WIRELESS SENSOR NETWORKS FOR WATER QUALITY MANAGEMENT

10 January 2008
Outline

✓ Project goals
✓ AquaWSN System
✓ The hardware Implementation:
  • Interface circuits
  • Solar charger
✓ The software implementation:
  • Software modules
✓ Calibration of sensors
✓ Conclusions
✓ Future work
Goal:
- To measure the water quality, regularly and automatically, using SUNSPOT and present the output in readable format.

Requirements:
- Design and develop, Low power, Low cost, Automatic WSN system
- Deploy the system in Mudi dam, Malawi
Aqua WSN System

Input Sensors → SunSPOT Client
                 - Data processing

Output
     - SunSPOT Base Station
     - Monitor System
Sun SPOT

- **Analog inputs:**
  - Pin A0-A3
  - Sensors output can be connected
  - Accept 0-3 V
  - Higher than 3.5V, device will be damaged
  - ADC converter, 10 bits

- **High current output:**
  - Pin H0-H3
  - Pin 9 (V_H) should be powered (4.5V to 18VDC)
  - Can be used to drive relays
Task I: Connecting the output of sensors to the eDemo board of SunSPOT through interfacing circuit.

Sensors → voltage output → Interface circuit → Accepted voltage output → SUNSPOT
pH Interface circuit

\[ \text{Ph} = 0 - 14, \ V = +413\text{mv to } -413\text{mv} \quad 0 - 3 \text{ V} \]

pH:
- Measures the Alkalinity (-mv), and Acidity (+mv) of water.
For example: 7.00 pH = 0mV, 8pH=-59mV, 6pH = +59mV
- Out put voltage is in mv.
- Output is sensitive to temperature changes

Interface Circuit:
- Amplifies the mV output in 2 stage to 0-2.8 V accepted by SUNSPOT
- Temperature change is not considered
- PCB design is required
Redox Interface circuit

Redox:
- Measures the amount of oxygen in the water
- Output voltage is in mv.
- Output is sensitive to temperature changes

Interface Circuit:
- Amplifies the mv output to 0-2.5 V accepted by SUNSPOT
- Temperature change is not considered
- PCB design is required
Turbidity:
- Measures the **clarity** of water.
- 4000 NTU (Nephelometric turbidity unit)
- Output is sensitive to the light of the nature and position of the sensor

Interface Circuit:
- Transfers the **0-5 V** output to **0-3 V** accepted by SUNSPOT (gain is 0.6)
- **Maximum** output is limited to **3 V**
- PCB design is required
Solar Power

Task II: Solar power control system for charging Sunspot batteries and sensors

Diagram:
- Solar Cells
- Regulator
- DC/DC Converter
- Accumulator or Capacitor
- Power supply of Relays, Transmitter, SUN SPOT, High current supply, and Turbidity sensor
Solar Power cont.

solar panel → regulators → accumulator → voltage output (5V, 9V)

Regulation part in detail.
Software: The Big Picture

AquaWSN Software Deployment
Software: Interaction & Features

- Base Station: Time Synch
- SUN Spot: Time Synch with Self Fixing
- Base Station: Data Trans
- SUN Spot: Acknowledged Data Trans
- Base Station: Mutual Synchronization
- Base Station: Acknowledgement Receiving
- SUN Spot: Optimal Sleeping Control

AquaWSN Features
Data Fetch & Backup Module

1. Base Station
   - Yes: Data Transfer → Data Request
   - No: Backup Data

2. Data Transfer
   - Data Request: Fetch Data

3. Fetch Data
   - Data Request: Backup
   - Reply: Current Data

4. Backup
   - Backup Data

Flowchart showing the process of data fetch and backup, with decision points and data flow.
Configuration Module

C:\AquaWSN>java writeconfig
Enter the Pin No (Range 0-3)
1
Enter the No of Samples (Range 1-999)
10
Enter the Base Station Address (Format Required:--> 0000.0000)
0000.0EAA
Enter Time after that samples are required to be taken)
24
YOU ENTERED THIS INFORMATION-->1:10:0000.0EAA:24
IT IS REQUIRED TO CONFIRM THIS BY EXECUTING FOLLOWING COMMAND
ant deploy run
C:\AquaWSN>
## pH sensor calibration

<table>
<thead>
<tr>
<th>Input Method</th>
<th>Results / Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal source/Power supply</td>
<td>- No Significant difference between the two measurements.</td>
</tr>
<tr>
<td></td>
<td>- Output of the pH sensor circuit against ideal input signal is linear</td>
</tr>
<tr>
<td>Three standard pH solutions: pH4, pH7, pH10</td>
<td>- Deviations from the real pH values.</td>
</tr>
<tr>
<td></td>
<td>- Further calibration is necessary</td>
</tr>
<tr>
<td>Self made water samples.</td>
<td>• The results were not linear in all cases.</td>
</tr>
<tr>
<td></td>
<td>• Inaccurate alkalinity of the samples.</td>
</tr>
<tr>
<td></td>
<td>• Unnoticed bobble on the node of the sensor.</td>
</tr>
</tbody>
</table>
# Turbidity sensor calibration

<table>
<thead>
<tr>
<th>Input method</th>
<th>Results /Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Standards water samples</td>
<td>• Non linear results obtained</td>
</tr>
<tr>
<td>4 Self supply water samples from the Lake Mälaren.</td>
<td>• No standard samples available</td>
</tr>
<tr>
<td>10 Self supply water samples from the lake Mälaren.</td>
<td>• Calibration method not adequate.</td>
</tr>
</tbody>
</table>
Conclusions

• Monitoring water quality using: pH, Redox and Turbidity.
• Designing and implementing Interfacing circuits.
  Sensors -> Voltage output -> Interface circuit -> voltage output -> Sun SPOTs.
• Designing and implementing Solar Power.
  Solar panel -> Capacitor -> Voltage output (5V, 9V)
• Designing and implementing the software.
Future Work

• **Hardware**
  - Temperature compensation
  - PCB design

• **Software**
  - Data Fetching noise removal
  - Gui for configuration module

• **Calibration**
  - Redox sensor calibration
  - Repeating the calibration with PCB circuits and temperature compensation
  - Deployment
Thank you for listening!

http://www.tslab.ssvl.kth.se/csd/projects/0726/

Team Members:
- strikos@kth.se
- ergawy@kth.se
- Siraj@kth.se
- ntareme@kth.se
- Kewang@kth.se
- moze@kth.se

Principal: Marco Zennaro
Coach: Awet Yemane
Co-coach: Neda Farahbakhshzad
Co-coach: William Sandquist
Teaching team: Björn Pehrson