IoT-based Precision Irrigation with LoRaWAN Technology Applied to Vegetable Production

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Introduction

- Agriculture accounts for 80% of water use in the US.
- Deficit or excess of water affects yield and quality of vegetables.
- Conventional irrigation is based on experiences and time availability.
- Precision irrigation decreases cost of water and manpower, and improves crop yield and quality.
- Internet of Things (IoT) makes farmers monitor the field and apply irrigation online.
- LoRaWAN, a new network technology, is not widely used for vegetables irrigation.

Materials and Methods

Experimental Setup

- 4 main pipelines for 4 treatments.
- 3 beds for 3 replicates.
- 0.60 m wide, 1.8 m apart center to center, mulched with black polyethylene film.
- Pressure regulated to 15 psi.
- Pressure sensors measure the water pressure in pipes, indicate if water is on.

Sensor system setup

- Control board
- Supports 8 sensor ports and an irrigation unit
- Soil water content (SWC) sensors
- Pressure sensors
- Soil water potential (SWP) sensors

Technology | Network type | Frequency | Range | Data rate | Power | Security
---|---|---|---|---|---|---
LoRaWAN | LPWAN | 915 MHz | 10 km | 0.3-50 kbps | 10mW | AES 128 bit
LTE | GERAN/UTRAN | 700-2600 MHz | 10 km | 0.1-1 Gbps | 1 W | 3GPP 128-256 bit
Wi-Fi | WLAN | 2.4, 3.6, 5 GHz | 100 m | 6-780 Mbps | 1 W | WEP, WPA, WPA2

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Results

- Read sensor data and control valves online stably.
- 4.3% data loss with a 300 m distance from gateway to sensors. May caused by obstacle of walls, long distance, and gateway performance.
- Most sensor boxes worked continuously without changing battery. SWC Sensor box often went down and had wrong readings because of false continuous power supply.

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The system can successfully read sensors data and control valves online with a acceptable data loss and low power consumption. SWP sensors work well for the system. But there are problems with SWC sensors power supply.

Conclusion

Testing period: 11/20/2019
- All production data because of no water supply in freezing winter.
- SWP of T2 and T3
- Start on 11/20/2019
- After irrigation on Day 6, sensor readings increase and then gradually decrease.
- 24 hours data on Day 6.
- It took a few hours for the sensor readings to be stable.

No production data because of no water supply in freezing winter.

Feasibility of the IoT system

- Read battery voltage, SWC, SWP, pressure, and valve status.
- Control valves by switching the button.
- Notify farmers when thresholds are reached by mobile app.

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