

INTEGRATING IOT FOR SMART GREEN ENVIRONMENT: A REAL TIME AIR QUALITY MONITORING APPROACH FOR BGSIT CAMPUS ADICHUNCHANAGIRI UNIVERSITY

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College : B.G.S Institute of Technology, Mandya

Branch : Civil Engineering

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Introduction:

The increase in air pollution has become a significant concern, especially in semi-urban and institutional areas where human activity is dense. Adichunchanagiri university bgsit Campus, being a hub of academic and healthcare activities, is particularly sensitive to variations in air quality. As part of this project, we study and analyze the concentration of pollutants like PM_{2.5} and PM₁₀ within the BGSIT campus environment. Traditional air quality monitoring stations are expensive and limited in range, making it challenging to implement widespread surveillance. To address this issue, our project introduces a real-time IoT-based air quality monitoring system that is cost-effective, scalable, and easily deployable. By using an ESP32 microcontroller and sensors such as DHT11 (for temperature and humidity), MQ-135 (for gas detection), and a dust sensor (for PM levels), the system collects environmental data continuously. This data is programmed and managed using C++ through the Arduino IDE and is uploaded to the ThingSpeak cloud platform for real-time visualization and analysis. The system aims to establish a reliable monitoring mechanism to assess environmental health, identify pollution sources, and provide alerts or recommendations based on data trends. This initiative not only supports sustainability goals but also educates the campus community on the importance of environmental awareness and action.

Objectives:

- To design and implement a real-time air quality monitoring system using IoT.

- To continuously measure PM2.5, PM10, temperature, humidity, noise levels, and harmful gases.
- To transmit collected data to the ThingSpeak cloud for real-time visualization.
- To analyze trends in pollution levels and relate them to human activity patterns.
- To raise awareness about air pollution and its health impacts within the campus.

Methodology:

The methodology followed a structured and practical approach. The first phase involved selecting suitable hardware components including the ESP32 microcontroller, which supports built-in Wi-Fi and is ideal for IoT applications. Sensors such as DHT11 for temperature and humidity, MQ-135 for gas detection, and a dust sensor for PM2.5 and PM10 levels were chosen for data collection. The next step was system design and sensor integration. All components were connected to the ESP32 and programmed using C++ in the Arduino IDE. The code included sensor initialization, data reading functions, and data formatting. The sensor values were read at fixed intervals and sent to ThingSpeak cloud via Wi-Fi. In case of network failure, the SIM900A GSM module was set up as a fallback to transmit data over a mobile network. The hardware was mounted and tested on the Adichunchanagiri university bgsit campus. Real-time data was logged and displayed using ThingSpeak's data visualization tools, including line graphs and dashboards. These tools helped track variations in PM2.5, PM10, temperature, humidity, and noise levels across different times of the day. Calibration and testing were conducted to ensure that sensor readings were accurate and responsive to environmental changes. The system was further evaluated under different environmental conditions to assess its consistency and performance. The collected data was later exported for further analysis and interpretation, allowing insights into pollution trends and their correlation with human activities on Bgsit campus.

Result and Conclusion:

The implemented system was able to successfully monitor multiple air quality parameters across the campus in real time. The recorded data showed noticeable variations in PM2.5 and PM10 levels during class hours and times of high vehicular movement. Noise levels consistently peaked during afternoon breaks, exceeding 70 dB. The ThingSpeak platform effectively displayed the environmental data through interactive graphs, allowing for easy interpretation of trends. The data also showed that humidity and temperature affected the dispersion of pollutants. Based on WHO guidelines, several instances were identified where air quality was in the moderate to unhealthy range, especially for sensitive individuals. The system proved efficient, reliable, and suitable for educational campuses. It not only helped visualize environmental health but also informed data-driven decisions and awareness among

campus users. The project successfully achieved its objective of creating a smart, real-time air monitoring system using IoT.

Project Outcome and Industry Relevance:

The project led to the successful creation of a low-cost, scalable air quality monitoring solution using ESP32 and sensors. The real-time monitoring capabilities allowed users to understand pollution trends and environmental health impacts. The system can be integrated with smart campus management and used in hospitals, schools, and smart cities. It promotes awareness, supports environmental policies, and provides a model for future IoT-based sustainability solutions.

Project Outcomes and Learnings:

Key outcomes of the project include the development of a fully functional, real-time IoT-based air monitoring system capable of detecting and reporting multiple environmental parameters. The system's integration with ThingSpeak enabled clear visualization and cloud storage of data, making it accessible from anywhere. It effectively captured pollution trends and provided insights for taking timely action.

Through the process, we learned how to design and build an embedded system using C++ and ESP32, interface various environmental sensors, and utilize cloud platforms for data communication and analytics. We also gained hands-on experience in circuit design, sensor calibration, troubleshooting, and interpreting real-time environmental data. The project enhanced our problem-solving, teamwork, and analytical skills and gave us practical exposure to the Internet of Things, which is essential for modern engineering solutions.

Project Model Photograph:

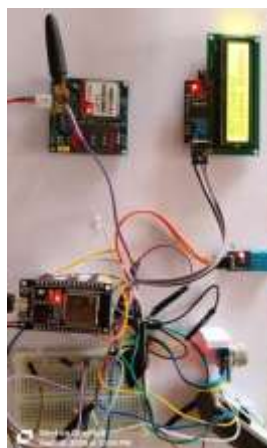


Figure 1: IoT-based Air Quality Monitoring System Setup

Future Scope:

1. Extend the system by deploying multiple sensor nodes across the entire campus for area-wise monitoring.
2. Add advanced sensors for gases such as carbon monoxide (CO), nitrogen dioxide (NO₂), and ozone (O₃) to improve pollutant profiling.
3. Develop a dedicated mobile application to provide instant air quality alerts to users.
4. Incorporate AI and machine learning models to predict air quality trends and pollution spikes.
5. Implement automated responses such as activating air filtration systems or alerts for high-risk groups.
6. Partner with government agencies or environmental groups for city-wide deployment and research collaboration.
7. Use solar-powered modules to create energy-efficient standalone monitoring systems.