IOT based Smart Monitoring system for Detecting Air Pollution

Dr.N.ANANTHI, M.E Ph.D
Assistant Professor (Selection Grade), Department of Information Technology,
Easwari Engineering College, Chennai, India.

M.J.NIRANJAN
Department of Information Technology,
Easwari Engineering College, Chennai, India.

NITHISHVKAUSHIK
Department of Information Technology,
Easwari Engineering College, Chennai, India.

K.SHANMUGAM
Department of Information Technology,
Easwari Engineering College, Chennai, India.

***Abstract*-The monitoring of weather is really helpful in various applications like in critical scientific systems or for simulation purposes. Weather sensing is one of the major functions in aerospace applications to check suited weather environments of other planets too. With the ongoing deterioration of environmental parameters. A chamber has been designed to monitor CO 2 and O2 level changes within the specific area. Monitoring of these gas levels is carried out by using solid electrolyte CO2 and oxygen gas sensor. Along with these gas sensors, non-contact temperature sensors and moisture sensors are used to calculate the environmental temperature and relative humidity. INTERNET OF THINGS (IOT) is designed to process and transmit the data to a system. Collected data is analysed and threshold values are calculated. Receiver can check the status through internet protocol. Receiver end is also notified when the threshold of these gases are reached with the help of their wireless devices.**

Keywords - Gas sensor, Temperature sensor, Moisture sensor, IOT, Arduino UNO

I. INTRODUCTION

Environmental concerns are growing day by day for human being. The degradation of environment has large impact on plants which are very sensitive to air pollutants. Air pollution consists of dust particles and pollutants. It occurs when the air contains harmful amount of gases, dust, fumes and odour. As urbanization causes the growth of Earth Air Pollution is not a recent occurrence. In 1952, the great smog of LONDON killed 8000 suburban communities the existing transportation infrastructure dependent on fossil fuels must expand. There is a constant increase in number of vehicles hence the emission of gases from vehicles also contributes to air pollution. Air pollution is a concern in many urban areas and is the major reason for respiratory problems among many people, monitoring the air quality may help many suffering from respiratory problems and diseases, and thereafter informing engineering and policy decision makers to improve the quality of air.

Major components of air pollution are

- Fine particles produced by the burning of fossil fuels(i.e. the coal, petroleum)
- Noxious gases (sulphur dioxide, nitrogen oxides, carbon monoxide-CO, chemical vapours.)
- Ground-level ozone (a reactive form of oxygen and a primary component of urban smog).

According to the US EPA, the six common air pollutants are particulate matter (PM), ground-level ozone, carbon monoxide (CO), sulphur oxides, nitrogen oxides, and lead. These are the major pollutants that has to be measured to calculate how high the air is polluted. CO, CO2 and nitrogen oxides are emitted from vehicles that contribute to the air pollution. In fact, seven million people die every year because they are exposed to harmful air conditions. One in every eight deaths globally, are due to poor air quality, making air pollution the single greatest environment health risk on people.65% of the deaths in ASIA and 25% deaths in INDIA are due to air pollution. Air pollution in India is estimated to cause 527, 700 deaths every year.

Accurate information are required to monitor air pollution in order to maintain environmental conditions. Considering there is nothing random in nature and everything around us follows a particular pattern. On the basis of these weather forecasting patterns, people can take precautions on even harsh weather conditions. A best approach would provide more frequent and spatially dense pollutant measurements. A scalable sensing

platform could effectively disseminate pollution information to users in need. Monitoring of environmental gases provides raw measurements of gases and pollutants concentrations in a particular area, which can then be analysed and interpreted. There are various methods available for measurement of air pollutants.

Present work focuses on developing efficient, accurate embedded system for monitoring CO2 and O2 levels. Various sensors are used to detect CO2 and O2 levels to provide information about levels of gas in environment. Temperature and humidity is also monitored using various sensors.

The design and development of the pollution gas monitoring system constitutes the following stages:

1. Gas sensors selection and calibration
2. Data collection and processing
3. Development of Software and
4. Field deployment

II. PRELIMINARY

Types of sensors:

2.1 GAS SENSOR:

Construction:

Two in contact electrolyte are present inside the sensor. The electrodes are typically fabricated by fixing a high surface area precious metal on to the porous hydrophobic membrane. The working electrode contacts both the electrolyte and the porous membrane are used to contact with the environmental air to find the contents in the air. Mineral acids are used as an electrolyte, plastic housing is used to contain the electrodes and other components which contains a gas entry hole for the gas and electrical contacts.

Theory of operation

The gases enters the sensor from backwards of the porous membrane to contact the electrodes where oxidation or reduction process occurs. This electrochemical reaction results in an electric current that passes through the external circuit. It also process other signal functions in addition to amplify the output signal, the external circuit maintains the voltage across the sensor between the working and counter electrodes for a two electrode sensor or between the working and reference electrodes for a three electrode cell. At the counter electrode an equal and opposite reaction occurs, such that if the working electrode undergoes oxidation, then the counter electrode undergoes reduction.

Specification:

Power supply Voltage : 5 volts

Output voltage Range : 0-0.9 Volts.

Gain in % : 3 %

2.2 TEMPERATURE SENSOR (LM35):

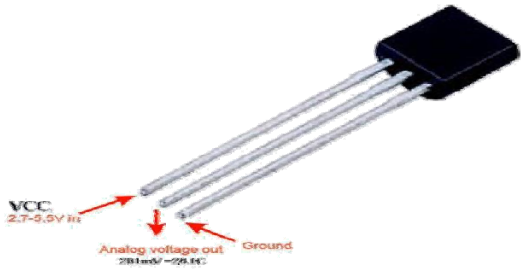
The LM35 is an integrated circuit sensor produces electrical output which is proportional to the temperature it senses which can be calculated to the unit we require. The LM35 - An Integrated Circuit Temperature Sensor

- You can measure temperature more accurately than a using a thermistor.
- The sensors are sealed such that it is not subjected to oxidation, etc..

The LM35 generates a higher output voltage than thermocouples and may not require that the output voltage can be amplified.

Two in contact electrolyte are present inside the sensor.

The electrodes are typically fabricated by

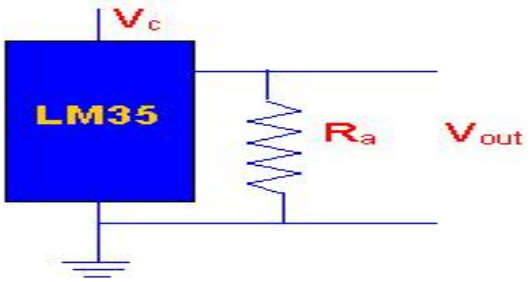


USING USES OF LM35:

- It has an output voltage that is proportional to the
- the scale factor is .01v/^{0}c
- the lm35 does not require any external calibration or trimming and maintains an accuracy of +/-
- 0.8 ^{0}c at 0 cand 100 c ando
- LM35 is that it provides low problems and only 60 micro taken from supply. The self-heating sensor causes less than still air.

CONNECTIVITY:.

- In this circuit, parameter values commonly used are:
- Vc = 4 volts to 30 volts
- Generally 5 volts or 12 volts are values used.
- Ra = Vc /10-6
- Actually, it can range from 80 K to 600 K
  but most just use 80 ktoolbar.



2.3 MOISTURE SENSOR OR HUMIDITY SENSOR:

Hygrometers or moisture sensors are instruments used for measuring relative humidity. A simple form of a hygrometer is specifically known as a psychrometer and consists of two thermometers, one of which includes a dry bulb and the other includes a wet bulb that is kept to measure wet-bulb temperature. Hair curvature is another old method of measuring humidity.

There are many different kinds of humidity / dew sensors categorized by accuracy, operating temperature range, humidity range, supply voltage, packaging type and supply current. The most common sizes for supply voltage are 4.75 to 5.25 V and 3 to 5.5 V. We also carry humidity / dew sensors with supply voltage as high as 15 V. Supply current can be between 100 µA and 15 mA, with the most common humidity sensor chips using a supply current of 100 µA, 500 µA and 2.8 to 4 mA.

ELECTRONIC HYGROMETER

A. MICROCONTROLLER(ARDUINOUNO):

Arduino Uno is a microcontroller based on the ATmega328Pin. This microcontroller has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal. It also contains USB cable with a power jack. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC- to-DC adapter to get started. You can use your UNO board without worrying too muchabout doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

Italian word "UNO" means one, so it 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 Arduino Uno board is the first in a series of USB Arduino breadboards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

PROGRAMMING:

The Arduino/Genuino Uno can be programmed with the (Arduino Software (IDE)).

Select "Arduino/Genuino Uno from the Tools > Board.The ATmega328 on the Arduino Uno board consists of pre-programmed boot loader that allows you to upload new code to it without the use of an external hardware programmer. Original STK500 protocol is used to communicate.You can bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details

PIN CONFIGURATION:

The Arduino/Genuino Uno board can be powered via the USB connection or with an external power supply. The power source is selected randomnly. Power source can come either from an AC-to-DC adapter or battery. The adapter can be connected by plugging a 2.1mm centre-positive plug into the breadboard's power jack. Vin pin headers of the POWER connector and leads from the battery are connected to GND.The board can operate on an external supply from 6 to 20 volts. The 5V pin may supply less than five volts and the board may become unstable. If the voltage range crosses more than 12V, the voltage regulator may overheat and damage the board. The range of the board is 7 to 12 volts. The power pins are as follows:

• Vin is the input voltage to the Arduino board when it is using an external power source. You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this *pin.*

• 5V.This pin produces a outputs of regulated 5 Volts from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't *advise it.*

• 3V3. A 3.3 volt supply generated by the on board regulator. Maximum current taken is 50 mA.

• GND. Ground pins.

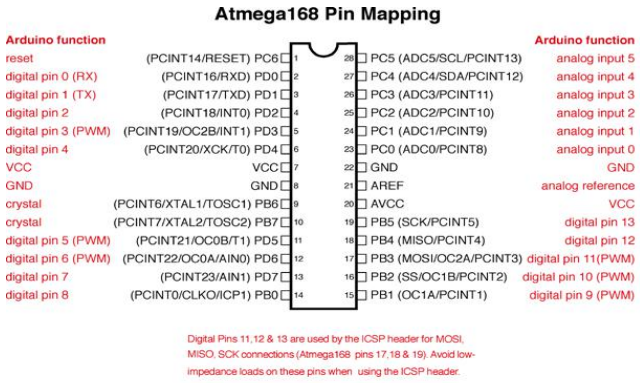
• IOREF. This pin on the Arduino/Genuino board provides the voltage reference with which themicrocontroller operates. The IOREF pin voltage can be configured using configured shield and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 32V

MEMORY:

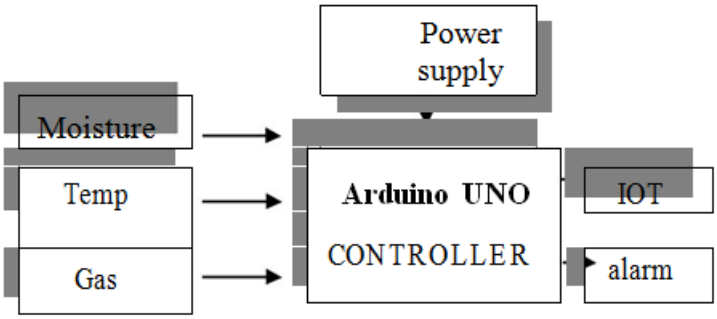
The ATmega328 has 32 Kb internal memory with occupied by the bootloader memory of 0.5 KB. It contains other component of SRAM of 2 KB and EEPROM of 1 KB (which can be read and written with the EEPROM library)

Input and Output:

See the mapping between Arduino pins and ATmega328P ports.



III. SYSTEM ARCHITECTURE:



WORKING PRINCIPLE:

The device works by taking readings from various sensors at different pins in arduino microcontroller. For this purpose we've used an arduino compatible WiFi shield stacked upon our arduino microcontroller which adds up extra functionality to our arduino board. It increases the scope of this projec various sensors are attached to the microcontroller each of them taking 5V input from arduino . All the sensors are connected using a breadboard.

For temperature sensor to prevent any damage behaviour a 10kΩ resistor is attached in parallel to the temperature sensor on the breadboard. We've used LM 35 temperature sensor to get the temperature and humidity readings connected to digital pin 7 on board for input signals. It gives us continuous reading of surrounding environment in the range of two to three seconds.

A humidity sensor (or hygrometer) senses, measures and reports the relative humidity in the air. It therefore measures both moisture and temperature of air. Relative humidity is the ratio of actual moisture in the air to the highest amount of moisture that can be held at that air temperature. The warmer the air temperature is, the more moisture it can hold. Humidity / dew sensors has a base concept of electrical capacitance hence it uses capacitive measurement. This sensor collects moisture from the environmental air, which causes the change in voltage between the two plates. These voltage changes are converted into digital readings showing the level of moisture in the air.

Gas sensors identify the levels of CO2 and CO in the air. These sensors alert the nearby people when the pollutants in that area increases. Exposure to toxic gases can also occur in operations such as painting, fumigation, fuel filling, vehicular emission, construction, excavation of contaminated soils, landfill operations, etc.

The other part of the system is wireless connectivity. We've attached a cc3000 wifi shield over the arduino to connect it to the local internet connection providers and connect. Its job is to transmit the data to a website linked to it and visualize the data over there for every minute or thirty seconds. There are many benefits of using this shield over other wifi circuit modules present there in market as it can accept DNS where others require IP address as well as good circuit components and inbuilt antenna with the help of IP address, the user can see the status of the data collected from the microcontroller threshold values can be calculated and alarm can be triggered to the user in their wireless device.

TECHNIQUES USED:

- Socket Communication
- Asynchronous serial communication

Socket communication:

Sockets are used in 4.2 BSD but it was initially introduced in 2.1 BSD. The sockets feature is now available with most current UNIX system releases. Sockets allow communication between two different processes on the inter and intra communication of machines. To be more precise, it's a way to communicate to other computers using standard Unix file descriptors. In Unix, every I/O action is done by writing or reading a file descriptor.

Asynchronous serial communication:

Asynchronous serial communication in which the data format and transmission speeds are configurable. The electric signal levels and methods are handled by a external driver circuit to the UART. UARTs are commonly used in conjunction with communication standards such as TIA, RS-232 RS-422. A UART is usually an individual or part of an integrated circuit (IC). It is used for serial communication or a peripheral device support. UARTs are now commonly included in microcontrollers.

IV. RESULT:

Designed CO2 and O2 Monitoring System

Gas sensors MQ135, LM35 temperature sensors and moisture sensors have been successfully interfaced to the microcontroller. The sensors data is being displayed on the system through internet protocol.A simple GUI has been designed to store a logged data to a text file, so that it can be analysed further. The developed system is lowest cost and energy efficient system. It requires minimum power for the developed system..

FUTURE SCOPE:

Adding one more sensor LDR(Light dependent sensor) one of the other available cheap sensors can be used to light cloudy weather or not. One of the future scope of it as desired is compatible with smartphone apps to give any critical feedback of data.

V. CONCLUSION

A low-cost, high-fidelity air quality monitoring device was designed, built and tested. The device can collect data at every second and transmit data via Wi-Fi and notify the personnel depending on the threshold level. And in places where the air-quality is very bad and can be a health hazard by alerting the people to dangerous levels of these sensed pollutants. This GUI design gives a look to the functioning wireless CO2 and O2 monitoring system. Wireless Sensor Networks have proven themselves to be a reliable solution in providing remote sensing environmental monitoring systems. The wireless sensor nodes were adapted according to sense application specific requirements to sense, collect and transmit relevant parameters. The information collected from the sensor was stored in a database and made available for displaying. In further improvements on small scale it is desired to be cased within a arduino case either own made or bought as desired.

REFERENCES

[1] W. Ye, J. Heidemann, and D. Estrin, “An energy-efficient MAC protocol for wireless sensor networks,” in Proc. IEEE INFOCOM, vol. 3,Jun. 2002, pp. 1567–1576.

[2] T. He, B. M. Blum, J. A. Stankovic, and T.Abdelzaher, “AIDA: Adaptive application independent data aggregation in wireless sensor networks,” ACM Trans. Embedded Comput. Syst., vol. 3, no. 2, pp. 426–457, May 2004.

[3] M. Hefeeda and M. Bagheri, “Forest fire modeling and early detectionusing wireless sensor networks,” Ad Hoc Sensor Wireless Netw., vol. 7,nos. 3–4, pp. 169–224, 2009.

[4] H.-Y. Kung, J.-S.Hua, and C.-T. Chen, “Drought forecast model andframework using wireless sensor networks,” J. Inf. Sci. Eng., vol.22,no. 4, pp. 751–769, Jul. 2006.

[5] Lo Re, G., Peri, D., Vassallo, S.D.: A Mobile Application for Assessment of Air Pollution Exposure. In: Mobile and Information Technologies in Medicine and Health 2013

[6] R. Shepherd, "Monitoring chemical plumes in an environmental sensing chamber with a wireless chemical sensor network", Sens. and Act. B, vol. 121, pp. 142-149, (2007)

[7] Baronti, P.; Pillai, P.; Chook, V.W.C.; Chessa, S.; Gotta, A.; Hu, Y.F. WSN: Wireless sensor networks: A survey on the state of the art and the 802.15.4 and ZigBee standards. Comput. Commun. 2007, 30, 1655-1695.

[8] A.Pardo, L. Caara, J. Care, “Gas Measurement System Based on IEEE451.2 standard”, Sensors And Acctutaors B, Vol.16, No.1, 2009, pp.11-16

[9] Zigbeespecification,www.zigbee.org/Products/Download/Zigbee Technical Document aspx, December2010

[10] Atzori, L., Iera, A., Morabito, G.: The Internet of Things: a Survey. Computer networks 54(15), 2787– 2805 (2010)

[11] Lo Re, G., Peri, D., Vassallo, S.D.: A Mobile Application for Assessment of Air Pollution Exposure. In: Mobile and Information Technologies in Medicine and Health 2013

[12] Setu Garg, Akash Chaudhary, Akash Pradhan, Heena Sharma, “WEATHER MONITORING SYSTEM BASED ON ZIGBEE TECHNOLOGY ”,International Journal of Advanced Research in Electrical,Electronics and Instrumentation Engineering, Vol. 2,Issue 5, May 2013.

[13] KarthikKrishnamurthi, SurajThapa, LokeshKothari, Arun Prakash, March 2015, “Arduino Based Weather Monitoring System”, International Journal of Engineering Research and General Science Volume 3, Issue 2.

[14] A. Zanella, S. Member, N. Bui, A. Castellani, L. Vangelista, and M. Zorzi, “Internet of Things for Smart Cities,” IEEE Internet of things, vol. 1, no. 1, pp. 22–32, 2014.

[15] A. Bouvet, T. Le Toan, and N. Lam-Dao, “Monitoring of the internet system in the Mekong Delta using ENVISAT/ASAR dual polarization data,” IEEE Trans. Geosci. Remote Sens., vol. 47, no. 2, pp. 517–526, Feb. 2009.