Development of Smart Aquaculture Quality Monitoring (AQM) System with Internet of Things (IoT)

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***Abstract*— This project is focusing on enhancement of shrimp farm management through an embedment of multiple wireless communication technologies. The technologies of RFID, WSN, mobile application platform and IoT system will be embedded into one platform as an efficient solution for aquaculture quality monitoring (AQM). The proposed wireless system known as "Smart Aquaculture Monitoring with Internet of Things System (SAM-IoT)" is designed to collect data of pH level, dissolve oxygen (DO) and water temperature at shrimp ponds. The proposed active RFID tag will transmit the captured data to its reader which is also designed as an internet gateway. A low power consumption AVR microcontroller will be embed to both of proposed RFID tag and its reader for efficient power management. This M2M communication is designed to utilize 802.15.4 based mesh protocol of WSN platform. The internet gateway utilizes TCP/IP protocol to re-transmit the captured data to cloud database. Meanwhile, user of this dedicated IoT system can monitor the captured data in real-time through their own mobile device. To enable this mobile monitoring, an application for monitoring on mobile platform will be developed. This proposed mobile application also is developed to alert user if the current readings of sensors are exceeding the allowed threshold values. Fast rectification work regarding water quality of shrimp pond could be deployed through this feature. Therefore, the valuable captured data from this proposed SAM-IoT system can be accessed at anywhere on anytime as long as the internet bandwidth is available.**

Keywords—aquaculture monitoring, wireless sensor network, internet of things

I. INTRODUCTION

This project involves the embedment of multiple wireless technologies for AQM which is known as SAM-IoT system for shrimp farming industry and continuation to previous work in [1]. The main challenge in ensuring safe water supplying for shrimp production is to minimize the effects of water quality issues with an appropriate water quality monitoring mechanism. Generally, most of the shrimp operators apply manual water quality inspection at each of their shrimp pond. This process requires a number of human operators to inspect the shrimp pond in wide area. On top of that, it will cause a high dependency on the skills of the worker to perform AQM manually. High probability of human error could be an issue if they are not consistently

trained in performing manual AQM. This issue will eventually cause water quality problems that will decrease the number of shrimp production due to poor shrimp health. Referring to [2], the shrimp health is ultimately depends on water quality of their pond or farms. Nowadays, the coupled Radio Frequency Identification (RFID) system and embedded Wireless Sensor Networks (WSNs) become an emerging single platform of wireless technology which is widely implemented for water quality monitoring process. Each sensor node is specifically designed for low power consuming, low operating cost in a small form factor which are the key factors on large scale deployment of WSNs [3] for optimizing the water monitoring system. WSN platform enables multi-hop communication between RFID tags to offer long range of wireless communication. This long-range communication can be extended by implementing virtual private network (VPN) routers to cover wide monitoring area. Currently, IoT becomes an emerging technology as the advancement of cloud computing technology provides a large-capacity of data storage over internet. Therefore, by incorporating these different wireless technologies into one proposed solution known as SAM-IoT system, the productivity of shrimp farming will be improved. This proposed automated SAM-IoT system will provide an efficient AQM for shrimp farming which can improve the economic status of the involve entrepreneurs. Finally, it can also improve the country's economic growth through the aquaculture industry.

II. Methodology

This project involved several methodologies which are outlined as below:

a) The proposed mesh wireless system will be developed using four different wireless technologies including RFID system, WSN platform, mobile application platform and IoT system.

b) The DigiMesh protocol utilization is proposed which is less complexity than IEEE 802.15.4 ZigBee protocol thus allows fast configuration on its nodes which can be configured as a one role in the same wireless sensor network and can intelligently find their own radio path to transmit information to the proposed IoT gateway.

c) The disadvantages of current AQM process shall be improvised in term of the number of human intervention, system mobility, data reliability and automated alert system through mobile application platform

d) The transceiver circuit will be designed to be embed into proposed RF front end to be fitted in small form factor enclosure for high mobility and portability.

e) The proposed SAM-IoT system should be design with deep sleep mode support for ultra-less power consumption and built-in energy harvester in the power management circuitry.

f) This proposed SAM-IoT system for AQM process should be designed to support long range indoor communication and can be extended for broader coverage by applying network router.

g) The performance analyses of proposed SAM-IoT system should be carried out to evaluate and validate its capability to achieve the project objectives

h) The findings and data analysis shall be used as proof of concept to promote and create awareness for such technologies in improving the aquaculture quality monitoring.

Figure 1 shows all stages of development involved for proposed SAM-IoT system including the development of RF front end with its algorithms, cloud storage and webserver, mobile application and prototype system evaluation.

The architecture of this proposed system in AQM environment is illustrated in Figure 2. The multiple wireless technologies are consolidated into single platform of automated and smart AQM for shrimp farming.

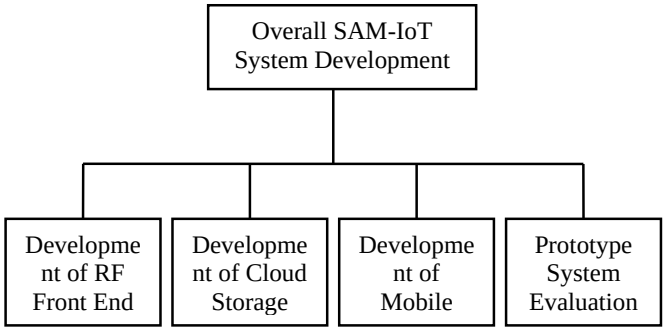

Figure 1: Overall proposed SAM-IoT system development stage

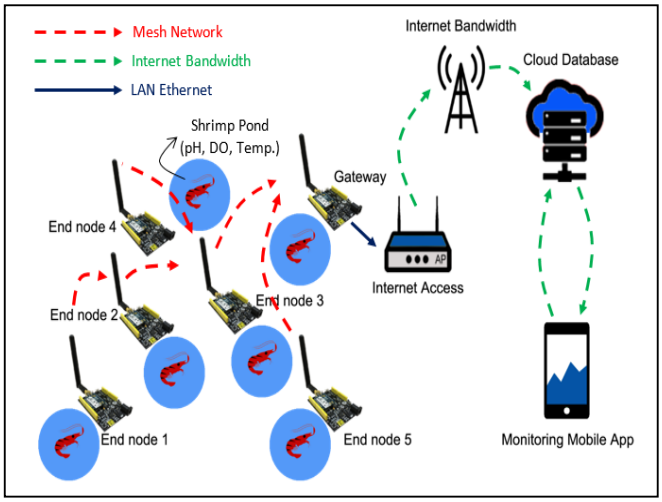

Figure 2: The Conceptual architecture of proposed SAM-IoT system in AQM environment

III. Conclusion

This project enhances the efficiency of current AQM method through multiple wireless technologies embedment. The RFID, WSN platform and IoT system are embedded together to become one smart automated system for AQM. Therefore, the shrimp pond can be monitored and managed efficiently by the user through real-time data capturing at low cost of operation with longer operation due to energy harvesting. This proposed SAM-IoT system is designed for greener and portability to support immediate mobilization from one location to another location of AQM spot without the need of fixed installation of hardware.

Acknowledgment

This work is the output of the ASEAN IVO (http://www.nict.go.jp/en/asean_ivo/index.html) project [Smart Aquaculture Quality Monitoring (AQM) System

with Internet of Things (IoT)] and financially supported by NICT (http://www.nict.go.jp/en/index.html).

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