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An Iot-Based Air Pollution Monitoring System

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ABSTRACT

Develop an economical approach for monitoring air pollution and implement it. The proposed method will enable workers to access data on nearby analyzed polluted sites. An ESP32 microcontroller is connected to various components of the proposed system. This system includes sensors for assessing air quality, humidity, and temperature. Data is collected and transmitted to the cloud via the ESP32 Wi-Fi module. The data is conveyed to the cloud platform via the MQTT protocol, which denotes Message Queuing Telemetry Transport. Subsequently, the application alerts the user. The proposed approach possesses significant potential applications, particularly in industries where monitoring hazardous gas emissions are essential. To inform workers of the subpar air quality in their vicinity, supplementary pollution data is utilized.

Keywords: *Internet of Things; Blynk; Arduino; arduino IDE; sensor; Air pollution.*

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I. INTRODUCTION

The Internet of Things system is seeing rapid expansion in the current economic and technological landscape. Numerous firms across all industries have acknowledged the increasing imperative of safeguarding their personnel, ensuring their health, safety, and protection from potential threats. The phrase "Internet of Things" denotes a network of interconnected physical objects that provide remote monitoring and control through wireless networks. Environmental issues may lead to catastrophic consequences. Significant issues exist with air and noise pollution. The primary objective is to ascertain the severity of air pollution and its associated costs.

Air pollution constitutes a significant issue in all nations, regardless of their level of development or growth. Both animals and humans are susceptible to the detrimental effects of gas pollution, which can lead to lung cancer, ocular discomfort, and respiratory issues. Significant health issues such as asthma, pneumonia, heart disease, and respiratory infections might exacerbate due to pollution. Furthermore, it may induce moderate allergic reactions in the lips, eyes, and nose. When corporations neglect environmental regulations and fail to reduce emissions, issues of this nature typically arise. Individuals are experiencing health issues at an increased frequency compared to prior periods. Cities in developing nations are especially impacted because to elevated amounts of gaseous emissions from industry and cars.

The proposed research offers a new solution to the critical necessity of accurately, consistently, and effectively monitoring pollution levels surrounding enterprises. The technology establishes criteria by comparing high pollution levels and monitoring dangerous compounds in plants. Furthermore, when air quality deteriorates above a specific threshold, it alerts individuals that the vicinity is hazardous. This configuration includes an LCD (Liquid Crystal Display) that presents data from the MQ6 and MQ135 sensors, which interface with the Arduino CPU. Due to the rapid advancement of technology, compact, cost-effective, and technically viable sensors have been created. Issues impacting both the environment and human health garner significant attention. The primary objective of an IoT air pollution monitoring system is to detect current elevated pollution levels. Adhering to and enforcing air quality regulations is essential for protecting public health and enhancing future prospects. The Internet of Things (IoT) is gaining popularity because to its affordability and adaptability.

IOT - The "Internet of Things" (IoT) refers to a cohesive network of physical objects that may transmit data and instructions through electrical devices, software, and several other methods. These devices can communicate with one another via the internet and exchange data with other structures and machinery. These devices encompass a wide range, from cutting-edge professional equipment to ordinary household items. By the conclusion of 2020, researchers anticipate that over 7 billion IoT devices will be interconnected. This figure is projected to escalate to 22 billion by 2025, an increase from 10 billion in 2022. Collaboration with other companies is essential for tool development at Oracle.

Arduino - Arduino is an accessible, open-source platform that integrates hardware and software. Arduino enables everyone, regardless of expertise, to effortlessly construct interactive electronic devices or environments. The board's processor does specified tasks upon receiving explicit instructions. This is accomplished through the use of the Processing-based Arduino IDE and the Wiring-based Arduino programming language.

Arduino IDE - Computer programmers possess a comprehensive array of tools for software development via integrated development environments (IDEs). Debuggers, code editors, and build automation tools are prevalent elements of integrated development environments (IDEs). Currently, the majority of IDEs have advanced code completion functionalities.

Blynk – Blynk is an application suite that enables communication between cellphones and other embedded systems, such as Raspberry Pi and Arduino. Individuals engaged in construction, design, education, or those who derive pleasure from manipulating technology all utilize it. Blynk employs a diverse selection of frequently deployed shields and boards. The user-friendliness of Blynk Cloud is a significant selling proposition for the company. It is crucial to acknowledge that cloud computing is both free and open source. Blynk is a versatile tool compatible with several shields. Conversely, it is intended to protect the boards and coverings. It is compatible with devices operating on Android and iOS.

Sensors - a device capable of detecting various concentrations of pollutants such as smoke, fire, and associated toxins. Sensors facilitate the Internet of Things (IoT). They collect data to enable individuals to make informed decisions.

II. BACKGROUND

The proposed method for monitoring air pollution uses an Internet of Things infrastructure. Using this strategy, a comprehensive review of the existing literature is conducted. This allowed them access to a wide range of methodologies and technology developed by other writers in the field.

In 2016, Marin B. Marinov This work uses a scalable sensor array with built-in infrared and amperometric gas sensors to demonstrate a cost-effective method for measuring crucial environmental parameters. The measurement was compared to data from the local environmental control body's stations after tests were conducted throughout the city. After seeing some first outcomes, this method appears to be a less expensive alternative to employing high-end tools. Another major issue is the sheer number of gadgets and links required.

Name: Marquez, David Viloria. This paper examines the development and implementation of an economical georeferenced air pollution measurement system. The system utilizes scatter-based methods to measure PM1, PM2.5, and PM10 particles. The device monitors ozone levels, humidity, barometric pressure, and air temperature. All components are connected to an economical microcontroller with integrated WiFi. This facilitates the rapid transmission of data to the cloud using the MQTT protocol. Similar to the Internet of Things (IoT) in its data collection and presentation, the data can be georeferenced and made available on an open-access website. This method may appear as costly software to certain individuals. Moreover, both the volume of data requiring entry and the number of inputs necessary for diverse applications are perpetually increasing.

Chen Xiaojun was born in 2015. This article presents a viable answer to the intricate issue of air pollution through an approach to its management and forecasting. A collection of devices is employed to ensure reasonable and accurate data collection within the monitored area, reduce the financial burden of oversight, and improve monitoring precision. An IoT architecture generally comprises three tiers: perception, network, and application. The limited use of this technology at a few business monitoring sites renders the data insufficient for forecasting the overall air pollution levels.

In 2014, Vasim K. Ustad disclosed his findings. The proposed architecture consists of a stationary pollution monitoring system with Internet connectivity and a mobile data acquisition (DAQ) unit. The Mobile-DAQ device is equipped with several air pollution sensors, a GPS receiver, and a single-chip microcontroller. A "Pollution-Server" is a high-performance, specialized application server designed for Internet-connected PCs. Concentrations of CO, NO2, and SO2 in the air are quantified and integrated utilizing the Mobile-DAQ apparatus. Subsequently, it consolidates all pertinent information into a container that includes the current date, time, and GPS coordinates. We intend to transmit data to the Pollution-Server via a Zigbee device. Moreover, ZigBee's data transmission rates are inferior to those of WiFi. The Zigbee protocol has a maximum data transmission capacity.

Ibrahim Kadri (2013) delineates a system for the immediate identification of air pollution, utilizing machine-to-machine (M2M) technology and a network of monitoring stations that wirelessly communicate with a central server. Consumers can retrieve information via mobile applications and websites after the back-end system acquires data in real-time from the stations. Cost-effective and essential, solar energy is transformative. The device requires a continuous active internet connection.

Air pollutants mostly comprise sulfur dioxide (SO2), nitrogen dioxide (NO2), and ground-level ozone (O3). This essay pertains to the forecasting component of the Air Pollution Monitoring System, as articulated by Khan and Khaled Bashir Shaban (2016). A diverse array of gas and meteorological sensors is integrated into economical air quality monitoring devices across the system. A multi-module intelligent sensor base is wirelessly linked to these motes. The modules are responsible for receiving.

The film Bathiya Bhavika was released in 2017. As urban areas and businesses have expanded significantly, environmental quality indicators have deteriorated. Our primary objective is to design an environment-monitoring system that integrates Wireless Sensor Networks (WSN). Each sensor node contains numerous radio devices and sensors. Although XBee radio modules are prevalent, alternative radio modules that comply with the specifications may also be utilized. In network design, a tree construction method is employed to structure sleep cycles and oversee the hierarchical connections between offspring and their progenitors. All individuals intending to utilize XBee-compliant devices must possess a comprehensive understanding of the system's functionality. This technology provides insufficient protection relative to WiFi-based security systems.

An enhanced iteration of JunHo Jo's 2019 design for an IoT-based indoor air quality monitoring system is now accessible. The system comprises a web server and an air quality monitoring device known as "Smart-Air. This technology continuously monitors indoor air quality in real-time through cloud computing and the Internet of Things. Utilizing IoT technology, Smart-Air rapidly evaluates air quality and transmits data in real-time to a web server via LTE. It comprises a central processing unit, an LTE modem, and pollution sensors. The experimental apparatus was designed to measure various air quality parameters, including humidity, temperature, carbon monoxide, carbon dioxide, aerosols, and volatile organic compounds.

III. SYSTEM REQUIREMENTS

Hardware Requirements

The ESP32 Microcontroller can function autonomously or as a supplementary unit to a more robust microcontroller, alleviating the burden on the application CPU's communication stack, based on your requirements. It possesses SPI/SDIO and I2C/UART interfaces, and it can also communicate with other computers via Wi-Fi and Bluetooth. The subject is to a 16x2 character LCD display module designed for the Arduino platform, equipped with an I2C interface. The sixteen characters, arranged in two lines, each measure 16 pixels per side. Black text on a green background is presented here. The LCD screen requires four ports: SCL, VCC, GND, and SDA.

The DHT11 is a cost-effective and user-friendly digital thermometer. It accurately measures both humidity and temperature. The apparatus employs a thermistor and a capacitive humidity sensor to assess the atmospheric conditions. Subsequently, a digital signal is conveyed via the data pin, eliminating the necessity for analog input connections. The program is intuitive; nonetheless, information retrieval requires caution.

The MQ-5 sensor module is capable of detecting gas leaks in both residential and commercial settings. This apparatus can detect alcohol, hydrogen, carbon monoxide, methane, and liquefied petroleum gas. The device's rapid response time and exceptional sensitivity enable instantaneous measurements.

The MQ-135 Gas Monitors can detect or measure many gases, including CO2, benzene, alcohol, smoke, NH3, and NOx. Devices that regulate air quality utilize them. The MQ-135 sensor module functions independently of a central processing unit (CPU) due to a digital pin.

The MQ-3 Sensor module can detect gas leaks in both commercial and residential structures. Its components comprise alcohol, benzene, hexane, liquid petroleum gas, and methane. An individual's immunity diminishes in direct correlation to their alcohol consumption. The concentration of alcohol is ascertained by evaluating the resistance. If your smartphone can access the internet, it can function as a mobile phone. Linking the breadboard components to the Arduino header ports will require jumper wires.

Software Requirements

Embedded C is a collection of extensions designed to function in conjunction with the C programming language. Integrating advanced microprocessor functionalities such as banking, fixed-point arithmetic, multi-memory management, and fundamental input-output (I/O) operations into the embedded C system necessitates innovative additions to the C language. Embedded C extensively utilizes the syntax and semantics of the C standard.

The Arduino IDE has menus, text displays, message boards, code editors, and toolbars with frequently used buttons. It facilitates access to programs and connections on your Arduino hardware. The software was developed by Blynk.

IV. PROPOSED SYSTEM

This section elaborates extensively on the proposed system. This system will utilize a web application to monitor and report air quality. An alarm will be issued promptly when air quality falls below a specified threshold. Smoking, liquefied petroleum gas (LPG), benzene, ammonia (NH3), and carbon dioxide (CO2) are hazardous substances that affect this level. A user-friendly mobile application and an LCD display will both indicate the current air quality level. Quantification will be conducted using parts per million (ppm). An LPG indicator is now included into this system, which is prevalent in residential settings. The technology displays both temperature and humidity values on an LCD monitor.

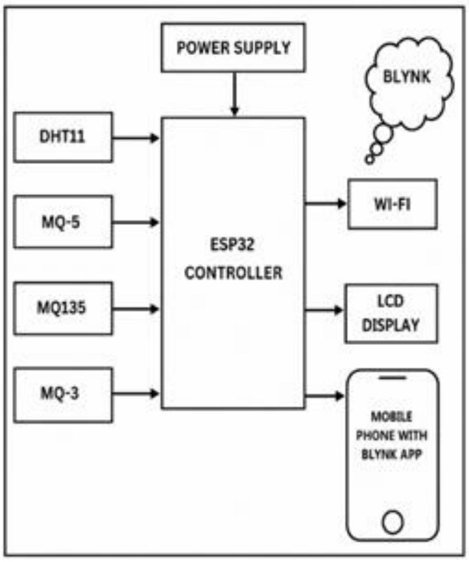

Figure 1: Block diagram for Air Pollution Monitoring System

The system comprises sensors, a microprocessor, I2C, and a smartphone operating the Blynk application. The ESP32 microprocessor is connected to all system sensors. The unit of measurement for pollution levels would be parts per million (PPM), as identified by the system's sensors. The MQ135, MQ3, and MQ5 vacuum sensors are capable of detecting gas concentrations. The output voltage increases proportionally with the gas concentration, and the voltage measurements are converted to parts per million (PPM). Utilizing libraries for MQ135, MQ3, and MQ5 gas sensors converts the results into parts per million (PPM). The proposed model quantifies gas concentration, humidity, and temperature based on data from four distinct sensors. The Blynk app and the LCD function as complimentary output devices. Upon activation of the system, the sensors, functioning as input devices, commence data collection. The ESP32 microcontroller acquires the previously specified data. The results are shown on the LCD following the module's data transmission. The gas concentrations are displayed in parts per million, humidity is represented in percentages, and temperature is indicated in degrees on the LCD.

Furthermore, the Blynk application acquires data from the ESP32 chip. The Blynk application displays temperature and humidity information in a user-friendly style. This program possesses its own cloud infrastructure as it utilizes cloud storage for data management. The application generates and presents graphs based on the input data. All data presented herein has been previously obtained.

V. FLOW CHART DIAGRAM

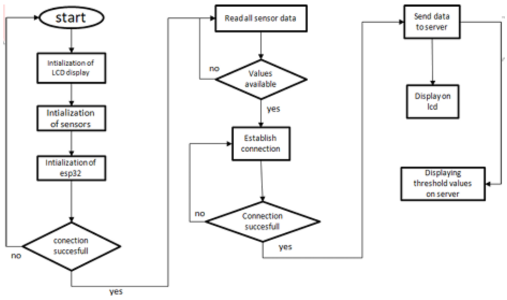

Figure 2: Flow Chart of proposed system

A flowchart illustrates the functioning of a process or workflow. The system's sensors and ancillary devices must be initialized prior to activating the hardware. Verifying and setting the hardware connections suffices to rectify an incomplete startup. Values are swiftly returned upon the commencement of data collection by the sensors. Upon the availability of the data, the Wi-Fi module displays the information and transmits it to the cloud. Upon getting the data from the Blynk server, the Blynk application authenticates it.

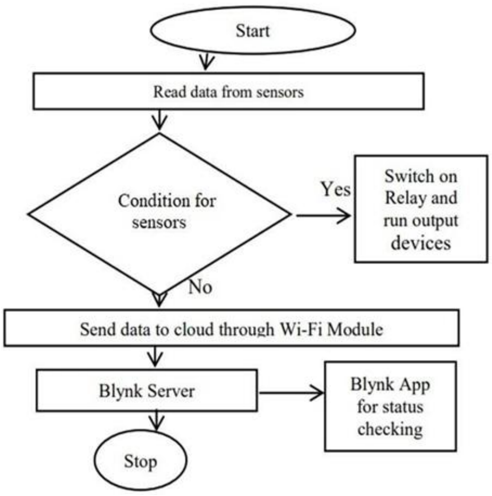

Figure 3: DFD for air pollution monitoring system

VI. RESULT AND DISCUSSIONS

	Experimental result	Expected result
Temperature	29 ppm	28 ppm
Humidity	83 ppm	80 ppm
Mq2	400 ppm	383 ppm
Mq5	905 ppm	912 ppm
Mq135	1230 ppm	1252 ppm

Figure 4: test result (*ppm – parts per million)

The data generated by the system is presented in both the experimental results and the previously mentioned table. The test findings incorporate an error margin of 2% to 3%.

Figure 5: Application output

The proposed system utilizes three gas detectors to identify gasses, collect data, display it on a screen, and transmit it to the Esp32. Subsequently, Blynk compiles the data, enabling us to observe the events occurring within that application.

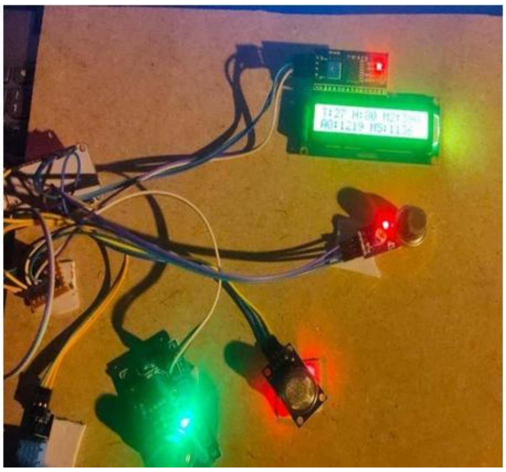

Figure 6: Hardware implementation

VII. CONCLUSION

The proposed system identifies hazardous gas emissions and tracks pollution levels utilizing the Blynk application, the Internet of Things, and an ESP32 microcontroller. This paper presents a model utilizing MQ135, MQ2, MQ5, and DHT11 sensors to monitor air pollution, detect hazardous substances, and activate an alert when air quality deteriorates. The microcontroller is the most crucial component of this module as it governs the entire system. The Blynk application is connected to the entire system via a Wi-Fi module, and the results are shown on an LCD screen. The proposed method for detecting air pollution is evaluated through experimentation.

The method was deemed successful upon achieving a precision of 97%. This method facilitates the identification of airborne pollutants. Individuals will soon have access to air quality data in their vicinity, enabling appropriate responses to any fluctuations. Utilizing air tracking technologies could significantly simplify the arduous task of devising innovative methods for remediating severely contaminated regions. Incorporating additional sensors enables the monitoring of pollutant levels within the system, including hazardous gasses.

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