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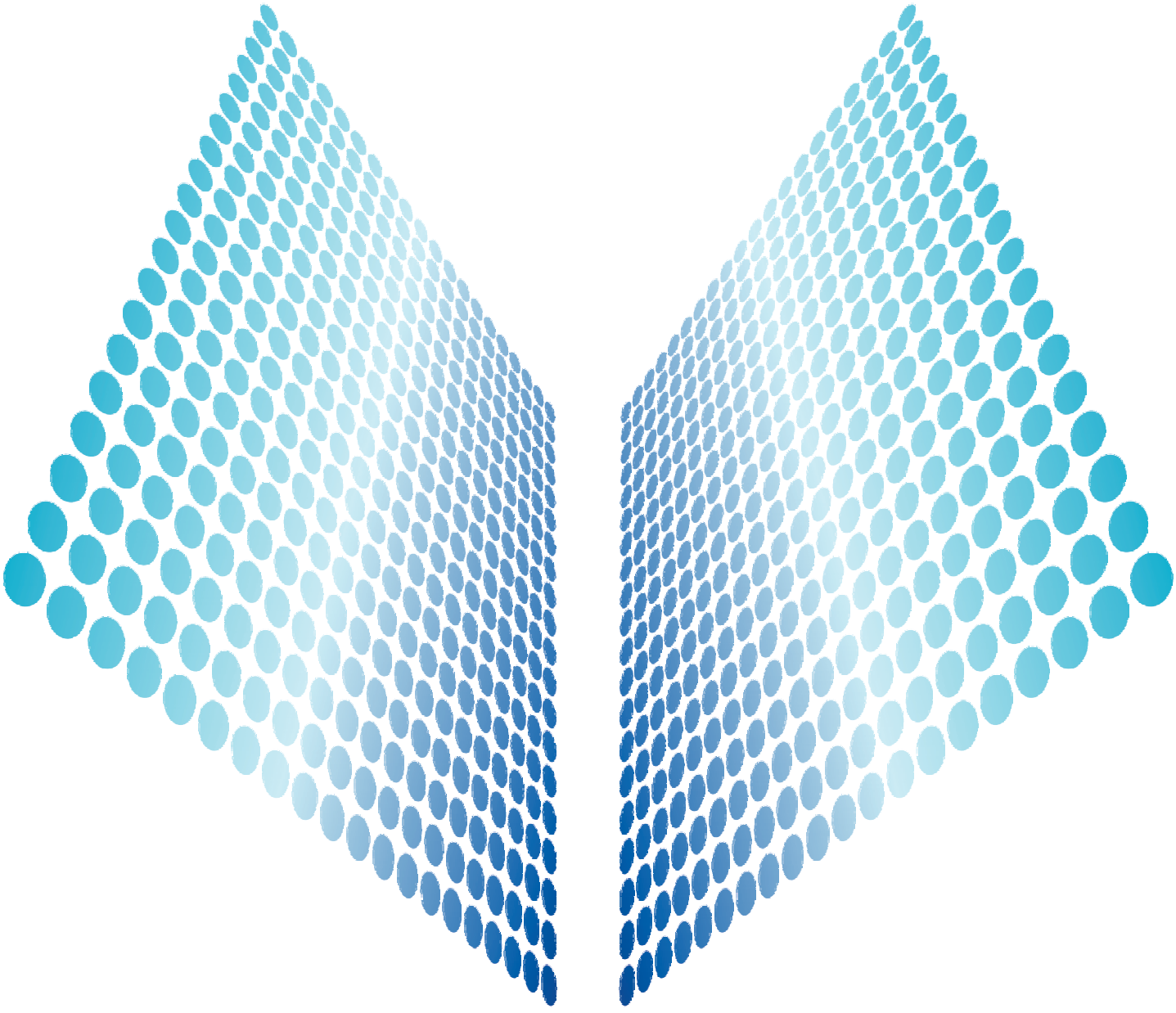

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DEVELOPMENT OF PORTABLE LOW COST PARTICULATE MATTER SENSOR BASED ON LASER SCATTERING TECHNOLOGY

Roberto Pasic, Aleksandar Markoski, Nikola Rendevski, Ivo Kuzmanov

Abstract: *Particulate matter (PM) pollutants are potential threat to human health. PM are tiny airborne pollutants floating in the air from dust, smoking, automobile exhaust, charcoal power plant, etc. PM with less than 10 μm is called PM10 (the inhalable particulate matter), and PM with less than 2.5 μm is called PM2.5 (fine PM). Long term exposure to high concentration of PM leads to bronchitis, asthma, allergy, lung cancer and many other diseases. In this research, we aim at developing a portable PM sensor based on laser scattering technology to measure the PM concentration and monitor the air quality. In comparison with standard PM sensors (expensive and heavy), portable model allow to monitor the air quality anywhere, to protect users from potential exposure to the polluted air in-door or during travel.*

Key words: *Air Quality Control, Particulate Matter (PM), Laser Dust Sensor, UART communication protocol.*

1. INTRODUCTION

Air pollution has become a major concern in big cities, especially due to the particulate matter with diameter of 2.5 micrometers or less (PM2.5). This research focuses on develop and evaluation of portable low cost particulate matter sensor based on SDS011 PM sensor.

Rising air pollution in all countries has made ailments like bronchitis, asthma, allergy, lung cancer, recurrent cough and chronic obstructive pulmonary disease. While quite a few air quality monitoring stations have been built by governments in a city's public areas in Republic of Macedonia, our intention was to allow PM monitoring with portable and low cost PM sensor with possibilities for direct measurment on any location, indoor and outdoor.

2. MATERIALS AND METHODS

Particulate matter (PM) consists of a mixture of extremely small particles and liquid droplets, including organic chemicals, metals, acids and dust particles. Main sources of PM include dust, fuel combustion and mobile emissions. PM is divided into two categories: fine particles and coarse particles.

Fine particles have diameters less than or equal to 2.5 micrometers (PM2.5), while coarse particles have diameters between 2.5 micrometers and 10 micrometers (PM10). Particulate matter is one of the six common pollutants for which the EPA has National Ambient Air Quality Standards, since it can have significant negative health impacts. These impacts vary by particle size, with smaller particles permeating into different parts of the body. PM can enter the lungs and the bloodstream, causing direct adverse effect on human health.

The adverse health impacts of PM and its presence make it an essential pollutant to measure. In this paper we introduce a portable low cost system to measure particulate matter using SDS011 particulate matter sensor whose results are compared with measurements made by TurnKey DustMate nephelometer.

A microcontroller (ATMega 328) was interfaced with SDS011 and was programmed to receive the serial (UART) data from sensor. Measured PM values was displayed on 2x16 Serial LCD display. The measured output of both these devices is shown in experimental results.

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Fig. 1: Block diagram of portable low cost pm sensor

Block diagram on Fig.1 showing a way of connecting the system components. Power bank enables continuous operation of about 16 hours. PM sensor is connected to the microcontroller via UART communication protocol and 2x16 serial LCD is connected to the microcontroller via I2C communication protocol.

Fig. 2: Portable low cost pm sensor

Fig. 3: Portable low cost pm sensor (inside view)

The PM sensor use laser scattering working principle, light scattering can be induced when particles go through the detecting area. The scattered light is transformed into electrical signals and these signals is amplified and processed. The number and diameter of particles can be obtained by analysis because the signal waveform has certain relations with the particles diameter. Service life is the key parameter of laser dust sensor. The laser diode in this sensor has high quality and its service life is up to 8000 hours. If you need real-time data (such as detector), you can use the default configuration that measures at the frequency of 1 time per second. On the occasion of real-time demand is not high (such as filter, air quality monitoring, etc.), you can use the discontinuous working method to prolong the service life.

3. EXPERIMENTAL RESULTS

Measurements are performed simultaneously by using two measuring systems (Portable low cost pm sensor and TurnKey DustMate nephelometer). Results of measurements are shown in micrograms per cubic meters.

Table 1: Separated PM values for PM2.5 and PM10 measured every 5 minutes with both systems (random part from 10 hours continuous measurements)

PM2.5 (ug/m3)		PM10 (ug/m3)	
Portable low cost PM sensor	TurnKey DustMate sensor	Portable low cost PM sensor	TurnKey DustMate sensor
6.02	7.15	13.02	15.50
4.02	5.02	8.00	11.25
12.00	14.50	19.00	24.50
18.00	20.50	26.00	25.00
19.00	21.48	30.00	30.00
25.00	28.30	67.00	69.50
75.00	80.25	74.00	77.50
33.00	35.00	32.00	35.00
21.00	21.50	29.00	30.00
15.00	17.00	17.00	22.50
9.00	9.60	12.00	13.10
6.00	6.80	8.00	10.50

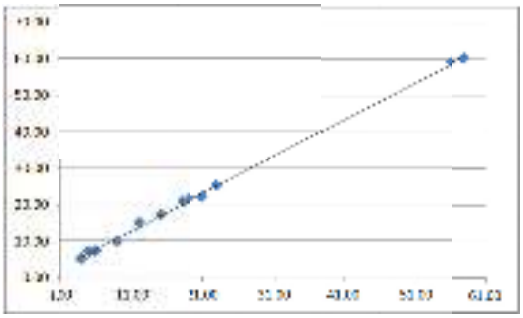

Fig. 4: Linear correlation between PM2.5 values measured using portable low cost PM sensor (x axis) and TurnKey DustMate (y axis), correlation factor 0,9992

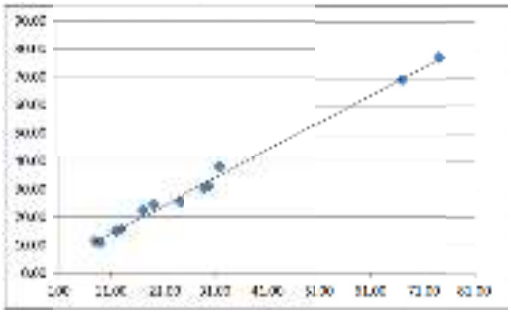

Fig. 5: Linear correlation between PM10 values measured using portable low cost PM sensor (x axis) and TurnKey DustMate (y axis), correlation factor 0,9967

4. CONCLUSION

We developed a portable low cost particulate matter sensor using SDS011 sensor. A excellent correlation was found between particulate matter measurements made by TurnKey DustMeter and the portable low cost monitoring system developed by us. As future work, we aim to develop a real-time web based platform with GPS locator for continuously monitor particulate matter. This will help to better inform people about the problem of air pollution.

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