Appendix J: Proposal

I. Background
Aquariums (saltwater or freshwater) are used for study, display, and hobby. The fish, plant, or other life forms that live in these aquariums are often valuable and very sensitive to slight changes in their environment. Two water conditions that commonly cause stress or death in aquarium life when changed are temperature and pH. The temperature of an aquarium can change due to heater failure. Surprisingly, this is not an uncommon problem as salt or sediments, over time, corrode the heater’s functioning parts. Fish can tolerate a wide range of pH, but tanks with plant life require pH level between 7.5 and 9.0. Over time, the pH of the water will change due to excess carbon dioxide, nitric acid from biological filtration, and organic acids from waste.

Currently, the most common way to monitor these conditions is to take measurements on a regular interval. This is cumbersome, not always possible, and in the case of temperature ineffective. A drastic temperature change that will kill all life in an aquarium can occur in around an hour, depending on how powerful the heating elements and the amount of water in the tank. To prevent against a rapid change in water conditions that will kill life, Overnight Tank Syndrome (OTS), constant monitoring of pH and temperature are required. This is not possible for an individual to do. A system that sends notifications when necessary to the appropriate destination is needed to protect valuable aquarium life from OTS.

I. Thesis Overview
The Internet Aquarium Monitoring System (IAMS) will solve the problems associated with monitoring the most vital water conditions in conditioned aquariums, temperature and pH. IAMS will fit on the back of aquariums that are 10 gallons and larger. Sensors for temperature and pH will “stick” down in the water similar to a heater or filter. Real-time data concerning the water’s temperature and pH will be supplied to a Web Server and to an LCD attached to the aquarium through IAMS. The LCD will display the current pH and temperature. The Web Server will post the data on the Internet, allowing the water conditions to be monitored from wherever an Internet Connection exists. Also, when the temperature or pH falls out of acceptable, pre-defined levels, notifications will be sent in the form of email. By sending alarms when the temperature or pH has fallen out of acceptable levels, OTS can be avoided.

II. General Description
To complete this project, there are two major components that must be completed and configured to work together. The first of these two components, the Aquarium Monitoring Device (AMD) will take temperature and pH measurements, display these measurements at the aquarium, and send the data to the Web Server. The Web Server is the second major component, which will take the data supplied by the AMD, post it on the Internet in a meaningful way, and send alarms in the form of email when temperature or pH fall out of acceptable levels.

Figure 1: Major Components of the IAS
The AMD will have a temperature and a pH sensor that will be immersed in the water, a microcontroller, an LCD, and a RS232 port. The temperature sensor will consist of an IC Precision Temperature Sensor encased in a waterproof metal container. The housing for the temperature chip should be metal so heat is conducted easily to the IC chip. The IC chip produces voltage proportional to the temperature, which in turn can be interpreted by a voltmeter. The output data from the voltmeter can then be fed to the microcontroller on the AMD.

The pH sensor will consist of an electrode that will produce voltage proportional to the pH level of the water. The sensor will be purchased from Omega Engineering. The data produced by the sensor will then be used by the microcontroller to display the pH on the LCD and send data to the Web Server.

The microcontroller will contain hardware and software to display the pH and temperature on the LCD and to supply data to the Web Server through the RS232 port. When designing the microcontroller, power consumption will not be top consideration because the AMD will not be powered by batteries.

Figure 2: Block Diagram of AMD
The Web Server will run Internet Information Services (IIS) to post information to the Internet and will run a process that will constantly monitor the temperature and pH of the water. IIS is included in Windows NT 4.0 Operating Systems and above. IIS will use Integrated Windows Security to allow only authorized users of the computer to log on to the site. Real-time and historical data will be posted in a way that is easy to interpret.

The process that monitors the pH and temperature levels will compare the data that is supplied by the AMD and threshold values that will be defined by the user. When the pH or temperature fall out of acceptable range, the process will send notifications in the form of email that the water quality has fallen into a critical condition. Notifications will be sent every 30 minutes until a recognition is sent. The process will use IIS to send the email.

Data will be read from the AMD through the RS232 port that is included on all standard PCs. The RS232 port is a serial port that can be interfaced to peripheral devices.

![Figure 3: Block Diagram of Web Server](image)

### III. Components List

The following table includes the major items that will be required along with their estimated costs. As the project progresses, this list is subject to change.

<table>
<thead>
<tr>
<th>Category</th>
<th>Item</th>
<th>Description</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>Web Server</td>
<td>Server to display data on the Internet</td>
<td></td>
</tr>
</tbody>
</table>
Temperature Sensor | Water temperature sensor
---|---
Temperature Sensor Housing | Water-proof housing for the temperature sensor
pH Sensor | Sensor to measure the pH of the water
Microcontroller | Microcontroller for LCD display and to send data to the Server
LCD Display | LCD Display to be located directly on the device
Software IIS | Internet Information Services (Included with Windows 2000 Operating System)
Development Environment | Environment to develop all software in.

**IV. Time Schedule**
The following table lists the planned phases of the project.

<table>
<thead>
<tr>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research and Initial Planning</td>
<td>1/10/2002 – 1/22/2002</td>
</tr>
<tr>
<td>Web Server Configuration</td>
<td>3/1/2002</td>
</tr>
</tbody>
</table>

**V. Acceptance Testing**
The following is a list of what will be accomplished, at a minimum, and will be demonstrated.
- Completion of the hardware. Testing will demonstrate at a minimum, accurate temperature readings displayed on the LCD and sent to the Web Server. The housing for sensors will be shown to be waterproof.
- Correct configuration of the Web Server. Testing will demonstrate that security has been correctly set up to allow only authorized persons access.
- Development of the Server software. Functionality will be demonstrated by sending email notifications when critical water conditions exist. This also includes software to display data in a meaningful way over the Internet. Demonstration will show real-time measurements and historical data through a browser.

**VI. Summary**
Temperature and pH are two water conditions that can kill fish, plants, and other life in an aquarium when not at acceptable levels. A system is needed that will monitor these conditions around the clock and send notifications when temperature or pH becomes critical. The Internet Aquarium Monitoring System will fill this need by displaying real-time measurements of temperature and pH at the aquarium and over the Internet, and also send notifications in the form of email when a critical condition arises.
This will be accomplished through two main components: the Condition Monitor and a Web Server. The Condition Monitor will consist of a sensor for temperature, a sensor for pH, a microcontroller, an RS-232 port, and an LCD to display the measurements. The Web Server will be running Internet Information Services (IIS). Internet Information Services will be used to display data over the Internet and to send email.

This project will be completed during the Spring Semester of 2002. The estimated cost of parts for this project is $350.00, and will be funded by myself. The research, design, and implementation of this project will all be done by myself.