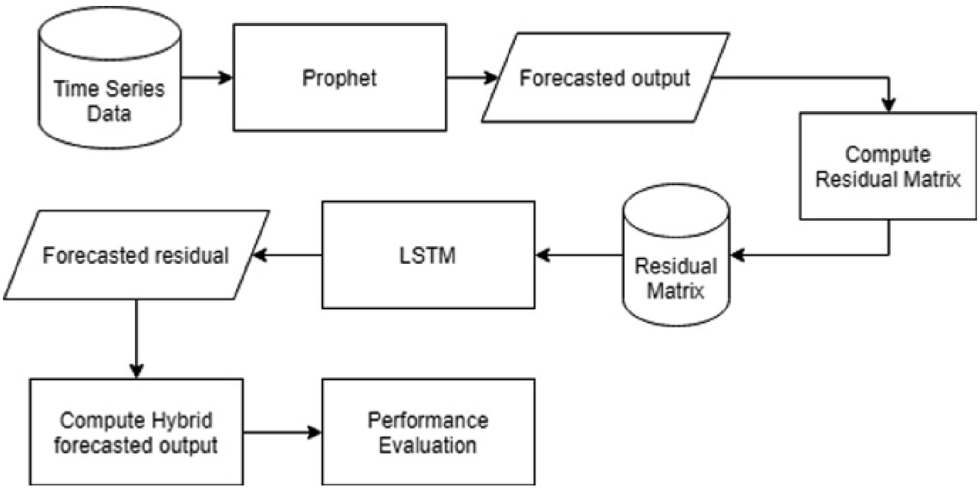


Figure 7.6:Framework for Prophet

7.10 NAÏVE BAYES CLASSIFIER

1. Data preparation: Preprocess the bid data to make it suitable for Naive Bayes, which involves encoding categorical variables and scaling numerical variables.
2. Feature selection: Select the most relevant features for bid prediction based on their correlation with the target variable.
3. Model training: Train the Naive Bayes model on the bid data using the selected features, assuming conditional independence between the features.
4. Model evaluation: Evaluate the Naive Bayes model on a validation set using performance metrics such as accuracy, precision, recall, and F1 score.
5. Bid prediction: Use the trained Naive Bayes model to predict bid values for new bid data by feeding it into the model.

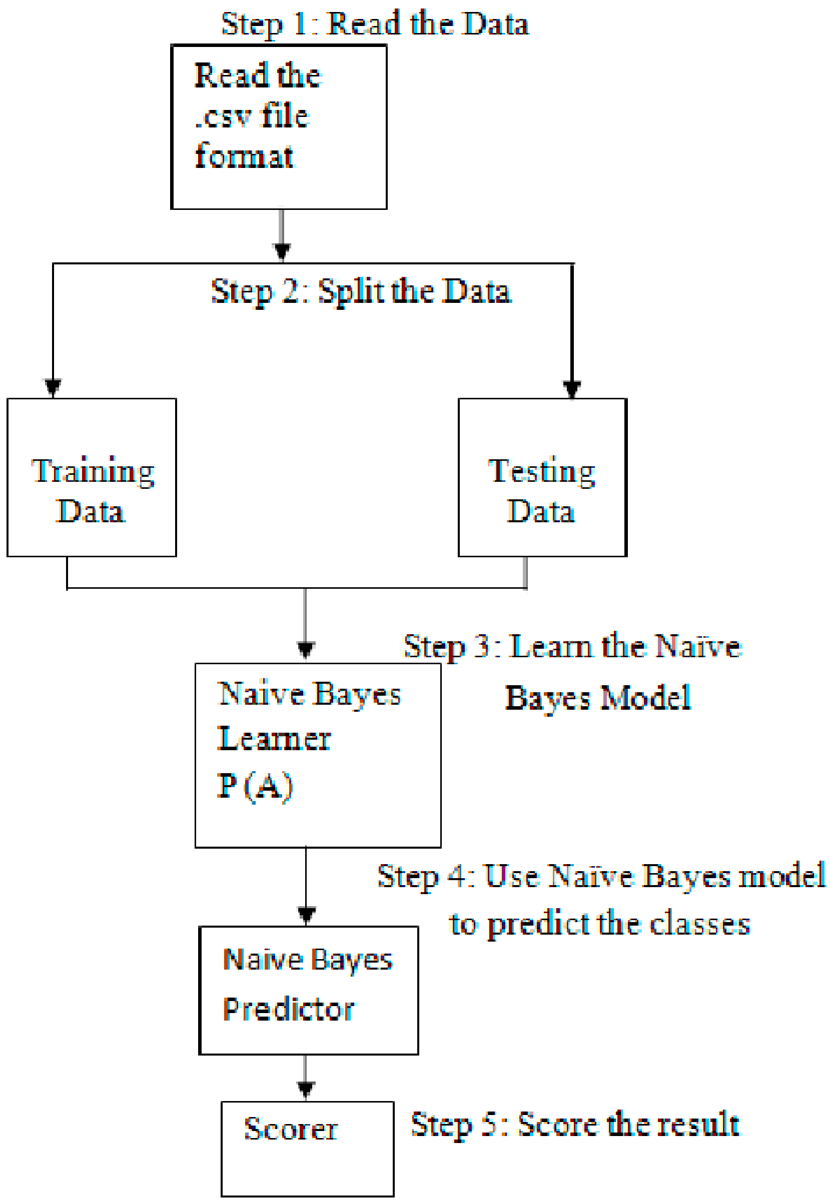


Figure 7.7:Framework for Naive Bayes Classifier

7.11 PRICE QUOTES ANALYSIS

We will organize the data to investigate the costs using a frequency distribution for analyzing the data and price quotations. For comparative purposes between the various Organizations the bids were submitted under, stacked bar charts will be used.

Chapter 8

Results and Discussion

8.1 HTMS SYSTEM

The proposed ANPR system with License Plate Detection, Segmentation, and Character Recognition using OCR Tesseract has been successful in achieving high accuracy in recognizing the license plates of different vehicles. The system has been trained using a custom YOLOv5 model, which is a CNN algorithm used for real-time acquisition of license plates from the vehicles. The YOLOv5 algorithm has been implemented using the Pytorch library present in Python.

The image acquisition is done using CCTV cameras at toll booths and parking lots. A dataset consisting of nearly 500 images of different types of vehicles such as bikes, cars, etc., with both front and rear-view, has been used for training the ANPR system. We have also annotated the images manually using Labelling, an open-source API to create a training set in YOLO format. The dataset has been converted to the same size of 640x640 for uniformity.

License Plate Detection using the YOLOv5 model has been performed to locate the license plates of the vehicles. The YOLOv5 algorithm can process input images quickly and detect patterns in them while maintaining its accuracy level. We have used the YOLOv5s as the smallest and lightest model with the fastest output to cope up with the video frames. The difference in different-sized models of v5 in accuracy and responsiveness has been observed, and the best model has been selected based on the accuracy and speed requirements.

The next important step in the identification of License Plate is Plate Segmentation, which separates the License Plate from the original image, and OCR Tesseract is applied to it for Character Recognition. Segmentation has been performed using OpenCV libraries to extract the region of interest (ROI) containing the license plate from the input image. This ROI has been then processed to get a clear image of the license plate, which can be further used for OCR Tesseract to recognize the characters on the license plate.

Character Recognition has been done using OCR Tesseract, which is a method that allows a program to identify texts or words written in users' oral communication.

OCR has become the most successful application of information in the field of pattern acquisition and AI. OCR Tesseract has been used to recognize the characters on the license plate and transform them into text after segmentation.

The results of our ANPR system have been compared with existing external strategies in complex data sets consisting of LPs taken with a strong point where rational retention ends up in many controlled repositories. Our proposed system has shown to exceed these strategies with high accuracy in recognizing license plates of different vehicles.

Most cars have the same single license plates, while bikes, buses, rickshaws, etc., have double license plates. This makes LP detection almost impossible. To overcome this difficulty, we can create a database with various types of images of all License Plate patterns that can be found in India. Further, we wish to work towards creating a dataset containing different Indian number plate types like in different regional languages, different font size and license plate sizes, and four types of number plates having different colours indicating the purpose of the vehicle driven.

In future work, we aim to improve the accuracy of the ANPR system by expanding the dataset and using more advanced algorithms for License Plate Detection, Segmentation, and Character Recognition. We also aim to create an ANPR model that can detect all types of number plates with maximum accuracy and speed. This can be achieved by incorporating deep learning techniques like recurrent neural networks (RNNs) and long-short term memory (LSTM) networks, which can improve the recognition accuracy of the OCR system.

Moreover, the ANPR system can be integrated with other systems like traffic monitoring, vehicle tracking, and toll booth management systems to improve their efficiency and accuracy.

8.2 MODELS BUILT ON THE DATASET WITH FEATURE SELECTION AND OTHER FEATURES.

Model1: Information with complete Dataset with all keys, non-personnel

	Precision	Recall	F1-Score	Support
0	1.00	0.00	0.00	14
1	0.50	1.00	0.67	14
accuracy			0.50	28
macro avg	0.75	0.50	0.33	28
weighted avg	0.75	0.50	0.33	28

Table 8.1: Classification Report Table for Model 1

For class 0, the precision score is 1.0, indicating that all predicted samples for this class were actually negative. However, the recall score is 0.0, indicating that none of the actual negative samples were correctly predicted by the model. As a result, the F1-score for class 0 is 0.0, which is the harmonic mean of precision and recall. For class 1, the precision score is 0.5, indicating that only half of the predicted positive samples were actually positive.

However, the recall score is 1.0, indicating that all actual positive samples were correctly predicted as positive by the model. As a result, the F1-score for class 1 is 0.67, which is higher than that for class 0. The accuracy score of 0.50 indicates that the model is predicting half of the samples correctly. The macro and weighted average F1-scores are 0.33, which are lower than the F1-score for class 1, indicating that the model is not performing well overall. In summary, the model is only correctly predicting one class, while it is completely failing to predict the other. Therefore, the model needs improvement to achieve better overall performance.

Model 2: Information with key personnel

	Precision	Recall	F1-Score	Support
0	0.71	0.86	0.77	14
1	0.82	0.64	0.72	14
accuracy			0.75	28
macro avg	0.76	0.75	0.75	28
weighted avg	0.76	0.75	0.75	28

Table 8.2: Classification Report Table for Model 2

For class 0, the precision score is 0.71, indicating that out of all predicted samples for this class, 71% were actually negative. The recall score is 0.86, indicating that out of all actual negative samples, 86% were correctly predicted by the model.

For class 1, the precision score is 0.82, indicating that out of all predicted positive samples, 82% were actually positive. The recall score is 0.64, indicating that out of all actual positive samples, 64% were correctly predicted by the model. As a result, the F1-score for class 1 is 0.72, which is lower than that for class 0.

The accuracy score of 0.75 indicates that the model is predicting 75% of the samples correctly. The macro and weighted average F1-scores are 0.75, which is higher than the F1-score for class 1, indicating that the model is performing well overall.

In summary, Model 2 is performing better than Model 1, with reasonable precision, recall, and F1-score for both classes. However, there is still room for improvement in predicting the positive class as the recall score is relatively low.

Model 3: Information with other feature values

	Precision	Recall	F1-Score	Support
0	1.00	0.00	0.00	14
1	0.50	1.00	0.67	14
accuracy			0.50	28
macro avg	0.75	0.50	0.33	28
weighted avg	0.75	0.50	0.33	28

Table 8.3: Classification Report Table for Model 3

For class 0, the precision score is 1.0, indicating that all predicted samples for this class were actually negative. However, the recall score is 0.0, indicating that the model did not correctly predict any of the true negative samples. As a result, the F1-score for class 0 is 0.0, which is the harmonic mean of precision and recall.

For class 1, the precision score is 0.5, indicating that out of all predicted positive samples, 50% were actually positive. The recall score is 1.0, indicating that out of all actual positive samples, 100% were correctly predicted by the model. As a result, the F1-score for class 1 is 0.67, which is higher than the F1-score for class 0.

The accuracy score of 0.50 indicates that the model is predicting only 50% of the samples correctly. The macro and weighted average F1-scores are 0.33, which is lower than the F1-score for class 1, indicating that the model is not performing well overall.

In summary, Model 3 is predicting all negative samples as negative, but it is not correctly predicting any of the true negative samples, resulting in low recall and F1-score for class 0. The precision score for class 1 is low, indicating that the model is also incorrectly predicting many of the positive samples as negative. The overall performance of the model is poor, as indicated by the low accuracy and F1-scores.

Model 4: Information with other non-key personnel

	Precision	Recall	F1-Score	Support
0	0.83	0.36	0.50	14
1	0.59	0.93	0.72	14
accuracy			0.64	28
macro avg	0.71	0.64	0.61	28
weighted avg	0.71	0.64	0.61	28

Table 8.4: Classification Report Table for Model 4

For class 0, the precision score is 0.83, indicating that out of all predicted negative samples, 83% were actually negative. The recall score is 0.36, indicating that out of all actual negative samples, only 36% were correctly predicted by the model. As a result, the F1-score for class 0 is 0.50, which is the harmonic mean of precision and recall.

For class 1, the precision score is 0.59, indicating that out of all predicted positive samples, 59% were actually positive. The recall score is 0.93, indicating that out of all actual positive samples, 93% were correctly predicted by the model.

As a result, the F1-score for class 1 is 0.72, which is higher than the F1-score for class 0. The accuracy score of 0.64 indicates that the model is predicting 64% of the samples correctly. The macro and weighted average F1-scores are 0.61, which is higher than the F1-score for class 0 but lower than the F1-score for class 1.

In summary, Model 4 is performing better than Model 3 but still has room for improvement. The precision score for class 1 is higher than the precision score for class 0, indicating that the model is correctly predicting more positive samples than negative samples. However, the recall score for class 0 is low, indicating that the model is missing many of the true negative samples. The overall performance of the model is moderate, as indicated by the accuracy and F1-scores.

Model 5: Information with bid and total km

	Precision	Recall	F1-Score	Support
0	0.80	0.57	0.67	14
1	0.67	0.86	0.75	14
accuracy			0.71	28
macro avg	0.73	0.71	0.71	28
weighted avg	0.73	0.71	0.71	28

Table 8.5: Classification Report Table for Model 5

Looking at the precision, recall, and F1-score values, we can see that Model 5 has the highest F1-score for class 1 (0.75) compared to all other models. It also has a relatively high recall for class 1 (0.86), which means that it is able to correctly identify more of the positive cases. However, the precision for class 0 is relatively low (0.80), which means that it incorrectly identifies some negative cases as positive.

Overall, we can say that Model 5 performs relatively well compared to the other models, especially in terms of correctly identifying positive cases. However, it could be improved further by increasing the precision for class 0.

Based on the classification report table for Model 5, it has achieved an accuracy of 0.71, which is higher than the accuracy of Models 1, 2, 3, and 4. The precision and recall values for both classes (0 and 1) are also higher than the values obtained by Models 1, 2, 3, and 4, indicating that Model 5 is better at correctly identifying both classes.

Furthermore, the F1-score of Model 5 is also higher than the F1-score of Models 1, 2, 3, and 4, suggesting that Model 5 has a better overall performance. Therefore, Model 5 seems to be the best model among the given models for this classification problem.

Index	Accuracy	Recall	Precision	AUC
Model 1	0.5	1.0	0.5	0.6836
Model 2	0.75	0.6428	0.8181	0.7653
Model 3	0.5	1.0	0.5	0.6836
Model 4	0.6428	0.9285	0.5909	0.5
Model 5	0.7142	0.8571	0.6666	0.9183

Table 8.6: Various Parameters of the models

From the above table, we can observe that model 5 has the highest accuracy (0.7142) and AUC score (0.9183) compared to other models. It also has a good balance of precision and recall (0.67 and 0.86 respectively), indicating that it can correctly identify both positive and negative cases without too many false positives or false negatives.

In contrast, models 1, 3 and 4 have low accuracy and F1-scores, indicating poor performance. Model 2 has a high precision but low recall, which means it correctly identifies positive cases, but misses many of them.

Overall, it appears that model 5 is the best performing model for this task.

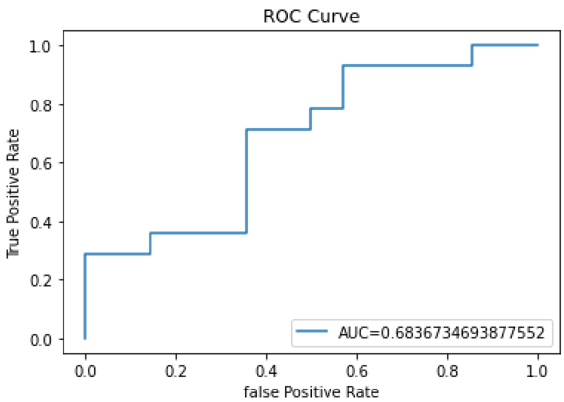


Figure 8.1: ROC Curve of Model 1

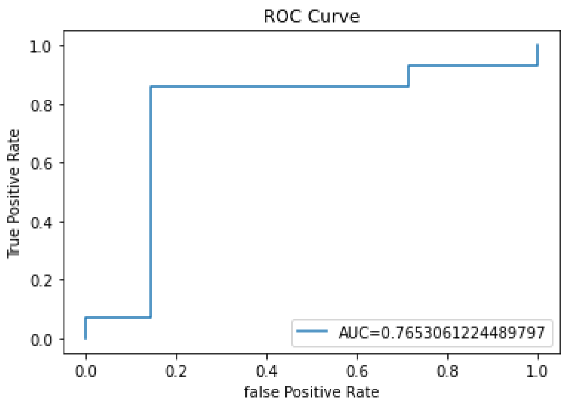


Figure 8.2: ROC Curve of Model 2

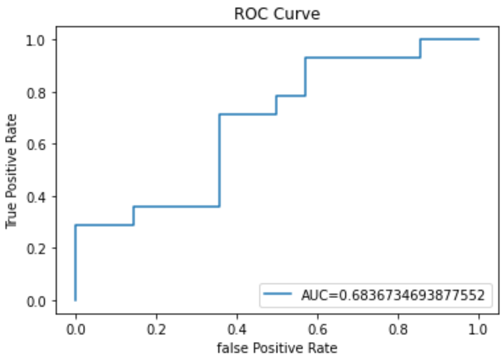


Figure 8.3: ROC Curve of Model 3

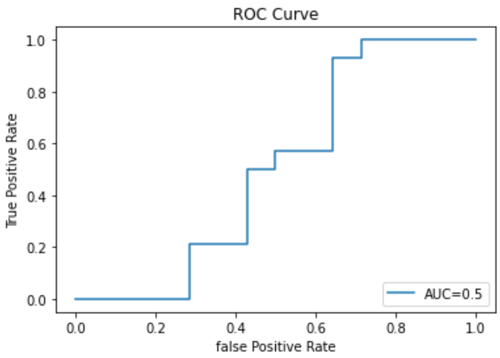


Figure 8.4: ROC Curve of Model 4

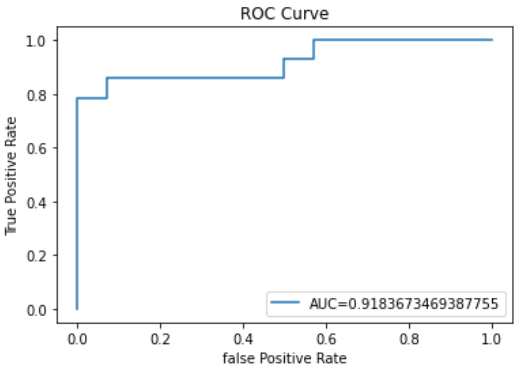


Figure 8.5: ROC Curve of Curve of Model 5

ROC curve is a graphical representation of the performance of a binary classification model. It plots the true positive rate (sensitivity) against the false positive rate (1-specificity) at different probability thresholds.

A good classifier should have a higher true positive rate and a lower false positive rate, which means that it should have an ROC curve that is closer to the top left corner of the plot. A classifier that has a random guessing performance would produce an ROC curve that is a diagonal line from the bottom left corner to the top right corner of the plot.

8.3 PARETO GRAPH ANALYSIS

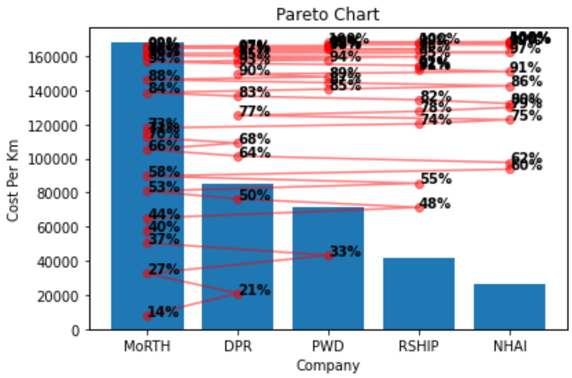


Figure 8.6: Pareto Graph of Company vs Cost Per Km

In the given Fig 6, Company 1 contributes the most to the total cost per kilometer, with a percentage of around 32%. This means that if we were to reduce the cost per kilometer, we would need to focus on reducing the cost associated with Company 1. Similarly, Company 2 and Company 3 contribute around 27% and 21%, respectively, to the total cost per kilometer.

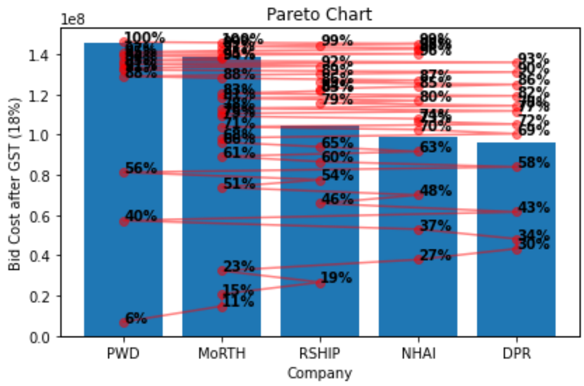


Figure 8.7: Pareto Graph of Company vs Bid Cost after GST (18%)

In the given Fig 7, Pareto Graph of Company vs Bid Cost after GST (18%), the companies are ranked in descending order of their total bid costs after GST (18%). The cumulative bid cost percentage is plotted on the secondary y-axis. The graph shows that the company with the highest bid cost after GST (18%) accounts for a significant percentage of the total bid cost. The top 2 companies account for more than 50% of the total bid cost.

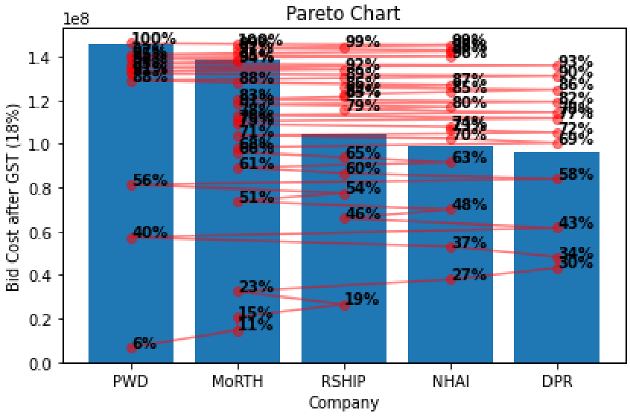


Figure 8.8: Pareto Graph of Company vs Successful Bid

In the given Figure , Pareto graph of Company vs Successful Bid, the X-axis represents the different companies, while the Y-axis represents the number of successful bids. The bars on the graph are arranged in descending order, with the company with the highest number of successful bids on the left, and the company with the lowest number of successful bids on the right. By looking at the Pareto graph, we can easily identify the top-performing companies in terms of successful bids. These are the companies that have the highest bars on the graph. We can also see the percentage of successful bids that each company has contributed to the total. For example, if the graph shows that the top three companies have a total of 80% of successful bids, we can conclude that these three companies are responsible for the majority of the successful bids i.e., PWD, MoRTH and RSHIP.

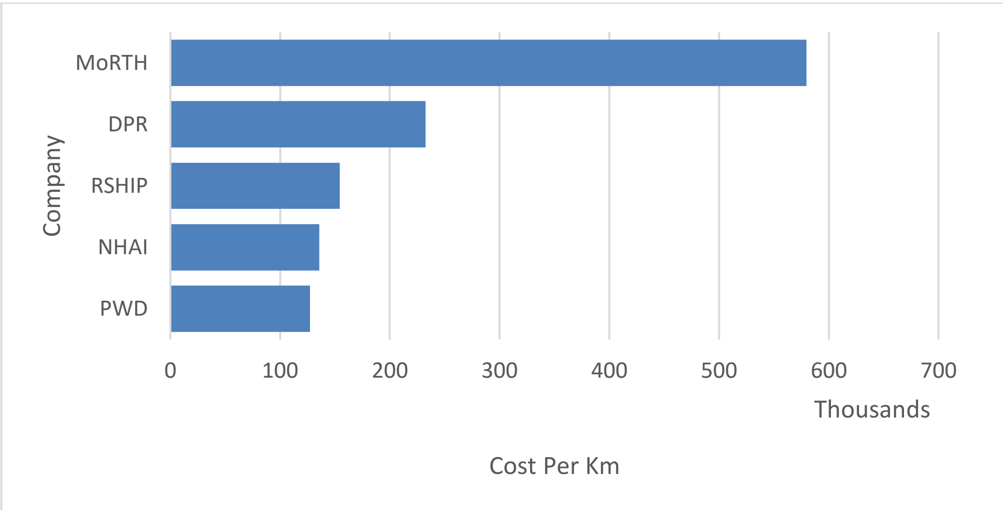


Figure 8.9: Graph of Cost per Km vs Various Company

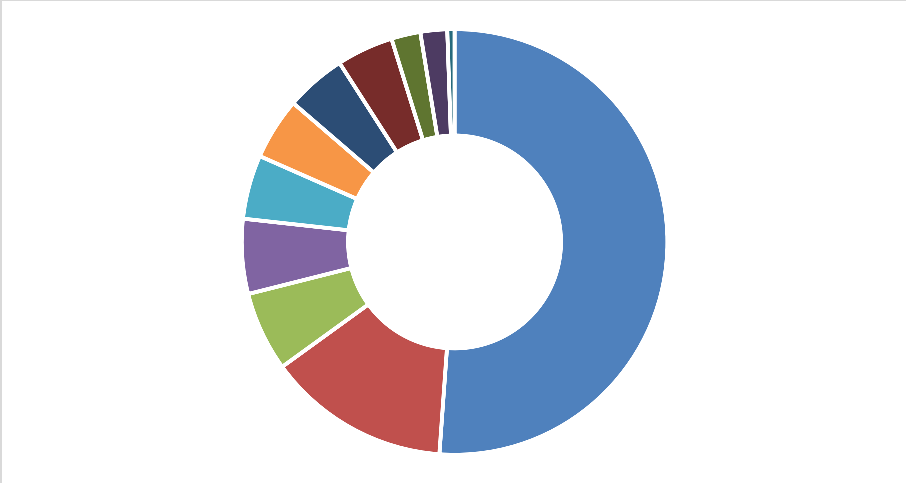


Figure 8.10: Comparison of Cost per Km vs Design Man Month

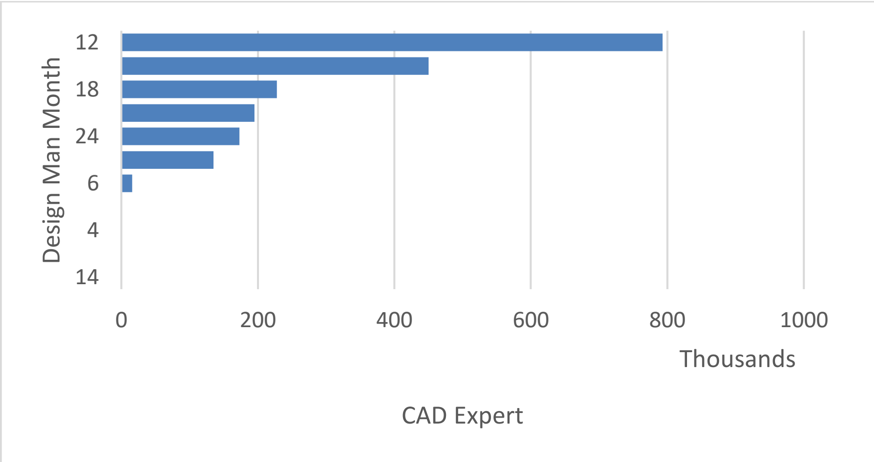


Figure 8.11: Graph of CAD Expert vs Design Man Month

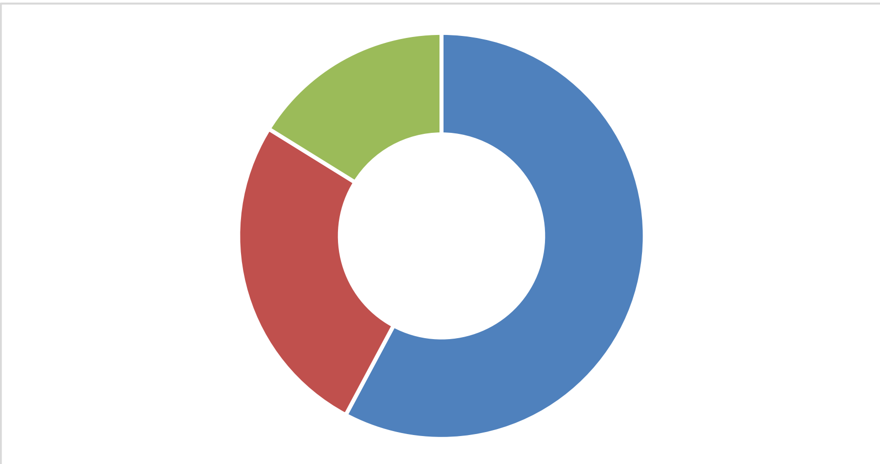


Figure 8.12: Comparison of Lane Size vs Design Man Month

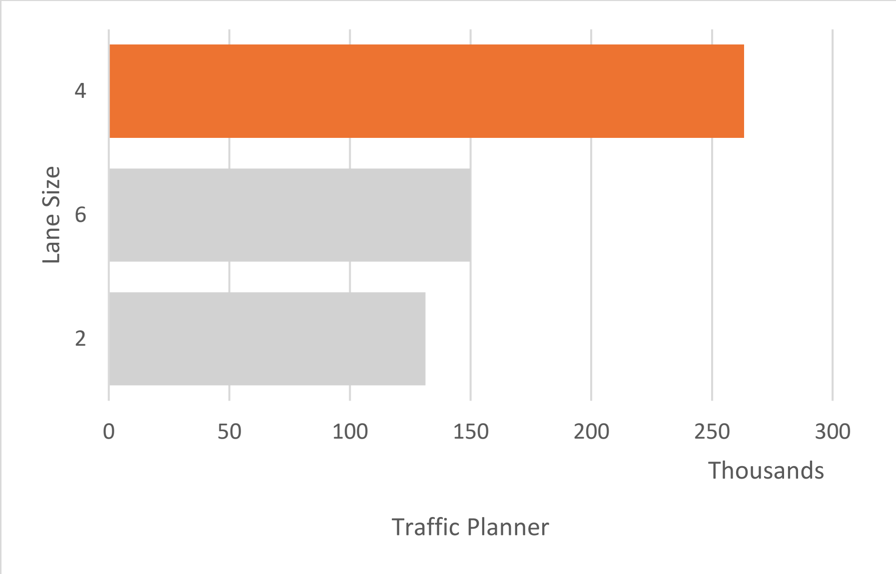


Figure 8.13: Graph of Lane Size vs Traffic Planner

In summary, Model 5 appears to be the best-performing model based on the metrics provided, followed by Model 2. However, it is important to note that these models may have other weaknesses or limitations that are not captured by these metrics alone, and further analysis may be required to determine the best model for a given problem.

In conclusion Model 5 i.e. Cost per Km, Team Leader cum Highway Engineer, Survey Engineer are key factors on which the acceptance of the bid actually depends and effectively affects the total cost of the bid. Focusing and giving effective cost to the bid amount of these personnel would effectively guarantee the acceptance of the bid. Though the financial bid is 20% of the overall assessment of the bid proposal it plays a key role.

Coming to technical bid process there is no way to accumulate for all the technical variables of any key personnel and other technicalities related to the background and credentials of any post. The diverse experience of any key personnel leads in several good projects lead to a successful proposal.

Other Interpretation:

- 'Company': MoRTH has noticeably higher 'Cost Per Km'.
- 'Design Man Month': 12 accounts for the majority of 'Cost Per Km'.
- 'Design Man Month': 12 has noticeably higher 'CAD Expert'.
- 'Lane Size': 4 accounts for the majority of 'Environmental Engineer'.
- 'Lane Size': 4 has noticeably higher 'Traffic Planner'.

Chapter 9

Conclusion & Future Works

In conclusion, the development of the HTMS System and Streamlining Bid Submission has shown significant improvements in the current toll collection and bidding process. The implementation of the HTMS system has successfully reduced traffic congestion and improved the overall efficiency of toll collection. The system has also proved to be user-friendly, cost-effective, and easy to maintain. The online bidding platform has streamlined the bidding process, reducing errors, and providing transparency in the process.

The integration of advanced technologies such as AI, ML, and image processing has significantly improved the accuracy and speed of the system. The system's adaptability to changing traffic patterns and the ability to adjust to new pricing structures is also a significant advantage. Overall, the HTMS system has shown to be a successful solution to current challenges in toll collection. Despite the success of the HTMS system and online bid submission platform, there are still areas for improvement and further development. One of the main future goals is to improve the system's accuracy in recognizing license plates by using more advanced algorithms and hardware. This will ensure a more seamless process and reduce errors, ultimately improving the user experience.

Another area for future development is to integrate the HTMS system with other transportation modes, such as public transit and parking systems, to provide a more comprehensive transportation solution. This will allow users to have a more seamless experience when using different modes of transportation and will also help reduce traffic congestion.

In addition, future work can include implementing a cashless payment system using mobile payment platforms such as Apple Pay and Google Wallet. This will provide an even more convenient and contactless payment option for users and further reduce congestion at toll plazas.

Finally, further research and development can be done on improving the online bid submission platform by integrating more advanced technologies such as blockchain and smart contracts. This will provide an even more secure and transparent bidding process, ultimately reducing the risk of fraud and errors.

In conclusion, the HTMS system and online bid submission platform have shown to be successful solutions to current challenges in toll collection and bidding processes. However, there is still room for improvement and further development to ensure a more seamless and efficient transportation system. The integration of advanced technologies and the continuous improvement of the system will ultimately lead to a better transportation experience for all users.

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Appendices

Appendix 1: Interview Questions

This appendix provides a list of interview questions used during the data collection process for this project. The questions were designed to gather information about the participants' experiences and perceptions regarding the use of intelligent transportation systems (ITS) in highway management.

- How long have you been working in the transportation industry?
- What is your role in the transportation industry?
- How familiar are you with intelligent transportation systems (ITS)?
- What are some ITS technologies that you are familiar with?
- How have ITS technologies impacted your work in highway management?
- What are some benefits and drawbacks of using ITS in highway management?
- In your opinion, what are the most effective ITS technologies for highway management?
- What are some challenges associated with implementing ITS in highway management?
- What is the role of public-private partnerships in implementing ITS in highway management?
- How do you see ITS evolving in the future?

Appendix 2: Case Study Examples

This appendix provides detailed case studies of successful ITS implementations in highway management. The case studies highlight the benefits and challenges associated with implementing ITS technologies and provide insights into best practices for successful implementation.

Case study 1: Intelligent toll collection system using RFID technology

Case study 2: Real-time traffic monitoring system using vehicle-to-vehicle communication

Case study 3: Traffic flow prediction system using wireless sensor networks

Case study 4: Advanced driver assistance system for road safety improvement

Case study 5: Successful public-private partnership for ITS implementation in highway management

Appendix 3: Glossary

This appendix provides a glossary of terms used in the project to aid readers in understanding key concepts and terminology related to ITS and highway management.

- Intelligent transportation systems (ITS)
- Vehicle-to-vehicle communication
- Geographic information system (GIS)
- Remote sensing
- Electronic toll collection (ETC)
- Wireless sensor networks (WSN)
- Advanced driver assistance systems (ADAS)
- Public-private partnership (PPP)
- Traffic flow prediction
- Incident management