International Journal of Scientific Research in Science and Technology
Available online at : www.ijsrst.com
Print ISSN: 2395-6011 | Online ISSN: 2395-602X
doi : https://doi.org/10.32628/IJSRST524111104

Advanced Ambiance Sensing Device using ESP32 and BME680

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ARTICLEINFO

Article History:
Accepted: 20 Feb 2024
Published: 03 March 2024

Publication Issue :
Volume 11, Issue 2
March-April-2024
Page Number :
32-36

ABSTRACT

This paper presents a comprehensive exploration of an innovative ambience sensing device developed through the integration of the ESP32 micro-controller and the BME680 sensor module. Ambient conditions play a crucial role in human health, comfort, and productivity, necessitating efficient monitoring systems. The device described herein offers a cost-effective, portable, and precise solution for monitoring various ambient parameters, including temperature, humidity, air pressure, and volatile organic compounds (VOCs). Through detailed hardware implementation and software programming, coupled with integration with the ESP32 IoT Development Framework (ESP-IDF), this device enables real-time data collection, analysis, and transmission. Applications encompass indoor air quality assessment, environmental research, and smart home automation, with potential for broader applications in diverse domains.

KEYWORDS: ESP32 Micro-controller ,BME680 Sensor, ESP-IDF, Ambience Monitoring, IOT, Environment

I. INTRODUCTION

Understanding and optimizing ambient conditions are paramount for human well-being, productivity, and comfort. Traditional monitoring methods are often expensive and stationary, hindering their widespread adoption. This research presents a novel ambience sensing device leveraging the cost-effective ESP32 microcontroller and the versatile BME680 sensor module. This device aims to bridge the gap, offering portability, affordability, and precision in ambient sensing[1].

The Ambiance Monitor Project introduces a comprehensive initiative aimed at revolutionizing the monitoring and management of environmental conditions in diverse settings. In today's dynamic and interconnected world, understanding and optimizing ambient factors such as temperature, humidity, air quality, and noise levels have become imperative for enhancing overall well-being and productivity.

This project addresses the growing need for a sophisticated monitoring system that goes beyond traditional approaches. By strategically deploying

advanced sensors, the system captures real-time data, providing an accurate and nuanced representation of the surrounding environment. The significance of this endeavor lies in its potential to contribute to healthier living and working spaces, with applications ranging from homes and offices to public areas [2].

Key components of the Ambiance Monitor Project include the meticulous selection of cutting-edge sensors, robust data acquisition mechanisms, and the development of an intuitive user interface. These elements work synergistically to empower users with actionable insights into their surroundings, fostering informed decision- making and a heightened awareness of environmental quality[2]. As society continues to prioritize sustainability and well-being, this project endeavors to play a pivotal role in promoting a harmonious coexistence with the environment. The following sections will delve into the technical intricacies, methodologies, and anticipated outcomes of the Ambiance Monitor Project, offering a comprehensive understanding of its objectives and potential impact.

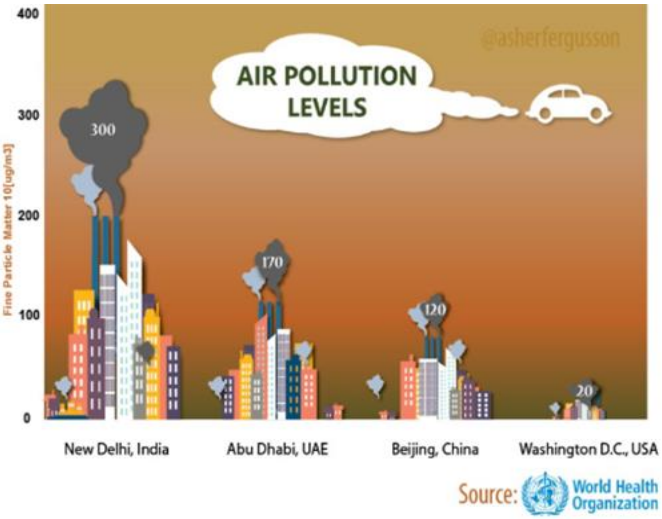
II. LITERATURE SURVEY

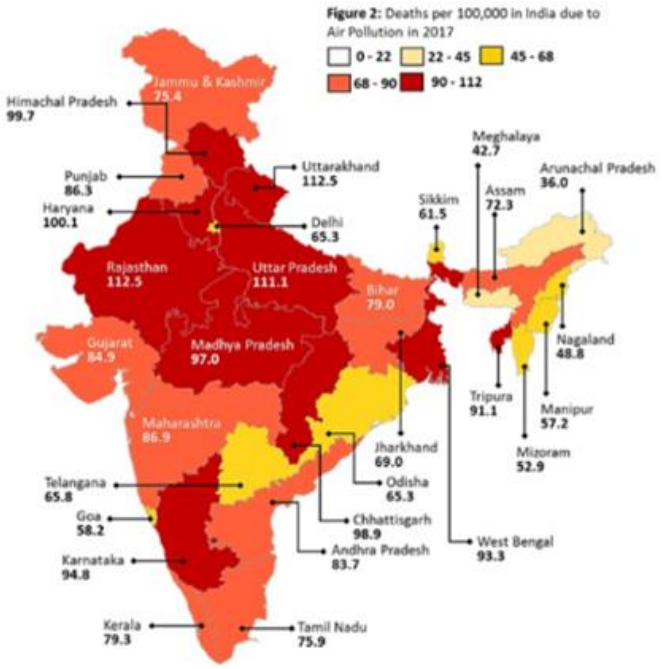
The Air Quality Index (AQI) in India, like in many other countries, is divided into several categories with corresponding numerical ranges. These numerical values can vary slightly depending on the specific standards and calculations used by local environmental agencies[5]. However, as of my last knowledge update in September 2021, here is a general representation of the AQI categories and their numerical values in India:

0-50: Good
51-100: Satisfactory
101-200: Moderate
201-300: Poor
301-400: Very Poor 401 and above:[3] Severe

These numerical values correspond to different levels of air quality, ranging from "Good," which indicates clean air, to "Severe," which signifies. highly polluted air. The AQI is calculated based on the concentrations of various air pollutants and is used to provide information about air quality on a given day and in a specific location. Please note that should refer to the latest local standards and measurements for the most up-to-date AQI information in India[4].

Air Quality Index and Impact on INDIA

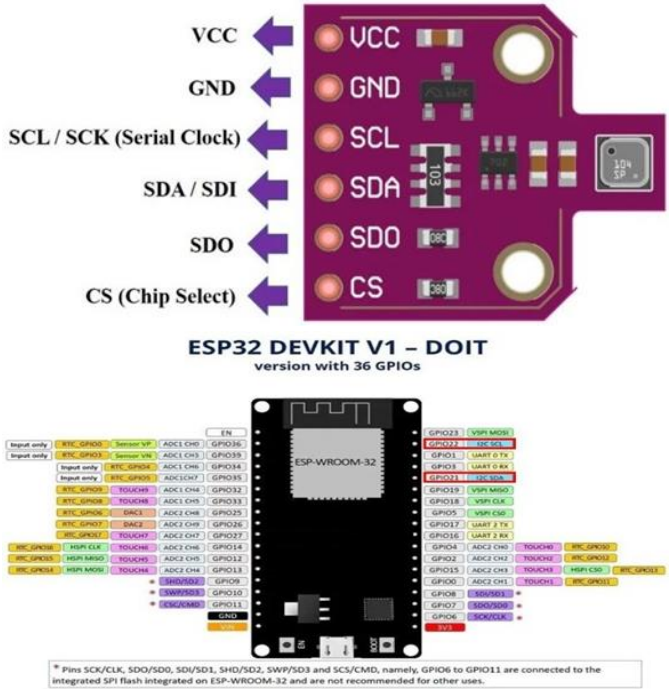




DEVICE ARCHITECTURE : The ambience sensing device comprises an ESP32 microcontroller as the

central processing unit, facilitating data processing and communication. The BME680 sensor module, encompassing temperature, humidity, pressure, and gas sensors, serves as the primary sensory apparatus. Alongside, power management, data storage, and wireless connectivity components complete the architecture, ensuring seamless operation and data transmission.

The Pin out diagram of BME680 sensor is shown below:



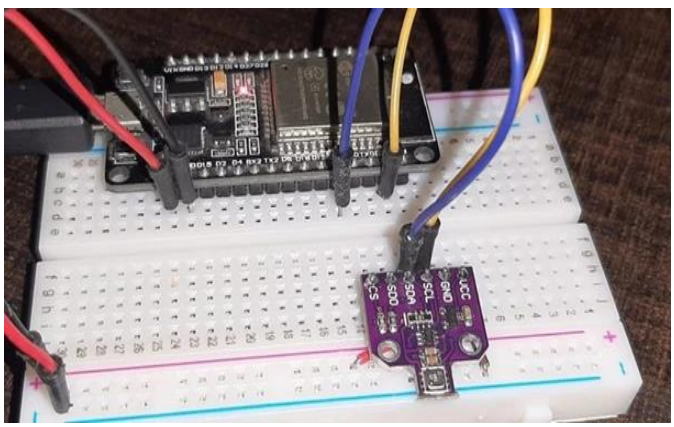
Pin Name	Description
VCC	Pin to power up sensor
GND	GND pin for power supply
SCL	BME680 provides 2 interfaces such as SPI and I2C to get sensor readings. This pin is serial clock signal for both I2C and SPI interfaces.
SDA	With I2C protocol this pin acts as SDA or Serial Data pin and when using SPI protocol this pin acts as SDI or Serial Data In also known as MOSI ('Master out Slave in').
SDO	This is the SDO (Slave data out) /MISO (Master in slave out) pin for SPI communication. This pin is used for SPI interface only.
CS	This is the Chip Select pin used in SPI communication. Acts as an input to the sensor.

III. METHODOLOGY

IMPLEMENTATION : Utilizing the Arduino IDE, the ESP32 microcontroller is programmed to orchestrate sensor data acquisition and transmission protocols. Interface libraries and drivers simplify integration with the BME680 sensor module, enabling seamless data retrieval. The device operates in a continuous monitoring mode, periodically collecting ambient data and transmitting it wirelessly to designated end points. Energy- efficient strategies are employed for prolonged battery life in portable applications.

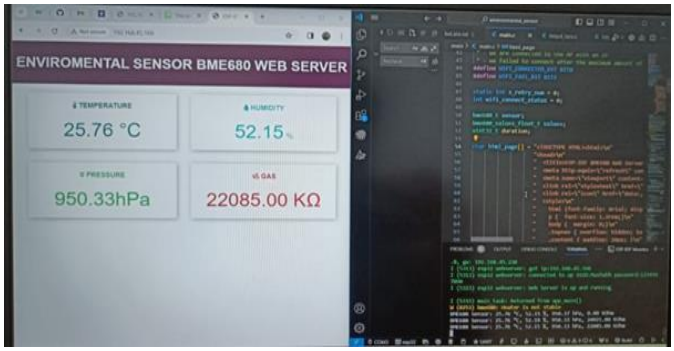
INTEGRATION WITH ESP-IDF : The development process leverages the ESP32 IoT Development Framework (ESP-IDF) for enhanced flexibility and functionality. ESP-IDF's comprehensive set of tools and libraries facilitates seamless integration of the ESP32 microcontroller with the BME680 sensor module. By utilizing ESP- IDF, developers gain access to advanced features and optimizations, ensuring robust performance and scalability in ambient sensing applications.

Interface BME680 with ESP32 ESP-IDF



IV. EXPERIMENTAL RESULT

The ESP32 and BME680-based ambience sensing device exhibited accurate and consistent results in temperature, humidity, pressure, and gas resistance measurements. It demonstrated sensitivity to volatile organic compounds, providing valuable insights into air quality. The device's power efficiency and seamless connectivity via ESP32 make it a reliable tool for real-time environmental monitoring.



Serial Number	Air Quality Parameters	Measurements
1	Temperature	25.03 Degree C
2	Humidity	52.15%
3	Pressure	950.33 hPa
4	GAS	22085.00 K Ohm

SOME OF THE ADVANTAGES FROM THE ABOVE RESULTS :

Environmental Awareness: Provides real-time data on various environmental parameters, such as temperature, humidity, pressure, air quality, helping users stay informed about their surroundings.

Health and Safety: Helps maintain a healthy indoor environment by monitoring factors that can impact well-being, such as air quality and ventilation, reducing the risk of health issues.

Energy Efficiency: Enables better control over energy usage by optimizing heating, cooling, and ventilation systems based on accurate environmental data, leading to potential energy savings.

Early Warning System: Alerts users to potential issues like gas leaks or abnormal conditions, allowing for prompt intervention and prevention of more significant problems.

V. CONCLUSION

The development of the ambiance sensing device using ESP32 and BME680, augmented by integration with ESP-IDF, represents a significant advancement in ambient monitoring technology. By offering a cost-effective, portable solution with real-time data analysis capabilities, this device empowers users to create healthier and more comfortable living environments. Further enhancements and refinements promise broader applications and enhanced user experiences in ambient sensing.

VI. FUTURE DIRECTION

Future research endeavours may focus on expanding the device's functionality by integrating additional sensors for monitoring ambient parameters such as light intensity and sound levels. Moreover, advancements in data analytics algorithms and cloud integration can enhance the device's capabilities, paving the way for advanced ambient sensing applications in various domains.

VII. ACKNOWLEDGMENT

I would like to express my sincere gratitude to Prof. Mrs. Neeta Bajpai & Prof. Shital Umale for their invaluable guidance and support throughout the development of the ambiance monitor project. Their expertise and encouragement significantly contributed to the successful completion of this endeavor. I also extend my thanks to my team for their collaboration and efforts. This project wouldn't

have been possible without the collective dedication and hard work of everyone involved

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Cite this article as :

Neeta Bajpai, Kajal Kotangale, Asmita Bhaire , "Advanced Ambiance Sensing Device using ESP32 and BME680", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 11 Issue 2, pp. 32-36, March-April 2024. Available at doi : https://doi.org/10.32628/IJSRST524111104
Journal URL : https://ijsrst.com/IJSRST524111104