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Monitoring and Analysing Air Pollution in the Atmosphere Using Smart Citizen Kit

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ABSTRACT: Environmental science is a study which integrates physical and biological sciences to study the environment. The environment means the distinct dimensions of biological, physical and cultural backgrounds. The researchers and environmental scientists today mainly focus on the continuous monitoring and analysing of environmental data. The reason to monitor the environment is to conserve the biodiversity and to use the resources equitably. Continuous monitoring and analysis of climatic condition and its effect on our environment have been observed using Smart Citizen Kit (SCK) and in this kit multiple sensors are used with Arduino. In this paper we have continuously monitored and analysed the affect of air pollution by only two air pollutants which are carbon mono oxide (CO) and nitrogen dioxide (NO₂). Pollution from vehicles is a major contributor to high carbon monoxide levels. Nitrogen dioxide is an important air pollutant because it creates photochemical smog, which can have notable impacts on human health. Hence these two pollutants levels have been monitored using SCK. Thus SCK helps in continuous monitoring of the environmental data and the graphs have been plotted according to the observed pollutant levels.

KEYWORDS: Environment monitoring, pollutants, gas sensors, smart citizen kit.

I. INTRODUCTION

One of the significant sources of air pollution in urban areas, towns and cities of the developing countries is the emissions from motor vehicle exhausts. India, one of the fast developing countries of the world and it has registered a sharp increase in vehicular pollution, particularly, in the urban area. In this paper we have observed only the CO and NO₂ levels among all the major air pollutants.

Carbon monoxide is a colourless, odourless gas. It is formed from both naturally and by man's activities when fuels containing carbon are burnt in low-oxygen conditions. The main source of carbon monoxide is from petrol vehicles which are not fitted with a catalytic convertor. Carbon monoxide levels in urban areas closely reflect traffic density. Pollution from vehicles is a major contributor to high carbon monoxide levels. Carbon monoxide reacts with other pollutants in the air to form potentially harmful ground level ozone. This occurs close to the site of emission. It does not have any significant environmental effects at a global level. Inhalation of carbon monoxide at high concentrations can be fatal, because it prevents the transport of oxygen in blood around the body. It releases from poorly maintained appliances in poorly ventilated spaces and could result in concentrations high enough to cause death.

Nitrogen dioxide is formed naturally in the atmospheric lightning and produced by plants, soil and water. However, only about 1% of the total amount of nitrogen dioxide found in our cities' air is formed this way. The major source of nitrogen dioxide is the burning of fossil fuels. About 80% of the nitrogen dioxide in cities comes from motor vehicle exhaust and other sources of nitrogen dioxide are petrol and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing. The main effect is caused by breathing raised levels of nitrogen dioxide is the increased likelihood of respiratory problems. Nitrogen dioxide inflames the lining of the lungs, and it can reduce immunity to lung infections. This can cause respiratory problems. The increased levels of nitrogen dioxide can have major affects on people with asthma because it can cause more frequent and more severe attacks. Children with asthma and older people with heart disease are most at risk.

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II. LITERATURE SURVEY

An Open-Source Environmental Monitoring Platform consisting of arduino-compatible hardware, data visualization web API, and mobile app. The Smart Citizen project is based on geo location, Internet and free hardware and software for data collection and, and the production of objects; it connects people with their environment and their city to create more effective and optimized relationships between resources, technology, communities, services and events in the urban environment. Sensors are needed to convert a wide range of physical parameters into electrical signals. In the relationship between the history of automation and sensors, it appears that a sensor-technology of automation and sensors, it appears that a sensor-technology lag still exists. This can only be overcome with the concept of integrated smart sensors.

Later stages, various advance wireless network sensors have been invented by clubbing wireless communication. A smart sensor node is a combination of sensing, processing and communication technologies. Sensors have progressed through various stages. The first generation devices had little electronics associated with the, while second generation sensors were part of purely analog systems with electronics as remote control for the sensors and in the third generation, first stage of amplification occurred on the sensor chip itself. In fourth generation sensors, more analog and digital electronics were on the chip itself to make the sensor addressable and self testing. In fifth generation, data conversion is accomplished on the same sensor chip. The fifth generation sensor is addressable, self testing and communicates over a bi-directional digital bus.

III. HARDWARE REQUIREMENT

The Smart Citizen Kit is designed to work with most home and office standard Wi-Fi routers and access points. The main board contains the basic functionality like sensor I/O to read the sensor values, communication with the platform through the wifi module, manage the power and battery charging.

The main parts of SCK consists of

1. Arduino UNO R3 Hardware board
2. Sensors (Light, Noise, Temperature, Humidity & Gas sensor)
3. WiFi Module
4. Power Supply
5. Monitoring Section
- 6.

1. Arduino UNO R3 Hardware board

Both versions of the SCK (1.0 and 1.1) are using the same CPU, ATMEGA32U4. The sensor board contains the sensors for measuring all the parameters like NO₂ and CO gases, sunlight, noise pollution, temperature, humidity. Also, the sensor board has an I₂C bus, which allows expanding the SCK to other kind of sensors also.

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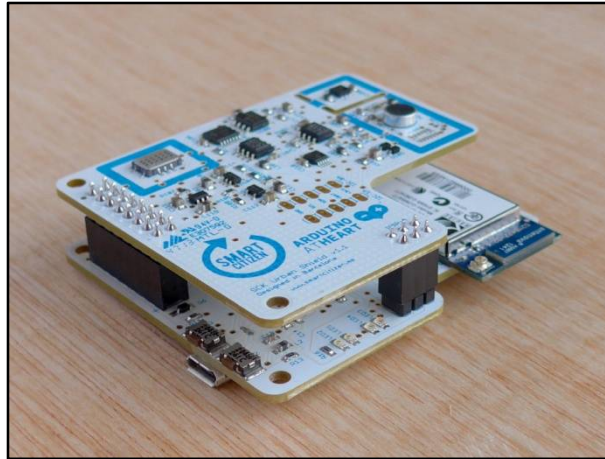


Fig 1 Smart Citizen Kit for Environmental Monitoring

2. Sensors

The main board has some basic sensors for measuring battery level, solar panel level and the measurement of wireless networks which are detected. The sensor board also contains the necessary sensors for measuring all the other parameters like NO₂ and CO gases, sunlight, noise pollution, temperature, humidity. Also, this sensor board has an I2C bus; this allows expanding the SCK to other kind of sensors. In this paper our main interest is the analysis of the sensor reading of the air pollutant levels in the atmosphere.

NO₂ and CO Sensors

To measure these two gases we chose e2v sensors. In particular, metal oxide sensors MICS5525 and MICS2710, for version 1.0. And MICS4514, for version 1.1, that contains both sensors in one. Metal oxide sensors are based on oxide semiconductors. Their electrical conductivity is modulated due to the reaction between the semiconductor and the gases in the atmosphere. The below are the sensor connected in the board figures.

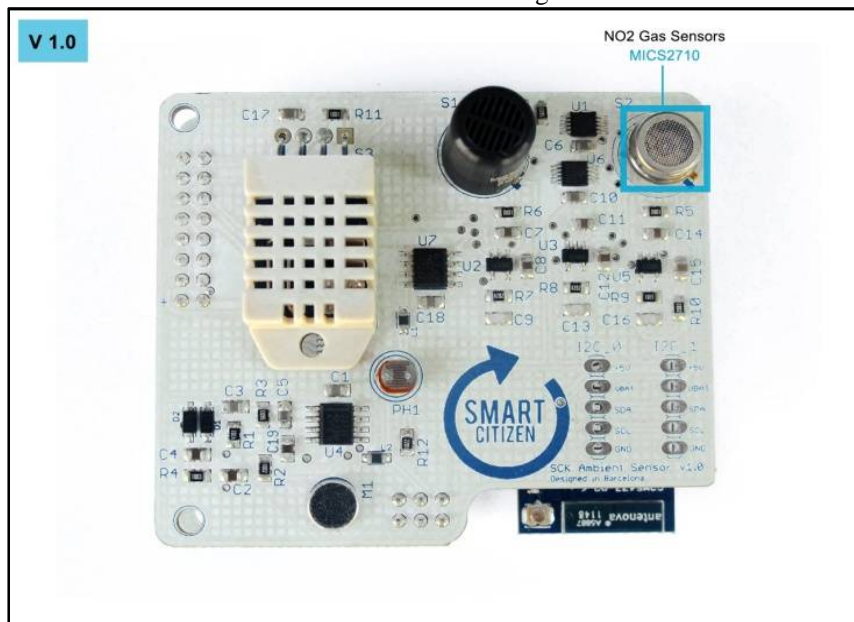


Fig 2 SCK v 1.0 showing NO₂ gas sensor

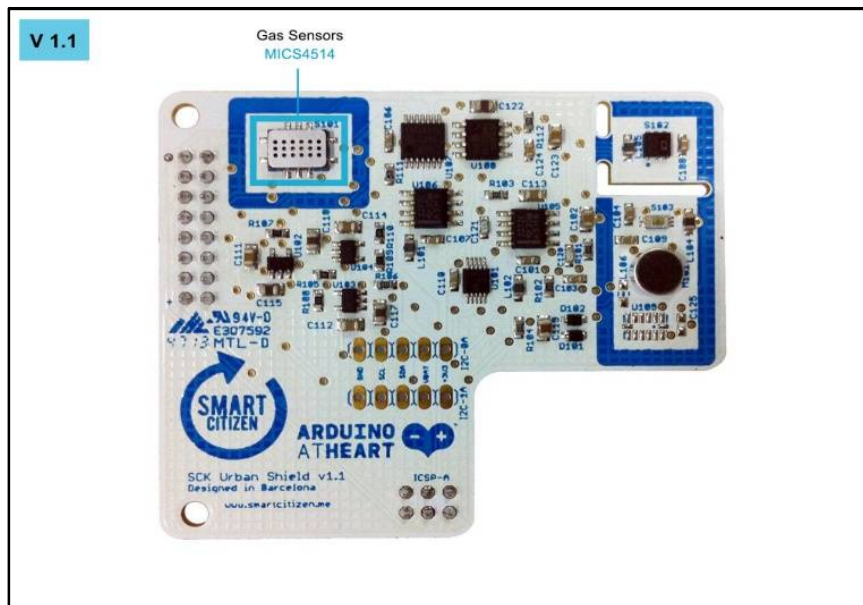
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The above fig 2 shows the sensor board of v1.0 having NO₂ and CO gas sensors separately. In particular, metal oxide sensors MICS5525 and MICS2710 are available in the same sensor board. These sensors help in monitoring the pollution in the air.



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sending data correctly, you can interact with the platform in several ways. Through the website we can visualize the data, download the data and interact with the data through the API.

V. RESULTS

CO and NO₂ are both toxic and detrimental particularly to human beings and in general, to all life forms that respire. Thus CO levels in the ambient air play a role in determining the air quality of a region. In the following graphs we discuss the ambient levels of CO and NO₂; its variation and its response to traffic exhaust Emissions at two environmentally differing sites. At one of the sites, viz., urban Visakhapatnam, the variation is studied. The second site is urban Guntur. From the pollution point of view, the CO levels are examined at 1-hour intervals. The similar is done for NO₂ monitoring also.

We can see that in Fig 4 the time wise data for carbon monoxide reading which is the result continuous monitoring by the smart citizen kit is plotted. These CO levels are in kohm/ppm and are in the range of 200 to 400 kohm/ppm. These continuous monitoring of data was done in Visakhapatnam in open atmosphere. It can be clearly observed that the levels of air pollution of this particular gas, carbon monoxide is gradually rising during day time and there is a fall in night time. Each day there is a difference in reading but the readings have not crossed 400kohm/ppm.

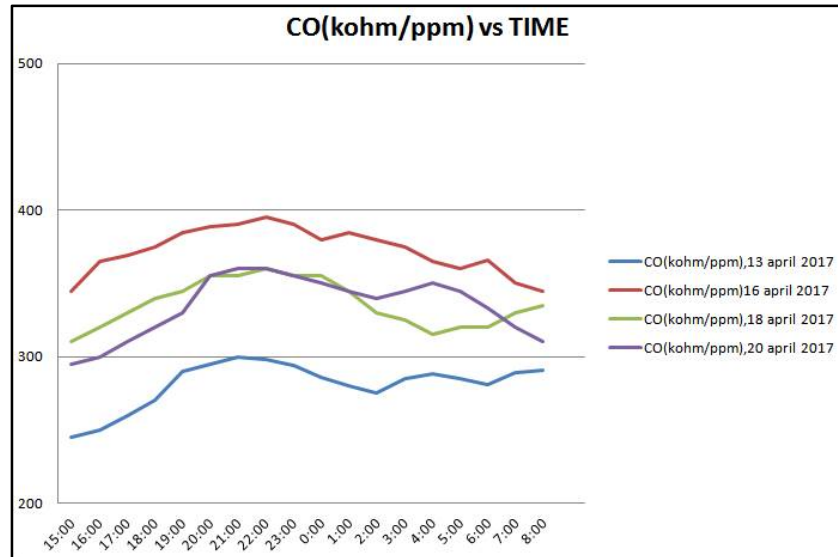


Fig 4 CO vs Time period at location 1

The Fig 5 shows the graph plotted for NO₂ pollutant and time duration. It can be seen that the NO₂ levels are also plotted in kohm/ppm. The values are observed at location urban visakhapatnam. The values are seen to be between the range 15 to 30 kohm/ppm.

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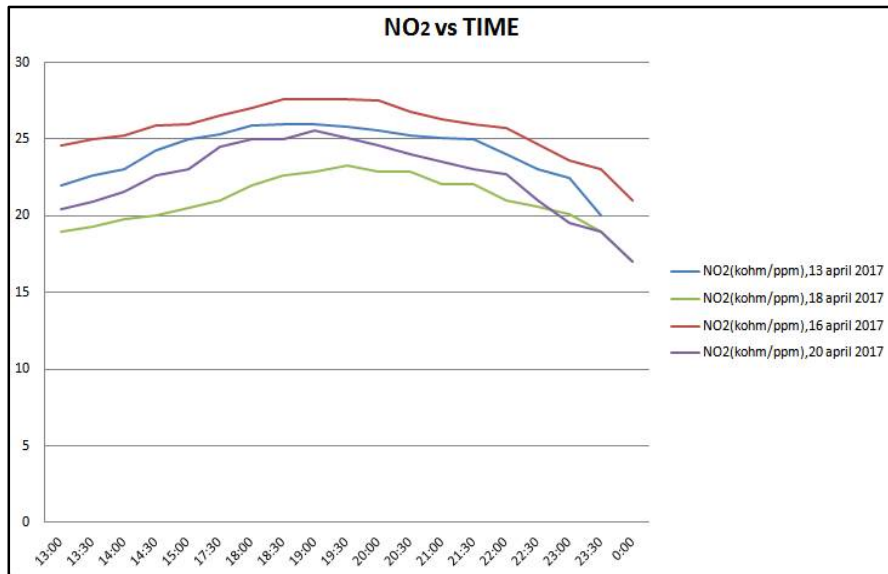


Fig 5 NO₂ vs Time period at location 1

The Fig 6 shows the graph plotted for CO pollutant and time duration. It can be seen that the CO levels are also plotted in kohm/ppm. The values are observed at location urban Guntur. The range of values is between 150 to 300kohm/ppm. It can be seen that the CO reading observed at both the locations have almost similar graph plotting

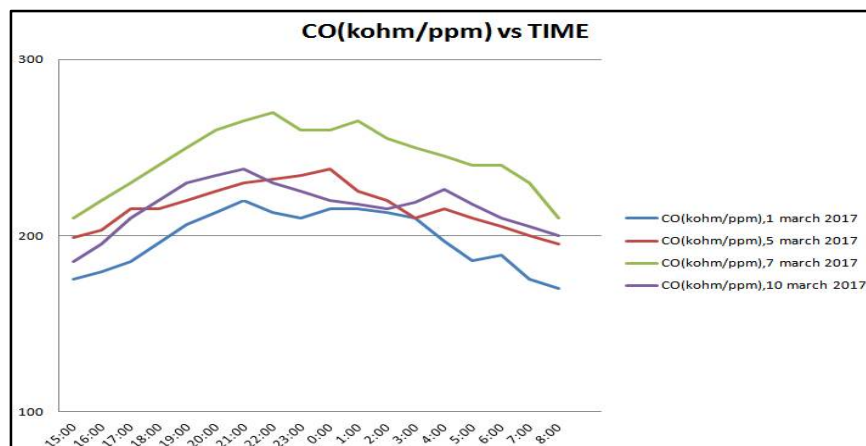


Fig 6 CO vs Time period at location 2

The Fig 7 shows the graph plotted for NO₂ pollutant and time duration. It can be seen that the NO₂ levels are also plotted in kohm/ppm. The values are observed at location urban Guntur. The range of values is between 10 to 30 kohm/ppm. It can be seen that the pollutant readings observed at both the locations have almost similar graph plotting but with different values.

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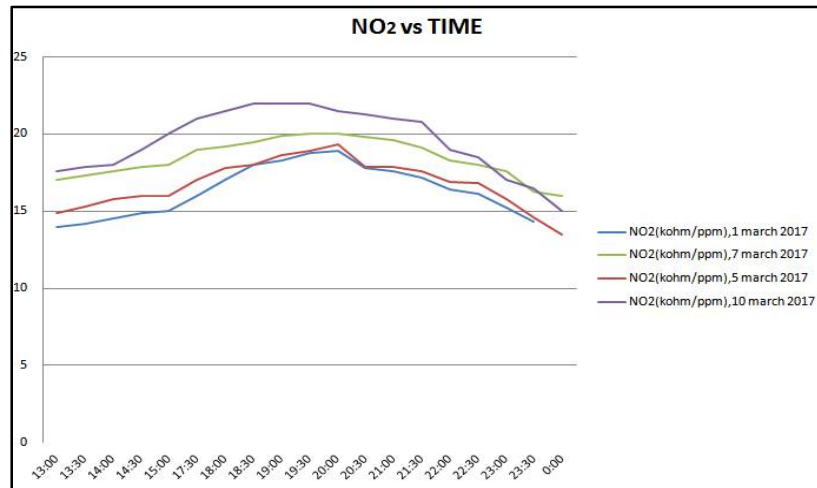


Fig 7 NO₂ vs Time period at location 2

VI. CONCLUSION

Using SCK continuous monitoring can be done accurately. The SCK kit cost is very high as it is imported one. Using the SCK different parameters can be monitored. In this paper the air polluting levels in our surrounding areas have been observed. The values attained are not the exact reading but approximate reading. This is a simple and yet reliable method to study the air pollution at any location. SCK can help in only analyzing the air pollution level but cannot prevent it. The purpose of this monitoring is that every individual can understand the condition of his ambient atmosphere and thus can help in controlling the pollution in air.

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