Embedded Based Real-Time Monitoring and Controlling System for Fish Hatchery

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Abstract—In this paper a real time monitoring and controlling system for Fish hatchery is designed, developed and proposed. The pH, dissolved oxygen, salinity, temperature and water level are prominent parameters which are responsible for the sustained growth of fishes. Mainly hatcheries of fresh water ornamental fishes are concentrated. Dissolved Oxygen content is a highly important parameter which if not available in the required amount will affect the growth of fishes and even lead to death. Salt helps in fighting disease, parasites and chemical poisoning. The pH is a key parameter that has to be maintained between 6.0 and 8.0. Temperature is in turn another important parameter which affects the health of fishes as well as the pH value. The proposed system monitors and controls the above said parameters. A real time video streaming unit is also incorporated into the system in order to have round the clock surveillance of the farm. Web server is designed to host a portal and help the person in charge to monitor the farm remotely.

Keywords- pH, Dissolved Oxygen, Salinity, Temperature, Water level, Portal, Web server.

I. INTRODUCTION

A fish hatchery is a facility designed to raise fish. It provides an optimum environment for fish to grow by maintaining proper pH value, salinity, water temperature, oxygen levels, safety etc. In order to survive in fresh water, the fish needs a wide range of physiological adaptation in order to keep the ion concentration in their body balanced. Fresh water fishes require a salinity level of 0-0.05%. The pH is a key parameter which affects the life of fishes and is best between pH 7.0 to 8.0. Fresh water has a natural pH range of 6.0 to 8.0. The small changes in the value of pH make the life of fish highly stressful and toxic. Temperature is another key parameter that influences the value of pH. At elevated temperatures the toxicity level increases which affect the fishes. Salt being a natural ingredient make the fishes feel home and defeats toxic chemicals and avoid fish poisoning. It also helps to gain energy due to illness and stress and hence helps in their metabolism. In an aquarium like atmosphere the density of fishes is very high. The dissolved oxygen content can be very easily go down and it makes a hazardous situation. The water has to be aerated to top-up the oxygen levels. One approach to resolve all the above problems is to employ a sensor circuit which monitors the required parameters such as pH, dissolved oxygen, temperature, salinity and water level.

<table>
<thead>
<tr>
<th>SI No</th>
<th>Parameter</th>
<th>Standard values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dissolved Oxygen</td>
<td>&gt;4.0 mg/l</td>
</tr>
<tr>
<td>2</td>
<td>Temperature</td>
<td>Species Dependent</td>
</tr>
<tr>
<td>4</td>
<td>Salinity</td>
<td>Freshwater &lt;0.5 ppm, Brackishwater 0.5-30 ppm, Seawater 30-40 ppm, Brine &gt;40 ppm</td>
</tr>
<tr>
<td>5</td>
<td>Carbon dioxide (CO₂)</td>
<td>&lt;10 ppm</td>
</tr>
<tr>
<td>6</td>
<td>Ammonia (NH₃/NH₄⁺)</td>
<td>0-0.5 ppm</td>
</tr>
<tr>
<td>7</td>
<td>Nitride(NO₂⁻)</td>
<td>&lt;1 ppm</td>
</tr>
<tr>
<td>8</td>
<td>Hardness</td>
<td>40-400 ppm</td>
</tr>
<tr>
<td>9</td>
<td>Alkalinity</td>
<td>50-300 ppm</td>
</tr>
<tr>
<td>10</td>
<td>H₂S</td>
<td>0 ppm</td>
</tr>
</tbody>
</table>
exceeds, alkaline solution is poured in using a pump to maintain the required value of pH for water. A temperature sensor LM35 attached to the system senses the variations in water temperature and whenever the temperature exceeds the critical values, cooling system or heating system is activated in accordance to it. When the oxygen level goes below the critical value due to the high population density of the fishes the Aerator is activated to bring it back to the optimum condition. There is a water level sensing unit and using water pumps the water level is also maintained. Alarm goes on for conditions exceeding the optimum threshold levels. An alert message and the current parameter values are sending to the concerned persons mobile as well as to the system via GSM module, to inform the present status. For real time monitoring of the conditions, there is a wireless web cam which is used to stream real time video to the control room. The received values at the system are sending to a portal, so that the values can be monitored via internet.

III. HARDWARE DESCRIPTION

The monitoring system consists of Atmega32 microcontroller and a set of sensors. Figure 1 is the block schematic and Figure 2 is the circuit diagram of the system. In order to monitor the different parameters we make use of corresponding sensor units.

Each parameter is monitored continuously using different types of sensors and analysed the values for the requirement of control over the parameters. When the monitored value exceeds the critical limits, the controlling section comes into action and brings back the optimum condition. An alert message also will be sent from the control unit. The user is also updated with the scenario of the hatchery with the help of 24 hour video streaming, so that they can avoid intruders. For real time surveillance, even if the user is far away from the hatchery, can get the updates and monitored values and details of the hatchery, with the help of Internet. For that a portal is created, which gives the updated information.

A. Monitoring Sections

1) **pH:** In this project a glass type combination electrode type pH sensor is used. In that type the measuring and reference electrodes are joined together in a single glass body assembly. The pH measurement is comprised of two half-cells, or electrodes. One half-cell is the pH sensitive glass measuring electrode and the other is the...
reference electrode. Just as the two half-cell potentials of a battery are required to complete a circuit so does a pH sensor. It uses a potentiometric measurement technique. The mathematical expression for this is:

\[ E = E_m - E_r \]

Where,
- \( E \) = Potential developed at the electrode output
- \( E_m \) = the electrode potential of the measuring electrode
- \( E_r \) = the electrode potential of the reference electrode

Combined pH electrode is used to measure the value of pH which is a kind of immersion probe with a precision of \( \pm 0.01\% \). It gives an output range of 4 to 10. As the optimum range for fresh water fishes is 6.0 to 8.0, if the value drop is below 7.0, a pumping system is activated to pump in alkaline solution and thus brings back the optimum condition. The analog output obtained is given to the ADC pins of the AVR and the corresponding digital output is obtained. The range of pH required varies with fishes.

![Figure 2. Circuit Diagram for the monitoring and control system of fish hatchery.](image)

2) **Dissolved Oxygen:** To keep the water with saturated oxygen the water will be sprinkled through fresh air as fine particles and the water will be saturated. Additional aerator is also provided in the fish tanks for the additional supply of oxygen to the water.

3) **Salinity:** Salinity is the amount of dissolved salt in water. For fresh water fishes a range of 0-5 grams of salt per 1 kl of water is considered to be safe. Depends on the species of the fish an optimum value will be set. Salinity meter is used to check the salt content in water and the lower threshold level is set as 0.3ppt. If it goes below this, rock salt is pumped into water and thus optimum condition is maintained. Even if the fresh water is free from salt, to keep a better atmosphere for fish by keeping away the diseases, parasites and toxic items adding salt is a must.
4) **Temperature:** Temperature sensor LM35 produces an analog output with change in temperature which is about 10 mV per degree. The output of the temperature sensor is connected to the ADC pin of the AVR which gives a digital output which is then converted to degrees with the help of software. The lower and upper threshold is set as 20 and 30 degree Celsius respectively, as it is the optimum range for ornamental fishes. Fresh water is circulated to cool off the water and heater is switched on to heat the water up.

5) **Water level:** For different fish species, the depth of water they resides varies. So, water level too is an important factor in fish farming. In order to detect the water level, we make use of a variable resistance float type sensor. In which the resistance will changes with variation in water level.

![Figure 3. The float mechanism to sense the water level.](image)

The above figure shows how the water level indicator used in this project works. As it is a float type, it floats on the surface of the water. It moves up and down corresponding to the increase and decrease of the water level. Resistance values for two levels (level 1 and 2) are shown above. The output of this indicator is given to two ADC input pins of the AVR.

**B. Controlling Sections**

1) **Alerting Unit:** The main parts of the alerting unit are a buzzer and a GSM modem. The buzzer goes on for few seconds to alarm the person in the control room or in the vicinity of the system that one of the monitoring parameter has exceeded the critical value. The GSM modem is used to send alert and other messages to the concerned person. When a request is made via the web page to read a particular parameter value, the value will be read from the portal. The portal is updated at regular intervals or on demand.

![Figure 4. The Alerting Unit of the System.](image)

2) **Controlling Unit:** The threshold values of each parameter is checked continuously, when this exceeds a threshold critical value the alarm buzzer goes on, and a message is send to the user indicating the change in the parameter value, along with all this these parametric values can be viewed by the user through the web page provided, the current value and the history of values recorded with the help of the web server. This page can be accessed by the user from anywhere around the world via internet.
3) **Real Time Monitoring and Operation:** The wireless web cam connected in the system streams a real time view of the surroundings of the hatchery round the clock to the control room. The video sent are of 2.4 GHz RF to the wireless video receiver connected to a PC in the control room. The received video is thus viewed here using the software called as Honestech2.5 and any abnormalities or extra presence of weird things is identified. This software has the options to play, pause, re-play, rewind, stop etc., so that the video can be viewed conveniently according to the user’s need and time.

The web server designed is used to store the values of the monitored parameters in a database. A web page is exclusively designed for this project via Adobe Dreamweaver and Netbeans software. Html language is used to design and set the web page. Java is incorporated into this system to access the received parameter values via the serial port (GSM module unit) and store it in the database.

Initially a request is made from the embedded section to help understand the Java section about the GSM number. Once the request is made, the GSM number in the embedded section is extracted and stored for further communication. Then at each time the user requests the parameter values via a java application, it is send via GSM to the embedded unit, and the values are received in a specific format and are stored in a database. This message is received and processed at the destination and is understood that the pH value is been requested. Hence the pH value, the value is sent in this specific format. The received value is inserted into database tables and is uploaded to the web page. The user can hence view the received parameter value in the web site.

Jsp language is used to convert the html codes of the page to create each page in the web site. A user interactive section also provided in the web site so that feedback about this system can send.

IV. **SYSTEM OVERVIEW**

![System Overview Diagram](image)

Figure 5. System Overview.

V. **RESULTS**

### TABLE III

<table>
<thead>
<tr>
<th>SI No</th>
<th>Parameter</th>
<th>Standard values</th>
<th>Values changed by Action</th>
<th>Values corrected by control unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dissolved Oxygen</td>
<td>&gt;4.0 mg/l</td>
<td>Decreased due high population density of fishes</td>
<td>Corrected by aerator activation</td>
</tr>
<tr>
<td>2</td>
<td>Temperature</td>
<td>Species Dependent</td>
<td>Increase/Decrease</td>
<td>Fresh water flow/Heater operation</td>
</tr>
<tr>
<td>3</td>
<td>pH</td>
<td>7.5-8.5</td>
<td>Increased by Temperature increase</td>
<td>Corrected by Alkaline pump</td>
</tr>
<tr>
<td>4</td>
<td>Salinity</td>
<td>&lt;0.5 ppt</td>
<td>Fresh water salinity is naturally low</td>
<td>Increased to 0.3ppt by addition of brine for healthy surroundings for the fish.</td>
</tr>
</tbody>
</table>
Most of the critical factors which can affect the life of fish in a hatchery are identified and monitored in real time. Many of the parameters are controlled automatically without the intervention of human being. By this the volume of production can be improved and the cost can be reduced.

VI. CONCLUSION

The developed prototype can control the real time hatchery environmental factors such as pH, dissolved oxygen, salinity, temperature and water level. It has proven to successfully acquire accurate measurements for the above said parameters. The alarming message is sent to the user if the value monitored is more or less than the upper and lower threshold values respectively. So this helps us to monitor the fish hatchery and facilitate the stay of fresh water fishes comfortably. In future, the alerting system can be extended to applications of very long distances.

In this project, using AVR microcontroller for real time analysis and monitoring of pH, water level and temperature, we provide optimum conditions for the growth of ornamental fishes. Alarms are set for every system which goes on for conditions exceeding the optimum levels; also an alert message is sent to the concerned persons mobile via GSM module, to alarm the person about the present situation of the hatchery. A wireless web cam is used to stream real time video to the control room (PC) through wireless video receiver.

We have also implemented a website along with this project to make it more flexible and easy monitoring. Through this project, we can automatically monitor and control the water parameters. It’s very easy to install and maintain.

REFERENCES


BIOGRAPHY

Ajji Joy received his B. E. degree in Electronics and Communication Engineering from Mangalore University, Karnataka, India in 1996 and the M. E. degree in Power Electronics and Drives from PSG College of Technology, Tamil Nadu, India in 2008. Currently he is carrying out research at the PSG College of Technology, Tamil Nadu, India. His main interests lie in the architecture of Open CNC, PLC, and Embedded systems. He is working as Assistant Professor in the Department Electronics and Communication Engineering, Mar Athanasius College of Engineering, Kothamangalam, Kerala, India.