Spatiotemporal Air Quality Index Forecasting Using LSTM Networks and Time-Series Modeling Techniques

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Abstract—The Spatiotemporal Air Quality Index (AQI) Fore- casting Using LSTM Networks and Time-Series Modeling Tech- niques focuses on predicting air pollution levels with the help of Machine Learning techniques. AQI is a numerical value that indicates how clean and polluted the air is. If the AQI is High that means Increase air pollution, and Low AQI means cleaner air. In this project we predict air quality index(AQI) by using some techniques i.e Artificial intelligence(AI) and Deep learning. The main problem is the air quality that no one predicted before, and there is no chance so after increasing pollution we take actions and precautions.The System how to work, it can be classified in two types IOT sensors and AI models. In IOT sensors they measure gases such as NO_2, SO_2, CO, O_3. AI models using LSTM, it will remember previous data and predict future values. The process is in five steps we have, 1). collect AQI data, 2). Clean and preprocess the data, 3). Train LSTM model using past AQI values, 4). Predict future AQI levels, 5). Display results using graphs and charts.

Index Terms—LSTM Model, Spatiotemporal Analysis, Air Quality Index(AQI), Time-Series Forecasting, Machine Learning.

I. INTRODUCTION

Nowadays, surrounding air is very important for our health. But in some areas due to vehicles, industries are releasing harmful gases into the air, for this the pollution is increasing day by day. Earlier, air quality was checked only in a few places by people. Because of this, the information was late and people could not take action on time. The air quality is very important, for our health and the earth. So the main aim of this project is to predict the air pollution in advance using Machine Learning techniques. In our model we can use digital technologies, and machine learning solutions for air quality management. Machine learning models, like the LSTM [3], can analyze data to predict future Air Quality Index (AQI) levels.Now, we use smart technology to solve this problem. Small devices called IoT sensors check the air all the time in many places. These sensors send the air data to a small computer called ESP32. A smart computer program called LSTM studies this data. It remembers old information and helps predict how clean or dirty the air will be later.

People can see the air quality on their mobile or computer screens. If the air becomes bad, they get an alert quickly.

II. PROBLEM STATEMENT

Air pollution is increasing day by day and it is injurious to people's health. We know how to clean the air in advance. But the previous used to find the air quality is not very accurate. Due to, people did not have exact data about the air quality.

So we need to overcome this problem, by using a better system that can learn from old air data and predict future air quality data. Using best models like LSTM [3]. It helps us to understand the air pollution changes easily and get alerts to take precautions.

III. OBJECTIVES

- To observe the air quality data and air pollution
- To collect previous air quality data
- To understand the air quality data changes instantly.
- To use accurate models like LSTM to predict the future air quality.
- To give alerts and updates when the air pollution is high.

To help the people stay healthy and safe.

IV. LITERATURE SURVEY

In olden days air pollution was checked by using few machines that worked slowly. And data collection was manual, so alerts and warnings came late. Sensors measure only one pollution and we don't have a proper internet. After methods used previous data but could not handle pollution changes. Now the system uses IOT and LSTM for real time prediction. They give data that will be useful for updated alerts. Many systems are more expensive and difficult to use everywhere. That's why we are using mostly the LSTM model [3], it is a type of deep learning technique. The LSTM is very simple, low - cost that can be easily found in air quality. It will be helpful for managing pollution in cities and taking precautions about their health.

V. RESEARCH GAP

From the existing literature [3], we observe that the old methods used to find air quality. But these methods do not give exact outputs. And also they did not understand changes in air overtime or how it is used in different places at a time. Because of this, the results are too late and the output is wrong. The old methods do not give alerts about the dirty air in the environment. So we need for better system to predict future air quality from the past air data.

VI. PROPOSED SYSTEM

In the proposed system we use a computer model to predict the air quality in future. It will collect old data and find future air quality. The collected data given to the long short-term memory(LSTM) model. Then we learn the air quality data changes day by day. Now the model then predicts future air quality correctly and the people also get alerts when the air pollution becomes high. This helps the government to take decisions about controlling pollution.

VII. METHODOLOGY

The methodology of this project, spatiotemporal AQI fore- casting, works step by step to check and predict the air pollution. This method helps me save time, reduce human work, people's health can be protected, and some areas will be glowing. The given diagram is the most important diagram. It provides how data flows from sensors to clouds through the LSTM model.

It can be consist of several steps as shown in the following

A. AQI data collection

The first step is collection of data using sensors. These sensors are placed in different places. It analyses the dangerous gases and estimates the smoke and harmful chemicals

B. Use ESP32

ESP32 is a type of sensor and it is also a chip, used for providing Wifi, and Bluetooth connectivity for devices. In this project it collects data from sensors. After this information will be sent to the cloud via the internet.
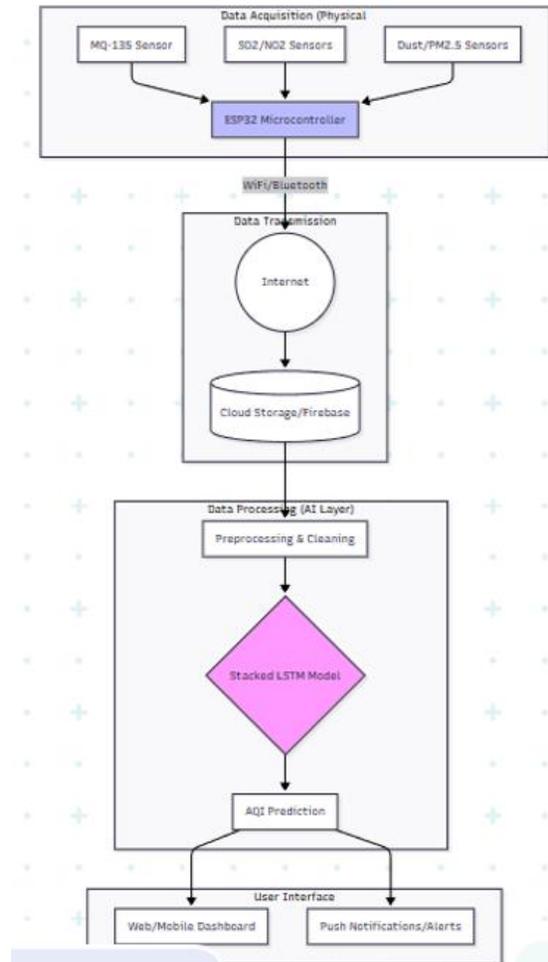
Fig. 1. Data flow diagram from sensors to cloud through LSTM model

A. Cloud storage

In the above step the collected data can be stored safely in the cloud. It will remember both previous data and future data. cloud is updated platform for prevent data from Unauthorized users.

B. Analysis of data

The data can be analysed by using LSTM [3], it is a type of deep learning technique. It learns past air quality data and based on the data next day values can be predicted.

C. Finding air quality

Finding the air quality by using AQI data will be very easy. It has two types. first one if there is HIGH AQI it shows more air pollution. And second one if there is LOW AQI data then it refers to cleaner air.
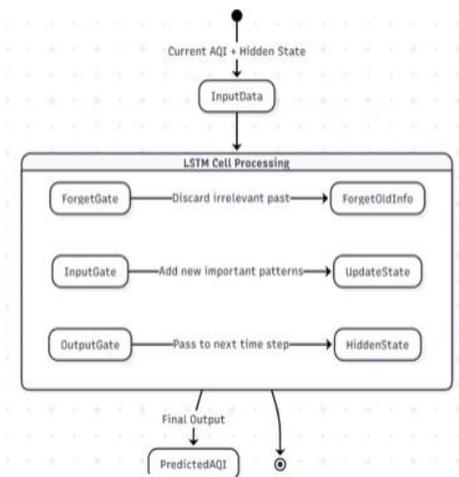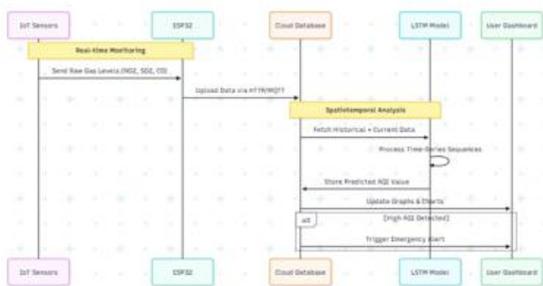

Fig. 2. Data analysis process using LSTM model

D. Output

The outputs will be shown on a dashboard in mobile and laptop.

1) Present air data
2) Previous data
3) Future air quality data

Fig. 3. Output dashboard displaying air quality data

E. Updates and Alerts

The LSTM predicts if the air pollution becomes high:

- Immediately alerts are sent to the people.
- Then people can take precautions about their health.

VIII. RESULTS & DISCUSSIONS

A. Results

This project gets excellent results about the air quality and the air pollution. Using the mini sensors placed in different locations they measure any dangerous gases, liquids, chemicals and also dust. These sensors worked well in full time and checked data would be sent to mobile and computer is known as ESP32. Then the ESP32 sent the data to the cloud via the internet.

The computer will understand the patterns by using past air quality data and future air quality data. A long short term memory(LSTM) model [3] used for this process, it remembers the previous air data and then predicts the future air quality data. During this, the computer tells whether the air pollution is clean or dirty.

The air quality data can be displayed using graphs and images. Because it is very easy to understand the users or people about the air quality. When the air quality level is crossed too much, then the model sends alerts to people. Automatically the people take safety actions before increasing air pollution, like wearing masks, staying in houses.

It helps to reduce the air pollution and take better actions. Finally, this project helps people's health, early warnings towards air pollution to people and developing the polluted areas, clean villages.
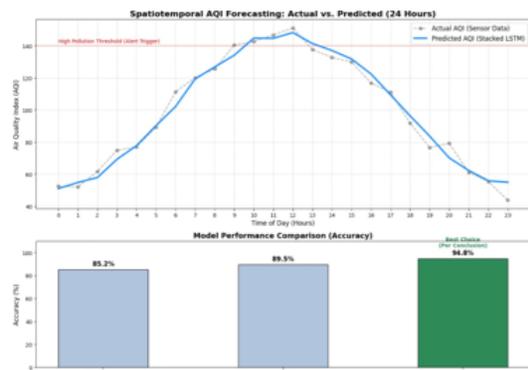
B. Discussion

This project aims to check the air quality by using smart sensors. It is better than traditional methods, because it works faster. In this we use one type of machine learning technique i.e LSTM model [3]. The LSTM model remembers the old data and predicts patterns. It will predict the dirty air in different places. When the air pollution becomes high then automatically people get alerts.

The results will be shown in the dashboard about air quality. The traditional method needs manual analysis. But the LSTM model automatically predicts accuracy without human power. This helps to reduce the pollution in cities. Overall, this project helps people stay healthy.

IX. CONCLUSION

This project presents a Spatiotemporal AQI Forecasting using LSTM that shows that we can predict air pollution. It analyses previous data and finds the polluted air in future. The LSTM model type of machine learning. In this we have different variants such as simple LSTM, stacked LSTM, CNN

- LSTM models [1]. The stacked LSTM has more than one LSTM layer. It learns better patterns in air pollution data. The Stacked LSTM type gives fast AQI predictions. Based on types of LSTM, the Stacked LSTM is the best choice because it can manage large time series data.

Overall, this project helps us to tell how much clean air data in the environment. For this, we use one model known as LSTM. It can remember old data and predict future air quality data.

People can see the predicted air quality data in screens and take precautions towards health and safety. And getting alerts when air pollution increases. The benefits of this project is to help the government control air pollution in cities. It shows the air quality in graphs.

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