A WIRELESS INDOOR AIR QUALITY SENSOR FOR HEALTH MANAGEMENT USING IOT

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ABSTRACT:

In today's busy scheduled world, Asthma is a chronic disease, which has an increasing prevalence in urban areas[1]. Here, suggest an IOT based indoor air quality monitoring device to measure the air quality parameters relevant for asthma management. It focuses on decentralized air quality monitoring by the patients themselves using affordable and available hardware platforms based on Arduino. It is a portable and cost-effective platform, which is equipped with a dust sensor, CO2 sensor and humidity sensor. The integration of such a user-centered and geographical-information integrated platform enables to gather fine-grained air quality along with contextual information. Such a system will allow doctors to match potential asthma symptoms and aggravation reports from patients with environmental factors without having to personally be present.

KEY WORDS: Internet Of Things (IOT), Indoor Air Quality (IAQ), Environmental Protection Agency (EPA)

INTRODUCTION:

Bronchospasm is associated with asthma and bronchitis. Due to the Spasmodic contraction of the Smooth muscle of the Bronchi, it results in reducing the amount of oxygen that is available to the individual causing breathlessness, coughing and hypoxia. The causes of asthma are different kinds of smoke, air pollutants such as dust and Cold air or weather changes.

It is established that most people spend more than 90% of their time indoors, either in office or in residential buildings. An indoor environment is a combination of thermal, mechanical/non-mechanical, electronics, atmospheric, psychological and various other types of agents[2]. One of the most critical elements of an indoor environment is good indoor air quality (IAQ), i.e. fresh and clean air for better human health and comfort[3].

Air pollution levels are unacceptably high in Delhi throughout the year. Between November 2016 and October 2017, both RK Purim in South Delhi and AnandVicar in East Delhi exceeded national daily standard (60 microgram/cubic meter for PM2.5) 75% of the time[10,11,12].

According to the statistical data from Environmental Protection Agency (EPA), indoor air is two to five times more polluted than the outdoor air. Hence, collecting mobile data from these factors and their analysis in real time is critical for humans to live and work indoors. Enclosed spaces inhabited by humans often faces decreased oxygen level and increased CO2 level (and carbon monoxide, in case of smoking); and increase in indoor temperature and humidity leads to growth of microbial contaminants (mold, fungus)[4]. These pollutants can induce both short and long term adverse health effects to building occupants, collectively called sick building syndrome (SBS)[5]. SBS symptoms include respiratory disorders; headache; irritation in eyes, nose and throat; dizziness and nausea; poor concentration and fatigue.
It has been observed that the risk of SBS can be greatly reduced if ventilation rate or the rate of inflow of outdoor air in the building is monitored and corrective measures are taken, in real time. CO2 is one of the gases that is always present in indoor air. Human metabolic activities are bulk generators of CO2, and concentration of CO2 can substantially rise in a short time span due to human activities and occupancy pattern[6]. Whereas a normal outdoor CO2 concentrations stays around 400 particles per million (PPM), in indoors, it can easily grow several times, even with a sound ventilation system, leading to several disorders and health issues. CO2 is a non-flammable, inert, non-toxic, easily quantifiable gas with a steady background concentration, and can be used as a tracer gas in assessing air change rate (ACR) of a room[7]. CO2 level of 1,000 PPM is considered as a determinant of ventilation system performance.

Levels of CO2 can be an perfect indicator to assess whether adequate volumes of fresh outdoor air are being mixed into indoor air. Hence, a context aware sensing system, if developed can be helpful in this regard as the user may manually increase the freshened air or develop a system to automatically control ventilation (demand control ventilation) of the room. While there are several sensing systems available to measure outdoor air quality, to the best of our knowledge, there is almost no smart phone based sensing system available for general users that can collect real time CO2 data and analyze it generally. With the availability of miniaturized microcontrollers, new wireless sensors, powerful smart phones and modeling techniques, relationships between CO2, humidity and ventilation can now be monitored in mobile/web platform in real time and with greater details.

IMPLEMENTATION: In this work, it contains a smart phone based context aware sensing system and explained how to sense and analyze data from 2 setups, (a) temperature, humidity and air quality sensor can be matched with arduino (b) an off-the-self Android phone compatible sensor, Sensor drone

Fig.1,Block diagram for transmitter

Fig.2,Block diagram for receiver

ASTHMA MANAGEMENT:

Asthma is a habitual inflammatory disorder specified by airflow blockage, bronchial hyper responsiveness. It causes coughing and chest tightness, wheezing. The short-term effect inhalers were used by the patients during such attacks. The patient’s lifestyle and his surroundings is strongly associated with growth of asthma[8]. In our application, the suitable air quality factors for asthma can be monitored. Medical agenda usually
occur in two phases: diagnosis and schedule follow-up care. In the diagnosis phase, the doctor can analyze the medical history of the patient by conducting the physical examination. The medication are deep rooted based on the hardness of the disease. Medical history can be presented as an e-health record. The second phase is dependent on suggestion of the doctor and on the actions of the patient. The doctor archives the patient, consults the medical history and updates it whenever it is the case. According to the evolution of the disease the patient can also update the medical history.

Information is also taken from external sensors in charge with acquisition climate data.

AIR QUALITY MONITORING SYSTEM:

A new criterion in order to gain access to more air quality measurement records, which can be viewed as an expansion of participatory medicine in which patients themselves measure and share the results. It have advanced features in very small and affordable devices with the accelerated technology advancements. This enables more and more fields to take advantage of the Internet of Things (IOT) trend, small devices with particular functions and internet connectivity now becoming available[9]. Many sensors that can be used in health information sensing can also provided by the smart phones. The goal was to develop an affordable, scalable, robust and easy to use system for air quality monitoring in real time. The system developed has 4 main parts, they are the air quality parameters can be collected by using sensors, centralizing the data from the sensors and sending it via the internet, the raw data can be displayed using central server and for freezing the data in a database. To superimpose the air quality data over a map an interface is offered to the user. A carbon monoxide (CO) sensor is used to measure air quality and pollution level. But the platform is not limited to this, a vast array of sensors being adaptable. To read the data from the sensor and sending it via the internet, the sensor is linked to Arduinouno microcontroller shown in fig. 3.

**Fig.3, Arduino uno microcontroller.**

The pin diagram for Arduino uno microcontroller is shown in fig 4.

**Fig.4, Pin diagram for microcontroller**

PLATFORM DESIGN:

The proposed Air Sense device is a unified platform for personal air quality monitoring. The system consists of several sensor modules: a dust sensor, to monitor the air quality, a temperature and humidity sensor, to measure the temperature and humidity in the contextual environment. To recognize various contextual scenes the dust, temperature and humidity sensors can work together. The sensed values is given as the input to the Arduino uno microcontroller. In addition to this, already the threshold values of the different air quality checking parameters are programmed into
this mc. By receiving the input from the sensors, the mc compares the received values with the threshold values. When the received value exceeds the threshold value, the mc gives intimation to the holder and the caretaker as well through the cloud based architecture. Fig. 5, shows the flow diagram for the proposed model.

**Fig. 5, Flow diagram for the proposed model**

**DUST SENSOR:**

The ambient air quality can be monitored by using the dust sensors in the contextual scenes. Because of its cost-effective and compacted features we select the Sharp GP2Y1010AU0F which is shown in fig. 6. This sensor is an optical sensing based dust sensor. An infrared emitting diode and a phototransistor are diagonally arranged into this device, to allow it to detect the reflected light of dust in air. It contains Built-in microcomputer. The sensitivity of this sensor is 0.5V/0.1mg/m³ with the low-power consumption (20mA max, 11mA typical) and compact size (46.0 x 30.0 x 17.6 mm). Sensing can discriminate between PM2.5 and PM10. The circuit diagram for dust sensor is shown in fig. 7.

**Fig. 6, Diagram for GP2Y1010AU0F optical dust sensor**

**Fig. 7, Circuit diagram for dust sensor**
FEATURES:
Compact, thin package (46.0*30.0*17.6mm). With low consumption current (ICC: MAX 20mA). It is enable to distinguish smoke from house dust. It is Lead-free and ROHS directive compliant.

HUMIDITY SENSOR:

Fig.8, diagram for (DHT11) humidity sensor

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 sensor is composed of two metal plates and contains a non-conductive polymer film between them. This film collects moisture from the air, which causes the voltage between the two plates to change. These voltage changes are converted into digital readings showing the level of moisture in the air. Capacitive sensors were used for humidity sensing, mainly because they provide a full range relative humidity measurement with a linear output, which means little or no external circuitry is required. The DHT11 capacitive humidity sensor was used, which is interchangeable, shown in fig.8. It consumes low power, has a fast response time. The percentage humidity has a linear relation to the voltage output of the sensor; therefore the microcontroller calculates the humidity as:

\[ \% \text{RH} = \frac{(\text{Voltage} - \text{Zero Offset})}{\text{Slope}} \]

Table: Specification of humidity sensor

<table>
<thead>
<tr>
<th>Power supply</th>
<th>3-5.5V DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensing element</td>
<td>Polymer resister</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Humidity+/-4%RH</td>
</tr>
<tr>
<td>Temperature+2.0C</td>
<td></td>
</tr>
<tr>
<td>Interchange ability</td>
<td>Fully interchangeable</td>
</tr>
<tr>
<td>Sensing period</td>
<td>Average: 2s</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Size</td>
</tr>
<tr>
<td></td>
<td>12<em>15.5</em>5.5mm</td>
</tr>
</tbody>
</table>

CARBON DIOXIDE SENSOR:

Fig.9, diagram for MQ-135 gas sensor

Here, MQ-135 gas sensor is used to sense the CO2 gas amount which is shown in fig.9. The gas sensor module consists of a steel exoskeleton under which a sensing element is housed. This sensing element is subjected to current through connecting leads. This current is known as heating current through it; the gases coming close to the sensing element get ionized and are absorbed by the sensing element. This changes the resistance of the sensing element which alters the value of the current going out of it. It is stable and long life simple drive circuit. Its Size is 35mm x 22mm x 23mm (length x width x height). The amplification diagram for CO2 sensor is shown in fig.10.
Fig.10, Amplification diagram for CO2 sensor

TABLE:2. SAFE LEVELS OF CO2 IN ROOMS:

<table>
<thead>
<tr>
<th>LEVELS</th>
<th>CONDITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>250-350 ppm</td>
<td>Normal background concentration in Outdoor ambient air.</td>
</tr>
<tr>
<td>350-1,000 ppm</td>
<td>concentrations typical of occupied indoorspaces with good air exchange.</td>
</tr>
<tr>
<td>1,000-2000 ppm</td>
<td>complaints of drown and poor air.</td>
</tr>
<tr>
<td>2,000-5,000 ppm</td>
<td>Headaches, sleepless and stagnant, Stale, stuffy air.</td>
</tr>
<tr>
<td>5,000 ppm</td>
<td>Workplace exposure limit(as 8 hour TWA)in most jurisdictions.</td>
</tr>
<tr>
<td>&gt;40,000 ppm</td>
<td>Exposure may lead to serious oxyge Deprivation resulting in permanent Brain damage, coma, even death.</td>
</tr>
</tbody>
</table>

THRESHOLD VALUE OF DIFFERENT PARAMETERS:
TEMPERATURE THRESHOLD:

The average normal body temperature is 98.6degreefarenheit. For adults, the temperature about 120 degreefarenheit will leads to asthma attack. For child, the temperature about 86degreefarenheit will leads to asthma attack, as it contains high carbon content.

HUMIDITY THRESHOLD:

Both the high and low humidity levels is not good for Asthma. Lower than 50% in the humidity level, doesn’t trigger any Asthma symptom. Every 10% increase in the humidity level, leads to 2.7% increase in the prevalence of asthma attack.

CO2 THRESHOLD:

Normal outdoor level: 350-450ppm, acceptable level: <600ppm, adverse health effects may be expected: 2500-5000ppm.

SAMPLED OUTPUT:

Thefig 11, displays about the varying temperatures in the environment in varying time, which is remotely sensed and cloud monitored.
The fig 12, displays about the varying dust content in the environment in varying different time, which is remotely sensed and cloud monitored.

FIG.12. SAMPLED OUTPUT FOR VARYING DUST CONTENT

The fig 13, displays about the varying humidity content in the environment in varying different time, which is remotely sensed and cloud monitored.

FIG13. SAMPLED OUTPUT FOR VARYING HUMIDITY CONTENT

CONCLUSION:

Here showed promising results in creating a lightweight, affordable air-quality sensor which uses cloud based architecture for aggregating and the readings. Here found that principal components, pollution and climate, with a total classification accuracy of 98% across all the events (cooking and smoking). We have analyzed asthma management guidelines in order to introduce the use of intelligent devices in the protocol and support the patient empowerment using IOT. Also the system can be extended by implementing the GPS sensor and exhaust fan to filter dangerous indoor air pollutants.

REFERENCE:


