IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121222

IoT Based Gas sensors for Biogas Leakage Measurement

Dr.R.Jayakarthik[1], Dr.JayanthilaDevi[2]

Post-Doctoral Research Fellow, Srinivas University, Karnataka, India[1]

Professor, Institute of Computer Science& Information Science, Srinivas University, Karnataka, India[2]

Abstract: At present, gas sensors are assuming a critical function in facilitating the shift from residential to industrial monitoring. Gas sensors are indispensable for a vast array of applications, including the detection of hazardous gases and the monitoring of environmental factors. An extensive range of semiconductor gas sensors that have attained an exceptional standing on the market on account of their rapid response time, dependability, affordability, and minimal maintenance needs are currently available for purchase. In the past, ceramic gas sensors were employed for gas detection. The gas sensors demonstrate oxidising and reducing properties preponderantly. Reducing sensors results in the formation of donor states, as opposed to oxidising sensors which generate acceptor states. Sensitivity, resistive, potentiometric, and amperometric sensors rank foremost.

Keywords: Gas Sensing, Monitoring, Gas Sensing Unit, Arduino UNO, Biogas Detection Sensor

I. INTRODUCTION

The oil factory sense of a human being is very good at detecting odours that are either present in large amounts or entirely undetectable. To protect human life and reduce the danger of exposure to hazardous gases and explosive gas concentrations, it is vital to make use of a gas sensor to detect gases in low concentration ranges. Gas sensors allow for the detection of a variety of gases at low concentrations, which helps to avoid gas leaks in a variety of contexts, including residences, factories, and other establishments [1]. Due to this reason, the gas sensor has developed into an indispensable component of contemporary life.

II. METHODOLOGY

3.1 The Biogas Sensing

An instrument that converts a physical quantity into an electrical amount is referred to as a sensor, according to the definition provided by the Instrument Society of America. There are several ideas and points of view about sensors that have been accepted by scientists and engineers. Sensors are devices that are capable of transferring one kind of energy into another type of energy. Generally speaking, sensors are classified according to how they generate and receive signals. Sensors are classified according to the amount of energy that they either create or receive. One cannot categorise sensors based on a single criterion since the categorization of sensors is a broad issue that cannot be classified [2]. An example of this would be the categorization of sensors according to their relevance, the material that they are constructed from, and the particular characteristics that they monitor.

Figure 1. Biogas Sensing Unit

In terms of their characteristics, the sensors might be either active or passive. To acquire and measure the signal, a passive sensor is used. To measure signals that have been reflected, refracted, or scattered by the sensors, an active sensor is used. Sensors may be classified as either active or passive depending on how they transmit signals during operation [3]. The following is a condensed description of the most important qualities that sensors possess.

- Execution Time
- How sensors are reproducible
- An ageing effect of the sensor
- The sensitivity and stability possessed by the sensor
- Dynamic range
- Cost

When referring to a sensor, the term "reaction time" refers to the amount of time that it takes for the sensor to reach 90% of its steady output value after being exposed to the measurement. The recovery time, on the other hand, refers to the amount of time that passes until the sensor returns to a value that is within ten per cent of its starting value after being subjected to the quantity being measured [4]. An example of a sensor that is considered to be of good quality has a response time and recovery time that are both shorter. The ability of a sensor to reliably provide the same characteristic even after being subjected to a certain measure on several occasions is referred to as its reproducibility. When applied to a certain measurement, a sensor that has great repeatability will display the same recovery time, reaction time, and general response. Despite this, it is to be anticipated that the signature of the sensor may deteriorate with time as a result of prolonged usage. Ageing is a phrase that is often used to refer to the amount of time that it takes for a sensor to become less effective. When it comes to applications that need precise measurement systems or applications that entail detecting potentially dangerous measurements, the sensitivity and resolution of the sensor are two very essential properties [5]. In the context of a sensor, the resolution of the sensor is defined as the smallest change in the measured that can be detected, while the sensitivity of the sensor is defined as the change in the output that occurs for every unit change in the measured. The particular application in which a sensor is going to be used is a significant factor in determining the relevance of the features shown by the sensor [6]. When it comes to detecting very dangerous gas, for example, sensitivity is the most important quality to possess, particularly in an online management system where the measurement is regularly exposed. The use of biosensors in animal implantation requires careful consideration of several important issues, including reproducibility and ageing. Within the scope of this discussion, weight and size are key factors.

3.2 The Gas Sensing Unit

The gas detecting unit is made up of a metallic chamber that is cylindrical in shape, impermeable, and built of high-quality stainless steel. The chamber has a capacity of about 250 cubic centimetres. The dimensions of the item are 8.6 centimetres by 6 centimetres as a standard. A foundation made of copper with dimensions of 16.5 centimetres by 15 centimetres is used to secure the item. Using metallic and rubber O-rings, which were firmly secured to the chamber using a screw mechanism, the chamber was made impermeable. This was accomplished by making the chamber impermeable [7]. A metallic (S.S.) capillary with an internal diameter of 2 millimetres was installed in the chamber so that the expected quantity of gas could be introduced. To make the measurements more straightforward, the electrical connections were made with the sensor, and after that, the sensor was positioned within the chamber. All of the tests were carried out at a temperature of 299 Kelvin, which is equivalent to the temperature of the natural environment [8].

Figure 2. Gas Sensor

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ※ Peer-reviewed journal & Refereed journal ※ Vol. 12, Issue 12, December 2023
DOI: 10.17148/IJARCCE.2023.121222

3.3 Circuit for the gas sensor

To identify biogas, the wireless gas sensing system that is now in use makes use of the MQ-2 gas sensor. The sensor is very well-suited for detecting the presence of potentially dangerous biogas leaks in a wide variety of environments, such as residential dwellings, service stations, storage tank facilities, and vehicles that are powered by biogas fuel [9].

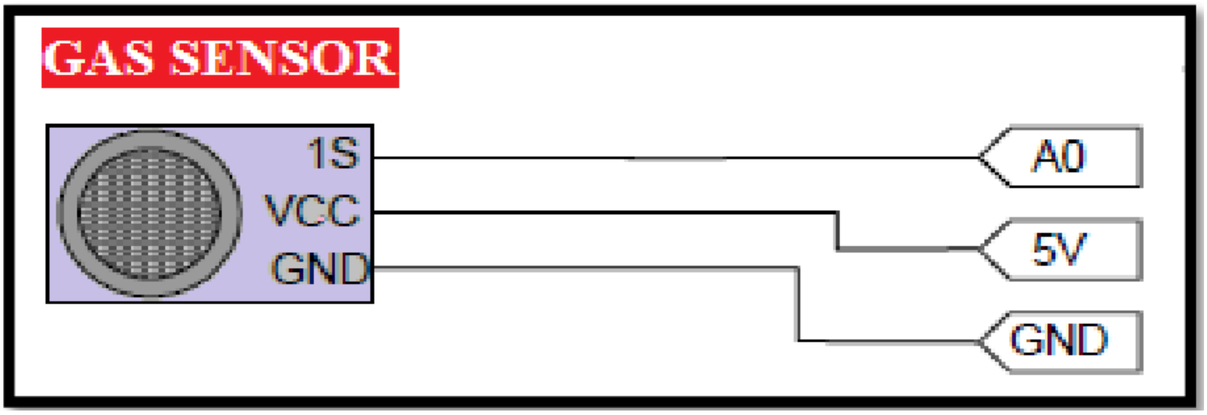

Figure 3. The gas sensor connection to the arduino pin

There is a possibility that this device might be easily included in an alarm circuit or unit to either offer a visual signal of the biogas concentration or sound an alarm. In addition to having a quick response time, the sensor has an extraordinary level of sensitivity [15]. It is observed that the conductivity of the sensor rises in proportion to the concentration of the target combustible gas when the gas is present [10]. VCC, GND, and V0 are the three output pins that accompany the sensor. A connection is made between the terminal of the heating coil and one of the input pins, which is where the load resistor (RL) is connected.

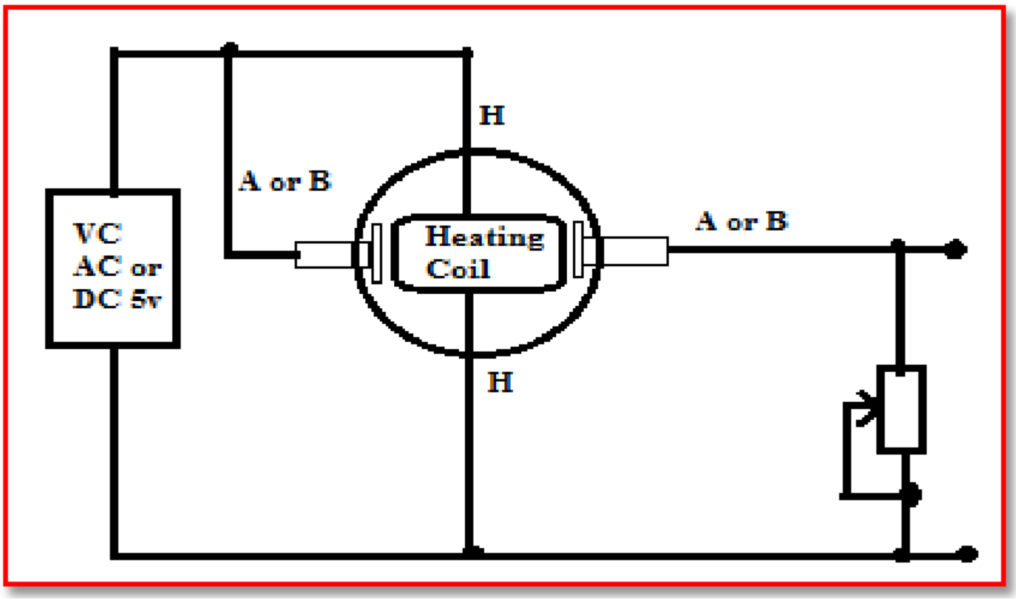

Figure 4. Gas sensor circuit diagram

A sound alarm should be activated as soon as the gas concentration reaches 800 parts per million (ppm) to alert users that the surrounding environment has reached a harmful level and that they must immediately evacuate the affected area [14].

The warning stage will be signalled by the activation of the fan the moment the gas concentration reaches a level that is between 400 and 800 parts per million. After that, it will remove the gas from the area where it has leaked, which is a preventative measure against the possibility of explosive accidents occurring [11].

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 12, December 2023

DOI: 10.17148/IJARCCE.2023.121222

3.4 The Arduino UNO for Gas Sensor

To connect the sensor, the wireless gas leak detection system makes use of an Arduino Nano board. This board can measure gas concentrations at the level of parts per million (ppm). The information that has been measured is subsequently sent to the Arduino UNO board, which serves as the Gateway Node [12]. It is possible to see the current status of the sensor nodes that are experiencing leakage using the serial monitor window that is located on the gateway node. It is important to declare all of the input and output pins in the Arduino before it can be used. The next step is to ensure that the initial sensor value is set to 0. Making use of the float sensor, which is detailed further below, it is possible to convert the data that was collected from the sensor into decimal format. The analogue input pin A0 is linked to the potentiometer that is located on the gas sensor [13].

Figure 5. Biogas Leakage Measurement

III. CONCLUSIONS

The deployment and installation of various sensor nodes may be accomplished rapidly and effectively because of the characteristics that wireless sensor networks feature. This is because many of these networks confer capabilities of self-organization, self-configuration, self-diagnosis, and self-healing on the sensor nodes. This is the reason why this is the case. Further, it offers the benefit of mobility and flexibility in connection, which enables the expansion of networks according to the requirements of the situation. Furthermore, it is feasible to create WSN nodes by using Arduino UNO and Nano microcontrollers throughout the construction process. To ensure the secure transmission and reception of data, the sensor coordinator nodes are responsible. The buzzer may be activated to provide the user with a warning if biogas leakage is discovered.

REFERENCES

[1]. Schwietzke, S.; Sherwood, O.A.; Bruhwiler, L.M.; Miller, J.B.; Etiope, G.; Dlugokencky, E.J.; Michel, S.E.; Arling, V.A.; Vaughn, B.H.; White, J.W.; et al. Upward revision of global fossil fuel methane emissions based on isotope database. Nature 2016, 538, 88–91.

[2]. Emran, B.; Tannant, D.; Najjaran, H. Low-altitude aerial methane concentration mapping. Remote Sens. 2017, 9, 823.

[3]. Gogola, K.; Rogala, T.; Magdziarczyk, M.; Smoliński, A. The mechanisms of endogenous fires occurring in extractive waste dumping facilities. Sustainability 2020, 12, 2856.

DOI: 10.17148/IJARCCE.2023.121222

[4]. Chećko, J.; Urych, T.; Magdziarczyk, M.; Smoliński, A. Resource Assessment and Numerical Modeling of CBM Extraction in the Upper Silesian Coal Basin Poland. Energies 2020, 13, 2153.

[5]. Kalisz, P. Impact of Mining Subsidence on Natural Gas Pipeline Failures; IOP Conference Series: Materials Science and Engineering; IOP Publishing: Bristol, UK, 2019; Volume 471, p. 042024.

[6]. Adegboye, M.A.; Fung, W.K.; Karnik, A. Recent advances in pipeline monitoring and oil leakage detection 422 technologies: Principles and approaches. Sensors 2019, 19, 2548.

[7]. Gómez, C.; Green, D.R. Small unmanned airborne systems to support oil and gas pipeline monitoring and mapping. Arab. J. Geosci. 2017, 10, 202.

[8]. Lu, B.; He, Y. Species classification using unmanned aerial vehicle (UAV)-acquired high spatial resolution imagery in a heterogeneous grassland. ISPRS J. Photogramm. Remote Sens. 2017, 128, 73–85.

[9]. Iwaszenko, S.; Kelm, M. Computer Software for Selected Plant Species Segmentation on Airborne Images. In Proceedings of the International Conference: Beyond Databases, Architectures and Structures, Poznan, Poland, 18–20 September 2018; Springer: Berlin/Heidelberg, Germany, 2018; pp. 309–322.

[10]. Golston, L.; Aubut, N.; Frish, M.; Yang, S.; Talbot, R.; Gretencord, C.; McSpiritt, J.; Zondlo, M. Natural gas fugitive leak detection using an unmanned aerial vehicle: Localization and quantification of emission rate. Atmosphere 2018, 9, 333.

[11]. Yang, S.; Talbot, R.; Frish, M.; Golston, L.; Aubut, N.; Zondlo, M.; Gretencord, C.; McSpiritt, J. Natural gas fugitive leak detection using an unmanned aerial vehicle: Measurement system description and mass balance approach. Atmosphere 2018, 9, 383.

[12]. Martinez, B.; Miller, T.W.; Yalin, A.P. Cavity Ring-Down Methane Sensor for Small Unmanned Aerial Systems. Sensors 2020, 20, 454.

[13]. Barchyn, T.E.; Hugenholtz, C.H.; Fox, T.A. Plume detection modeling of a drone-based natural gas leak detection system. Elem. Sci. Anthropos. 2019, 7.

[14]. Bretschneider, T.R.; Shetti, K. UAV-based gas pipeline leak detection. In Proceedings of the Asian Conference on Remote Sensing, Nay Pyi Taw, Myanmar, 27–31 October 2014.

[15]. Kamrat, W.; Ostrowski, T. Zastosowanie dronów w diagnostyce infrastruktury energetycznej. Przegląd Gazowniczy 2017, 4, 15–16.

