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Air Pollution Monitering Using Arduino and Iot

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ABSTRACT

Air pollution is both an environmental and a social problem, as it leads to a multitude of adverse effects on human health, ecosystems and the climate. Air pollution is one of the largest Environmental health risks in Europe today. Quality of the air in city and urban areas is the most important factor that directly influences the incidence of diseases and decreases the quality of life.

Taking appropriate decisions in a timely period depends on the measurement and analysis of the parameters of the air, which creates the need for the development of real time air quality monitoring. The use of multi-parameter air quality monitoring systems makes it possible to do a detailed level analysis of major pollutants and their sources. These monitoring systems are important components in Many smart city projects for monitoring air quality and for controlling the main pollutant concentrations in urban areas. In this paper we present an approach for cost-effective measurement of relevant environmental parameters, based on a scalable sensor array with integrated ampero metric and infrared gas sensors. The device has been tested in the city and the measurement was compared with the output data of the local environmental control authority stations. The preliminary results show that this approach can be used as an economical alternative to the professional grade systems.

Keywords: Neural Network; Air Quality Monitoring; Air Pollution Forecast

I. INTRODUCTION

Any activity involving burning things/fuels and mixing substances that cause chemical reactions may release toxic gases in the process and some activities like construction, mining, transportation, etc. produce large amounts of dust which has the potential to cause air pollution. As generation of toxic gases from industries, vehicles and other sources is tremendously increasing day by day, it becomes difficult to control the hazardous gases from polluting the pure air. Air pollution not only brings serious damage to human health but also causes negative effects to natural environments. The air pollution occurs due to contamination of air with Carbon monoxide (CO), Carbon dioxide (CO2), Nitrogen dioxide (NO2), Sulfur dioxide (SO2) and many other harmful pollutants. This pollutant causes serious damage to environment. It also has hazardous effects on human health. Carbon monoxide reduces oxygen carrying capacity of the body's organs and tissues which may lead to cardiovascular disease. Carbon monoxide causes visual impairment, reduced manual dexterity, reduced work capacity, poor learning ability.

So it becomes more and more important to monitor and control air pollution. It will become easy to control it by monitoring the concentration air pollutant parameters in air. Using laboratory analysis, conventional air automatic monitoring system has relatively complex equipment technology, large bulk, unstable operation and high cost. This system can only be installed in key monitoring locations of some key enterprises, thus system data is unavailable to predict overall pollution situation. Using empirical analysis, conventional air automatic monitoring system has high precision, but large bulk, high cost make it impossible for large-scale installation. Nowadays, air pollution is monitored by static air quality measurement stations which are highly reliable and can measure the pollutants in air to a high level of accuracy and precision using analytical instruments, such as mass spectrometers, operated by official authorities. However, extensive cost of acquiring and operating such stations limits the number of installations. To monitor air quality, wireless sensor networks (WSNs) might be a great tool, because they can automatically collect air quality data. It will also help us to keep a working staff away from danger and a high security can be achieve and it will also help the Government authorities to monitor the air pollution.

The proposed system will focus on the monitoring of air pollutants concentration with the help of combination of Internet of things with wireless sensor networks. The analysis of air quality can be done by calculating air quality index. This information will be displayed on the webpage via internet in real time. By the combination of internet of things and wireless sensor networks for purpose of air pollution monitoring it becomes easy to keep the air quality data updated in real time. Also the system is cost effective which make its installation possible in various areas. The system existing before was based on microcontroller based toxic gas detecting and alerting system and the developing system will have a complete monitoring system which is IOT based. Also the information will be directly sent to the internet from system; no need of computer for transmission purpose which reduces the cost further.

II. RESULTS AND DISCUSSION

1. SYSTEM ARCHITECTURE

In this section, we present the architecture of the implemented System named Out Sense. As shown in Figure 1, it includes several basic components: sensor nodes, wireless routers, server and end devices which are described in the following subsections.

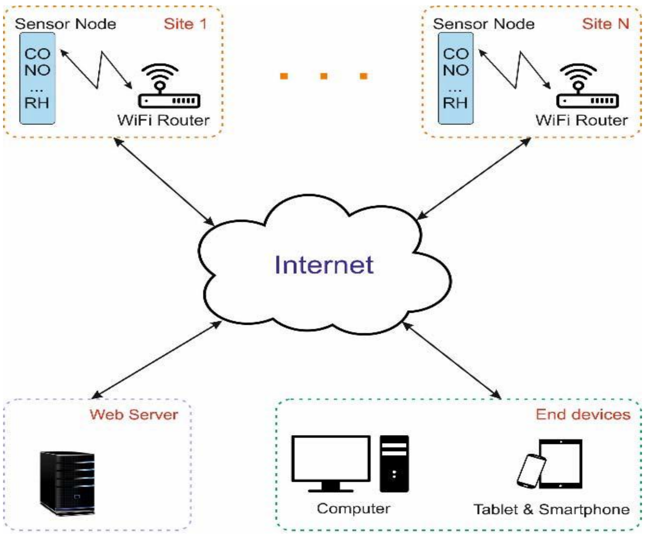

Figure 1

1.1 Sensor Nodes

The sensor nodes measure the concentration of the main air pollutants and send the acquired data to the web server. To extend the node battery life a mechanism which alternates activity and sleep periods is used. To be more precise, each sensor node performs the following actions every 10 minutes:

1.2 Node Activation and Data Acquisition

The algorithm for node activation and data acquisition is developed using the preliminary calculations for power consumption of the microcontroller, peripheral modules and sensors. It takes into account the recommendations of the ampere metric sensors manufacturer which say that, for biased circuits, the bias voltage has to be maintained on at all the times. This does not affect the operating life of the sensors [10]. In this particular case the main consumers are the Wi-Fi module with 140 mA and the CO_2 sensor with about 40 mA and that is why while developing the node activation algorithm the time of their operation has been limited as much as possible. After a warm-up period the sensor node goes into a measuring mode. The time needed for the ampere metric sensors (O_2, O_3, CO_2 and NO_3) to go into an operating mode is around 30 seconds. The conditioning time for the other sensors (temperature, humidity and pressure) is below the 30 seconds mark. The overall warm-up time is determined by the CO_2 sensor, and it is 60 seconds later, after which the device starts measuring values. At that time all sensors and the GPS module are powered up and operating, and the mean value of the measured supply current of the node is around 135 mA. The procedure of measuring is started at the same time for all sensors. Every sensor is read when its data collection has finished or when its measurement time has elapsed. Every parameter is measured 10 times and an average of all values is taken, thus eliminating the noise. The maximum measurement time of all 10readings for all the sensors is less than 60 seconds.

1.3 Sleep Mode

Finally, the node disables the communication module(s) and enters the low-power state. The only component that remains active is the real time clock (RTC) that wakes up the Microcontroller Unit (MCU) through an interrupt after a predefined time interval (e.g. 10 min). Then, the steps for measuring and transmitting of data are performed again. After data have been gathered by the sensor nodes, they are sent to the back-end server. In this approach we have decided to use a Wi-Fi connection. Hence, the user is assumed to have a Wi-Fi access point (or router) covering the area where the sensor node is located. As an option we have provided the possibility of adding a GPRS modem.

1.4 Gas sensors

For the carbon monoxide we have used a sensor CO-AF from Alpha sense with a range of 0 to 5000 ppm, for nitrogen dioxide – NO2-A42F sensor, for ozone – OX-A421 and for oxygen – O2-A2 sensor [11]. These sensors use a programmable analog front end (AFE) LMP91000 from Texas Instruments. It provides a complete signal path solution between the sensors and the microcontroller that generates an output voltage proportional to the sensor cell current. The output voltage of AFE is measured via an external 16-bit resolution ADC placed close to the LMP91000 to reduce noise. Carbon dioxide is measured using a K30 sensor with the non-dispersive infrared principle produced by Sense Air and has an operating range of up to 5 000 ppm.

1.5 Server implementation

For the web server we have decided to use a desktop computer with open source software – for the operating system a Linux distribution – Debian, Apache for the web server and the free database

MySQL. We have used Google Maps for displaying the data measured on a map.

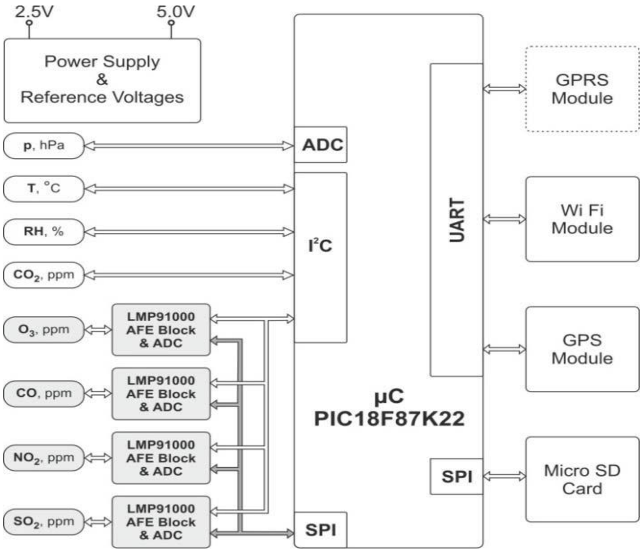

Figure 2

III. CONCLUSION

In this study we present the preliminary results about the quality of the data obtained by low cost sensors and compare them with the results reported by the official authority stations. Out Sense has been tested through an in-situ experiment, in different urban areas. The experimental measurements compared with the values provided by the local environmental control authorities show that the measurements obtained from low-cost sensors are not as accurate as official data but they can provide useful indications of air quality in a specific location. The data quality provided by the sensor nodes depends significantly on the accuracy of the used low cost sensors. In our approach a scalable sensor array with integrated ampere metric and infrared gas sensors has been selected for this implementation. The Combination of ampere metric gas sensors for pollutant and oxygen measurement with sensors for precise measurement of basic physical parameters, such as Atmospheric pressure, temperature and humidity make it possible to perform higher precision measurements of gas concentrations. The precision achieved after the so called collocation calibration is comparable with the precision after calibration in laboratory conditions, which entails higher costs (in terms of materials and time) and that has been proven by other studies too [14, 15]. The co-location calibration can be considered as a valuable tool in the next generation of mobile air quality monitoring. This is what makes the present approach an interesting alternative for calibration of sensors to measure air parameters and will thus be the subject of our future studies. In this study we did not examine the long-term performance response characteristics (e.g., drift of signal over extended time periods, stability of response depending on sensor lifetime etc.). We envisage to make extended measurements and design a calibration model, which will take into consideration not only the changes in temperature, humidity and atmospheric pressure, but also the corrections for the temporal drift.

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