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LoRa Wireless Micro Irrigation: Advantages and Challenges

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Abstract

Water management in Agriculture is a challenging task. Traditional irrigation systems like flood irrigation and micro irrigation may give too much or too little water, which causes improper crop growth and yield. Automating micro irrigation makes water usage more accurate. LoRa technology is suitable for this, because it has long range communication and works even in remote areas where internet or mobile network is not available. This paper presents a simple LoRa based wireless micro irrigation model that operates without internet and supports operation of Pump and latching solenoid valves using very low power. The concept, workflow, advantages and challenges are discussed in this paper.

Keywords: *LoRa, LoRa WAN, latching solenoid, micro irrigation.*

1. Introduction

Irrigation management is a challenging task in agriculture, one of the traditional irrigation method[1], flood irrigation is so popular and it is the oldest irrigation method in the world. Other classical irrigation methods like drip or micro irrigation methods are used by the many Farmers for their Farmlands. Many more fields are neither autonomous nor automated. Traditional methods causing under irrigation or over irrigation of the crops, these systems are operated manually or some setups are semi automated but not autonomous. Lack of the long range automation leads to Farmer involvement in irrigation. Irrespective of day or night, weather conditions, Farmers have to visit their Farms to switch off/on the pump set and valves have to be operated manually to irrigate their crops in micro irrigation. Un availability of long range operation setups or autonomous systems made the task of irrigation is a challenge. Sometimes Farmers forget to switch off the pump sets, this causes wastage of water and electricity and increases stress on aquifers. As a result, there is no sufficient water in summer, leads to crop loss, causing economical stress on Farmers. Huge losses are causing the poverty among Farmers. LoRa is a viable solution for all the irrigation related challenges as it does not need internet, can cover 10 to 15 Km range, Lora wireless micro irrigation system is energy efficient and maintainable by the Farmers.

2. About LoRa Technology

2.1 LoRa Basics

LoRa is a wireless communication technology. Abbreviation of LoRa is Long-range. LoRa transceiver can send and receive the signal in range of 10 to 15 Km in rural area and 2 – 5 Km in urban areas. This technology enables Farmers to operate their pump sets and valves remotely [5][12].

2.2 Frequency Regulations in India

The approved frequency from DOT, TRAI of Government of India is 865-867 MHz. This is freely available frequency and need not pay to the any agency to utilize this frequency. So it is ideal to use in Agriculture.[1][5].

2.3 About LoRa WAN

LoRa WAN is the gateway for LoRa technology. It is above the physical layer of LoRa and enables communication among nodes. LoRa WAN works with the 12V battery. Supports Aurdino, Raspberry

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Pi and NVIDIA jetson boards for logic execution. [13],[14]

2.4 Nodes

Sensors and other end devices used in LoRa micro irrigation are called as Nodes. Temperature sensors, Humidity sensors, Light intensity sensors, Pressure sensors and other end devices are end nodes. Figure 1 LoRa shows Architecture for Micro Irrigation

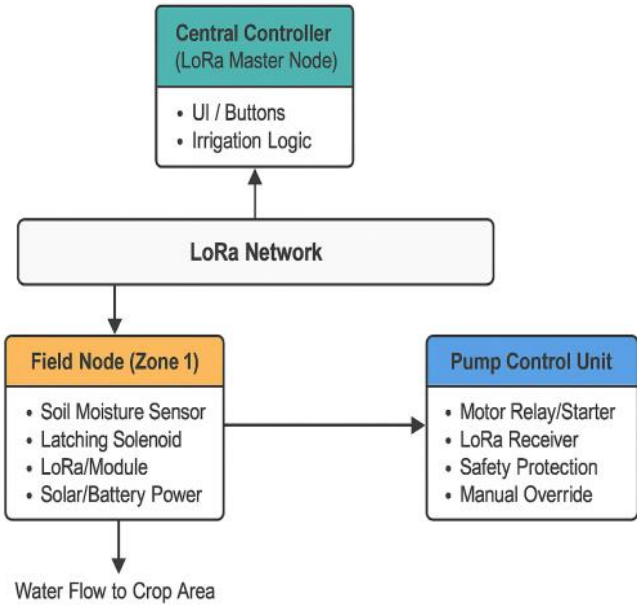

Figure 1 LoRa Architecture for Micro Irrigation

3. 3. Latching solenoids in LoRa micro irrigation

Micro irrigation systems like drip irrigation are common in oil palm, mango orchards, and fruit gardens. These systems often require manually opening and closing valves and manually switching the pump. Latching solenoid valves are suitable for automation because they use very low energy. A short positive pulse opens the valve, and a short negative pulse closes it. The pulse time is less than 0.5 seconds and requires about 0.42 joules of energy. A 3.7 volt battery can run these nodes for many years. Sensors like temperature, flow, light intensity, and pressure can be added for better irrigation control[8][10].

4. Proposed Lora Based Micro Irrigation System

The proposed system uses LoRa nodes to communicate between the controller and valves. Each node can handle latching solenoids for clusters or segments of the Farm. The system works without internet, supports long range communication, runs on a 9-12 V battery, and supports multiple field sensors. It also supports pump control and simple schedules, which makes it suitable for large Fields[4][11].Irrigation logic is controlled by single board computers, Raspberry pi or Jetson, LoRa WAN gateway manages the LoRa network, zone wise field nodes managed by LoRa and sends the data to SBC's through LoRa WAN based on the sensor data pump control unit and latching solenoid valves(nodes) are operated automatically based on logic.

5. Advantages

- Water saving through accurate supply.
- Energy saving by preventing over running of pump sets. [11-13]
- Less manual work for farmers.
- Long battery life due to low energy usage.
- Flexible implementation plant wise, cluster wise, or segment wise.
- Pipeline protection using pressure sensors.
- Offline operation without internet.

6. Limitations

- Low bandwidth and low data rates.
- More nodes can create packet collisions.
- Trees, slopes, and buildings reduce range.
- Weatherproofing is needed for nodes.
- Hard to do realtime, highfrequency monitoring. [14-16]

7. Future Scope

- Solarpowered LoRa nodes.
- Soil moisture sensor integration.
- Machinelearningbased irrigation.
- Weatheraware irrigation schedules.
- Multi crop automation support.
- Mobile app for manual override.
- Predictive maintenance using pressure and flow analytics.

Conclusion

LoRa technology is a practical solution for automating micro irrigation in remote farm areas. It saves water, power, and labor. The system works on low power; supports long distances, and can operate offline. Although LoRa has limitations such as low bandwidth and reduced range in complex terrain, it is still useful for agriculture. With further upgrades like AI-based control and sensor integration, LoRa-based

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irrigation can become fully autonomous and highly reliable[2],[7].

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