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Water Quality Measurement and Control from Remote Station for Pisiculture Using NI myRIO

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Abstract: *A Wireless sensor network is designed and implemented to automatically and remotely monitor and control the water quality parameters such as temperature, turbidity, pH and dissolved oxygen required for pisiculture. The measurements of the system which is at base station are communicated to the remote farmer through built-in Wi-Fi of NI-myRIO and displayed on user's computer screen from where he can monitor and change the settings of the system. An audio output is also produced from speakers of the computer. SMS alert is sent to farmer's mobile for variations in the monitored parameters of the system at the base station via GSM modem. The programming of the entire system is done using LabVIEW software and NI myRIO which has inbuilt processor, FPGA, Wi-Fi and web servicing capabilities. Web publishing tool of LabVIEW allows internet access to the front panel of the system to any remote user.*

Keywords: *Pisiculture, Wireless sensor Network, Water quality parameters, Measurement and control, LabVIEW, NI myRIO*

1. INTRODUCTION

Fisheries and aquaculture plays an important role in removing hunger, improving health and decreasing poverty. The most important form of aquaculture is pisiculture or (fish farming), where the fishes are commercially produced specially for food in tanks or enclosure. The fishes that are captured to fulfill the need from the natural resources like lakes, oceans and seas lead to overfishing and fall in the wild stock across the world. Hence there is a need of pisicultureto increase the production of fishes in order to meet the requirements. [1-3]

Among all the food commodities around the world, fish is one of the most traded commodities. Fish is the best and cheapest source of animal protein. A portion of 150 g of fish can provide about 50–60 percent of an adult's daily protein requirements [1].

Water bodies are generally not easily accessible and are more prone to pollution. Hence for healthy pisiculture, maintaining the quality of water is more crucial because fishes perform all its functions, such as breathing, reproducing, excreting its wastes, maintaining salt balance and eating and growing in water. [4]

Due to the numerous benefits associated with the wireless sensor network (WSN) such as easy deployment, network robustness, relative low implementation cost, unmanned operation & reduced maintenance complexity and with the wireless communication technologies like Wi-Fi, Bluetooth, GSM, GPRS etc, it is possible for the farmer to comfortably monitor and control the parameters from remote place.[5]

The main objective of this paper is todevelop and implement wireless sensor network to automatically and remotely monitor & control the water quality parameters (temperature, turbidity, pH and dissolved oxygen)in the pisiculture system. The advantages include GSM technology and web publishing tool, which updates the farmer about the status of the system, alerts him upon the deterioration of water quality and allows the internet access to monitor the status of the system on the computer remotely. The system is designed and programmed with NI myRIO-1900 device using LabVIEW software.

2. Related Works

An electronic system for the management of pond for fish/prawn cultureto measure the water quality parameters such as pH, DO, temperature, water level, dissolved carbon dioxide and dissolved ammonia is developed by **Kamisetti SNR, Shaligram AD & Sadistap SS.** It is capable of controlling DO using aerator. It also generates alarm if any of the parameters go out of range. An arragement for perodic cleaning of pond by flushing out the water is provided [2].

Vaddadi SK, Sadistap & Kumar Phave developed and implemented a wireless sensor network for measuring water quality parameters (dissolved oxygen, pH, temperature, environment pressure and conductivity) for aquaculture in multiple fish ponds. All these parameters are monitored in real time from remote place using Zigbee wireless sensor network and LabVIEW application software [6].

An automated real time monitoring system for monitoring water quality parameters such as PH, temperature and DO for fish farming is proposed by **Wen-Tsai S, Jui-Ho C & Hsi-Chun W**. The measurements are wirelessly communicated using zigbee. The contolling unit comprising of heating rod and air compressor which controls the changes in temperature and DO. The feeding system is also automated and the system is powered using solar panels. The application software is developed using Visual Basics [7].

Simbeye DS &Yang SF have developed and presented aZigbee wireless sensor network for monitoring and controlling water quality parameters (temperature, dissolved oxygen and pH) in aquaculture. An SMS alert is also sent to the owner. The developing software used is LabVIEW[8].

Epinosa-Faller FJ &Rendon-Rodriguez GE have developed a wireless sensor network using Zigbee to just monitor the water quality parameters such temperature, DO, water level, air pressure and electric current. When the parameters cross the desirable range then an alert is sent to the farmer. Email and SMS are also sent to the farmer so as to take an appropriate action. The measured data is seen on the computer monitor and also from web interface[9].

3. Scope of Research

There are various methods of pisiculturefollowed in India. But in many regions still they use old and traditional techniques, where the farmer visits the fish pond to monitor and control it manually i.e. he takes the water sample to the lab in order to know the values of the water quality parameters and then take appropriate controlling measures. This entire process is tiresome, lengthy and costly. In order to improve the yield of fishes, the farmer should continuously monitor for some critical parameters and maintain the records. This requires the system to be automated and new & innovative technology has to be used to simplify the maintenance complexity, fasten the process and finally earn good profit. [5-7]

4. Proposed Methodology

The crucial water quality parameters for pisiculturesuch as temperature, turbidity, pH and dissolved oxygen are measured using temperature sensor, turbidity sensor, pH electrode and dissolved oxygen electrode respectively.

These sensors are connected to the input of NI myRIO-1900 (National Instrument's LabVIEW product), which acquires the data from each sensor separately and compares with its desirable range required for pisiculture. All the controlling units like heater, filter, outlet water pump, inlet water pump and aerator are connected at the output of myRIO using relay. The relay is used to switch ON/OFF the appropriate controllingcomponent required to bring parameter in the desired range as shown in table 1.

The NI myRIO has built-in processor, FPGA and Wi-Fi. Programming of processor and FPGA of NI myRIO allows the automatic monitoring and controlling of the pisiculture system. The built-in Wi-Fi feature of NI myRIO is used to communicate the readings of all the sensors to the remote farmer. It is then displayed on the screen of the farmer's computer. He can then monitor and control them if required. An audio output of the readings is also produced from his computer's speakers. An SMS alert is also sent to the user if any of the parameters go beyond the specified range with the use of GSM modem.

The software programming is done using LabVIEW 2014.The web publishing application of LabVIEW is used, which allows any remote user to monitor the front panel of the program online.

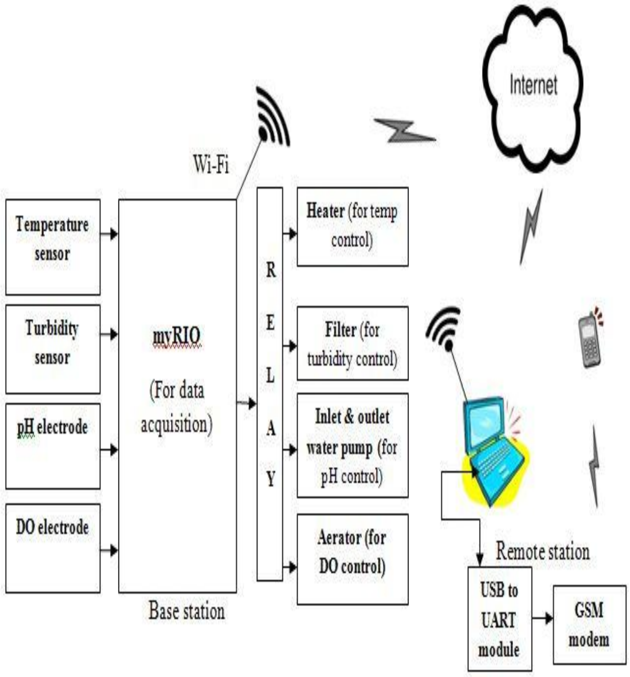

Fig.1. *Overview of system block diagram*

Table 1. *Desirable ranges of water quality parameters and controlling actions taken*

Serial number	Measured parameters	Unit	Desirable range		Measured values	Action taken
			Minimum value	Maximum value		
1	Temperature	Degree Celcius (°C)	20°C	35°C	<20°C	Heater is turned ON
					>35°C	Outlet water pump is turned ON & then Inlet water pump is turned ON
2	Turbidity	Nephelometric Turbidity Unit (NTU)	-	30 NTU	>30 NTU	Filter in turned ON
3	pH	-	6.5	9	<6.5	Outlet water pump is turned ON & then Inlet water pump is turned ON
					>9	Outlet water pump is turned ON & then Inlet water pump is turned ON
4	Dissolved Oxygen	Parts Per Million (PPM)	5PPM	-	<5PPM	Aerator is turned ON

5. Software Design

LabVIEW which is a graphical programming language is used here to program the entire system. It makes the programming flexible. The processor and FPGA of NI myRIO is pre programmed to automatically monitor and control the system. The host program is written to the processor of the computer.The front panel of the system is generated when real time program written to processor of NI myRIO and the host program written to the computer processor are executed as shown in fig 2. This front panel is used by the farmer to monitor and control the system which is at the base station. In the mean while SMS alert is sent to the farmer upon change in the water quality parameter from its desirable range and after the controlling action is taken as shown in fig 3 and the web page is created by configuring the web publishing tool of LabVIEW which allows the internet access of the system byany remote user as shown in fig4.

6. Results and Discussion

The experiment was carried out with portable water in a big plastic container acting as a mini pisiculture system. This is done to just check whether all the system components are working well. All the sensors such as temperature, turbidity, pH electrode and dissolved oxygen electrode are immersed in the water. The water heater and the filter are fixed within the fish pond.

The outlet water pump is also fixed within the fish pond with the water tubing connected to the container into which the water is to be pumped out. The aerator is fixed to the outside wall of the pond with the tubing let into the fish pond, from this tube the air enters in to the fish pond water. The inlet water pump is fixed into another container containing fresh water in order to pump in the fresh water into the fish pond.

Necessary wiring is done from each of these components to the myRIO using relays, adapters and main power supply.The GSM modem is connected to the computer through USB to UART module & USB cable, the SIM card is inserted in the SIM holder of the GSM modem powered using an adapter connected to the power supply.

The COM port number of the computer to which the GSM modem is connected and the phone number to which the SMS alerts are to be sent areentered in the host program of the application software.The Wi-Fi button on NI myRIO and on the computer is switched ON.

The real time program and the FPGA program dumped into processor and FPGA of NI myRIO and host programwritten on to the computer’s processor are executed on the computer. The mini pisiculture system starts working and displays the front panel of the system on the computer screen which contains the measurements of water quality parameter (temperature, turbidity pH & DO),working of the controlling component (heater, filter, aerator, outlet water pump or inlet water pump) when the respective sensor readings go beyond its desirable range & the SMS that is to be sent to the farmer.SMS alert is sent to the user when any of the parameter goes out of range and after it has been controlled.

Computer interface: The fig 2 shows the front panel of the system. The farmer can monitor the real time change in the values of the parameter and the controlling action taken at the fish pond from the monitor tab and can also change the predefined values of the parameters from the settings tab of this front panel. An audio output of the SMS that is to be sent to the farmeris heard from the speakers of the computer and also displayed on the front panel.

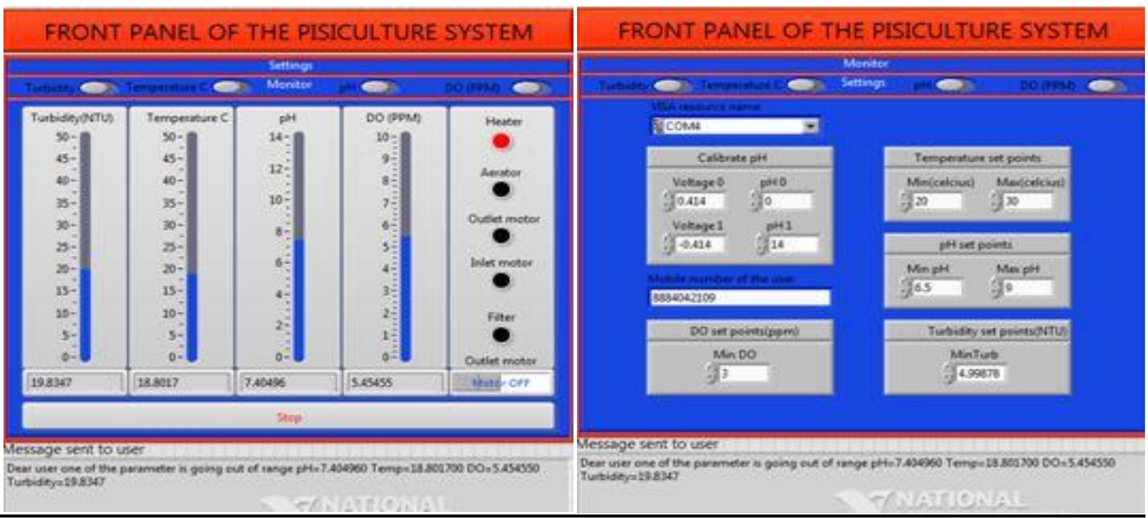

Fig 2. *Front panel of the system showing both monitor and settings tab*

In the front panel, when the parameters go out of desired range then the LED of the corresponding controlling component glows as per the table1 and after the controlling action is completed, then all the LEDs are turned OFF .

Mobile interface: The farmer receives a SMS when one of the parameters goes out of desired range and after the parameters are brought back within the desired range. This facilitates the farmer to know the values of the parameters & the status of the system even when he is away from the system and when not on computer. Fig 3 shows the SMS alerts that are send to the user's mobile from the system.

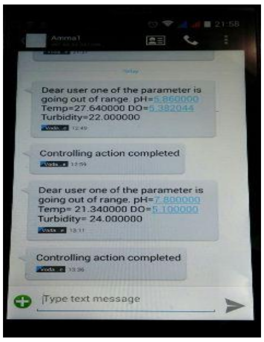

Fig 3. *SMS received on the users mobile*

Webpage

By configuring the web publishing tool in the LabVIEW, the front panel of the system can be made access to any other remote user who is online. It is possible by knowing the URL generated for the webpage of the system and when the farmer releases the control of the web page to the remote user. Fig 4 shows the generated webpage on internet explorer.

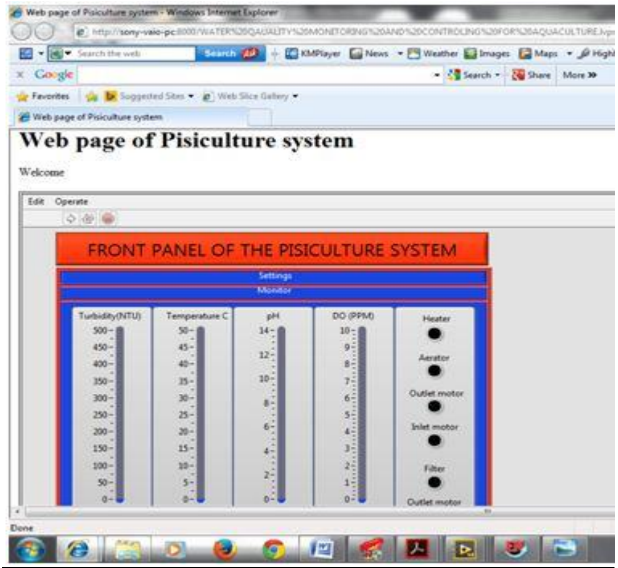

Fig 4. *The webpage of the system on internet explorer*

7. Conclusion

Wireless Sensor Network (WSN) for monitoring and controlling water quality parameters such as temperature, turbidity, pH and dissolved oxygen is successfully implemented and the system is capable of automatically controlling the water quality parameters within the desirable range suitable for pisiculture. Farmer receives SMS alerts at the right time when the parameters go beyond the specified range and when they are successfully controlled. The URL of the web page i.e. the front panel of the system is generated and tested for access in the other system connected to an internet.

Since the water quality parameters are interrelated, there measurements vary so frequently that controlling the parameters in the desired range is critical and it takes time.

On the programming side, working with NI myRIO is interesting and it is a flexible platform to develop the present application. The LabVIEW, being a graphical and user friendly programming language facilitates the easy coding of the proposed system and with less complexity.

8. Future Scope

The proposed system can be implemented in real pisiculture and in any forms of aquaculture like prawn farming, shrimp farming etc. Few more water quality parameters such as water level, electrical conductivity, unionized ammonia, dissolved carbon dioxide also can be monitored and controlled so that still better environment can be provided for the fishes to grow healthy and reproduce at a faster rate. The process of adding feeds and fertilizers can also be automated. The entire system can be powered using solar power in order to save the electrical energy.

The wireless network (Wi-Fi) range can be enhanced by further using repeaters, expanders etc. or by using any alternative wireless network that has vast coverage area. Usage of excess water can be saved by using water recirculating system.

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