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Internet of Things for Enhancement the Quality of Community: Case Study of Aquatic Nursery in Songkhla Lake Basin

***Abstract**. The Internet for all things is commonly known as (IoT). This system allows users to achieve more in-depth automation, analysis, and embedment within a system. This paper proposes IoT-water monitoring system (WMS) for enhancing the quality of water for the fishing community aquatic nursery at Songkhla Lake Basin. The objectives of this work are 1) to study the embedded IoT-system used for water monitoring in an aquatic animal pond and to explore the relationship between water temperature and dissolved oxygen (DO) values. Both parameters, water temperature and DO are tracked to observe and analyze their relationship within a period time. The analyzed results using Pearson's correlation statistic found that the water temperature and dissolved oxygen values are negatively related. Namely, whenever the water temperature is high, the DO decreases accordingly and vice versa.*

***Streszczenie.** W artykule zaproponowano wykorzystanie Internetu Rzeczy IoT do monitorowania wody w Songkhla Lake Basin w Tajlandii. Monitorowano zależność między temperaturą wody i rozpuszczonym w niej tlenem DO. Znaleziono negatywna korelację, tzn im wyższa temperatura wody tym mniej tlenu. (**Zastosowanie Internetu Rzeczy IoT do analizy jakości wody w wylęgarni ryb w Tajlandii**)*

Keywords: IoT, water temperature, DO, WMS, Pearson's correlation
Słowa kluczowe: Internet Rzeczy, jakość wody

Introduction

Nowadays, IoT utilizes existing and emerging technology for sensing, networking, and robotics. It exploits recent advances in software, falling hardware prices, and modern attitudes towards technology. Its new and advanced elements bring significant changes in the information delivery of products and services to make human life easier and more comfortable. Moreover, it involved the social, economic, and political impact of those changes to connect the world. The applications of IoT in environmental monitoring are broad: ecological conservation, extreme weather monitoring especially, about dust monitoring in many countries around the world, which are facing air pollution.

In this study is to present the water and weather environments with the case study of an aquatic nursery center in the Songkhla Lake Basin, Thailand. The current monitoring technology for water and weather primarity uses manual labor along with advanced instruments, and lab processing. In this era of the 20th century, the IoT solution brings on this technology and directly reducing the need for human labor, allowing frequency sampling, increasing the range of sampling and monitoring, hence allowing sophisticated testing on-site through smart devices, and binding response efforts to detection systems. All of these benefits are to prevent substantial contamination and related disasters. More details of extreme monitoring from advanced methods currently in use allow in-depth tracking. New IoT advances promise more fine-tuned data, better accuracy, and flexibility. Moreover, effective forecasting requires excellent detail and flexibility in range, instrument type, and deployment. This technology allows early detection and early response to detecting loss of marine life and their environment.

Proposed functional architecture of IoT platform

The underwater networks will enable IoT monitoring in oceans, estuaries, rivers, lakes, streams, canals, and wetlands [1, 2]. Due to different wave propagation characteristics in the water medium from over-the-air (OTA), acoustic and laser propagation can be utilized to attain accurate data for underwater communication and networking.

1. Proposed IoT monitoring end device

This work proposes dissolved oxygen and temperature in the aquatic pond, of Songkhla Lake Basin, Thailand. The prototype is embedded with the limitation of two sensors, which are dissolved oxygen sensor and temperature sensor. Volume and quality of the detected information data generated by the wireless IoT module device. The IoT solution proposes a different approach from the traditional transaction-oriented analytic data. Coming from a pilot research by using bi-sensors and sensor-enabled devices, hence the obtained IoT data is more dynamic heterogeneous, imperfect, unprocessed, unstructured and real-time than typical collected data. With this reason it demands more sophisticated, IoT-specific analytics to make it meaningful. The proposed functional architecture of IoT-water quality monitoring as shown in Figure 1.

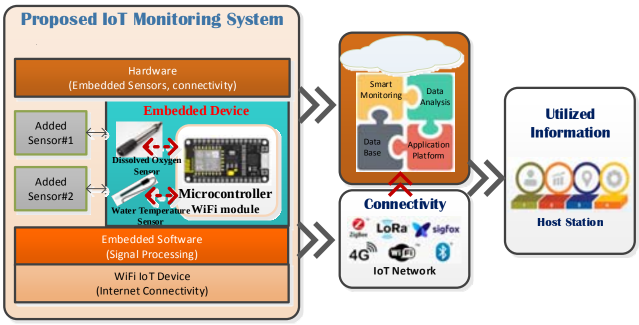

Fig.1. Proposed IoT monitoring system for nursery pond

Figure 1 presents the IoT monitoring system, which is used in the aquatic nursery in Songkhla lake basin. The broadest view of the proposed structure reveals two primary functions performed by an embedded design system. There are hardware and software sections, the central unit which the most important to manage all compositions within the IoT module is Microcontroller. Microcontrollers are of many types, depending on the programmer proficiency in programming. In this prototype, the ESP8266 ESP-12E UART WIFI wireless shield is adopted for controlling unit devices interfaced with WiFi IoT connectivity to achieve full compatibility standard. The critical factor in considering of the prototype design is low power consumption. The microcontroller board consumes a total power supply of 3.3V. It is an advanced chip more accurate and can lead to a WiFi module with an interface to facilitate adequate power supply and maintenance. The second section is the software programming to analyze data; typically in this part will be included with firmware [3]. The proposed Smart IoT monitoring device is not only hardware involved, but also it consists of an embedded software design with low power consumption on low-end IoT devices. The software programming on the IoT monitoring device module has been designed to support a firmware update mechanism. Namely, the device is provided with a bootloader, which is equipped with multiple bootloaders.

2. Proposed IoT relevant

The product cloud contains 4 primary duties, which are smart monitoring, database, data analysis, and application platform. The IoT relies upon edge components that collect sensed data, which can perform actions. These compositions need to run in the form of standalone devices, namely smart sensors that are embedded in larger systems. These edge components collect, store, and process data. The data transmission between the end device and the backend service, often, hosted within the cloud. Moreover, the data will be analyzed for utilization in a host station. The most important would be considered for the generation and analysis of data in protecting data throughout its lifecycle. The data management is quite complicated due to the data flowing across many administrative boundaries with different policies and intents under other users.

The IoT connectivity is to communicate and notify, which IoT is the network of things with clear element identification, embedded with software programming intelligence, sensors, and ubiquitous connectivity to the internet [4].

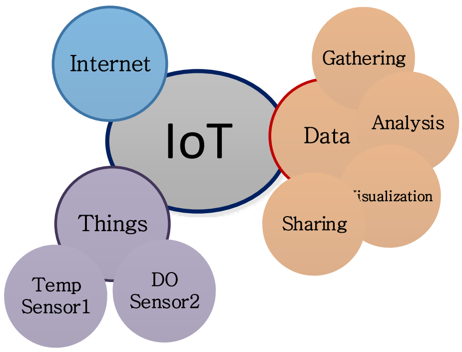

Fig.2. The components of applied IoT-water monitoring

Figure 2 presents the main concept of the proposed IoT water monitoring. It is physically connect with water quality sensing such as temperature, and dissolved oxygen sensors. The things as mentioned need to process over the internet for tracking and control functionality. In addition, data management is the one of IoT lifecycle, which is related to managing data as a valuable resource. IoT is usually involved with three key components, which are people, process, data and Things.

People: Connecting people in more relevant ways. Internet of People means all the internet applications used by people. People is the most important, which taking action based on notifications from connected applications. Internet of Every things is then combining the Internet of People and the IoT. The IoT makes lifestyle become worth with real-time monitoring, it connected with smartphone, smart watches, or smart home automation system [5].

3. Wireless IoT for Underwater Monitoring System

In this work, the smart IoT monitoring and controlling things from anywhere in the world is tested. The fundamental requirements are about the unique identity per "sensor" (IP address), which the ability to connect and communicate between sensors and other devices using wireless communication network. Furthermore, the design that is able to detect specific data (multi-sensors), such as temperature and dissolved sensors to connect with users. However, one requirement that is an important medium network to communicate between monitoring sensors and users. In this proposal, bio-sensors are sustainability things, which integral part of the paradigm can have a physical or virtual connection with the IoT system. These sensors interface is for networking and communication, which may have on-unit processing, data storage capabilities.

Cloud-based Storage and Data Analytics is an important parameter to be considered. The data from the aquaculture ponds are collected, and information needs to be intelligently analyzed, processed, and stored for more efficient use, all data can be searched back for research, actuation, and real-time decision making in the future [6]. This part supports the networks and communications. They are the interconnection of sustainability and sensor components.

The reliable and efficient communication in IoT applications is considered one of the most complex tasks in large-scale networks. All data communication networks, including IoT applications in use nowadays are based on the Open System Interconnection (OSI). The proposed sustainability IoT system consists of the interconnection of different elements, bio-sensors used to detect the water status, communication components integrated to perform certain unique functions based on the microcontroller with WiFi module. Thus, a holistic IoT paradigm in which different IoT systems work together to achieve goals for a particular environment [7].

Results and discussion

This study, the IoT water monitoring device (WMD) was tested, and the parameters of temperature have dissolved oxygen in the water. The tested results were fluctuated between 21.14 to 25.83 ^{o}C and 5.29 to 7.95 mg/L for temperature and dissolved oxygen, respectively. The obtained results are analyzed by using Statistical Package for the Social Science (SPSS) for Windows. The correlation coefficient was used to compare the relationship between temperature and dissolved oxygen. It was found that both variables are a negative correlation, which indicates that they are inverse relationships whereby one temperature increases, the DO decreases.

The DO value is an important indicator of water quality, ecological status, productivity and health of a water bodies. The DO concentration of 3 ml/L to 12 ml/L will promote the growth and survival of aquatic animal in reservoir. The range of DO recorded 4.8 mg/L to 8.2 mg/L shows that the water to be in good quality and will support fish production [8]. Based on the reference information and the obtained test results, it can be hypothesized that the water quality in the test pond was in good condition and suitable for survive of aquatic animal.

The results received is consistent with the study of N. A. Hussain and *et al*. [9]. The relationship between water temperature and dissolved oxygen illustrated the opposite relationship in Al-Huwaza, West and East Hammar marshes.

Figure 3 (a) and (b) compares the relationship between water temperature and dissolved oxygen values. The DO concentration in the aquatic pond was tested. The dissolved oxygen impacts the water temperature according to the season and daily cycle factors. Based on an individual test indicated that in the water that lower temperature can hold more dissolved oxygen than higher temperature water. Therefore, the weather in the water will change according to each season. The obtained results in Figure 3 (b) show clearly that the water temperature (Blue) and DO values are in opposite direction.

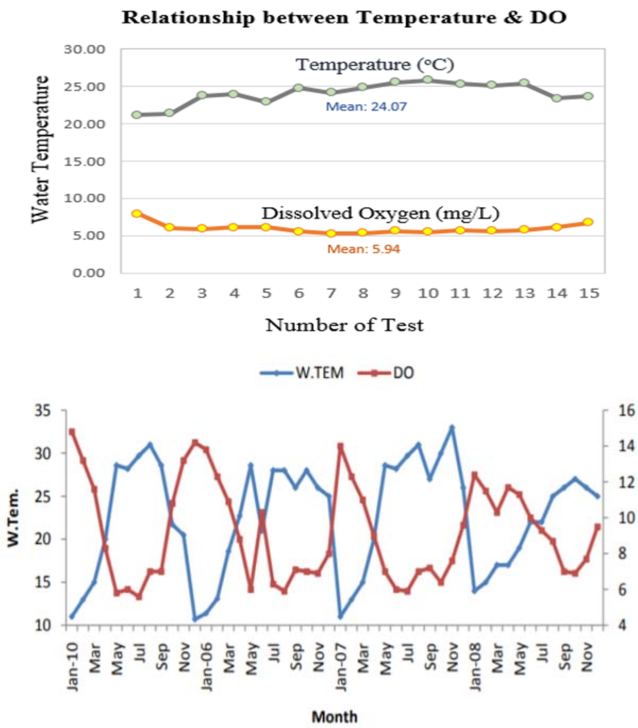

Fig.3. The relationship between water temperature and DO variables: a) Proposed test results of WMS. b) Reviewed test results (N.A. Hussain, 2010)

Table 1. The descriptive statistics of water temperature and DO variables

	Mean	Std. Deviation	N
TEMP	24.0727	1.43259	15
DO	5.9480	0.66852	15

Table 2. The correlation test results of water temperature and DO

				TEMP	DO
TEMP	Pearson Correlation			1	-.732**
	Sig. (2-tailed)				.002
	N			15	15
	Bootstrap[c]	Bias		0	-.008
		Std. Error		0	.126
		95% Confidence Interval	Lower	1	-.944
			Upper	1	-.473
DO	Pearson Correlation			-.732**	1
	Sig. (2-tailed)			.002	
	N			15	15
	Bootstrap[c]	Bias		-.008	0
		Std. Error		.126	0
		95% Confidence Interval	Lower	-.944	1
			Upper	-.473	1

**. Correlation is significant at the 0.01 level (2-tailed).

c. Unless otherwise noted, bootstrap results are based on 100 bootstrap samples

Table 1 summarizes the descriptive statistics of studied parameters of water temperature and DO. The water test was done between 9.00 am to 4.00 pm during sunny season. The averaged water temperature was 24.0727 ^{o}C, at the meanwhile DO variable was 5.9480 mg/L. The IoT-water monitoring was applied in the crab nursery pond. The data were sampled 15 times, approximately every half an hour. The standard deviation of data fluctuation was analysed during the test. It was found that the water temperature had a standard deviation (S.D.) value of 1.43259, while the DO had a S.D. value of .66852.

Both parameters to be considered of basic water quality for aquaculture. They are exciting parameters to analyze their relationship. Therefore, the Pearson Correlation was a statistical tool to analyse, estimate and summarise the relationship of them precisely. Again, the tested data were analyzed in detail using Pearson Correlation to verify. The results as shown in Table 2.

Figure 5 demonstrates in term of statistic proof test using Pearson Correlation statistic. The two parameters are analyzed by the Pearson correlation. The statistical analysis results indicate that the temperature and DO values have an analysis value of -.732**, which means that the relationship between them is at a slighly high level in a unconsistent direction.

Conclusions and future work

The IoT applications according to the problem situation is gaining momentum. This work presents the concept based on an individual application using IoT-water quality monitoring system. The proposed prototype was used for enhancement of the quality marine life for the fishing community of aquatic nursary in Songkhla Lake Basin. The usefulness of this application is helpful into protecting the crab life in an aquaculture pond. The IoT is high impact for human life, and fishing community. Moreover, it can be used for employing IoT to create new entrepreneur models, improve business processes, and IoT can help for reduction of lost and risks in business.

In the future, authors would like to present and discuss in more details about data management to get more efficiency. Data management obtained will be managed into the process of ingesting, storing, organizing, maintaining, and including of data sharing efficiency.

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REFERENCES

[1] Bell a., Applying human viewpoints to risk-based decision-making, In The Human Viewpoint for System Architectures, Berlin: Springer, (2019), 103-107
[2] Chi H., Welch S., Vasserman E., Kalaimannan E., A framework of cybersecurity approaches in precision agriculture, In proceedings of the ICMLG2017 5th International Conference on Management Leadership and Governance, (2017), 90-95
[3] Zandberg, K., Schleiser K., Acosta F., Tschofenig H., Baccelli E., Secure Firmware Updates for Constrained IoT Devices using Open Standards: A Reality Check, IEEE Acess, 7(2019), 71907-71920
[4] Rayes A., Salam S., Internet of Things From Hype to Reality, Springer:ISBN 976-3-319-99515-1, (2019)
[5] Meynecke J. O., Richards, R. G., A full life cycle and spatially explicit individual-based model for the giant mud crab (Scylla serrata): a case study from a marine protected area, ICES Journal of Marine Science, (2013), 2-15
[6] Abdul-Oawy A. S., Pramod P. J., Magesh E., Srinivasulu T., The Internet of Things (IoT): An Overview, International Journal of Engineering Research and Applications: ISSN: 2248-9622, 5(2015), No.12, 71-82
[7] Cookey P.E., Darnswadi R., Ratanachai C., Governing Songkhla Lake Basin, Thailand: the requirements for adaptive integrated lake basin management, 1st National and 2nd International Conference on Ecotourism and Social Development for ASEAN Community, (2015), 1-16
[8] Mustapha M.K., Assessment of the Water Quality of Oyun Reservoir, Offa, Nigeria, Using Selected Physico-Chemical Parameters: Turkish Journal of Fisheries and Aquatic Science, 8(2008), 309-319
[9] Hussain N.A., Lazem L.F., Resan A.K., Taher M.A., Sabbar A.A., Long term monitoring of water characteristics of three restored southern marshes during the years 2005, 2006, 2007 and 2008, Basrah Journal of Science, 28 (2010), No. 2, 216-227