DEVELOP AN AIR QUALITY INDEX MONITORING APPLICATION BASED ON INTERNET OF THINGS

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ABSTRACT

Air pollution has become a significant environmental concern, affecting public health and overall well-being. Monitoring air quality in real-time and providing accessible information to the public is crucial for making informed decisions about outdoor activities and potential health risks. The problem is the lack of real-time, easily accessible air quality information for the general public. Traditional air quality monitoring systems are often expensive and limited in coverage. The project proposes an IoT-based solution that employs low-cost air quality sensors to continuously monitor key air pollutants. The collected data from these sensors are transmitted wirelessly to a central data processing unit. The data is then analyzed, and the AQI is calculated using formulas. The calculated AQI values are then made available to the public through a website. The project leverages Internet of Things (IoT) technology, including microcontrollers, wireless communication modules , and cloud computing for data storage and processing. The website development may involve programming languages like Python. The final output of the project is an AQI monitoring website accessible to the general public. Users can view real-time AQI values, receive air quality alerts, and access historical data and trends.

Introduction

1. Background

Air pollution is a widespread issue that affects people's health and wellbeing. Although many individuals are concerned about the safety of their food and water, the quality of the air people breathe is often overlooked. Harmful gases, such as nitrogen oxide (NOX), are released into the environment through various sources, including open fires, vehicle exhaust, and industrial waste. These gases contribute to the formation of acid rain and can cause lung cancer and chronic heart disease, even when indoors, as outdoor pollution can seep inside through windows and doors. To address this issue, it is essential to implement air quality monitoring systems that enable people to track the levels of pollutants and take appropriate measures to mitigate their effects.

2. Objective

The Research objective is to develop an iot-based air quality detection website, which greatly reduces the threshold of air quality detection for ordinary people.

1. To develop a webpage that is fully functional for AQI, Temperature, Humidity and CO_2 value in air.
2. To detect air data by the IoT sensor and store to the cloud database.

3. Restrictions

The research of this project is mainly the production of web pages, the detection of air quality is based on IoT, and the data is uploaded to the cloud database.
In this project, the sensors and other devices used cannot be integrated. And because relatively cheap sensor equipment is used, the detected data may have a certain range of data deviation. In addition, the Raspberry Pi needs to have Wi-Fi to upload data to the database.

4. Importance

The development of an Air Quality Index Monitoring Application based on the Internet of Things is a significant step towards addressing the pressing issue of air pollution. By leveraging IoT technology and low-cost air quality sensors, the website provides accessible and user-friendly information, offering real-time AQI values and historical data for different locations. By making this data readily available to users, the project fosters greater awareness about air pollution and its impact on public health. It encourages individuals to take proactive measures to reduce exposure to harmful pollutants and adopt environmentally conscious practices.

5. Literature Review

Air pollution is a significant environmental issue affecting the health and well-being of people worldwide. The Internet of Things (IoT) offers promising opportunities to monitor air quality in real-time, providing valuable data for informed decision-making and public awareness. This literature review aims to explore existing research on IoT-based air quality monitoring systems and applications, with a focus on their design, implementation, and potential impact on public health and environmental sustainability.

IoT-based Air Quality Monitoring Systems:
Several studies have explored the design and architecture of IoT-based air quality monitoring systems. These systems typically consist of sensor nodes deployed to measure pollutant concentrations, which then transmit data to website for analysis and visualization.

Sensor Technologies for Air Quality Monitoring:
The literature indicates a variety of sensor technologies used in IoT-based air quality monitoring. Gas sensors and environmental sensors play a crucial role in detecting pollutants.

IoT Communication Protocols and Connectivity:
Studies have investigated various communication protocols suitable for IoT-based air quality monitoring applications. Wireless technologies like Wi-Fi, Bluetooth are often used to ensure seamless data transmission between the sensor nodes and the central server.

Research Methodology

Study Methodology in a technical report is the part that explains the methods and approaches used in conducting the study. It also describes the specific development process model used and explains why the process model was chosen.

In the technical report, several important elements are included:

1. Development Process Model

The development process model used for developing the Air Quality Index Monitoring Application based on Internet of Things (IoT) is the Waterfall Model. The Waterfall Model is a traditional software development approach that follows a linear and sequential process, where each phase must be completed before moving on to the next one.

The reasons for choosing the waterfall model are as follows.

Sequential and Linear: The Waterfall model follows a sequential and linear flow, with each phase dependent on the completion of the previous phase. It emphasizes a structured and well-defined approach to software development. My software development process fits it perfectly.

Well-Defined Phases: The Waterfall model typically consists of distinct phases, such as requirements gathering, system design, implementation, testing, deployment, and maintenance. Each phase has specific objectives and deliverables.

Document-Driven: The model places significant emphasis on documentation. Detailed requirements, design specifications, and plans are documented before proceeding to the next phase. This documentation serves as a reference throughout the project lifecycle.

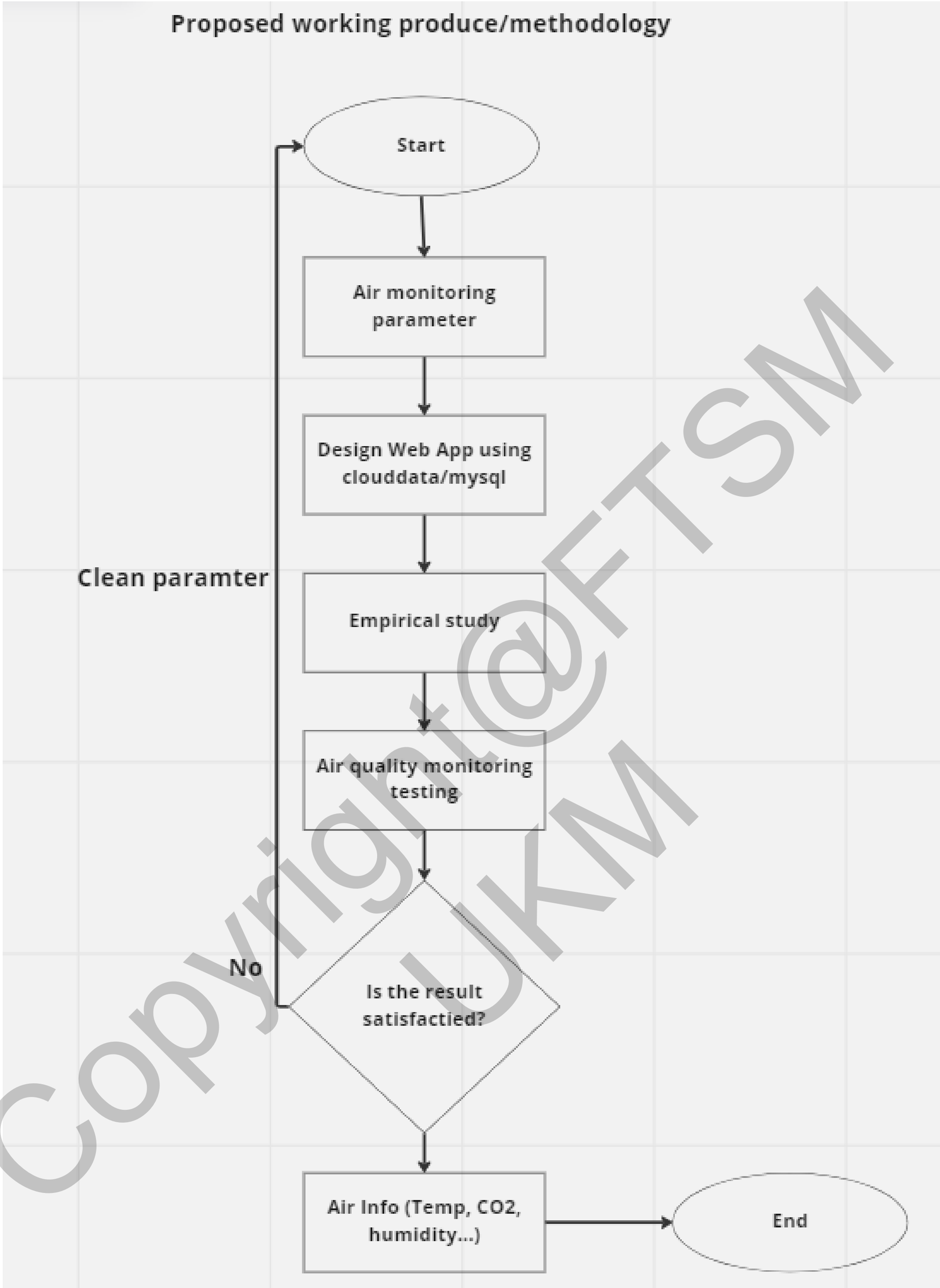

Figure 1: Proposed working methodology flowchart

2. Data Collection Method

Air quality data is collected through sensors connected to the Raspberry Pi. The sensors measure various air quality parameters, including temperature, humidity, carbon dioxide (CO_2), and air quality index (AQI). The Raspberry Pi acts as a data aggregator and transmitter. It receives data from the sensors and uploads it to a web database.

3. Data Analysis Method

The collected air quality data in the web database will undergo analysis using statistical methods and data visualization techniques. The objective is to derive an accurate and comprehensive Air Quality Index (AQI) that provides real-time information on air pollution levels.

The website will display the air quality data in a variety of ways. Display the latest data in the form of a dashboard, making the data intuitive and clear. Select a date and present all data in a tabular form, allowing users to view any time's air data. A histogram is used to present AQI data, and users can visually see the changes in air quality.

4. Measurement and Measuring Tools

In the development of the Air Quality Index Monitoring Application based on Internet of Things (IoT), evaluating its effectiveness and performance is essential to ensure its accuracy, reliability, and user satisfaction. The measurement and measuring tools used in this project aim to assess various aspects of the website's functionality and user experience. Below are the detailed measurement and measuring tools employed.

4.1 Data Presentation Accuracy

To measure the accuracy of data presentation, a validation process will be conducted. This process involves comparing the air quality data presented by the website with reference data from validated and reliable sources, such as official air quality monitoring stations or environmental agencies. Discrepancies between the website's data and the reference data will be analyzed, and corrective measures will be taken if necessary.

4.2 User Feedback and Usability Testing

User feedback will be collected through surveys, questionnaires, or interviews to gauge users' satisfaction with the website's design and functionality. Usability testing will be conducted to identify any usability issues or bottlenecks in the user interface. Participants will be asked to perform specific tasks using the website, and their interactions will be observed and recorded. Feedback and observations will be analyzed to identify areas of improvement and make necessary adjustments to enhance the website's usability.

4.3 Data Upload Frequency

The frequency of data uploads from the Raspberry Pi to the web database will be monitored to ensure that air quality data is collected and updated in real-time. Data upload intervals will be optimized to strike a balance between real-time updates and efficient use of network resources.

Results and Discussions

The findings are meticulously organized in a systematic and concise manner, accompanied by a range of graphical representations, tables, and charts that are labeled consecutively for ease of reference.

Real-Time Dashboard

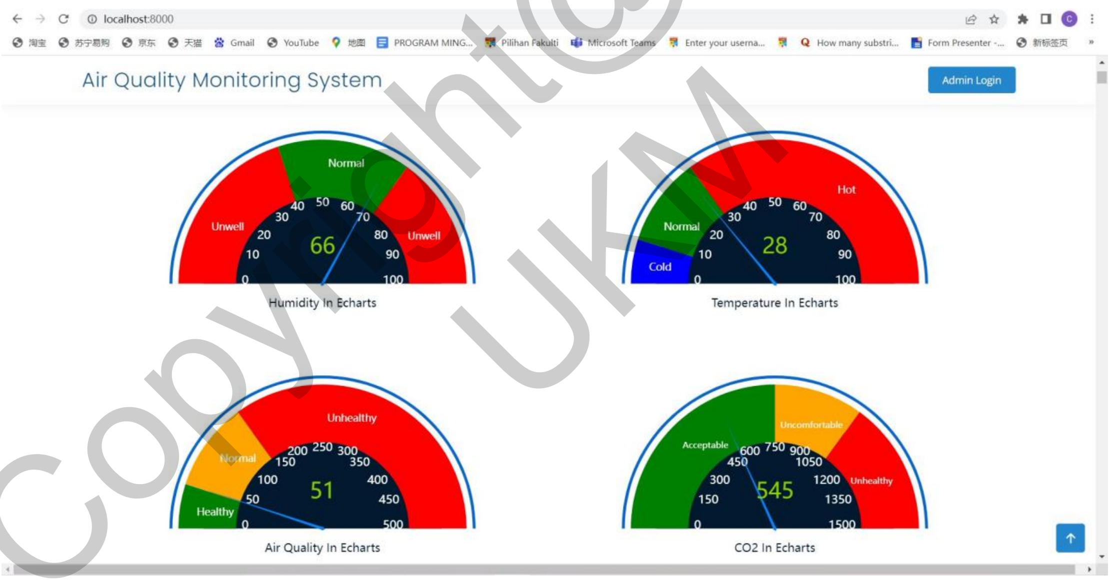

Figure 2: Real-Time Dashboard

The real-time dashboard displays the current Air Quality Index (AQI) and other data information, including Temperature, Humidity and CO_2. Users can monitor air quality levels at a glance, enabling them to make informed decisions about outdoor activities and precautionary measures.

Historical Charts

Figure 3: Historical Charts

Time-series charts show trends in air quality over specific time intervals, ranging from daily to monthly data. Users can identify patterns and fluctuations in air quality, helping them understand seasonal variations and pollution trends.

Detailed Information Table

Display all the data detected at each time node, and give the judgment of the air quality level according to the AQI value.

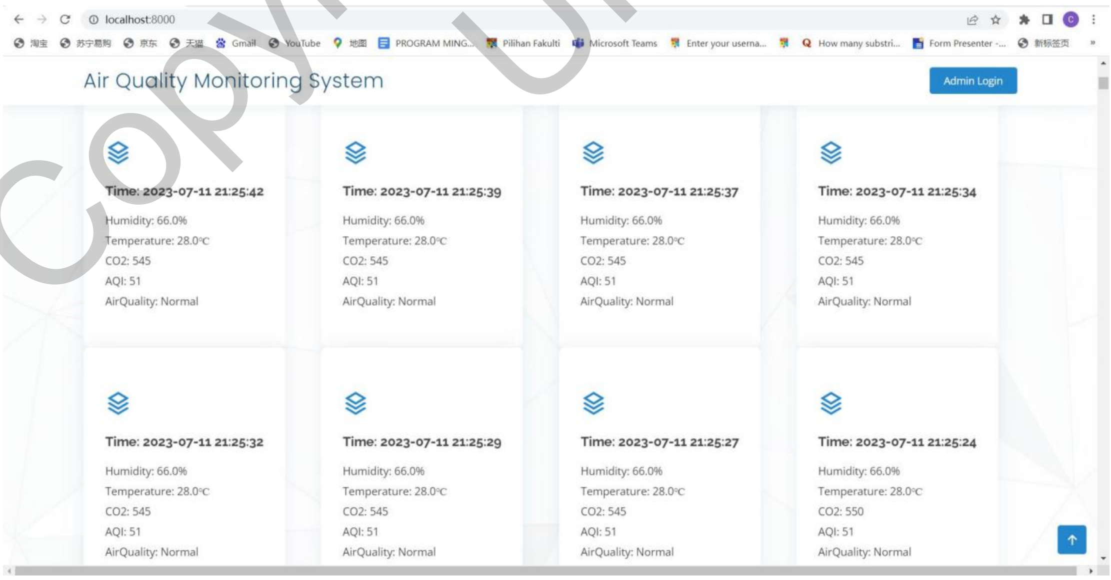

Figure 4: Detailed Information Table

Analysis of Results:

The presented results demonstrate the successful development and implementation of the Air Quality Index Monitoring Application based on IoT. The website provides real-time and historical air quality information through an intuitive and user-friendly interface.

Comparison with Previous Studies:

In comparison to other air quality monitoring website, the website stands out for its seamless integration of IoT sensors, data analysis, and web-based presentation. The use of IoT technology ensures continuous data collection and transmission, providing users with up-to-date information. Furthermore, the graphical representation of data aids in easy interpretation, enhancing user awareness of air pollution levels.

Explanation:

The study results confirm that the Air Quality Index Monitoring Application effectively fulfills its objectives of providing accurate and reliable air quality information to users. The system's use of Raspberry Pi as a data aggregator and transmitter ensures efficient data collection, and the Waterfall Model's development approach guarantees a well-structured and thoroughly tested website.

Implications and Conclusions:

The implications of this study extend to various fields, including environmental science, public health, and urban planning. By empowering individuals with real-time air quality data, the website contributes to increased public awareness of air pollution's impact on health and fosters responsible decision-making.

Future Recommendations:

While the website has been successfully developed and deployed, future research could focus on enhancing its capabilities. Potential areas for further study include:

Integration with air quality prediction models for more accurate forecasting. Expanding the sensor network to cover a wider geographical area for comprehensive air quality monitoring. Exploring the use of machine learning algorithms to improve the website's AQI prediction accuracy.

Conclusion

This technical report has presented the successful development and implementation of the "Air Quality Index Monitoring Application based on Internet of Things (IoT)." The study aimed to create a robust and user-friendly website that provides real-time air quality information to users, empowering them to make informed decisions for their well-being.

Summary of Study Results:
The study results showcased the website's efficacy in collecting and presenting air quality data through IoT-connected sensors. The real-time dashboard, historical charts, and datailed information table offer users comprehensive insights into air pollution trends and concentrations.

Objectives:
The objectives set in the Introduction section were fully achieved. The website achieved its primary goal of providing accurate and timely air quality information to users, enabling them to monitor pollution levels and protect their health.

Impact and Implications:
The Air Quality Index Monitoring website has significant implications for environmental science, public health, and urban planning. By raising awareness of air pollution's detrimental effects on health, the website promotes responsible decision-making and encourages individuals to adopt eco-friendly practices. The availability of real-time air quality data can aid local authorities in implementing pollution control measures and improving overall air quality standards.

Weaknesses and Recommendations:
While the website proved successful, there are areas that warrant improvement. there are still problems such as the webpage needs to be covered by the WIFI signal
to receive the data and store it in the database and the need for socket power supply. Additionally, the accuracy of air quality sensors is critical. Further research could focus on sensor calibration and validation to ensure precise and reliable measurements.

Overall Summary:
In conclusion, the Air Quality Index Monitoring website based on IoT has emerged as a valuable tool for tracking air pollution levels. The systematic presentation of data, along with insightful analysis, demonstrates the website's efficiency in delivering real-time air quality information to users.

The successful implementation of this website lays the foundation for future advancements in air quality monitoring and environmental sustainability efforts. By utilizing IoT technology, we can continue to refine and expand the website's capabilities to foster a healthier and cleaner environment.

Appreciation

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