AGRICULTURE & ENVIRONMENT
E-NEWSLETTER
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Article ID: AEN-2021-02-09-016

Use of Sensor based Irrigation in India

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Sensor based irrigation provides detailed information on soil moisture and temperature along with crop status that allows to understand irrigation requirement of the crops. In last three decades, India has seen great development in irrigation facilities although it has not been free from water crises and vast barriers still prevailing in Indian agricultural domain. Connectivity between farms and farmers is essential to meet water crises. Scientists, academicians and experts in agricultural water management and monitoring are continuously making efforts to find viable solutions to improve this connectivity. Sensor based Irrigation is one of the advanced technology that improves this connectivity without much human intervention. Now day's Indian farmers are stepping up towards advanced irrigation technology. Despite of such advancements there are many obstacles and limitations that must be addressed from stakeholder's inclusion to government policies.

Equipments and Methods

Sensor based irrigation is done using wireless sensor networks (WSN). WSN methodology works in combination of various electronic devices. Gutiérrez, et. Al. (2014) suggested two major components used in wireless sensor network.

A. Wireless Sensor Units (WSU) – It comprises Microcontroller, transceiver (Radio modules), moisture sensor, temperature sensor and power source (Rechargeable batteries and Solar panel). These components are encapsulated in waterproof Polyvinyl chloride (PVC) container to make the unit waterproof. The microcontrollers are appropriately programmed devices that controls radio modems (X-Bee modules) and processes information received from soil sensors (moisture and temperature sensors) inserted in root zone of the plants. The soil sensors are placed in plant roots in an array at appropriate distance. XBee modules are one of the best suitable devices among various ZigBee devices available in the market. XBee modules further establish communication between WSU and Wireless information unit (WIU) to transmit information received from soil sensors.

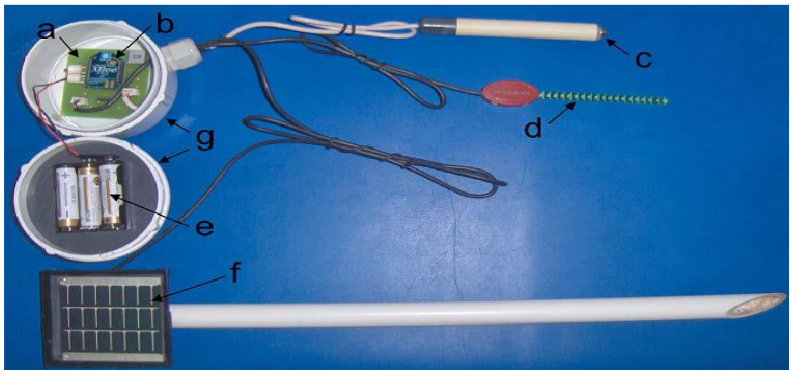

Fig. 1. WSU. (a) Electronic component PCB. (b) Radio modem ZigBee. (c) Temperature sensor. (d) Moisture sensor. (e) Rechargeable batteries. (f) Photovoltaic cell. (g) Polyvinyl chloride container. Source - Gutiérrez, et. Al. (2014)

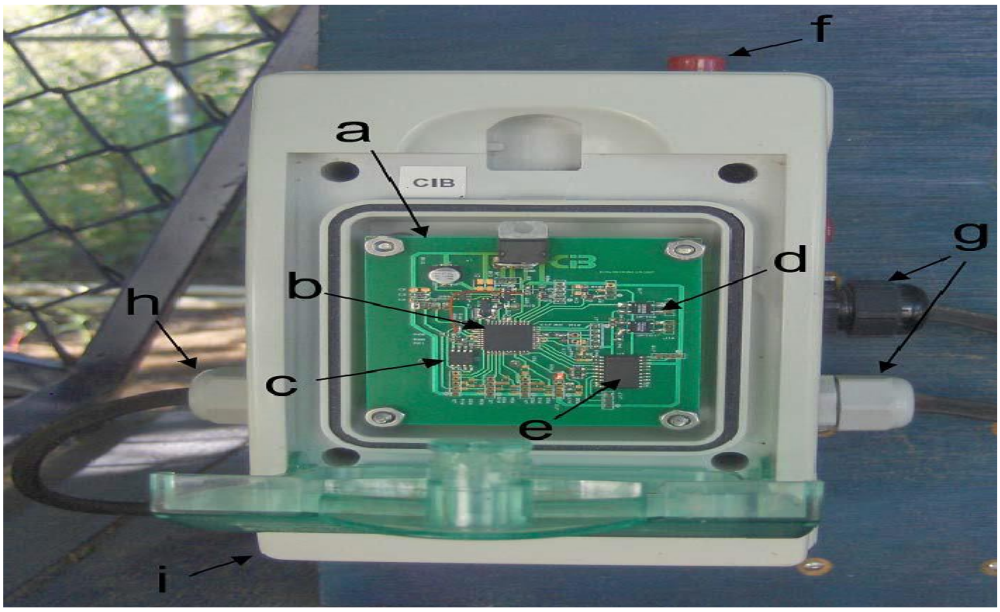

Fig. 2. WIU. (a) Electronic component PCB. (b) Master microcontroller. (c) Solid state memory. (d) Optical isolators. (e) RS-232 interface. (f) Push button. (g) Output cables to pumps. (h) Supply cable from charge controller. (i) PCV box. Source - Gutiérrez, et. Al. (2014)

B. Wireless Information Unit (WIU).

XBee from each WSU establish communication with WIU to transmit data to WIU's master microcontroller. The data received by WIU is recorded, processed, and analyzed by WIU to implement irrigation schedule. WIU stores date and time of service request from each WSU. The master microcontroller functions on a set of algorithm. This algorithm decides what action should be taken in response to service request from moisture and temperature sensor. There are four types of action performed by WIU algorithm:

1. Push button manual irrigation for fixed duration on service request.
2. GPRS module based scheduled irrigation for desired time using web page.
3. Fixed duration automated irrigation when at least one temperature sensor reading drops below threshold limit.
4. Fixed duration automated irrigation when at least one moisture sensor reading drops below threshold limit.

GPRS modules in WIU establish communication with web server to download and upload data for irrigation scheduling. In case the signal strength is low it stores the data in WIU storage and attempts to communicate it each hour. Web applications are developed to communicate with MIU to minimize direct human intervention in irrigation. Theses web applications are connected directly to web server to store and retrieve data. Ghodake and Mulani (2017) suggested GSM technology in place of GPRS that works through GSM phones. Among GSM and GPRS the choice depends on robustness of information handling knowledge of operations. Furthermore the application of solar powered energy in WSU and WIU works effectively and refrain the system to collapse. The type of irrigation is one of the important factors under sensor based irrigation. The basic types of irrigation used in India are Surface, Sprinkler and Drip irrigation. Among these types, Sprinkler and drip irrigation is most suitable in Sensor based Irrigation technology. If surface irrigation is opted it must be done in proper array of small segments where water is equally divided in all segments otherwise there may be the danger of unfinished water splash or water splash in excess.

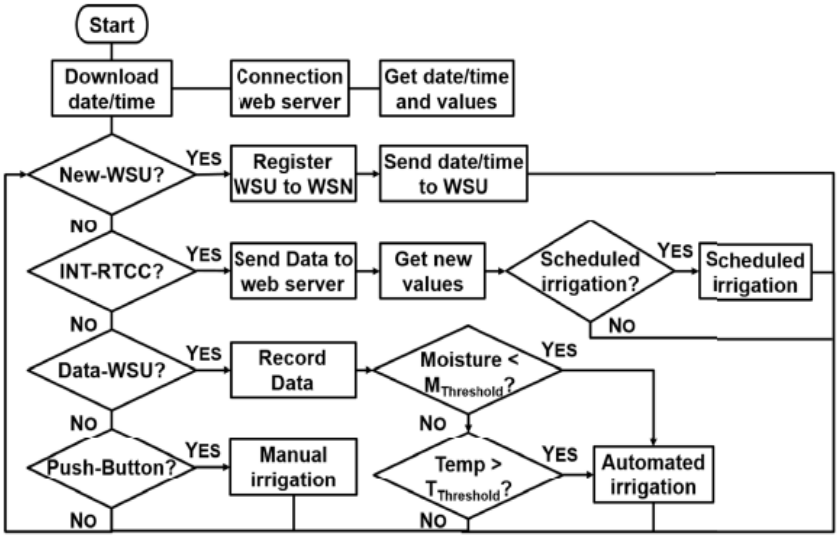

Fig. 3. Algorithm of the master microcontroller in the WIU for the automated irrigation system. Source - Gutiérrez, et. Al. (2014)

Benefits of Sensor Based Irrigation

A shift from traditional agriculture to data driven agriculture brings new horizons of growth. Sensor based irrigation is data driven irrigation that operates on the basis of data retrieved and processed by electronic computational devices. To implement such technologies there is a need of robust system with minimal chances of failure. Saiz-Rubio and Rovira-Má (2020) argues that for data based advanced agricultural techniques there is a strong need of Volume, Velocity, Variety, Veracity and Valorization. These 5V's when applied in data driven agriculture increases productivity, reduces farming costs, and substantially reduces production time and crop losses.

Cost Analysis

The cost of production in sensor based irrigation in nursery crops increases approximately 3.6% over standard practice irrigation and revenue has been found 12.8% increased over standard practice (Lichtenberg et.al., 2013, 3). The increasing costs in irrigation are critical for small farmers because cost of equipments are higher then return.

Limitations

Irrigation is widely affected by various inputs such as – soil type, plant's water requirement, climate, plant growth, landscape, climate, water quality, operational costs and awareness among farmers. Although Sensor based irrigation is successful technology but it has some limitations that does not allow the farmers in country like India to adopt on large scale. Some of the limitations are –

I. Sensor based irrigation generally operates on the data received from soil sensors. Currently there is no viable facility for this technology to interact directly with automated weather station networks.
II. India is a vast country where its geographical area spreads from mountainous region to plains and rocky landscape to sand dunes. There are various limitations associated with infrastructure development in such heterogeneous landscapes. This technology is not suitable in the areas which lacks basic infrastructure such as electricity, road links, marketplaces and scarcity of agricultural inputs.
III. Literacy and awareness are one of the significant factors that help in implementation of this technology. Huge segment of farmers in India opt for traditional farming techniques and lacks awareness of ultra modern technologies such as sensor based irrigation.

IV. Limited supply of power to agricultural sector is critical factor to implement this technology. To avoid any delays because of power shortage the farmer should switch over to renewable energy operated pump sets. Solar powered pump sets is best suitable alternative that helps maintain irrigation scheduling in time.

V. To make this technology widely used Government's inclusion through policies and programmes is necessary. Subsidised equipments of sensor based irrigation could help farmers to implement this technology ate their farms.

VI. While using this technology the farm must be secured with fences to avoid any type of destruction to the MSU or MIU units.

Conclusion

This analysis confirms that Sensor based irrigation system is viable, cost effective and water saving. Controlled irrigation using moisture and temperature sensors minimizes human intervention and avoids delays in irrigation. This technology is highly suitable in those geographical areas where water resources are scarce. Now days, there is an urgent need to save natural resources and this technology has been proven highly suitable to achieve this goal. The aid for farmers in form of subsidies and awareness campaign for this technology potentially brings advancements in Indian irrigation system. To attain sustainable agricultural growth India needs a paradigm shift from traditional agriculture to data driven intelligent techniques. To implement such a shift all stakeholders in agricultural domain needs greater awareness and support from each other.

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