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DESIGN AND DEVELOPMENT OF ESP 32 FOR IOT APPLICATION

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ABSTRACT

The Internet of Things (IoT) has opened up new possibilities for creating smart, connected devices that can gather and share data in real time. These devices are now used across a wide range of fields—from tracking environmental changes to managing industrial systems and improving healthcare. In this project, we designed and developed an IoT-based device cantered around the ESP32 microcontroller, known for its power, versatility, and built-in Wi-Fi and Bluetooth system uses an LM35 temperature capabilities. Our sensor to measure temperature and feeds the data into a high-precision ADS1256 Analog-to-digital converter (ADC). This ensures that even small changes in temperature are captured accurately. We also included a signal generator in the design to test and validate the system during development. At the heart of the setup, the ESP32 manages both local processing and communication with the cloud. An LED indicator is programmed to blink as a simple way to confirm the system is running.

Once processed, the temperature data is sent to a cloud platform where it can be stored and accessed remotely. The development process involved hardware integration, firmware programming, signal handling, and data transmission. Testing showed that the system

is reliable, precise, and communicates with the cloud smoothly and quickly. This setup offers a cost-effective, scalable solution for applications that require high-resolution Analog data and real-time online access.

INTRODUCTION

The Internet of Things (IoT) has emerged as a transformative technology that connects devices, sensors, and systems, enabling seamless data exchange and automation. From industrial automation to healthcare, IoT has made real-time monitoring and remote control possible, significantly enhancing efficiency and reducing operational costs. IoT applications rely heavily on embedded systems, which combine hardware and software to collect, process, and transmit data from sensors to cloud platform. Among the various hardware platforms available, the ESP32 microcontroller has gained popularity due to its versatility, affordability, and ease of use. With its built-in Wi-Fi and Bluetooth capabilities, dual-core processor, and compatibility with a wide range of sensors, the ESP32 is an excellent choice for IoT systems. When combined with the ADC1256, a precise Analog-to-digital converter (ADC), the ESP32 can efficiently convert and process Analog signals into digital data for analysis and visualization. The advancement of Internet of Things (IoT) technologies has significantly transformed the landscape of automation, data handling, and remote monitoring across various industries. This project focuses on the design and development of an IoT-based solution utilizing the ESP32WROOM-1 microcontroller and the ADC1256 Analog-to-digital converter. The integration of these components aims to process Analog sensor data and transmit it to cloud platforms, enabling remote access, real-time monitoring, and smart decision-making. The ESP32WROOM-1 is a versatile and high-performance microcontroller that supports Wi-Fi and Bluetooth connectivity, making it ideal for IoT applications. Paired with the ADC1256, which efficiently converts Analog signals into digital data, the project leverages these components to establish a seamless data acquisition and connectivity system. The project's focus extends to diverse use cases, including industrial automation, environmental monitoring, and smart home applications. This endeavour emphasizes the creation of a robust and scalable IoT system that integrates sensor data acquisition, processing, and cloud connectivity to enhance operational efficiency and decision-making.

LITERATURE SURVEY

The Internet of Things (IoT) has revolutionized the way we monitor and control physical systems. Recent studies have proposed IoT-based monitoring systems for various applications. IoT-based environmental monitoring systems have been developed to monitor temperature, humidity, and air quality parameters. Similarly, wireless sensor network-based systems have been presented for industrial automation to monitor temperature, pressure, and vibration parameters. Data acquisition systems have also been designed to acquire and process Analog data from sensors. Furthermore, cloud-based IoT platforms have been proposed for remote monitoring and control of industrial systems.

While existing studies have proposed IoT-based monitoring systems, there is a need for a comprehensive system that integrates ESP32, ADC1256, and cloud platforms for real-time monitoring and data analysis. This study aims to address this gap by designing and developing an IoT-based monitoring system using ESP32, ADC1256, and cloud platforms. The proposed system will acquire and process Analog data from sensors, transmit the data to cloud platforms, and enable real-time monitoring and data analysis.

The proposed system will contribute to the existing literature by providing a comprehensive IoT-based monitoring system that integrates ESP32, ADC1256, and cloud platforms. The system will be scalable, efficient, and applicable to various industrial and environmental monitoring applications.

METHODOLOGY

The methodology adopted in this project employs a structured approach to ensure seamless integration of hardware and software components, aiming for a fully functional and efficient IoT solution. Each phase is carefully planned to meet the project objectives, from hardware design to final testing and validation.

Hardware Design and Development

The initial phase focuses on designing and developing the hardware, laying the foundation for the IoT system.

1. Circuit Diagram Design:

The circuit design is created using KiCad software to illustrate the connections between the ESP32-WROOM-1 microcontroller,
ADC1256 Analog-to-digital converter, and the LM35 temperature sensor.
The design process prioritizes error-free routing and optimal component placement to ensure efficient and reliable operation.

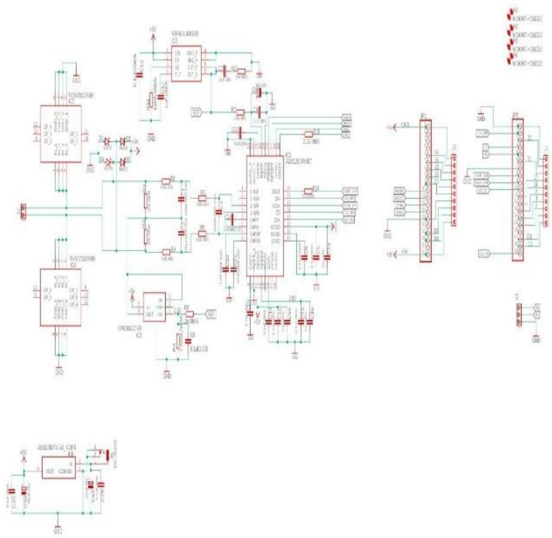


FIG 1: Circuit diagram of ESP32.

2. Printed Circuit Board (PCB) Fabrication:

The schematic diagram is converted into a physical PCB
layout, arranging components and routing connections to minimize interference and maximize performance. The finalized design is then sent to a PCB manufacturer for fabrication. The result is a high quality, robust physical board that integrates the microcontroller and sensors.

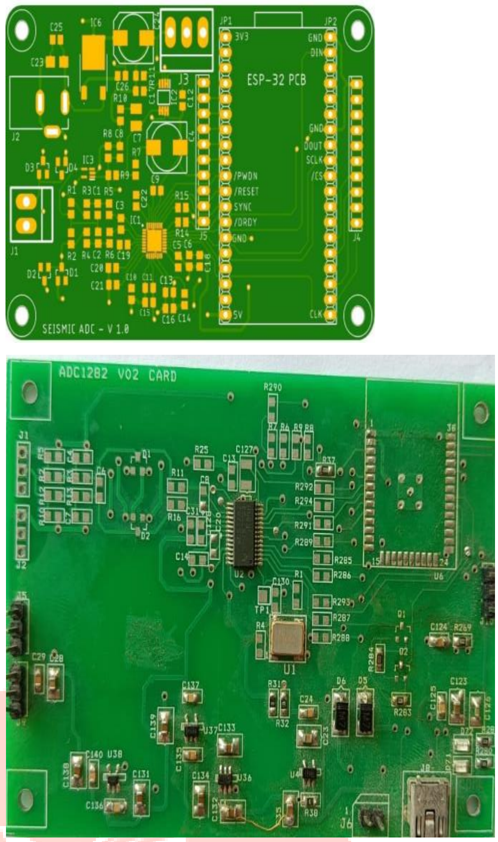
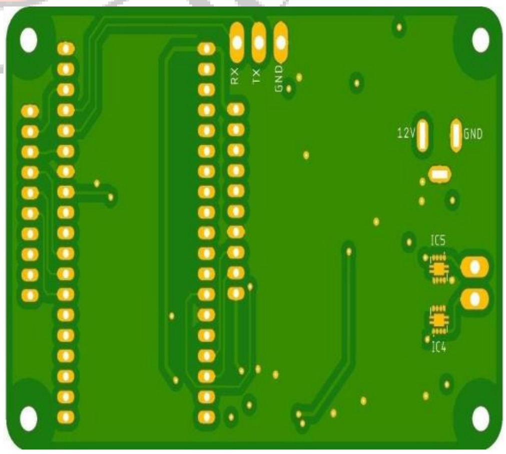


FIG2:Printed circuit board

2. Sensor Selection and Integration:

The LM35 temperature sensor is selected for its reliability, accuracy, and compatibility with the system.



Future scalability is considered, allowing for the integration of additional sensors to expand the system's functionality across various applications.

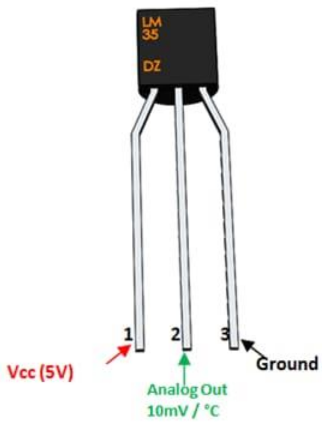


FIG3: Temperature sensor LM35

Software Development

Software development is integral to achieving system functionality, focusing on programming the microcontroller and establishing cloud connectivity.

1. Programming the Microcontroller:

The ESP32-WROOM-1 is programmed using C and C++ languages to manage data acquisition, processing, and transmission.

Specific libraries and APIs are employed to facilitate seamless communication between the microcontroller, ADC1256, and the cloud platform.

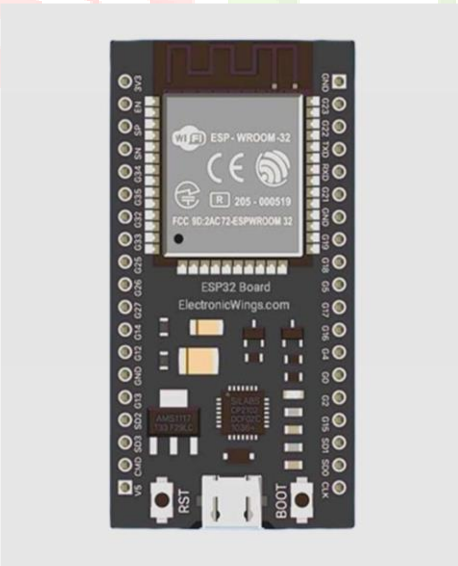


FIG4: Microcontroller ESP32

2. Cloud Integration:

Wi-Fi capabilities of the ESP32-WROOM-1 are leveraged to transmit data to cloud platforms like Blynk, enabling real-time monitoring and data storage.

The cloud platform provides users with visualizations, notifications, and remote access to system data, enhancing its utility for automation and smart decision-making.

Testing and Validation

The testing phase ensures that the hardware and software components function as intended and meet the project's requirements.

1.Board Testing:

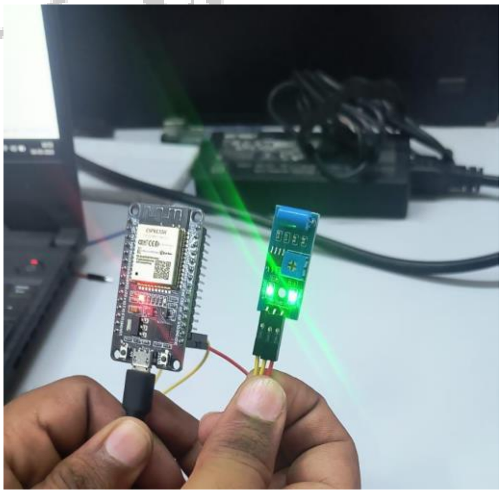
The fabricated PCB undergoes rigorous testing to validate the connections and functionality of the components.

Debugging is performed to address any issues identified during testing, ensuring the system is free of hardware-related errors.

2.System Testing:

The system is tested for accurate real-time data acquisition, seamless processing, and reliable cloud connectivity.

Environmental variables are simulated to validate the system's performance under different conditions, ensuring robustness and reliability.



Testing Process

RESULT AND DISCUSSION

- Temperature Sensing

Using the LM35, temperature changes were monitored accurately. The output (10 mV/°C) was digitized by the ADS1256. The system was calibrated using a commercial thermometer, showing a deviation of ±0.2°C, validating its use for precision monitoring.

- ADC Performance

The ADS1256 demonstrated excellent noise immunity and high precision. Configurable sampling rates allowed flexible acquisition strategies, from low-frequency environmental monitoring to high-speed signal capture.

- Cloud Upload and Visualization

Cloud transmission had low latency (\~150 ms) and high reliability. Data was continuously uploaded and rendered in real time on dashboards, confirming robust ESP32-cloud communication.

- System Responsiveness and Power

Power consumption was around 200 mA with Wi-Fi active. The LED blink pattern indicated system health, with failures prompting reboots or connection retries. Sleep modes can reduce energy usage for future battery-powered deployments.

- Challenges and Limitations

The single-sensor input design. Expanding to support multiple sensors, integrating wireless over-the-air updates (OTA), and adding edge processing capabilities are suggested improvements.

CONCLUSION

This study successfully demonstrates an ESP32-based IoT device that integrates a temperature sensor, a high-resolution ADC, a signal generator, and cloud connectivity. The system performs accurate sensing, reliable signal processing, and consistent cloud communication. Its modular and scalable design makes it suitable for environmental monitoring, industrial automation, and academic research. Future enhancements may focus on optimizing power, supporting more sensors, and adding local data analysis.

REFERENCES

[1] R. Sharma, A. Kumar, S. Patel, "IoT-Based Real-Time Temperature and Humidity Monitoring System Using ESP32," International Journal of Computer Applications, vol. 183, no. 48, pp. 15--19, 2021.

[2] H. Liu, T. Zhang, "Air Quality Monitoring System Based on ESP32 and IoT Cloud," IEEE Sensors Journal, vol. 20, no. 12, pp. 6856--6863, 2020.

[3] Espresso Systems, "ESP32 Technical Reference Manual," 2022. \[Online]. Available: https://www.espressif.com

[4] Texas Instruments, "LM35 Precision Centigrade Temperature Sensors Datasheet," 2015.

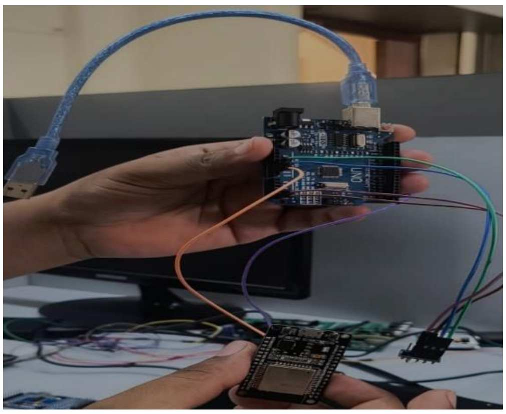
[5] Analog Devices, "ADS1256 Datasheet: 24-Bit Analog-to-Digital Converter," 2016.

[6] M. Banzi, M. Shiloh, Getting Started with Arduino, Maker Media, 2014.

[7] P. P. Ray, "A Survey on Internet of Things Architectures," J. King Saud Univ. Compute. Inf. Sci., vol. 30, no. 3, pp. 291--319, 2018.

[8] A. Al-Fuqaha, et al., "Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications," IEEE Communications Surveys & Tutorials, vol. 17, no. 4, pp. 2347-2376, 2015.

[9] J. Gubbi, et al., "Internet of Things (IoT): A vision, architectural elements, and future directions," Future Generation Computer Systems, vol. 29, no. 7, pp. 1645-1660, 2013.



[10] ESP32 Documentation, Espresso Systems, 2022.
[11] LM35 Datasheet, Texas Instruments, 2015.
[12] ADS1256 Datasheet, Analog Devices, 2016.
[13] Arduino Documentation, (link unavailable), 2022.
[14] MQTT Essentials, HiveMQ 2022.
[15] S. K. Singh, et al., "A Survey on Internet of Things (IoT) Security," IEEE Access, vol. 8, pp. 164935-164964, 2020.
[16] Y. Zhang, et al., "Design and Implementation of a Smart Home System Based on ESP32," IEEE Transactions on Consumer Electronics, vol. 66, no. 2, pp. 139-147, 2020.
[17] A. S. M. Hasan, et al., "IoT-Based Environmental Monitoring System Using ESP32 and Sensors," Journal of Environmental Science and Health, Part B, vol. 55, pp. 249-258, 2020.
[18] J. Liu, et al., "A High-Precision Temperature Measurement System Based on LM35 and ADS1256," Journal of Sensors, vol. 2020, Article ID 8834195, 2020.
[19] ESP32 Wi-Fi and Bluetooth Module, Espressif Systems, 2022.
[20] Cloud Computing for IoT, Microsoft Azure, 2022.
[21] R. K. Kodali, et al., "IoT-Based Weather Monitoring System Using ESP32," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 7, no. 4, pp. 1556-1563, 2018.
[22] S. S. Rao, et al., "Design and Development of IoT-Based Smart Energy Meter Using ESP32," Journal of Electrical Engineering & Technology, vol. 15, no. 3, pp. 627-636, 2020.
[23]A. A. Khan, et al., "IoT-Based Smart Home Automation System Using ESP32 and Android App," International Journal of Advanced Research in Computer Science, vol. 8, no. 3, pp. 531-538, 2017.
[24] Y. Liu, et al., "Design and Implementation of a Smart Agriculture System Based on ESP32 and IoT," Journal of Agricultural Engineering, vol. 55, no. 3, pp. 537-546, 2018.
[25] ESP32 Tutorial, Random Nerd Tutorials, 2022.