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Design and Implementation of Water TDS Monitoring and Control System Using IOT

G.indhuja[1],V.suganya[2],S.surendiran[3],M.vinisha[4]

ABSTRACT
Maintaining the water quality of a pond is one of the main issues on aquaculture management. Water quality represents the condition of a pond based on several water parameters such as dissolved oxygen (DO), temperature, pH, and salinity. All of these parameters need to be strictly supervised since it affects the life-sustainability of cultivated organisms. However, DO is said to be the main parameter since it affects the growth and survival rate of the shrimp. Therefore, a water quality control and monitoring system is needed to maintain water parameters at acceptable value. The system is developed on a mini-PC and microcontroller which are integrated with several sensors and actuator forming an embedded system. Then, this system is used to collect water quality data that is consisting of several water parameters and control the DO as the main parameter. In accordance with the stability needs against the sensitive environment, a fuzzy logic-based controller is developed to maintain the DO rate in the water. This system is also equipped with SIM800 module to notice the farmer by SMS, built-in wifi module for web-based data logging, and improved with Android-based graphical user interface (GUI) to perform user-friendly monitoring. From the experiment results, a fuzzy controller that is attached to the system can control the DO at the acceptable value of 6 ppm. The controller is said to have high robustness since its deviation for long-time use is only 0.12 ppm. Another test shows that the controller is able to overcome the given disturbance and easily adapt when the DO'S set point is changed finally the system is able to collect and store the data into cloud storage periodically and show the data on websit

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I. INTRODUCTION

The wastewater treatment process is a kind of complex large-scale system, and also an energy intensive process. For the urban wastewater treatment plan, about 50 to 70 percent of the total power energy is consumed in the aeration stage, and meanwhile the actual control method for the aeration process usual simple and crude. So it is possible to reduce the running cost of the entire wastewater treatment system effectively by using more accuracy control method. A kind of fuzzy logic control method to control the aeration process of the urban wastewater treatment plant was presented in this paper. It can control the aeration process by regulating the oxygen transmission coefficient according to the dissolved oxygen index. Simulation results show its validity[1].In a mixed liquor biological wastewater treatment process, the dissolved oxygen level is a very important factor. This paper proposes an adaptive neural network control strategy to maintain a set point in aerated bioreactors. The proposed method prevents weight drift and associated bursting, without sacrificing performance. The controller is tested on a simplified version of the benchmark simulation model number 1, with disturbances in influent. The proposed controller outperforms PI control[2].In the many part of the word, availability of potable water is an issue as it is contaminated, there are basic qualitative observations that quickly determine if water is not safe to consume. To prevent the pollution, first part is to detect that pollutant. This system is to develop, implement, monitor and control some parameter of water such as pH level, temperature, turbidity. In this system low cost sensors are used to control and monitor the parameters. Arduino UNO interface with LabVIEW[3]Water is a prerequisite element required for humans and therefore there must be mechanisms put in place to vigorously test the quality of drinking water in real time. This paper proposes a low cost system for real time water quality monitoring and controlling using IoT. The system consist of physiochemical sensors which can measures the physical and chemical parameters of the water such as Temperature, Turbidity, Conductivity, pH and Flow. By these sensors, water contaminants are detected. The sensor values processed by Raspberry pi and send to the cloud. Finally the sensed data is visible on the cloud using cloud computing and the flow of the water in the pipeline is controlled through IoT[4]. In order to solve the existing traditional rural drinking water monitoring in a lot of manpower, material resources, real-time, this paper introduces a WSN based on the rural drinking water source monitoring system design, the system consists of five parts: water quality monitoring, soil monitoring node node, node, routing node and gateway server. Water quality monitoring node, soil monitoring nodes send the collected data to the gateway node through the wireless module sent directly, or through the routing gateway node to the gateway node, each node of the data collection, unified by the GPRS module to upload server. The system can periodically detect the water quality and the important indicators of the soil in the rural water sources, and combine the water pollution with the soil non-point source pollution to realize on-line monitoring and provide guidance for pollution control. Network test shows that the designed system can realize data acquisition and remote transmission, stability, range of dissolved oxygen system for 1.09%~1.86% acquisition error, pH error is in the range of 0.64%~1.68%, Cu concentration in the range of error is 1.98%~2.22%, Cu concentration in the range of error is 1.58%~ 2.01%[5]. A review of the fundamentals of fuzzy sets, fuzzy rules and fuzzy inference systems is provided in this chapter. Beginning with crisp or classical sets and their operations, we derived fuzzy sets and their operations. Classical set membership functions and fuzzy membership functions are discussed in detail following set theory. Fuzzy rules are described using an air conditioner control example. The different defuzzification techniques and their processes are discussed with the same example step by step. Finally, some other fuzzy techniques are discussed such as off-line and on-line fuzzy control systems as well as a fuzzy closed-loop control system including multiple lookup tables. Because of space limitations, the author cannot cover all different fuzzy systems and their applications such as sliding mode fuzzy, adaptor fuzzy and neural fuzzy control systems in one chapter. With the development of new fuzzy techniques, fuzzy control will play a more and more important role in our society[6].Water distribution networks suffer from huge amount of losses due to frequent burst and leak events. This problem is conspicuous in intermittent water networks due to their inherent limited supply and service irregularity characteristics. A continuous monitoring of the operating hydraulic parameters of the network combined with accurate critical event detection can vastly reduce the ramifications of the problem. Wireless sensor networks (WSN) and the trending Internet of Things (IoT) technologies can offer a smart, low-cost, and scalable mechanism to attain such objective. In this paper, we present the initial phase of building a smart wireless system optimized for continuous monitoring of intermittent water distribution network (IWDN). The system design properly exploit the intermittent nature of the water supply in order to optimize the performance of the proposed system and algorithms. We demonstrate the system node and server prototypes and the performance results of the proposed adaptive Kalman filtering burst and leakage detection algorithm using simulated events and real measurement data from a case study of a pilot intermittent supplied district meter area (DMA)in Hurghada, Egypt[7]

II. RELATED WORKS:

There is plenty of control and monitoring system that has been developed in several kinds of research. In [7], an optimal PID control is used to manage DO concentration in the wastewater treatment plant. An expert system is also developed in [8] to control the DO rate in wastewater aerobics treatment process. A fuzzy logic controller can be used to control the DO concentration in an activated sludge process [9] and SBR water treatment process [10]. Another approach like a heuristic method such as neuraladaptive control is applied to control the DO of activated sludge bioreactors in [11]. Then, a nonlinear control is implemented to control the DO rate of Pseudomonas Putida bacterium fermentation in [12]. Several works about monitoring systems also have been developed in [13][14][15][16][17] to do continuously monitoring task with ease. In another hand, IoT-based system is performed to give effective monitoring and data recording in [18][19][20][21].all of the system have been proven to work properly in replacing human intervention on monitoring supervising and acquiring the data.

III. ORIGINALITY:

This research is giving detail development of WQCM system which is used to control and supervise the water quality of a shrimp pond. The water quality itself is represented by the value of DO, pH, salinity, and temperature. Several particular functions such as DO control, early warning notification, water quality monitoring, data logging, etc are integrated into this system to support the farmer in managing the cultivation. The system is equipped with appropriate sensors and modules to perform pond supervising. A control method called fuzzy logic is also used to control an aerator in maintaining DO at an acceptable value. By using WQCM system, the risk of shrimp death and losses are expected can be reduced. In other words, the cultivation results are expected to be better than the current traditional method which is not effective and causing cultivation problems. Therefore, the novelty and contribution of this research is the real implementation of the proposed system (WQCM) to overcome the aquaculture management problem, especially on indoor shrimp cultivation. Further analysis of system performance including the fuzzy controller during cultivation is described in experiment and analysis section.

SYSTEM DESIGN As mentioned in the previous section, there are several particular systems that have their own specific function in the cultivation process. The grand design of indoor cultivation with its particular systems can be seen in . There are several things to be concerned with developing the system. As the first step, a calibration for each sensor that is used to measure water quality parameter is performed.

4.1 **Sensor Calibration:** There are 4 kinds of sensors which are used to measure the water quality of the pond, that are: DO, pH, salinity and temperature sensors. In order to ensure that all sensors work properly and perform a correct measurement, each sensor is calibrated using several methods based on their characteristic. First, a statistical approach named linear regression is used to calibrate pH and salinity sensor. The sensor generates an analog signal to interpret the measured quantities. Then, the analog signal is processed by an analog to digital converter (ADC) in Arduino microcontroller to obtain its digital value. By using simple linear regression, the equation which shows the correlation between measured pH or salinity with the ADC value can be obtained. To perform this, 3 kinds of water solution with different pH and salinity with the ADC value can be obtained.

4.2 Monitoring System: After performing calibration for each sensor, we connect every sensors and modul to the microcontroller in acquiring the water parameters data. Then the data is stored to the cloud storage and processed for early warning notice or water quality control purposes. Block diagram of this system which shows the connectivity between equipment is shown in Water parameters which are pH, salinity, DO, and temperature is measured by the appropriate sensors. Temperature measurement is performed by AZ8403, then the data of temperature are sent to Arduino using serial communication. Thus, we use RS232 to TTL serial converter to transfer the data from AZ-8403 to the microcontroller. Meanwhile, DO, pH and salinity measurement are performed by analog sensors. However, the generated signals from each sensor are very weak to be read by the ADC, so a simple amplifier circuit is used to amplify the analog signal with the range of 0 – 5V. By using the calibration model that has been obtained in the previous subchapter, the ADC value can be converted to the actual value of pH and salinity. All of these measured parameters are 20*4 LCD so that the farmer can know the water condition at any time.

4.3 Early Warning System: As mentioned in the previous chapter, the system is able to give a warning notice to the farmer if any bad condition occurred. This system is equipped with SIM800 module to send an early warning notice by SMS once a time when a bad condition occurrs. The system will detect a bad condition and send an early warning SMS if measured water parameters are not in their acceptable values. The SMS is contained of kind of occurred bad condition and its recommendation.

4.4 Control System: An actuating device is needed to maintain the water quality, especially for DO parameter. Based on [1], an electronic device called aerator is used to flush the air into the pond by using a pipeline and aeration stones. The important thing that needs to be done before designing the fuzzy controller is knowing the working voltage of the aerator. To obtain its characteristic, several tests are performed to the aerator by giving various AC voltage from an auto-transformer. Then, visual justification is used to look at the bubble appearance in the water.

5.1 Early Warning Test: In order to ensure that early warning system works properly, we test it by moving the pH sensor probe to water tub which contains acidic liquid with a pH value of 4 and bases liquid with a pH value of 8.1. Thus, the system detects bad condition for cultivation process and send an early warning SMS to the farmer. Received message of early warning .

5.2 Control System Test: As in [1], the DO set the set point value is set to 6 ppm and the system is expected to control the air flushing and maintain the stability of DO around the setpoint value. DO response from the lowest state to 6 ppm .

5.3 Changing-Set Point: Test In this test, the setpoint value is changed from 6.5 ppm to 6 ppm. The goal of this test is to ensure that the system can adapt to changing set point.

5.4 Disturbance Test: This test is used to observe the system response when any disturbance occurred. The disturbance is given by switch the power line off so that the DO rate will decrease due to no aeration process [1]. Then, the power line is switched on again and the system is expected to control the DO automatically.

5.5 Long-Time Control: Test (Robustness Test) To test its robustness, the controller is applied for long-time use and expected to manage the DO with stability. To ensure its capability.

5.6 Monitoring System and Data Record: The system is implemented on a shrimp pond to measure water parameters and upload them to cloud storage. The system is tested for 31 days of cultivation to gather the data twice a day.

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BIOGRAPHIS

Ms.G.Indhuja received the B.E Degree from KSR college of Technology, Tiruchengodu, India in 2014.The

M.E degree from Annai Mathammal Sheela Engineering college Namakkal, India in 2018. Since 2018 she has been working as an Assistant professor in Annai Mathammal Sheela Engineering college, Erumapatty, Tamilnadu, India. She is member of ISTE.

SUGANYA V She obtained her BE of Electronics and Communication Engineering at Annai Mathammal Sheela Engineering college in Namakkal in 2022. Her research interest include ,basic python.

SURENDIRAN S

He obtained his BE of Electronics and Communications Engineering at Annai Mathammal Sheela Engineering College in Namakkal in 2022.His research include Basic python.

VINISHA M

She obtained her BE of Electronics and Communications Engineering at Annai Mathammal Sheela Engineering College in Namakkal in 2022.Her research include Java.