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# IoT based Smart City and Air Quality Monitor

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**Abstract -** *Air pollution winds up serious toxicological impact on human health and environment. Substandard quality of air in city and urban areas aggravate the diseases and decreases the quality of life. Necessary measures need to be taken for the reduction of air pollution which subsequently requires awareness about the presence of harmful gases in ambient air. This paper proposes an applied design for real-time standalone air quality monitoring system (AQMS) along with continuous monitoring of temperature, humidity and barometric pressure. The live air quality and so on can be viewed through computer or mobile by the power usage of Internet of Things. Internet of things converging with cloud computing offers a novel technique for better management of data from MCU to the cloud transmitted by low power, low cost GSM module.*

***Key Words*: *Air quality monitoring system,* MCU, Internet of things, cloud computing,**

## 1. INTRODUCTION

Air pollution is the presence of particulate matter, harmful materials and biological molecules in earth atmosphere [3]. It has adverse impact on living organisms such as humans, animals and food crops. World Health Organization data shows that 9 out of 10 people breathe air containing high levels of pollutants. Extremes of body temperature are also dangerous. High temperatures can cause dehydration, heat stroke whereas low temperatures cause hypothermia and even death if untreated. Humidity is the presence of water within air. The amount of water vapor present in air not only affects personal comfort but can also affect various manufacturing process within industrial applications. The presence of humidity indicates the chance of dew, fog and precipitation. Atmospheric pressure or the barometric pressure is the pressure within the atmosphere of Earth. A drop in barometric pressure causes headaches and some of additional effects like nausea and vomiting, increased sensitivity to light, numbness in the face and neck and pain in one or both temples.

To address these problems, a system consists of BME680, a special sensor which can measure simultaneously air quality, temperature, humidity and barometric air pressure is used in which the sensed data is transmitted by low power, low cost GSM module to the cloud through Internet of Things. Internet of Things and cloud computing are the most emerging technologies in recent years. Internet of Things is a concept or a paradigm in which without human interruption devices sense, identify, process and communicate with each other [7]. Cloud computing is a practice of consuming the resource of remote servers such as storage, virtual machines, applications and utilities that are hosted on internet rather than building and maintaining infrastructure for computing in house. Internet of Things becomes very powerful when converges with Cloud computing. The data stored at the cloud can be retrieved any time and the scenarios can be analyzed in a better way leading to the solutions for controlling air pollution to some extent.

## 2. LITERATURE SURVEY

Phala, kgoputjo et al [1] presented an air quality monitoring system (AQMS) which is based on the IEEE/ISO/IEC 21451 standard. Concentrations of CO, CO2, SO2 and NO2, were measured using electrochemical and infrared sensors. Results are saved in the data server.

Zheng, Kan, Shaohang et al [2] presented Design and implementation of LPWA-based air quality monitoring system,IEEE 2016 in which sensors collect the air quality information timely and transmitted through a low power wide area (LPWA) network

Jha, Mukesh et al [7] presented a paper for monitoring the environmental parameters, modeling and manipulating microclimate of urban areas. An efficient urban infrastructure after analyzing the urban micro-climate is implemented.

Somansh Kumar et al [4] on Air Quality Monitoring System Based on IoT using Raspberry Pi

(ICCCA2017). The sensors are connected to Arduino Board and Raspberry pi is interfaced with Arduino Uno for data transmission to the cloud.

## 3. PROPOSED SYSTEM

LPC11E66 is an ARM cortex-M0+ which has been used as it is easy to use, low-cost 32- bit MCU family, energy efficient core using a two-stage pipeline and fast single cycle I/O access. All the instructions is written in embedded C language using Keil Software which is especially for ARM cortex M based Micro controllers.

The BME680 in Fig.1 is a great choice of sensing element as it can integrate high linearity and high accuracy gas, pressure, humidity and temperature sensors since size and low power consumption are critical requirements. Optimized consumption, long-term stability and high EMC robustness which is depending on the specific operating

mode guarantees the sensor. The gas sensor within the BME680 can detect a broad range of gases such as volatile organic compounds (VOC) to measure air quality for personal wellbeing.


Fig. 1

GPRS DTU (Data Transfer Unit) in Fig.2 is selected to push the data to the web server as USR-GPRS232-730 is an Ultra-low power GPRS DTU, which allows almost any RS232 devices to transmit data the through GPRS / GSM network. HTTP format is obtained by packing the serial data and sending it to HTTP server. The communication between MCU and GPRS DTU is established by IC MAX232.


Fig.2

**Block diagram:**

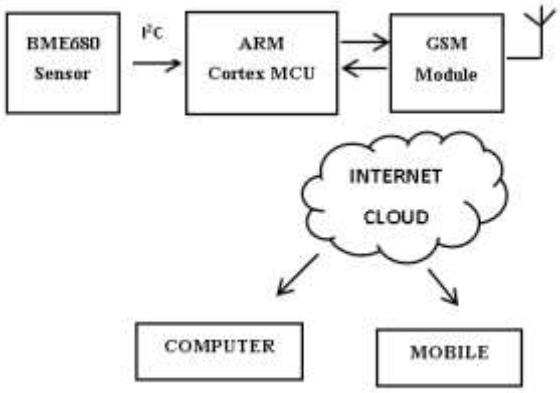


Fig 3

The simplified block diagram of the proposed system is demonstrated in the Fig.3. Power supply to the device is setup in such a way that it can accept the industrial standard i.e. 5v to 24v DC and eventually an adaptor is needed for converting AC to DC and to reduce to the preferred voltages. Voltage regulator LM1117 has been used since ARM cortex MCU, BME680 sensor and MAX232 can only operate at 3.3v. BME680 sensor measures simultaneously all four environmental parameters (temperature, humidity, and pressure and air quality). The sensor sends the measured data to the ARM cortex MCU by $I^2C$ protocol as $I^2C$/SPI protocols can only be used in BME680 sensor. The interaction of ARM cortex MCU and GSM Module is made through MAX232 IC as both uses different protocols (MCU-UART and GSM Module – RS232) for data transmission. GPRS DTU (Data Transfer Unit) sends the data to the internet cloud. Fig.4 shows how the kit looks like. The final output can be viewed through computer and mobile which is given in fig 5.

Fig.4


Fig.5

| IAQ Index | Air Quality | Impact (long-term exposure) | Suggested action |
|---|---|---|---|
| 0 – 50 | Excellent | Pure air; best for well-being | No measures needed |
| 51 – 100 | Good | No irritation or impact on well-being | No measures needed |
| 101 – 150 | Lightly polluted | Reduction of well-being possible | Ventilation suggested |
| 151 – 200 | Moderately polluted | More significant irritation possible | Increase ventilation with clean air |
| 201 – 250 | Heavily polluted | Exposition might lead to effects like headache depending on type of VOCs | optimize ventilation |
| 251 – 350 | Severely polluted | More severe health issue possible if harmful VOC present | Contamination should be identified if level is reached even w/o presence of people; maximize ventilation & reduce attendance |
| > 351 | Extremely polluted | Headaches, additional neurotoxic effects possible | Contamination needs to be identified; avoid presence in room and maximize ventilation |

Fig.6

Fig.5 shows the temperature in Celsius, humidity in percentage, pressure in mbar and air quality index at different areas and also the current date, time. The color differentiation in the Fig.6 indicates how polluted the air currently is or how polluted it is forecast to become and the suggested actions need to be taken at substandard air quality.

## 4. CONCLUSION

The device has been designed in such way that it is user friendly, compact, and portable, consumes less power with no maintenance. In the proposed system, we overcome the disadvantages of existing system such as reduction of hardware size, and continuous monitoring of air quality rather than long time basis. The reduction of hardware size is achieved by using a single sensing device (which measures multi environmental parameters such as air quality, temperature, humidity and barometric pressure). It can be used in both indoor and outdoor in places such as mall, theater, railway station, home, and car and even in industrial areas.

## ACKNOWLEGEMENT

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