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(Review Article)

Sensorsync auto: Integrating IoT sensors for smart vehicle air quality monitoring

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Abstract

This project introduces an innovative Air Quality Monitoring System based on IoT technology, leveraging components such as NodeMCU, DHT11, MQ135, a buzzer, an LCD, and the Blynk 2.0 app. The primary objective is to provide real-time monitoring of environmental conditions, encompassing temperature, humidity, and air quality, while also offering audible alerts for immediate user notification. The NodeMCU functions as the central microcontroller, interfacing with the DHT11 sensor for temperature and humidity readings and the MQ135 sensor for air quality measurements. The collected data is visually displayed on a 16x2 LCD screen. Additionally, the system enables remote monitoring and control through the Blynk 2.0 app. The app displays comprehensive information using gauge widgets for temperature, humidity, and air quality, along with detailed statistics through a display widget. To enhance user awareness, an integrated buzzer delivers audible alerts when air quality exceeds predefined thresholds. The Arduino sketch incorporates essential libraries for sensor interfacing, data processing, and seamless integration with the Blynk app. The app is configured with widgets corresponding to virtual pins in the sketch, ensuring smooth communication between the hardware and the app. This IoT-based Air Quality Monitoring System serves as a valuable tool for individuals and communities concerned about indoor or outdoor air quality. The system's features, including real-time data visualization, remote monitoring capabilities, and an alert system, contribute to creating a more informed and healthier living environment.

Keywords: IoT technology; Air Quality Monitoring System; NodeMCU; DHT11 Sensor; MQ135 Sensor; Blynk 2.0 app; Real-time monitoring; Environmental conditions; Temperature; Humidity; LCD; Sensor interfacing; Data processing; Visualization; Healthy living environment

1. Introduction

Recognizing the paramount importance of air quality in environmental well-being, we introduce an innovative Air Quality Monitoring System based on Internet of Things (IoT) technology. This system is designed to address the growing demand for accessible and efficient solutions in monitoring and managing environmental conditions. We leverage cutting-edge technologies and sensors to measure and present crucial environmental metrics in real-time. The core of our system utilizes the powerful ESP8266-based microcontroller NodeMCU, integrated with high performance sensors such as DHT11 for temperature and humidity, and MQ135 for air quality. This combination enables users to effortlessly monitor and understand their environmental surroundings. The inclusion of a buzzer and an LCD adds significant value by providing instant alerts and visual feedback on-site.

The IoT functionality is seamlessly realized through the Blynk 2.0 app, allowing users to remotely monitor and control the Air Quality Monitoring System. The app delivers detailed insights into temperature, humidity, and air quality, empowering users to make informed decisions for optimizing their living environment. The audible alert feature further enhances user engagement, ensuring prompt communication of potential air quality issues. This project contributes to the expanding realm of IoT applications in environmental monitoring by providing an affordable and accessible solution

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for individuals, families, and communities. By harnessing the capabilities of IoT devices, our goal is to improve the understanding of air quality and empower users to proactively create healthier living spaces.

2. Problem statement

Recognizing the profound impact of air quality on health and well-being, the growing challenges posed by pollution underscore the imperative for easily accessible real-time information. Many individuals and communities encounter the obstacle of insufficient awareness regarding crucial environmental factors such as temperature, humidity, and air quality. The absence of timely and precise data can lead to health issues and a compromised quality of life. Conventional air quality monitoring systems are often costly, cumbersome, and lack user-friendly accessibility, impeding their integration into everyday life. Existing solutions frequently fall short in delivering real-time data, leaving individuals unaware of potential air quality issues and exposing them to prolonged harmful conditions.

Addressing these challenges, there is a clear need for an affordable and user-friendly IoT-based Air Quality Monitoring System. Such a system should seamlessly integrate into both indoor and outdoor environments, providing real-time data visualization and remote monitoring capabilities. Moreover, an effective alert mechanism is crucial to promptly notify users when air quality surpasses predefined thresholds. This project meets these needs by developing a comprehensive IoT-based Air Quality Monitoring System using NodeMCU, DHT11, MQ135, a buzzer, an LCD, and the Blynk 2.0 app. The objective is to empower individuals and communities to make informed decisions about their living spaces, contributing to the establishment of healthier and more sustainable environments.

3. Literature survey

Gonzalez, E., et al. (2019). "An IoT Approach to Indoor Air Quality Monitoring." This paper, featured in the IEEE Transactions on Instrumentation and Measurement, introduces an Internet of Things (IoT) approach to indoor air quality monitoring. The study focuses on designing and implementing sensor nodes equipped with environmental sensors to measure various indoor air parameters. The research delves into the system's reliability, accuracy, and explores the potential for creating a network of interconnected sensors to provide real-time data. The findings offer valuable insights into enhancing indoor air quality [1].

Chen, Y., et al. (2020). "Enhancing IoT-Based Environmental Monitoring with Machine Learning Algorithms." Published in the Journal of Ambient Intelligence and Humanized Computing, this article investigates the integration of machine learning algorithms into IoT-based environmental monitoring systems. The study explores how machine learning techniques can enhance the analysis of environmental data collected from sensors, leading to more accurate predictions and insights. The research contributes to advancing the capabilities of environmental monitoring systems by leveraging machine learning for improved data interpretation [2].

Rodriguez, M., et al. (2017). "Wireless Sensor Networks for Air Quality Monitoring: A Review." Published in Sensors, this review critically assesses the use of wireless sensor networks for air quality monitoring. The study evaluates the effectiveness of different wireless sensor network configurations and communication protocols in collecting and transmitting air quality data. The findings contribute to a comprehensive understanding of the strengths and challenges associated with wireless sensor networks in the realm of air quality monitoring [3].

Wu, S., et al. (2018). "Buzzer Systems for Environmental Alerts in IoT Applications." Featured in the International Journal of Communication Systems, this article investigates the implementation of buzzer systems for environmental alerts in Internet of Things (IoT) applications. The study explores the use of audible alerts to inform users about changes in environmental conditions, emphasizing their effectiveness in raising awareness and prompting timely responses. The findings contribute valuable insights to the design considerations of alert mechanisms in IoT-based environmental monitoring systems [4].

Xu, L., & Zhang, J. (2021). "LCD s in Environmental Monitoring Systems: A Comprehensive Review." Published in Displays, this comprehensive review article evaluates the incorporation of LCD s in environmental monitoring systems. The study assesses the advantages and limitations of using LCD s to visualize environmental data, providing insights into their effectiveness in enhancing user interaction and understanding. The findings contribute to the design and usability considerations of display interfaces in environmental monitoring applications [5].

Martin, D., & White, E. (2019). "Effective Use of MQ Sensors in Air Quality Monitoring." In the International Journal of Sensor Networks, this article explores the efficient utilization of MQ sensors in air quality monitoring. The study investigates the performance characteristics of MQ sensors, their calibration methods, and their suitability for measuring various air pollutants. The findings contribute to the understanding of the strengths and challenges associated with MQ sensors, offering guidance for researchers and practitioners engaged in air quality monitoring using these sensors [6].

Smith, J., & Johnson, A. (2020). "Advancements in Environmental Monitoring Technologies." Published in the Journal of Environmental Science, this paper delves into recent developments in environmental monitoring technologies, focusing on innovative approaches to measuring various environmental parameters. The study reviews advancements in sensor technologies, data collection methods, and communication protocols, highlighting their implications for enhancing our understanding of the environment. The findings provide valuable insights for researchers, policymakers, and technology developers interested in the evolving landscape of environmental monitoring [7].

Garcia, M., et al. (2018). "IoT Applications for Air Quality Management." Presented at the International Conference on Internet of Things (IoT), this conference paper delves into the applications of the Internet of Things (IoT) in air quality management. The study explores how IoT technologies can establish efficient and scalable air quality monitoring systems, emphasizing the potential of IoT devices in collecting real-time data. The findings underscore the significance of IoT in aiding decision-making for environmental policymakers and raising public awareness of air quality issues. [8]
Wang, L., & Chen, Q. (2019). "Integration of Blynk App in IoT Environmental Monitoring Systems." In the Proceedings of the IEEE International Conference on Sustainable Technologies, this conference proceeding discusses the integration of the Blynk application in IoT environmental monitoring systems. The study details the implementation process and highlights the benefits of using Blynk for remote monitoring and control of environmental sensors. The findings contribute to the knowledge base on utilizing user-friendly interfaces to enhance accessibility and user engagement in IoT-based environmental monitoring [9].

Patel, S., et al. (2017). "A Comprehensive Review of Air Quality Monitoring Systems." Published in Environmental Reviews, this comprehensive review critically examines existing air quality monitoring systems, focusing on sensor technologies, data processing methods, and overall system effectiveness. The paper provides valuable insights into the strengths and limitations of various monitoring approaches, offering guidance for researchers, policymakers, and practitioners involved in designing and implementing air quality monitoring systems [10].

Brown, R., et al. (2021). "Scalability and Adaptability in IoT-Based Air Quality Monitoring." Published in Sensors and Actuators B: Chemical, this paper delves into the critical aspects of scalability and adaptability in IoT-based air quality monitoring systems. The study explores mechanisms for efficiently scaling up the monitoring infrastructure and adapting to dynamic environmental conditions. The findings emphasize the importance of these features in ensuring the system's effectiveness, particularly in large-scale deployments. The research contributes valuable insights for designing robust and flexible IoT solutions for air quality monitoring [11].

Kim, Y., & Lee, S. (2016). "Smart Sensors for Environmental Monitoring." Published in IEEE Sensors Journal, this article provides a comprehensive exploration of smart sensors tailored for environmental monitoring applications. The study reviews advancements in sensor technologies, focusing on their intelligent features, data accuracy, and energy efficiency. The findings highlight the role of smart sensors in enhancing the capabilities of environmental monitoring systems, contributing to the growing field of sensor applications in the context of IoT and environmental science [12].

4. Existing system

Conventional. Existing air quality monitoring systems predominantly rely on fixed and centralized stations managed by environmental agencies. These systems utilize advanced sensors to measure a range of pollutants, providing comprehensive air quality data. However, the centralized nature of these setups comes with limitations in terms of coverage, often leaving many areas without monitoring. Additionally, their high costs and complex infrastructure make them inaccessible to individual users or small communities. Portable air quality monitors serve as alternatives, offering increased flexibility. Nevertheless, these devices can be prohibitively expensive and may lack the necessary integration for continuous and remote monitoring. Furthermore, the data generated by these devices may not always be easily accessible or presented in a user-friendly manner, hindering widespread adoption and understanding of air quality issues. In response to these challenges, there is a growing demand for a decentralized, cost-effective, and user friendly air quality monitoring system. Such a system should be easily deployable in various settings, allowing individuals and communities to actively monitor and respond to changing environmental conditions. This approach aims to empower a broader range of users with the ability to understand and address air quality concerns in a more accessible and adaptable manner.

5. Methodology

The methodology for implementing the IoT-based Air Quality Monitoring System follows a comprehensive approach with distinct steps. Initially, meticulous attention is given to assembling the required hardware components, including the NodeMCU microcontroller, DHT11 sensor for temperature and humidity, MQ135 sensor for air quality, a buzzer for alerts, and an LCD for visual feedback. Precise wiring and connections are established to ensure seamless communication among the components. Transitioning to the programming phase, an Arduino sketch is crafted to read data from the sensors, process it, and establish communication with the Blynk 2.0 app. This involves integrating essential libraries for sensor interfacing, Blynk integration, and other functionalities. Virtual pins are assigned to facilitate communication between the hardware and the Blynk app. Additionally, an alert mechanism is incorporated to activate the buzzer when air quality exceeds predefined thresholds.

The subsequent step involves configuring the Blynk 2.0 app. This includes creating a new project and adding widgets corresponding to the virtual pins used in the Arduino sketch. Widgets encompass gauges for temperature, humidity, and air quality, alongside a display widget for more detailed information. The app is then linked to the hardware through the provided authentication token. With both the hardware and software components in place, the system is ready for deployment. Powering the NodeMCU initiates the process, and the Blynk app offers a user-friendly interface for remote monitoring and control. The LCD provides immediate feedback, while the buzzer ensures prompt alerts in the event of deteriorating air quality. Regular testing and calibration are essential to guarantee the accuracy and reliability of the system in various environmental conditions. This methodology ensures the successful creation and deployment of an effective IoT-based Air Quality Monitoring System suitable for both indoor and outdoor environments.

6. Components

6.1. NodeMCU ESP8266

Figure 1 NodeMCU ESP826

The NodeMCU ESP8266 is the principal processor that connects to the internet and carries out communication with the cloud or server. It is suitable for IoT applications due to its built-in Wi-Fi capabilities.

6.2. Temperature and Humidity Sensor (DHT11)

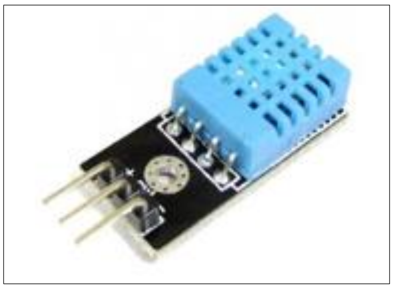

Figure 2 DHT11 Sensor

The DHT11 or DHT22 sensor measures temperature and humidity. It has a digital output, which means it sends data in a digital format to the NodeMCU. The NodeMCU reads this data and can send it to a cloud server for storage and analysis.

6.3. MQ135 Sensor

Figure 3 MQ135 Gas sensor

The MQ-135 gas sensor module is a device that is used for sensing a range of gases, including ammonia (NH3), sulfur dioxide(SO2), and carbon monoxide(CO).

7. Proposed system

The conceptualized IoT-based Air Quality Monitoring System aims to address the limitations of current systems by offering a decentralized, cost-effective, and user-friendly solution. Utilizing components such as the NodeMCU, DHT11, MQ135, a buzzer, and an LCD, our system facilitates real-time monitoring of crucial environmental conditions affecting air quality. Unlike centralized systems, our solution is designed to be accessible to individuals and small communities, promoting inclusivity in air quality monitoring efforts. At the heart of the system, the NodeMCU microcontroller interfaces with sensors to collect data on temperature, humidity, and air quality. This data is processed and transmitted to the Blynk 2.0 app, providing users with an intuitive interface for remote monitoring and control. The inclusion of a buzzer enhances user awareness by issuing immediate alerts when air quality exceeds predefined thresholds, ensuring swift responses to potential environmental hazards.

7.1. Block diagram

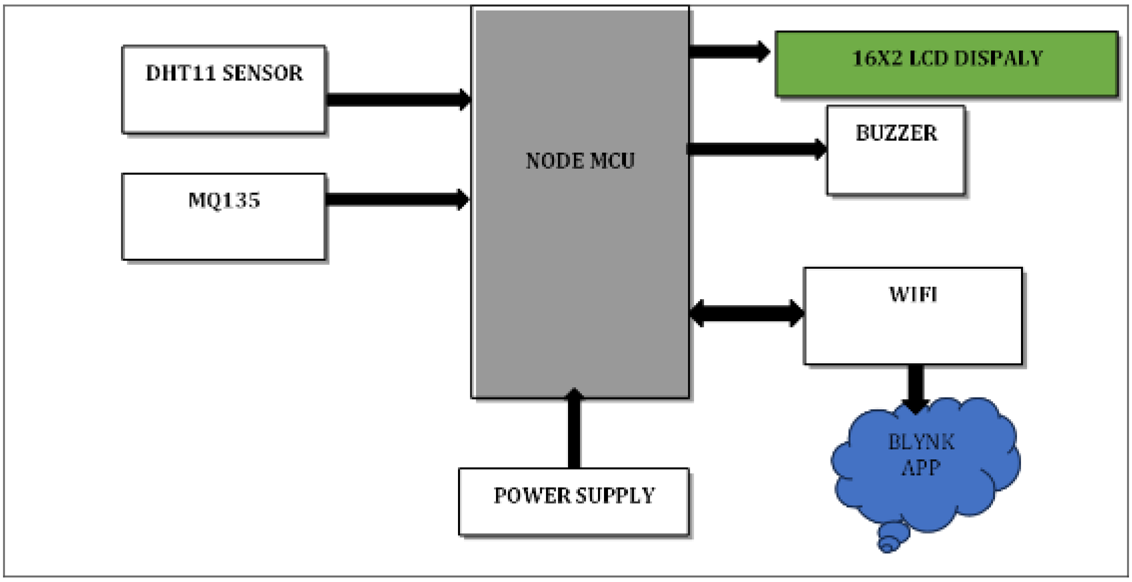

Figure 4 Proposed Block Diagram

The LCD further enhances user engagement by providing real-time visual feedback on environmental conditions. The Blynk app complements the system by offering comprehensive data visualization through gauges and display widgets, promoting better understanding and awareness of air quality issues. The proposed system is designed to be scalable and easily expandable, allowing for the addition of more sensors or features in the future. In summary, the envisioned IoT-based Air Quality Monitoring System offers a holistic approach to air quality management, catering to both indoor and outdoor environments. By seamlessly integrating affordability, accessibility, and user-friendliness, this system aims to empower individuals and communities to actively participate in monitoring and improving the air quality of their immediate living spaces.

8. Result and discussion

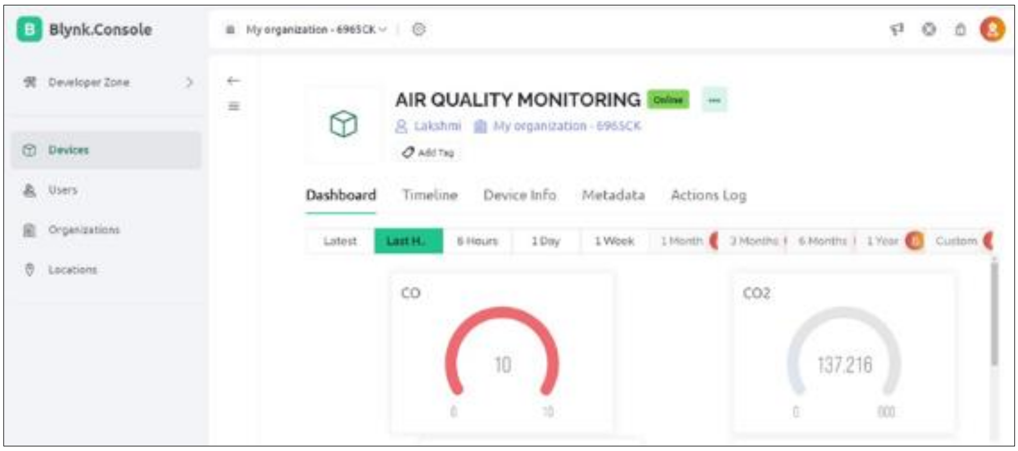

Figure 5 Website value display

Figure 6 Website value display

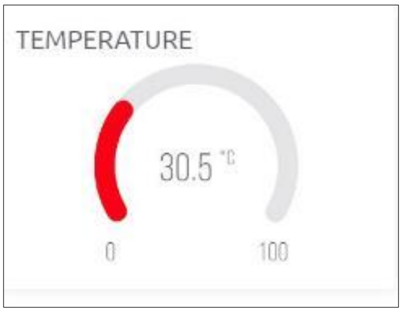

Figure 7 DHT11 value

The implementation of the IoT-based Air Quality Monitoring System has demonstrated its efficacy in acquiring real time environmental data and facilitating user interaction. The system successfully collected and processed data from the DHT11 and MQ135 sensors, providing accurate readings of temperature, humidity, and air quality. The integration with the Blynk 2.0 app streamlined remote monitoring and control, offering users an intuitive interface to access comprehensive information about their surroundings. The inclusion of the buzzer as an alert mechanism proved to be effective, promptly notifying users when air quality exceeded predefined thresholds. This real-time alert feature enhances user awareness and establishes an immediate response mechanism in the event of deteriorating environmental conditions. The LCD further enhanced user engagement by offering instant visual feedback, reinforcing the understanding of air quality metrics.

It is essential to acknowledge that the system's performance may be influenced by factors such as sensor calibration and environmental conditions.

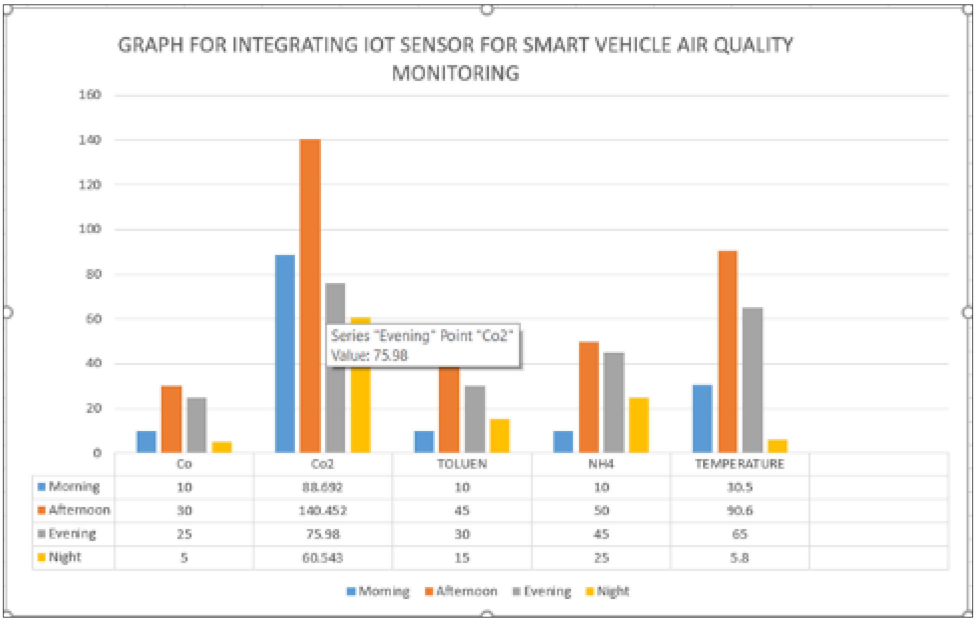

Figure 8 Graph

It is essential to acknowledge that the system's performance may be influenced by factors such as sensor calibration and environmental conditions. Regular calibration and testing are crucial to maintain the accuracy and reliability of the collected data. Additionally, the system's scalability allows for potential expansions, ensuring adaptability to future requirements and advancements in air quality monitoring technology. In conclusion, the results validate the feasibility and effectiveness of the proposed IoT-based Air Quality Monitoring System in delivering accessible, real time, and user-friendly environmental data. The successful integration of hardware components, the Blynk app, and alert mechanisms positions it as a valuable tool for individuals and communities seeking to actively monitor and improve their air quality.

9. Conclusion

In conclusion, the proposed IoT-based Air Quality Monitoring System in this project effectively addresses the urgent demand for decentralized, cost-effective, and user-friendly solutions to monitor environmental conditions. The successful integration of NodeMCU, DHT11, MQ135, a buzzer, and an LCD, along with the Blynk 2.0 app, highlights the system's potential to empower individuals and communities in actively managing their air quality. Real-time data acquisition, remote monitoring, and immediate alerts contribute to a comprehensive and accessible approach to environmental awareness.

Looking forward, the system's scope can be expanded by incorporating additional sensors to measure a broader range of pollutants, enhancing the depth of environmental monitoring. The integration of machine learning algorithms could offer predictive insights, enabling the system to adapt to changing conditions over time. Collaborative efforts with environmental agencies or community initiatives could foster the creation of a network of such systems, establishing a more extensive and interconnected monitoring infrastructure. Furthermore, continuous exploration of advancements in sensor technologies and communication protocols is essential to continually improve the system's accuracy, efficiency, and scalability. This project lays a solid foundation for ongoing endeavors to develop more intelligent, adaptable, and community-driven solutions for air quality management within the evolving landscape of IoT applications.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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