"Smart Enviro": Environmental Monitoring Based on the Internet of Things (IoT)

Herlina Miur Zabidin[1], Zawiyah Mokhtar[2], Nor Hidayah Jamaludin[3]

[1] *Padang Terap Community College, Lot 1529, Jalan Kuala Nerang, Taman Belimbing Indah, Kuala Nerang, Kedah, Malaysia*
E-mail: herlina@kkpt.edu.my

[2] *Tuanku Sultanah Bahiyah Polytechnic, Kulim Hi Tech Park, 09000 Kulim, Kedah, Malaysia*
E-mail: zawiyah@ptsb.edu.my

[3] *Gopeng Community College, 2, Pejabat Pengurusan Fama, Kompleks RTC Perak, Aras 1, KM16, Jalan Gopeng, Kawasan Perindustrian Gopeng, 31600 Gopeng, Perak, Malaysia*
E-mail:nor.hidayah@kkrtcg.edu.my

Abstract

The future of technology is increasingly shifting to Industrial Revolution 4.0 and about to step on Society 5.0. This shows that the Internet of Things (IoT) technology has led to the production of automatic smart devices that have more efficient interaction and communication features without human assistance. The widespread use of IoT technology through interconnection on the Internet accelerates the use of machines as a method of equipment control, especially in controlling and automating various tasks or daily human work to things that are easier to implement in the busyness of human time. IoT-based real-time monitoring is now widely implemented to enable faster and efficient reactions in addition to being able to access the latest data continuously no matter where the user is. Therefore, in the aspect of environmental monitoring as well, IoT technology can be utilized, i.e. using devices or sensors to monitor the quality of water, air, atmosphere, soil, flora and fauna habitats; can further help preserve the environment through effective preventive measures against pollution of water, air, soil and so on as it has often hit our country lately.

Keywords **:** *Monitoring; Environment; Internet of Things (IoT)*

I. INTRODUCTION

IoT is a man-made technology with the concept of virtual and intelligent objects. IoT is a technology that is able to know everything and allows surrounding devices to interact with themselves automatically without human control [1]. IoT refers to a rapidly growing network of objects that can collect data using sensors. Now, its use is very widespread in every sector and also plays an important role in the environmental monitoring system [2]. IoT is a network of Internet-based objects – from industrial machines to consumer goods that can share information and complete tasks while you are busy with other activities [3]. IoT is a trendy concept where machines or things are created to interact with the environment by exchanging data or information through detection by sensor devices. The device will collect information and data from the environment using various latest technologies, resulting in the flow of data between devices [4].

IoT has provided an opportunity to build robust industrial systems and applications by leveraging a variety of RFID (Radio frequency identification systems), wireless, mobile devices and sensors. Many industrial applications of IoT are growing and being used lately. Nowadays, control and monitoring play a major role in our daily lives [5]. IoT is a technique that provides an intelligent environment for humans by combining sensor nodes, cloud environment and wireless communication. Many smart devices are being used in the contemporary world but are still based on the energy efficiency issue of these IoT devices [6]. This writing aims to help understand the implementation of the latest industrial revolution (Industry 4.0) by using IoT as a requirement for aspects of developing environmental control and monitoring systems. Figure 1 shows the diversity of IoT applications.

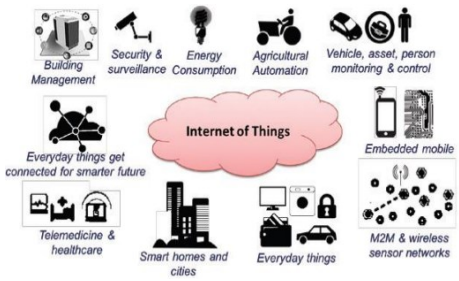

Figure 1 IoT applications

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II. LITERATURE REVIEW

The world is now increasingly threatened by worsening environmental problems which are largely linked to the excessive use of energy by humans. The overuse that is not environmentally friendly has resulted in the climate becoming unstable, the earth's temperature rising and the sustainability of the environment continuing to decline [7]. Degradation of water resources has become a common issue. Conventional methods of water quality monitoring involve manual collection of samples from different locations and tested in the laboratory. In Malaysia, the five most polluted rivers are Sungai Pinang, Sungai Juru, Sungai Klang, Sungai Penchala and Sungai Segget. The latest situation according to a report by UNESCO, river pollution is getting worse in Africa, Asia and Latin America [8]. Conventional methods in water quality measurement are also time-consuming, high-cost and inefficient, including the manual analysis process carried out in the laboratory. While the cost of an IoT-based system using machine learning techniques to monitor water in real time is lower.

QExisting systems for weather monitoring can be used to measure weather parameters such as carbon dioxide (Co2), temperature, humidity, pressure and can help prevent natural disasters. Systems are generally designed to avoid human intervention. Collected weather information can be used to assess climate change over a period of time and to create weather forecast reports. Most systems use a microcontroller and use a network of sensors to collect physical parameter data. Problems arise when a large data space is needed to store the data. A typical database cannot handle such a large amount of data. So, to overcome the problem, cloud computing is very necessary. Air pollution monitoring stations are also large and incur high costs for installation and maintenance. However, the air quality data produced by the station is very accurate. Therefore, alternative IoT attracts academic and industrial attention. Pollution detection and periodic monitoring are important tasks nowadays. To provide a better and safer environment for humans, animals and plants; then pollution screening and control is through IoT innovation.

1) IoT Based Environmental Monitoring

The use of cloud computing models that have the potential to interact with the concept of sustainable development, understood in three dimensions: economic, environmental and social. Cloud unifies environments, saving power, cooling, space and money. Cost savings and operational flexibility are among the benefits often cited in relation to the decision to adopt cloud computing solutions [9]. In a study on the effects of environmentally friendly green computers, it proved to be the best technology that solves the traditional problems of Cloud technology. Combining IoT with Cloud computing offers new techniques for better data management and data storage. The IoT work process is shown in Figure 2 below.

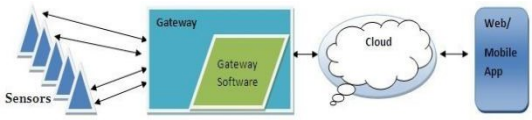

Figure 3 IoT Work Process

Accordingly, the introduction to Industry 4.0 has led to the emergence of sensor network systems covering the environment. The system is capable of monitoring important physical phenomena and is stored in the cloud. The resulting data can be used to trigger short-term actions such as remotely controlling heating or cooling devices or long-term statistics. Environmental monitoring in real time (real time) brings many benefits such as monitoring the storage center for any gas leaks, extreme temperature changes or humidity as well as monitoring the number of people visiting the room during the week.

III. RESEARCH METHODOLOGY

For environmental monitoring purposes, systems that use WSN (Wireless Sensor Network) applications work to receive, store and provide access to data fields which are based on IoT requirements for low cost, fast use and long time without the need for supervision [10]. For the weather monitoring aspect, an example of a system based using open-source hardware platform and raspberry pi. The design presented is through aspects of the WSN platform that can be used to remotely monitor weather parameters such as daylight, rain, fire, gas leakage and others.

Data can be stored online, which can be used to predict the weather and ultimately analyze climate patterns, as well as for other meteorological purposes [11]. Further, the proposed system uses low power wireless technology (Zigbee) and high reliability. It is suitable for industrial activities that involve monitoring on a large scale. The parameters involved are such as the determination of pH levels, turbidity and temperature measured by sensors and the data sent to the base station or control room. This environmental monitoring is also expanded for the purpose of garbage collection and parking which may affect the lives of citizens in the city [12].

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For systems that use sensors to measure water quality, microcontrollers and Zigbee Modules make the sensor network easier, lower cost and more efficient [13]. Most of the water quality monitoring using WSN has a limited range and to increase the coverage it is necessary to use repeater nodes while some others depend on the mobile network. Apart from that, a Supervisory Control and Data Acquisition System (SCADA-Supervisory Control and Data Acquisition) integrated with Internet of Things (IoT) technology is proposed for real-time water quality monitoring. This aims to determine water pollution, leaks in pipelines, and also automated parameter measurements such as temperature sensors.

As for the air quality monitoring aspect, an example of the system is using an air sensor that can detect the presence of gases or dangerous compounds and this device will always send data to the microcontroller and report directly to the online server through IoT [14]. Monitoring methods using wireless sensor networks can gather information through a web server. Next, the proposed system uses different sensors such as temperature, humidity and others that are collected and sent by a low-power microcontroller "Arduino UNO", a Wi-fi module that helps in processing and transferring data to Thingspeak Cloud.

Low Power Wide Area Network (LPWPAN)appears as a communication system in the IoT context. It is proven to be effective in environmental monitoring and smart metering. Specifically, LPWAN is named as LoRAWAN [15]. The monitoring of environmental parameters contributes to increasing production and quality of crops and greenhouses. LoRa (Long Range) technology is a wireless monitoring network that operates over long distances, high interference resistance and low energy consumption [16]. Technology based on wireless sensor network using LoRA is suitable to be applied to communicate with all nodes and sensors. This system covers a distance of up to 900 m and measures the concentration of carbon monoxide or dioxide and nitrogen oxide [17].

IV. RESULT AND DISCUSSION

Data collection for this Smart Enviro parameters is using the open.projekiot.com platform. Figure 3 shows the physical connection of the circuit for the IoT circuit which is hardware installation while Figure 4 shows the display of the software interface which is software installation.

Figure 3 Hardware installation

Figure 4 Software Installation

In this real time measurement session, the three parameters selected are the measurement of water level, temperature and humidity. Figure 5 shows the minimum and maximum reading limits for some sensors such as water level, temperature and humidity.

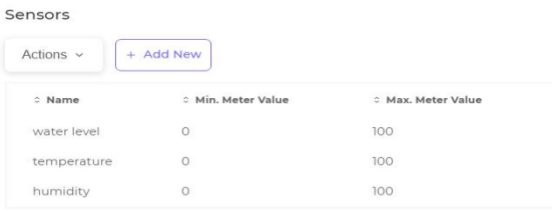

Figure 5 Sensor reading measurement limits

Further, readings taken or recorded can be done on a daily, weekly or monthly basis. The readings obtained are useful and give implications if users want to make a comparison in terms of operating costs or energy savings. Figure 6 shows the reading of Smart Enviro parameters and Figure 7 shows the data of 3 parameters taken in Real Time.

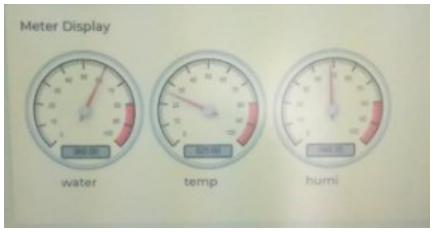

Figure 6 Smart Enviro parameter readings

Figure 7 Smart Enviro 3 parameter data

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V. CONCLUSION

By applying the concept of "Internet of Things" or IoT, which is a device that is portable to a real object and can be connected to the Internet, making IoT an object that can communicate with each other. In addition, IoT is the concept of physical and virtual objects that are around us. The goals of IoT-based smart environment monitoring are: (1) energy consumption monitoring (2) energy consumption reduction and (3) energy efficient management. This means that the system used is using a computer or mobile device that can control the function of parameters or features automatically through the internet from anywhere in the world and this system can definitely save electricity and human energy from being wasted.

REFERENCES

[1] S. H. Mahmud, L. Assan, and R. Islam, "Potentials of internet of things (IoT) in Malaysian construction industry," *Annals of Emerging Technologies in Computing*, vol. 2, no. 4, pp. 44–52, Oct. 2018, doi: 10.33166/AETiC.2018.04.004.

[2] R. P. Deekshath Dharanya, K. R. Dimpil Kabadia G Deepak Dinakaran, and S. Shanthini Assistant Professor, "IoT Based Environmental Monitoring System using Arduino UNO and Thingspeak," 2018. [Online]. Available: www.ijste.org

[3] V. K. sagar N and K. S. M, "Home Automation Using Internet of Things," 2015. [Online]. Available: www.irjet.net

[4] "International Journal of Innovative Research in Computer and Communication Engineering (A H igh I m pa ct Fa ct or , M on t h ly, Pe e r Re vie w e d Jou rn a l)", doi: 10.15680/IJIRCCE.2016.

[5] A. Hukeri and M. P. B. Ghewari, "REVIEW PAPER ON IOT BASED TECHNOLOGY," *International Research Journal of Engineering and Technology*, 2017, [Online]. Available: www.irjet.net

[6] S. Lakshmanan and S. Joseph', "An intelligent energy aware approach for IoT devices in smart environment." [Online]. Available: https://www.researchgate.net/publication/325882125

[7] "JurnalKomunikasiBorneo2018Vol66-6".

[8] N. S. Mustakim, M. W. Ramli, and C. Ngai Weng, "Kesedaran komuniti terhadap isu pencemaran sungai di Sungai Pinang, Pulau Pinang," *Malaysian Journal of Society and Space*, vol. 15, no. 3, Aug. 2019, doi: 10.17576/geo-2019-1503-03.

[9] P. Pazowski, "GREEN COMPUTING: LATEST PRACTICES AND TECHNOLOGIES FOR ICT SUSTAINABILITY."

[10] Dr. E. N. Ganesh, "IOT Based Environment Monitoring using Wireless Sensor Network.," *Int J Adv Res (Indore)*, vol. 5, no. 2, pp. 964–970, Feb. 2017, doi: 10.21474/IJAR01/3241.

[11] S. Sharma and G. Sharma, "Impact of Energy-Efficient and Eco-Friendly Green Computing," *Int J Comput Appl*, vol. 143, no. 7, pp. 20–28, Jun. 2016, doi: 10.5120/ijca2016910250.

[12] A. Professor, "Internet of Things for Environmental Monitoring," *International Journal of Advanced Networking & Applications*.

[13] J. Navarajan, B. Aswin Kumar, S. Venkatesh, T. Jayachandran Professor, and T. Jayachandran, "Detection of Water Pollution and Water Management Using Smart Sensors with IOT," 2017. [Online]. Available: www.irjet.net

[14] F. beebi, "ENVIRONMENTAL MONITORING SYSTEM USING IOT," 2018.

[15] M. Luvisotto, F. Tramarin, L. Vangelista, and S. Vitturi, "On the Use of LoRaWAN for Indoor Industrial IoT Applications," *Wirel Commun Mob Comput*, vol. 2018, 2018, doi: 10.1155/2018/3982646.

[16] Y. Liu and M. Wang, "Wireless greenhouse environment monitoring system based on lora network," *J Food Sci Technol*, vol. 4, no. 8, 2019, doi: 10.25177/JFST.4.8.RA.573.

[17] N. Abd, A. Husein, A. Hadi, A. Rahman, and D. P. Dahnil, "Evaluation of LoRa-based Air Pollution Monitoring System," 2019. [Online]. Available: www.ijacsa.thesai.org

AUTHOR'S INFORMATION

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First Author: Herlina

Padang Terap Community College, Lot 1529, Jalan Kuala Nerang, Taman Belimbing Indah, Kuala Nerang, Kedah, Malaysia

E-mail: herlina@kkpt.edu.my

Second Author: Zawiyah

Electrical Engineering Department, Tuanku Sultanah Bahiyah Polytechnic, Kulim Hi Tech Park, 09000 Kulim, Kedah, Malaysia

E-mail: zawiyah@ptsb.edu.my

Third Author: Nor Hidayah

Gopeng Community College, 2, Pejabat Pengurusan Fama, Kompleks RTC Perak, Aras 1, KM16, Jalan Gopeng, Kawasan Perindustrian Gopeng, 31600 Gopeng, Perak, Malaysia

E-mail:nor.hidayah@kkrtcg.edu.my

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