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ECORELEAF: An IOT based Eco-Solution

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Abstract

Green space usually comes at a price when living in a city. The state of air pollution is escalating globally. A sustainable solution to this problem is to plant more trees, but it's not as simple as it seems. Selecting the right plants that will thrive in the local climate is also important. It has long been known that plants can help in the reduction of pollutants in the air. We introduce a novel solution, Ecorelaf: A Plantation Prediction Application, which leverages the integration of Artificial Intelligence and the Internet of Things (AIoT) for effective environmental monitoring and conservation. Through a network of sensors and IoTs strategically placed to monitor pollution levels, Ecoreleaf collects valuable data on air quality, which is then seamlessly transmitted to a centralized database. Which then calculates the AQI according to the various pollutant levels.Moreover, future levels of the air quality index (AQI) can be predicted using data on air quality.[13] Our Objective is to combine the pollution data i.e. AQI of an area to design a model which predicts suitable plants for that area. ECORELEAF is a user-friendly application designed for keeping Environmental Monitoring and Conservation in mind to bridge the gap between information and action.

Keywords

IOT, Environmental Monitoring, Air quality, Real time analysis, Conservation.

1. Introduction

The sustainability of the environment and public health are increasingly threatened by air pollution and it may lead to the shortening of expectancy by 22 months in large cities. [1] Conventional approaches to this problem frequently fall short because they don't take advantage of plants' innate ability to purify the air. Plants can help in the avoidance of 670,000 cases of acute respiratory symptoms. [11]

Because it necessitates a careful balance between air quality tolerance, climate adaptability, and local accessibility, choosing the appropriate plant species for a given location is essential. The answer to this problem is the Ecoreleaf. It offers an easy-to-use platform for evaluating data on air quality, making recommendations for appropriate plant species that both thrive in the surrounding environment and successfully reduce air pollution. Important components are missing from the current method of choosing plants to reduce air pollution:

Local air quality consideration: Current techniques frequently overlook the differences in ozone concentrations and air pollution levels between different locations.

Pay attention to plant tolerance: To ensure successful growth and efficient pollution reduction, choose plants that can withstand local air pollution and climate conditions.

Accessibility of plant species: The broad implementation of this strategy depends on the identification of locally thriving plants that are easily accessible to users.

Convenience and user support: Users are currently unable to make knowledgeable plant decisions due to a lack of readily available resources and professional advice.

These flaws result in:

Inefficient pollution reduction: Selecting the incorrect plant species may result in insufficient air purification and resource waste.

Unsuccessful Plant growth: Unsuitable plants are likely to suffer and not flourish in the surrounding environment.

Missed chances to improve the environment: We lose out on important chances to build healthier communities by not fully utilizing plant-based air purification.

Ecoreleaf takes care of these problems by:

- By utilizing real-time air quality data, giving priority to plant species that can withstand a range of pollution levels and climates.
- Forming partnerships with nearby nurseries to ensure seamless plant accessibility.
- Its intuitive interface enables users to make well-informed decisions, and a centralized communication system guarantees expert advice and assistance.
- Real-time monitoring is made possible by the integration of sensors and Internet of Things (IoT) technology.With its dynamic and data-driven approach to addressing the intricate interactions among air quality, plant selection, and community engagement, Ecoreleaf represents a paradigm shift in the field.

2. Literature Review

Air pollution is a major environmental and public health concern. According to the World Health Organization (WHO), 9 out of 10 people worldwide breathe air that exceeds safe limits. Air pollution is estimated to cause 7 million premature deaths each year, making it one of the leading environmental risk factors for mortality. Acid rain and global warming are two consequences of air pollution's major impact on the concentration of atmospheric constituents. It is crucial to have an air pollution monitoring system in place to prevent these harmful natural imbalances. This paper aims to develop a real-time wireless air pollution monitoring system, which is an efficient way to monitor pollution using wireless sensor networks (WSN) in real time [6].

Recent technological developments have opened the door for the integration of Internet of Things (IoT) devices and sensors in the field of improving air quality. By providing real-time monitoring capabilities, these innovations make it possible to address air pollution in a flexible and adaptable manner. Studies conducted in this area highlight how IoT and sensors can supply precise and timely data, increasing the efficacy of green projects meant to reduce air pollution. [2]

The Internet of Things (IoT) solution uses multiple IoT devices and connected sensors to monitor pollution levels, particularly those found in cities. [3] The concept calls for placing several stations in various parts of cities. Those stations upload data to the Internet of Things cloud on a periodic basis.One of the concepts behind the sensors is that, should they become widely available, they would enable regular people to take greater responsibility for air pollution.Modern developments in micro-electromechanical systems (MEMS) and electronic circuit miniatures have produced small sensor nodes that combine a wireless transceiver, memory, a central processing unit (CPU), and multiple sensors.There are also inexpensive sensors for measuring particulate matter (PM), and mass concentration of PM is usually determined by how much light the airborne particles scatter. [14] A collection of these readily deployable sensor nodes, known as sensor networks [9, 10], offer a high degree of visibility into actual physical processes as they occur, which is advantageous for a range of applications.

For example, users might steer clear of dangerously high areas and might be more inclined to put pressure on local authorities to address the issue. Additionally, the public may receive far more thorough and precise reports on air quality than is currently feasible thanks to data collected from a wide variety of sensors located throughout an area. [3] The university claims that even though San Diego County is roughly 4,000 square miles (10,360 sq km) in size, there are currently only ten or so air-quality monitoring stations in the county.

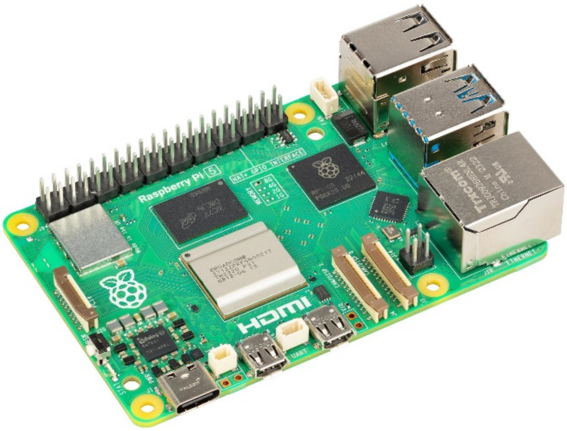
The following elements make up the Internet of Things platform for tracking pollution in smart cities: Sensors for different metrics measurements, both wired and wireless; IoT node(s) or gateway(s) for data collection—development boards are currently utilized for proof of concept; [1] IoT clouds can receive data through IoT communication middleware that has security features. This technique will reduce the hardware utilized to the previous level by utilizing IOT. The setup of the system is in an enormous diversity in the observation area to establish a network of observation devices. In addition to the automatic pollution observation system's functions, it also displays the ability to predict the development trend of pollution by analyzing data from sensors in real time and making it available to users in the front-end perception system.[7]

A network of smartphone-based air pollution monitors has been created by researchers at the University of California, San Diego. Users can use the monitors to track pollution levels in real time and contribute daily trends in the city's air quality to a central database. The sensors on the so-called CitiSense [8] devices measure carbon monoxide, nitrogen dioxide, and ozone. A digital app shows the color-coded results based on the U.S. These are all novel solutions but they lack the action that the user must take after viewing the possible solution. Anthropogenic and natural environmental factors interact intricately to cause deterioration of the air quality in cities.[12]Therefore Ecoreleaf provides users the ultimate proactive action option by connecting a network of nearby nurseries so that users can view the plants they want to choose for their home. The application therefore combines local business with pollution control; making it more sustainable, affordable and convenient.

2.1 Hardware devices and gateways

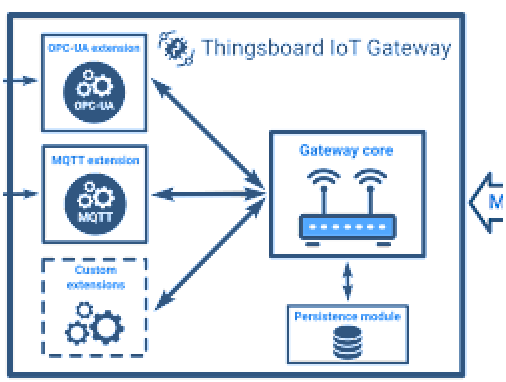
1. MQ135 Gas Sensor: To measure the concentration of gasses such as ammonia (NH3), nitrogen oxides (NOx), sulphur dioxide (SO2), and other hazardous gasses, the MQ135 sensor can be connected to an ESP32 or Raspberry Pi. An analogue or digital output proportionate to the airborne gas concentration is produced by the sensor. [5]

2. Raspberry Pi: The Raspberry Pi can serve as the system's central processing unit. Because of its adaptability, it can support a wide range of programming languages and operating systems, including Python and C++ and Raspbian and Linux. To read the sensor data, connect the MQ135 sensor to the Raspberry Pi and use GPIO pins or analog-to-digital converters. [4]



3. ESP32: It can be utilized for Bluetooth and Wi-Fi wireless connectivity. It can exchange wireless sensor data with the Raspberry Pi through communication.Where wired connections are not practical, ESP32 can be positioned strategically to cover the necessary areas.[4]

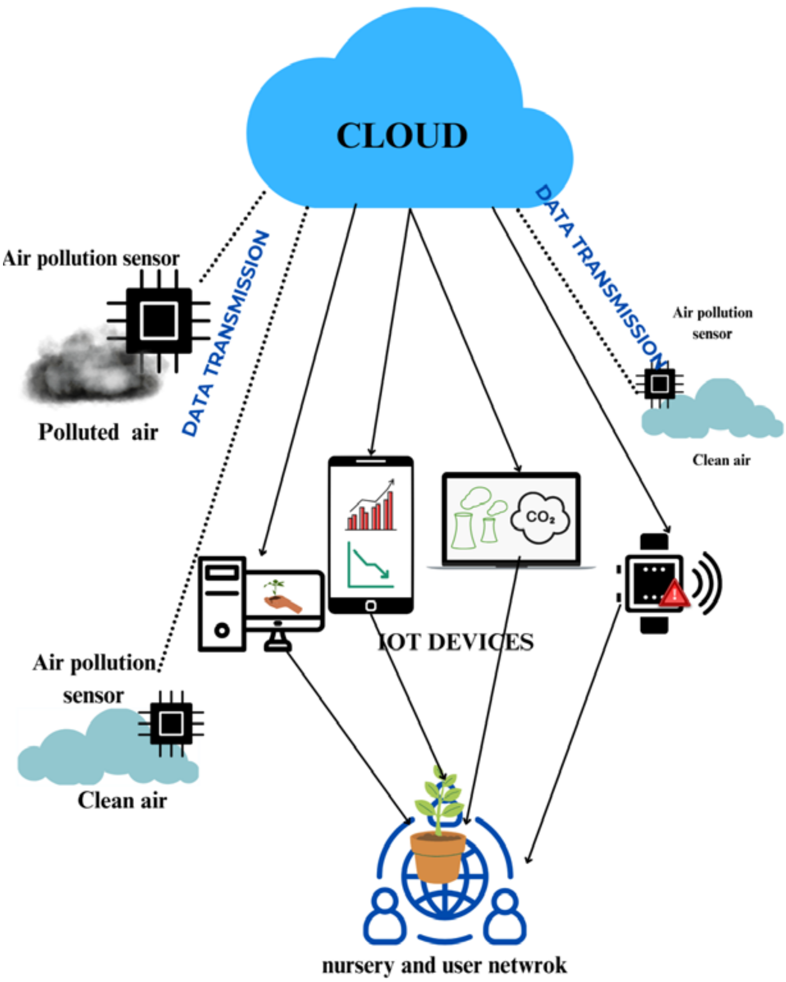
4. ThingsBoard Gateway: ThingsBoard Gateway is an open-source gateway programme that helps the ThingsBoard IoT platform and edge devices (like ESP32) communicate with one another. It guarantees effective and safe data transfer between gadgets and the cloud.



5. TensorFlow: TensorFlow is a potent machine learning and deep learning library that can be utilized for prediction and data analysis. In order to forecast trends or anomalies in air pollution levels, train a model with historical data on air quality.Use TensorFlow on the Raspberry Pi to analyze sensor data in real time.

3. Proposed Hardware model

The following diagram showcases the proposed model and the communication between the systems.



4. Proposal

Through the recommendation of suitable plantations that can reduce air pollution and improve local air quality, Ecoreleaf seeks to promote environmental preservation. The application uses information on ozone and air pollution to produce precise and pertinent plant species recommendations, enabling informed decision-making for efficient vegetation management. Through the recommendation of plant species that are suited for particular conditions, it promotes the adoption of sustainable practices.The temperature, humidity, smoke, LPG, carbon monoxide, and other dangerous particulate matter, such as PM2.5 and PM10 levels in the atmosphere, can all be measured by the smart devices. The collected data is available via an Android application or a web based application anywhere in the world.[15].By streamlining the process of choosing appropriate plantations, the application reduces the possibility of planting unproductive species and optimizes resource utilization. Users can quickly put into practice efficient plantation strategies by gaining real-time insights into suggested plant species and their advantages. Through bringing to light the connection between vegetation and air quality, the application fosters a more profound comprehension of environmental matters.

To use the application, users must register and create accounts. Secure system access is ensured by user authentication. The system produces precise and pertinent recommendations for plant species that can flourish and efficiently reduce pollution in the specified area. By putting their preferred plants on a wish list, users can review their previous plantation recommendations. In order to help users make well-informed decisions, the system offers real-time insights into the suggested plant species. Users can view the profiles and contact details of approved nurseries that can assist them in purchasing plants. Through secure messaging, users can interact with plantation agents and select their preferred plant based on factors such as availability, affordability, and sustainability of nearby plants.

4.1. SRS

4.1.1 Purpose

1. Environmental Improvement: The online programme aims to promote environmental preservation by suggesting suitable plantations that can lower air pollution and enhance local air quality.

2. Recommendations: The application makes informed decisions for effective vegetation management by using data on ozone and air pollution to generate accurate and relevant plant species recommendations.

3. **Encourage Sustainable Practices:** The application encourages the adoption of sustainable practices by suggesting plant species that can thrive in specific environments and positively affect neighboring ecosystems.

4. **Effective Plantation Planning:** The application minimizes the risk of planting species that won't work and maximizes resource utilization by simplifying the process of selecting suitable plantations.

5. Real-Time Insights: By obtaining real-time insights into recommended plant species and their benefits, users can promptly implement effective plantation strategies.

6. Educational Tool: By raising awareness of the relationship between vegetation and air quality, the application encourages a deeper understanding of environmental issues.

4.1.2 Product Scope

1. Input and Analysis: The application allows users to input their location to analyze the input data and derive suitable plant species recommendations.

2. User Registration and Authentication: Users can register and create accounts to access the application. User authentication ensures secure access to the system.

3. Plantation Recommendations: Based on the input data, the system generates accurate and relevant recommendations for plant species that can thrive and mitigate pollution effectively in the given area.

4. Viewing Recommendation History: Users can review their past plantation recommendations by wish listing the plants they prefer.

5. Real-time Information: The system provides users with real-time insights by taking the help of sensors and suggesting plant species that fit the user requirements, aiding informed decision-making.

4.1.3 Functional Requirement

1. User Authentication: Users can register, log in, and log out through the user route.

2. Input Data Collection: Users can input their location, address, and contact information, etc. based on which nearby AQI data sensors will be activated and the data will be sent.

3. Pollution Recommendation Display: The system should display the pollution level in an area according to the input location given by the user.

4. User Profile: Registered users have personalized profiles where they can manage their information, and preferences, and view their activity history.

5. Nursery Profile: Nurseries have dedicated profiles showcasing their details, including location, contact information, types of plants available, and user reviews.

6. Plantation Recommendation Display: The system provides recommendations for suitable plantations based on user input and environmental factors.

4.1.4 Non Functional Requirement

1. Data Encryption: All sensitive user data, including login credentials and personal information, must be encrypted during transmission and storage using industry-standard encryption protocols.

2. Access Control: Implement strict access controls to ensure that only authorized users can access specific functionalities and data within the system.

3. User Authentication: Employ secure user authentication methods, including password policies, and consider the implementation of two-factor authentication for enhanced security.

4. Intellectual Property: Respect intellectual property rights and ensure that all content, including images and text, used in the system is either original or used with proper authorization and attribution.

5. Privacy Policy: Clearly communicate a privacy policy to users, outlining how their data will be collected, processed, and stored, and obtain explicit consent for data handling activities.

5. Limitation of the project

1. Data Accuracy and Availability: The accuracy of pollution and plantation recommendations heavily relies on the availability and accuracy of input data provided by users. It also relies on the data provided by the API which might not be consistent. Inaccurate or incomplete data may affect the reliability of the system's recommendations.

2. Nursery Data Reliance: The system heavily relies on accurate and up-to-date information from nurseries. Inaccuracies or delays in updating nursery profiles may impact the relevance of recommendations.

3. Expertise Limitations: While the system provides information and recommendations, it does not substitute for expert advice.

4. Limited Plantation Types: Users seeking recommendations for unique or specialized plants may need to consult additional sources.

5. Dependence on Internet Connectivity: Users require a stable internet connection for optimal use of the system. Offline functionality is not available yet.

6. Language and Cultural Considerations: The system's effectiveness may vary based on language barriers and cultural differences, potentially impacting user understanding and engagement.

6. Conclusion

To sum up, this project aims to address environmental issues and promote sustainable practices by creating a comprehensive and user-centric solution. Through the incorporation of intuitive functionalities like proposals for plantations, informing users about pollutants, AQI, and direct communication with nurseries.The platform aims to enable individuals, organizations, and sectors to make knowledgeable decisions toward a more environmentally conscious future. We aim to combine sustainable practices with uplifting local nursery businesses. The application's planned future extensions—plantation tracking, plantation expansion to universities and enterprises, and the addition of a digital nursery experience—signify our dedication to ongoing development and adaptation to changing environmental requirements.

7. Future works

1. **Notification System:** Implementing in place a notification system to tell users of updates, plant availability, fresh suggestions, or crucial data about the scenarios they have submitted.
2. **Language help:** To ensure diversity and accessibility, offer multilingual help to users from other regions.
3. **Historical Data Analysis:** Give consumers the ability to examine and analyze historical plantation and pollution data for a specific area, offering insights into patterns and alterations over time.
4. Extending the application to institutions and industries

5. Combining pollution information with plant oxygen emission information and using the decision tree model to predict Plant.

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Conflicts of Interest

This research work is done for the partial fulfillment of the engineering degree without any sponsorship or financial help.

References

[1] Toma C, Alexandru A, Popa M, Zamfiroiu A. IoT Solution for Smart Cities' Pollution Monitoring and the Security Challenges. Sensors (Basel). 2019 Aug 2; 19(15):3401. Doi: 10.3390/s19153401. PMID: 31382512; PMCID: PMC6696184.

[2] H. N. Saha et al., "Pollution control using Internet of Things (IoT)," 2017 8th Annual Industrial Automation and Electromechanical Engineering Conference (IEMECON), Bangkok, Thailand, 2017, pp. 65-68, doi: 10.1109/IEMECON.2017.8079563.

[3] Roseline, R., Devapriya, M. and Sumathi, P. (2013) Pollution Monitoring Using Sensors and Wireless Sensor Networks: A Survey. International Journal of Application or Innovation in Engineering & Management, 2, 119-124.

[4] S. Muthukumar, W. Sherine Mary, S. Jayanthi, R. Kiruthiga and M. Mahalakshmi, "IoT Based Air Pollution Monitoring and Control System," 2018 International Conference on Inventive Research in Computing Applications (ICIRCA), Coimbatore, India, 2018, pp. 1286-1288, doi: 10.1109/ICIRCA.2018.8597240.

[5] Anand Jayakumar A, Praviss Yesyand T K, Venkstesh Prashanth K K, Ramkumar K, “IoT Based Air Pollution Monitoring System,” International Research Journal of Engineering and Technology (IRJET), vol. 8, no. 3, pp. 2458-2462, March, 2021.

[6] Raja Vara Prasad Y. et al. (2011) Real Time Wireless Air Pollution Monitoring System. ICTACT Journal on Communication Technology, 2, 370-375.

[7] C. Xiaojun, L. Xianpeng and X. Peng, "IOT-based air pollution monitoring and forecasting system," 2015 International Conference on Computer and Computational Sciences (ICCCS), Greater Noida, India, 2015, pp. 257-260, doi: 10.1109/ICCACS.2015.7361361.

[8] Ben Coxworth. Portable sensor lets users monitor air pollution on their smartphone. https://newatlas.com/citisense-air-quality-monitor/25512/.

[9] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci. (2002) Wireless sensor networks: a survey. Computer Networks, 38, pp. 393-422, doi: https://doi.org/10.1016/S1389-1286(01)00302-4.

[10] D. Culler, D. Estrin and M. Srivastava, "Guest Editors' Introduction: Overview of Sensor Networks," in Computer, vol. 37, no. 8, pp. 41-49, Aug. 2004, doi: 10.1109/MC.2004.93.

[11] Nowak, D. J., Crane, D. E. (2007). Trees, Air Quality, and Human Health: A review. Environmental Pollution, 147(3), 391-407.

[12] S. Manna, S. S. Bhunia and N. Mukherjee, "Vehicular pollution monitoring using IoT," International Conference on Recent Advances and Innovations in Engineering (ICRAIE-2014), Jaipur, India, 2014, pp. 1-5, doi: 10.1109/ICRAIE.2014.6909157.

[13] S. Dhingra, R. B. Madda, A. H. Gandomi, R. Patan and M. Daneshmand, "Internet of Things Mobile–Air Pollution Monitoring System (IoT-Mobair)," in IEEE Internet of Things Journal, vol. 6, no. 3, pp. 5577-5584, June 2019, doi: 10.1109/JIOT.2019.2903821.

[14] Caubel JJ, Cados TE, Kirchstetter TW. A New Black Carbon Sensor for Dense Air Quality Monitoring Networks. Sensors. 2018; 18(3):738. https://doi.org/10.3390/s18030738.

[15] H. Gupta, D. Bhardwaj, H. Agrawal, V. A. Tikkiwal and A. Kumar, "An IoT Based Air Pollution Monitoring System for Smart Cities," 2019 IEEE International Conference on Sustainable Energy Technologies and Systems (ICSETS), Bhubaneswar, India, 2019, pp. 173-177, doi: 10.1109/ICSETS.2019.8744949.