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ON DETECTING ACCEPTABLE AIR CONTAMINATION IN CLASSROOM USING LOW COST SENSORS

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Abstract— *In present scenario of the world, environmental pollution is one of the leading challenges. Most often the educational institutes and organizations in developing countries suffer from polluted environment due to overcrowded rooms, improper planning and poor infrastructure. Students/faculties in a classroom could suffer from health issues due to prolonged exposure to such environment. On an average a student/faculty is exposed to such environment for eight hours per day. A student/faculty could undergo physical as well as cognitive hazards. This paper tends to detect the duration for which a classroom environment can be considered healthy for a given number of students. In this system we use PIC16F877A microcontroller for controlling the working and different sensors such as oxygen sensor, temperature sensor, gas sensor, RFID Reader, LCD Display.*

Keywords—*PIC 16F877A,OXYGEN SENSOR ,LM35, MQ5,*

I. INTRODUCTION

Pollution- If you don't kill it, it will kill you. Today mankind has become a slave to technology, especially the people living in the urban areas. Technology thrive on power and the more power we generate, the more natural resources are depleted as a result of which harmful pollutants are released in the environment. Residing in closed environments does not safeguard us from the adverse effect of pollution on our health. Considering the scenario, we cannot ensure the safety of students in their classrooms. This has made the Air Quality Index of an indoor environment as important as that of outdoor. In recent times, Indoor Air Quality Monitoring has been focused as people spend more than 90% of their time in closed environments. According to the Environment Protec-tion Agency (EPA), indoor air is 2-5 times more polluted than the outdoor air.

Air quality is generally assessed by the concentrations of different pollutant like Carbon Di-oxide (CO_2), Carbon Mono-oxide (CO), Particulate Matter ($PM_{2.5}$) etc. Number of students increases in the classroom the temperature and CO2 level is increases, oxygen level is automatically decreases. High concentration of CO2 causes an enhanced greenhouse effect when in a closed environment which leads to warmer temperature and decreased Oxygen level resulting in breathing problems.

High concentration of CO can affect the heart rate and respiratory system. Sick Building Syndrome (SBS) such as irritation in eyes and nose, fatigue, dizziness, nausea and cognitive problems such as difficulty in concentrating, impaired memory and slowed mental processing, can be experienced due to the exposure to the indoor pollutants affecting students' academic performance. Human comfort, productivity, and a sense of health and well being are the positive outcome of healthy indoor environment. Indoor air quality is measured with CO2, temperature and humidity sensors to ensure standards for human comfort indoors. Although human comfort depends on an interaction of multiple variables optimizing both temperature and relative humidity satisfies the comfort requirements for a variety of occupants than optimizing only temperature. CO2 level is surrogate measurement for indoor air quality and human presence.

Fig 1: Class room with healthy Environment

The study focused on schools because of recent attention to the health effects of air pollution on sensitive populations, one of which is children. According to recent reports by the Centres for Disease Control, children have experienced a dramatic increase in asthma, which is exacerbated by air pollution.

To overcome from this problem we have designed and environment monitoring unit using low cost sensor for measuring the concentration of CO2, CO, and temperature. We have designed an Environment Monitoring Unit (EMU) using low cost sensors for measuring the concentration of CO2, PM 2.5, Temperature and Humidity.

II. RELATED WORK

kim et al. [3] proposed a method for monitoring the indoor pollutant in a real time basis by using MOS (Metal Oxide Semiconductor) sensors, they have used different calibration techniques and aggregation algorithm for reduced network trafc and power consumption.

Spachos et al. [4] monitors and detects the concentration of Carbon Dioxide in a real time basis and provide overall air quality alerts in a timely manner by using iAQ-2000 CO2 Sensor.

Shaban et al. [5] presented a technique for air pollution monitoring and forecasting where the system uses low-cost air quality monitoring motes equipped with an array of gaseous and meteorological sensors. The sensed data communicate with an intelligent sensing platform that is responsible for receiv-ing and storing pollution data. Based on above historical data, the system forecasts the pollutant level.

Jiang et al. [6] proposed Indoor Air Quality sensing without using sensors for air pollutants, in this work they used Air exchange rate to measure the IAQ by using humidity, light and temperature sensors.

Chen et al. [7] proposed a system to monitor indoor air quality on different oors of a building using Purication Time Inference (PTI) model based on ANN. Most of the works found have put their effort to monitor or, to ventilate or, to forecast the Indoor Air quality; however, our emphasis is on the variation of pollutant contamination level against the class duration and the number of persons present in the classroom.

III. MOTIVATION

Today the whole world is suffering from the plague of pollution. Whole ecosystem has been affected adversely. Keeping ourselves in home, offices and indoor will not prevent us from getting affected by the contaminated air. To analyse the effects of pollutants in indoor environment, we have done some survey where it is seen that how badly some pollutants are affecting the classroom & laboratory environment.

From the survey it is clear that the duration of a class is an important feature which infers some informations as follow:

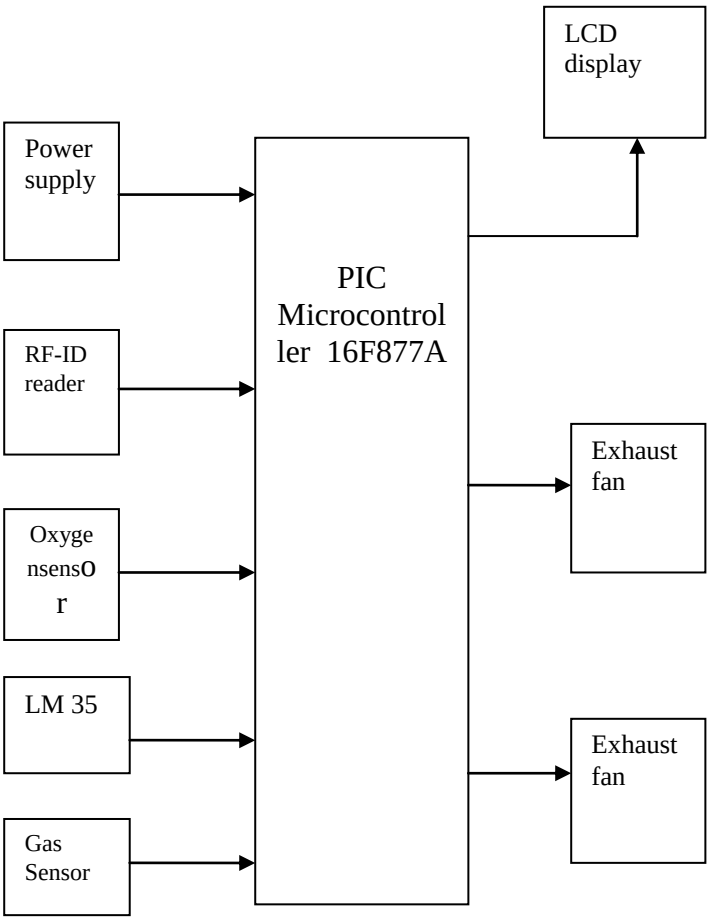
- Most of the students feel good in the starting hour of the class.
- Most of the students start feeling suffocated if the class duration is long.
- Most of the students start feeling even more suffo-cated and irritation if the the no. of students is more in the same class duration as mentioned in above point.
- Most of them rated the environment good at less no. of students and worst if the no. of students and duration of the classes increase.

After analysing the survey report we have designed our problem such that it will be easier for any administration to allot classes for their students with a safe and healthy routine.

IV. PROPOSED METHOD

Now in this paper we are using locally available gas sensors for observing the polluted gases like Carbon monoxide(co), Carbon dioxide(co_2) and parameters like temperature, humidity. By using this method people can view the level of pollution through wireless system. It reduced cost, reliable and comfortable for any place where we are monitoring the gases. We built an Air Quality Monitoring Unit using low cost gas sensors which could compare the air con-tamination level of the environment with specified standards to detect when the environment tends to get uncomfortable for students/faculties. This in turn could result in reduced absentees and improved performance of students/faculties. Some useful results came to our observation such as, in a class of 30 students the concentration level of CO_2 increases about 28.14% as compared to empty classroom whereas in a class of 40 students in the same classroom it increases about 55.33% in a duration of 2 hours.

V. BLOCK DIAGRAM



- PIC MICROCONTROLLER

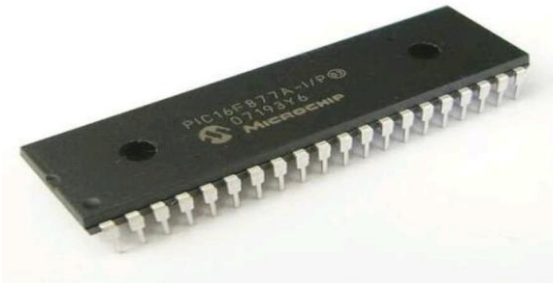


Fig 2: Pic microcontroller

Here we use PIC16F877A microcontroller controlling all the working. It is a 16bit, 40 pin IC. Embedded c programming is the program of the paper for its control. In this paper 12v AC supply is provided which is converted to 5v DC supply.

- OXYGEN SENSOR

Fig 3: Oxygen sensor

Oxygen sensor used is to measure the oxygen level. This sensors is part of the emissions control system that supplies data to the engine's power control module(PCM). Usually if the oxygen level more than 80% then it is said to be normal oxygen level but if it reduces to 60% and less then it is said to be abnormal oxygen level which is not suitable for a student suffering from Asthama, Hypoxemia or Anemia. Here is the program we have given the binary values of oxygen level as 0-120.

- TEMPERATURE SENSOR

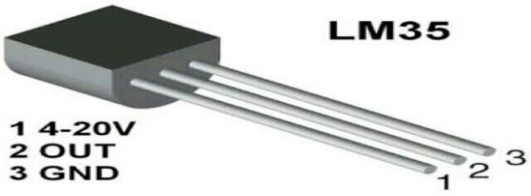


Fig 4: Temperature sensor

When the voltage increases then the temperature also rises. We can see this operation by using a diode. An example for a temperature sensor is LM35. The LM35 series are precision integrated circuit temperature sensors. Whose output voltage is linearly proportional to the Celsius temperature. we use LM-35 temperature sensor for measuring the room temperature. In the program we taken the value as 0-80c.

- GAS SENSOR

Fig 5: Gas sensor

Here we use MQ-5 and MQ-7 gas sensor. This gas sensor measure the co_2, co and other gases. If a co_2 level crosses 53.33% then this it not suitable for a student.

RFID reader contains all the data of the student based on the health condition of the student mainly like oxygen consumption level When a student try to enter a class RFID card is readed. All the parameters like temperature, oxygen, carbon-di-oxide level is calculated and displayed. When a RFID card of astudent is read all these parameters are

calculated compared with the health conditions of a student and it is displayed as suitable or not suitable on the LCD display. Student with a normal health condition the card read as suitable and can enter into the class. When a student with unhealthy condition(suffering from hypoxemia, anaemia, asthma) the card read as notsuitable if the co_2 level increases and is not allowed. To enter the class, instead he/she be given two options 1) wait for a few minutes 2) go to next class. If a student chooses the option 1 then the exhaust fan turn on and the co_2 level and temperature is reduced to a suitable level, then the student is allowed to the classroom. If the student selects option 2, then he/she is allowed to go the next class is suitable to it. Here LCD display is used to display the contents like oxygen level, temperature of the room, gas level etc. Here we use a 16-bit LCD display to display the data as the card is suitable or notsuitable. To display the character only the ASCII values are sent to LCD. The ASCII is 8-bit

VI. FUTURE SCOPE

The existing cross ventilation system in the class room only supports limited number of students. Continuing classes after permissible duration could affect the health of students (or faculties) and possible sick building syndromes could be observed. It is seen that after the class is over the pollutants start decreasing. It is recommended to develop a predictive model using machine learning techniques for estimating the time duration for which the classroom should leave vacant and reduce the duration by redesigning the cross ventilation system of existing set up.

VII. CONCLUSION

In this work, the concentration of the air pollutants have been collected with the help of Air Quality Monitoring Unit placed inside the classroom with four different scenarios: empty classroom, 30 students, 40 students and 60 students. After analysing the data it could be concluded that, for N number of students and after a certain duration, whether the indoor condition of the classroom is permissible for continuing the class or not.

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