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Air Pollution Monitoring System Using IOT

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Abstract: To Design and develop a low-cost air pollution monitoring system. The proposed system alert workers, notify data of polluted area that has been checked for the immediate surroundings. The proposed system has various parameters such as Air Quality, Temperature and Humidity sensors with ESP32 microcontroller which collects and upload data into the cloud using ESP32 Wi-Fi module. The data is transmitted to the cloud platform using MQTT(Message queuing Telemetry Transport) protocol and alerts the user through an application. The proposed system has various applications like in industry where the pollution levels check of dangerous gasses is paramount. Further pollution information is used to alert the workers about the air quality in their surroundings are not good for health.

***Keywords*— Internet of Things, Blynk, Arduino, arduino IDE, sensors, Air pollution.**

I. INTRODUCTION

Internet of things system is a rapidly expanding idea in this era of industrialization technology meanwhile. It has become important for many manufacturing companies and other industries care about employees health, safety and other side effects. The internet of things that can monitor the physical objects that are connected to the Internet (wireless networks) and can be controlled from anywhere in the world. Environment issues may cause big disaster these days. One of the huge issues faced are Air pollution and sound pollution. By finding and detecting air pollution levels is the main objective.

Air pollution is the biggest problem of every nation, whether it is developed or developing. Many times the emission of gases affects both the human beings and animals are affected by lung cancer, irritation of eye, breathing. Some other harmful effects caused by pollution are mild allergic reactions near throat, eyes and nose as well as some serious problems like bronchitis, heart diseases, pneumonia, lung and aggravated asthma. These are the problems that usually occurs while the industry does not take proper steps to reduce the gases as per government rules. Health problems have been growing at faster rate especially in urban areas of developing countries where industrialization and growing number of vehicles leads to release of lot of gaseous pollutants.

To overcome this problem, proposed work is one step forward towards the environment and pollution levels around the manufacturing industries needs to be monitored efficiently, reliably and accurately. By monitoring harmful gases present around industry it also checks high pollution rate and compare it with standard levels and when quality goes down beyond a certain level it sends notification to human that it's not safe. Existing System only uses arduino controller, two sensors MQ6 and MQ135. For output it uses LCD (Liquid Crystal Display). Due to rapid development in technology, the development material for little and low cost sensors became technically and economically feasible. Particular attention is given to factors which can affect human health and the health of the natural system. The main objective of IOT Air pollution Monitoring System is to monitor pollution levels, that is major issue these days. It's necessary to watch air quality and keep it in check for a far better future and healthy living for all. Due to flexibility and low-cost Internet of things (IoT) is getting popular day by day.

IOT - The Internet of Things (IoT) describes the community of bodily gadgets— "things"—which might be embedded with sensors, software, and different technology for the motive of connecting and changing statistics with different gadgets and structures over the internet. These gadgets variety from normal family gadgets to state-of-the-art business tools. With greater than 7 billion linked IoT gadgets today, professionals are watching for this variety to develop to ten billion via way of means of 2020 and 22 billion via way of means of 2025. Oracle has a community of tool partners.

Arduino - Arduino is an open-source electronics platform supported easy-to-use hardware and software. Arduino is designed to make electronics more accessible to artists, designers, hobbyists and anyone interested in creating interactive objects or environments. Board can perform specific operations by sending a set of instructions to the microcontroller on the board. To do so the Arduino programming language (based on Wiring), and the Arduino Software (IDE) is used based on Processing.

Arduino IDE - An integrated development environment (IDE) is a software application that provides comprehensive facilities to computer programmers for software development. An IDE normally consists of a source code editor, build automation tools, and a debugger. Most modern IDEs have intelligent code completion.

Blynk – Blynk is a toolset for all makers, inventors, designers, teachers and geeks who would love to use their smart phones to control electronics like Arduino, Raspberry Pi and similar ones. Blynk will work with all popular boards and shields. It allows users to enjoy the convenience of Blynk Cloud. By the way cloud is free and open-source. Blynk is not an application that works only with a particular shield. Instead, it's been designed to support the boards and shields. It also works on iOs and Android.

Sensors - A detecting object which detects varies quantities like smoke, flame and many more. Sensors enable the Internet of Things (IoT) by collecting the data for smarter decisions.

II. BACKGROUND

The proposed method is based on air pollution monitoring system using IOT. The extensive literature survey is carried out based on this technique. This led exposure to so many earlier methodologies and technologies proposed by many authors in this field.

Marin B. Marinov(2016) In this paper present an approach for cost-effective measurement of relevant environmental parameters, based on a scalable sensor array with integrated amperometric and infrared gas sensors. The device has been tested in the city and the measurement was compared with the output data of the local environmental control authority stations. The preliminary results show that this approach can be used as an economical alternative to the professional grade systems. Major disadvantage is lot of connections are required and many devices are used.

David Marquez-Viloria(2016) This work presents the development and implementation of a low cost georeferenced air-pollution measurement system that offers information of particulate measurement PM1, PM2.5 y PM10 by scatter. In addition, the system measures the levels of ozone concentration, and atmospheric variables such as temperature, humidity and barometric pressure. The whole system is connected to a low cost microprocessor with integrated Wi-Fi allowing to send the data to the cloud in real-time using MQTT protocol, and thus the data can be georeferenced and published on an open access platform, used to the Internet of Things (IoT), for the acquisition and visualization of the data. This technology might be considered as expensive software. It as well requires enormous data inputs amount that are needed to be practical for some other tasks and so the more data that is to put in.

Chen Xiaojun(2015) Air pollution and forecasting system designed in this paper proposed a good solution to the complexity of air pollution. The use of a large number of sensors ensures monitoring accuracy, reduces monitoring cost and makes monitoring data in monitoring area more systematic and perfect. According to IOT architecture, the system is mainly composed of perception layer, network layer and application layer. This system can only be installed in key monitoring locations of some key enterprises, thus system data is unavailable to predict overall pollution situation.

Vasim k.ustad(2014) The proposed framework comprises of a Unit of Mobile-DAQ and a fixed Internet-Enabled contamination observation System. The Mobile-DAQ unit incorporates a solitary chip microcontroller, air pollution sensors exhibit, and GPS Device. The Pollution-Server is a top of the line individual computer application server with Internet network. The Mobile-DAQ unit assembles air toxins levels (CO, NO2, andSO2), and packs them in a casing with the GPS physic distribution, time, and date. The reason is to send the Pollution-Server by means of zig bee device. ZigBee's data transfer speed is lower than WiFi's, too. The zig bee has low transmission rate.

Abdullah Kadri(2013) Wireless sensor network for real-time air pollution monitoring- This paper presents the system which consists of several distributed monitoring stations that communicate wirelessly with a back-end server using machine-to-machine (M2M) communication. The back-end server collects real time data from the stations and converts it into information delivered to users through web portals and mobile applications. Always solar energy must be present and it is cost effective to develop. It must be always connected to internet

Khaled Bashir Shaban(2016) This paper presents the Air Pollution Monitoring System and its forecasting module. The causes of Air Pollution are ground level ozone (O3), nitrogen dioxide (NO2), and sulfur dioxide (SO2). The system uses low-cost air-quality monitoring motes that are equipped with an array of gaseous and meteorological sensors. These motes wirelessly communicate to an intelligent sensing platform that consists of several modules. The modules are responsible for receiving.

Bhavika Bathiya(2017) Rapid urbanization and industrialization has resulted in a sustained degradation of environmental quality parameters. Our main aim is to implement environmental monitoring system with WSN. Each sensor node includes an array of sensors and radio modules. We have used XBee radio module but depending on the application, radio modules may vary. In network architecture, tree construction mechanism is implemented to maintain parent-child relationship and sleep scheduling algorithm. It requires knowledge of the system for the owner to operate xbee compliant devices. It is not secure like

wifi based secured system.

JunHo Jo(2019)
proposed an IoT-based indoor air quality monitoring platform, consisting of an air quality-sensing device called "Smart-Air" and a web server, is demonstrated. This platform relies on an IoT and a cloud computing technology to monitor indoor air quality in anywhere and anytime. Smart-Air has been developed based on the IoT technology to efficiently monitor the air quality and transmit the data to a web server via LTE in real time. The device is composed of a microcontroller, pollutant detection sensors, and LTE modem. In the research, the device was designed to measure a concentration of aerosol, VOC, CO, CO_2, and temperature-humidity to monitor the air quality.

III. SYSTEM REQUIREMENTS

i. Hardware Requirements

ESP32 Microcontroller can perform as a complete standalone system or as a slave device to a host MCU, reducing communication stack overhead on the main application processor. It can interface with other systems to provide Wi-Fi and Bluetooth functionality through its SPI / SDIO or I2C / UART interface. I2C 16x2 Arduino LCD display module. It is able to display 16x2 characters on 2 lines, black characters on green background. It only needs 4 pins for the LCD display: VCC,GND,SDA,SCL.

The **DHT11** is a basic, ultra low-cost digital temperature and humidity **sensor**. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin (no analog input pins needed). Its fairly simple to use, but requires careful timing to grab data.

The **MQ-5** sensor module is useful for gas leakage detection (in home and industry). It is suitable for detecting H2, LPG, CH4, CO, Alcohol. Due to its high sensitivity and fast response time, measurements can be taken as soon as possible.

The **MQ-135** Gas sensors are used in air quality control equipments and are suitable for detecting or measuring of NH3, NOx, Alcohol, Benzene, Smoke, CO2. The MQ-135 sensor module comes with a Digital Pin which makes this sensor to operate even without a microcontroller.

The **MQ-3** Sensor module is useful for gas leakage detection (in home and industry). It is suitable for detecting Alcohol, Benzene, CH4, Hexane, LPG, CO. More the alcohol, the lower the resistance. The alcohol is measured by measuring this resistance.

Mobile Phone that can be any smart phone which can be connected to internet. Jumper wires are used for making connections between items on your breadboard and your Arduino's header pins.

ii. Software Requirements

Embedded C is a set of language extensions for the C programming language. The embedded C system requires an unexpected expansion of the C language to support advanced microprocessor features such as fixed-point arithmetic, multi- memory, banking, and basic I/O(input-output) function. Embedded C uses most of the syntax and semantics of -C standard.

Arduino IDE contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to real Arduino and Hardware to download programs and contacts.

Blynk application

IV. PROPOSED SYSTEM

In this section, the description of the proposed system is provided. This system will monitor the Air Quality over an application using internet and will trigger a notification when the air quality goes down beyond a certain level, means when there are sufficient amount of harmful gases are present in the air like CO2(carbon dioxide), smoke, alcohol, benzene and NH3(ammonia), LPG(liquefied petroleum gas). It will show the air quality in parts per million(PPM) on the LCD and as well as on mobile application that can be monitored very easily. LPG sensor is added in this system which is used mostly in houses. The system will show temperature and humidity, they are displayed on LCD.

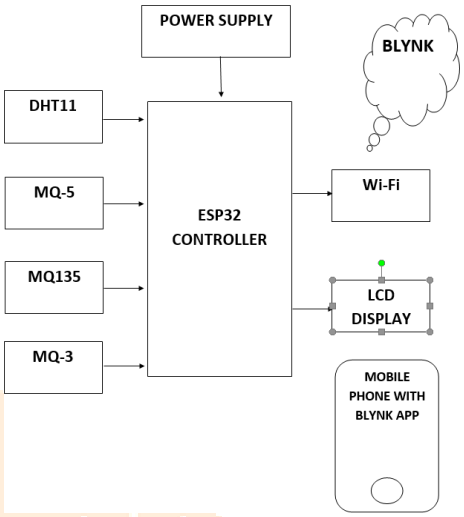

Figure 1: Block diagram for Air Pollution Monitoring System

The system is developed with help of sensors, microcontroller, I2C and mobile phone with blynk application. All sensors used in system are connected to ESP32 microcontroller. The sensors used in system will sense all gases, and it will give the Pollution level in PPM (parts per million). MQ135, MQ3 and MQ5 gas sensor will give the output in form of voltage levels. If the gas concentration increases output voltage increases and the voltage values are converted it into PPM. So for converting the output in PPM, MQ135, MQ3 and MQ5 gas sensor libraries are used. According to the model developed four sensors are used that works as input data, to know the concentration levels of gases, humidity and temperature values. LCD and blynk application are the output devices. When the system is powered the sensors start working and acts like input taker and sends the collected data to ESP32 microcontroller. The module sends the collected information to LCD where output is displayed .On LCD the values are displayed in PPM for gases levels, temperature in degrees and humidity in percentage.

ESP32 microcontroller sends data to blynk application as well. In Blynk application humidity and temperature is seen in graph manner. This application has it's own cloud for storing data. According to the information recieved the data is displayed in application and graph is been shown, it includes the previous data that has been collected..

V. FLOW CHART DIAGRAM

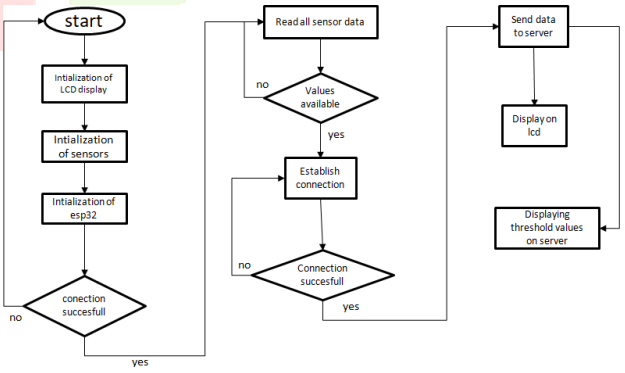

Figure 2: Flow Chart of proposed system

A flow chart is type of diagram that represents a workflow or process. The hardware part of the system need to get connected to power and then the sensors and devices present are initialized. If initialization is not done, hardware connections need to be checked and once connection is successful. The sensors start reading data and values are read. Next when values are available the data is displayed and data is send to cloud through Wi-Fi module. Data is checked on blynk application retrieved from blynk server.

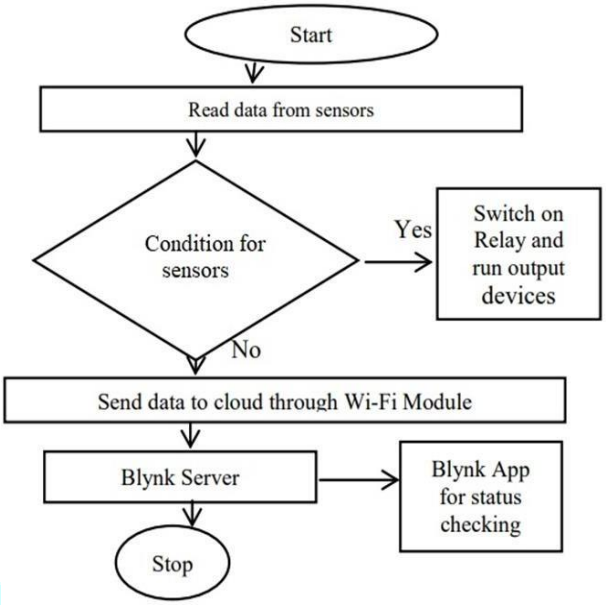

Figure 3: DFD for air pollution monitoring system

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 values produced by system can be seen in the above table and the experimental result. There is difference of 2-3% accuracy from experimental results.

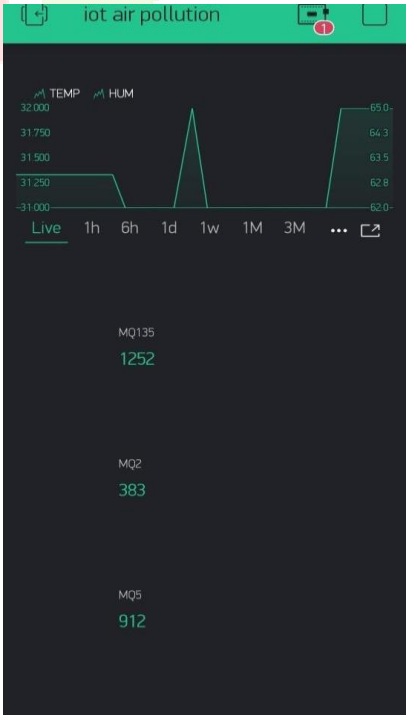

Figure 5: Application output

In proposed system we used 3 sensors that captures the gases and collect data and display it on screen and send it to Esp32 and from that data is send to Blynk and we can see results in that application.

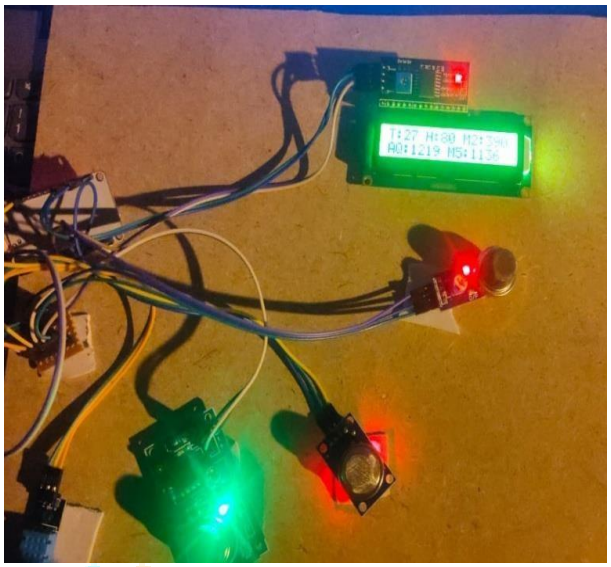

Figure 6: Hardware implementation

VII. CONCLUSION

The proposed system which can monitor the leakage of toxic gases and the level of pollution using blynk application, ESP32 microcontroller and IoT is proposed. In this paper, a model is developed using MQ135, MQ2, MQ5 and DHT11 sensors where we can monitor the level of air pollution and the poisonous gases can be sensed of the surroundings and get notified when air quality drops to some degree. Microcontroller serves as the heart of this module which controls the entire process. Wi-Fi module connects the whole process to blynk application and LCD is used for the visual Output. Proposed Air pollution monitoring system is checked with experimental results.

The system has given a successful results which yields an accuracy rate of 97%. By the help of this system monitoring air pollution can be made easier. Soon everyone will know the quality of the air around them and take appropriate action if the quality drops. The air monitoring system can help in the innovation of new practices to overcome the problems of the highly polluted areas, which is a major issue. Further by additional sensors for the system pollution levels of more different harmful gases can be monitored.

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