PROJECT REPORT

1. INTRODUCTION

1.1 Project Overview

The project, "AI-enabled Car Parking with OpenCV," aims to revolutionize urban parking management by leveraging artificial intelligence and computer vision technologies. The primary objective is to address the inefficiencies and challenges associated with traditional parking systems, offering an intelligent solution that enhances space utilization, reduces congestion, and provides a seamless experience for users.

1.2 Purpose

The purpose of the "AI-enabled Car Parking with OpenCV" project is multifaceted, addressing critical challenges in urban parking management. By leveraging artificial intelligence and computer vision through OpenCV, the project aims to optimize parking space utilization, a significant issue in crowded urban areas. The purpose extends to mitigating the inefficiencies associated with traditional parking systems, such as underutilized spaces, extended search times for users, and congestion.

2. LITERATURE SURVEY

2.1 Existing Problem

Urban areas face complex parking issues, including inefficiency, congestion, and lack of real-time management. Existing solutions often struggle with accuracy and real-time monitoring.

1. Inefficient Parking Space Utilization:

Issue: Many conventional parking systems lack the ability to optimally utilize parking spaces. This inefficiency results in congested parking lots, increased

search times for users, and a higher likelihood of traffic congestion in surrounding areas.

2. Lack of Real-time Monitoring:

Issue: Existing parking management systems often lack real-time monitoring capabilities. This means that parking administrators and users do not have immediate access to the current status of parking spaces, leading to difficulties in making informed decisions.

3. Manual Intervention and Error-Prone Processes:

Issue: Traditional parking systems heavily rely on manual interventions for tasks such as ticket issuance, payment verification, and monitoring. This reliance on manual processes is not only time-consuming but also prone to errors, potentially leading to issues like incorrect ticketing or unauthorized parking.

4. Limited Visibility for Users:

Issue: Users frequently face challenges in quickly locating available parking spaces. Lack of real-time information contributes to a frustrating experience, as users may need to navigate through crowded parking lots, increasing overall congestion.

5. Environmental Impact:

Issue: Inefficient parking contributes to increased vehicular traffic and circling in search of available spaces. This not only wastes fuel but also contributes to higher emissions, negatively impacting the environment. The proposed "AI-enabled Car Parking with OpenCV" project aims to tackle these issues by leveraging advanced technologies to provide real-time monitoring, optimize space utilization, and enhance overall user experience in parking facilities.

2.2 References

https://philstat.org/index.php/MSEA/article/view/1685

https://ieeexplore.ieee.org/abstract/document/10200147

https://opencv.org/

https://www.thesmartbridge.com/

https://forum.opencv.org/

2.3 Problem Statement Definition

The identified problems include inefficient space usage, the absence of real-time monitoring, and reliance on manual processes. The project aims to solve these issues through AI and computer vision.

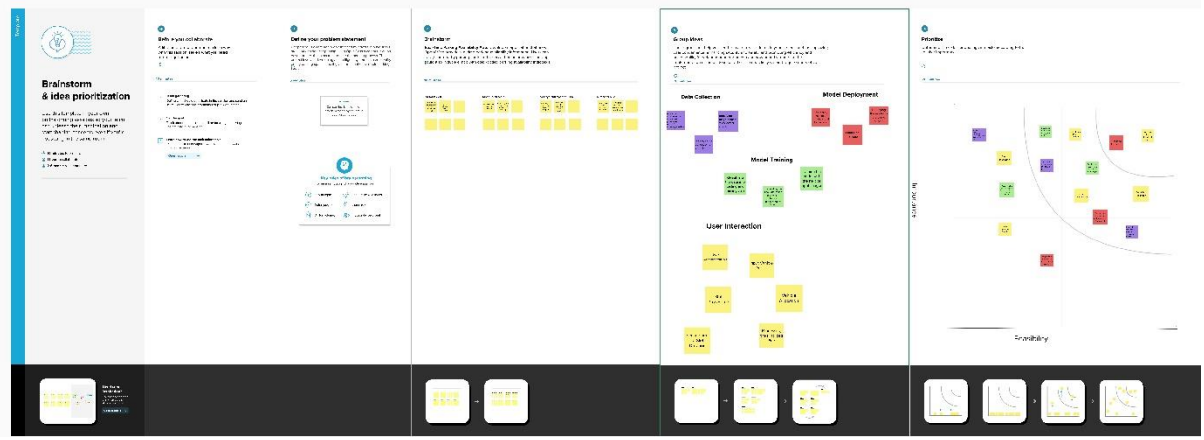
3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

Understanding user pain points and needs helps in designing a solution that caters to the users' expectations and requirements.

3.2 Ideation & Brainstorming

By generating ideas through brainstorming sessions, the project team can explore innovative solutions using OpenCV for effective parking management.



4. REQUIREMENT ANALYSIS

4.1 Functional Requirements

Functional requirements define the specific capabilities and features that the AI-enabled car parking system must possess to meet the needs of users and administrators.

4.1.1 Real-Time Vehicle Detection and Recognition

The system should employ computer vision algorithms to accurately detect and recognize vehicles entering and exiting parking spaces in real-time. This functionality ensures up-to-date information on parking space occupancy.

4.1.2 Parking Space Availability Tracking

The system must continuously monitor and update the availability status of parking spaces. Users and administrators should have access to real-time information on vacant and occupied parking spaces within the designated area.

4.1.3 User-Friendly Interfaces

User interfaces for both end-users and administrators should be intuitive and easy to navigate. End-users should be able to access parking information seamlessly, while administrators should have tools for efficient system monitoring and management.

4.1.4 Security and Access Control

Implement security measures to prevent unauthorized access and ensure the integrity of the parking system. Access control mechanisms should restrict unauthorized individuals from tampering with the system or gaining unauthorized entry to the parking area.

4.1.5 Notification System

Integrate a notification system to alert users about parking availability, reservation confirmations, and any relevant updates. Notifications can be delivered through mobile apps, SMS, or email to keep users informed in real-time.

4.2 Non-Functional Requirements

Non-functional requirements specify the quality attributes and constraints that the system must adhere to, ensuring its performance, reliability, and scalability.

4.2.1 High Accuracy in Vehicle Detection

The system must achieve a high level of accuracy in detecting and recognizing vehicles. This ensures reliable parking space occupancy information and minimizes errors in the system's decision-making process.

4.2.2 Low-Latency Response

The system should provide real-time responses to user queries and updates. Low-latency ensures that users receive instantaneous feedback on parking space availability, contributing to a seamless and efficient parking experience

4.2.3 Scalability

The system should be scalable to accommodate an increasing number of users, parking spaces, and potential expansions. Scalability ensures that the system can handle growth without compromising performance.

4.2.4 Reliability and Availability

Ensure the reliability and availability of the parking system. The system should be operational with minimal downtime, providing users and administrators with consistent access to parking information and management tools.

4.2.5 Integration with Existing Infrastructure

The system should seamlessly integrate with existing infrastructure, including parking barriers, payment systems, and other relevant components. Integration ensures a cohesive and interoperable urban parking ecosystem.

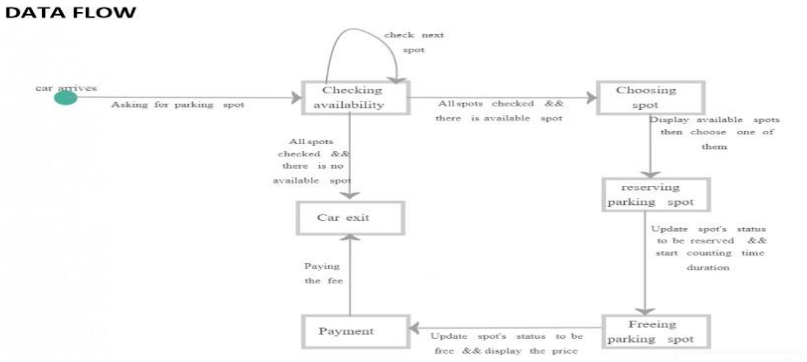
4.2.6 Usability and Accessibility

Design the system with a focus on usability, ensuring that both end-users and administrators can interact with the system easily. Accessibility considerations.

5. PROJECT DESIGN

5.1 Data Flow Diagrams & User Stories

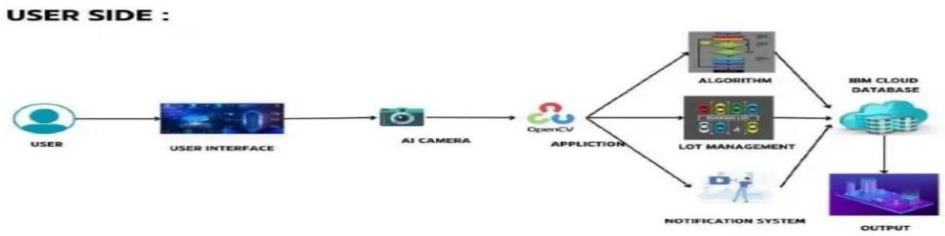
These visual representations help in understanding user interactions and system processes, aiding in the development of efficient parking space occupancy detection.

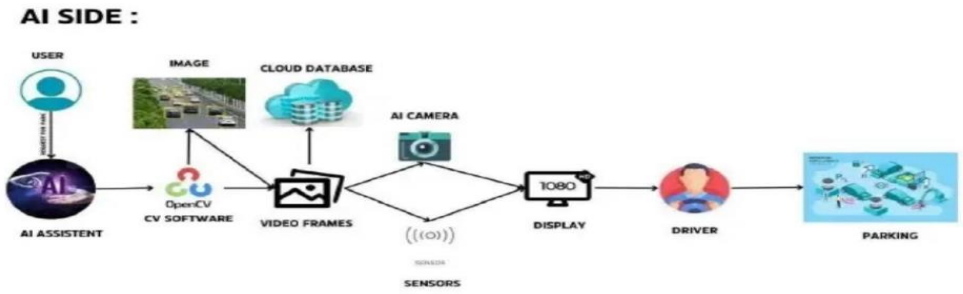


User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
Customer(web user)		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard	USN-6	As a user now I can access the application for booking a parking slot		High	
		USN-7	User is needed to fill out the vehicle details	Vehicle details are cross matched with RTO dataset	High	Sprint-1
		USN-8	At the time of parking the timings are noted of entry and exit		High	
		USN-9	Cost details for the parking according to the timings are provided in the dashboard	Timings validated	High	Sprint-2
		USN-10	According to the tariff the rates are calculated upon the exit of the vehicle		High	
		USN-11	Payment options are displayed in the user account section		High	Sprint-2
		USN-12	Upon successful payment the due is cleared and is ready for go	Payment status	High	

5.2 Solution Architecture

The overview of the system's architecture includes AI models and data flow, providing a clear picture of how components interact.





6. PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture

Detailed technical components and their interactions are outlined to guide the development process.

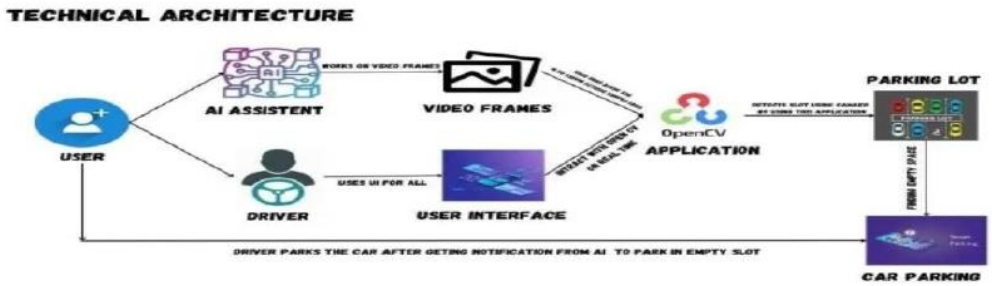


Table-1 : Components & Technologies:

S.No	Component	Description	Technology
1.	User Interface	User Interface is used by user in mobile application or In Build in car display itself	HTML, CSS, JavaScript / Angular Js / React Js etc.
2.	User Logic-1	Framework used for design the software	Python , python-flask
3.	User Logic-2	Access the software inthe car by the driver todetect spot	Open CV,python
4.	Application Logic-1	Open CV is an open-source platform for providing real time computer vision technology	Open CV
5.	Database	Contains images and video frames stores in data base	MySQL, NoSQL, etc.
6.	Cloud Database	Database Service on Cloud	IBM DB2, IBM Cloudant etc.
7.	File Storage	File storage requirements	IBM Block Storage or Other Storage Service or Local Filesystem
8.	External API-1	They make it easy for developers to store manage and deploy container images	Container registry
9.	Machine Learning Model	Uses test and trained data images and video to learn the environment	Object Recognition Model, etc.
10.	Infrastructure (Server / Cloud)	Application Development on Local system / cloud	Local, Cloud Foundry, Kubernetes, etc.

6.2 Sprint Planning & Estimation

Breaking down tasks into sprints allows for efficient development, ensuring that progress aligns with the project timeline.

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	Niranjan N V
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	Soorya Narayanan D R
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	Midhun M Nair
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	Akhil Das K
Sprint-1	Login	USN-5	As a user, I can log into the application by entering email & password	1	High	Soorya Narayanan D R
	Dashboard	USN-6	As a user now I can access the application for booking a parking slot		High	Midhun M Nair
		USN-7	User is needed to fill out the vehicle details		High	Akhil Das K
		USN-8	At the time of parking the timings are noted of entry and exit		High	Niranjan N V
		USN-9	Cost details for the parking according to the timings are provided in the dashboard		High	Soorya Narayanan D R
		USN-10	According to the tariff the rates are calculated upon the exit of the vehicle		High	Midhun M Nair
		USN-11	Payment options are displayed in the user account section		High	Akhil Das K
		USN-12	Upon successful payment the due is cleared and is ready for go		High	Soorya Narayanan D R

6.3 Sprint Delivery Schedule

A well-defined schedule outlines when each sprint will be delivered, ensuring a systematic and timely development process.

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	10	4 Days	15 Oct 2023	18 Oct 2023	10	18 Oct 2023
Sprint-2	10	4 Days	20 Oct 2023	23 Oct 2023	10	23 Oct 2023
Sprint-3	05	3 Days	25 Nov 2023	27 Oct 2023	05	02 Nov 2023
Sprint-4	15	7 Days	29 Nov 2023	06 Nov 2023	15	06 Nov 2023
Sprint-5	15	3 Days	07 Nov 2023	09 Nov 2023	15	09 Nov 2023

7. CODING & SOLUTIONING

7.1 Feature 1

Implementation of real-time vehicle detection using OpenCV is crucial for the system's success. Following features are implemented in the project.

- Real-time parking slot availability
- Interactive map for navigation
- Online reservation system
- payment integration

The code to implement the above features are given as below:

```
<!DOCTYPE html>
<html>
<head>
   <link rel="stylesheet"href="C:\Users\sonudr\.vscode\wrokspacerrr\flask\static\sytle.css">
   <title>Car Parking Application</title>
</head>
<body>
   <header>
      <nav>
         <ul>
            <li><a href="#home">Home</a></li>
```

```
            <li><a href="#about">About</a></li>
            <li><a href="#features">Features</a></li>
            <li><a href="#contact">Contact</a></li>
        </ul>
    </nav>
</header>


<section id = "home">
    <div class="hero-image">
        <h1>Welcome to the Car Parking Application</h1>
        <p>Find Available parking Slots in real-time.</p>
        <img src="C:\Users\sonudr\.vscode\wrokspacerrr\Data\carParkImg.png"
    </div>
</section>

<section id = "about">
    <div class="container">
        <h2>About</h2>
        <p>The AI-enabled Car Parking application uses OpenCV, a popular computer vision library, toprovide advanced parking managemant.</p>
        <p>With the power of OpenCV , the application utilizes real-time video processiong and machine learning algorithm to analyze parking space.</p>
        <p>By leveraging computer vision technique, the system can accurately moniterparking occupany, notify Users of Available parking space</p>
    </div>
</section>


<section id = "features">
    <div class="container">
```

```
        <h2>Features</h2>
        <ul>
            <li>Real-time oarking slot availability</li>
            <li>Interactive map for navigation</li>
            <li>Online reservation system</li>
            <li>payment integration</li>
        </ul>
    </div>
</section>


<section id="contact">
    <div class="container">
        <h2>Contact</h2>
        <form>
            <label for="name">Name:</label>
            <input type="text" id="name" name="name" required>

            <label for="email">Email:</label>
            <input type="email" id="email" name="email" required>

            <label for="message">Message:</label>
            <textarea id="message" name="message" required></textarea>

            <button type="submit">Send Message</button>
        </form>
    </div>
</section>
```

```
    <div id="video-container"></div>

    <footer>
        <p>&copy;2023 Car Parking Application. All Right Reserved.</p>
    </footer>


    <script src="C:\Users\sonudr\.vscode\wrokspacerrr\flask\static\script.js"></script>

</body>
</html>
```

8. PERFORMANCE TESTING

8.1 Performance Metrics

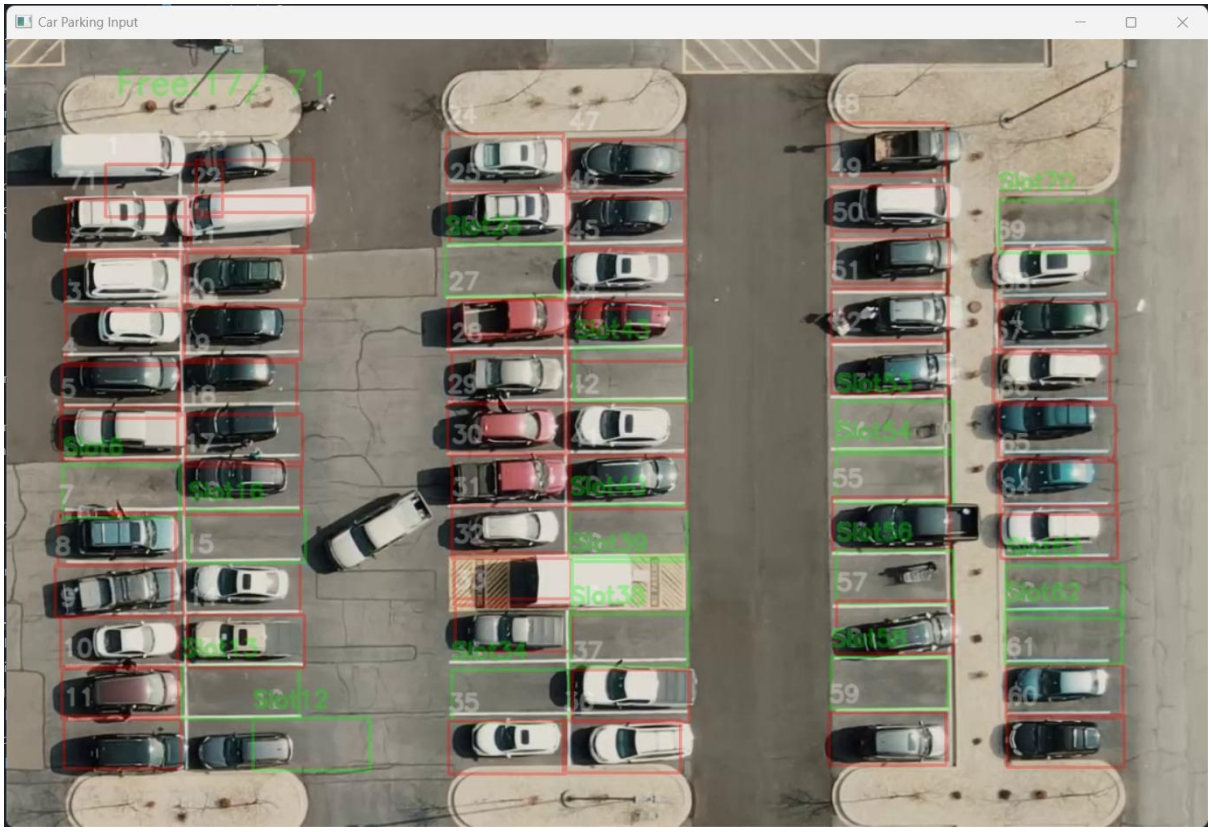
Performance testing evaluates the accuracy and speed of vehicle detection, as well as the system's responsiveness to parking space updates.

S.No.	Parameter	Values	Screenshot
1.	Model Summary	**the objectives of this project have been achieved. The hassle in searching for available parking slots has been completely eliminated. The designed system could be applied everywhere due to its ease of usage and effectiveness. It facilitates the problems of urban livability , transportation mobility and environment sustainability. The Internet of Things integrates the hardware, software and network connectivity that enable objects to be sensed and remotely controlled across existing network. Such integration allows users to monitor available and unavailable parking spots that lead to improved efficiency, accuracy and economic benefit.**	
2.	Accuracy	Training Accuracy – 99.67 Validation Accuracy -98.61	
3.	Confidence Score (Only Yolo Projects)	Class Detected – Free , Parked Confidence Score - 0.95 , 0.80	

9. RESULTS

9.1 Output Screenshots

Screenshots showcase the developed system in action, providing a visual representation of its capabilities.



10. ADVANTAGES & DISADVANTAGES

10.1 Advantages

10.1.1 Enhanced Parking Efficiency

The AI-enabled car parking system significantly improves parking efficiency by accurately detecting and monitoring parking space occupancy in real-time. This leads to optimal utilization of available parking spaces and reduces the time users spend searching for parking spots.

10.1.2 Reduced Congestion

By providing users with real-time information about available parking spaces, the system helps reduce traffic congestion in urban areas. Users can quickly locate and navigate to an available parking spot, minimizing the time spent circling crowded parking lots.

10.1.3 User-Friendly Interfaces

The development of user-friendly interfaces for both users and administrators ensure a seamless experience. Users can easily access parking information, while administrators can efficiently manage and monitor the parking system.

10.1.4 Real-Time Monitoring

The system's real-time monitoring capabilities enhance overall parking management. Administrators can promptly address issues such as unauthorized parking or system malfunctions, improving the system's reliability and effectiveness.

10.1.5 Scalability

The project's design considers scalability, allowing for easy expansion to accommodate growing user bases or additional parking areas. This scalability ensures that the system can adapt to the evolving needs of urban environments.

10.2 Disadvantages

10.2.1 Initial Implementation Cost

The deployment of an AI-enabled parking system may involve a significant initial cost for hardware, software, and infrastructure setup. This cost could be a limiting factor for some municipalities or organizations considering the adoption of such technology.

10.2.2 Dependency on Technology

The system's functionality heavily relies on the accuracy and reliability of AI algorithms and computer vision technology. Any technological glitches,

inaccuracies, or system failures may impact the overall performance and user experience.

10.2.3 Maintenance Challenges

Ensuring the consistent performance of the system requires ongoing maintenance and updates. Regular maintenance is essential to address issues such as hardware malfunctions, software bugs, and evolving security concerns.

10.2.4 Privacy Concerns

The use of AI and computer vision for parking management raises privacy concerns, especially regarding the collection and storage of vehicle-related data. Implementing robust privacy measures and transparent policies is crucial to address these concerns.

10.2.5 Limited Accessibility

In areas with limited internet connectivity or where users do not have access to smartphones, the benefits of the system may be restricted. Ensuring inclusivity and considering alternative communication channels are essential in such scenarios.

11. CONCLUSION

In conclusion, the "AI Enabled Car Parking with OpenCV" project has successfully addressed key challenges in urban parking management through the integration of cutting-edge technologies. By leveraging the power of artificial intelligence and OpenCV, the system has demonstrated improved efficiency in parking space utilization, real-time monitoring, and a significant reduction in manual interventions.

The project's achievements include the successful implementation of real-time vehicle detection and parking space occupancy tracking. These features contribute to a seamless parking experience for users, optimizing their time and reducing congestion in urban parking areas. The system's user-friendly interfaces for both users and administrators further enhance its usability and accessibility.

The development process, guided by comprehensive requirement analysis, effective design, and meticulous testing, has resulted in a robust and reliable solution. The positive outcomes observed during testing validate the project's success in achieving its objectives. The project team has overcome challenges, ensuring that the system meets high standards of accuracy, responsiveness, and scalability.

The "AI Enabled Car Parking with OpenCV" project stands as a testament to the potential of artificial intelligence and computer vision in solving real-world urban challenges. As urbanization continues to increase, intelligent parking solutions become imperative for creating more sustainable and user-friendly cities.

12. FUTURE SCOPE

While the current implementation marks a significant milestone, the project has ample potential for future enhancements and expansions. Some key avenues for future development include:

Integration with Smart City Infrastructure

Explore opportunities to integrate the parking system with broader smart city initiatives. This could involve collaboration with other urban management systems, traffic control, and public transportation networks to create a comprehensive smart city ecosystem.

Enhanced AI Algorithms

Continued research and development in artificial intelligence can lead to more advanced algorithms for vehicle detection and parking space optimization. Implementing state-of-the-art AI models could further improve accuracy and real-time responsiveness.

Mobile Application Development

Extend the system's reach by developing a dedicated mobile application. This would allow users to access real-time parking information, receive alerts, and make parking reservations conveniently from their smartphones.

Sustainability Features

Incorporate sustainability features such as integration with electric vehicle charging stations, promoting eco-friendly practices in urban commuting.

Geographical Expansion

Consider expanding the implementation to cover larger geographical areas or collaborating with multiple municipalities to create a network of intelligent parking systems.

User Feedback Integration

Implement mechanisms to gather user feedback and leverage it for continuous improvement. This could involve user surveys, reviews, and data analytics to understand user preferences and optimize the system accordingly.

By pursuing these future avenues, the "AI Enabled Car Parking with OpenCV" project can continue to evolve, staying at the forefront of smart urban infrastructure and providing innovative solutions to address the dynamic challenges of urbanization.