OVERVIEW

Keysight tasked our team with creating an Internet of Things (IoT) case study implementing their IoT Development Kit that has the potential to increase efficiency and simplify everyday life for consumers. Our team has chosen to create a Smart Water Management System for livestock owners that will keep track of water levels and temperatures in outdoor tanks and troughs and be able to detect freezing conditions, all while sending real-time updates to a cloud interface.

OBJECTIVES

Primary Goals:
- Establish communication between the U3800A and the Zigbee
- Measure water level and water temperature from a remote location
- Detect Freezing conditions
- Implement automatic updates to the cloud to be checked by user
- Write data to an SD-Card
- Display water level on LCD

Stretch Goal:
- Implement the automatic opening and closing of valves
- Obtain accurate data from the water level and temperature sensors connected to the Zigbee
- Upload real-time water level data to the cloud

KEYSIGHT TECHNOLOGIES

Keysight Technologies Inc. is the world’s leading electronic measurement company, transforming today’s measurement experience through innovations in wireless, modular, and software solutions. With its Hewlett-Packard and Agilent legacy, Keysight delivers solutions in wireless, communications, aerospace and defense and semiconductor markets with world-class platforms, software and consistent measuring science.

BENEFITS

-Safety
Prevent risk of travelling to water stations in freezing conditions to manually turn off valves

-Time
More time to focus on other tasks instead of traveling to each water station multiple times a week

IO Development Kit

U3800A Specifications:
- Intel Edison compute module
- WLAN 802.11 a/b/g/n, Bluetooth LE, & Zigbee wireless connectivity for wireless communications
- UARTs, I2C, SPI, SD card, & LCD communication interfaces

XBee Zigbee Specifications:
- UART & SPI communication interfaces
- RF data rate of 250 kb/s
- 1200 meter outdoor line-of-sight range

FREEZE DETECTION METHOD

Test to determine if and when freezing conditions are near or present. If conditions are met the system will send a signal to close the valves on the pipes to prevent damages and re-open the valves once the water warms up above freezing.

DATA ACQUISITION/DISPLAYS

Steinhart-Hart Equation:
Thermistor – Temperature Relationship

\[
\text{Temp} = \left( \frac{1}{g} + 1 \ln \left( \frac{R}{R_0} \right) \right)^{-1}
\]

\[
R_{\text{sensor}} = \frac{A \cdot g}{R_0} - 1
\]

LCD Screen Display:

Sensor Data

Water Level

Water Temperature

Freezing Conditions

Communication

SD Card File:

Console Screen Display:

The water level sensor provides accurate readings
The water temperature sensor provides accurate readings
Signals must be sent to the XBee when the temperature reaches 34 degrees F
No signal is sent when the temperature drops below 34 degrees F

RESULTS

<table>
<thead>
<tr>
<th>Test Case</th>
<th>Specification</th>
<th>Result</th>
<th>Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Accuracy</td>
<td>Water temperature sensor provides accurate readings</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Reading Accuracy</td>
<td>Water temperature sensor provides accurate readings</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Data Transfer Efficiency</td>
<td>Data must be transmitted and received between the U3800 and XBee</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Communication Range</td>
<td>The U3800A must be able to receive data from the XBee from a distance of at least 100m</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Communication Range</td>
<td>Data must be transmitted and received between the XBee and the U3800A</td>
<td>Yes</td>
<td></td>
</tr>
</tbody>
</table>

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