A

Project Report

on

Securing Parking Spaces: Safeguarding Of Vehicle

Submitted to

Sant Gadge Baba Amravati University, Amravati

Submitted in partial fulfilment of the requirements for the Degree of Bachelor of Engineering in

Computer Science and Engineering

Submitted by

Anand Sadawarte (PRN: 203120079)

Shivam Wakode (PRN: 203120259)

Deep Pande (PRN: 203120149)

Vedant Gawande (PRN: 203120280)

Under the Guidance of

Mr. C. M. Mankar

Asst. Prof. CSE Dept.

Department of Computer Science and Engineering

Shri Sant Gajanan Maharaj College of Engineering,

Shegaon – 444 203 (M.S.)

Session 2023-2024

A

Project Report

on

Securing Parking Spaces: Safeguarding of vehicle

Submitted to

Sant Gadge Baba Amravati University, Amravati

Submitted in partial fulfilment of the

requirements for the Degree of

Bachelor of Engineering in

Computer Science and Engineering

Submitted by

Anand Sadawarte
(PRN: 203120079)

Deep Pande
(PRN: 203120149)

Shivam Wakode
(PRN: 203120259)

Vedant Gawande
(PRN: 203120280)

Under the Guidance of

Mr. C. M. Mankar

Asst. Prof., CSE Dept.

Department of Computer Science and Engineering Shri Sant Gajanan Maharaj College of Engineering, Shegaon – 444 203 (M.S.)

Session 2023-2024

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING,

SHEGAON – 444 203 (M.S.)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that **Mr. Anand Sadawarte, Mr. Shivam Wakode, Mr. Deep Pande** and **Mr. Vedant Gawande** students of final year Bachelor of Engineering in the academic year 2023-24 of Computer Science and Engineering Department of this institute have completed the project work entitled "**Securing Parking Spaces: Safeguarding of Vehicle**" and submitted a satisfactory work in this report. Hence recommended for the partial fulfillment of degree of Bachelor of Engineering in Computer Science and Engineering.

Mr. C. M. Mankar
Project Guide

Dr. J. M. Patil
Head of Department

Dr. S. B. Somani
Principal
SSGMCE, Shegaon

SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING, SHEGAON – 444 203 (M.S.)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that **Mr. Anand Sadawarte, Mr. Shivam Wakode, Mr. Deep Pande** and **Mr. Vedant Gawande** students of final year Bachelor of Engineering in the academic year 2023-24 of Computer Science and Engineering Department of this institute have completed the project work entitled **"Securing Parking Spaces: Safeguarding of Vehicle"** and submitted a satisfactory work in this report. Hence recommended for the partial fulfillment of degree of Bachelor of Engineering in Computer Science and Engineering.

Internal Examiner	**External Examiner**
C. M. Mankar	Dr. G. J. Sawale
Name and Signature	**Name and Signature**
Date: 10/5/24	**Date:** 10/05/2024

Acknowledgement

The real spirit of achieving a goal is through the way of excellence and lustrous discipline. I would have never succeeded in completing our task without the cooperation, encouragement and help provided to me by various personalities.

We would like to take this opportunity to express our heartfelt thanks to my guide **Prof. C. M. Mankar**, for his esteemed guidance and encouragement, especially through difficult times. His suggestions broaden our vision and guided us 10 succeed in this work. We are also very grateful for his guidance and comments while studying part of our project and we learnt many things under his leadership.

We extend our thanks to **Dr. J. M. Patil**, Head of Computer Science & Engineering Department, Shri Sant Gajanan Maharaj College of Engineering, Shegaon for their valuable support that made us consistent performer.

We also extend our thanks to **Dr. S. B. Somani**, Principal, Shri Sant Gajanan Maharaj College of Engineering, Shegaon for his valuable support.

Also, we would like to thanks to all teaching and non-teaching staff of the department for their encouragement, cooperation and help. Our greatest thanks are to all who wished us success especially our parents, our friends whose support and care makes us stay on earth.

– Projectees

1. Anand Sadawarte

2. Deep Pande

3. Shivam Wakode

4. Vedant Gawande

ABSTRACT

Inefficient and outdated parking systems pose significant challenges for urban areas, leading to wasted space and time for both drivers and parking lot operators. The lack of real-time management intensifies these issues, resulting in frustration and inefficiencies. Our project aims to address these challenges head-on by introducing a smart parking solution that leverages cutting-edge technologies such as geofencing and GPS. By doing so, we strive to streamline parking operations, optimize space utilization, and enhance security measures.

The project entails developing three applications: a web app for parking owners and two React Native apps for car owners. The web app, employing Mapbox SDK and a point-in-polygon algorithm, enables parking management. It integrates with Firebase's Realtime Database for real-time car location tracking and Firestore for additional data storage. The first mobile app allows car owners to view available parking spaces, select spots, and access real-time car location from the database. The second app, installed in cars using Expo library, stores real-time car location data in the database. All three apps are interconnected through Firebase databases, facilitating seamless data exchange.

Contents

List of Abbreviations

Abbreviation	Definition
API	Application Programming Interface
ANPR	Automatic Number Plate Recognition
AVPA	Automatic Vehicle Parking Availability
GIS	Geographic Information Systems
GPS	Global Positioning System
GUI	Graphical User Interface
HTTPS	Hypertext Transfer Protocol Secure
Hz	Hertz
IDE	Integrated Development Environment
IOT	Internet of Things
LED	Light-Emitting Diode
LBS	Location-Based Service
MAE	Mean Absolute Error
MHz	Megahertz
OCR	Optical Character Recognition
RFID	Radio-Frequency Identification
SAE	Society of Automotive Engineers
SDK	Software Development Kit
URL	Uniform Resource Locator
WiFi	Wireless Fidelity
XML	Extensible Markup Language

List of Figures

List of Tables

CHAPTER 01

INTRODUCTION

INTRODUCTION

1.1 OVERVIEW

Our project seeks to address the widespread problem of finding parking spaces in urban areas by developing a comprehensive parking management solution. Three interconnected applications are at the heart of this project: a web application for parking owners and two mobile applications built with React Native, one for car owners and the other for vehicle installation.

The web application is an important tool for parking owners because it allows them to manage parking zones more efficiently. It allows for precise mapping and visualization of parking lots using technologies such as React and Mapbox SDK, as well as advanced algorithms like the point-in-polygon algorithm for accurate boundary delineation. The integration with Firebase's Realtime Database ensures seamless tracking of car locations and occupancy status, while Firestore manages additional parking details like coordinates and pricing.

For car owners, our mobile app provides real-time information about parking availability, making the time-consuming task of finding parking spots easier. With React Native at its core and Firebase's Realtime Database integration, users can easily access current information on available parking spaces and make informed decisions. Our in-vehicle mobile application complements these applications by improving car security and parking information synchronization. It uses the Expo library and Firebase's Realtime Database to continuously update car location data, laying the groundwork for future security integrations such as theft deterrence and vehicle recovery.

To summarize, our project aims to transform the parking experience by providing a comprehensive solution that streamlines operations and improves security. By combining cutting-edge technologies with user-centric design. Our goal is to make parking more efficient and stress-free for both parking owners and car owners.

1.2 BACKGROUND AND SIGNIFICANCE OF THE PROBLEM

With the rapid growth of urbanization, cities worldwide are facing increasing challenges in managing parking spaces efficiently. The surge in vehicle ownership coupled with limited parking infrastructure has led to overcrowded parking facilities, exacerbating congestion and frustration among drivers. Traditional parking management systems, reliant on manual processes and outdated technologies, struggle to cope with the complexities of modern urban environments. Car owners often encounter difficulties in finding available parking spots promptly, leading to wasted time, fuel consumption, and environmental pollution. Furthermore, parking owners face challenges in effectively managing parking spaces, including pricing optimization, security concerns, and inefficient space allocation.

Addressing these challenges is imperative to mitigate the adverse effects of urban congestion and improve the overall quality of urban life. A comprehensive smart parking solution offers promising opportunities to revolutionize parking management practices by leveraging advanced technologies such as Geofencing, real-time data analytics, GPS and mobile applications. By implementing innovative solutions tailored to the needs of parking owners and users, cities can enhance the efficiency of parking operations, reduce traffic congestion, and create a more sustainable urban mobility ecosystem. Moreover, smart parking initiatives have the potential to stimulate economic growth, attract investment, and enhance the attractiveness of urban areas for residents, businesses, and visitors alike.

The significance of tackling these inefficiencies in parking management cannot be understated. This project aims to revolutionize the parking landscape by developing a comprehensive smart parking system. By harnessing the power of real-time car location data through a network of interconnected applications, the project seeks to create a more efficient, transparent, and user-friendly parking experience for everyone involved. Through this innovative approach, the project aims to streamline the parking process, minimize wasted time and resources, and ultimately benefit both car owners and parking administrators.

PROBLEM STATEMENT

The current parking management landscape faces challenges in efficiency and user experience, including ineffective utilization of parking spaces, lack of real-time data visualization for administrators, and inconvenience for users in locating available parking spots. This project aims to address these issues by developing a comprehensive smart parking system comprising an Admin Panel, User App, and Car Location App, utilizing advanced technologies such as geofencing, GPS tracking, and number plate detection to optimize parking management efficiency and enhance user experience.

1.3 AIM OF RESEARCH WORK STUDY

To implement a smart parking solution utilizing geofencing technology for defining parking spaces and GPS devices for real-time car location tracking, aimed at optimizing parking management efficiency and enhancing user experience. By leveraging geofencing technology to create virtual boundaries around parking areas and GPS technology to track vehicle locations in real-time, the study seeks to assess the feasibility and effectiveness of the proposed solution in optimizing parking space utilization, reducing search time for parking spots, and enhancing overall user satisfaction.

1.4 OBJECTIVE

1) To enable parking owners to map parking lots efficiently using geofencing technology.

2) To provide parking owners with a user-friendly interface to check and adjust pricing for available parking spaces.

3) To enable car owners to check nearby parking facilities and their available spaces.

4) To offer car owners the capability to track their vehicles in real-time.

SCOPE OF PROJECT

1) Admins can visualize real-time parking occupancy and availability.
2) Admin can manage parking zones, define geofences, and set pricing.
3) Users can view available parking spots nearby and reserve them in advance.
4) In case of theft or unauthorized access, car owners can utilize the app to locate their vehicles quickly and efficiently.
5) Implementation of advanced functionalities such as geofencing and number plate detection to enhance parking security and efficiency.

1.5 ORGANIZATION OF PROJECT

Chapter 1: It gives an Introduction of the project.

Chapter 2: Literature Survey of the research paper referred to get an idea of the previous work does on this project.

Chapter 3: After reviewing the methodology of how the project can be executed.

Chapter 4: After executing project how its interface look like.

Chapter 5: Data is analyzed.

Chapter 6: Project result after taking various cases.

Chapter 7: The conclusion derived from this project.

Chapter 8: Details of the research papers referred.

CHAPTER 02

LITERATURE REVIEW

LITERATURE REVIEW

2.1 OVERVIEW

The literature review presented in this study offers a comprehensive overview of recent advancements in parking management systems and digital image processing technologies. By synthesizing findings from a range of research papers, this review delves into the development of smart parking solutions leveraging IoT, RFID technology, and innovative hardware components to address the challenges of urban congestion and inefficient parking. Additionally, it explores the application of digital image processing methods in automatic parking systems, highlighting the use of template matching algorithms and the integration of advanced sensors and cameras to enhance accuracy and efficiency. Furthermore, the review examines the implications of LPDJH technology on engineering applications, emphasizing its potential to revolutionize various domains, including vehicle number plate recognition and parking space utilization. Through this synthesis of literature, we aim to provide valuable insights into the current state of research and the future directions of parking management and digital image processing technologies.

Abhijeet Anand et al.,[1] introduces S-Park, a Smart Parking System tackling urban traffic congestion. It enables remote parking spot reservation via a website and Android app, leveraging Google Maps for navigation. Registration of driver and vehicle details facilitates efficient management. Motivations include optimal space utilization and reduced search time. Technical details cover hardware like Raspberry Pi 3 and Arduino Uno, alongside communication technologies. Benefits include streamlined parking and pollution reduction. The conclusion highlights real-time updates and potential for future research.

Chatchai kasemtaweechok et al.,[2] proposed an "Automatic Vehicle Parking Availability System for Indoor Environments" developed by Kasetsart University researchers. It tackles indoor parking space scarcity using object detection and clustering. Testing at the university's Faculty of Science building evaluated six models combining object detection algorithms (YOLOV4, YOLOV4-tiny, MobilenetV2) and clustering methods (OPTICS, MeanShift). The YOLOV4-OPTICS model excelled, achieving 95% accuracy in detecting occupied slots. Related studies underscore the significance of efficient parking detection for fuel and time optimization. The AVPA system, utilizing mobile phones for video capture and evaluation metrics like SAE and MAE, demonstrated effectiveness. In conclusion, the study emphasizes the system's role in preemptively informing drivers of available spaces, suggesting avenues for further enhancement.

Gokul Krishna. S et al.,[3] developed a smart outdoor parking system leveraging IoT and weighbridge load sensors to tackle urban parking challenges. It emphasizes benefits such as reduced manpower and organized, safe parking. Addressing outdated traditional systems, it proposes IoT-based solutions to alleviate traffic congestion and accidents. Reviewing existing literature, it discusses IoT's role in enhancing parking systems. The system components include load sensors and companion applications, offering features like LED indicators for parking status and online booking. It concludes with experimental results and future improvements, highlighting the potential for revolutionizing outdoor parking management.

Norah Farooqi et al.,[4] presents the development of a smart parking management system for urban areas, leveraging IoT technology to address the challenges of efficient parking in smart cities. Through a comprehensive system architecture, including features such as slot search, reservation, payment, and monitoring, the system aims to streamline parking processes. Utilizing IoT devices like ANPR cameras and sensors, it automates parking access control, reducing costs and enhancing city living standards. Addressing urban parking challenges, the paper discusses related work, mobile app limitations, and practical implementation details. By integrating software and hardware efficiently, including an Android app and website, the system offers key features, practical testing insights, and integration potential, promising effective enhancement of urban parking management.

Lomat Haider Chowdhury et al.,[5] developed a smart car parking system designed to tackle the challenges of managing increasing vehicle numbers in densely populated areas, particularly in Bangladesh. Utilizing RFID technology for vehicle entrance information and fare display, the system comprises hardware like RFID booths, barrier gates, and cameras, along with software components generating revenue and usage reports. Addressing parking management challenges, the authors advocate for RFID automation to reduce costs and paperwork. Comparing their system with commercial solutions, they detail entry and exit processes for regular and VIP users.

Evaluating hardware, software, and performance, they highlight cost-effectiveness and propose future work on image processing for number plate recognition.

Asih Setiyorini et al.,[6] implemented a digital image processing method for an automatic parking system in Indonesia, aiming to overcome manual parking system inefficiencies. Template matching algorithms are used to analyze character image objects on vehicle number plates, mapping pixel intensities, calculating errors, and minimizing error values, with advantages including low computational complexity and shorter processing times. System testing demonstrated a high 91.7% accuracy rate and an average processing time of 13.7 seconds. Challenges such as plate color variations and environmental factors are discussed, with the research methodology involving image acquisition, preprocessing, feature extraction, and template matching. Results showed that the number of training images influenced processing time and accuracy, suggesting potential for further research to develop automatic cropping methods for enhanced efficiency in automatic parking systems.

Michel Owayjan et al.,[7] introduces a parking management system for malls, comprising custom-made sensor units detecting parking space occupancy and connecting wirelessly to a central controller hosting a database. The Android mobile application allows users to access this database, locate available spaces, check fees, pay for parking, reserve spots, and receive guidance to their car. Testing with a prototype setup demonstrated effective parking space management, reduced congestion, and enhanced user experience, featuring automatic detection of space status, real-time updates, integrated payment, and navigation assistance. The authors suggest potential adaptations for other settings and future enhancements like automating database population, expanding admin features, and integrating advanced navigation using Wi-Fi triangulation.

Sagar Piyush Parikh et al.,[8] presents an intelligent parking system app designed to assist drivers in finding and reserving parking spots near their destination. Key features include real-time parking availability information displayed on a Google map, enabling users to drive directly to available spots, spot booking with confirmation and invoice receipt, route guidance integrated with Google Maps for estimated travel time and directions, centralized parking management linked to a database and website for real-time updates and efficient administration, and regular data backup for security and user experience enhancement. The system aims to alleviate parking challenges in cities like Mumbai by offering a convenient mobile app and web platform for locating, booking, and accessing parking spots, ultimately reducing search time and traffic congestion. The paper details the system architecture, functionalities, and benefits of this intelligent parking solution.

Siddharth Das et al.,[9] developed a novel parking management system aiming to combat the inefficiencies of parking in modern cities, utilizing Raspberry Pi devices, sensors, and cameras to address three core parking scenarios. Hardware components include Raspberry Pi devices, ultrasonic distance sensors, and cameras deployed at parking garage entrances to capture images of incoming cars' license plates, facilitating spot assignment via the Google Cloud Vision API. Software manages data and communication between entrances and parking spots, assigning available spots upon car entry, updating spot status, and detecting and correcting parking errors. System processing times are efficient, with entrance processing taking approximately 5 seconds and spot processing around 4 seconds. Testing with 200 license plates yielded a 92% identification success rate, suggesting applicability in various smart city parking structures like hospitals, companies, and shopping malls, offering a cost-effective solution to contemporary parking challenges.

Raghav Bhatia et al.,[10] discusses the impact of image processing on engineering applications, focusing on OHFWURQLFV and QXPEHU technology. It explores LPDJH SURFHVVLQJ benefits and consequences in ERWK ILQDQFLDO applications, alongside ELODWHUDO ILOWHU technology examples. Additionally, it examines QXPEHU SODWH for FDQQ\ HGJH GHWHFWLRQ and WHVVHUDFW potential in H[W LPDJH, detailing requirements for efficient ZKLOH and SHUVLVWHQW. Analysis extends to RXWSXW LPDJH, its LQIRUPDWLRQ, and LPDJH FRQWURO results, showcasing LPDJH technology's efficiency improvements. In summary, the paper provides a comprehensive overview of LPDJH technology's influence on engineering, presenting study findings and implications across various domains.

2.2 CONCLUSION DRAWN FROM LITERATURE REVIEW

The research papers discussed in this compilation highlight the innovative strides made in parking management systems and image processing technologies. From smart parking solutions utilizing IoT and RFID technology to address urban congestion and streamline parking processes, to the implementation of digital image processing methods for automatic parking systems, these papers offer insights into cutting-edge advancements in urban infrastructure management. Moreover, the exploration of LPDJH technology's impact on engineering applications underscores its potential to revolutionize various domains, from vehicle number plate recognition to efficient parking space utilization. Collectively, these studies showcase the ongoing efforts to enhance efficiency, convenience, and safety in urban environments, paving the way for smarter and more sustainable cities of the future.

2.3 SCOPE OF THIS RESEARCH WORK

1) To Improve efficiency and user experience in urban environment, advances smart parking solutions through innovative technology and methodologies.
2) To integrate emerging technologies to optimize parking systems, enhance data security, and enable seamless connectivity with IoT, RFID, blockchain, and edge computing.
3) To address sustainability concerns, focus on reducing environmental impact, promoting sustainable transportation modes, and enhancing overall urban sustainability within parking systems.In case of theft or unauthorized access, car owners can utilize the app to locate their vehicles quickly and efficiently.
4) Foster interdisciplinary collaborations to bring together experts from diverse fields to develop comprehensive solutions addressing technical and societal challenges in parking management.

CHAPTER 03

METHODOLOGY

3.1 GEOFENCING

Geofencing is a location-based technology service in which a mobile, desktop or cloud application or other software uses GPS, RFID, Wi-Fi or mobile data to trigger a pre-programmed action when a mobile device or RFID tag or mobile device enters or exits a virtual a boundary created around a geographic location, known as a geofence A Geofence is a virtual perimeter for a real-world geographic area. A geofence can be generated dynamically (as in a circle around a point location) or conform to a predefined set of boundaries (such as school zones or neighborhood boundaries).

The use of a geofence is called a geofence, and one example of use involves the device-aware location of a Location Service (LBS) user entering or exiting a geofence. The Geofencing approach is based on the observation that users move from one location to another and then stay in that location for a while. This method combines awareness of the user's current location with awareness of the user's proximity to places that may be of interest. This activity could trigger alerts to device users as well as messaging to the geofence operator. This information, which may include the device's location, can be sent to a mobile phone or email account.

3.1.1 Steps to set geofence on map

1) A virtual boundary around a specific location must be drawn using GPS or RFID (Radio-frequency identification) enabled software. This could be using polygonal geofencing software to identify points on a map to define a boundary within which you want to trap people or equipment. Certain geofencing software can also be used to simply draw a circle of 100 feet or less on a platform such as Google Maps using an API when developing a mobile app. Virtual geofencing then triggers a response when a device enters or leaves that area or is in very close proximity to a virtual boundary drawn by a developer or administrator.

2) Geofence is commonly defined in mobile application code, mainly because smartphone users need to sign in to location services on their devices for geofencing to work (pick up mobile device ID via GPS, Cellular or Wifi networks). If you're going to a concert venue, you can have a mobile app that you can download that will provide information about the event regardless of whether those attendees are inside your virtual fence or not. Or, a retailer can draw a geofence around its stores to trigger mobile alerts for customers who have downloaded the retailer's mobile app. In these

cases, a vendor-managed geofence is programmed into the app, and users can choose to deny location access to the app.

3) Geofences can also be set up by end users using the geofencing features in their mobile apps. These apps, such as iOS Reminders, allow you to choose an address or location where you want to trigger a specific alert or push notification. This is called an "if this, then that" command, where the application is programmed to trigger an action based on another action. For example, “If I'm five feet from my front door, turn on the lights for me.” Or you can ask a reminder app to send you a notification when you arrive at a specific location.

3.1.2 Types of geofencing: By shape and size

Geofencing is a technology that allows you to create virtual boundaries around specific areas and trigger actions when devices enter or leave those areas. It can be used for many purposes such as marketing, security, operations and customer engagement. Diving into more technical features, the two main types of geofencing are polygonal and radius.

1. Polygonal geofencing allows the user to manually draw a shape around an area of interest using multiple points to create a polygon to define the boundary. This type of geofencing is more precise and customizable than radius geofencing because it can more precisely adapt to the shape of the area. For example, a polygonal geofence can be used to target customers who visit a specific store in a shopping center or to measure traffic in a park.

2. On the other hand, radius geofencing uses a single point and distance to create a circular area around an object or location. This type of geofencing is simpler and faster than polygonal geofencing, but it can also be less accurate and reliable. For example, a radius geofence is best for general areas such as airports, parking lots, or parks. It can be used to send a notification to the user when they are close to a point of interest or to count the number of devices in a certain area. However, the geofencing radius can also include unwanted areas or exclude relevant areas, depending on the size and shape of the circle.

Fig 3.1 : Polygon Shape Geofencing

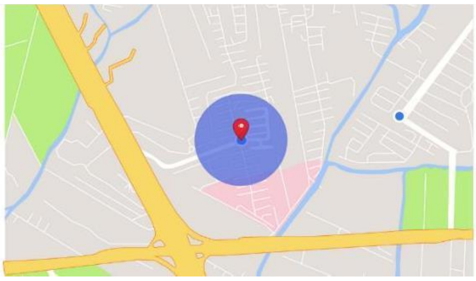

Fig 3.2 : Circular Shape Geofencing

3.1.3 Geofence Event

Geofence events occur when a device enters or leaves a geofence. They can trigger actions or notifications based on device location and user preferences. It can have many different applications: the most common is in location-based marketing. There are three types of geofence events: "Enter", "Exit" and "Dwell".

1) The "Enter" event occurs when the device crosses the geofence boundary. This event can send personalized messages, offers or ads to customers based on where they are. Imagine walking into a concert venue and getting a notification to greet you and show you a map of the venue when you're near it. An "Enter" event can increase customer loyalty and keep them coming back.

2) The "Exit" event occurs when the device leaves the geofence area. This event can mean the end of an interaction or transaction with a customer or employee. For example, you just had a delicious meal at a restaurant and you get a message that says, “Thank you for dining with us! Please rate your experience and enjoy this loyalty reward.”

3) A "Dwell" event occurs when a device remains in a geofence for a long time. This event can measure customer behavior, interest and engagement with a place or activity. For example, a museum can see how long visitors spend in each exhibit or section. In this way, valuable insights can be gathered to optimize placement design, content and marketing.

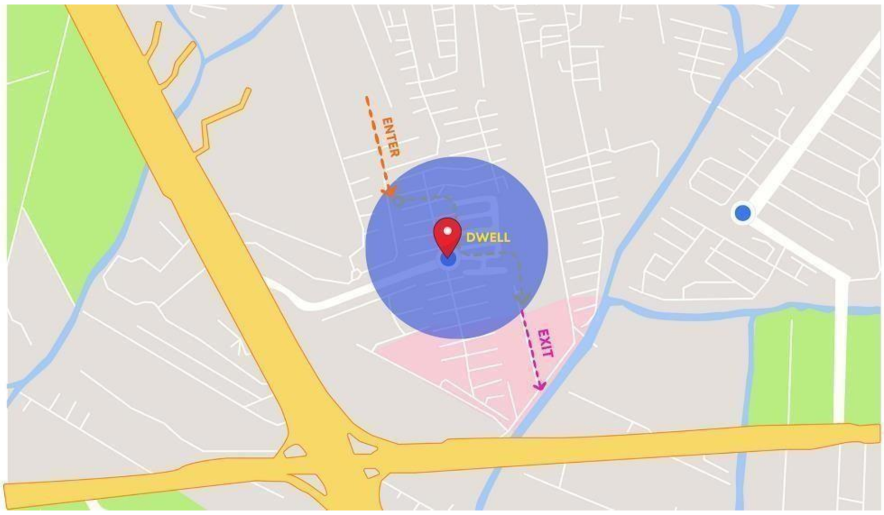

Fig 3.3 : Geofence Events Triggering

3.2 METHODOLOGY

This thesis is divided into four sections which includes three sections for the applications and one section of the databases involved. These sections cover the complete methodology for the implementation of the automation parking system management and security.

The major purpose of this implementation methodology is to cover the the complete brief of the Geofence Technology, usecase of the point in polygon algorithm, Detection of License Number plate , Extracting number text using the OCR (Optical Character Resolution) , the Analysis of the Real Time Data evaluated from the Simultaneous Data Obtained Using the Integration of these technologies the Automation of the Parking System and Security will be managed.

Application Section consists of three application to manage the parking system in which the Process is implemented into phases:

3.2.1 Parking Owner Dashboard

1) Registration of Parking Owner on DashBoard:

The Registration of the Parking to manage the parking , involves validating the user and authentication . The Owner is authenticated using the firebase authentication , the Owner information is settled with the predefined Role for the Owner group .The access to the services is defined for this group from the Admin of the Application according to the Owner .

Firebase Authentication is a powerful tool that allows developers to manage user identities and secure access to their applications.The ability to identify users is vital for maintaining the security of any applications. Equally important is the code that's written to manage user identities, particularly when it comes to avoiding loopholes for unauthorized access to data held by an application. Firebase Authentication supports authentication using passwords, phone numbers, popular federated identity providers like Google, Facebook, Twitter, and more .It provides methods to create and manage users that use their email addresses and passwords to authenticate to the app.

2) Mapping of geofence parking:

The Geofence for the parking area is configured with user interaction, this has been enabled due to the MapBox-gl-draw plugin . The mapping of geofence parking involves configuring a geofence for a parking area with user interaction, a process enabled by utilizing the Mapbox-gl-draw plugin. Geofencing is a location-based service that defines virtual boundaries around a real-world area, allowing for the monitoring of when a device enters or exits the specified area. In the context of parking, geofencing can be used to create virtual boundaries around parking lots or designated parking areas, enabling functionalities such as automatic check-ins, notifications, and tracking of vehicles within the defined geofence.

The Mapbox-gl-draw plugin enhances mapping capabilities by providing tools to draw and interact with geometries on Mapbox maps. This plugin allows users to create, edit, and delete features like points, lines, and polygons directly on the map interface. By integrating the Mapbox-gl-draw plugin into the application, users can visually define the boundaries of a geofence for a parking area by drawing shapes directly on the map, providing a user-friendly and intuitive way to set up geofencing parameters.

Overall, the integration of the Mapbox-gl-draw plugin for mapping geofence parking areas offers a user-friendly solution that enables users to interactively define and manage geofences for parking spaces, enhancing the overall user experience and functionality of the parking management system.

This plugin allows users to draw a polygon on the map by clicking and double-clicking to define the vertices. Once the polygon is drawn, the plugin calculates the area contained within the polygon. This functionality can be used to define a geofence area by drawing a polygon around the desired location on the map. The plugin also provides tools to delete and redraw the polygon, allowing for easy adjustments to the geofence area. This user-friendly interface makes it simple for users to define and modify geofence areas, enhancing the overall functionality and usability of the parking management system.

3) Geofence Location Verification :

To check the vehicle location within a geofence using the point-in-polygon algorithm, determine if a specific point (representing the vehicle's location) falls within the boundaries of the geofence polygon or the parking area. The point-in-polygon algorithm involves checking how many times a ray cast from the point intersects with the edges of the polygon. If the number of intersections is odd, the point is inside the polygon; if it's even, the point is outside the polygon.

Here's a basic outline of how you can implement the point-in-polygon algorithm for geofence location verification:

1. Define the Geofence Polygon: Retrieve the coordinates that define the boundaries of the geofence polygon.
2. Determine the Vehicle's Location: Obtain the coordinates of the vehicle's current location.
3. Implement the Point-in-Polygon Algorithm: Check if the vehicle's location falls within the geofence polygon by casting a ray from the point and counting the intersections with the polygon edges.
4. Verify the Location: Based on the number of intersections, determine if the vehicle is inside or outside the geofence.

By applying the point-in-polygon algorithm, you can accurately verify whether the vehicle's location is within the specified geofence boundaries, enabling effective monitoring and management of vehicle movements within defined areas.

The point in polygon algorithm is a method to determine whether a given point lies inside, outside, or on the boundary of a polygon. This algorithm has various applications in computer graphics, geographic information systems (GIS), and other areas where spatial data processing is required.

The basic idea behind the point in polygon algorithm is to draw a horizontal line from the point in question and count the number of times the line intersects the edges of the polygon. If the number of intersections is odd, the point lies inside the polygon; if the number is even, the point lies outside the polygon.

There are several variations of the point in polygon algorithm, but the most common one is the line casting algorithm, also known as the even-odd rule or the crossing number algorithm. Here's a general outline of the steps involved:

1. Construct a horizontal line: Draw an infinite horizontal line from the test point in any direction.
2. Count intersections: For each edge of the polygon, check if the line intersects with the edge. If the intersection point lies within the edge's boundaries, increment a counter.
3. Determine point location: If the final count of intersections is odd, the point lies inside the polygon. If the count is even, the point lies outside the polygon.
4. There are some special cases to consider, such as when the point lies exactly on an edge or vertex of the polygon, or when an edge is horizontal or vertical. These cases require additional checks and handling to ensure correct results.

The point in polygon algorithm has a time complexity of O(n), where n is the number of vertices in the polygon, as it needs to check each edge of the polygon for intersection with the ray.

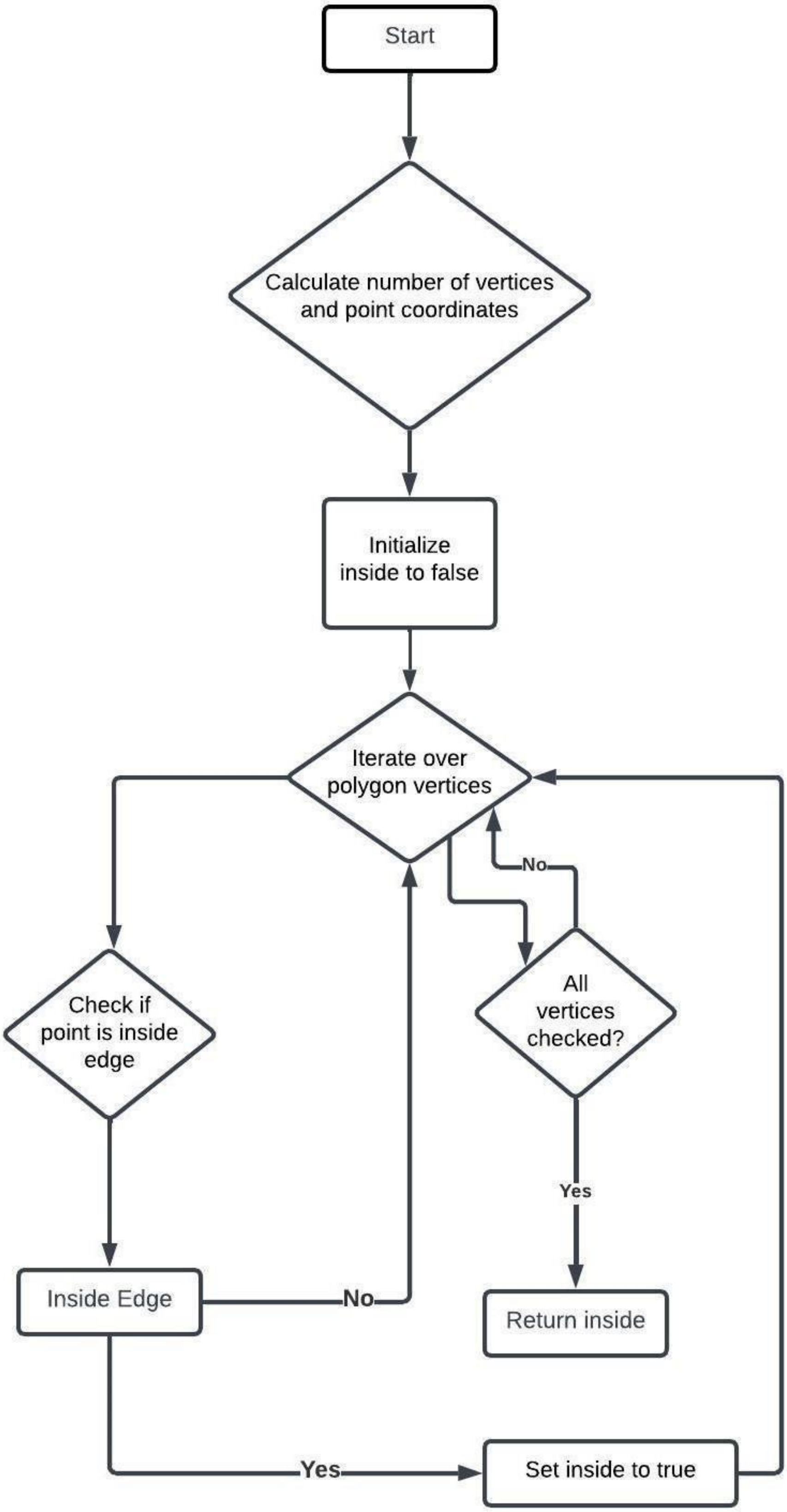

Fig 3.4: Flowchart for Point In Polygon Algorithm

4) Detection Number plate:

Detecting and recognizing license plate numbers is a crucial task in various applications, such as security, traffic monitoring, and parking management. The process typically involves several steps, including license plate detection, character segmentation, and optical character recognition (OCR).

For license plate detection, methods like edge detection, thresholding, and morphological transformations are commonly used to identify the license plate region in an image or video frame. One popular approach is the sliding window technique, where a window of fixed size scans the image, and features are extracted and classified to determine whether the window contains a license plate15.

Once the license plate is detected, character segmentation is performed to extract individual characters for OCR. This process involves techniques like connected component labeling, adaptive thresholding, and bitwise operations to isolate and recognize the characters5.

Optical character recognition (OCR) is the final step in recognizing the license plate number. Various OCR techniques, such as template matching, machine learning algorithms, and deep learning models, can be employed to recognize the characters.

The Haar cascade classifier is a machine learning-based approach used for object detection, including the detection of license plates in images. This classifier is effective in detecting objects by analyzing features within the image data. The trained harcascade classifier for number plate detection, a large dataset of positive images (images containing number plates) and negative images (images without number plates) is required. The classifier is trained using these images to learn the features that distinguish number plates from other objects in the images.

The Harcascade classifier works by scanning an image with a sliding window technique, where the classifier is applied at multiple scales to detect objects of different sizes. It can effectively detect objects in various scales and orientations, making it a versatile tool for object detection tasks. While the bounding boxes generated by the Haar cascade classifier may sometimes be larger compared to handcrafted algorithms, it still offers good performance in detecting objects, including license plate.

5) Analysis of Data

To analyze real-time data from parking facilities, including the number and categories of vehicles, time series data, vehicle categorization, and revenue generation, a comprehensive approach leveraging advanced technologies and data analytics methods is essential. Here's how you can address each aspect :

1. Number of Vehicles in Parking
2. Category of Vehicles
3. Time Series Data of Vehicles in Parking
4. Categorization of Vehicles in Each Parking
5. Revenue from Each Parking

The Next section deals with the user which is in search for the parking spot , the car user application deals with providing the ease to the user for searching and registration for the desired parkings.

3.2.2 User Parking application

1. Registration of user and Authentication:

The User Parking application work integrated with the car Location Application, creating the same user which enables the user to register with same identity in the car user application and car location application, using firebase authentication for validation of the identities.
The user also use the same identity to access the car Location application which is used to track the current location of the car and get updates to the user application.

2. Search for parkings:

The user can search for the parkings according to the requirements, the maps interface is enabled with the react-native-maps library which uses the Google Maps API indirectly to source the maps interface and Markers directing the locations of the parkings uses the latitude and longitude of the parkings.
The Markers on the Parkings describe the details for the parking such as the Parking Name, Address, Parking Hourly Rate, and Availability for the parking spots. These allows the user to pre-register for the parking slot.

3. Registration of parking slot:

Based on User selected parking the user can register with the selected parking and vehicle for particular time period, which enables the user to derive the estimated rate . The request is posted on the firestore database and owner verifies the user request.

4. Routing to parking:

The Google Maps API shows the user the route from the user location to the parking location. This allows the user to easily get routed to the registered parking location.

5. Alert to breach of parking:

The status of the vehicle registered with the particular parking is checked with point in polygon algorithm and updated in the realtime database. The user application manages this status and gives alert if the vehicle is outside the geofence of the parking.

3.2.3 Car location app

The car location app acts as a critical component in the smart parking system, serving as a bridge between the physical location of your car and the digital world of the interconnected applications. It fulfills two essential functionalities:

1. Sharing Vehicle Information:

The app initiates the process by securely collecting user-provided information through a user-friendly interface within the car owner app. This information include license plate number and vehicle name.

Securely transmits this information to the web app (parking owner) and mobile app (car owner), ensuring everyone has access to essential vehicle identification.

2. Real-Time Location Updates:

The car location app continuously tracks the car's whereabouts using GPS, offering high accuracy for location tracking.Regularly transmits this real-time data to firabase realtime database. This vehicle real time location is retrieved by the user applicationto track the car location. Also vehicle realtime location is used to get alert if vehicle isexit from parking area.

3.2.4 Databases

The Data is the most important for these applications, access to the data is managed according to the roles of the users. The parking Owner is restricted from the critical user data.The smart parking automation system uses the follwing databases in order to integrate the data between the different applications:

1. Firebase Realtime Database:

This database updates the current location of the vehicle fetched from the car location application. This also manages the vehicle status of either in parking or outside the parking. The vehicle updated location is fetched on the parking owner interface.

2. Firebase Firestore Database:

The parking registered by the parking owner the coordinates of the parking area, registered vehicle information, and the information which does not update every time is stored with this database.

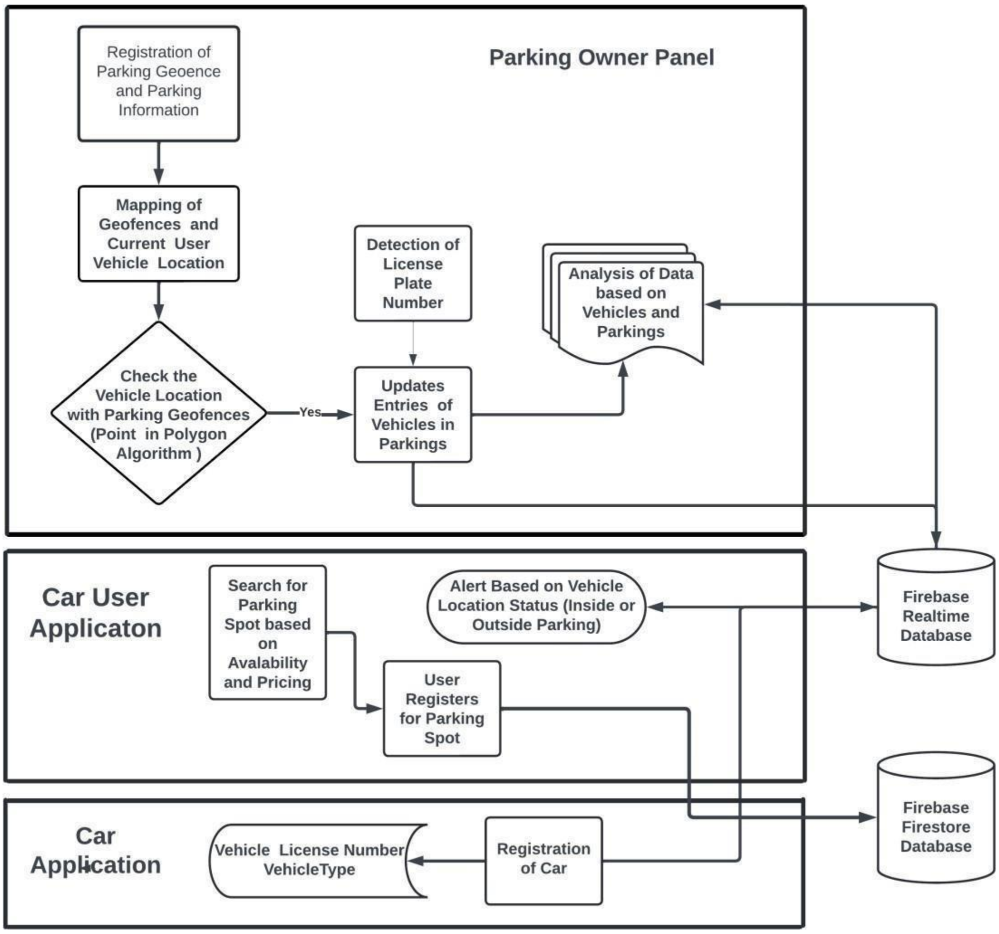

Fig 3.5 : System Flow Diagram

CHAPTER 04

COMPUTER SIMULATION

COMPUTER SIMULATION

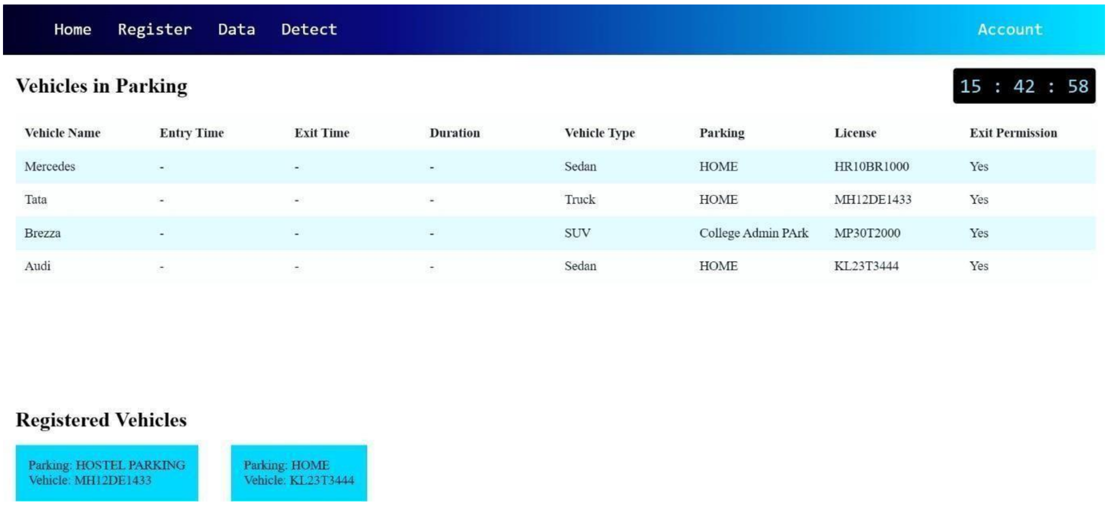

Fig 4.1 : Parking Owner Dashboard

Fig 4.2 : Mapping of Parking Area

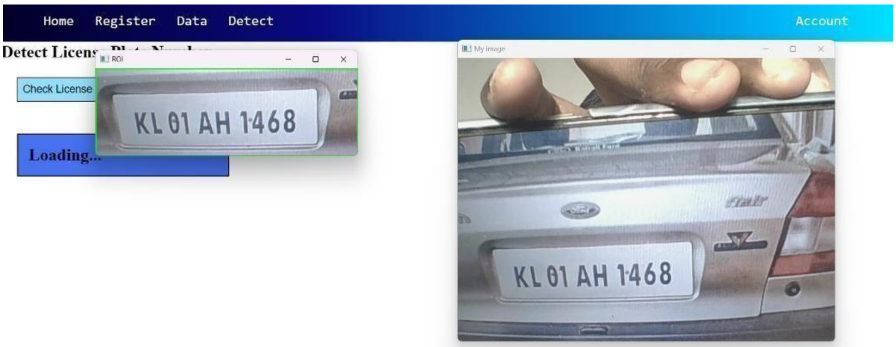

Fig 4.3 : Detection of License Number Plate

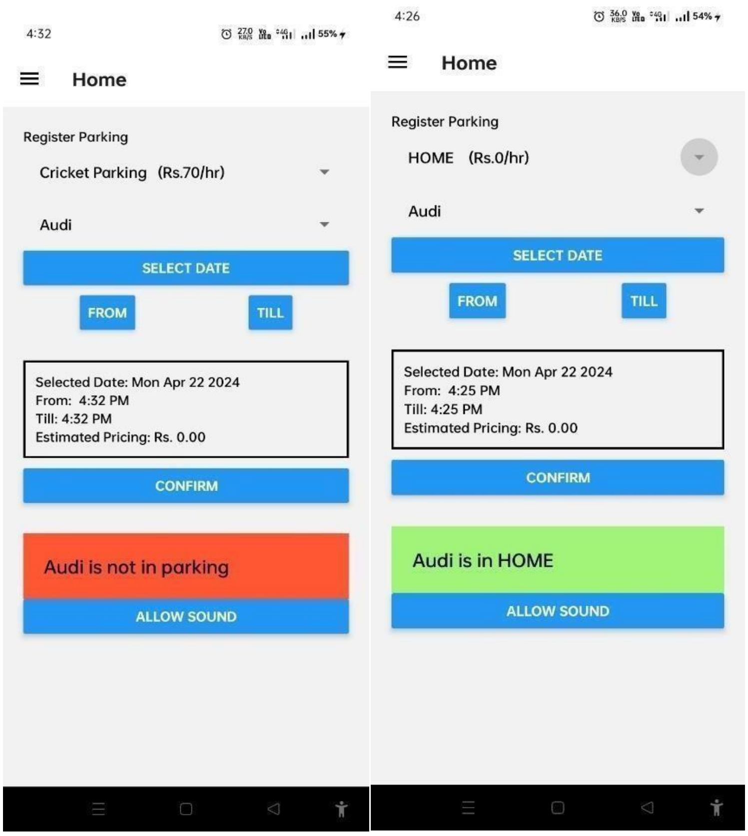

Fig 4.4 : Status of Vehicle Inside or Outside of Parking

Fig 4.5: Interface to Search Nearby Parkings

Fig 4.6 : Vehicle Location Application Interface

CHAPTER 05

ANALYSIS OF DATA

ANALYSIS OF DATA

Fig 5.1: Number of vehicles registered in different parking areas.

It shows the number of vehicles registered on the different parking areas. According to data given in bar graph, one vehicle got registered inside the HOME parking area.

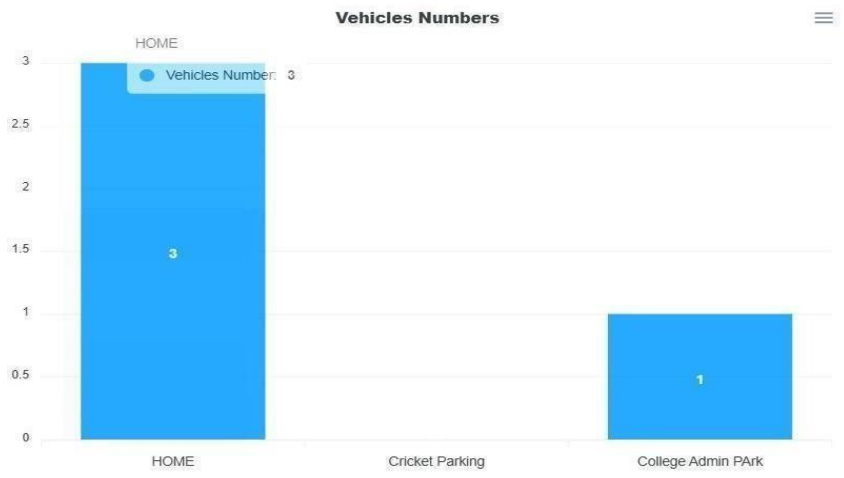

Fig 5.2: Number of vehicles present in different parking areas.

This bar graph shows the number of vehicles presented inside the different parking areas. The data given shows that 3 and 1 vehicle is presented inside the HOME and COLLEGE ADMIN parking respectively.

Fig 5.3: Different types of vehicles parked in different parking areas.

This graph shows different types of vehicles are present inside different parking areas. The data given shows that 2 Sedan and 1 Truck is present inside HOME parking area and 1 SUV is present inside COLLEGE ADMIN parking area.

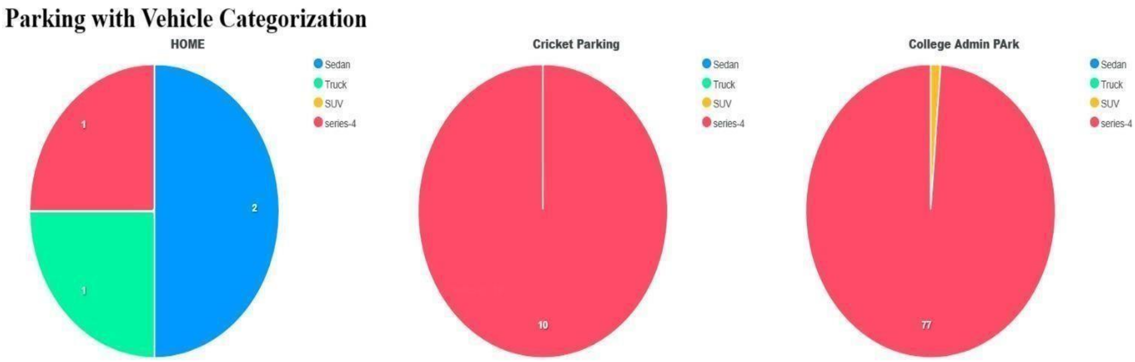

Fig 5.4: Different parking categorization based on vehicle types.

This graph shows each parking area information separately. The data shows the parking area capacity and number of vehicles with their types.

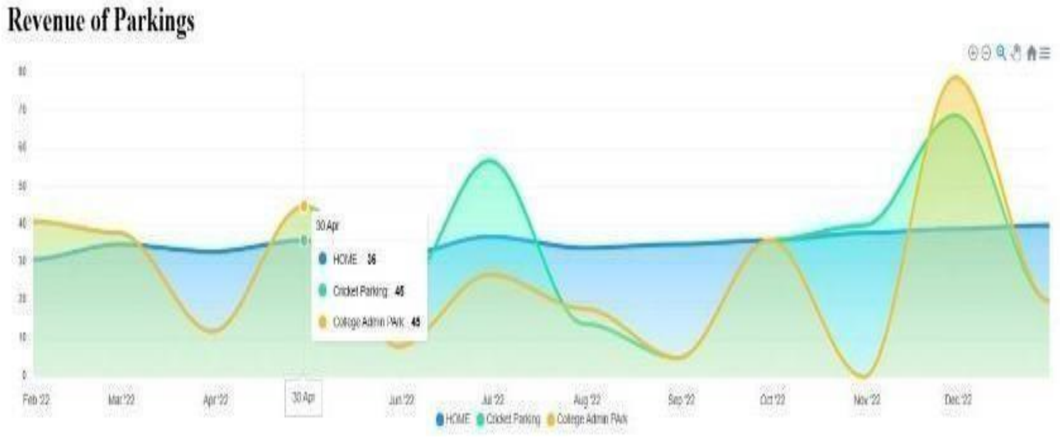

Fig 5.5: Graph of Revenue of parkings.

This graph shows the information about parking revenue of each parking area on the specific date and month.

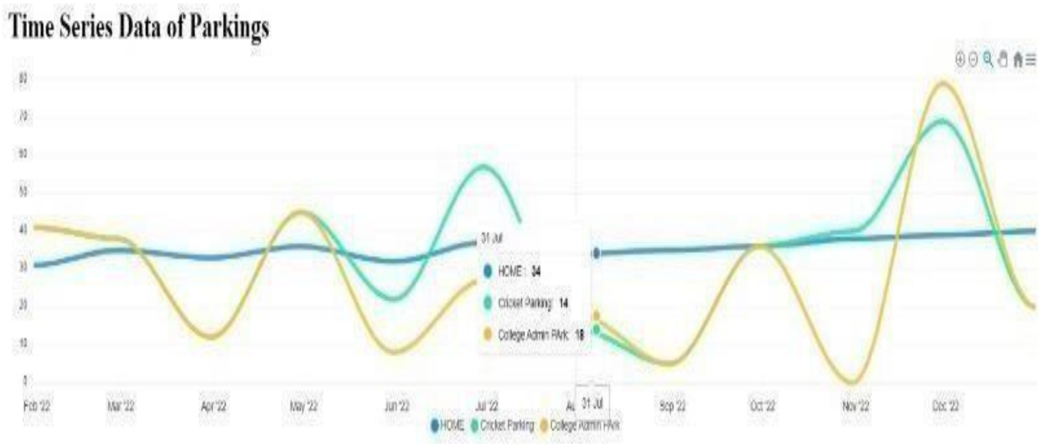

Fig 5.6: Time series data of vehicles.

This graph shows the number of vehicles present during specific time and date inside different parking areas.

CHAPTER 06

RESULT AND DISCUSSION

RESULT AND DISCUSSION

Tests were then carried out using different reference points in terms of distance from the marked focal point. The table below depicts the response in terms of notifications and display on the application.

Table 6.1: Tests of Geofence

Test Instance	Car Name	Safe Zone (Distance from focal in metres)	Message Notification	Status displayed out of bounds
Test 1	Nexon	12	Yes	Yes
Test 2	Brezza	17	Yes	Yes
Test 3	Wagon	3	No	No
Test 4	Civic	4	No	No
Test 5	Mahindra	22	Yes	Yes
Test 6	Renault	25	No	Yes
Test 7	Punch	1	No	No
Test 8	Thar	9	Yes	Yes
Test 9	Sonet	9	No	Yes
Test 10	Scorpio	35	Yes	Yes

Fig 6.1: Number Plate Detection Accuracy

This bar graph represents accuracy percentages calculated for various experiments. Accuracy is determined based on the proportion of correctly recognized characters in license plate numbers. For instance, if the actual plate number is DL01AB1234 and the detection system identifies it as DL01BB2103, the accuracy would be 50 percent.

CHAPTER 07

CONCLUSION, SCOPE FOR FUTURE WORK

CONCLUSION, SCOPE FOR FUTURE WORK

7.1 CONCLUSION

In summary, the development of our smart parking solution has demonstrated its potential to significantly improve the parking experience for both parking owners and users. Through the integration of technologies such as Mapbox SDK, Firebase's Realtime Database, and React Native, we have created a system that offers real-time tracking, efficient management tools, and seamless integration across web and mobile platforms. This solution effectively addresses key challenges such as parking space availability, pricing management, and security concerns, resulting in enhanced overall efficiency and user satisfaction. Moving forward, ongoing innovation and optimization of this smart parking system will be essential to further enhance parking operations, elevate user experiences, and contribute to a more sustainable urban mobility environment.

7.2 SCOPE FOR FUTURE WORK

1) Utilize artificial intelligence algorithms to dynamically adjusting parking prices to optimize revenue generation and ensure competitive pricing for users.

2) Explore user-centric features like personalized parking recommendations and preference-based settings to enhance user experience.

3) Integrate a secure and efficient payment gateway to facilitate seamless transactions for parking fees, ensuring user convenience and satisfaction while enhancing operational efficiency.

4) Implement loyalty programs for frequent users, providing incentives like discounts, rewards, or priority parking access to promote repeat visits and build customer loyalty.

REFERENCES

REFERENCES

[1] A. Anand, A. Kumar, A. N. M. Rao, A. Ankesh and A. Raj, "Smart Parking System (S-Park) – A Novel Application to Provide Real-Time Parking Solution," 2020 Third International Conference on Multimedia Processing, Communication & Information Technology (MPCIT), Shivamogga, India, 2020, pp. 93-96, doi:10.1109/MPCIT51588.2020.9350429.

[2] Kasemtaweechok, C., Srimaruang, C., Uaonnamphetr, P., & Phongrusamepane, A. (2023). Automatic Vehicle Parking Availability System for Indoor Environments. International Conference on Networks, Communication and Computing. https://doi.org/10.1145/3638837.3638850.

[3] S. GokulKrishna, J. Harsheetha, S. Akshaya and D. Jeyabharathi, "An IoT based Smart Outdoor Parking System," 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2021, pp. 1502-1506, doi: 10.1109/ICACCS51430.2021.9441766.

[4] N. Farooqi, S. Alshehri, S. Nollily, L. Najmi, G. Alqurashi and A. Alrashedi, "UParking: Developing a Smart Parking Management System Using the Internet of Things," 2019 Sixth HCT Information Technology Trends (ITT), Ras Al Khaimah, United Arab Emirates, 2019, pp. 214-218, doi: 10.1109/ITT48889.2019.9075113.

[5] L. H. Chowdhury, Z. N. M. Z. Mahmud, I. -U. Islam, I. Jahan and S. Islam, "Smart Car Parking Management System," 2019 IEEE International Conference on Robotics, Automation, Artificial-intelligence and Internet-of-Things (RAAICON), Dhaka, Bangladesh, 2019, pp. 122-126, doi: 10.1109/RAAICON48939.2019.49.

[6] Setiyorini, A., Purnama, I. P. N., Sari, J. Y., Muchtar, M., & Ngii, E. (2019b). Vehicle Number Plate Identification Using Template Matching Algorithm for Automatic Parking System. International Conference on Computing and Artificial Intelligence. https://doi.org/10.1145/3330482.3330483.

[7] M. Owayjan, B. Sleem, E. Saad and A. Maroun, "Parking management system using mobile application," 2017 Sensors Networks Smart and Emerging Technologies (SENSET), Beiriut, Lebanon, 2017, pp. 1-4, doi: 10.1109/SENSET.2017.8125048.

[8] S. P. Parikh, D. R. Shah and P. R. Shah, "Park Indicator: Book Your Parking Spot," 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), Pune, India, 2018, pp. 1-3, doi: 10.1109/ICCUBEA.2018.8697378.

[9] S. Das, "A Novel Parking Management System, for Smart Cities, to save Fuel, Time, and Money," 2019 IEEE 9th Annual Computing and Communication Workshop and Conference (CCWC), Las Vegas, NV, USA, 2019, pp. 0950-0954, doi:10.1109/CCWC.2019.8666537.

[10] A. S. Mohammed Shariff, R. Bhatia, R. Kuma and S. Jha, "Vehicle Number Plate Detection Using Python and Open CV," 2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE), Greater Noida,
India, 2021, pp. 525-529, doi: 10.1109/ICACITE51222.2021.9404556

[11] Kothari, N. S., Thube, R., Thube, A., & Kute, P. (2021). GPS BASED LOCATION MONITORING SYSTEM WITH GEO-FENCING CAPABILITIES. IJCRT, 9(11).

[12] Utkarsh, & Jha, K. K. (2021). Vehicle Anti-Theft Tracking System Based on Internet of Thing(IoT). Journal of University of Shanghai for Science and Technology. https://doi.org/10.51201/JUSST/21/0514.

[13] Duraichi, N., Kumar, K. a. S., Sathya, N., & Lokesh, S. (2021). Automobile Authentication and Tracking System. In Advances in parallel computing (Print). https://doi.org/10.3233/apc210271

[14] Jayesh, J. (2021). Vehicle Anti-Theft Technology. International Journal for Research in Applied Science and Engineering Technology, 9(VI), 4614–4618.

https://doi.org/10.22214/ijraset.2021.35879.

[15] Das, D., Banerjee, S., & Biswas, U. (2020b). A secure vehicle theft detection framework using Blockchain and smart contract. Peer-to-peer Networking and Applications (Print), 14(2), 672– 686. https://doi.org/10.1007/s12083-020-01022-0

[16] Thakran, E., Bhattacharya, S., & Verma, S. (2020). PROPOSED METHOD FOR CAR THEFT PREVENTION TECHNIQUES. International Journal of TechnicalResearch & Science, Special(Issue3), 108–113. https://doi.org/10.30780/specialissueicaccg2020/022.

[17] Mudasar Basha, P.Raja, A.V.Rakesh, & Ch.Anvesh Reddy. (2018). Vehicle tracking and security system. IJCRT, 6(2).

[18] Sundararajan, S. N. (n.d.). BIOMETRIC AND RFID BASED VEHICLE SECURITY SYSTEM. International Journal of Engineering Applied Sciences and Technology, 6(9), 108–110. https://doi.org/10.33564/ijeast.2022.v06i09.013.

[19] M. S. Rudramurthy et al., "Real Time Vehicle Tracking System for Smart Cities," 2023 International Conference on Data Science and Network Security (ICDSNS), Tiptur, India, 2023, pp. 1-6, doi: 10.1109/ICDSNS58469.2023.10245776.

[20] S. Mohanasundaram, V. Krishnan and V. Madhubala, "Vehicle Theft Tracking, Detecting And Locking System Using Open CV," 2019 5th International Conference on Advanced Computing & Communication Systems (ICACCS), Coimbatore, India, 2019, pp. 1075-1078, doi: 10.1109/ICACCS.2019.8728460.

LIST OF DELIVERABLES ON PRESENT WORK

PUBLICATION DETAILS

Sr. No.	PAPER TITLE	CONFERENCE NAME	CONFERENCE DURATION	ISSN NUMBER
1	Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.	JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE (Volume 14 Issue 04 – 2024)	April 14,2024	ISSN: 1548-7741

Journal of Information and Computational Science

ACCEPTANCE LETTER TO AUTHOR

Dear Author,

With reference to your paper submitted **"Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft."**

We are pleased to accept the same for publication in **JoICS**.

Manuscript ID: JOICS/7263

Maintenance/processing fee of 2000 INR Per paper. Please note that the amount we are charging is very nominal & only an online maintenance and processing fee.

The Fee includes:
Online maintenance and processing charge
No limitation of number of pages
Editorial fee and Taxes

Note: Fee paid for the publication of the paper does not refund under any circumstances.

In case of any query please do not hesitate to contact us at submitjoics@gmail.com . Early reply is appreciated.

DATE
14-April-2024

Sincerely,
Best regards,
Joseph Sung

http://www.joics.or

Editor-In-Chief
Joseph Sung

ISO International Organization for Standardization 7021-2008

DOI:10.12733.JICS

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE

Journal of Information and Computational Science

UGC - Care Group - II Certified Journal

ISSN NO: 1548-7741 / web : www.joics.org / E-mail : submitjoics@gmail.com

Certificate of Publication

This is to certify that the paper entitled

Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.

Authored by :

ANAND SADAWARTE

From

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SSGMCE SHEGAON, MAHARASHTRA, INDIA

Has been published in

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE,VOLUME 14 ISSUE 04,APRIL - 2024

ज्ञान-विज्ञान विमुक्तये
An Emblem Symbolising The Future

S. Joseph
Joseph Sung
Editor-In-Chief
JOICS

6.2 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

Journal of Information and Computational Science

UGC - Care Group - II Certified Journal

ISSN NO: 1548-7741 / web : www.joics.org / E-mail : submitjoics@gmail.com

Certificate of Publication

This is to certify that the paper entitled

Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.

Authored by :

DEEP PANDE

From

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SSGMCE SHEGAON, MAHARASHTRA, INDIA

Has been published in

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE,VOLUME 14 ISSUE 04,APRIL - 2024

Joseph Sung
Editor-In-Chief
JOICS

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE

Journal of Information and Computational Science

UGC - Care Group - II Certified Journal

ISSN NO: 1548-7741 / web : www.joics.org / E-mail : submitjoics@gmail.com

Certificate of Publication

This is to certify that the paper entitled

Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.

Authored by :

SHIVAM WAKODE

From

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SSGMCE SHEGAON, MAHARASHTRA, INDIA

Has been published in

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE,VOLUME 14 ISSUE 04,APRIL - 2024

ज्ञान-विज्ञान विमुक्तये
An Emblem Symbolising The Future

S. Joseph

Joseph Sung
Editor-In-Chief
JOICS

6.2 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

JOURNAL OF INFORMATION
AND COMPUTATIONAL SCIENCE

Journal of Information and Computational Science

UGC - Care Group - II Certified Journal

ISSN NO: 1548-7741 / web : www.joics.org / E-mail : submitjoics@gmail.com

Certificate of Publication

This is to certify that the paper entitled

Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.

Authored by :

VEDANT GAWANDE

From

DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
SSGMCE SHEGAON, MAHARASHTRA, INDIA

Has been published in

JOURNAL OF INFORMATION AND COMPUTATIONAL SCIENCE,VOLUME 14 ISSUE 04,APRIL - 2024

ज्ञान-विज्ञान विमुक्तये
An Emblem Symbolising The Future

S. Joseph
Joseph Sung
Editor-In-Chief
JOICS

6.2 IMPACT FACTOR

ISO International Organization for Standardization 7021-2008

Securing parking spaces: Safeguarding vehicle with GPS and Geofencing against theft.

Anand Sadawarte[1], Deep Pande[2], Shivam Wakode[3], Vedant Gawande[4], Prof. C.M.Mankar[5]

B.E. Student, Department of Computer Science & Engineering SSGMCE Shegaon, Maharashtra, India [1,2,3,4]
Associate Professor, Department of Computer Science & Engineering SSGMCE Shegaon, Maharashtra, India[5]

ABSTRACT

In recent year car theft has increased a lot, there is huge concern about car safety in the mind of car owner. The geo fencing and GPS are the two emerging technology which can be used to overcome this issue. "Securing parking spaces" is introduced to provide safety to vehicle in the geofence area. Geofencing within "Securing Parking Spaces" can also improve security by issuing alerts, particularly when unauthorized individuals attempt to access the vehicle. The GPS is helpful in tracking the car if car found vulnerable. An android application is developed which can operate on any device. This user friendly application provide user the ability to track and monitor car if any unauthorized access found to the car.

KEYWORDS: Geo-fencing, GPS, Tracking, Monitor, GNSS, Google map API, Point in Polygon, Alert Notification, Map-box SDK.

I. INTRODUCTION

Vehicle theft has been on a steady rise in recent years, there is estimation about 1 lakh car stolen cases appear each year in India. Traditional methods of safeguarding vehicles, such as physical barriers and surveillance cameras, have proven insufficient in addressing the evolving tactics of modern-day thieves. There is need of advanced technology which can overcome car safety issues. A game-changing technology has emerged as a powerful strategy against auto theft: smart geofencing combined with GPS systems.

Geo-fencing enabled remote monitoring of geographic areas surrounded by a virtual fence (geofence), and automatic detections when it tracked mobile objects that entered or exited these areas[1]. Unlike physical fencing, Geo fencing is flexible and easy to modify. The Global Positioning System (GPS) is a system based on Global Navigation Satellite System (GNSS) that provides reliable location and time information at all times in any weather condition on earth[1]. There is huge demand of GPS in the technology market due to its tracking ability of objects in the real time.

The GPS system tracks the location of a vehicle and enables owners to monitor their vehicles in real-time while also receiving notifications. The combination of geofencing and GPS technology opens up possibilities, for enhancing vehicle security. The geofencing capabilities can provide more security to parking areas to prevent vehicle theft and optimize parking management system.

II. LITERATURE REVIEW

There are many different types of methods which are used for preventing car theft. We have reviewed some research papers on car anti-theft system which are listed below.

Utkarsh et al. [2] discusses the development of a vehicle anti-theft tracking system based on the Internet of Things (IoT). The system described in the paper uses GSM, GPS, and wireless communication modules to track and identify auto theft. The role of the DC motor, GPS, GSM, and wireless module ESP 8266 in linking to the vehicle anti-theft device is highlighted. The paper also focuses on the capabilities of the GPS system to accurately pinpoint the latitude and longitude positions of a vehicle in any climate.

N.Duraichi et al. [3] has proposed the implementation of a smart license verification technology in vehicles to address vehicle theft and reckless driving by unknown users. The system uses deep learning to detect and authenticate the driver's details and integrates this technology with the vehicle's engine mechanism to prevent unauthorized use. Various technologies such as RFID tags, infrared sensors, and USB cameras are utilized for driver authentication, and the use of Arduino ATmega328 microcontroller is outlined. The proposed system aims to allow only authorized license holders to drive, reducing accidents and criminal activities related to unauthorized vehicle use.

Jayesh et al. [4] proposed a system to mitigate vehicle thefts by sending an SMS message when the vehicle is moved or crosses a Geo-Barrier grid. The system also offers location updates and various control mechanisms. The paper provides a detailed overview of embedded systems and their applications, as well as specific components like Arduino Uno, SiM7600E, and Neo M8 GPS module. The paper also discusses fleet tracking and secondary operations of the proposed system inside Electronic Control Module.

Debashis Das et al. [5] proposes a decentralized and secure framework using blockchain and smart contracts for vehicle theft detection. It introduces a 2-Step Authentication (2SA) and unauthorized access detection algorithms to ensure data security and user authentication. The framework allows multiple authorized users to drive the vehicle without compromising data security. The proposed system utilizes blockchain technology to provide a secure, transparent, and trusted environment for the security of vehicles and user privacy.

Eva Thakran et al. [6] developed a new method for preventing car theft focused on tracking the car alarm system using noise, light, and button sensors. The paper also introduces "Let's Track," a GPS and mobile tracking system. A proposed mobile application is presented with features for real-time location tracking, emergency notifications, and immobilization of the car. The proposed method integrates GPS systems, RFID technology, and alarm systems to create an affordable and effective car theft prevention kit.

Mudasar Basha et al. [7] presents the development of an onboard GPS-equipped autopilot system with theft control for automobiles. It utilizes an embedded system based on GSM technology, with a mobile interfacing for alerting the vehicle owner in case of theft. The system operates by sending an alert SMS to the vehicle owner if the vehicle is stolen, allowing the owner to control the ignition of the engine via SMS.

Sai Nithish Sundararajan [8] proposes a biometric security system using Arduino Nano, EM18 RFID, and R305 Fingerprint sensor to address the increasing concern of vehicle theft, specifically car theft. The system works by verifying the RFID tag code and fingerprint authenticity before allowing ignition. In case of repeated unauthorized attempts, the system raises an alarm and sends a text message to the registered user using the GSM module.

III. PROPOSED WORK

In this section we are discussing the car anti-theft solution using the geofence and GPS technology. The GPS is used to track the vehicle and the alert system is built to provide extra security using geofence. The main feature of our system is to provide alert notification to the car owner if the vehicle exit the virtual boundary.

In this project, we are building two application one for mobile user and other for vehicle. Mobile user application is used for user registration, authentication, map geofence coordinates, provide alert notification and to track vehicle. While the vehicle application is used to retrieve real time location of vehicle. The mobile app makes requests to the vehicle app's API to retrieve location data or send alerts.

1. System component

A) Hardware component

a) GPS(Global Positioning System)

GPS is used to get the real time location of vehicle. The vehicle is equipped with GNSS(Global Navigation Satellite System) module, specially designed for receiving signal from GPS satellite. The GNSS module calculates the vehicles location coordinates and provide the precise location to the vehicle application. Afterwards the vehicle application provides vehicle’s location to the Mobile user app using API.

Fig1: GPS module

B) Software component

a) Mobile user application

This application deals with the Mapping of Geofences for securing the desired locations. User is registered into the application using user credentials. This user credentials are stored on Firebase Firestore Database. The Mobile app provides the functionalities like mapping geofence on google map, alert notification for breaching of the boundary and tracking of vehicle using GPS. The Maps Interface is build using the Google Maps API. The user can register the geofence coordinates on map by searching for the location on the maps and mapping the geofence in form of polygon shaped area. User is able to modify the number of vehicles to track for the particular geofence on the maps interface. The selected vehicles are linked with the user information in the Firestore database. The live location is fetched from the firebase realtime database and displayed on the maps interface. If the vehicle exits through particular geofence then the user which is linked with specific vehicle gets alert notification and vehicle can be tracked for security purposes.

b) Vehicle application

The vehicle app updates the Live location coordinates of the particular vehicle, the information is acquired by integrated GNSS module in the vehicle. The Location data is fetched from the Firebase Realtime Database and transmitted to the user application.

c) Map-Box:

Map-box is used for Geofencing functionality. Map-box allows defining geofence which has shapes like polygon or circle. The shapes are plotted using the Latitude and Longitude Coordinates of the Fence. Map-box SDK integrates with the user application for managing the geofences on the maps interface and the Markers for displaying the location of the vehicles.

2. Implementation:

This section focuses on the proposed vehicle theft detection, geofence mapping, monitoring and Alert Notification.

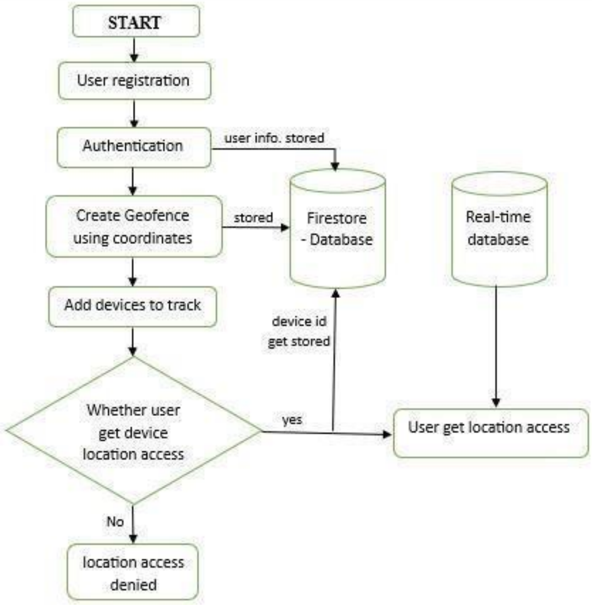

Fig2: System Diagram

A) Authentication

We are using firebase for authentication purpose. Firebase authentication support various sign-in methods like emails/passwords and google sign-in. We are using shared sign-in methods in which credential on both mobile app and vehicle app are same enabling them to share the vehicle location data. This enable the securing sharing. Firebase real-time database stored the car location data that needs to be shared between both apps. When user successfully login to either app using their credentials to access and manage their data within the database.

B) Geofence mapping

Google Maps API provides the map interface in the user app, through this interface user can plot the geofences. The Geocoding API perform geocoding which is the process of converting textual location description to geographic coordinates (latitude and longitude). This can also perform forward and reverse geocoding. By combining these functionalities location search operation is achieved in user application.
For the mapping of the Geofences the Map-Box SDK is used. This SDK provides functionalities to Map the geofences for creating and mapping geofences within a mobile app. To define geofence, the user can manually add coordinates using longitude and

latitude. The coordinates data of geofence gets stored into the Firebase database.

C) Location validation

The current location of the vehicle is fetched from the real time database where it is constantly updates from the vehicle application. The current location fetched and the Geofences coordinates and sent to the point in polygon algorithm as parameters. The current location is checked with specified geofences.
The point in polygon algorithm decides if the current location of the vehicle is inside or outside the predefined geofence.

Point in Polygon algorithm:-

1. Get the number of vertices in the polygon.
2. Get the latitude and longitude of the point.
3. Initialize a variable 'inside' to false. This will be used to track whether the point is inside the polygon.
4. Get the first vertex of the polygon.
5. Loop over the vertices of the polygon:
   A. Get the current vertex.
   B. If the point's longitude is greater than the minimum longitude of the current and next vertex AND less than or equal to the maximum longitude:
      a. If the point's latitude is less than or equal to the maximum latitude of the current and next vertex:
         i. Calculate the x-coordinate of the intersection of the line through the point and the line through the current and next vertex.
         ii. If the latitudes of the current and next vertex are equal OR the point's latitude is less than or equal to the x-coordinate of the intersection:
            a. Flip the value of 'inside' (if it was false, make it true; if it was true, make it false).
      b. Move to the next vertex.
6. Return the value of 'inside'. If 'inside' is true, the point is inside the polygon. If 'inside' is false, the point is outside the polygon.

This algorithm take the current location as a point containing latitude and longitude and coordinates of the geofence polygon.
as a input. It then perform calculation to determine if the point falls inside or outside the polygon.

D) Alert System

After Checking with the algorithm, the status of vehicle location whether inside or outside of the geofence, the Event is triggered based on that result. When the vehicle exits the predefined geofence boundary the event gets triggered. This event generate a push notification to the verified user application. The Notification alerts the user to check the vehicle location and security, The user can then also track the updating vehicle location which increases the security of the vehicle.

IV. RESULT

The mobile app designed for vehicle tracking was developed first. Tests were conducted using a lightweight mobile app-based tracker simulator, which simulates the behavior of an actual vehicle tracker by sending location updates once loaded. Upon logging in, the user is prompted to select the vehicle they wish to track. This selection is typically for vehicles of particular importance or those requiring closer monitoring. After selecting the vehicle, its live location is displayed on a map interface powered by Google Maps, represented by a car icon. This feature provides the user with real-time tracking and monitoring of the vehicle's movements.

Fig3: Interface for tracking car location in Geofence

Field tests were conducted using various parking spaces at different distances from the designated entry/exit point. The table below summarizes the system's performance in terms of sending notifications and updating the parking availability on the app.

Table1: Geofence Alert Testing

Trial	Car Name	Safety Range (Distance from central point in meters)	Notification Sent	Status Indicated as Exceeding Limits
Trial 1	Tata Nexon	12	yes	yes
Trial 2	Scorpio	17	yes	yes
Trial 3	Toyota	3	no	no
Trial 4	Hyundai i20	4	no	no
Trial 5	Bolero	22	yes	yes
Trial 6	Ertiga	25	yes	yes
Trial 7	Renault	1	no	no
Trial 8	Harrier	9	yes	yes
Trial 9	Range Rover	9	yes	yes
Trial 10	Kia	35	yes	yes

V. CONCLUSION

Our project explored a system that uses GPS tracking and virtual boundaries (geo-fences) to improve vehicle security and monitoring. This system offers real-time location awareness, alerts for unauthorized movement, and eliminates the need for constant manpower or security cameras. The future scope of this system lies in exploring advanced functionalities like integration with smart car features and customizable alerts. With further development, this app system has the potential to revolutionize vehicle security and monitoring, leading to a future with more secure vehicles and a more efficient response to critical situations can take regarding action as early as possible. This can be used by fast food service provider, tourism, for nearby hospitals alerting.

VI. REFERENCES

[1] Kothari, N. S., Thube, R., Thube, A., & Kute, P. (2021). GPS BASED LOCATION MONITORING SYSTEM WITH GEO-FENCING CAPABILITIES. IJCRT, 9(11).

[2] Utkarsh, & Jha, K. K. (2021). Vehicle Anti-Theft Tracking System Based on Internet of Thing(IoT). Journal of University of Shanghai for Science and Technology. https://doi.org/10.51201/JUSST/21/0514.

[3] Duraichi, N., Kumar, K. a. S., Sathya, N., & Lokesh, S. (2021). Automobile Authentication and Tracking System. In Advances in parallel computing (Print). https://doi.org/10.3233/apc210271

[4] Jayesh, J. (2021). Vehicle Anti-Theft Technology. International Journal for Research in Applied Science and Engineering Technology, 9(VI), 4614–4618. https://doi.org/10.22214/ijraset.2021.35879

[5] Das, D., Banerjee, S., & Biswas, U. (2020b). A secure vehicle theft detection framework using Blockchain and smart contract. Peer-to-peer Networking and Applications (Print), 14(2), 672–686. https://doi.org/10.1007/s12083-020-01022-0

[6] Thakran, E., Bhattacharya, S., & Verma, S. (2020). PROPOSED METHOD FOR CAR THEFT PREVENTION TECHNIQUES. International Journal of Technical Research & Science, Special(Issue3), 108–113. https://doi.org/10.30780/specialissue-icaccg2020/022

[7] Mudasar Basha, P.Raja, A.V.Rakesh, & Ch.Anvesh Reddy. (2018). Vehicle tracking and security system. IJCRT, 6(2).

[8] Sundararajan, S. N. (n.d.). BIOMETRIC AND RFID BASED VEHICLE SECURITY SYSTEM. International Journal of Engineering Applied Sciences and Technology, 6(9), 108–110. https://doi.org/10.33564/ijeast.2022.v06i09.013.

PLAGIARISM REPORT

Project report Securing Parking Spaces Safeguarding Of Vehicle.pdf

ORIGINALITY REPORT

23%	20%	11%	15%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Gujarat Technological University	Student Paper	3%
2	propellant.media	Internet Source	3%
3	pdfcoffee.com	Internet Source	2%
4	wiki2.org	Internet Source	2%
5	Submitted to Swinburne University of Technology	Student Paper	1%
6	ssgmcefablab.in	Internet Source	1%
7	www.coursehero.com	Internet Source	1%

Project Group Members

Name: Anand G. Sadawarte
Address: Shivaji Ves, Khamgaon,
Dist. Buldhana (444303).
Email id:
anandsadawarte284@gmail.com
Mobile no: 8329796415

Name: Deep A. Pande
Address: Singhaniya Nagar, Yavatmal,
Dist. Yavatmal (445001).
Email id:
deeppande2117@gmail.com
Mobile no: 8483859909

Name: Shivam G. Wakode
Address: Civil Line, Washim,
Dist. Washim (444505).
Email id:
shivamwakode10@gmail.com
Mobile no: 9322853782

Name:Vedant P. Gawande
Address: Sai prasad,Sai Heritage,
Sai Nagar,Amravati,
Dist. Amravati (444607).
Email id:
vedantgawande02@gmail.com
Mobile no: 8080483324