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Smart AI-Based Air Pollution Monitoring and Prediction System

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ABSTRACT- ***Air pollution is a growing environment concern that directly impacts public health and the ecosystem. With rapid urbanization and the industrialization, monitoring air quality has become essential for sustainable living. The Air Quality Index (AQI) is a key indicator used to assess air pollution levels and communicate associated health risks to the public. The fundamental aim of the Smart AI-Based Air Pollution Monitoring and Prediction System is to monitor air quality and accurately predict the Air Quality Index (AQI) using Artificial Intelligence and Machine Learning techniques. The proposed system is developed using the Flask framework and employs Machine Learning algorithms such as Linear Regression, Decision Tree, and Random Forest. The system evaluates the performance of each algorithm using standard metrics like R^2 Score, Mean Absolute Error (MAE), and Mean Squared Error (MSE) to identify the most accurate model for AQI prediction. The system categorizes AQI into levels ranging from Good to Hazardous and provides real-time health recommendations based on the prediction values. By offering an accessible and data-driven solution, this system aims to support individuals, policymakers, and environmental agencies in making informed decisions to reduce air pollution and improve public health.***

KEYWORDS: Air Quality Index, Air Pollution Prediction, Machine Learning, Random Forest, Flask Framework, Smart Monitoring System.

INTRODUCTION

Air pollution has become one of the major environmental challenges affecting human

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health and the ecosystem. With advancements in Artificial Intelligence (AI) and Machine Learning (ML), air quality prediction has become more accurate and efficient. This project combines AI-based Machine Learning techniques with environmental data analysis to monitor and predict the Air Quality Index (AQI). The proposed system not only provides accurate AQI predictions but also helps users, researchers, and environmental agencies make informed decisions by identifying air quality levels and supporting timely preventive measures for a healthier environment.

LITERATURE SURVEY

Air pollution monitoring systems have gained significant importance in recent years due to the increasing levels of environmental pollution and their harmful effects on human health. A Smart AI-Based Air Pollution Monitoring and Prediction System is an intelligent solution that combines Artificial Intelligence (AI), Machine Learning (ML), and environmental data analysis to monitor air quality and predict future Air Quality Index (AQI) levels. The primary objective of this system is to provide accurate air pollution predictions, support environmental monitoring, and help individuals and authorities take preventive measures to reduce the impact of air pollution.

RELATED WORK

Several researchers have contributed to the development of air pollution monitoring and prediction systems with the aim of improving environmental monitoring, public health, and decision-making. Early research focused on traditional air quality monitoring systems that relied on fixed monitoring stations to measure pollutant concentrations. Although these systems provided accurate real-time measurements, they lacked the capability to predict future air quality levels and required expensive monitoring infrastructure.

EXISTING SYSTEM

The existing air pollution monitoring systems mainly depend on fixed air quality monitoring stations that measure pollutant levels such as PM2.5, PM10, CO, NO_2, SO_2, and O_3**.** These systems provide only real-time air quality measurements and do not

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accurately predict future Air Quality Index (AQI) levels. The collected data is often displayed through monitoring dashboards without offering intelligent analysis or forecasting capabilities.Traditional systems require continuous monitoring by environmental agencies and generally rely on historical observations rather than advanced predictive techniques. They do not utilize Artificial Intelligence or Machine Learning to identify pollution trends or forecast upcoming air quality conditions. As a result, people receive limited early warning about hazardous pollution levels.

PROPOSED SYSTEM

The proposed system implements Artificial Intelligence (AI) and Machine Learning (ML) techniques to accurately monitor and predict the Air Quality Index (AQI**)**. It analyzes air quality parameters such as CO AQI Value, Ozone AQI Value, and NO_2 AQI Value to forecast AQI levels in real time. The system uses Machine Learning algorithms such **as** Linear Regression**,** Decision Tree**,** and Random Forest to improve prediction accuracy and identify pollution trends. A user-friendly Flask-based web application allows users to train the prediction model and obtain AQI predictions by entering pollution parameter values. The predicted AQI is automatically classified into standard air quality categories such as Good, Moderate, Unhealthy for Sensitive Groups, Unhealthy, Very Unhealthy, and Hazardous.

.SYSTEM ARCHITECTURE

The architecture of the Smart AI-Based Air Pollution Monitoring and Prediction System **consists** of an air quality dataset**,** data preprocessing module**,** Machine Learning model**,** Flask web application**,** and AQI prediction module**.** The system first loads the air quality dataset containing pollution parameters such as CO AQI Value, Ozone AQI Value, and NO_2 AQI Value. The data preprocessing module cleans the dataset by removing missing values and prepares it for model training.The Machine Learning module trains the selected algorithm Linear Regression, Decision Tree, or Random Forest using the processed dataset to learn the relationship between pollution parameters and the Air Quality Index (AQI). Through the Flask-based web application, users can train

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the model and enter air quality parameter values for prediction.

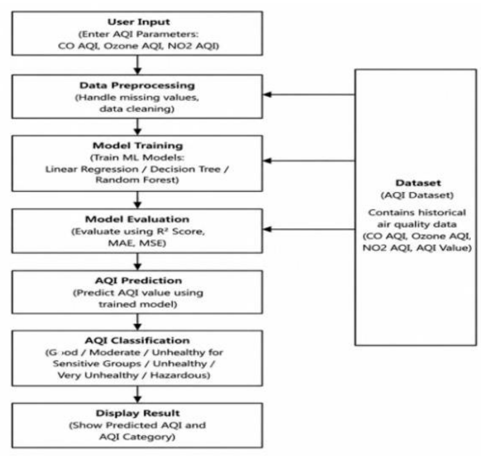

Fig 1: System Architecture

METHODOLOGY DESCRIPTION

The methodology of the Smart AI-Based Air Pollution Monitoring and Prediction System is designed to provide intelligent air quality monitoring and accurate AQI prediction using Artificial Intelligence (AI) and Machine Learning (ML) techniques. The system follows a structured approach that includes data collection, data preprocessing, model training, AQI prediction, air quality classification, and result visualization**.** Air quality data is first collected from the dataset, cleaned by removing missing values, and prepared for training. Machine Learning algorithms such as Linear Regression, Decision Tree, and Random Forest are trained using the processed dataset.

RESULTS AND DISCUSSION

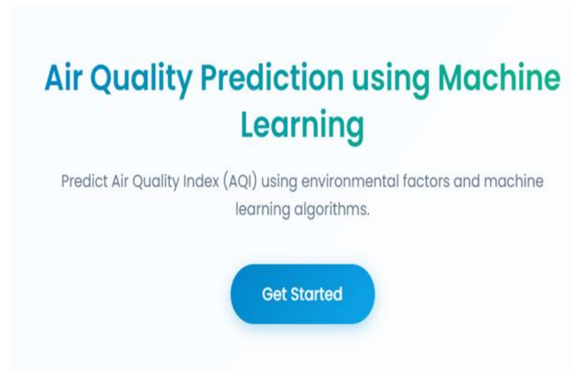

Fig2: Home page

The **Home Page** serves as the main interface of the Smart AI-Based Air Pollution Monitoring and Prediction System. It provides users with a simple and attractive interface to access the application's features. The page introduces the project and allows users to navigate to the login page, model training, AQI prediction, and other modules.

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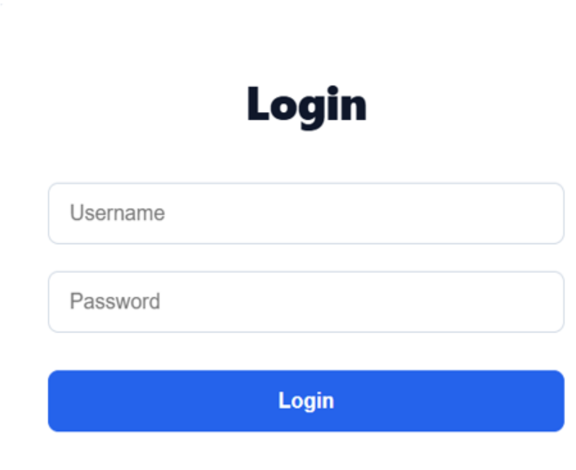

Fig 3: Login page

The **Login Page** allows authorized users to access the system securely. Users enter their username and password to log into the application. After successful authentication, they are redirected to the home page where they can train the machine learning model and predict the Air Quality Index (AQI).

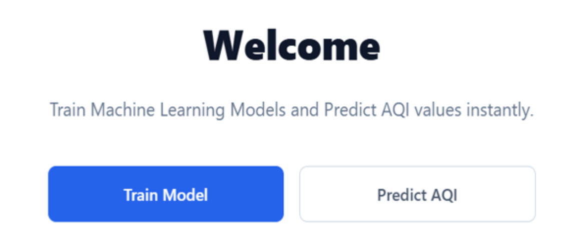

Fig 4: Train Model Page

The Model Training page enables users to select a Machine Learning algorithm such **as** Linear Regression**,** Decision Tree, or Random Forest. The selected model is trained using the AQI dataset, and the system displays performance metrics including Accuracy (R^2 Score)**,** Mean Absolute Error (MAE)**,** and Mean Squared Error (MSE)**.**

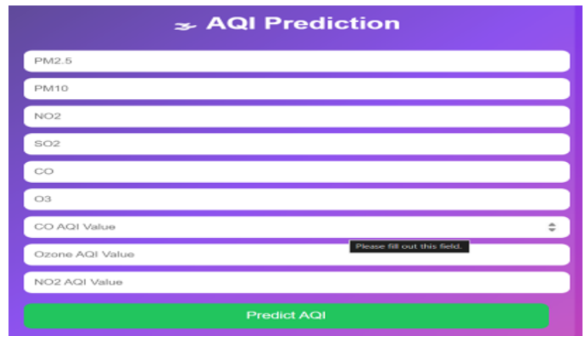

Fig 5: AQI Prediction page

The AQI Prediction page allows users to enter air quality parameters such as CO AQI Value**,** Ozone AQI Value**,** and NO_2 AValue. After clicking the Predict AQI button, the trained Machine Learning model predicts the Air Quality Index and classifies it into categories such as Good**,** Moderate**,** Unhealthy**,** Very Unhealthy**,** or Hazardous**.**

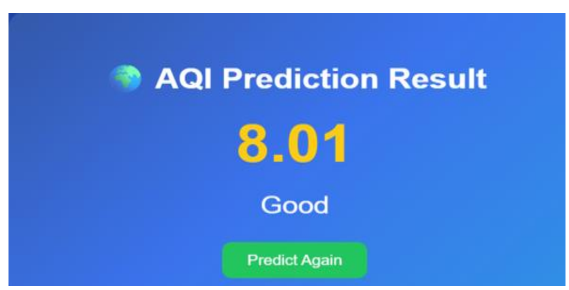

Fig 6: AQI Prediction Result page

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The Prediction Result page displays the predicted AQI value along with the corresponding air quality category. It provides users with an easy-to-understand interpretation of the air quality, helping them assess pollution levels and take necessary precautions.

CONCLUSION

The Smart AI-Based Air Pollution Monitoring and Prediction System was successfully developed using Python, Flask, and Machine Learning algorithms. The system accurately predicts the Air Quality Index (AQI) using air pollution parameters such as CO AQI Value, Ozone AQI Value, and NO_2 AQI Value. By comparing different Machine Learning models, the system provides reliable predictions along with performance metrics such as R^2 Score, MAE, and MSE. The web-based interface is simple, user-friendly, and enables users to monitor air quality efficiently.

FUTURE SCOPE

The Smart AI-Based Air Pollution Monitoring and Prediction System can be further enhanced by integrating IoT-based air quality sensors to collect real-time pollution data automatically. Advanced Deep Learning models such as Artificial Neural Networks (ANN) or Long Short-Term Memory (LSTM) networks can be incorporated to improve prediction accuracy. The system can also be extended with mobile applications, cloud-based storage, and real-time notification services to provide instant air quality alerts. Integration with GPS-based location tracking, weather forecasting, and government pollution monitoring systems can further improve the effectiveness of environmental monitoring and public health awareness.

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