Measuring Pollution Level for Asthma Patients using IoT

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ABSTRACT: In present scenario of the world, controlling air pollution is one of the leading challenges. Most often the educational institutions and organizations in developing countries suffer from contaminated environment due to improper planning and poor infrastructure. Students and faculties in a classroom could suffer from health issues due to prolonged exposure to such environment. A lot of people suffer from asthma and it becomes extremely difficult for a person when experiencing an asthma attack. A low cost environment monitoring device is developed to detect different pollutant gases like CO, CO2 and noise along with relative humidity and temperature. A low cost environment monitoring device is developed to detect different pollutant gases like CO, CO2 and noise along with relative humidity and temperature. It has observed that the same type of sensors for the same gases give different values although the sensitivity of sensors is acceptable, so it has also tried to perform calibration of the sensors using machine learning technique. It can also be used to detect the pollution in the indoor environment and give prior warnings of possible asthma attacks to the user.

INTRODUCTION

People living in the urban areas are highly affected by the indoor pollution; it cannot ensure a healthy environment. Some of the hazardous indoor pollutants are CO, CO2, and VOC & Particulate matter. A person spends most of his time in indoors, so the air quality control is very much important. The poor air quality may cause health issues, less concentration in work, even premature death, etc. It becomes extremely difficult for a person to breathe in polluted air for he has the highest risks of having a terrible asthma attack [6]. Though air quality monitoring stations are present but these are very expensive and not portable and customized especially for the asthma patients. According to the United States Environment Protection Agency: Ozone triggers asthma as it is irritating to the lungs and the airways airborne particles pass through the nose or mouth cause Irritation in the trachea (mucus formation) and cause breathing problems. In short if the AQI (Air Quality Index) is 101 or higher, it's dangerous with people suffering from asthma to such an extent that they may have to change the activities and medicines and even way of living. Symptoms also worsen even when ozone levels are moderate from 50 to 100[7]. Asthma is a long-term condition with rapid onset worsening of symptoms ('attacks') which can be unpredictable and may prove fatal. Models predicting asthma attacks require high sensitivity to minimize mortality risk, and high specificity to avoid unnecessary prescribing of preventative medications that carry an associated risk of adverse events. So an accurate sensor prediction is required when it comes to customizing it for asthma patients. To resolve this issue sensor based device has been developed. The sensors are main elements for sensing the environmental data. For real time monitoring data validation of these sensors and for ascertaining the precision of the data in the system, calibration of sensors is very crucial. The data captured by low quality sensors may affect the quality of decision making process[5]. Calibration is a process of applying the known inputs to the measuring unit and by doing that can observe the overall error of the system. Then those errors are corrected by trimming the errors to zero. In brief, calibration involves comparison of obtained and standard measurement. After the values are received we input this data into a machine learning algorithm which processes these data sets and predicts the chances of having asthma attack and give prior warnings and recommendations to the users[8].

PROBLEM STATEMENT

Models predicting asthma attacks require high sensitivity to minimize mortality risk, and high specificity to avoid unnecessary prescribing of preventative medications that carry an associated risk of adverse events. So an accurate sensor prediction is required when it comes to customizing it for asthma patients to resolve this issue sensor based device has been developed. The sensors are main elements for sensing the environmental data. For real time monitoring data validation of these sensors and for ascertaining the precision of the data in the system, calibration of sensors is very crucial. The data captured by low quality sensors may affect the quality of decision making process.

Using Arduino it is possible to implement economical approach for air quality monitoring system. Energy consumption: implementation of this IoT Circuit consumes less energy below 100mA current.

RELATED WORK

Authors: N Jahnavi Reddy, Nikitha R Sherkhane , Roja Pravallika , Mrs. J Ruby Dinakar[1].
In this paper, they have proposed a system of three unit as System hardware unit which uses low cost environment monitoring device designed to detect different pollutants gases like CO, CO2,VOC and particulate matter. The experiment is conducted in a closed environment. They have used IOT Cloud (ThingSpeak) to store data and finally Software part to perform calibration the data.

Disadvantages

- Air Quality Stations are expensive and not portable.
- Calibration of sensors must be done.

Authors: Devahema , P.V. Sai Surya Vamsi , Archit Garg , Abhinav Anand , Desu Rajasekhar Gupta. [2]
In this paper, they have used a most dynamic and efficient gas sensor(i.e. MQ135) which is able to sense different toxic gases like NH3, NOx, alcohol, Benzene, smoke, CO2 which shows the result in PPM(Parts Per Million).So it is dynamic gas sensor for our Air pollution Monitoring system. When it is connected to an Arduino then it will sense all gases, and will give the Pollution level in PPM (parts per million). MQ135 gas sensor will give the output in form of voltage levels and which has to be converted into PPM.

Disadvantages

- You will have to refresh the page again and again if you want to see the current Air Quality Value in PPM
- A local server needs to be setup to demonstrate its working and to monitor the air quality from anywhere in the world, we need port 80 (used for HTTP or internet).

Iot Based Air and Noise Pollution Monitoring In Urban and Rural Areas, Important Zones Like Schools and Hospitals in Real Time
Authors : Mahantesh B Dalawai, Mr. Pradeep S and Dr Siva Yellampalli [3].
Mahantesh B Dalawai used R5F100LEA microcontroller from Renesas RL78 series containing contains of Flash ROM 64KB, RAM 4KB and Data Flash 4KB, and it has High speed on-chip oscillator, Self-reprogrammable under software control, 58 GPIO's, etc to implement his project. The pollution level at each sensor node can be provided to server by using GSM/GPRS system or we can display the pollution level information on large display close to square. The main aim is that people who have generally more than one alternate path to reach some destination. If person knows the pollution information in advance he can follow safe path & simultaneously pollution can also control

Disadvantages

- Implementing sensors for detecting dust, noise, smoke and other parameters is not done.
- Time consuming because the pollution level from each vehicle on road has to be read.

BRIEF OVERVIEW OF MQ135 SENSOR

The MQ135 sensor is like a variable resistor, whose resistance depends on the gases surrounding it. To

sense the gases, the MQ135 sensor contains a gas sensing material that is made up of SnO2. An electrode and electrode line of materials Au and Pt is present in the MQ135 sensor. A heater coil that is made up of Ni-Cr alloy, is used to provide the necessary working conditions for the sensor to work. The MQ135 gas sensor is available in two formats, one in only sensor format and the other in module form. The difference between them is that the module format sensor contains an extra pin D0 along with an A0 pin, which gives only digital value. To find the ppm or to get the analog value, we will be using the A0 pin. As I am having the module format of the MQ135 sensor, I'm using this module in this project. The MQ135 sensor module contains four pins Vcc, GND, D0, and A0. Their connections will be shown in the circuit diagram section. The internal circuit of the MQ135 gas sensor is shown below.

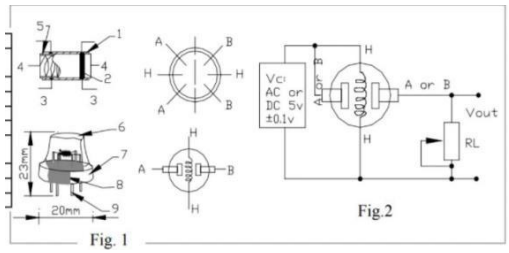

Figure 1: internal circuit of the MQ135 gas sensor

Iot Air Pollution Monitoring Circuit Diagram

The connections for the MQ135 gas sensor module and 16x2 LCD are shown below. The Vin pin and GND pin of the node MCU are connected to the power rails of the breadboard, as shown in the below diagram. The VCC and GND pin of the MQ135 gas sensor, is connected to the positive and negative rail of the breadboard. Note: Potentiometer's fixed ends are connected to the positive and ground rail of the breadboard, and its variable end, is connected to the 3rd pin(pin VEE) of the LCD (16X2). The remaining connection for the Lcd to node MCU are as follows:

Air Quality prediction Algorithm

False Positives (FP): When the air quality is actually good and if our prediction algorithm predicts that it is poor, then it is called false positive.

False Negatives (FN): If the air quality is actually bad and if our prediction algorithm predicts that it is good then it is called false negative.

True Positives (TP): If the air quality is bad and if it is correctly predicted to be bad then it is true positive.

True Negatives (TN): If the air quality is good and if it is correctly identified as good then it is true negatives.

Accuracy calculation
Accuracy = (TP + TN) / (TP + TN + FP + FN)
Accuracy is essentially an important efficiency parameter and it is without problems. It is the ratio of properly expected commentary to the total number of records. We may think that, if we've got excessive correctness then the mannequin is exceptional.

Precision: The percentage of confident predictions which can be surely right.
Precision = TP / (TP + FP) It is the ratio of safely envisioned constructive records to the complete predicted optimistic records.
Recall: The proportion of positive observed values correctly predicted. (The proportion of actual defaulters that the model will correctly predict) Recall = TP / (TP + FN).

F-Measure: F1 rating is the weighted typical of Precision and recall. Actually a good predictor should have detection rate and low false positive rate. F- Measure give a tradeoff between the two most important parameters.

General Formula:
F- Measure = 2TP / (2TP + FP + FN)

F1-Score Formula:
F1 Score = 2*(Recall * Precision) / (Recall + Precision).

Nodemcu - Arduino Sketch : Here we are using the **Arduino IDE** to write the code. To write the code for this IoT pollution monitoring project we are keeping in mind that first, our code has to connect the local area network by using the credentials provided in the code. After that, our code has to work on getting the input from the sensor, and then it must

display the data on the webpage, which is created using nodeMCU.

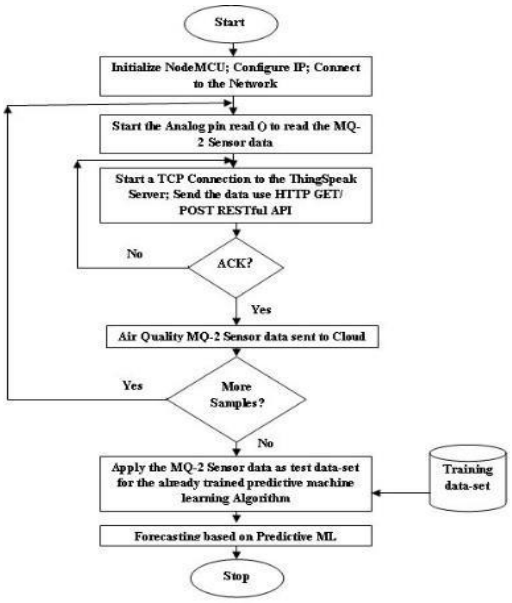

Figure 2: Flowchart of Air Quality measurement

Please note that we are not dealing directly with the ppm. We are calculating the voltage variations with respect to the pollution content in the air. If the output voltage of the MQ sensor is less than 20% of the max voltage value, we considered it a normal amount of pollution content present in the air. If the output voltage is increased and stabilizes in the range of more than 20% to less than 70%, then it is considered as a medium amount of pollution content present in the surrounding air. If the output voltage increases more than 70% of the maximum value, then it is considered as dangerous level. These values are transmitted and shown at the cloud.

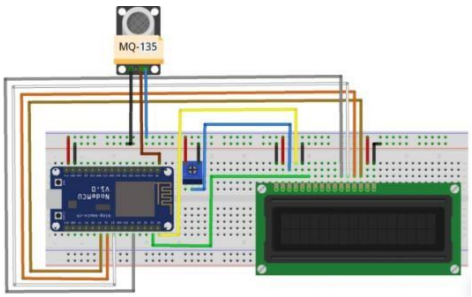

Figure 2. circuit connection for the LCD to nodeMCU, Mq135.

Proposed Air Pollution Monitoring System is based on the block diagram as shown in Fig.2. The data of air is recognized by MQ135 gas sensor. The MQ135 sensor can sense NH3, NOx, alcohol, Benzene, smoke, CO2. So it is dynamic gas sensored for our Air pollution Monitoring system. When it will be connected to nodemcu then it will sense all gases, and it will give the Pollution level in PPM (parts per million). MQ135 gas sensor will give the output in form of voltage levels and we have to convert it into PPM. So for converting the output in PPM, we have used a library for MQ135 gas sensor and MQ6 sensor. Sensor is giving us value of 90 when there is no gas near it and the air quality safe level is 350 PPM and it should not exceed 1000 PPM. When it will exceed the limit of 1000 PPM, it will cause Headaches, sleepiness and stagnant, stuffy air. If it exceeds beyond 2000 PPM then it will cause increased heart rate and many different diseases. When the value will be less than 1000 PPM, then the LCD and webpage will display “Fresh Air”. When the value will increase from 1000 PPM, then the buzzer will start beeping and the LCD and webpage will display “Poor Air, Open Windows”. And when it will increase 2000, the buzzer will keep beeping and give an alert message. LCD shows the data of the gases in ppm (parts per million) and Buzzer is used when ppm crosses above a threshold limit

PERFORMANCE

The proposed approach is independent of different kinds of respiratory diseases, but case study has taken for asthma patients. Pollution level is predicted based the pre recorded data of that particular location and we are using decision making algorithm using machine Learning. When the pollution level is beyond the threshold value alert has been sent to the android application. So that it will alert all the people in the locality. If the pollution is more than usual, the model will start the alarm and danger signal will be indicated through red lamp and also will start the exhaust fan to evacuate the pollutant air.

Compared to the existing approaches our approach has provide 98% of accuracy to the actual pollution in the environment.

The app have following features, indices of air quality for a specific city using real-time computation, air quality daily forecasts etc.

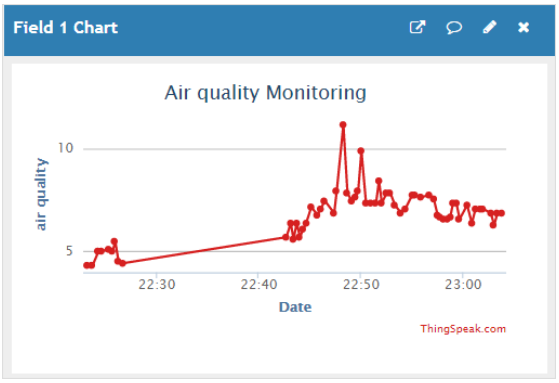

Figure 3: performance graph on ThingSpeak server

CONCLUSION

Pollution in earlier days was negligible. Currently, however, pollution is increasing day-by-day because of various reasons such as industrial growth, development of automobile industries, and chemical industries. To protect humans and the environment from harmful gasses, this air pollution kit was developed that helps a person to detect, monitor, and test air pollution in a given area. The model has been integrated with the mobile application that helps the user in detecting the pollution level of their locality. This proposed air pollution monitoring kit along with the integrated mobile application can be helpful to people suffering from any kind of respiratory diseases.

BIBLIOGRAPHY

[1] N Jahnavi Reddy, Nikitha R Sherkhane " POLLUTION MONITORING SYSTEM BASED ON IOT" , International Research Journal of Computer Science (IRJCS),Issue 06, Volume 6 (June 2019),SPECIAL ISSUE - 5th International Conference - "ACCE – 2019"

[2] Devahema , P.V. Sai Surya Vamsi ,Archit Garg , Abhinav Anand , Desu Rajasekhar Gupta " IOT based Air Pollution Monitoring System" , Journal of Network Communications and Emerging Technologies (JNCET), Volume 8, Issue 4, April (2018).

[3] Mahantesh B Dalawai, Siva Yellampalli, Pradeep S.V, "IOT Based Air and Noise Pollution Monitoring in Urban and Rural Areas, Important Zones like Schools and Hospitals in Real Time.", International e-Journal for Technology and Research-2017.

[4] Ms.Sarika Deshmukh, Mr. Saurabh Surendran, Prof. M.P. Sardey, "Air and Sound Pollution Monitoring System using IoT" in International Journal on Recent and Innovation Trends in Computing and Communication, Volume: 5 Issue: 6, June 2017.

[5] Manish R.Deshmukh, Suraj J. Chavan, Renuka A. Chavan, Prof. Ganesh Atarde "IOT Based Air & Sound Pollution Monitoring System", IJARIIE- ISSN(O)-2395-4396, Vol-4 Issue-3 2018.

[5] L.Ezhilarasi, K.Sripriya, A .Suganya , K.Vinodhini, ,"A SYSTEM FOR MONITORING AIR AND SOUND POLLUTION USING ARDUINO CONTROLLER WITH IOT TECHNOLOGY", in INTERNATIONAL RESEARCH JOURNAL IN ADVANCED ENGINEERING AND TECHNOLOGY (IRJAET) E- ISSN: 2454-4752 P - ISSN : 2454-4744 VOL 3 ISSUE 2 (2017) PAGES 1781 – 1785.

[6] K. B. Shaban, A. Kadri, and E. Rezk, "Urban air pollution monitoring system with forecasting models," IEEE Sensors Journal, vol.16, no. 8, pp. 2598-2606, Apr. 2016.

[7] Dawit Uta Urku, Himanshu Agrawal, "Smart Real-Time Indoor Air Quality Sensing System and Analytics", International Journal of Engineering and Technology (IJET) DOI: 10.21817.

[8] Arushi Singh, Divya Pathak, Prachi Pandit, Shruti Patil, Prof. Priti. C. Golar, "IOT based Air and Sound Pollution Monitoring System" in International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 6, Issue 3, March 2017.