IOT enabled Cloud based application for Air Quality Monitoring System-"O_2 TOCSIN"

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Abstract. In recent years, the focus on environmental pollution has increased. In order to have continuous monitoring of the air in the biosphere several research have been done and many sensor based systems have been tested. Most of these kind of systems use the sensors to sense the data and the system will transfer the data to the user applications. In order to provide limited data, the sensor data is processed in GCloud. The proposed system "Oxygen tocsin" is developed to measure the oxygen level in the air. The tocsin is an alarm like system that beeps or notifies the server whenever there is an oxygen deficient (atmosphere that contains oxygen less than 19.5 percent) or high level of carbon monoxide, nitrogen, etc., which are all the poisonous gases considered to be unsafe for breathing. If the human body inhales this oxygen, the red blood cells might get poisonous because of these extra gases. The server connected to all the devices displays the percentage of oxygen in the air and alerts the people to move to the safe places. This proposed work can mainly help the workers in the chemical industries which use more toxic gases like phosgene, nitrogen dioxide, chlorine, etc. This device can also be used in mining industries such as gold, coal, ore, etc. Thus, people working in those industries will be indicated when there is an oxygen deficiency. The proposed system is to measure the oxygen saturation in the air and notify the server. When the oxygen is low, the server displays the nearby places to move to safe places where the oxygen level in the atmosphere is good.

Keywords: Oxygen tocsin, IoT, cloud, PM Sensor,Gcloud IoT.

1 Introduction

Continuous monitoring of all health parameters is mandatory for all old age people and ill health patients. Likewise monitoring our ecosystem is an important one. Recent development in perfect air components monitoring is done using raspberry pi without the use of any real time sensors. In some industries the specific gases are monitored using sensors and Arduino. A PC server is used to save the data and it is viewed in a web page. But this mechanism works only at specific conditions. The system should be able to predict any toxic gases. The purpose of this work is making an air monitoring system to sense the various dangerous gases present in the environment. Today all the industries affect the air worthiness by polluting the air with varied amount of unwanted gases like nitrogen, carbon dioxide, carbon monoxide etc.. This in turn affect the ecosystem leading to the critical situation to human's respiratory system

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2. Related Work

This section describes some previous works related to the monitoring of differnet components of air using varied technology. The work presented by Angrisani et al.,[1] have developed a system using web based STM32L073RZ microcontroller via MQTT protocol for monitoring air in remote areas. This system is developed using low long range and low-power wireless technology and there was a central station that performed data flow operation of the applications.In recent years, the impurity of air in major cities is the major crisis around the world. Thus, it becomes necessary to monitor the air worthiness index in all cities to fit the situation for human to live. In [2] H. Gupta et al addresses that " a system capable of sensing air and analyzing the air components like, Temperature, Humidity, Carbon Monoxide, LPG, Smoke and other hazardous particulate matters like PM2.5 and PM10 levels in the atmosphere is possible " and tested it with their lab set up. Their system is an Android based one system for observing real data of the air components through the smart devices. The devices were capable of measuring humidity, CO, LPG and other hazardous gases. In [3] R. K.Kodali et al have proposed a model that investigated a variety of pollutants concentrated in the indoor and alerted users the same. In [4] M. Hussain et al., have designed a scalable Air Quality Monitoring System using AVR Microcontroller and GSM modem for monitoring air quality. The system was monitored using a miniature suction pump which was established with electromechanical sensors. To locate the critical emissions and suspicious disastrous for the environment is analyzed by applying analytic algorithms. In [5] M. Muladi et al., developed web based air monitoring system for determining the concentration of O2, CO2 and NH3 using gas sensors in an learning environment. They used real time data using IoTvo Wireless LAN networks. Here the sensor is controlled by Arduino and a real time clock for activating the nodes for 2 minutes in an interval of every 5 minutes of sleep. This work has succeeded with good accuracy of measurement of gas concentration. In [6] Sung, WT and Hsiao, SJ developed indoor air quality monitoring system using fuzzy control and developed fuzzy model for analyzing air quality. This system used the past indoor air quality for fixing threshold value. They combined the Arduino Uno development board and ESP8266 Wi-Fi wireless transmission modules for their investigation.In [7] Rohi et al., et al., investigated air pollution in the environment using E-drones. The method involved measures the air pollutants using the recommended threshold value. This method found pollution concentration of toxic gases in different locations.Saini J and Dutta M in their work [8] analyzed the factors associated with indoor and outdoor air pollution. They promised that the possible research is needed to develop a cost effective monitoring system. Hapsari et al., in their work [9] investigated the details of sensors and devices used for indoor air quality monitoring.

The proposed work is implemented as an IoT enabled cloud based system. The Internet of Things, or IoT, refers to the interconnection of billions of electronic devices around the world via the Internet for collecting and sharing data. Connecting up all these different objects and to sensors makes the system intelligent enough to process real time data and take action with no human intervention. The Internet of Things is making the fabric of the world around us smarter and more responsive, merging the digital and physical universes. Cloud computing is the delivery of on-demand computing services, from applications to storage and processing power typically over the internet and on a pay-on-use basis. Cloud based systems meets the benefits of infrastructure less development environment and companies could have reliable and secured data centers upon cloud. The proposed system is help users to monitor the quality of the air in the specific place. As the world has reached high industrialization large amount of tocsin gasses is transformed to the atmosphere, these kind of systems are at need.

3. Proposed Work

In this work we have implemented a highly accurate, affordable and an easy to use cloud based monitoring system to be used in industry places. The system is implemented and tested in our own laboratory. The system uses Sensor DSM501A, a PM (Particulate Matter)sensor, connected to digital pin 5 of Arduino. Arduino interfaced with Raspberry pi via a USB cable whereas Raspberry pi connected to the internet were used as smart devices. The sensors connected to the Arduino board are used for sensing data.The data is sent from Serial port to raspberry pi and Serial in node is connected to GCloudIoT node for sending the data to the cloud.

The data is shown globally on the dashboard of the GCloudIoT platform. The only requirement is that the device should be connected to the internet. The data in the GCLoud is passed to the mobile application using APIs.

The proposed system is best represented in the flow diagram in figure 1. It explains the step by step process of the proposed system.

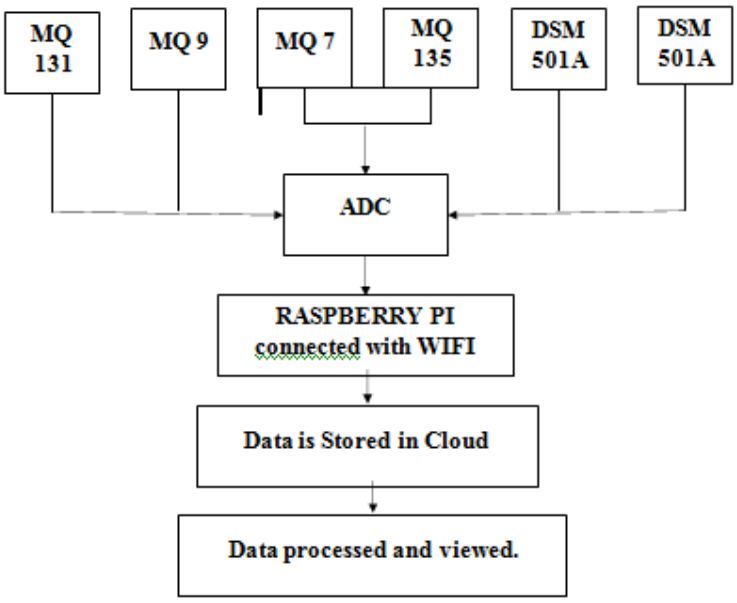


Figure 1. Flow Diagram of "O_2 Tocsin " System

MQ7 is connected to the Digital pin of 3 of the Arduino board whereas MQ135 and MQ9 are interfaced to analog pin 2 and 3 of Arduino. The experimental setup for underground liquid level indication can be used for both residential and commercial purposes.

4. Experimental Setup

The proposed system is implemented using android studio with Flutter and Dart packages installed in it. The technology used in implementation and different phases of the air monitoring system are discussed in brief in this section.

ANDROID STUDIO

To support application development within the Android operating system, Android Studio uses a Gradle-based build system, emulator, code templates, and GitHub integration. One or modalities of every project has source code and resource files. Modalities are Android app modules, Library modules, and Google App Engine modules. Instant Push feature of Android is useful to push code/resource to a running application.

FLUTTER AND DART

Flutter is an open-source and any mobile SDK developer can use to build native-looking Android and iOS applications from the same code base. Flutter also provides developers with reactive-style views. To avoid performance issues flutter uses Dart. Dart comes with a repository of software packages for extending the capabilities of apps.

RASPBERRY PI

Quad-core Raspberry Pi 3B+ microcontroller version of Pi has the Ethernet and USB ports with an additional USB port for the Ethernet Adapter. In the previous models of this microcontroller, i.e., A, A+, and Pi Zero models, there was an on-board USB port. For our work Raspberry pi model that has an five-port USB hub is used .The operating systems like Raspbian, windows 10 and Ubuntu are supported by Raspberry Pi 3 B+.

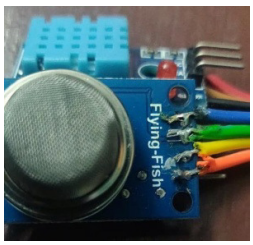
SENSING DEVICE

MQ series sensors are used in the system to collect the data. These are interfaced with the raspberry pi 3 B+ to determine the end results. MQ 9 is useful for gas detection such as LPG, CO and CH4, i-butane, smoke and so on. The sensitivity of the sensor can be adjusted by using potentiometer. MQ 7 is used in detecting Carbon dioxide. An analog-to-digital (ADC) converter is used to convert all the analog outputs from the sensors. DSM 501A sensor senses the PM in the environment, a very important parameter of air pollution. It operates on a wide range of temperatures and produces effective results. DHT 11 is used for sensing temperature and humidity.

Phases of the proposed system

Raspberry pi devices installed with proper OS by downloading images from the Raspberry pi official website is to be made ready initially. The device is registered with Google cloud services, GCloudIoT platform will acknowledge the user by providing the Auth token which enables the communication of data from device to GCloudIoT platform.

Phase1 – Integrate sensors with Arduino



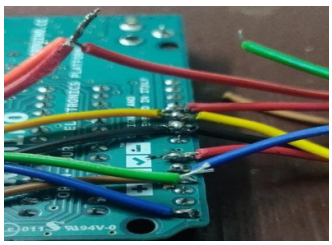
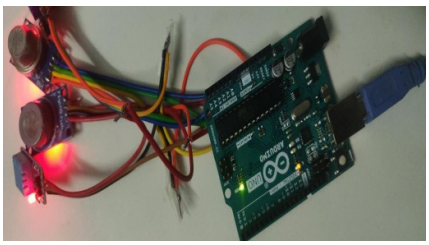



Figure 2: Sensors Connected to Arduino Board

- Every sensor will have a minimum of 3 pins i.e. a data pin, a ground pin and a power pin and connected as shown in Fig 2.
- The sensors MQ 7, MQ 9, MQ 135, DHT 11 are connected the analog data pin A0, A1, A3, A5 respectively for data communication

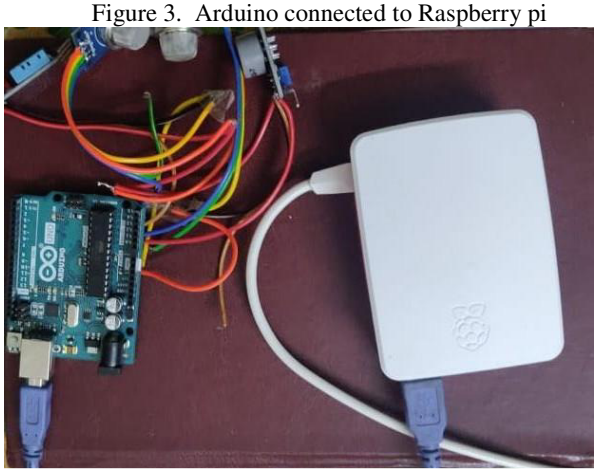
Phase 2 –Serial Monitoring using Arduino

- After uploading the sketch i.e., code onto the Arduino, select the serial monitor from the toolbar which is a part of Arduino IDE software.

Phase 3 – Interfacing Arduino with Raspberry pi

- To compute intensive tasks transfer the data to raspberry pi.

Figure 3. Arduino connected to Raspberry pi



- To get data from Arduino enable Serial and I2C in PiConfig.
- Connect the Arduino to raspberry pi[2] using a USB cable.
- Detect the devices from a list of devices connected with pi and connect with Arduino.
- Now monitoring the data directly from the Raspberry pi is possible. It is shown in Fig 4.

Figure 4 : Visual data from Raspberry pi.

Phase 4 – Transferring data to Google Cloud

- Create a Project [1] in Google Cloud Console. A project consists of a set of users, a set of APIs, authentication, and monitoring settings for those APIs.
- Make sure that the following APIs are enabled:

Dataflow API
Cloud Pub/Sub API
Cloud IoT API

- Setup IoT Core by creating a new Cloud pub/Subtopic.
- Download API Credential JSON File and store it in raspberry pi, as it gives access to cloud account
- Setup Google Big Query. Create a new dataset and newtable. Datagenerated from the sensor will be stored here as shown Fig 5.

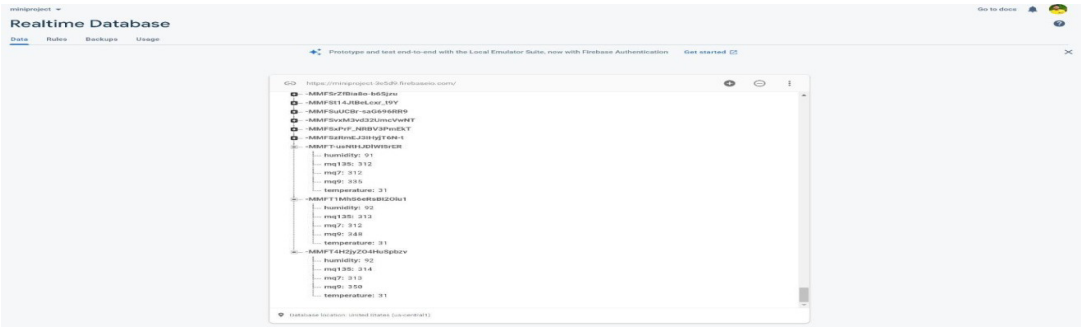
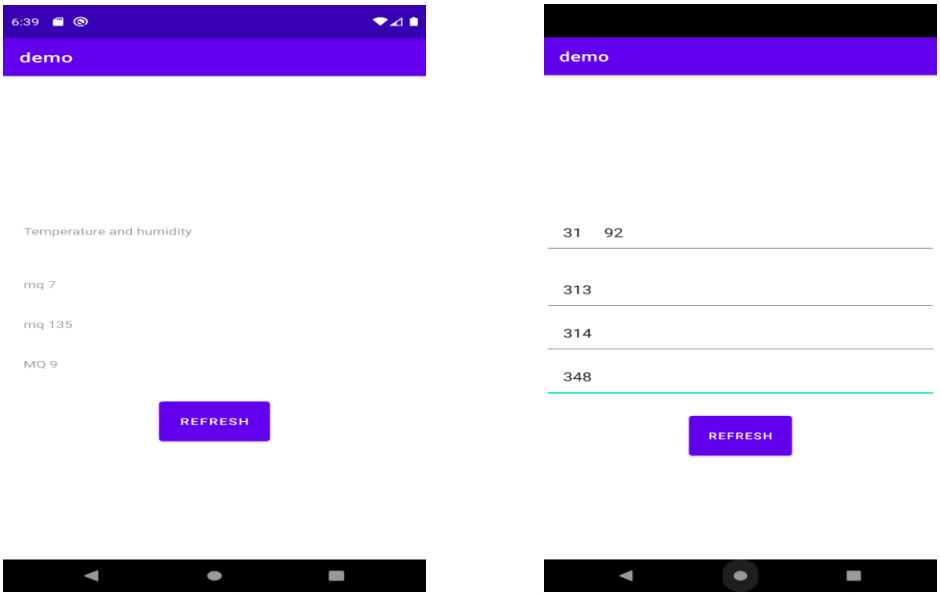


Figure 5. Data from GCloud

Module 5 – Visualize data from Cloud

- To visualize the data graphically useanGoogle product called data studio is used.

Fig 6. Data Visualization



The application assists the users to move to a safe place by alerting with the information that the environment is polluted in their current place**.** This makes them respond immediately without any delays.

5. CONCLUSION

This work provides a best system for monitoring the atmosphere with the use of necessary sensors fixed at any place of interest. The system is developed to overcome the issues in air purity by properly fixing the sensors mainly to sense the various dangerous gases present in the environment.

This device can be well used in mining industries such as gold, coal and ore. Thus, people working in those industries will be indicated when there is an oxygen deficiency. As future enhancement a system that monitors pollutants like Sulfurdioxide, nitrogen dioxide and ground level ozone etc., could be done.

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