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Monitoring System Transportation using Air Quality Based on IoT in Semarang

Agus Alwi Mashuri[1]* and Nely Zulfa[2]

[1] Informatics, STMIK HIMSYA Semarang, Indonesia
[2] Environmental Science Study Program, Faculty of Science and Technology, University IVET Semarang, Indonesia

Email: agusalwismg@gmail.com[1]

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Abstract

Air Pollution Standard Index in a city is Semarang City with PM 10 7 and Air Quality Index (AQI) 67. Air pollution monitoring with portable systems is rarely found to obtain direct data. This research aims to make a portable device to determine air quality in the city of Semarang to facilitate control. Air quality testing is integrated with Internet of Things technology to adjust the conditions of the 4.0 industrial revolution so that air conditions are immediately known in real-time. The prototype method is a series of systems that determine the air quality and quantity of components. The prototypes are the MQ-6 type sensor for CO_2 and smoke identification, MQ-7 (CO, LPG, and CH_4), MQ135 (Butane and Air Quality), and DHT-11 (Humidity and Temperature). A gas sensor equipped with an Arduino microcontroller was tried in a location and tested to produce the average pollution conditions in a traffic activity for CO and CO_2 with levels of 8.72 ppm and 6.63 ppm, respectively. The result is that CO and CO_2 are still below the threshold, while NH3 and C4H10 are still safely below the threshold. This value shows that the pollutants that affect, especially CO_2 and CO, generated from the land transportation system during busy working hours at 8-9 a.m and 4-7 p.m that the result of fuel combustion during transportation.

Keywords: Air quality; sensors; IoT; Internet; emision

INTRODUCTION

The main objective of the Air Quality Monitoring and Decision Support System in Semarang City Using this IoT is that air pollution is a problem that is currently very important to be overcome. This system is for monitoring air quality (Mir Alvarez et al., 2020) and keeping it under control for a healthier future and healthier living for all. The internet of things (IoT) is increasingly popular day by day because it can change lives and make it easier for humans. With the population growth and the increase of automobiles and industry, the atmospheric conditions are deteriorating significantly by the day. The pollution's dangerous effects include some allergic reactions that cause eye, nose, and throat irritation. It can also cause inflammation within the lungs, which opens the way to problems such as bronchitis, heart disease, pneumonia, worsening lungs, and asthma (Cukic et al., 2012).

These pollution-related problems can be overcome by having an efficient monitoring system. Observations provide measurements of air pollutant concentrations, which can then be examined, interpreted, and presented. Environmental monitoring with intelligent systems allows us to measure air pollution's extremities, which can help develop techniques to reduce it. IoT, when applied to industry, is broadly defined under the Industrial IoT (IIoT) category. Environmental responsibility and worker safety go hand in hand with increasing the efficiency and productivity of any industry. This research mainly focuses on pollution monitoring, which can especially be applied to the city of Semarang. The city of Semarang, the administrative and industrial center of Central Java, has recently increased its temperature to 38-40°C. Some of them may be fatal to human life if inhaled more than ppm (Sai, 2017). Leaks such as C_4H_{10}, CH_4, CO_2, and CO. Must be monitored to avoid explosions and accidents. An effective monitoring system will help identify the air quality index level. This system can be built by implementing sensors that can detect various gases. The sensor will send data to Google's cloud server, where users can monitor data. Notifications can be started to alert users in a specific area in the form of a color indicator (red, yellow, green). Thus, preventive measures can be taken to reduce air pollution in a room.

Many types of research on air quality have been carried out by combining current technology connected to the internet, making it easier to use to monitor it. The analysis was carried out using the MQ135 sensor, which is the best way to watch Air Quality because it can detect the most dangerous gases and measure the amount accurately. We can monitor pollution levels from anywhere using your computer or mobile. We can install this system anywhere and can trigger some devices when pollution exceeds a certain level. We can turn on the exhaust fan or send SMS/warning letters (Mir Alvarez et al., 2020). This research proposes an air pollution monitoring system. This system was developed using an Arduino microcontroller. The air pollution monitoring system is designed to monitor and analyze real-time air quality and log data to a remote server, keeping the data updated via the internet. Air quality measurements were taken based on the parts per million (ppm) metric and analyzed using Microsoft Excel.

The air quality measurements taken by the system designed are accurate. The results are displayed on a hardware interface that is created also accessed via the cloud anywhere (Rajan, 2019). Experimental study on real-time air pollution monitoring using wireless sensors on public transport vehicles. The study is part of the GreenIoT project in Sweden, which leverages the Internet-of-Things to measure air pollution levels in downtown Uppsala. By deploying low-cost wireless sensors, it is possible to obtain smoother and real-time air pollution levels in different locations. Industrial air pollution monitoring system based on wireless sensor network PT technology (WSN). This system is integrated with the global strategy for cellular communication (GSM), and the communication protocol used is zigbee. The system consists of sensor nodes, a control center, and a database with which sensing data can be stored for history and plans (Swagarya et al., 2014).

The urban air quality monitoring system is based on wireless sensor network technology (WSNs) integrated with the global cellular communication system (GSM). The system consists of sensor nodes, gateways, and a control center managed by the LabVIEW program to retrieve data stored in a database. This system is deployed to Taipei city's main roads to monitor carbon monoxide (CO) concentrations caused by vehicle emissions. The experimental results show that the proposed method is suitable for real-time micro-scale air quality monitoring through WSN technology (Burke et al., 2019, Lei-hong, et al., 2013).

(a) (b) (c)

Figure 1. The Intelligent Iot Based Air Monitoring System Technology (A) Sensor, (B) Rasberry Pi3+, And Oled

In general, the intelligent iot based air monitoring system technology can be carried anywhere practically and portable, and it is easy to use to determine the air quality around. This technology consists of three leading equipment, namely sensors, rasberrypi3 +, and oled shown in figure 1. The sensor input is transmitted serially to the rasberrypi3 through a machine learning algorithm used to predict water quality based on trained data sets. The prepared data set and the predicted data are stored on the server with the oled display. The sensor can be attached to a hat, helmet, or watch that workers can wear. The introduction of flexible and lightweight sensors can further improve implementation (nag et al., 2017). This idea can be realized by introducing raspberry-pi and iot shields (singh et al., 2017). This research aims to determine the level of air pollution sent to google spreadsheets and provides a warning if the gas level exceeds the allowable limit. With iotshield, device manufacturers, system integrators, and iot network operators can quickly secure and manage devices without requiring any security expertise, costly development and testing resources, and no application code or device functionality changes.

METHOD

Real-time monitoring of air pollution using wireless sensors caused by ground transportation. The utilization of the Internet of Things is used to measure the level of air pollution in Semarang. By implementing low-cost sensors, it is possible to obtain smoother, real-time air pollution levels at different locations. This experiment was conducted to evaluate the quality of communication and data quality of the system. This prototype (Fig.2) is for detecting hazardous toxic gases and demonstrating real-time monitoring of the concentration of gases on industrial floors (Carter & Ragade, 2014)

Some of these dangerous gases can be detected in concept by three gas sensors, namely MQ-6, MQ-7, MQ-135, while for temperature and humidity using the DHT11 sensor. IoT provides solutions for multiple layers of application-level security and is ideal for protecting gateways, industrial PCs, and Linux-based edge devices (Swagarya et al., 2014). IoT protectors prevent damage to plan operations and protect connected IoT network components. Application Program Interface (API) can be activated, which acts as a medium between the Raspberry Pi and Google servers. It permits sensors to write readings on the Google cloud web server by sharing the client's email id from (.json folder), which can be downloaded after enabling the API for google spreadsheet. MQ-6/7/135 is a series of Gas Sensor semiconductors that can be used to detect gases mainly used for workshops and commercial buildings. It has many features such as high sensitivity, fast response, wide detection range, stable performance, and long life, simple drive circuit. This sensor resistance value varies with various gas concentrations. When using this component, a sensitivity adjustment is required.

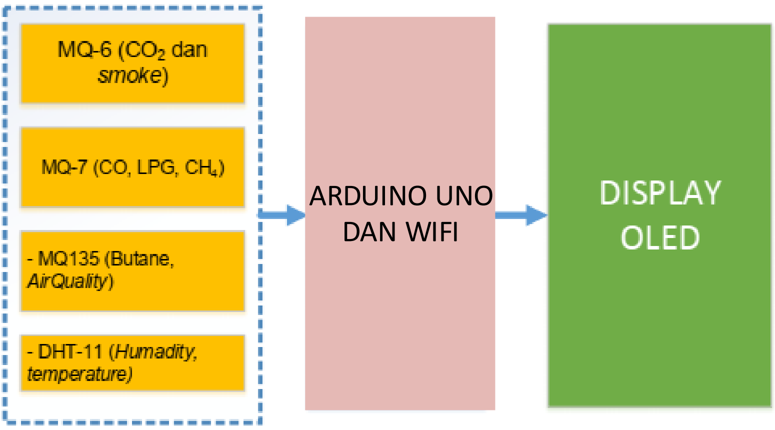


Figure 2. Data flow system from (a) analog, (b) digital, and (c) display

RESULT AND DISCUSSION

Gas Sensor Calibration

Research on air quality monitoring systems using IoT has produced a product to measure the surrounding air condition using three gas sensors: MQ 7, MQ 6, and MQ 135. The three sensors can measure the requirements of hazardous gases, namely MQ7 to measure CO (carbon monoxide) levels, MQ 6 to regulate levels of C4H10 (butane), and MQ 135 to measure levels of CO_2 (carbon dioxide) and NH3 (ammonia) in the form of ppm (parts per million). This is similar to selecting the Portable Gas Sensor Module sensor used by Mane et al. 2020. The gas sensor needs to be calibrated so that it can be converted into ppm. The calibration process on a gas sensor requires knowledge of basic circuit diagrams because of each product's differences. Figure 3 shows the most common and widely used gas sensor circuits in this research.

Symbols A and B are input and output terminals, meaning that both A and B can be used as input or output terminals. The symbol H is the coil terminal of the heater. The variable resistor is used to regulate the output voltage and to maintain high sensitivity. We are obtaining ppm values via a graph datasheet that corresponds to the type of sensor, for example, the MQ-7, as shown in Figure 4. The ppm value by knowing Rs/Ro, where Rs is the sensor resistance at a specific CO level/measured, and Ro is the sensor resistance in clean air with a CO level of 100 ppm. The graph above was taken at 200C, 65% humidity, 21% oxygen concentration, and RL 10K Ohm. The data needed are Ro and Rs data to find out the level of CO in ppm, Ro here is for calibration, to equate the measurement results of our sensors with the actual results or at least with the results of measurements with standardized tools, so in this section, we ignore Ro first. , Ro, we will use later to calibrate the measurement results by changing the values.Rs = (Vc x RL / V RL) – RL, where Rs is Resistance to the sensor, Vc is Voltage entering the detector, RL is Load resistance in the circuit, and VRL is the output voltage of the course.

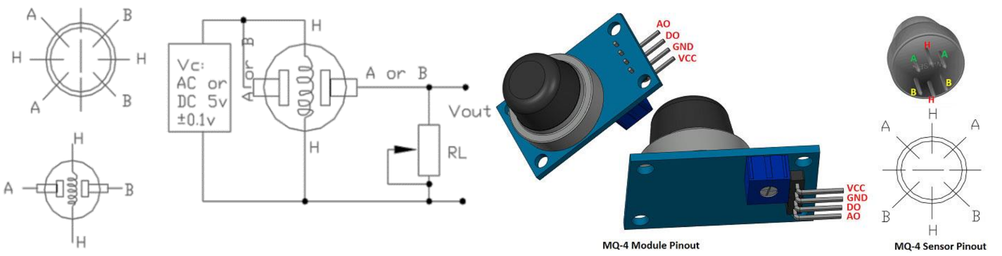
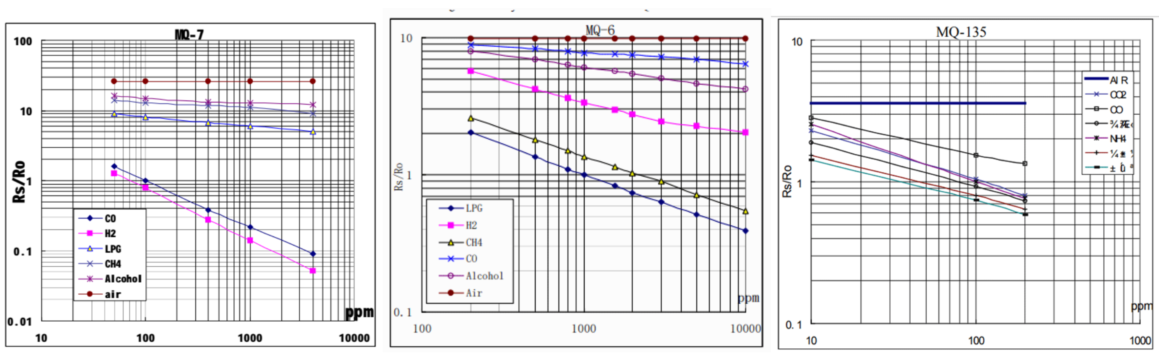


Figure 3. Gas sensor circuit in research



(a) (b) (c)

Figure 4. (a) MQ-7, (b) MQ-6, and (c)MQ-135 ppm charts

Primary pollutants are the carbon oxides (CO, CO_2), sulfur oxides (SO_2, SO_3) and nitrogen oxides (NO, NO_2, NO_3) compound resulting from photochemical reactions, particles (smoke, dust, asbestos, metals, oil, sulfate salts), inorganic compounds (HF, H_2S, NH_3, H2SO4, HNO_3), hydrocarbons (CH_4, C_4H_{10}) radioactive elements (Titanium, Radon), heat energy (temperature, noise). Data Table 1 shows the monitoring system can be seen the quality of the surrounding air by looking at the hazardous gas threshold.

Table 1. Gas Pollution Threshold

No	Type of Parameters	Units	Maximal Level	Information
1	Carbon Dioxide(CO_2)	Ppm	9.0	8 hours
2	Carbon Monoxide (CO)	Ppm	1000	8 hours
3	Ammonia (NH_3)	Ppm	25	8 hours
4	Butane (C_4H_{10})	PPM	1900	8 hours

Basic Circuit

This air monitoring and decision support system is in the form of a device that is connected to the internet and can monitor surrounding gases such as Carbon Dioxide (CO_2), Carbon Monoxide (CO), Ammonia (NH_3), Butane (C_4H_{10}) in ppm units. The following is a schematic image of the air quality monitoring system, where the system works by taking the sensor data to process the data to get Carbon Dioxide (CO_2), Carbon Monoxide (CO), Ammonia (NH_3), Butane (C_4H_{10}) which is then sent to the server for display and analyzed. The detected gas can also be carried out in the indoor air quality monitoring system (Saini et al., 2020). The results of monitoring can be used in determining air quality, as in Figure 5.

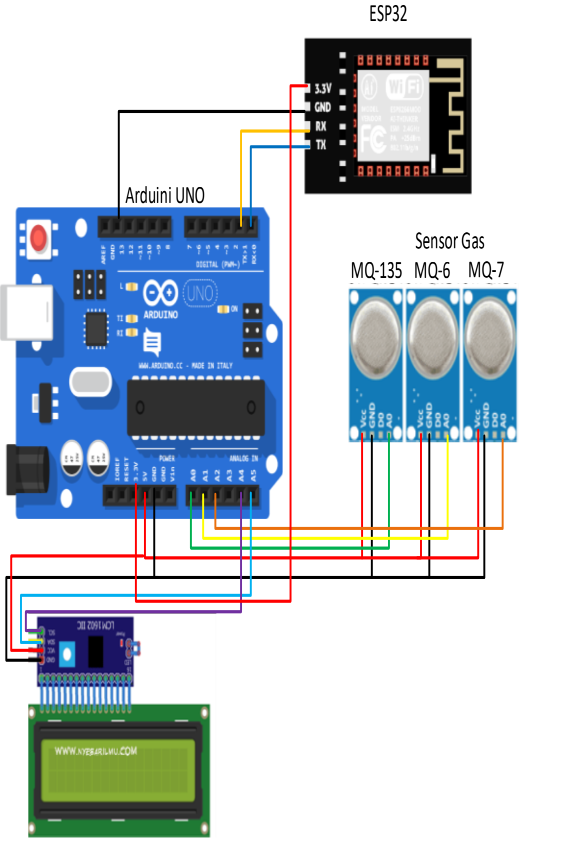


Figure 5. Basic Air Monitoring Sequence

The circuit consists of an MQ-135 sensor, MQ-6 sensor, MQ-7 sensor, Arduino Mega, cable, 16x2 LCD, line, and adapter. The following tools are required for Multimeter, Soldering, and Pliers. The current circuit is tested in Figure 6, equipped with figure 7 is shown the monitoring results on the web.

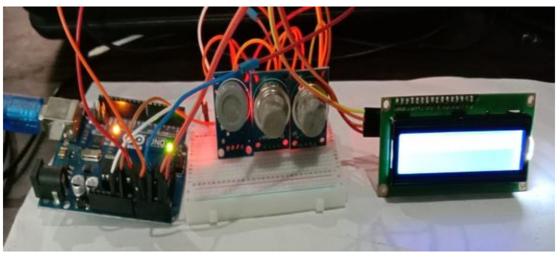


Figure 6. Test circuit gram

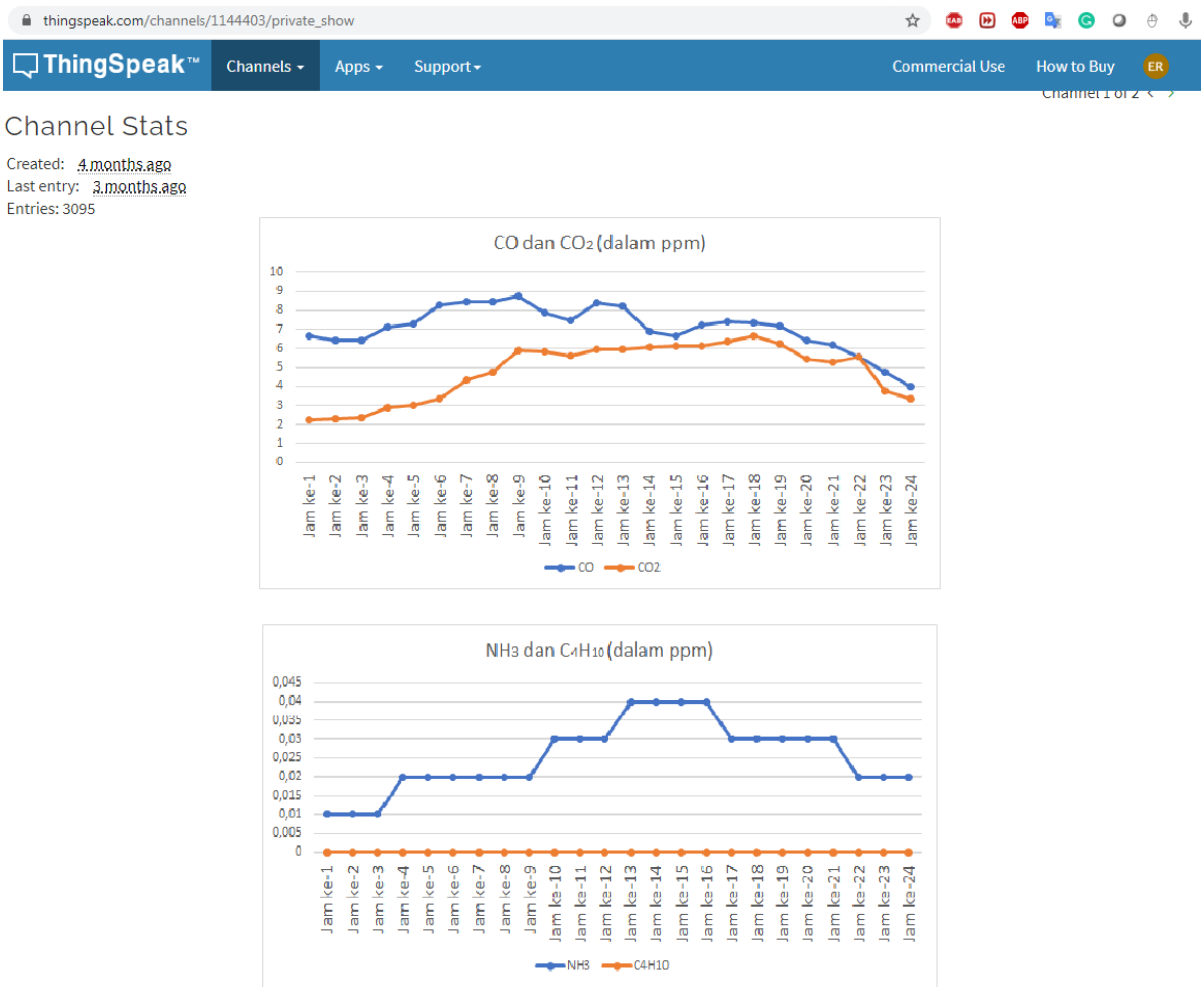


Figure 7. Monitoring using the web

Table 2. The following are the results of monitoring 24 hours a day

Times	CO	CO_2	NH_3	C_4H_{10}
1st hour	6.64	2.26	0.01	0
2nd hour	6.43	2.29	0.01	0
3rd hour	6.43	2.34	0.01	0
4th hour	7.13	2.89	0.02	0
5th hour	7.32	2.99	0.02	0
6th hour	8.27	3.32	0.02	0
7th hour	8.43	4.33	0.02	0
8th hour	8.47	4.76	0.02	0
9th hour	8.72	5.93	0.02	0
10th hour	7.87	5.87	0.03	0
11th hour	7.45	5.99	0.03	0
12th hour	8.42	5.98	0.03	0
13th hour	8.22	5.97	0.04	0
14th hour	6.87	6.32	0.04	0
15th hour	6.67	5.42	0.04	0
16th hour	7.22	6.13	0.04	0
17th hour	7.43	6.34	0.03	0
18th hour	7.33	6.63	0.03	0
19th hour	7.21	6.23	0.03	0
20th hour	6.45	5.44	0.03	0
21st hour	6.22	5.24	0.03	0
22nd hour	5.54	4.64	0.02	0
23rd hour	4.76	3.78	0.02	0
24th hour	3.98	3.34	0.02	0

Pollution condition data collection is shown at the location in Semarang. When it started at 00.00 (the first hour), the CO and CO_2 conditions were still low because the road conditions were still little traversed by motorized vehicles passing at 05.00, it appeared that the CO content was already high at 7.32 ppm. After the time showed 06.00 - 10.00, the activities of people going to work and the pollution data obtained were 8.72 ppm of CO and 5.93 ppm of CO_2. Different results at the lowest point at night is 24.00 hours, but the data on CO and CO_2 pollution and NH_3 are 3.98 ppm, 3.34 ppm, and 0.02 ppm, respectively. The selected vehicles and roads can optimize road safety and traffic flow (Dong et al., 2019), reduce incidents, avoid congestion where data is obtained from gas emission conditions at the time (Brincat et al., 2019).

Motorized vehicles emit exhaust gases or emissions, one of which is carbon monoxide (CO), which results from incomplete combustion of vehicles. If in excess conditions, can isolate the earth so it becomes hot and can cause health problems if it exceeds the threshold value of 25 ppm (PER .13 / MEN / X / 2011). The potential for CO levels that are not too high indicates that the area is safe from pollution (Sager, 2016).

CONCLUSION

This research has created a traffic monitoring system and solves the problem if any air emissions exceed the threshold. The system provides a new way to control traffic using real-time traffic monitoring information to detect dangerous road situations. Overall, IoT will carry out a series of studies in assembling several sensors for air pollution such as CO, CO_2, NH_3, and C_4H_{10}. Air monitoring conditions CO and CO_2 depending on the time conditions and the minimum number of motorized vehicles. Emissions peak during the hours of departure, rest and return from work.

REFERENCES

Brincat, A. A., Pacifici, F., Martinaglia, S., & Mazzola, F. (2019, April). The internet of things for intelligent transportation systems in real smart cities scenarios. In *2019 IEEE 5th World Forum on Internet of Things (WF-IoT)* (pp. 128-132). IEEE.

Burke, C. J., Aleo, P. D., Chen, Y. C., Liu, X., Peterson, J. R., Sembroski, G. H., & Lin, J. Y. Y. (2019). Deblending and classifying astronomical sources with Mask R-CNN deep learning. *Monthly Notices of the Royal Astronomical Society*, *490*(3), 3952-3965.

Carter, B., & Ragade, R. K. (2006, June). Message Transformation Services for Wireless Sensor Networks (MTS-WSN). In *ICWN* (pp. 3-7).

Cukic, V., Lovre, V., Dragisic, D., & Ustamujic, A. (2012). Asthma and chronic obstructive pulmonary disease (COPD)–differences and similarities. *Materia socio-medica*, *24*(2), 100.

Dong, Y., Xu, J., Liu, X., Gao, C., Ru, H., & Duan, Z. (2019). Carbon emissions and expressway traffic flow patterns in China. *Sustainability*, *11*(10), 2824.

Lei-hong, L., Yue-shan, H., & Xiao-ming, W. (2013). A community health service architecture based on the internet of things on health-care. In *World Congress on Medical Physics and Biomedical Engineering May 26-31, 2012, Beijing, China* (pp. 1317-1320). Springer, Berlin, Heidelberg.

Mane, S. A., Nadargi, D. Y., Nadargi, J. D., Aldossary, O. M., S Tamboli, M., & Dhulap, V. P. (2020). Design, Development and Validation of a Portable Gas Sensor Module: A Facile Approach for Monitoring Greenhouse Gases. *Coatings*, *10*(12), 1148.

Nag, A., Mukhopadhyay, S. C., & Kosel, J. (2017). Wearable flexible sensors: A review. *IEEE Sensors Journal*, *17*(13), 3949-3960.

Rajan, A. P. (2013). Evolution of cloud storage as cloud computing infrastructure service. *arXiv preprint arXiv:1308.1303*.

Sager, L. (2016). Estimating the effect of air pollution on road safety using atmospheric temperature inversions. *Grantham Research Institute on Climate Change and the Environment working paper*, *251*(2), 30.

Sai, P. Y. (2017). An IoT Based Automated Noise and Air Pollution Monitoring System. *International Journal of Advanced Research in Computer and Communication Engineering*, *6*(3), 419-423.

Saini, J., Dutta, M., & Marques, G. (2020). Indoor air quality monitoring systems based on Internet of things: A systematic review. *International journal of environmental research and public health*, *17*(14), 4942.

Singh, A., Pathak, D., Pandit, P., Patil, S., & Golar, P. C. (2017). IOT based air and sound pollution monitoring system. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, *6*(3), 1273-1278.

Swagarya, G., Kaijage, S., & Sinde, R. S. (2014). Air pollution monitoring system based on wireless networks simulation. Innovative Systems Design and Engineering, 5(8), 1727-2222.

Mir Alvarez, C., Hourcade, R., Lefebvre, B., & Pilot, E. (2020). A Scoping Review on Air Quality Monitoring, Policy and Health in West African Cities. International Journal of Environmental Research and Public Health, 17(23), 9151.

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