VISVESVARAYA TECHNOLOGICAL UNIVERSITY

"JNANA SANGAMA", BELAGAVI - 590 018

PROJECT PHASE - I REPORT

on

"SMART CARBON EMISSION TRACKING SYSTEM FOR SUSTAINABLE LIVING"

Submitted by

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In partial fulfillment of the requirements for the VI semester

BACHELOR OF ENGINEERING

in

COMPUTER SCIENCE & ENGINEERING

Under the Guidance of

Dr. SHIVANNA K

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at

SAHYADRI

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CERTIFICATE

This is to certify that the phase - I work of project entitled **"SMART CARBON EMISSION TRACKING SYSTEM FOR SUSTAINABLE LIVING"** has been carried out by **Deepa Bhat (4SF22CS054), Karshima Kotecha (4SF22CS089), Vishal Komal Pujar (4SF22CS245) and Yesha Jatin Kalola (4SF22CS251)**, the bonafide students of Sahyadri College of Engineering and Management in partial fulfillment of the requirements for the VI semester of Bachelor of Engineering in Computer Science and Engineering of Visvesvaraya Technological University, Belagavi during the year 2024 - 25. It is certified that all suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the said degree.

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DECLARATION

We hereby declare that the entire work embodied in this Project Phase - I Report titled **"SMART CARBON EMISSION TRACKING SYSTEM FOR SUSTAINABLE LIVING"** has been carried out by us at Sahyadri College of Engineering and Management, Mangaluru under the supervision of **Dr. Shivanna K ,** in partial fulfillment of the requirements for the VI semester of **Bachelor of Engineering** in **Computer Science and Engineering**. This report has not been submitted to this or any other University for the award of any other degree.

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Abstract

Climate change and environmental destruction are driven by anthropogenic carbon emissions and transportation fuel use is a key area of concern. Urbanization and industrial growth has led to increased needs for personal and commercial transportation and this creates significant issues in transportation-induced greenhouse gas emissions. This continued emissions growth will only allow for a continued increase in atmospheric greenhouse gases, contributing to global warming and creating deleterious effects on human health due to pollution. The Smart Carbon Emission Tracking System yields a practical direction to begin to ameliorate this issue. The smartphone or web-based software permits power users to log vehicle odometer mileage in built-in odometer log and using semi-automatic Fleet Vehicle Tracking to quantify carbon cycle footprints accurately according to determined emission coefficients. The built-in dashboards allow users to monitor emissions in real time, determine aggregate weekly improvement, realized emissions goals, and access comparative leaderboards to provide motivation and engagement opportunities. Smart Carbon Emission Tracking System functionality incorporates artificially intelligent and machine learning algorithms for intelligent recommendations based on individual log records, and cloud-based technology for vertical/ horizontal scaling and multi-engagement from smartphone and web browser. As an added bonus the Smart Carbon Emission Tracking System provides the full administrative dashboard capability to allow non-transport user time-legend record for fleet vehicles, companies, and governments to easily source, measure, monitor, and track GHG emissions and provide ease in establishing sustainability goals from previous emissions tracking.

Acknowledgement

It is with great satisfaction and euphoria that we are submitting the Project Phase - I Report on **"SMART CARBON EMISSION TRACKING SYSTEM FOR SUSTAINABLE LIVING"**. We have completed it as a part of the curriculum of Visvesvaraya Technological University, Belagavi in partial fulfillment of the requirements for the VI semester of Bachelor of Engineering in Computer Science and Engineering.

We are profoundly indebted to our guide, **Dr .Shivanna K**, Associate Professor, Department of Computer Science and Engineering for innumerable acts of timely advice, encouragement and we sincerely express our gratitude.

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Chapter 1

Introduction

Fuel combustion in vehicles, especially in the transportation sector, is one of the leading contributors to greenhouse gas (GHG) emissions. These emissions, primarily composed of carbon dioxide (CO), significantly impact the climate of the planet and contribute to global warming. With the rising use of personal and commercial vehicles for mobility, logistics, and everyday tasks, transportation emissions have become an unavoidable environmental concern. Although climate change is now widely recognized as one of the most critical global issues, the mechanisms to track and reduce emissions are often complex and inaccessible to ordinary individuals.One of the primary challenges lies in the fact that most people, including small organizations, do not have the resources, expertise, or tools to calculate and monitor their individual carbon footprints. Currently, the responsibility for the tracking of emissions is primarily undertaken by governments, environmental agencies, or large industries. As a result, the average individual remains largely disconnected from the process of tracking personal carbon output, even though daily actions, especially travel habits, have a measurable impact. This disconnect not only hinders awareness, but also reduces the effectiveness of environmental campaigns that aim to promote sustainability through behavior change.

Most existing emission monitoring tools are designed for professional or industrial use. They often require advanced technical knowledge, including data formatting, programming, or integration with specific systems. Furthermore, these platforms may require consistent and detailed input from users, which becomes impractical for the general public. Consequently, individuals often underestimate the value of small but meaningful changes in their transportation habits such as carpooling, using public transport, reducing unnecessary travel, or opting for electric vehicles.

To address these limitations, the Smart Carbon Emission Tracking System has been conceptualized as a simple, intuitive, and technology-driven solution aimed at empowering individuals. The primary goal of this system is to make carbon tracking accessible and actionable by offering a user-friendly interface available on both web and mobile platforms. The system allows users to enter or upload their vehicle's odometer readings on a recurring basis. By applying standardized emission factors, the system calculates the estimated CO emissions based on the distance traveled. This process eliminates the need for manual calculations or technical understanding, making it easier for users to engage with the system regularly.A central feature of the platform is its interactive and visually appealing dashboard, which displays real-time data insights, trends over time, and progress toward personal emission reduction targets. The system enables users to set customized goals and track their monthly or weekly emissions, helping them stay informed and motivated. Personalized suggestions based on usage patterns are also provided to guide users in adopting more eco-friendly travel behaviors. To further enhance engagement, the platform includes gamification elements such as achievement badges, leaderboards, and environmental scores. These features not only reward users for reducing emissions, but also promote a sense of friendly competition and community involvement. By participating in challenges or comparing performance with peers, users can become part of a larger network focused on sustainability. In addition to tracking and motivation, the system also offers educational and actionable content. Users receive personalized tips and insights based on their data, ranging from suggestions to switch to greener transportation methods to reminders about vehicle maintenance for fuel efficiency. The system also generates downloadable and shareable reports that visualize progress and provide useful analytics, reinforcing accountability, and promoting continuous improvement.Another key advantage of the Smart Carbon Emission Tracking System is its role in raising awareness and creating behavioral change at the grassroots level. By transforming a complex global issue into an interactive, personalized, and daily activity, the system makes climate action approachable and achievable for everyone. It bridges the gap between awareness and action, enabling individuals to understand and reduce their environmental impact in a meaningful way.

In conclusion, the Smart Carbon Emission Tracking System is a step toward democratizing sustainability. Convert abstract environmental data into clear and manageable information and promote behavioral changes through participation, education, and motivation. By making emission tracking a regular part of people's lives, the system fosters environmental responsibility, encourages informed decision-making, and contributes to a broader cultural shift toward eco-conscious living. It is not just a tool for monitoring emissions, but a platform for building a sustainable future one kilometer at a time.

Chapter 2

Literature Survey

Chen and Li [1] proposed deep learning models for predicting urban air quality and carbon concentrations. Their approach integrated historical pollution data and meteorological variables into neural networks. The study demonstrated a significant increase in prediction accuracy compared to traditional statistical models. Their models help forecast air pollution trends in cities. This enables timely policy interventions and public health alerts.

Wang and Zhao [2] utilized satellite imagery and AI for real-time industrial carbon emission monitoring. Their system processes high-resolution satellite data to detect emission patterns across industrial zones. AI techniques were applied to distinguish carbon signatures from background noise. The methodology proves cost-effective and scalable for national-level monitoring. It supports regulators in identifying non-compliant industries efficiently.

Green and Carbon [3] introduced a blockchain-based carbon offset trading platform. The system ensures transparency and trust in carbon credit transactions. Smart contracts enforce rules automatically, minimizing fraud. Their work highlights how blockchain can bridge gaps in current emission trading systems. The platform supports global sustainability goals through decentralized accountability.

Singh and Patel [4] applied reinforcement learning in smart city energy systems to reduce carbon footprints. Their algorithm adapts to energy demand patterns, optimizing resource use. It enables real-time decision-making in dynamic urban environments. The study shows potential for smart grids to significantly reduce emissions. The model aligns with smart city sustainability goals.

Khan and Sharma [5] evaluated the environmental impact of cloud computing workloads. Their study quantified the carbon footprint of data centers using various ML workload types. Energy consumption was profiled and mapped to carbon emissions. Their findings stress the need for carbon-aware cloud resource management. The study promotes sustainable computing practices.

Liu and Zhang [6] forecasted renewable energy generation to stabilize power grids and reduce emissions. They used hybrid ML models to improve energy prediction accuracy. The study bridges the gap between clean energy forecasting and emission planning. Their approach supports energy grid reliability while minimizing fossil fuel dependence. This aids long-term climate strategies.

Nguyen and Kim [7] explored ML techniques for anomaly detection in carbon capture and storage systems. The models identify leaks and system inefficiencies in real time. Their framework enhances safety and performance in carbon sequestration facilities. Accurate anomaly detection reduces operational risks. This contributes to the viability of CCS as a climate solution.

Popov and Volkov [8] reviewed data-driven techniques for estimating forest carbon stocks. Remote sensing combined with ML was found effective in large-scale estimation. The study compared multiple models for biomass prediction accuracy. It highlights the importance of precise forest monitoring for carbon budgeting. Their work supports forest conservation initiatives.

Rahman and Bibi [9] developed an IoT-based smart waste management system. Their system reduces methane and CO2 emissions through optimized waste collection. Sensors detect bin fill levels and schedule pickups efficiently. The approach reduces vehicle trips and landfill emissions. It demonstrates how IoT can support municipal emission reduction efforts.

Gupta and Kumar [10] used explainable AI to identify key emission drivers in manufacturing. The models provided insight into the most carbon-intensive processes. Explainability ensured that industrial experts could interpret AI outputs. The research aids targeted emission reduction strategies. It promotes industry adoption of AI tools.

Davies and Brown [11] proposed ML-based predictive analytics for carbon footprints in supply chains. The system assesses supplier emissions and forecasts cumulative impact. Their tool supports sustainability assessments in procurement decisions. It helps companies monitor Scope 3 emissions. This enhances green supply chain practices.

Evans and Lee [12] integrated digital twin technology for real-time emission monitoring in buildings. Their system simulates energy usage and predicts carbon emissions under various scenarios. The digital twin is updated in real time using sensor data. The study offers a scalable tool for green building management. It aligns with smart building policies.

Miller and White [13] analyzed various carbon emission forecasting models in the transportation sector. The study compared ML and statistical models using transport datasets. Accuracy, robustness, and computational efficiency were evaluated. The research helps transportation planners choose suitable forecasting tools. Their findings support sustainable urban mobility planning.

Smith and Jones[14] developed a hybrid ML model for regional carbon budget estimation. Their approach combined satellite, meteorological, and economic data. The model produced region-specific emission trends. The study supports localized emission control policies. It enhances climate planning precision.

Garcia and Rodriguez [15] assessed edge computing's impact on data center emissions. Their case study showed that edge processing reduces centralized energy demand. The findings encourage distributed computing for greener data processing. Their model balances performance and environmental costs. It supports edge-enabled sustainable computing architectures.

Patel and Chen [16] worked on integrating smart grids with distributed renewable energy systems. Their model improved grid resilience and reduced carbon intensity. Real-time data was used to optimize load balancing and renewable usage. The research supports decentralized clean energy transitions. It fits modern grid sustainability requirements.

Devi and Reddy [17] applied computer vision for detecting industrial smoke plumes. Their models estimate plume size and carbon content from video footage. The approach offers continuous, automated emission surveillance. It enables fast violation detection. The system supports stricter industrial emission enforcement.

Thomas and Young [18] used sentiment analysis to understand public views on carbon policies. Social media and news data were analyzed using NLP techniques. Their findings reveal key topics influencing climate policy acceptance. The study helps design more effective communication strategies. It supports policy development through public engagement insights.

White and Green [19] introduced digital tools for personal carbon footprint tracking. Their system provides feedback and behavior change nudges to users. Gamification and social comparison improved engagement. It promotes individual accountability in emissions. The research supports consumer-level climate action.

Adams and Baker [20] reviewed AI-driven solutions for greenhouse gas monitoring. The study categorized tools by sector and technology used. Challenges in data availability and model transparency were discussed. The review offers a roadmap for future AI climate tools. It highlights cross-sector innovation in emission monitoring.

Chapter 3

Problem Statement

Transportation-related carbon emissions are a major contributor to global greenhouse gas (GHG) levels, significantly impacting climate change. However, individuals often lack the tools and knowledge to track their personal carbon footprint resulting from daily vehicle use. Existing emission monitoring systems are typically complex, industry-focused, and inaccessible to the average user. This gap prevents individuals from understanding the environmental impact of their transportation habits, limiting their ability to make sustainable choices. There is an urgent need for a user-friendly, accessible, and automated platform that helps everyday users monitor, manage, and reduce their vehicular carbon emissions in a meaningful way.

Problem Description

Climate change has emerged as a global crisis, largely driven by the increase in greenhouse gas (GHG) emissions. A significant portion of these emissions originates from fuel combustion in the transportation sector. Despite growing awareness of environmental issues, individuals and small organizations lack practical tools to quantify and reduce their own carbon footprint. Existing emission tracking tools are primarily designed for corporate or governmental use and often require specialized knowledge, making them unsuitable for general public engagement.This disconnect means that the average individual remains uninformed about their contribution to carbon emissions through everyday vehicle use. Moreover, small changes in behavior—such as reducing unnecessary travel, carpooling, or choosing public transportation—can collectively have a substantial positive impact, yet many users are unaware of their potential.Furthermore, current systems either require manual data entry or technical integration, which discourages regular usage. There is a noticeable lack of systems that automate data collection (e.g., through odometer inputs), provide real-time analytics, and offer actionable suggestions for emission reduction. The absence of motivational features also leads to low user retention in the few tools that do exist.The core problem is the lack of a personalized, automated, and engaging emission tracking platform that empowers individuals to monitor and improve their transportation habits. Without such a system, public participation in emission reduction remains minimal, and the broader goal of sustainable living becomes harder to achieve.Therefore, a solution is needed that not only simplifies the process of carbon tracking but also encourages behavioral change through intuitive interfaces, personalized feedback, and motivational tools such as gamification and community-based challenges.

3.1 Objectives

- Real-time Dashboards displays users carbon emissions visually, helping them understand and track their progress instantly.
- Personalized Goals allows users to set their own carbon reduction targets and monitor achievements, encouraging sustainable habits.
- Admin Dashboard gives administrators insights into user activity and app performance to improve engagement and system efficiency

Chapter 4

Software Requirements Specification

Functional Requirements

- **User Registration and Authentication:** Users should be able to securely register, log in, and manage their profiles.
- **Vehicle Data Entry and OCR Upload:** Users can manually enter odometer readings or upload odometer images for automated text extraction via OCR.
- **Emission Calculation Module:** The system must calculate CO_2 emissions based on vehicle data and emission standards.
- **Dashboard and Analytics:** Users should be able to view emission trends, reduction goals, and monthly statistics through an interactive dashboard.
- **ML-Based Emission Prediction:** Machine learning models predict emissions based on historical patterns and vehicle type.
- **Gamification and Badges:** Users should receive motivational badges and view their rank on leaderboards.
- **Personalized Recommendations:** The system must generate user-specific tips to reduce emissions.

Non-Functional Requirements

- **Platform Compatibility:** The system should be accessible on Windows 10/11, macOS, and Ubuntu 20.04+.
- **Performance and Scalability:** The application must perform efficiently under load and support future scalability.
- **Security and Privacy:** User data, including personal and vehicle information, must be encrypted and stored securely.
- **User Interface and Usability:** The interface should be intuitive, responsive, and easy to navigate for users with minimal technical knowledge.
- **Maintainability and Extensibility:** The codebase should follow modular and well-documented standards to allow future enhancements.
- **Availability and Reliability:** The system should offer high uptime with minimal downtime during usage.

Software and Tools Used

1. **Operating System:** Windows 10/11, Linux (Ubuntu 20.04+), or macOS : The system is designed to be platform-independent for development and deployment.
2. **Programming Languages:** Python (Flask, Django), JavaScript (React.js) : Python is used for backend logic, while React.js ensures a responsive frontend.
3. **Database:** MySQL : Used for structured data management including user information, emission logs, and system metadata.
4. **AI/ML Frameworks:** TensorFlow, Scikit-learn: These frameworks are used to train and deploy models for emission estimation and OCR.
5. **Web Technologies:** JavaScript, HTML5, CSS3, React.js : Build the interactive, browser-based user interface.
6. **Development Tools:** VS Code, Jupyter Notebook, Postman : VS Code is the primary IDE, Jupyter is used for ML model prototyping, and Postman is used for API testing.

7. **OCR Model:** Utilizes deep learning to extract odometer readings from uploaded images. It includes steps like image preprocessing, text detection, recognition, and post-processing.

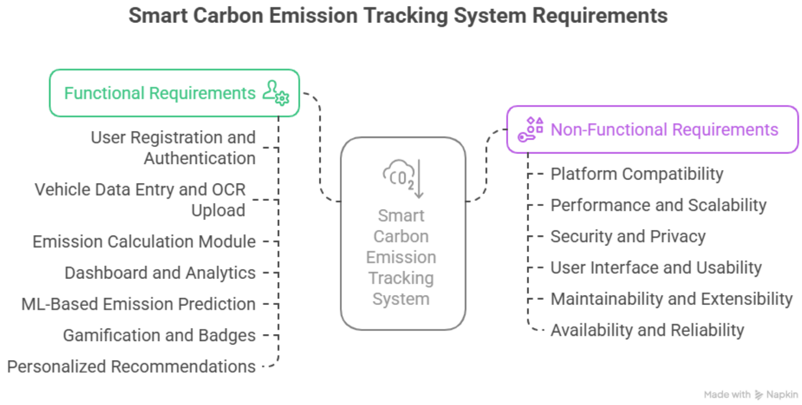

Figure 4.1: Pictorial Representation Of Software Requirements.

Chapter 5

System Design

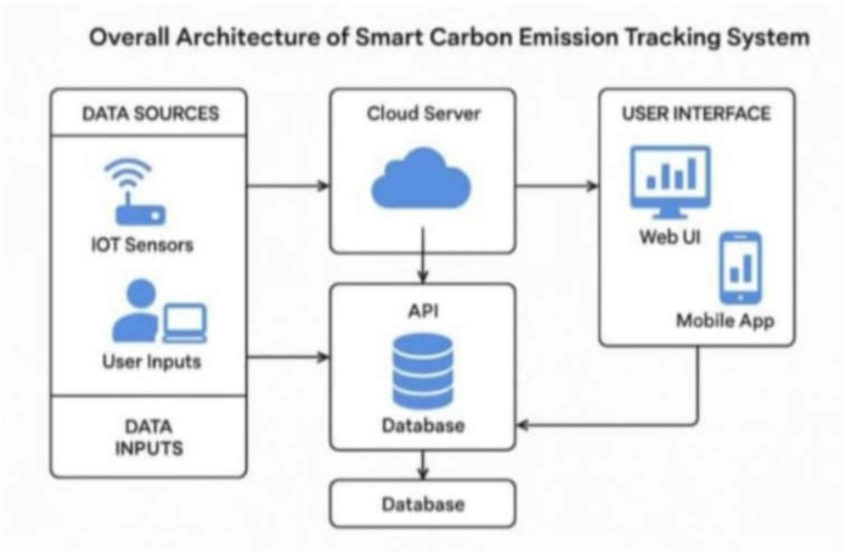

Figure 5.1: Architectural Diagram Based On Project.

This diagram outlines the comprehensive architecture of a Smart Carbon Emission Tracking System. It begins with Data Sources, encompassing both automated IoT sensors for real-time environmental data and user inputs for manual information. This raw data is fed into a central Cloud Server, which processes it into meaningful carbon emission insights. The Cloud Server interacts with a "Database" via an API for secure storage and retrieval of all processed and historical data. Finally, the system provides a User Interface through both a web application and a mobile app, enabling users to conveniently access, visualize, and manage their carbon footprint data, promoting informed sustainable living choices.

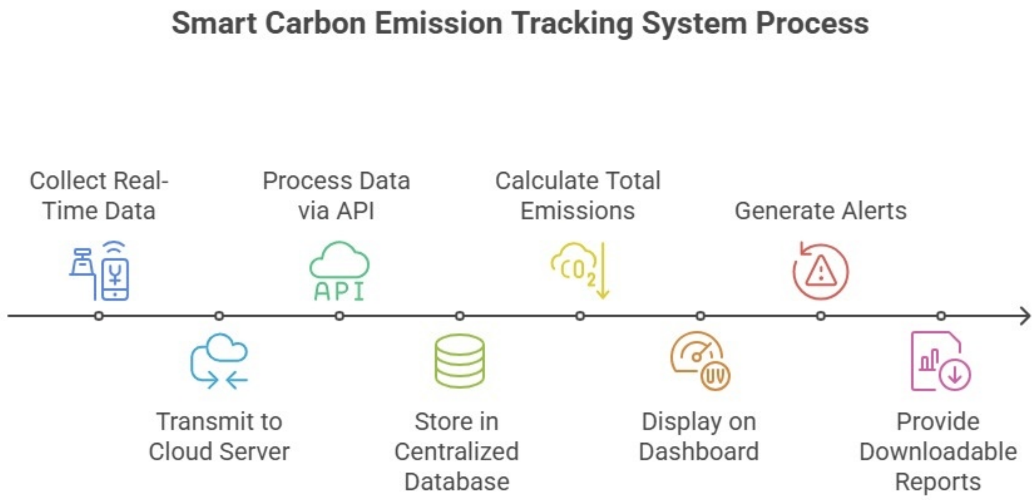

Figure 5.2: Pictorial Representation Of Data Flow Process.

This image illustrates the step-by-step process of the Smart Carbon Emission Tracking System. It begins with the collection of real-time data, which is then transmitted to a cloud server. This data is processed via an API before being stored in a centralized database. Subsequently, the system calculates total emissions and generates alerts if necessary. Finally, the processed emission data is displayed on a user-friendly dashboard, and users can access downloadable reports for further analysis. This visual timeline effectively outlines the continuous cycle of data handling, calculation, and reporting within the system.

The below Figure 5.3 and Figure 5.4 outlines the complete cycle of carbon emission tracking. It typically illustrates sequential stages from data collection, processing, and analysis, through to reporting and potential actions for reduction. Key steps may include real-time data acquisition, calculation of emissions, data storage, generation of insights, and feedback loops for continuous improvement. This visualization helps in understanding the operational flow of emission monitoring and management. It presents the functional components of the system, showing data input mechanisms, processing blocks, databases, and output channels. Each module is designed to perform specific tasks in emission tracking, ensuring modularity, reliability, and scalability. The arrows indicate the logical flow and dependencies among the components.

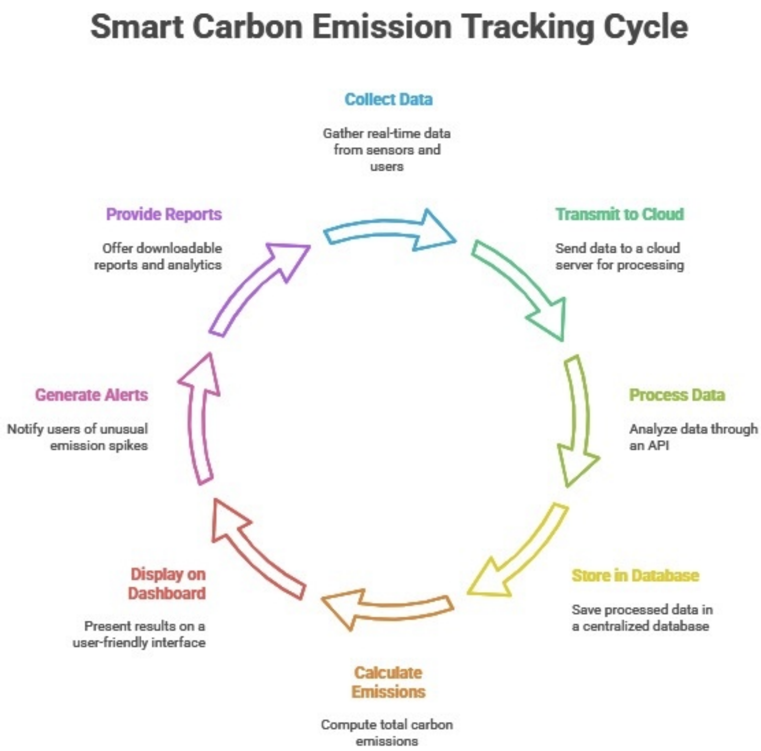

Figure 5.3: Diagrammatic Representation of Carbon Emission Tracking Cycle.

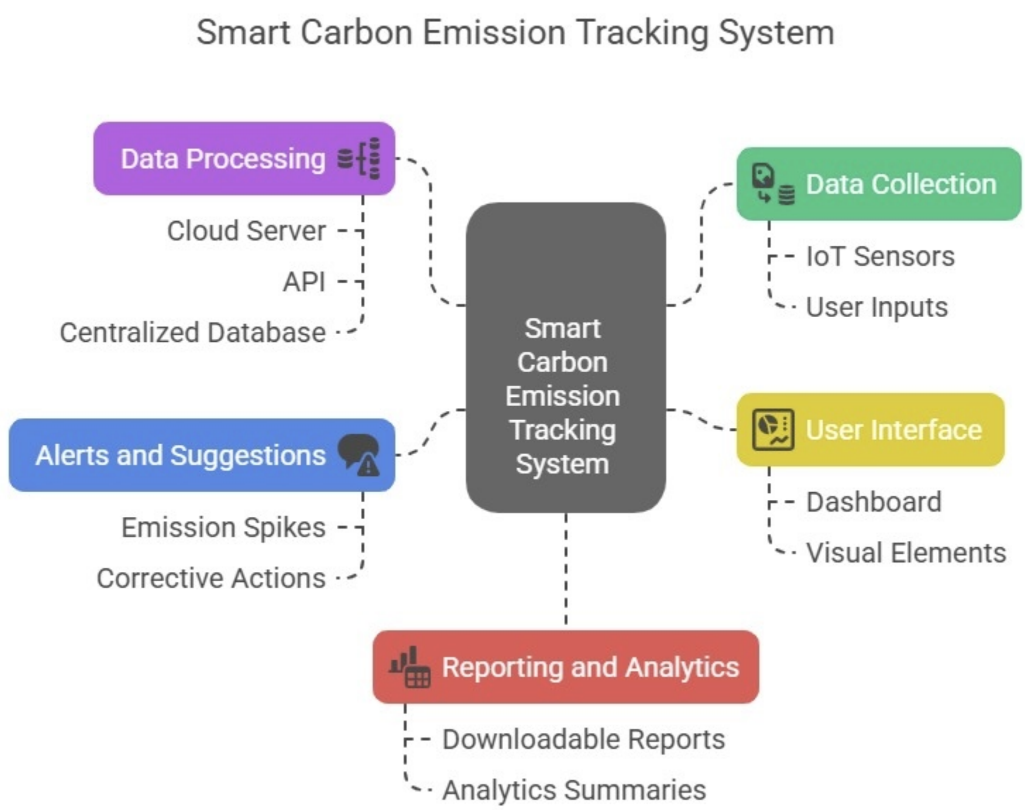

Figure 5.4: Block Diagram of the Project.

Chapter 6

Results and Discussion

The Smart Carbon Emission Tracking System (SCETS) is designed with features that promote user engagement, environmental responsibility, and data-driven decision-making. One of the primary components is user registration and authentication, allowing individuals to create accounts and securely log in. This ensures personalized access to dashboards while maintaining data privacy. Once registered, users can input travel data through emission data entry, either manually or by uploading images of their vehicle's odometer. The system then calculates the corresponding carbon emissions using standardized and scientifically validated emission factors to ensure accuracy.

To build awareness and reinforce eco-friendly habits, SCETS provides real-time dashboards that visually display individual carbon footprints using charts and statistics. Users can view their emissions trends daily, weekly, or monthly, helping them understand how their travel behavior impacts the environment. The platform also includes a goal-setting and tracking module, where users can set personalized emission reduction targets. Progress toward these goals is monitored continuously, with notifications and alerts encouraging sustained participation and behavioral change.

For increased engagement, SCETS features leaderboards and community involvement tools. These rank users based on their emission reduction achievements, fostering motivation through gamification and healthy competition. This social element helps transform carbon tracking from a personal task into a shared mission. On the administrative side, the admin interface provides full oversight of platform usage. Administrators can monitor active users, average emissions, and usage trends, while also detecting anomalies or periods of inactivity. Additionally, the system supports the generation and export of detailed analytical reports, which are valuable for institutional planning or regulatory compliance.Overall, SCETS combines ease of use with powerful functionality, making it a robust solution for promoting sustainable behavior. It not only helps users track and reduce emissions but also cultivates a community committed to fighting climate change through informed, everyday decisions.

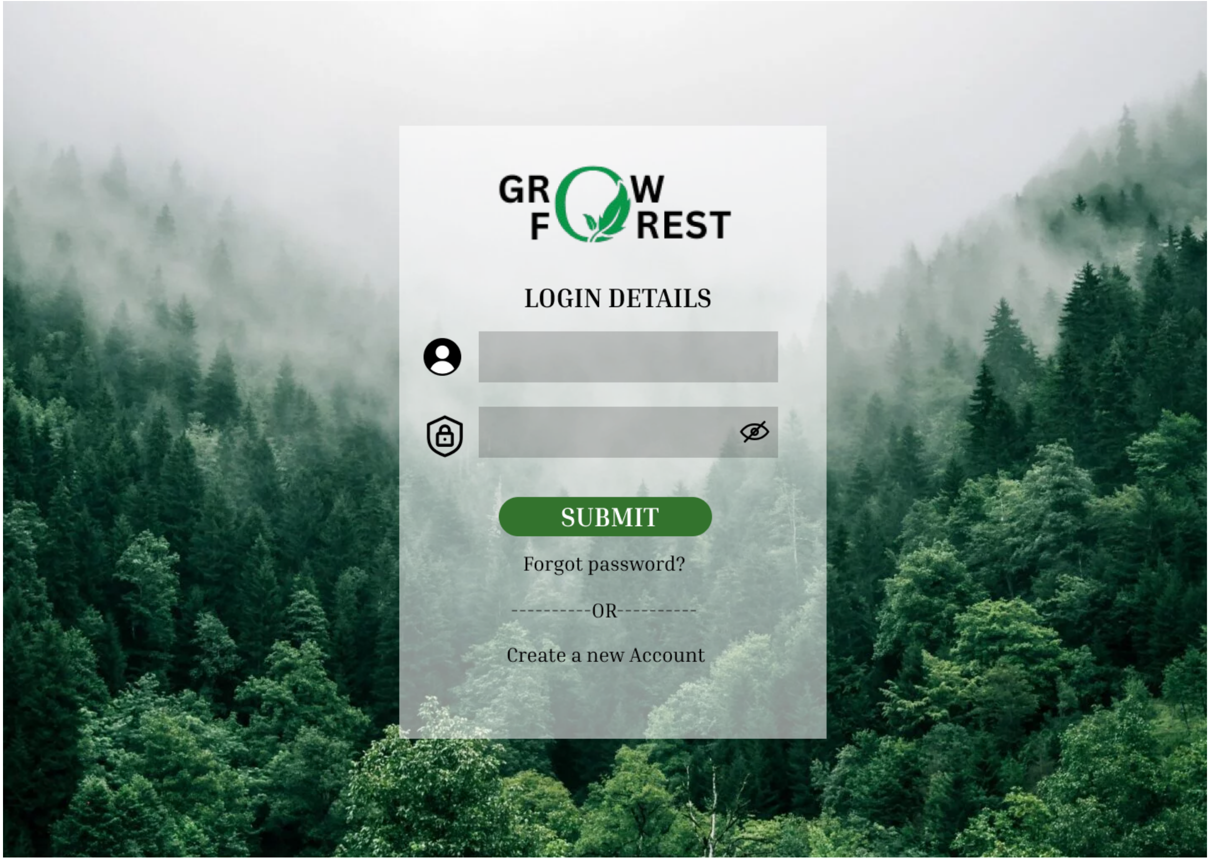

Figure 6.1: Login Page Interface.

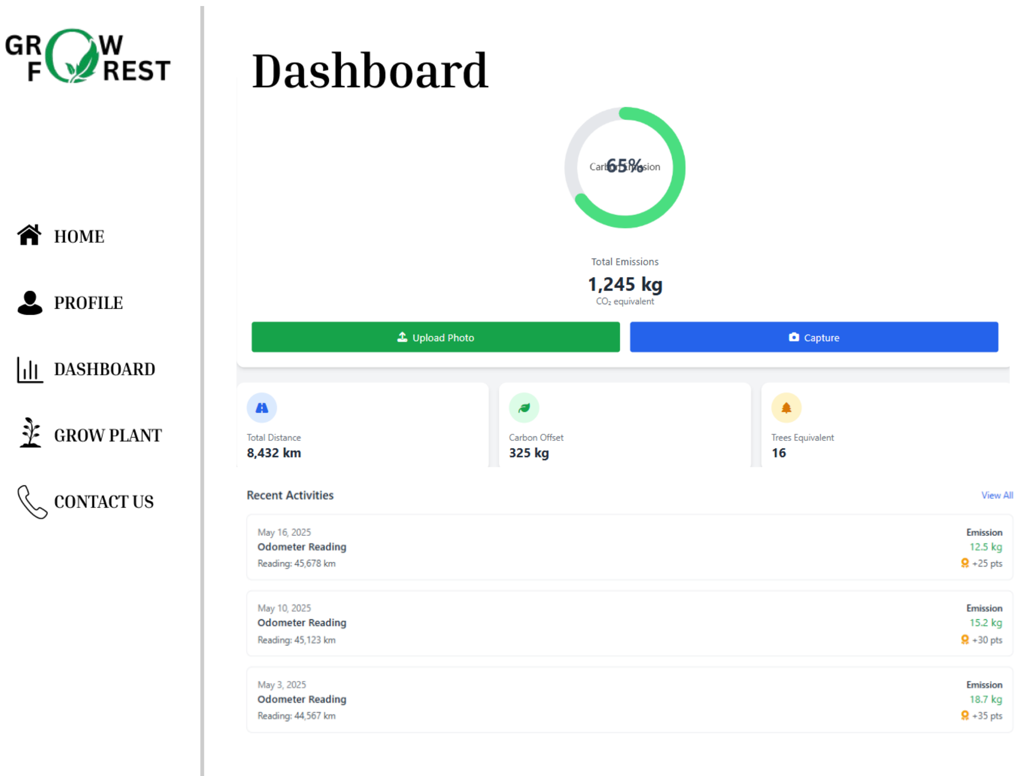

Figure 6.2: Dashboard Interface.

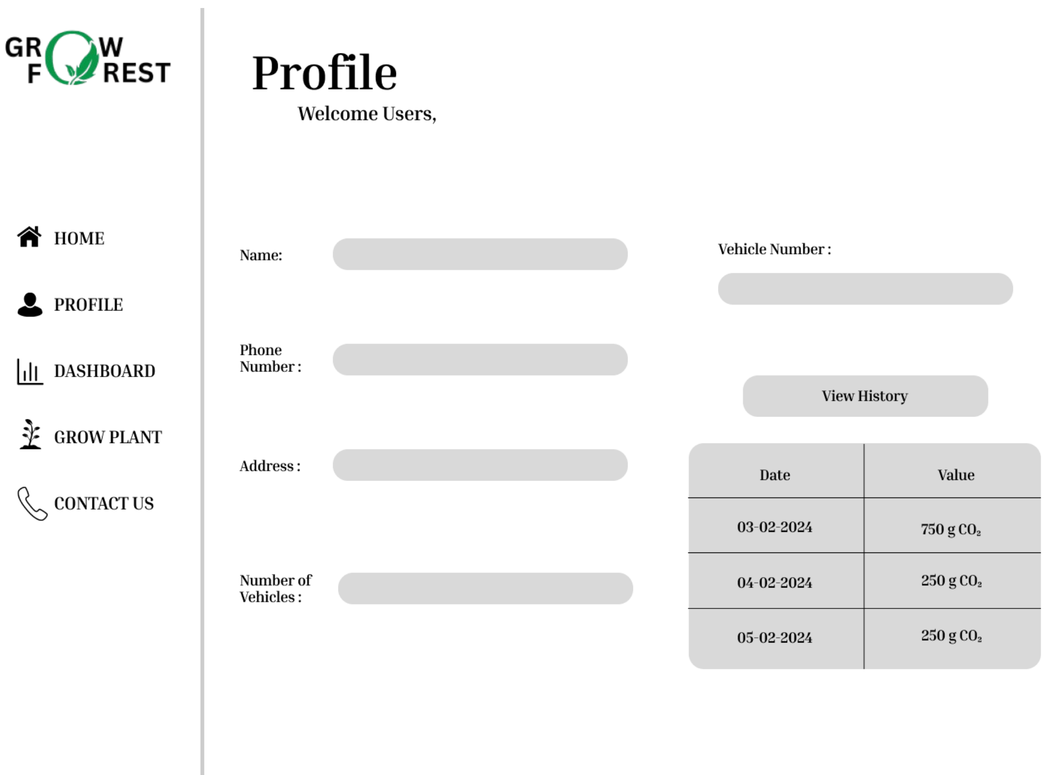

Figure 6.3: Home Page.

Chapter 7

Project Plan

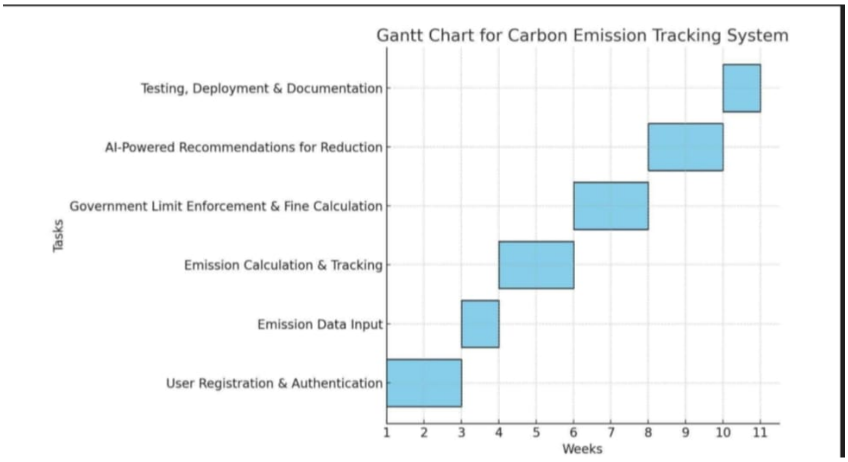

Figure 7.1: Project Plan(Using Gantt Chart).

This Gantt chart outlines the project timeline for developing a Carbon Emission Tracking System across 11 weeks. It begins with User Registration Authentication in Week 1–2, followed by Emission Data Input in Week 3. Next, Emission Calculation Tracking is carried out from Week 4–5. The system then implements Government Limit Enforcement Fine Calculation (Week 6–7), and AI-Powered Recommendations for Reduction (Week 8–9). Finally, Testing, Deployment Documentation are completed in Week 10–11. Each task is scheduled sequentially, ensuring a structured and systematic development flow.

Chapter 8

Conclusion

Carbon emissions are not just environmental indicators; they represent an immediate and quantifiable danger to the well-being of our planet and future generations. Every kilometer traveled by road contributes greenhouse gases to the atmosphere, intensifying climate change, polluting the air, and disrupting ecosystems. Although awareness around these issues is increasing, a consistent gap remains between understanding and taking action—particularly among individuals and small-scale enterprises. Regulatory efforts do exist, but the lack of accessible tools for tracking and managing emissions has hindered everyday contributors from making measurable changes. The Smart Carbon Emission Tracking System (SCETS) addresses this issue by offering a digital platform that empowers users to actively monitor and reduce their carbon footprint.

SCETS is designed with a user-centric approach, offering a smooth and intuitive interface across both web and mobile platforms. Users can easily register, input data, and track their emissions without any technical background. Emissions are calculated using scientifically verified coefficients and user-provided odometer readings, either through text input or uploaded images, ensuring both accuracy and trust. To keep users engaged, the system provides visual feedback through charts, graphs, progress bars, and gamified features like leaderboards and digital badges. These elements encourage goal-setting, competition, and collaboration within a community.

In addition to user-focused features, SCETS includes powerful administrative tools. The admin dashboard enables tracking of user activity across regions, report generation for compliance or analysis, anomaly detection, and targeted notifications. This makes the system suitable for large-scale deployment in government initiatives, educational institutions, and corporate sustainability programs. Pilot studies have shown that regular users of the system often adopt more environmentally conscious habits, such as reducing unnecessary trips, using public transportation, and improving fuel efficiency. SCETS ultimately represents more than a technological innovation—it is a behavioral catalyst designed to embed sustainability into daily life.

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