Design of IOT Enabled Environmental Monitoring System for Smart Cities

Dr.C.Bennila Thangammal[1], R.Belin Rose[2], M.Angala Parameswari[3], M.Amala Sweena[4]
[1]*Associate Professor/ Department of ECE, R.M.D Engineering College, Tamilnadu 601206*
[2,3,4] *UG Student/ Department of ECE, R.M.D Engineering College, Tamilnadu 601206*

***Abstract*- The air pollution rates now a days are drastically increasing in all the developed and the developing countries which requires a more portable and cost effective solution. The proposed system includes the design for monitoring air pollution and creating awareness among the public. The Air and Sound Pollution Monitoring device can be accessed by the authorities and the common people belonging to the area. The device will be installed through a mobile application which will show the live updates of the pollution level of the area. This device is also capable of detecting the fire in its area and notify the same to the fire brigade authorities so that they could take necessary actions accordingly, and also the mobile applications will be installed in the fire brigades itself so that if a fire is taking place nearby, it could be controlled in time to reduce loss of people and property. This system works on the methods of IOT which is a rising technology based on the fusion of electronics and computer science. The embedded sensors in the system help to detect major air polluting gases such as CO2, SO2 and CO and level of sound pollution. The concept of IOT helps to access data from remote locations and save it in database so that we don't need to actually be present in that area. The gathered information is sent to the concerned authority association to tell them in the event of any infringement with the goal that they can take the fundamental measures. Moreover if the estimation of the deliberate poisons surpasses the edge, a caution framework is activated taking a few activities to caution the encompassing individuals**

***Index terms*- air pollution, IOT, sensors, monitoring system, Air Quality; Smart Cities; Smart App**

I.INTRODUCTION

Air pollution is the worst environmental problem and it causes a multitude of adverse effects on human health, water bodies and climate. The main source of air pollution in all major cities is due to vehicles and the second major source remains the industries. The massive use of vehicles has resulted in vital increase of toxins in the atmosphere. This is the cause of environmental pollution affecting the human health. It has also resulted in other respiratory problems like asthma attacks and skin rashes. The Central Pollution control board has set a standard to these levels but the public is reluctant to follow them. The pollutants which spoil the air are invisible which has led to the negligence of the people. So, public acknowledgement is the prime requisite of today. Hence the proposed system solves this major issue. The air pollution monitoring system is installed in a particular locality where there are traces of acute air pollution to detect the constituent gases of air which may lead to harmful effects on human health and other living beings This system uses arduino and several gas sensors to predict the level of various harmful gases like CO, NH3, particulate matter and smoke. Carbon Monoxide is given the highest preference ,as it is a greenhouse gas and a major pollutant that is warming the earth. The previous products did not have an advantage of getting the pollution rates up to date. So to overcome this, an android app is used, which the public can install it to get regular updates on the quality of air in the area they live.

The measured air quality level is also displayed in android application which helps the users in getting updates about the current air quality. Users are able to view the air quality level in numerical as well as graphical format. In addition, the Air Quality Index (AQI) for the current pollution level is determined and displayed in the application along with health effects. Thus, this application lets the users to take effective measures in advance to protect themselves from harmful effect.

Real-time monitoring of the air quality requires the live data transfer between the devices over the

internet and it can be visualized using an Android Application. It reduces the mobilization of system hardware at different locations, which is cost efficient as only one-time installation cost is involved. In the Internet of Things (IoT) based applications [9], Raspberry pi 3B, having a wide range of specifications, is the mainstay of the system. It not only gathers data from various sensors via an inbuilt Wi-Fi module but is also responsible to send the recorded data to the ThingSpeak [10], an open source cloud platform on which data can be stored and retrieved via hypertext transfer protocol (HTTP) over the internet. ThingSpeak acts as a platform to store real-time sensor data and also used to plot graphs, charts, create plugins and apps for collaborating with web services, social network and other application program interface (API). Once signed in, a channel is created with a unique Channel ID. The primary feature of ThingSpeak is the term Channel in which there are eight fields for data storage, three fields to store latitude, longitude and elevation and one field to write a short message to describe the data. Once the channels are created in ThingSpeak, the data can be implemented and alternately one can process and visualize the information through various resources and platform, one of them being on an Android Application, designed in Android Studio. The increased demand for service over the internet has necessitated the data collection and exchange in an efficient manner. IOT has promised the ability to provide the efficient data storage and exchange by connecting the physical devices and vehicles via electronic sensors and internet.

Thus, in order to achieve efficient IOT accomplishment for an application; the proper sensing and monitoring system is essential. The devices can communicate with each other via Machine to Machine (M2M) communication and the physical devices can be controlled digitally. An IOT based monitoring system can be one possible solution.

II. LITERATURE SURVEY

The major cause of air pollution in cities is due to vehicles. Vehicular pollution leads to a vital increase in the emission of loads of myriad toxins into environment. The commercial systems available in the market are devices that use the semi-conductor sensors at the smoke emission outlets of vehicles and this system detects the pollutant levels and also indicates this level to the owner of the vehicle with a meter. When the pollution level increases beyond a particular threshold level, alarm will start ringing in the vehicle to indicate that the limit has been attained and the vehicle will automatically stop running after certain time[3][11]. This type of individual usage system does not help the public to get into an awareness zone. Bharat stage emission standards are the emission standards set by the Indian Government to regulate air pollutants from internal combustion engines in motor vehicles. Also over the years, several regulations have been made by the Government to regulate and reduce the emission from vehicles but in vain.

Also other cost effective measures were introduced to control the air pollution by calculating the levels of each and every pollutant [5][7][10]. Based on the observed values, the air quality index for that region is calculated and the values are made available through a web page. But the main disadvantage of this system is that, users are not provided with a portable application to view pollution levels then and there and also a pictorial format is missing for easy view[8][1].

The motive of making a smart city can be fulfilled by using technology, thus making the life better and also enhancing the quality of services, therefore meeting every individual's needs. With modern technology in fields of information and communication, it has become easy to interact with the authorized people of city to tell the where about of the area or city, how well the city is developing and how to make it possible to achieve a better life quality. In this system, an application was created to make one more step in the fulfillment of the goal. An area is analyzed for evaluating how much pollution is affecting the area. The components of gases and their amounts are calculated and checked. If the amount is higher than normal then the officials are reported about it. After that the people are made to clear the area and taken to a safe place. The combined network architecture and the interconnecting mechanisms for the accurate estimation of parameters by sensors is being explained and delivery of data through internet is presented.[1]

Some of the research work made for monitoring the pollution parameters in a particular location in order to make the environment safe and that area smart.

Different methods were used in the past and are described in this section [4]. First is Smart Environment Monitoring using Wireless sensor networks[5] in which the main focus was on the developing an environment free of pollution by making it smart. Wireless sensors are fitted all over the city and in public transports. By monitoring all the sensor networks, all the environmental happenings can be gathered as a streaming database to analyze the environmental position. The monitoring data gathered from stationary nodes installed in the city to the mobile nodes placed on public transports is given by this technique. Second is Toward a Green campus with the internet of things. It is an implementation of idea to save energy through adequate management of computer machines and air conditioner. It is based on the theory of internet of things [7].Third is WSN- and IOT based Smart Homes and their extension to Smart Buildings [7]. This work is based on the use of reliable, efficient, real-time and economical sensor networks for making smart homes. In this, the sensor nodes are fitted into the different areas of home. These nodes produce data of the movement done in the home or any usage of an object. Further, these homes are extended to smart buildings [4].

III. PROPOSED WORK

The main objectives of this proposed architecture is

- To aid in reducing human health problems due to industrial activities.
- To find solutions for the increasing problems of harmful gases amounting from industrial activities.

In the paper "IoT based air contamination observing framework utilizing arduino", we depict a total brilliant framework to control air contamination, subsequently making a keen situation. Air contamination levels can be levels can be estimated utilizing shrewd sensors. Moreover, Internet of Things innovation can be coordinated to remotely, identify contamination with no human collaboration. The information accumulated by such a framework can be transmitted in a split second to an online application to encourage checking ongoing information and permit impending danger the board. This information is examined and estimated a foreordained edge. The gathered information is send to the concerned authority association to advise them on the off chance that any infringement with the goal that they can take the important measures. Moreover if the estimation of the deliberate toxins surpasses the limit, an alert framework is activated taking a few activities to caution the encompassing individuals. Internet of Things (IoT) technology can be integrated to remotely detect pollution without any human interaction .An entire Internet of Things system that monitors air pollution by collecting real time data in specific locations. This data is analyzed and measured against a predetermined threshold. The collected data is send to concerned official organization to notify them in case of any violation so that they can take the necessary measures.

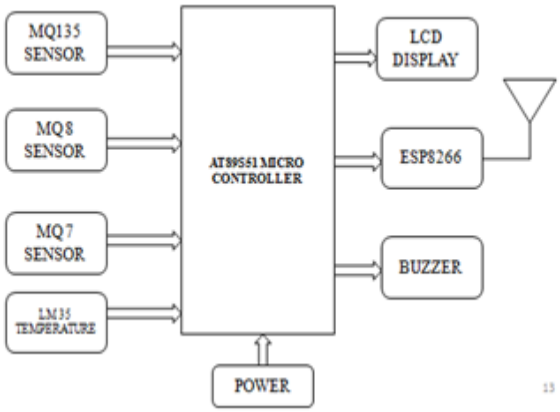

Fig.1.Block Diagram

IV. HARDWARE REQUIRED

A. Arduino UNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by arduino. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 Digital pins, 6 Analog pins, and programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under Common Creative Attribution Share-Alike 2.5 license and is available on the arduino website. Layout and production files for

some versions of the hardware are also available. "UNO" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.The UNO board and version 1.0 of arduino Software (IDE) were the reference versions of arduino, now evolved to newer releases. The UNO board is the first in a series of USB arduino boards, and the reference model for the arduino platform. The ATmega328P on the arduino UNO comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. The UNO also differs from all preceding boards in that it does not use the FTDI USB-toserial driver chip. Instead, it uses the Atmega16U(Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

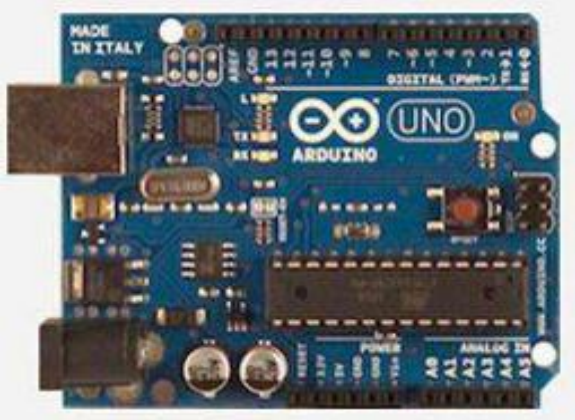

Fig -2: Arduino Board

B. DTH 11 Humidity Sensor

DHT11 Humidity Sensor features a temperature & humidity sensor complex with a calibrated digital signal output. By using the exclusive digital-signal-acquisition technique and temperature & humidity sensing technology, it ensures high reliability and excellent long-term stability. This sensor includes a resistive-type humidity measurement component and an NTC temperature measurement component. The single-wire serial interface makes system integration quick and easy. Its small size, low power consumption and up-to20 meter signal transmission making it the best choice for various applications, including those most demanding ones. The component is 4-pin single row pin package. It is convenient to connect and special packages can be provided according to users' request.

Fig -3: DTH 11 Humidity Sensor

C. MQ 7 Gas Sensor

Sensitive material of MQ-7 gas sensor is SnO2, which with lower conductivity in clean air. It make detection by method of cycle high and low temperature, and detect CO when low temperature (heated by 1.5V). The sensor's conductivity is more higher along with the gas concentration rising. When high temperature (heated by 5.0V), it detects Methane, Propane etc combustible gas and cleans the other gases adsorbed under low temperature. . MQ-7 gas sensor has high sensitivity to Carbon Monoxide, Methane and LPG. The sensor could be used to detect different gases contains CO and combustible gases, it is with low cost and suitable for different application.

Fig -4: MQ 7 Gas Sensor

D. MQ-8

The MQ-2 sensor works on the ionization principle. There is a sensing element inside the sensor which is heated in the presence of the current and then this current is passed through the connecting leads. The air around the heated sensing element ionizes, which further changes the resistance and henceforth the output current from the sensor varies.

Fig -5: MQ 7 Gas Sensor

E. LCD

Liquid Crystal Display (LCD) is used to display the output to the user in the form of GUI (Graphic User Interface) and a mono chromatic display. LCD used in this project is JHD162A series. There are 16 pins in all. They are numbered from left to right 1 to 16 (if you are reading from the backside). Generating custom charcters on LCD is not very hard. It requires the knowledge about custom generated random access memory (CG-RAM) of LCD and the LCD chip controller. Most LCDs contain Hitachi HD4478 controller. CG-RAM is the main component in making custom characters. It stores the custom characters once declared in the code. CG-RAM size is 64 byte providing the option of creating eight characters at a time. Each character is eight byte in size.

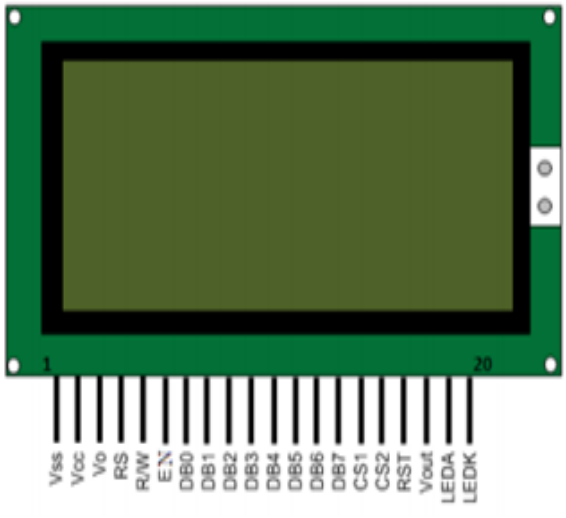

Fig -6: LCD

V. SOFTWARE REQUIRED

A. Arduino IDE

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, Macos, Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino board.The source code for the IDE is released under the GNUGeneral Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library from the Wiringproject, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, that are compiled and linked with a program stub main() into an executable cyclic executive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware.

B. Thingspeak

ThingSpeak is an open-source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates".ThingSpeak was originally launched by Io Bridge in 2010 as a service in support of IoT applications. ThingSpeak has integrated support from the numerical computing software MATLAB from Math Works, allowing ThingSpeak users to analyze and visualize uploaded data using Mat lab without requiring the purchase of a Mat lab license from Mathworks. ThingSpeak has a close relationship with Math works, Inc. In fact, all of the ThingSpeak documentation is incorporated into the Mathworks' Matlab documentation site and even enabling registered Mathworks user accounts as valid login credentials on the Thing Speak website. The terms of service and privacy policy of ThingSpeak.com are between the agreeing user and Mathworks, Inc.

VI. RESULTS

The concentration of each gas measured using various sensors are observed through serial monitor of arduino. Further, the data will be collected in the respective thingspeak channels by means of Ethernet shield and this data is now available in live for further processing.

The analyzed results are viewed through thinspeak in a graphical format. Further the average pollution level is calculated using matlab analysis and the time controlled results are viewed through an android app as shown in figure 7 and figure 8

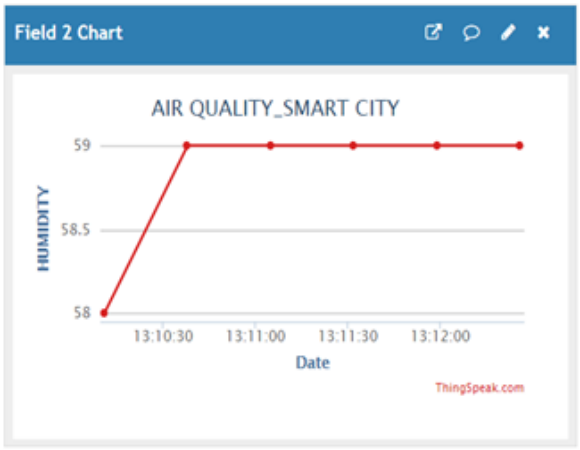

Fig 7:Thingspeak Humidity Field chart

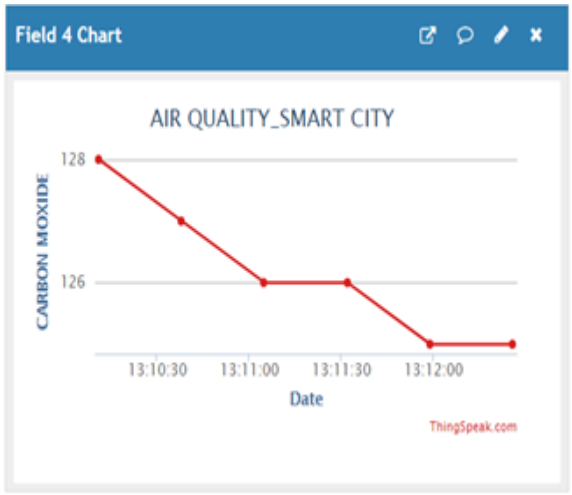

Fig 8:Thingspeak Carbon Monoxide Field chart

VII. CONCLUSION

The paper presented an IOT based Air Pollution Monitoring System for Smart Cities. A few sensors are deployed in the Jaypee Institute Campus to constantly monitor the Temperature, Humidity, Carbon Monoxide, Smoke, LPG, levels in the atmosphere. The created air quality checking and perception framework precisely estimated the grouping of poisons carbon monoxide, carbon dioxide, smoke and residue in climate. The sensor has been coordinated with IoT structure which has proficiently been utilized to quantify and screen the contaminations continuously. This framework beats the issue of contamination observing, wellbeing checking, vocation estimation, supportability evaluations and estimation related fields. The information's are naturally put away in the database; this data can be utilized by the experts to take brief activities. It additionally causes the typical individuals to think about the measure of contaminations in their general vicinity and to take control measures. This is a vigorous framework which is helpful in businesses due to the expanding contamination because of increment in ventures. This framework is easy to understand and cost of the item is reasonable. This framework is checking just five parameters and henceforth can be extended by considering more parameters that reason the contamination particularly by the ventures.

REFERENCES

[1] Frances Moore, "Climate Change and Air Pollution: Exploring the Synergies and Potential for Mitigation in Industrializing Countries", Sustainability, 2009. Vol. 1(1), pp. 43-54.

[2] Brook RD, F.B., Cascio W, Hong Y, Howard G, Lipsett M, Luepker R, Mittleman M, Samet J, Smith SC Jr, Tager I;, "Air pollution and cardiovascular disease: a statement for healthcare professionals from the Expert Panel on Population and Prevention Science of the American Heart Association", Circulation, Vol. 109 (21)June 1, 2004..

[3] H. Ali, J. K. Soe, and S.R. Weller, "A real-time ambient air quality monitoring wireless sensor network for schools in smart cities" In the ICSETS 2019 176 Proceedings of the IEEE First International Smart Cities Conference (ISC2'15). 25-28 Oct. 2015 Guadalajara, Mexico.

[4] Sarath K., Guttikundaab, R., "Health impacts of particulate pollution in a megacity—Delhi, India", Environmental Development, April 2013. Vol. 6, pp. 8-20.

[5] C. Kaiwen, et al. "An Intelligent Home Appliance Control-based on WSN for Smart Buildings", In the Proceedings of the IEEE International Conference on Sustainable Energy Technologies (ICSET), Hanoi, Vietnam, 14-16 November 2016, pp. 282-287.

[6] J. Dutta, et al., "AirSense: Opportunistic crowd-sensing based air quality monitoring system for smart city", In the Proceedings of the IEEE SENSORS, 30 Oct.-3 Nov. 2016 Orlando, FL, USA.

[7] Kwok Wai Tham, et al., "A Wireless Sensor-Actuator Network for Enhancing IEQ", In the

Proceedings of the The 15th Conference of the International Society of Indoor Air Quality & Climate (ISIAQ) 2018. Philadelphia, PA, USA,.

[8] W. Wang, Y. Yuan, and Z. Ling, "The Research and Implement of Air Quality Monitoring System Based on ZigBee", In the Proceedings of the 7th International Conference on Wireless Communications, Networking and Mobile Computing (WiCom). 23-25 Sept. 2011 Wuhan, China.

[9] Arun Kumar, et al., "Implementation of Smart LED Lighting and Efficient Data Management System for Buildings", Energy Procedia, December 2017. Vol. 143, pp. 173-178.

[10] Marcello A. Gómez Maureira, D.O., Livia Teernstra, "ThingSpeak — an API and Web Service for the Internet of Things", LIACS, Leiden University.

[11] Ming Zhao, et al., "Machine-to-Machine Communication and Research Challenges: A Survey", Wireless Personal Communications, 2017. Vol. 97(3), pp. 3569-3585.

[12] https://www.pololu.com/file/0J309/MQ2.pdf.

[13] DHT11, DHT22 and AM2302 Sensors by lady ada,https://cdnlearn.adafruit.com/downloads/pdf/dht.pdf.

[14] Arun Kumar, H.Y.S., Kai Juan Wong, Peter H. J. Chong, "LocationBased Routing Protocols for Wireless Sensor Networks: A Survey", Wireless Sensor Network, 2017, Vol. 9(1), pp. 25-72.