



# Design and Implementation of Wireless Sensor Network for Precision Agriculture

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*Abstract: The newly emerged wireless sensor network (WSN) technology has spread rapidly into various multi disciplinary fields. Agriculture and farming is one of the industries which have recently diverted their attention to WSN, seeking this cost effective technology to improve its production and enhance agriculture yield standard. This paper reports on the application of WSN technology to improve tomato crop production. Water is one of the largest renewable natural resources but fresh water is expected to emerge as a key constraint to future agricultural growth. The Automated Intelligent Wireless Irrigation System using LITE mote provides a real time feedback control system which monitors and controls all the activities of irrigation system efficiently and also monitors the reserve water tank storage so that overflow of tank will be avoided as well as helps in efficient water management so as to get more profit with less cost. This system overcomes the limitations of wired sensor networks and has the advantage of flexible networking for monitoring equipment, convenient installation, low cost, reliable nodes and high capacity.*

*Keywords: IoT, wireless sensor network, precision agriculture, tomato, LITE node.*

## I. INTRODUCTION

Tomato is the world's largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetables. The total global area under tomato is 46.50 lakh ha and the global production is to the tune of 1279.93 lakh tones. The world trade in tomato consists of an export of 49.50 lakh tones valued at 50802.88 lakh US\$ and imports are to the tune of 47.30 lakh tones estimated at 50415.26 lakh US\$. The study has revealed that adoption of precision farming has led to 80 per cent increase in yield in tomato production. Increase in gross margin has been found as 165 in tomato farming. The contribution of technology for higher yield in precision farming has been 33.71 per cent in tomato production. The elasticity of 0.39 for the adoption in

tomato has indicated that as the probability of adoption increases by 10 per cent, net return increases by 39 per in tomato cultivation.

Efficient water management plays an important role in irrigated agricultural. Under conventional blanket irrigation many parts of irrigated fields are effectively over or under-irrigated due to spatial variability in soil available water-holding capacity, water infiltration and runoff. Under-irrigated areas are subject to water stress, resulting in production loss, while over-irrigated areas suffer from poor plant health and nutrient leaching.

Recent low-cost, low-power wireless mesh networking technology is well suited to replace wires as the communication medium in many agricultural applications.

The networks consist of a number of wireless nodes, which are battery powered and backed up by solar energy, and attached to sensors in the ground; the nodes transmit data via other wireless nodes to a base station. The WSN which is capable of self-organizing and self-healing (mesh networking) requires minimum maintenance. Although the WSN uses low power radios, mesh networking technology enables transmission of data from one node to any other node in the network, without using high power radios. The mesh network allow greater flexibility in node placement since inability for two nodes to communicate (e.g. due to a physical obstruction) is handled by re-routing through any other possible alternative route within the network. Another advantage is that a failed node does not disable the network, as the other dependent nodes re-route through other available nodes (self-healing). Once the wireless sensor nodes are placed in management zones and the base station is activated, the sensor network is self-formed by allocating unique addresses to each node and defining the most efficient communication path to relay data from each node to the base station. The base station which processes the data also acts as a web server. Interested parties can access the real time data by directing a standard web browser to the URL of the web server in the base station.

It is observed that farmer bear huge financial loss because of wrong prediction of weather and incorrect irrigation method to crops. With the evolution of WSN now it is possible to use them for automatic environment monitoring and controlling the parameter of field for precision agriculture application.

## II. LITERATURE REVIEW

Mobile data collectors were proposed in [1], assuming centralized knowledge and decisions made at the Base Station (BS). These mobile nodes move along a set of predefined tracks in the sensing field. It was shown that using data collectors (mobile relays) extends the network

lifetime compared to conventional WSNs using static Sensor Nodes (SNs) only. In fact, data collectors were used earlier in [2] and [3]. The network lifetime was divided into equal length time intervals, called rounds. The data collectors are relocated at the beginning of each round based on a centralized algorithm running at the Base Station. The objective was to minimize the aggregate consumed energy during one round. It was shown that the optimal locations according to this objective function remain optimal even when the objective becomes to minimize the maximum energy consumed per SN. It should be remarked that these two energy metrics are not suitable for finding the optimal locations of mobile nodes since the optimal solutions will not be functions of time, i.e. time-independent. Consequently, the locations calculated may be far from optimal.

The energy effective WSN for agriculture proposed in [5] utilizes the sensor node hardware with CC1110 framework on chip with low power RF Tran's collector and 8051 MCU from texas. A CC 1110 assessment module connected to smart RF04 assessment board who's LCD and Drove catches are promptly accessible for observing and control. The equipment permits radio transmission in various force levels furthermore permit client to change beneficiary affectability. To contrast the execution of PDMAC and SMAC, the conduct of two nodes, a sender and a beneficiary was simulated utilizing TOSSIM.

The proposed configuration of node framework in [6] [7] utilizes the CC2420 zigbee/RF module as RF Tran recipient center unit of remote correspondence framework and MSP430 as microcontroller unit. The RF module is associated with SPI through MCU. The framework likewise incorporates the correspondence web server, the focal point of screen taking into account web, master arrangement of agribusiness. So the real time information joined through the sensor hub is transferred to the sink node and afterward

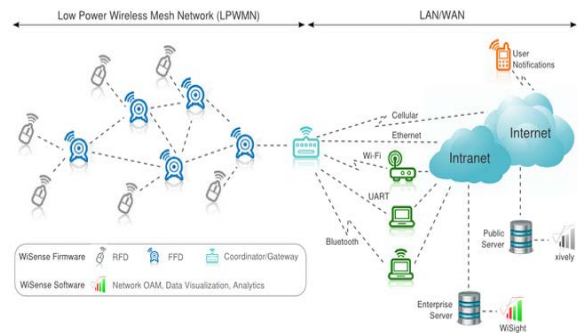
the data can be transferred to the continuous information base on the web by GPRS.

The paper [9] has proposed and examined the utilization of programmable framework on chip innovation as a piece of WSN to screen and control different parameters of green house. In this CC3271 PSOC is utilized which is the first touch starter unit with low power RF with minimal effort USB thumb infer pack including related IDE programming for sense and control of the information accumulation. It comprises of PC dongle with RF and multifunction board with force enhancer and two battery sheets. It can be utilized as touch detecting, temperature detecting, light detecting and closeness detecting necessity of green house.

### III. PROPOSED WORK

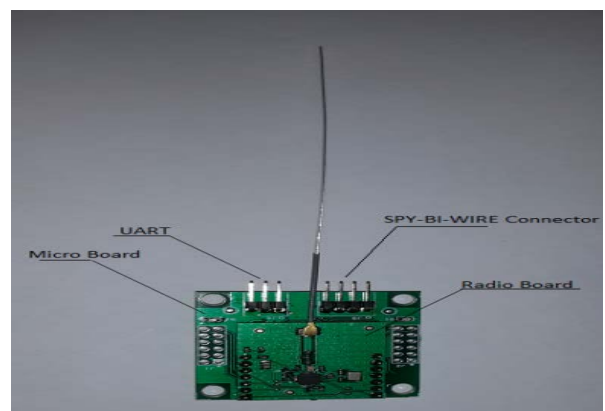
According to the above information, it is clear that growth of tomato is highly dependent on few climatic factors like air temperature, humidity, soil temperature and soil moisture. So it is essential to monitor few climatic conditions for the better yield of tomato.

This work makes an attempt to outline a design that can monitor the soil moisture, soil temperature and reserve water tank level of an agrarian field and transmit it to a remote collector outside the field. The framework in this paper is made out of the microcontroller, WSN base station, Information gathering nodes and sensors. The WSN information gathering node is associated with thermistor, soil moisture, LDR (light dependent resistor) and pressure sensor. The framework, indicated in Fig. 1, embodies a general self-sorting cross section WSN with detecting abilities, a Passage, which assembles information and gives data to the last client fit for observing and associating with the instrumented environment.



**Fig 1: WSN architecture of LITE nodes**

The architecture then to be implemented in the sensor nodes will construct a wireless networking data collection at crop field likely to replace the conventional manually data collection system. A general “LITE” mote shown in fig 2 has microcontroller for local processing, a radio module that provides wireless connectivity and external terminals to connect various sensors like soil moisture, thermistor, LDR and pressure sensors are integrated to all nodes. All the deployed nodes collect the parameters and report to the central coordinator /sink shown in fig 3. The coordinator coordinates the data collection. The individual nodes based on the soil moisture sensor content attached to it will excite the water sprinklers in that particular region. There by we can conserve water using this project.



**Fig 2: LITE node**

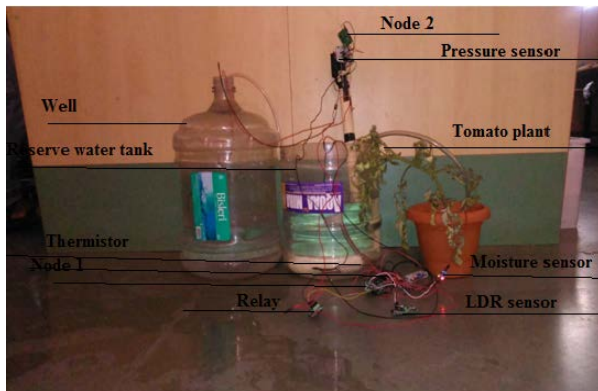


**Fig 3: Gateway node**

will be in on state depending on moisture level in soil.



**Fig 5: Soil moisture sensor and thermistor**



**Fig 4: Test bed setup**

The proposed system as shown in fig 4 and automatically maintains desired moisture level around root zone of plant. Sensor senses moisture level in root zone sends the data to control system via CC1101. Software control system receive data from sensor and take decision whether the electric pump has to turn on or turn off and send control signal to irrigation control unit. The MSP430 will receive signal from computer and send control signal to electric pump to make it turn on or off.

The light sensor stage was implemented using a calibrated Light Dependent Resistor (LDR). The resistance of the LDR varies with the intensity of light falling on its surface. The resistance of a photo resistor decreases with increasing incident light intensity. During day time pump

Temperature influence most plant development process such as photosynthesis, transpiration, absorption and flowering. Each species of plant has a different temperature range in which they can grow. Above this range, enzymes becomes inactive and processes essentials for life stops. Hence, temperature should be maintained at optimum level all the time.

A pressure sensor (MP3V5004G) is been made use for sensing water level in water reserve tank accurately. LITE node is used to control the overall system automatically that reduces the design and control complexity. LITE node takes input from the sensor unit which senses the water level as shown in fig 4. It sends sensed value from sensor to gateway, after processing input value resultant output decides the water pump's action (on/off) with respect to current water status of the tank. The whole design flow chart is shown in Fig 6. Water tank level sensor readings are continually uploaded to Xively cloud service and made available for access from any web browser using internet.

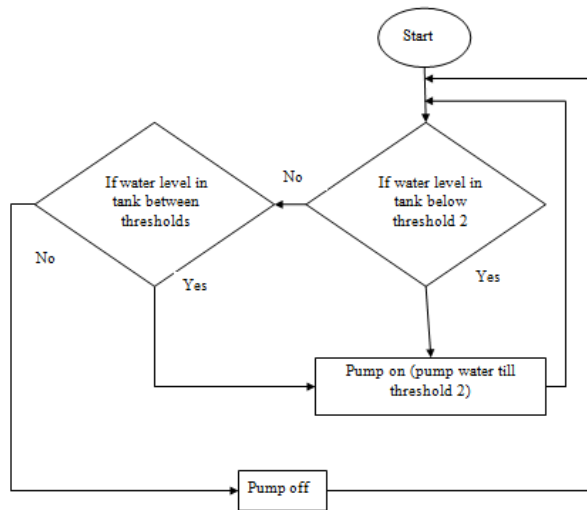


Fig6: Flowchart of reserve water tank system design

#### IV. RESULTS

The sensor readings are continually uploaded to Xively cloud service and made available for access from any web browser using internet. Xively’s API service is used to feed sensor data to channels created on their cloud service. It is possible to view current sensor reading value both visually and numerically as shown in fig 7, 8 and 9. The web application provides a graphical presentation of sensor readings over some period of time – which can range from current time up to three months of reading history.

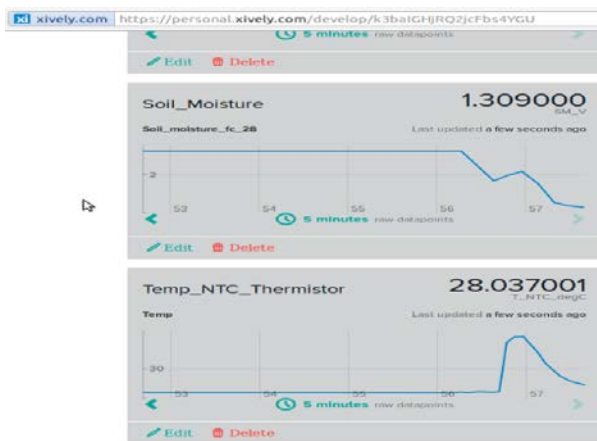


Fig 7: Screenshots of soil moisture and thermistor value in xively

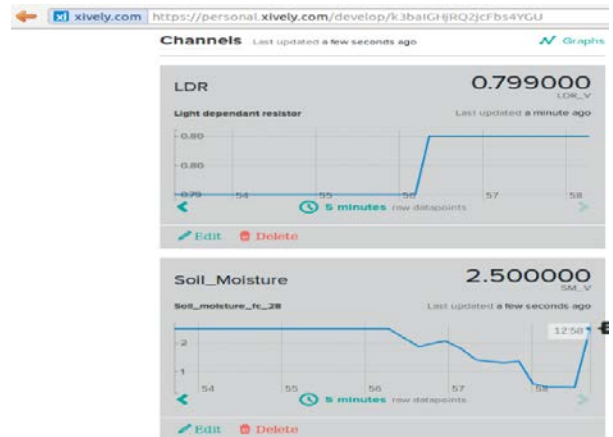


Fig 8: Screenshots of soil moisture and LDR value in xively

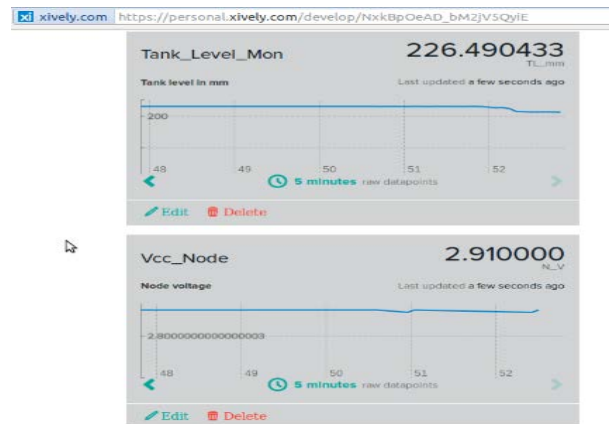


Fig 9: Screenshot of tank water level in xively

#### V.CONCLUSION

The soil moisture response monitoring system designed is very simple to understand and handle. It can be operated by all age-groups of farmer. It can be reprogrammable to add more features. The proposed system is able to determine the soil moisture and necessity of water to crop in order to supply to the soil plant system the just enough amount of water to maintain the moisture level around the levels set by the user. This system continuously monitors agriculture soil to get moisture level so avoids crops drying up or drained out by too lengthier irrigation period. Also monitors the reserve water tank storage so that overflow of

tank will be avoided as well as it helps to do the efficient water management in order to get more profit with less cost.

Another innovation involves data from farm, which are currently collected wirelessly at the gateway can be uploaded to web, xively. Data will be updated every 5 sec so that a farmer can look on farm condition from anywhere and anytime. Using this system, one can save manpower, as well as water to improve productivity and ultimately the profit.

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