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GP2Y1010AU0F Sensor as Dust Particle Measurement Device: Literature Study on its Efficiency and Application

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A B S T R A C T

Air pollution is an environmental problem that negatively impacts humans and the environment. An air quality monitoring system is required to track the effects of particulate matter (PM), one of the factors that contributes to air pollution. Accurate monitoring equipment is generally expensive and difficult to maintain, so low-cost sensors such as the GP2Y1010AU0F are used as a solution for air quality measurement. This literature review evaluates the efficiency and potential application of the GP2Y1010AU0F sensor by analyzing 20 relevant studies. Based on the review conducted, the GP2Y1010AU0F sensor shows acceptable sensitivity, moderate repeatability, and low error values when measuring air quality. It also showed a good level of correlation with similar devices. The sensor's small size, affordability, and compatibility with microcontrollers make it adaptable to system integration and development into applications and web-based monitoring. However, mass production leads to inconsistency and a reduction in the measurement accuracy of the device. It can be concluded that the GP2Y1010AU0F sensor has potential as a low-cost air quality monitoring equipment with extensive development potential despite its limitations.

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1. INTRODUCTION

Air pollution is a change in atmospheric characteristics due to an increase in the amounts of substances in the air above normal [1] [2]. It is brought on by physical, chemical, and biological factors that alter the atmosphere's condition [3]. Changes in atmospheric conditions affect living things and the environment [1] [4]. Fatal impacts may occur due to air pollution [5] [6]. One of the causes of air pollution is particulate matter (PM) [7]. The problem is not limited to humans but includes the environment [8]. increasing particulate matter in the environment affects the level of toxicity of the atmosphere which indirectly increases the risk of health problems in humans [7]. Thus, an air quality monitoring system is needed to determine air quality.

Air quality monitoring requires expensive equipment to obtain accurate results [9]. In addition, the large size of the equipment is a problem because it requires experts in operation and high maintenance costs [10]. Therefore, the use of inexpensive air quality assessment sensors is required as a remedy. The sharp GY2P1010AU0F is one of the low-cost sensors that may be used to measure air quality [11]. This literature review was made with the aim of knowing and understanding the efficiency and application of the GP2Y1010AU0F sensor. The subject matter is the analysis of a collection of studies to understand the work system and factors that affect measurement. Furthermore, it will analyze its use and development potential.

2. RESEARCH METHOD

This research uses a narrative literature review system. research is carried out by reviewing existing research. The literature search was conducted using the keyword GY2P1010AU0F. The articles selected were English articles with a search range of 2014 to 2024. Furthermore, relevance analysis was carried out based on inclusion and exclusion criteria. Based on the criteria that have been determined, the analysis will be carried out with a comparative approach method. The comparative approach is used to compare and integrate findings from different literature. Through comparison, similarities and differences will be analyzed to provide information systematically.

The search terms for the literature review came from a previous search conducted on air quality sensors that discussed a wide variety of low-cost sensors. To narrow down the search, the main keywords used focused on the sharp GP2Y1010AU0F sensor. In the search, related words such as "error" and "effectiveness" were added to get the desired results. In data collection, journal searches used the help of Google Scholar, IEEE journal, ELSEVIER, Science Direct, etc. The intended relevance focuses on air quality observation equipment that is in the 10-year range. Data collection includes author, article title, journal or conference name, and year of publication.

The type of data retrieved are research title, researcher, journal or conference name, and university, as well as research results that are relevant to the research problem, in this case the effectiveness and application of the GP2Y1010AU0F sensor.

3. RESULT AND DISCUSSION

Regarding the subject matter under discussion, 47 journals were chosen when the keywords GP2Y1010AU0F sensor, in English, and the years 2014 to 2024 were searched. Only thirty of the forty-seven journals were deemed to be inclusion journals. The remaining thirteen journals did not meet the inclusion criteria.

TABLE I. DATA BASED ON LITERATURE REVIEW

No	Author/Title	Result and Conclusion
1	Husain *et al.* with "Air quality monitoring: The use of Arduino and Android"	A portable and low-cost device has been developed to provide real-time data on air contaminants and to retain them to monitor air quality. All of the sensors are controlled by the Arduino in the system. Then, within range, wireless data transfer is also functional.
2	Guo *et al.* with "A dust sensor monitoring system using Wi-Fi mesh network"	The system's remarkable accuracy in measuring dust concentration is demonstrated by the results. Fast networking and quick repair times can demonstrate the network's strong resilience in the context of Wi-Fi mesh networking.
3	Y. Li and J. He with "Design of an intelligent indoor air quality monitoring and purification device"	the current state of indoor air and the need to create an air monitoring system, which will make decisions based on data. The design will have a wide range of potential applications due to the monitoring and purifying device's small size, low power consumption, and good applicability.
4	Zhao *et al.* with "Design and implementation of portable sensory system for air pollution monitoring".	With signs to indicate that detected values are over standard, the researcher was able to develop an automatic air pollution monitoring system that is inexpensive, tiny, and easy to use. Additionally, there is room for improvement in this design. To improve this device's dependability, a different dust sensor with a better sensitivity could be used. Other gases that contribute to air pollution, like NO, SO2, O3, and VOC, may also be detected in the later design in addition to PM2.5.
5	Winkler *et al.* with "Development of a low-cost sensing node with active ventilation fan for air pollution monitoring"	The impact of an active fan on dust sensor readings requires further research to confirm and explain. How inexpensive sensors can complement conventional reference sensors for environmental monitoring may be determined by more investigation.

6	Kodali *et al.* with "MQTT based air quality monitoring"	Through the use of an ESP8266, a sharp dust sensor (GP2Y1010AU0F), and a MQ-7 (carbon monoxide) sensor, the researcher created a device that is inexpensive to construct and maintain, portable, and simple to use.
7	Tasić *et al.* with "Measurement of PM 2.5 Concentrations in Indoor Air Using Low-Cost Sensors and Arduino Platforms"	The mean 15-minute PM2.5 concentrations measured with Sharp sensors and the Osiris monitor had a substantial positive association, according to an analysis of the measurement results. The Arduino platform has proven to be remarkably stable during measurements.
8	Kuula *et al.* with "Laboratory evaluation of particle-size selectivity of optical low-cost particulate matter sensors'	low-cost optical sensors exhibit widely varying response characteristics regarding their size selectivity. None of the sensors have precisely the same response characteristics stated by their manufacturers, which provides evidence of the fact that particle-size selectivity may play an essential role in the analysis of the sources of errors
9	Moreno-Rangel *et al.* with "Field evaluation of a low-cost indoor air quality monitor to quantify exposure to pollutants in residential environments"	The device has significant agreement with another instrument that is used to compare the data. The device also had the potential to identify high pollutant exposures and to provide high-density, reliable, temporal data at high granularity. the use of several units within the same space and with a calibration equation also affecting the result may improve the overall performance of the monitor.
10	Winkler *et al.* with "Gather Dust and Get Dusted: Long-Term Drift and Cleaning of Sharp GP2Y1010AU0F Dust Sensor in a Steel Factory"	There is a correlation between sensor drift and accumulated production of steel factories. To prevent early saturation, users need to keep an eye on the sensor. The author concluded that cleaning the sensor with air did not give significant results and suggested replacing the sensor or cleaning the sensor more extensively in a separate laboratory
11	Ubaidillah, A. with "Air Condition Monitoring Using Waypoint Based UAV (Unmanned Aerial Vehicle)"	Overall system was able to run in accordance with what is desired with small errors. The communication and data display system also work in accordance with what is desired. Overall sensor system errors have different values, with carbon monoxide with a 3.31% error average and dust particles with an 8.47% error average.
12	Yang *et al.* with 'Air-Kare: A Wi-Fi based, multi-sensor, real-time indoor air quality monitor"	The present situation of indoor air and the necessity of developing an air monitoring system and based on data the device will decide what to do. Because of the small size, low power, and good applicability of the monitoring and purifying device, the design will have broad application prospects.
13	Sharma *et al.* with "Monitoring respirable dust exposure in fettling work environment of a foundry: a proposed design intervention."	This prototype has a comparatively low development cost and effectively meets the goals of automation and air quality monitoring.
14	Wang *et al.* with "Laboratory evaluation and calibration of three low-cost particle sensors for particulate matter measurement. "	Low-cost particle sensors demonstrated the ability to report particle concentrations with relatively high linearity and moderate repeatability. In addition, the uncertainty of the measurement can be further reduced by averaging the measurements over longer periods of time.
15	Sudarsono *et al.* with "Development of SMS Gateway Information System for Detecting Air Quality"	The system can be used to detect parameters using a specialized sensor. The system also provides parameters that are used as threshold values. The average response time to the SMS communication system is about 5 seconds depending on signal quality and data traffic from cellular service

		providers. Differences in V out and ADC measurements are caused by several errors, such as an ADC ± 2-bit output error, rounding ADC conversion error to volt, or due to errors in the measuring instrument used
16	Jha, R. K. With ”Air quality sensing and reporting system using IoT”	The proposed design was tested successfully and it was able to sense and transmit air quality data to thing speak server and Android application. Given the concentration of different pollutants, the state of the air might be forecasted using historical data on air quality. When the air quality deteriorates, this technology can be used to create a warning system so that preventative actions can be performed.
17	Khadem *et al.* with “Smart Sensor Nodes for Airborne Particulate Concentration Detection”	Comparing the practical outcomes of two different kinds of optical dust sensors with the reference device Dylos DC1100 gave the researcher encouraging results. On the basis of this, the researcher thought that both sensors might be readily used in wireless system network applications, including energy monitoring, infrastructure and asset tracking, and general environmental monitoring.
18	Caya *et al.* with “Air pollution and particulate matter detector using Raspberry Pi with IoT based notification”	The suggested method offers a way to wirelessly transmit sensor data. If the system reaches a threshold and needs to notify the people whose emails have been added to the system, email address registration on the system offers IoT-Based notifications through information dissemination.
19	Nasution *et al.* with “Design of indoor air quality monitoring systems”	The system we built can show data on temperature, humidity, dust particles, and levels of polluting gases (H2S, NH3, CO, NO2, and SO2) based on the design results. To enable remote data monitoring, the Wi-Fi module also transmits the data collected by the sensors to the ThingSpeak Cloud.
20	Syahrorini *et al.* with “Design Measuring Instrument Dust Based Internet of Things”	Real-time, accurate, and appropriate dust concentration measurement is possible with the IOT-based dust measuring design. The NodeMCU transmits the same measurement data to the web server as what is seen on the LCD. Future enhancements could include the ability to use numerous devices simultaneously and at various locations. GPS-enabled web server display that changes dynamically while the measurement is being taken.
21	Mahetaliya *et al*. with “IoT based Air Quality Index Monitoring using ESP32”	The system was able to suggest an extremely accurate, low-cost, and power-efficient solution. Additionally, the system can show data that anyone with real-time capacity can understand. The system's low size, cost, and power consumption also allow it to offer excellent efficiency and adaptability.
22	Bučar *et al.* with “Statistics of a sharp GP2Y low-cost aerosol PM sensor output signals”	The simplicity and availability make it conceivable to be employed as “smart” IoT devices. Suitability and limits need to be deepened. Based on suitability and limitation, the user is able to determine output and input variables. Each step of using the sensor should be carefully researched and confirmed, including modifying each sensor instance separately.
23	Muhammed, Y. A. with “Using Wireless Sensors Networks to Investigate the Air Quality in Outdoor and	The concept was able to integrate a few sensors to measure interior and outdoor circumstances. The system was able to detect and report the measurement utilizing a wireless standard

	Indoor Environment in South of Erbil, Iraq"	network and a local network. The technology was also perfect for being used in different venues such as schools, hospitals, etc.
24	Hapsari *et al.* with "Real time indoor air quality monitoring system based on IoT using MQTT and wireless sensor network"	Indoor air quality measurement linked with Internet of Things technology was able to be installed on the prototype. The technology was able to send and receive real-time data.
25	Vidwans, A., & Biswas, P. with "A Systematic, Cross-Model Evaluation of Ensemble Light Scattering Sensors"	A comparison of six sensors that are used to quantify particle pollution provides some results. The Sharp sensor has superior sensitivity and precision. The TI sensor has better LOD and saturation. The experiment for the sensor is well-suited for the PM measurement setting to generate accurate results.
26	Thompson, J. E. with "Improved measurement performance for the sharp gp2y1010 dust sensor: Reduction of noise."	Based on the improvement few parameters, the Sharp sensor was able to approach the noise equivalent limit of detection of 3 µg m-3. Noise restricts the sensor capabilities caused by the photodiode component that is employed for detection.
27	Agrawaal *et al.* with "Personal exposure estimates via portable and wireless sensing and reporting of particulate pollution."	The optimal limit detection for the Sharp sensor is around 8 µg m-3–17 µg m-3. The measurement is relatively stable with only a few spikes. In the future needs to be calibrated for better outcomes and performance.
28	Khan *et al.* with "Environmental Particulate Matter (PM) exposure assessment of construction activities using low-cost pm sensor and latin hypercubic technique"	There is a good correlation between each sensor with identical characteristics. There is a need to implement control measures for improved results. The technology delivers good results on measurement and is capable of dust monitoring operations with the digital twin as an automated controlling system.
29	Prasetyo, J. E., & Jamaaluddin, J. with "Prototype Automation of Air Conditioning Treatment in the Grinding Area AK Based on IoT."	The utilization of several sensors as a system was able to work fairly optimals. All four sensors employed for the system are able to attain above 95% accuracy. The amount of ESP8266 was not enough for additional sensor for the amplifier and ESP32 might be a better alternative.
30	Hartono *et al.* with "Development of an Integrated Air Quality Monitoring System for Temperature, Humidity, CO, and PM10 Measurement"	The development of a system with many sensors was able to be done. All four sensors that are employed for measurement have more than 95% accuracy.

The results of the review of the selected articles show that the utilization of the GP2Y1010AU0F sensor is very good. the sensor can receive air quality information with an acceptable level of sensitivity and has a small error value [12]–[15]. Comparison with similar devices also shows a positive relationship at a certain measurement level [7][10]. In long-term observations, the device is able to display data with high linearity and moderate repeatability [8][16] [17]. The device is also able to send and receive data in real-time [18] small size and low price also expand the possibility of using sensors and their development [6][19][20].

When viewed based on the application aspect, the GP2Y1010AU0F sensor has many possibilities to be combined into a system by utilizing other supporting sensors. The combination of sensors used can help improve the quality of the observation data [4][6]. The utilization of sensors on the basis of applications and websites is very likely to be implemented considering that sensors can be operated with integration on many types of microcontrollers [1][3][21][26]. With the integration of applications and websites, monitoring of development becomes wider and can be connected to other sectors [27][28].

Although the device is able to fulfill the basic requirements of air quality observation equipment, the GP2Y1010AU0F sensor has shortcomings when compared to similar air quality observation equipment. This is because the mass-produced equipment causes differences in the observation results of each device [5][29]. Because of that, the sensor also needs to be validated and adjusted for each usage[16]. On top of that, the sensor

has limitations that cause the sensor to only be able to measure some types of particles [30][31]. Sensor drift is also possible if the observation equipment is not maintained and cleaned regularly [11].

4. CONCLUSION

Based on research results reviewed from 20 journals, the GP2Y1010AU0F sensor monitors air quality with acceptable sensitivity and low error values. The sensor shows a positive correlation with similar devices at a given measurement level and is capable of displaying data with moderate repeatability, high linearity, and real-time capability. This sensor is highly likely to be further developed due to its small size and affordable price. For applications, it can be used in conjunction with other supporting sensors to improve the quality of the data viewed. Also, with the integration of various types of microcontrollers, this combination enables the development of application and web-based systems. This increases the potential for use and connectivity to other sectors. Nevertheless, this sensor has some drawbacks compared to other air quality monitoring devices. Mass production results in different measurement results in each device makes the user need to configure each sensor, and if the sensor is not regularly maintained or cleaned, drift may occur.

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