PROGRESS OUTCOME 5

Irrigating the orchard

Context

Katie's aunt owns a citrus orchard in Northland and has issues with irrigation. Her concerns include knowing how much water is in the dam and where water is going in the orchard, ensuring she only accesses a certain amount of water each day, and making sure there is always enough residual water for the volunteer fire brigade.

She has asked Katie to help her find a way to manage her water use through both an automatic and a manual interface.

Insight 1: Investigating the issues

I went on a site visit with Auntie Jane to see the orchard and how it's laid out. After she had gone through the requirements for the project, I was able to start thinking about a range of considerations. These included:

- the systems that were currently set up – I sketched out the existing watering system, which was basically a timer on a pump sending water to irrigation hoses
- the electronics required for the size of the orchard
- how to maintain awareness of water levels in the dam
- the requirements for fire fighting
- how much water can be taken off the dam
- reliability concerns.

I then started thinking about how I could respond to each consideration.

Insight 2: Planning the outcome

I drew a number of interface sketches to help determine component selection and showed my ideas to my teacher and an electronics engineer to confirm my modelling process. I then carried out virtual testing of the components that I could possibly use.

The orchard is large and on a terrace so I needed to consider requirements such as longer watering times on the upper terraces and shorter times on the lower terraces. There was also a requirement that watering takes place until soil moisture sensors are at a certain resistance.

Using RF transceivers like the Dorji ASK modules, HC-12 short-range modules or LoRa long-range modules that enable remote data packet exchange would allow for a more 'internet of things' approach.

Components and sensors I determined I would need to test and configure included:

- a DC solenoid valve component such as the H-Bridge L9110H
- a decoupling capacitor to stabilise power supplies under high current loads
- analogue (resistive) moisture sensors to measure what level the dam is at
- digital temperature sensors such as the DS18B20
- an I2C-based sensor such as the BME280 digital sensor
- user Interface controls and feedback
- some SPST-type tactile switches, or a keypad (if many input switches are needed, a shift register may be appropriate)
- an LCD/OLED display via parallel or I2C communication
- a real-time clock with a secondary power supply.

Insight 3: Testing components and improvement

I tested the components to make sure that the system I was planning would work at a conceptual level and could be iteratively developed. I worked out the amount of current that would be needed and how to develop the required checks and balances to ensure the system was accurate and reliable. I also tested the input interface on expected sensor inputs, automated timing events, and manual interrupts.

I made a small-scale model to test the concept using an online circuit simulator. I started thinking about how to control the flow to the irrigation lines. I tested the relay to ensure that if the water level was low, the pump would not be turned on.

I discovered that a power cut in the area would mean that the time would be lost and reset to 1 January 1970. In my third version, I set up a clock module with battery backup using an RTC (real-time clock) to make sure it would function reliably in the future.

Insight 4: Meeting end-user requirements

I tested the orchard control system and made sure that it worked for Auntie Jane, who was able to control the timing and manual settings via her cellphone using Serial Bluetooth. This allowed me to shift the focus of interface design from the electronics system to an iOS or Android app interface. Using MIT App Inventor allowed for quick prototyping of Bluetooth-enabled apps without the need for high levels of software coding knowledge.

Auntie Jane now could set the upper and lower limits of the dam-filling system and control the times when the pumps turned on. She checked to see if water was coming out in the rows she wanted to irrigate.

Insight 5: The choice of components and subsystems

I decided to use an RTC instead of moisture sensing to automate the timing of the irrigation system because the soil moisture levels varied across the orchard rows due to the contours of the land.

I decided not to add multiple sensors as a trade-off between accuracy and dealing with multiple data readings. After analysing the maximum water capacity of the dam, I modified the timing of the valve to avoid over-filling and over-emptying.

ISBN: 978-1-77669-251-4

MINISTRY OF EDUCATION
TE TĀHUHU O TE MĀTAURANGA