A Smart Segregated Emission Analytics Framework For Sustainable Living And Industrial Responsibility

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Abstract: Carbon emissions are one of the major contributors to global climate change and environmental degradation. Accurate estimation of carbon footprints is essential for promoting sustainable living and responsible industrial practices. Most existing carbon emission calculation systems rely on generalized regional averages, which often fail to provide accurate insights into emissions produced by individual households and industries. This paper proposes a Smart Segregated Emission Analytics Framework that calculates carbon emissions separately for residential and industrial sectors. The proposed system utilizes a Decision Tree machine learning algorithm to analyze energy consumption and predict emission levels effectively. By separating emission data sources and applying intelligent prediction techniques, the system provides more accurate emission estimates and helps identify major pollution contributors. The framework improves prediction accuracy, reduces computational complexity, and supports better environmental decision-making. The proposed system offers a cost-effective and scalable solution for monitoring and reducing carbon emissions in modern societies.

Keywords: Carbon Footprint, Carbon Emission Prediction, Decision Tree Algorithm, Machine Learning, Environmental Sustainability.

I. INTRODUCTION

Climate change has become a major global concern due to the increasing levels of carbon emissions produced by human activities. Carbon footprint refers to the total amount of greenhouse gases released into the atmosphere as a result of various activities such as electricity usage, transportation, industrial production, and fuel consumption.

Many existing carbon emission estimation systems rely on generalized statistical averages based on population data. Although these approaches provide a rough estimation of carbon emissions, they fail to represent the actual emissions generated by individual households or industrial facilities.

In recent years, machine learning techniques have been increasingly used to improve prediction accuracy in environmental analytics. Among these techniques, Decision Tree algorithms have proven to be effective due to their simplicity, interpretability, and ability to handle complex datasets.

This research proposes a Smart Segregated Emission Analytics Framework that separates emission sources into two categories: household emissions and industrial emissions. By applying machine learning techniques, the system predicts carbon emission levels more accurately and helps identify major emission contributors within a specific region.

II. ARCHITECTURE

The architecture of the proposed system consists of multiple components that work together to collect, process, analyze, and predict carbon emission data.
The system mainly includes the following modules:

➢ **Data Collection Module**
This module collects data related to energy consumption, fuel usage, electricity consumption, and industrial production activities.

➢ **Data Processing Module**
The collected data is cleaned and organized for analysis. This step removes inconsistencies and prepares the dataset for machine learning algorithms.

➢ **Machine Learning Module**
The Decision Tree algorithm is used to analyze input data and predict carbon emission levels. This model helps classify

emission levels and identify high emission contributors.

➢ **User Interface Module**

The user interface allows users to enter data and view emission analysis results. It provides separate dashboards for household users, industrial users, and system administrators.
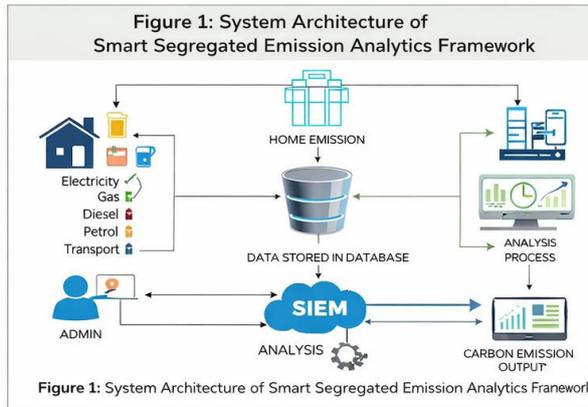

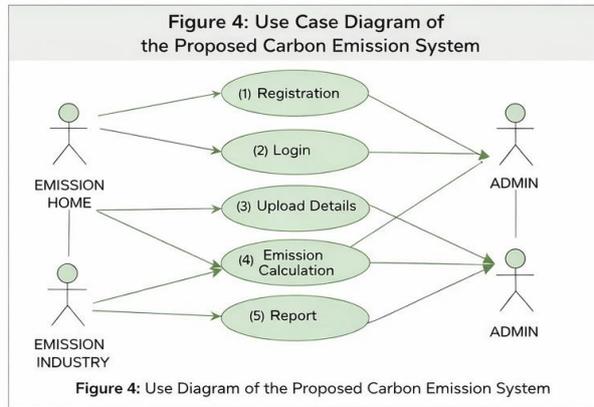Figure 1: System Architecture of Smart Segregated Emission Analytics Framework

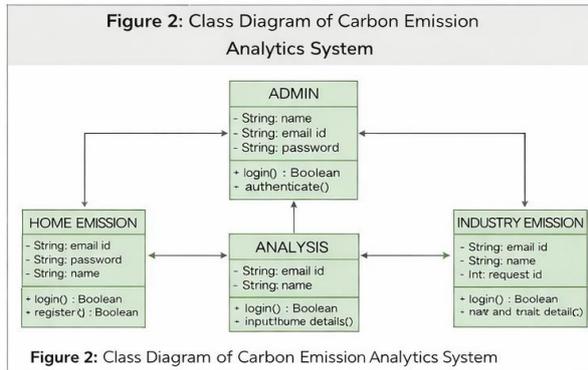Figure 2: Class Diagram of Carbon Emission Analytics System
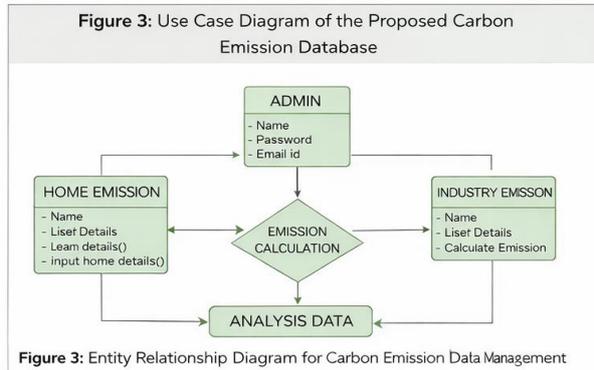
Figure 3: Entity Relationship Diagram for Carbon Emission Data Management

Figure 4: Use Diagram of the Proposed Carbon Emission System

FIG. 1 SYSTEM ARCHITECTURE OF SMART SEGREGATED EMISSION ANALYTICS FRAMEWORK

III. IMPLEMENTATION

The proposed system is implemented using modern web technologies and machine learning frameworks.

➢ **Software Tools**
1. Python Programming Language
2. Django / Flask Web Framework
3. MySQL Database
4. HTML, CSS, JavaScript

➢ **System Workflow**
1. User registers and logs into the system.
2. The user enters energy consumption details.
3. The system processes input data.
4. The Decision Tree model analyzes the data.
5. The system calculates predicted carbon emission levels.
6. The results are displayed through a graphical dashboard.

This implementation enables both residential users and industries to monitor their carbon footprint and understand their environmental impact.

IV. RESULTS AND ANALYSIS

The proposed system provides more accurate carbon emission predictions compared to traditional average-based estimation systems.

By separating emission sources and applying machine learning techniques, the framework achieves:

- Improved prediction accuracy
- Faster data processing
- Better identification of high emission contributors
- Efficient data management

The Decision Tree algorithm successfully analyzes emission patterns and helps users understand the major factors contributing to carbon emissions.

The system can also assist government organizations and environmental agencies in monitoring pollution levels and implementing sustainability policies.
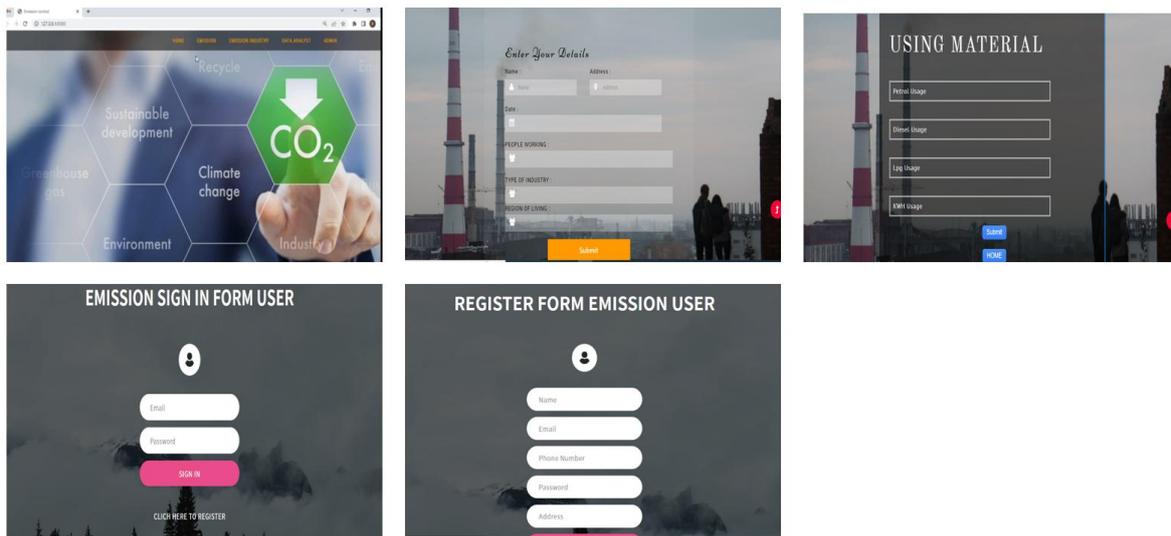

FIG. 2 WORKFLOW OF CARBON EMISSION PREDICTION SYSTEM

V. CONCLUSION

This paper presented a Smart Segregated Emission Analytics Framework designed to improve carbon emission prediction for both residential and industrial sectors. The proposed system utilizes a Decision Tree machine learning algorithm to analyze energy consumption data and predict carbon emission levels effectively.

By separating emission sources and applying machine learning techniques, the system provides more accurate and reliable emission estimates compared to traditional methods. The framework helps identify major emission contributors and supports better environmental planning and sustainable development.

In the future, this system can be enhanced by integrating real-time IoT sensors, advanced machine learning models, and large-scale environmental datasets to further improve prediction accuracy and environmental monitoring capabilities.

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