

Real time graphical monitoring of various sensors using wireless network

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Abstract: Real time graphical monitoring system using wireless network is developed for multiple sensors which is useful for indoor application. System is highly responsive, accurate and its mobility is the greatest advantage. Sensors are calibrated in proper environment for greater accuracy and reliability. This system is highly applicable for the measurement of indoor air pollutants which is very sensitive issue and directly affects the human health. Developed system detects maximum air pollutants such as CO, CO₂, LPG along with parameters temperature and humidity. To achieve the desired target goals semiconductor sensors, ZigBee communication module and PIC 16F877A microcontroller is used. It presents the result in graphical form using LabVIEW software and display result on LCD also. Main advantage of the system is that it detects the overall air quality of indoor air which gives indication of good or bad air quality.

Index Terms: Semiconductor sensors, IEEE 802.15.4 standard, Microcontroller, LabVIEW (GUI).

I. INTRODUCTION

Green and clean environment across the globe is very much essential for the health. Air pollution comes from both natural and human-made sources. An air pollutant is a substance in the air that can have adverse effects on humans and disturbs biological balance on the earth. So there is increasing demand for detection and monitoring of polluted gases [1]. There are many sources of indoor air pollution. This issue need to be addressed very carefully as it is very much concentrated with pollutants than outdoor air [2].

IAQ (Indoor Air Quality)

It refers to the nature of the air that circulates throughout space/area, where we work and live that is the air we breathe most of the time. As IAQ is not proper, there is reduction in oxygen level and increase in carbon dioxide, temperature and humidity level [3].

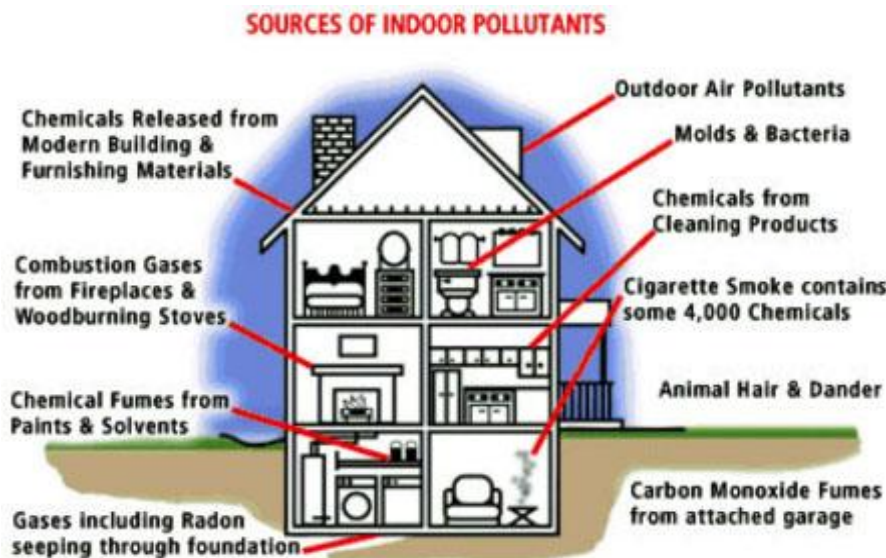


Fig 1 : Sources of Indoor pollutants

The present systems for measurement of Indoor air quality have lot of drawbacks and thus modifications are being continuously recommended. Our system concentrated on real time monitoring, calibration of sensors, sensitivity and cost. In the past many people have worked on this topic of Indoor air quality monitoring system and environmental monitoring system. Nihal Kularatna and B.H.Sudantha [4] presented environmental air pollution monitoring system in 2008. The system based on the IEEE 1451 standard. Octavian A.Postolache, J.M.Dias and P.M.B Silva Girao [5] in 2009 implemented Smart sensor network for indoor and outdoor air quality monitoring.



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In the year of 2010 A.R.Al-Ali, Imran Zualkernan and Fadi Aloul [6] introduced Mobile GPRS sensors for pollution monitoring.

Anuj Kumar and Gerhard P. Hancke [7] developed Energy Efficient Environment Monitoring System Based on the IEEE 802.15.4 Standard for Low Cost Requirements. Anuj Kumar, I. P. Singh, and S. K. Sud [8] developed Energy Efficient and Low-Cost Indoor Environment Monitoring System Based on the IEEE 1451 Standard. The literature also shows that despite some appealing solutions, very few are practically executed and tested in real-world establishing the existence of a gap between theory and real world application at scientifically accepted level. IAQ is a major concern to businesses, building managers, tenants, and employees because it can impact occupant health, comfort, well being, and productivity. The issue is mainly important in situations where people spend a lot of time indoors.

II. WIRELESS REALTIME MONITORING SYSTEM FOR INDOOR AIR POLLUTION

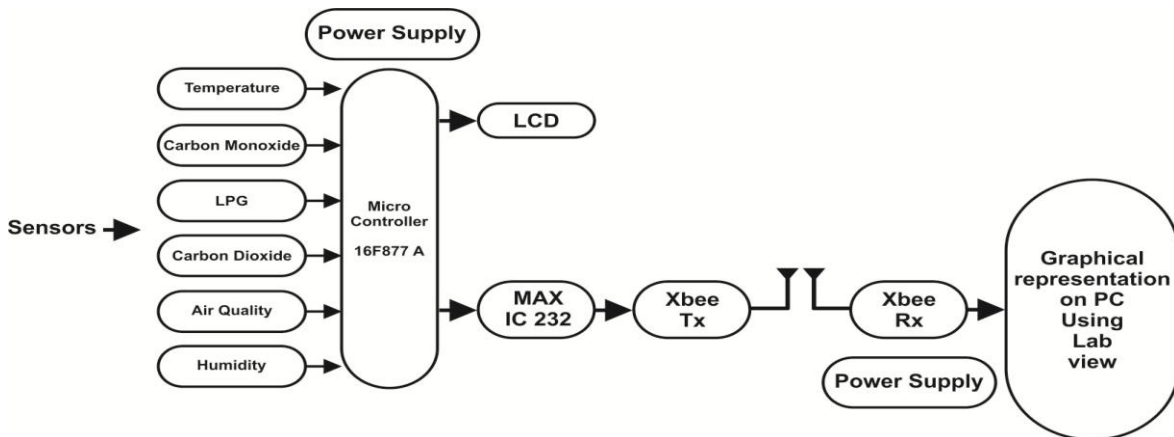


Fig 2: System block diagram

III. SYSTEM IMPLEMENTATION

1. Sensors

Sensors are major part of the system. Sensors are calibrated at Joseph Leslie Dynamics (JLD). JLD provides calibration of gas sensors in proper environment. Calibration of the sensors with appropriate accuracy is beneficial.

2. Procedure of Gas sensor calibration

- Gas sensors need to be calibrated and periodically checked to ensure sensor accuracy and system integrity.
- It is important to install stationary sensors in locations where the calibration can be performed easily.
- The intervals between calibration can be different from sensor to sensor. Generally, the manufacturer of the sensor will recommend a time interval between calibration.
- The calibration procedure we used is simple, straightforward, and comfortably carried out. Safety requirements are simple and economical.
- The procedure of calibration is consistent and traceable. The calibration executed in the field where sensors are installed so it can occur in any type environment.
- Calibration of the gas sensor involves two steps. First the “zero” must be set and then the “span” must be calibrated.
 - Step One: Setting the “Zero” Reading
- There is no established standard that defines zero air.
- Use pure nitrogen or pure synthetic air to establish the zero point.
- It is more realistic and practical to zero the sensor using the air surrounding the sensor when the area is considered to be clean.
- The output observed for exposure of nitrogen or pure synthetic air can be used to set Zero reference point.
 - Step Two: Span Calibration

- The span calibration can be fairly easy or it can be very complex and costly, depending on the gas type and concentration range.
- In principle, to achieve the best accuracy, a mixture of the target gas balanced in the background environmental air is the best calibration gas.
- Premixed gas mixtures are compressed and stored under pressure in a gas bottle.
- To get this highly pressurized gas out of the bottle in order to calibrate the sensor, a regulator assembly is required. This assembly consists of a pressure regulator, a pressure gauge, and an orifice flow restrictor. The orifice flow restrictor is placed with a hairline hole that permit a constant air flow at a given pressure difference.
- In operation, the high pressure from the bottle is reduced to a lower pressure of only a few psi, which provides a constant air flow through the orifice. Flow rates between 500-1000 cc/ min are most common.
- The output observed for standard gas mixture on standard testing device like DMM can be used to set signal in standard 4-20mA or 0.4 – 2 [9].

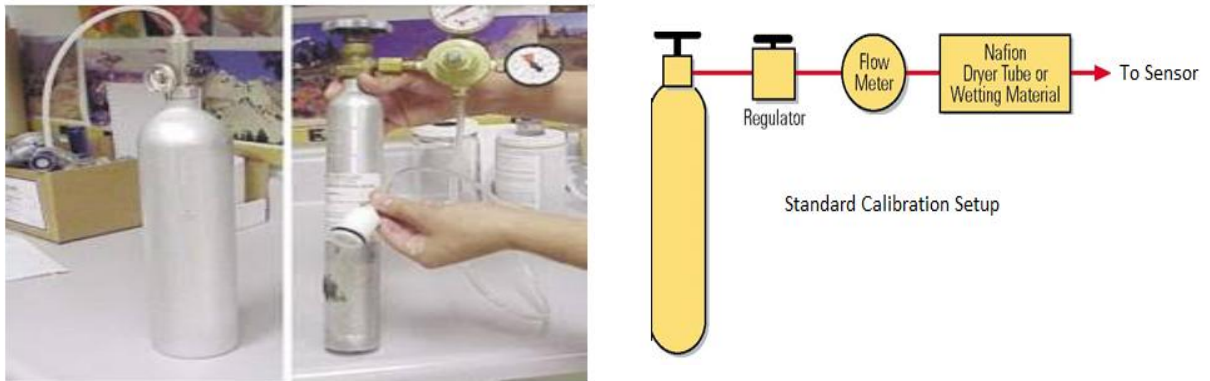


Fig 3: Standard Calibration Setup

3. Sensor calibration report

Table 1: Calibration report

STANDARD GAS USED FOR CALIBRATION		
Sr. No	Gas Concentration	Make/Model
1	Propane - 1.11 % V/V	Chemtron
2	CO - 150 PPM	Effectech
3	Ammonia - 80 PPM	Effectech
4	CO2 - 1% V/V	Pure Gas

CALIBRATION REPORT OF SENSORS					
	Test Gas	Test Gas Concentration	Sensor	Full Scale	Sensor Output
1	Fresh Air	0 PPM	MQ 5	0 – 10000 PPM	100 mV
	Propane (LPG)	1.11 % V/V			784 mV
2	Fresh Air	0 PPM	MQ 7	0 – 2000 PPM	271 mV
	Carbon Monoxide	150 PPM			1024 mV
3	Fresh Air	0 PPM	MQ 135	0 – 100 PPM	272 mV
	Air Quality (Ammonia)	80 PPM			794 mV
4	Fresh Air	400 PPM	MG 811	1 % V/V	310 mV
	Carbon Dioxide	1 % V/V			510 mV

5. Circuit Details

1. Main board

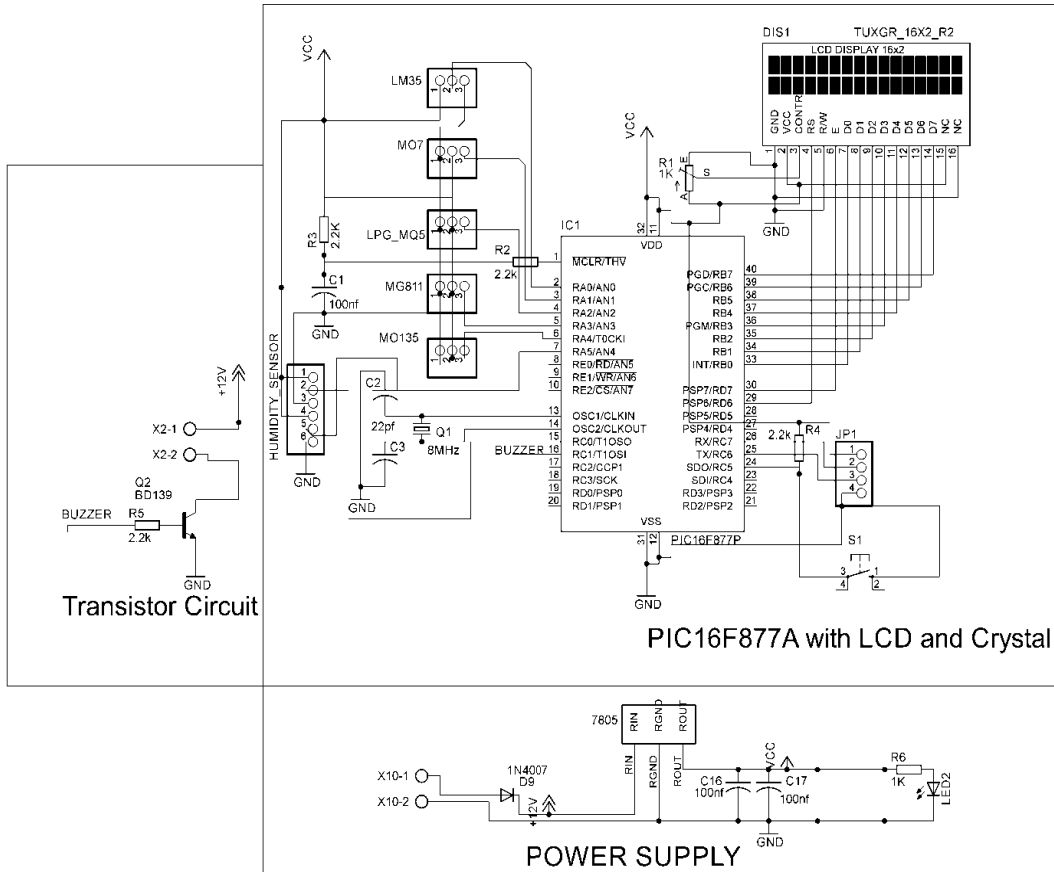


Fig 4: Main board

2. Zigbee section

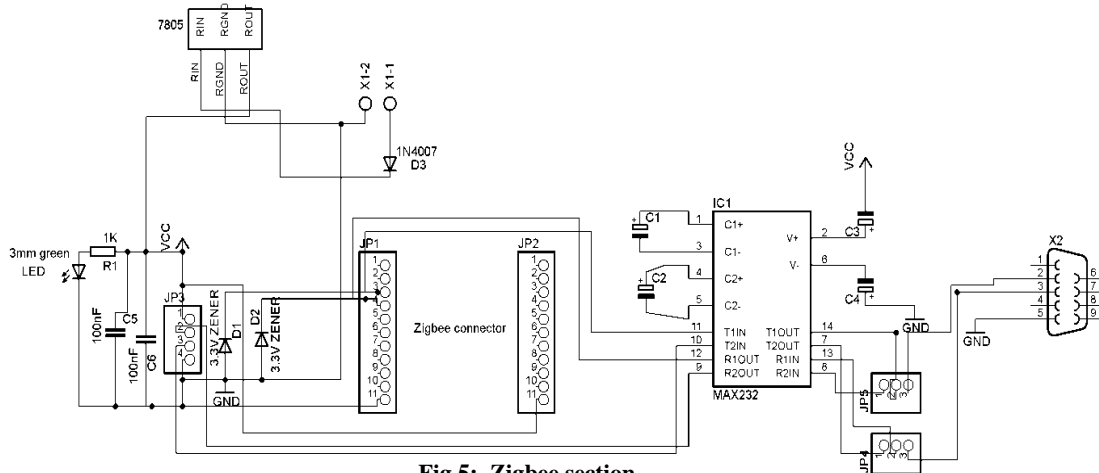


Fig 5: Zigbee section

IV. PIC MICROCONTROLLER

For controlling different functions such as ADC, mathematical calculations, and for display purpose microcontroller 16F877A is used. LCD display is used for display of numeric and alphanumeric characters. We can observe the concentration of different gases on LCD. For level conversion between microcontroller and Zig-



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Bee module Max IC 232 is used. Coding is done in C programming language. Information on PIC microcontroller found in [10].

Flow chart and program code

To get logical flow of the system, the development of flowchart has a prominent role. Complete system analyzing and organization of algorithm is required for proper understanding of the project at any stage.

After analyzing the problem a suitable program code in C language needs to be written for its accurate execution in microcontroller.



Fig 6: Flow chart of the program

V. ZIG-BEE COMMUNICATION MODULE

Zigbee communication is specially built for control and sensor networks on IEEE 802.15.4 standard for wireless personal area networks (WPANs), and it is the product from Zigbee alliance. ZigBee is a low-cost, low-power, 2.4GHz range low data rate wireless networking standard for connecting sensors, instrumentation and control systems. Features of ZigBee are low cost and low power-usage which allows longer life with smaller batteries [11].

VI. LABVIEW SOFTWARE

Lab view – short for laboratory virtual instrument engineering workbench, is a design environment in which you create programs using a graphical notation. LabVIEW provides more flexibility than standard laboratory instruments because it is software-based. Because of LabVIEW's graphical nature, it is naturally a data presentation package. Output appears in any form you require that are Charts, graphs, and user-defined graphics compose just a fraction of available output options. Information on LabVIEW can be found in [12].

LabVIEW Data Flow Diagram

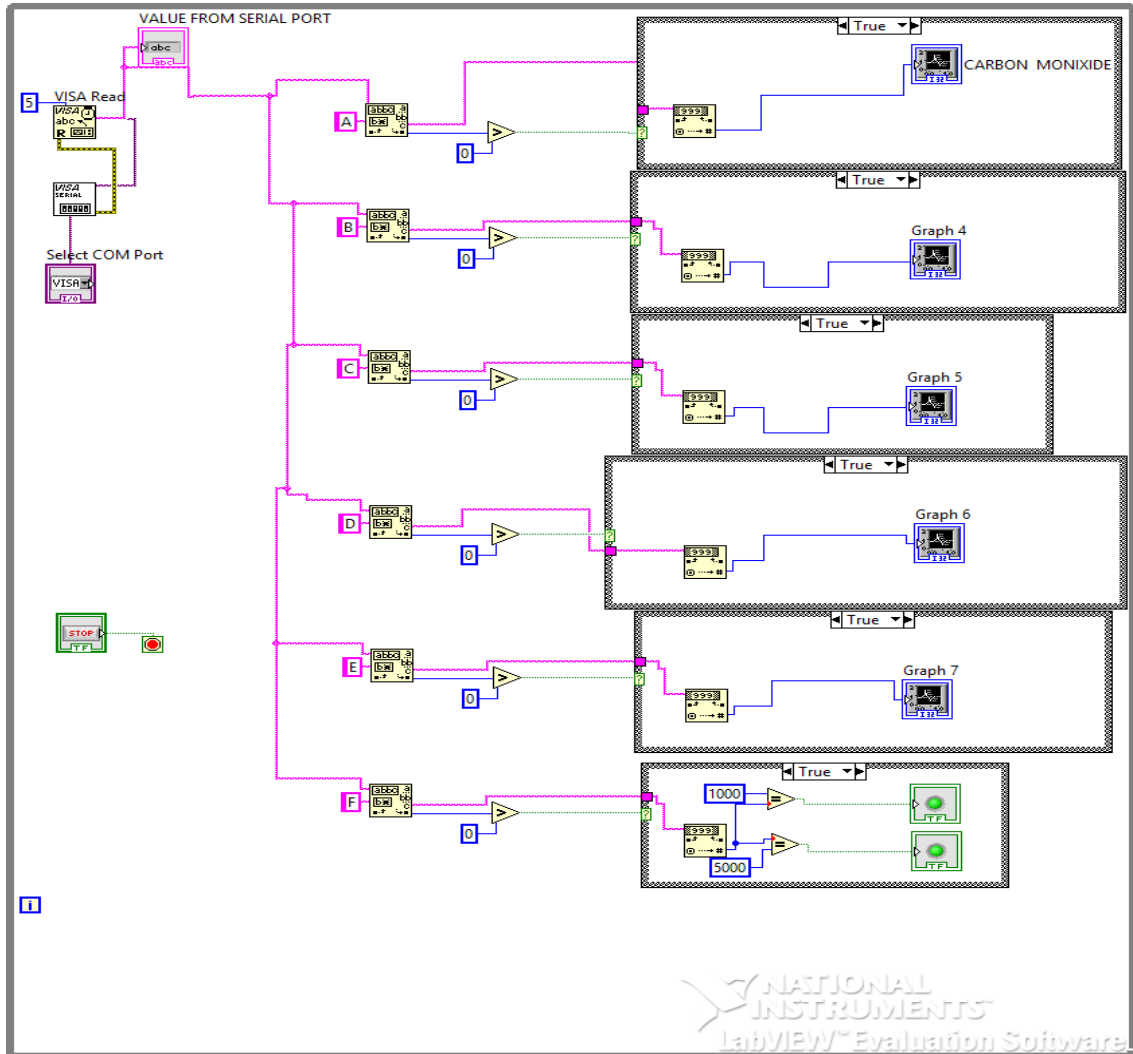


Fig 7: Data flow diagram

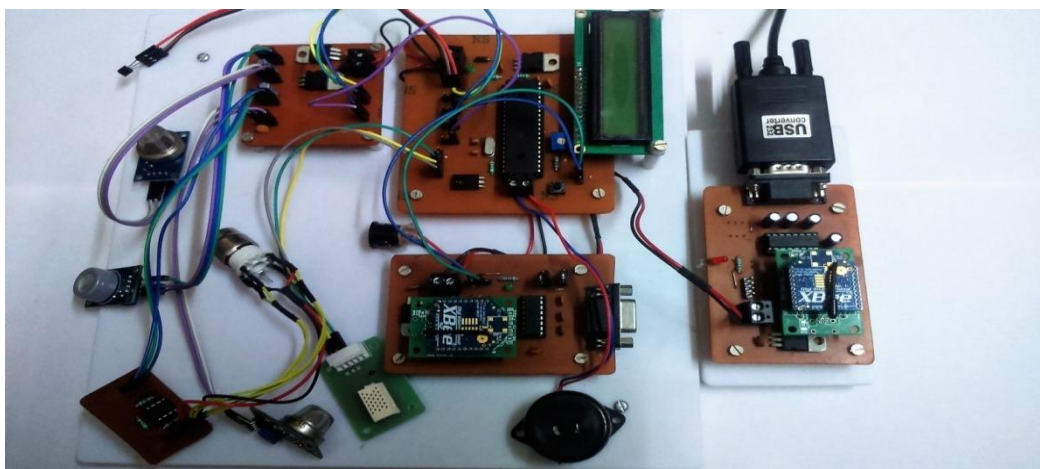


Fig 8: Experimental setup



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VII. RESULTS

As there are six sensors in our system each sensor observe the value for one second and after six seconds again the cycle repeats which gives indication by buzzer. If any parameter exceeds certain threshold value system gives alarm in terms that overall air quality is bad otherwise it indicates that air quality is good. Results are taken in different living rooms and class rooms. It presents results on LCD also.

1. TEMPERATURE

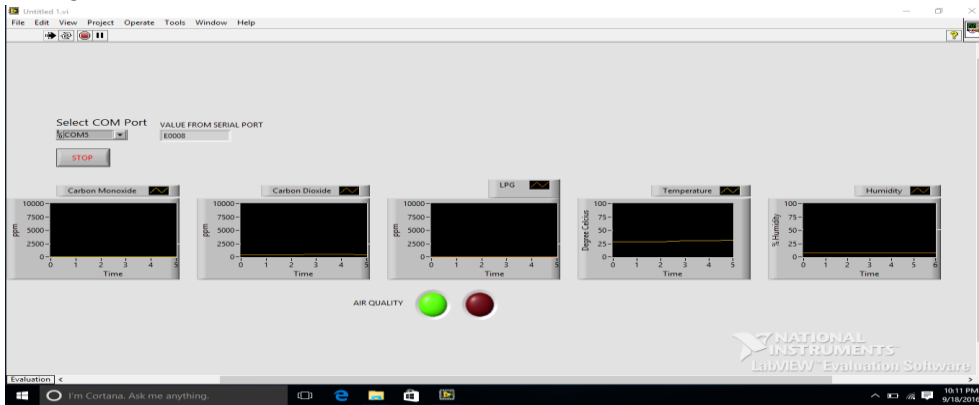


Fig 9: Temperature reading

2. CARBON MONOXIDE

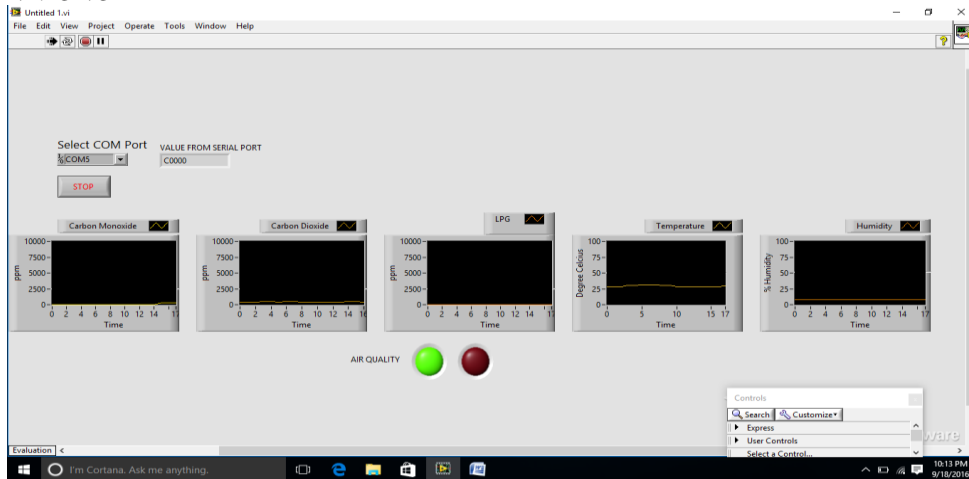


Fig 10: Carbon monoxide reading

3. LPG

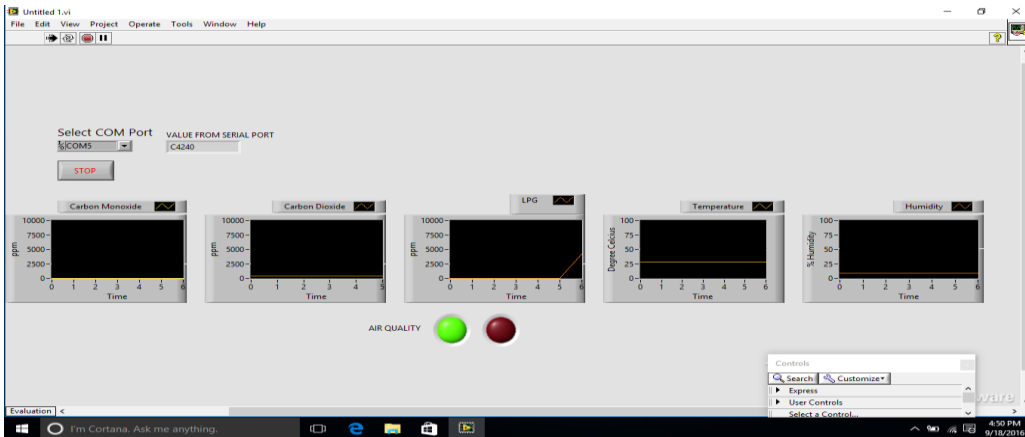


Fig 11: LPG reading



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4. CARBON DIOXIDE

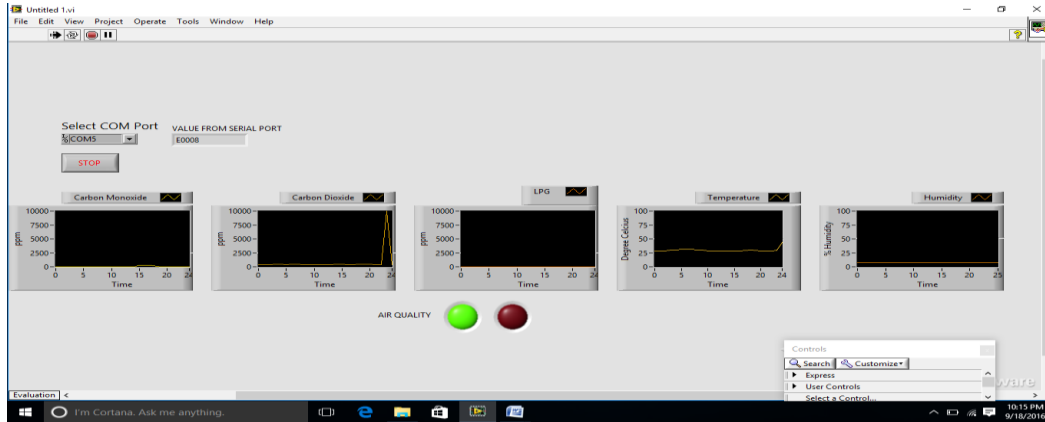


Fig 12: Carbon dioxide reading

5. AIR QUALITY GOOD

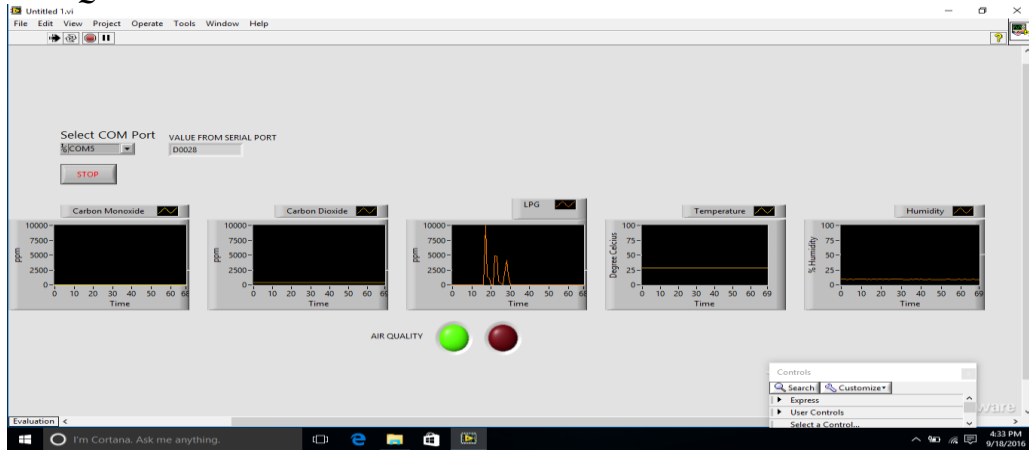


Fig 13: Air quality good reading

6. AIR QUALITY BAD

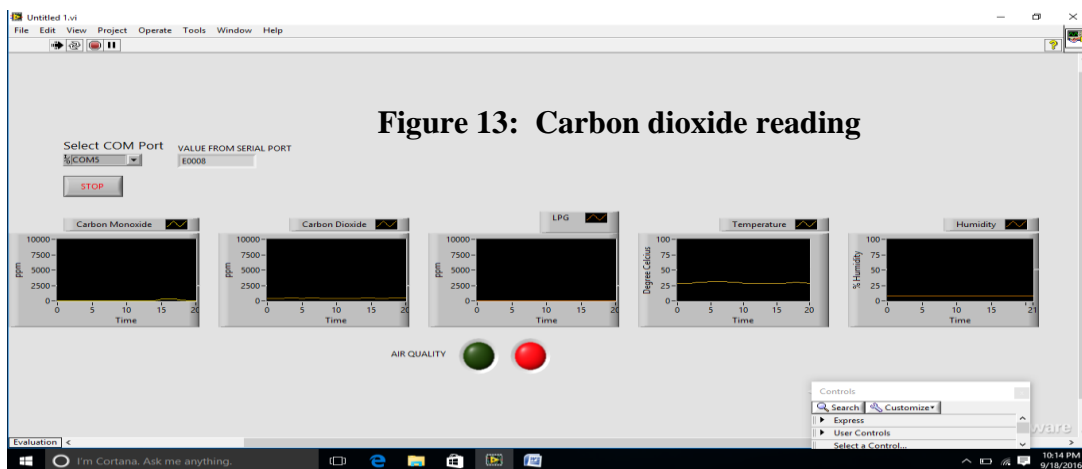


Fig 14: Air quality bad reading



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7. HUMIDITY

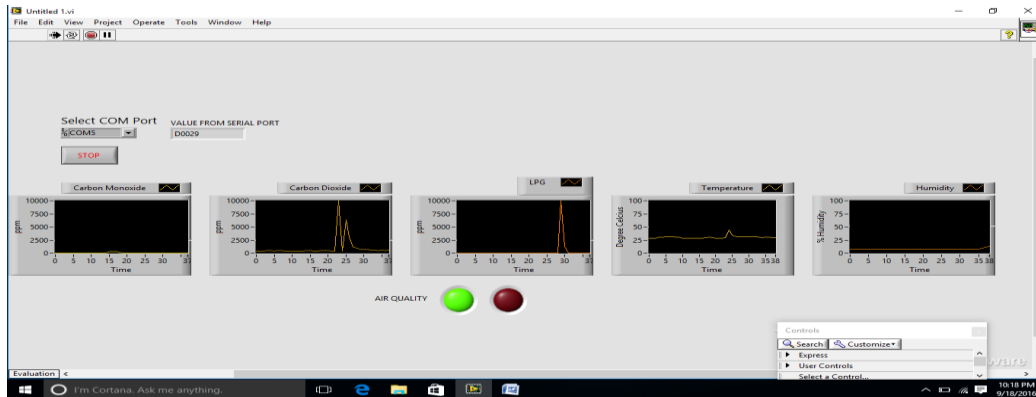


Fig 15: Humidity reading

VIII. CONCLUSION

The developed wireless smart sensor network for air quality monitoring system provides real time information about the level of air pollution for indoor application. It provides alert message in case of drastic change in the air quality. This system has been successfully developed in compliance with IEEE 802.15.4 standard (XBee). System successfully interfaces different sensors with microcontroller and microcontroller with NCAP through XBee communication. For greater accuracy sensors are properly calibrated at Joseph Leslie Dynamics (JLD). JLD provides calibration of gas sensors in proper environment. Calibration of the sensors with appropriate accuracy is beneficial. This prototype system is tested for monitoring different gases such as CO, CO₂, LPG along with temperature and humidity. It indicates overall air quality also. Use of semiconductor sensors added several advantages such as low cost, fast response, low maintenance and ability to produce continuous measurement etc. Indoor Air pollution has numerous ill effects on human beings so to reduce it we should take some preventive steps such as, Provide proper ventilation in every room, Use vacuum cleaners and kitchen chimney and ban smoking.

IX. FUTURE SCOPE

- 1) Controlling measures can be added to the system to take action on any inappropriate environmental condition. We can add Control for FAN, Air Conditioner etc.
- 2) We can add software Control of parameters. This will help in easy system maintenance and changing the threshold value for any sensor. It will increase the user friendliness of the system. Also then control can be provided on the internet, so any person at any location in the world having internet access can monitor and control the system.
- 3) We can implement data logging in the system through software. This will help in generation of reports. Reports can tell the true story of any plant and can be used to reduce the pollution. Also can be used to find the problems in machinery or plant installed in then industry.

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