AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Computer Engineering and Systems

Internet of Things for Aquaculture

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Electrical Engineering

(Computer Engineering and Systems)

by

Mohanad Mohamed Abdel Magid Abdel Khalek Odema

Bachelor of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

Faculty of Engineering, Ain Shams University, 2014

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Statement

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Aquaculture is the growing of fish in a controlled water environment. In order to ensure successful fish production, water quality parameters must be constantly assessed to ensure that the fish are grown in adequate conditions. Traditional methods for water quality assessment require periodic manual water inspections to retrieve water samples. Tests are then conducted on these samples in order to assess the water quality. These methods are effort and time consuming in addition to the manual inspections being costly especially in case of having to occasionally outsource a third party to perform the water assessment tasks.

The system proposed in this thesis serves as a more efficient alternative to evaluate water quality. It is based on the Internet of Things (IoT) technology where a single node has different types of sensors connected to it in order to constantly measure the different parameters. The node has also a number of actuators connected to it in order to keep certain water quality parameters within reasonable range. Through the Modbus TCP communication protocol, data acquired by this node is relayed to a certain client allowing remote monitoring. This client device allows the users to access the data, perform different analysis on them as well as control the actuators. In addition, this system presents as well an interactive alarm system informing the initiated of any irregularities plus controlling the actuators in case of any critical conditions.

Upon installation, it is pretty simple to use and access the node's information whilst maintaining the necessary security measures. The use of Modbus TCP as the communication protocol between the client and the node has rendered this system in conformity with the industrial communication standards. This enables the system to be easily integrated with other applications such as cloud computing where possibilities arise for further improving this system.

Keywords: Aquaculture, IoT, Smart Systems, Cloud Computing, SCADA, Modbus

Thesis Summary

This thesis aims to promote the development of an Internet of Things (IoT) based smart industrial aquaculture system. Aquaculture is the growing of fish under controlled conditions and since nutrition sufficiency threat around the globe is an issue, the need for simple, deployable and long-term solutions is dire.

Through this IoT based system, continuous monitoring and control of water quality parameters is available. Reaching a prototype system is a result of the integration of different parts including developing the node interfacing with the sensors, connection of the nodes with the server and developing the user interface.

Results of the system operation are collected eventually and analysis of the system performance and the challenges that arose is presented according to them. Choosing this topic is evident that utilizing the ever-growing IoT technology to develop such smart systems can provide reliable solutions for global issues.

This thesis is composed of six chapters covering the topic from its different angles. It includes a table of contents, lists of figures, tables and abbreviations in addition to one appendix and the references.

Chapter 1

This chapter is introductory providing the definition of aquaculture and its impact, the problem statement and motivation behind conducting the thesis in this topic.

Chapter 2

This chapter discusses how water quality, through its various parameters, is the key determinant in the success of aquaculture process. Also, the different types of aquaculture systems are discussed along with the merits and obstacles of these systems' deployment.

Chapter 3

Chapter 3 focuses on the core technology used for the development of such system which is the Internet of Things. It starts off with stating its history followed by the technology's paradigm discussion. The characteristics of the IoT technology are shown as well in addition to addressing topics such as the its integration with other technologies such as cloud computing.

Chapter 4

This chapter is concerned with the development of the system from scratch till becoming a prototype. It discusses the Modbus standard and how it is utilized as the primary communication protocol. The architecture of the system is then illustrated in detail showing what devices are needed to gather the required information and how this information is stored and displayed from the client side. The design of the printed circuit board mounted on the top of the Single Board Computer (SBC) alongside the installation and configuration of the software on the client side are also addressed. Finally, this chapter presents how this smart system can be integrated with a cloud platform.

Chapter 5

This chapter deals with the actual experimentation conducted on the system in real environment. The system has been deployed in an aquarium where the different water quality parameters' readings were recorded periodically. The chapter discusses the results obtained through a period of time as well as the arisen challenges and how they were dealt with.

Chapter 6

The final chapter presents the final conclusion and provides suggestions about issues to be addressed to enhance the system in future.

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