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Monitoring and Controlling of Indoor Air Quality Parameters with Iot Using Soft Computing Technique

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Abstract:
Indoor air quality (IAQ) describes the air quality of a building which includes the gases, temperature and relative humidity that affect the thermal comfort and health of the inhabitants. Air quality issues have attracted much more attention and indoor air pollution has become a worldwide issue in recent years. The main aim of this project is to achieve reduction in sickness of the occupiers and an improvement in their health by monitoring and controlling the indoor air pollution. In this proposed of IAQ measurement IAQ sensor, ATmega 324 microcontroller and IOT Module is used as the measurement unit and a room sterilizer is used as the control unit. This system is very useful in the universities, hospitals, warehouses where circulation of outdoor air is provided in constrained manner and in the areas where even a small degradation in the quality of air may severely affect the performance of the individual residing in the area in terms of breathing troubles.

Keywords*: Indoor air quality (IAQ), health, pollution, environmental safety, Indoor gas pollutants, IAQ sensor.*

I INTRODUCTION

Air quality contributes a major role in human performance especially in close environment where it is crucial to have an air quality management & control system, implemented in places with high occupancy like schools and multi-story offices or buildings. With high human occupancy, quality of air and the content in air becomes very important.

Gasses like Carbon-Monoxide (CO) and Carbon Di-Oxide (CO2) directly affect the human performance, causing sick building syndrome and other issues. In the last decade, there have been major advancements in various sensing technologies that enabled the application of active protective measures. Currently systems available in market are expansive, less portable and are and hard to implement. There is need of cost effective system with same functionality. The proposed system of indoor air quality monitoring is designed to meet the limitations of the other existing monitoring equipment like cost, implementation difficulties and maintenance of the system. The designed model requires low cost, no maintenance and minimal human intervention as it is fully automatic. The system is automatic, portable, compact, could be used in all the environment, user friendly and ecofriendly, it does not requires any maintenance at all. In this proposed system of Indoor Air Quality measurement, an IAQ sensor, ATmega 324 microcontroller, IOT Module and a room sterilizer is used. IAQ sensor is used to monitor the level of the gases in the room, ATmega 324 microcontroller is used as the programming and control unit and the IOT Module is used to save the data in real time for future reference, a LCD display is used as the display unit and a room sterilizer is used as the control unit. The accepted level of CO2 and VOC gases are meant to be set as per the WHO standard. If the level of the gases

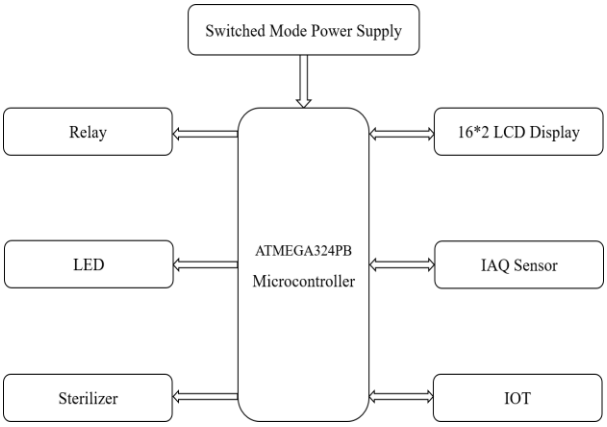
May-June 2020
ISSN: 0193-4120 Page No. 10587 - 10592

increases above the level accepted by WHO, the monitoring system will give an indication.

II PROBLEM STATEMENT

Indoor air pollution, poor ventilation on buildings and closed rooms of building causes multiple respiratory problems and health hazards on human health. The indoor air pollutants were the minute air particles, microbes and variety of unpleasant odor from the occupants of the room. Due to poor ventilation in the rooms, the microbes, pollutants and the unpleasant odor starts occupation and circulation in the room. They all together cause severe health issues particularly with respiration. On continual exposure to this environment may even lead to lung cancer. In closed room odor removal is another major problem. The usage of room fresh and any other flavored perfumes will results in additional chemical occupant and minute pollutants into the closed room. They can remove the odor only for particular time and the effect is not permanent.

III BLOCK DIAGRAM



IV MONITORING UNIT

A. IAQ Sensor

IAQ sensor act as the monitoring unit. IAQ sensor is used to measure the level of indoor gases and it operates at 3.3 V. A voltage regulator AM1117, 3.3V is used to convert the 12V DC from the SMPS to 3.3V. The IAQ sensor has four pins. Pin 1 is used to provide supply to the sensor.

Pin 2 and 3 are used for the data transmission between the IAQ sensor and microcontroller. Pin 4 is used to ground the sensor.The data transmission between the IAQ sensor and the microcontroller takes place through the pins 2 & 3 using 2 wire communication (Serial data and Serial Clock).

The IAQ sensor used here measures the level of CO_2 in PPM (Parts Per Million) and TVOC (Total Volatile organic compounds) in PPB (Parts Per Billion).

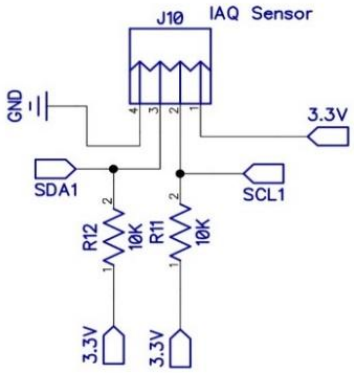


Fig 1. Circuit Diagram of IAQ sensor

Using the clock signal as reference, the data signal is transmitted.

SDA1 is the Serial Data Signal

SCL1 is the Serial Clock Signal

B. I2C Buffer:

Bidirectional I2C (Inter Integrated Circuit) buffer is used to establish communication between the IAQ sensor and microcontroller.

Since the IAQ sensor and microcontroller operates at different voltage level, they are not compatible with each other. Therefore to communicate between the two elements which are non-compatible, the buffer circuit is essential.

May-June 2020
ISSN: 0193-4120 Page No. 10587 - 10592

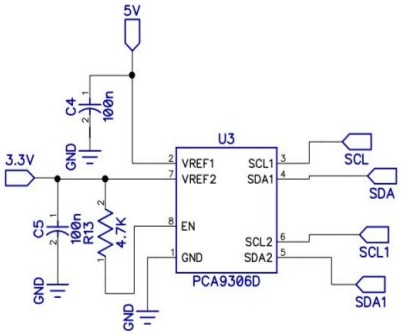


Fig 2. Circuit diagram of I2C Buffer

The operating voltage of microcontroller is 5V and the operating voltage of IAQ sensor is 3.3V.

The buffer compares two voltage references,

i. The microcontroller reference voltage
ii. The IAQ sensor reference voltage

V CONTROLLING UNIT

A. IOT

Internet of Things is generally defined as the scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention.

In this proposed system, IOT is used for the SMS system and real time storage of the values of indoor gases and the time of occurrence. The SMS value is sent using GSM module SIM 900. The real time value of CO_2 and TVOC gases is stored in a separate sheet and the stored values can be used for the analysis and prediction of the high threshold occurrence. This analysis of occurrence of the high threshold will help in taking actions to reduce the source of the TVOC gases in indoor.

B. Microcontroller

The microcontroller acts as the CPU of this circuit. Every single element is connected to the microcontroller. It is programmed and accordingly the data has been transmitted and received or only transmitted to the components connected with it. The microcontroller operates at 5V DC. Communication ports were used to establish communication in between the microcontroller and other elements as they differ in operating voltage.

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip.

Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile radio transceivers, vending machines and home appliances among other devices.The micro-controller is the CPU of the system, which is responsible for measuring the indoor Air quality and stores the information to the database.

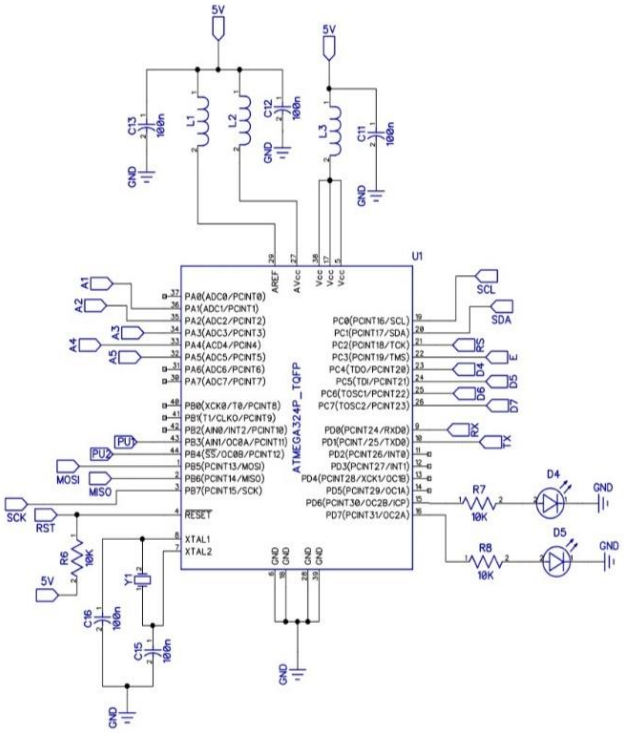


Fig 3. Circuit Diagram of Control unit

Microcontroller sends and receives signal from the IAQ sensor and sends signal to the sterilizer to

May-June 2020
ISSN: 0193-4120 Page No. 10587 - 10592

manage the level of the volatile gases in indoor air quality.

VI DISPLAY UNIT

A.LCD Display

In this model LCD display is used to display the indoor air quality to the user in the character format, which displays the real time value of the CO2 and TVOC gases of the indoor air. Usually LCD Displays are communicated with the micro-controller in parallel mode of communication (8-bit Mode). But in this project we are communicating with 4bit Mode. The LCD displays are very rugged in structure, so they will be used in the commercial products and they are very reliable in nature and the possibility of failure is minimum. The LCD has 16 pins. Pin 11, 12, 13, 14 are used for data transmission. Data lines D4, D5, D6 and D7 has been transmitted from Microcontroller to LCD display. Pin 7, 8, 9, 10 are grounded and they make the LCD to operate in 4-bit mode.The real time value of the indoor air quality parameters were displayed in the LCD display.

B. Mobile SMS

As part of IOT, GSM module is used to send SMS. SMS notification will be sent to the given mobile number when the IAQ gases level increases the predefined value. GSM module is used to interface the mobile number with the IOT. SIM 900 GSM module is used for the communication between the IOT and mobile. Whenever the level of the CO_2 and TVOC increases the predefined value, SMS notification will be sent to the given mobile number and another SMS will be sent to the mobile number when the CO_2 and TVOC values again reaches the normal level.

VII STERILIZER

Sterilizer is used as purifying agent inside the room. It oxides the volatile organic compounds inside the room and reduces the level of the gases. Ozone Generator is used as the sterilizer. Ozone is a powerful oxidant which will oxidizes the gases inside the room and make the place a suitable for living and improves human health by oxidizing the volatile organic compounds. The sterilizer is connected to the Microcontroller and receives signal from the microcontroller. Whenever the value of the volatile organic compounds increases, the predefined value, and microcontroller will turn the sterilizer on and the ozonationprocess will takes places inside the room. After ozonation, the level of the volatile organic gases will reduce and while the value of volatile organic gases reaches the predefined level, microcontroller will turn off the sterilizer.

VIII APPLICATIONS AND RESULTS

A. Applications

The proposed system can be used in

- Hotel Rooms to eliminate odor
- Living Room to remove smell of the occupants of the room
- Kitchen to eliminate the smoke
- Bathrooms and Toilet to reduce the odor
- AC Halls
- Party halls
- Meeting rooms without ventilation
- Server rooms
- Exhaust duct in industries

The system helps in detecting and removing the odor and the level of volatile organic compounds which are responsible for the bad odor and breathing problems in closed rooms.

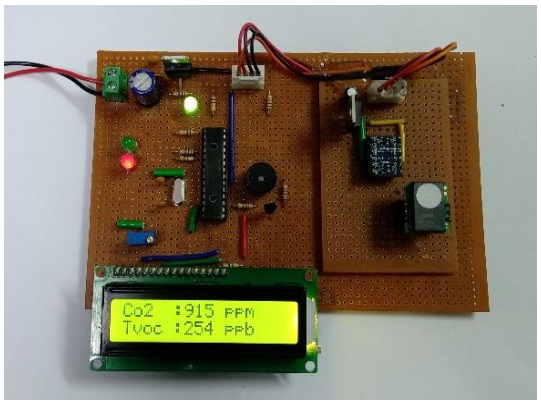
B. Results

1. Snap of the LCD display at normal level of VOC and CO_2.

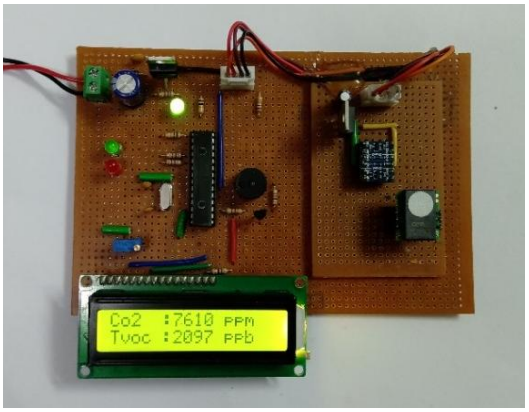
May-June 2020
ISSN: 0193-4120 Page No. 10587 - 10592

The normal level of the gases is defined by the World Heath Organisation(WHO).

Upto the normal there is no problem for the human health.



2. Snap of the LCD Display at high level of VOC and CO_2.



IX CONCLUSION AND FUTURE WORK

A. Conclusion

The monitoring system designed and prototyped has the capability to continuously monitor the air quality of an indoor system. The proposed system has been designed to monitor the essential parameters of an indoor air continuously throughout its operation. If the microcontroller senses any increase in the level of indoor CO2 and volatile organic compound gases, the buzzer will get activated. Also the real time value of the indoor air will be displayed using an LCD display. The system designed for monitoring the indoor air quality is compact, portable, low computation time and highly efficient. This system is used to monitor, display and indicate the level of the indoor air quality and also generate alarm so that proper measures can be taken in time. Basic design of this system supports portability and simplicity, which most of the systems in market do not provide. The indoor air pollution problem has a significant impact on quality of life, and has become a worldwide issue in recent years. As the increasing trend in urbanization results in crowded area with less space and higher human occupancy, air quality plays important role as it directly affect the human performance and bad air can cause serious damage to other in same ambient. It is obvious that too much air changes in sealed building results loss in heated/chilled air consequently loss of energy. Too less air changes causing bad indoor conditions results in bad indoor conditions. This system is very useful in the arrangement like universities, hospitals, warehouses where circulation of outdoor air is provided in constrained manner and even a small degradation in the quality of air may severely affect the performance of the individual residing in the area in terms of breathing troubles. Since sources creating indoor air pollutants cannot be removed completely, pollutants can be reduced by monitoring them and implementing a control action.

B. Future Work

In future the proposed system can be modified by adding one or two parameters such as temperature. Along with the level of the level of gases, temperature of the room can also be monitored and controlled and to develop an appropriate system to cover a large indoor environment or complete building. This model can be used in any circumstances as it is compact and portable. The design can be extended also to monitor the essentials gases in the indoor and if the level of those essential gases decreases that should be

May-June 2020
ISSN: 0193-4120 Page No. 10587 - 10592

indicated and controlled accordingly to maintain the normal range by using additional sensors and control unit.

X REFERENCES

1. ZaeemAslam, Waqas Khalid, Tallal Ahmed, DaniyalMarghoob. Automated Control System for Indoor Air Quality Management. 2017 International Conference on Energy Conservation and Efficiency (ICECE).
2. ShaodanZhi, Yongbin Wei, Zhen Cao, Chao Hou. Intelligent Controlling of Indoor Air Quality based on Remote Monitoring Platform by Considering Building Environment. The 2017 4th International Conference on Systems and Informatics (ICSAI 2017).
3. Yangjun Li, Juan He. Design of an Intelligent Indoor AirQuality Monitoring and Purification Device.
4. J. Esquiagola, M. Manini, A. Aikawa, L.Yoshioka and M. Zuffo. Monitoring Indoor Air Quality by using IoT Technology.
5. Goncalo Marquesa, RuiPitarmab. Health Informatics for Indoor Air Quality Monitoring
6. Liang Zhao, Wenyan Wu, Shengming Li. Design and implementation of an IoT based indoor air quality detector with multiple communication interfaces. IEEE Internet of Things Journal 2019.
7. Jung-Yoon Kim, Chao-Hsien Chu, and Sang-Moon Shin. An Integrated Sensing Systems for Real-Time Indoor Air Quality Monitoring.IEEE SENSORS JOURNAL, VOL. 14, NO. 12, DECEMBER 2014
8. Thinaharan Ramachandran, ThinagaranPerumal and Patrice Boursier. Fuzzy Logic Predictive Method for Indoor Environment Parametric Dataset.2017IEEEInternationalSymposiumon ConsumerElectronics(ISCE).
9. Elena Alexandrova, Ali Ahmadinia. Real-Time Intelligent Air Quality Evaluation on a Resource-Constrained Embedded Platform. 2018 4th IEEE International Conference on Big Data Security on Cloud.
10. Sanjay Shitole, Devika Nair, Nidhi Pandey and HeenaSuhagiya. Internet of things based indoor air quality improving system. 2018 3rd International Conference for Convergence in Technology (I2CT).
11. M.F.M Firdhous, B.H Sudantha, P.M Karunaratne. IoT Enabled Proactive Indoor Air Quality Monitoring System for Sustainable Health Management. 2017 Second International Conference on Computing and Communications Technologies (ICCCT'17).
12. Liu Peng, Fu Danni, Jiang Shengqian, Wang Mingjie. A Movable Indoor Air Quality Monitoring System. 2017 2nd International Conference on Cybernetics, Robotics and Control.
13. PallaviAsthana, Sumita Mishra. IoT Enabled Real Time Bolt based Indoor Air Quality Monitoring System. 2018 International Conference on Computational and Characterization Techniques in Engineering & Sciences (CCTES).
14. Distributed Contaminant Detection and Isolation for Intelligent Buildings. Alexis Kyriacou, Michalis P. Michaelides, VassoReppa, SteliosTimotheou, Christos G. Panayiotou, Marios M. Polycarpou. IEEE Transactions on Control Systems Technology, Vol. 26, No. 6, November 2018.
15. Adaptive PID Control of Indoor Air Quality for an Air-conditioned Room. XiaosongGu, Heng Li, Litie Zhao, Hanqing Wang 2008 International Conference on Intelligent Computation Technology and Automation.