Use of Linear Interpolation for Automated Drip Irrigation System in Agriculture using Wireless Sensor Network

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***Abstract*—India is better known for its agriculture and cultivation land. Indian economy is dependent on farming and farm product Business. It is one of the most adorable countries for farming/cultivating various farm products. As Indian economy depends on Agriculture product and its development, lots of experiments needs to be done in this sector to increase the productivity and the profit margin. The biggest concern in land cultivation is water utilization. In India Rainfall is very uncertain in various parts of country. And because of this agriculture yield production is unreliable. Especially utilization of available water for agriculture is major issue now days. In this paper, proposed system provides a mechanism for available water distribution among various crops cultivated in the farms and its effect on farm yield production. The Wireless Sensor Network provides a very optimal solution for water distribution using Interpolation methods. WSN describes the methods controlling various parameter like Temperature, Soil moisture and humidity to water management process.**

Keywords—wireless sensor network; water management; interpolation; sensor nodes

I. Introduction

It has been Decade and half years since drip irrigation was introduced in California to be used on commercial agricultural crops. In a small land of five acres, the experimental grove, initial use of drip irrigation was started in an avocado orchard in San Diego County, and For Drip Irrigation many small pieces of working items are used. They encircle plastic hose or pipe, spaghetti hose, emitters, pressure regulators, pressure gauges, valves, fertilizer tanks, filters — both sand and screen, time clocks, Tensiometer, evaporative pans, meters, and fertilizer injectors[1]. The filter is one of the vital accessories used in hardware for Drip Irrigation. A motorized management of greenhouse consorts precise control needed to sustain the most proper posture of plant growth. The five influential specifications to consider when implementing drip irrigation are humidity, temperature, groundwater, carbon dioxide, light intensity [2].

In this system, an advanced microcontroller ATMega-32 which is 32-bit features of 32kb internal memory, 32-bit timers and 10 bit built in ADC analog to digital converter is used. To control the flow of water according to the readings of sensor nodes, a timer is used to set timings of the valve. The system controlling unit also has a capacity for collecting readings from the temperature and moisture sensor.

The Sensor nodes are deployed at the roots of a crop at the undisturbed soil. Each node works on Temperature, Soil moisture, humidity and light intensity readings. The soil moisture sensor reads the moisture level of soil in the active root zone. Proper use of Soil moisture sensor can cut back irrigation by 50%. Water saving has been measured from 5% to 88% over typical timer-base irrigation system. Sensors are fixed at a minimum distance of five feet from the downspouts for averting the high moisture areas. Soil Moisture content can be measured using Tensiometer.

II. Literature Survey

From existing system conclusion with few remarks; we need to find out some common method to forepeak the accurate water prorating system which can lead to use optimum available water. Different climatic parameters have to be considered to presage the current requirements of crops. At the same time, we can say that, using modern technologies. The interpolation is one of the kosher methods to pin down or forepeak the required soil moisture values for water

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distribution. Interpolations methods can be applied to various data collection to predict, current water requirement of a specific crop in current climatic conditions [3].

III. System Architecture

The focus is on designing smart, automated Irrigation System Using Linear Interpolation Programming. This system is able to regularize the Valve timings of drips automatically

The system supports the calculated the water distribution among multiple crops. The decision is made on the basis of reading collected from different sensor nodes and their values. Once the data is collected then linear Interpolation is applied to generate or predict the optimum watering plan for less water utilization for maximum land cultivation with maximum profit sharing. A microcontroller triggers the commands to different devices such as water pumping motor, valve, to switch ON or OFF based on data analysis done on collected sensor values. Each node is communication to a neighbor node to transfer data up to master node. The master node is connected to the server where all data is collected and stored for further calculations by Linear Interpolation.

The three parameter need to check temperature, soil moisture, and light intensity. The farm field is divided into small parts and one node is deployed in each part. Each sensor node consists of LM35 for temperature reading and Tensiometer for volumetric soil moisture contents. The sensors are deployed 6-8 cm beneath the soil level. Whenever moisture level reaches the threshold value then it sends the information to micro-controller to take a decision over, valve switch OFF.

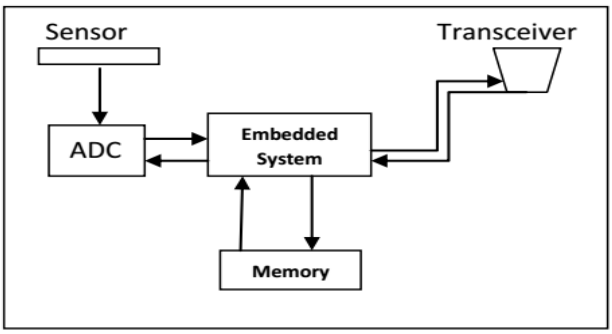

Fig. 1. Architecture of sensor node [4]

The Drip irrigation general architecture is given in following fig. 2 [5]

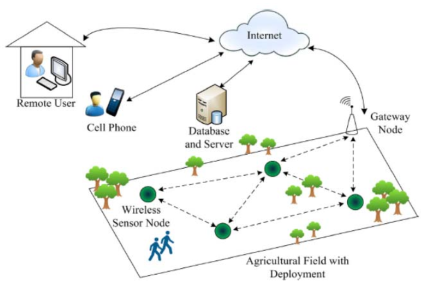

Fig. 2. A typical WSN deployment for agriculture application

based on sensor readings from the sensor nodes and it's formulated timings. The time stipulations for all the Valves can be fed into PC for an entire week or month. A microcontroller is used to collect the data from various points. The collected analog readings are converted to digital values using ADC convert so that at GUI everyone should be able to understand it.

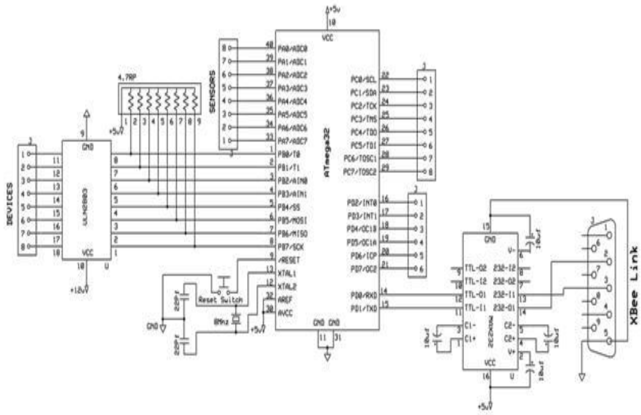

Fig. 3. Hardware schematic or circuit diagram

IV. Interpolation Method

As readings are being taken from parts of the field, to map the physical parameter readings, system uses Interpolation method to predict the intermediate values. As an example, if first reading is from x point and another reading from y point from 25 meter apart, and then interpolation is suitable methods to predict intermediate readings. Interpolation is a method of constructing new data points within the range of a discrete set of known data points. The term extrapolation is used to find data outside the range of known data points.

Linear programming (LP) is mathematical method suitable to find out best outcome in a given problem where some list of requirements is given in linear relationship. In the present system LP is used to calculate control parameters like how much water is available and how many crops can be used to optimize the throughput.

A. Algorithms

Mainly there are three algorithms used in present system as follows:

1) Master Side Algorithm
2) Node Side Algorithm
3) Remote Side Algorithm

B. Master Side Algorithm

1) Start
2) Initialize i=1
3) Select Sensor Node i
4) Send Node Address

5) Send ADC Read Command
6) Read Sensor reading at Node i
7) i=i+1
8) Repeat steps 3 to 7otherl Nodes.
9) Calculate sensor values
10) LP calculation from received data
11) Generation of control data for relay
12) Send node Address for command execution
13) Send H/W control command
14) Submit log to Remote Server.
15) Goto step 2

C. Node Side Algorithm

1) Initialize Atmega 32 Controller
2) Read node Address
3) Wait for transceiver Command
4) Read transceiver Command
5) If ADC Command, read ADC value send back to transceiver Xbee

   Else if DEVICE Command Control relays.

   End
6) Goto step 3

V. Result and Discussion

In the present system, three different sensors are used for data readings. The system works on the sensor values, transmitted to master node where decision is made and commands are set for the respective node to accomplish the execution. If the soil moisture values are below the pre-setted threshold values then trigger is generated to respective node for Valve ON and vice versa for more than threshold value. Temperature and light sensors are used for supporting data analysis to know the effect of other environmental parameter effect on the presented system. For volumetric soil moisture content measurement a standard formula is being get used

$$VWC\ (m^3/m^3) = 1.17 * 10\text{-}9 * ADC3 - 3.95 * 10\text{-}6 * ADC2 + 4.90 * 10\text{-}3 * ADC - 1.92 \qquad (1)$$

The Volumetric water contents are based on various soil properties such as soil texture, soil partiole density, Bulk density, temperature etc but in present system only one moisture holding capacity is considered

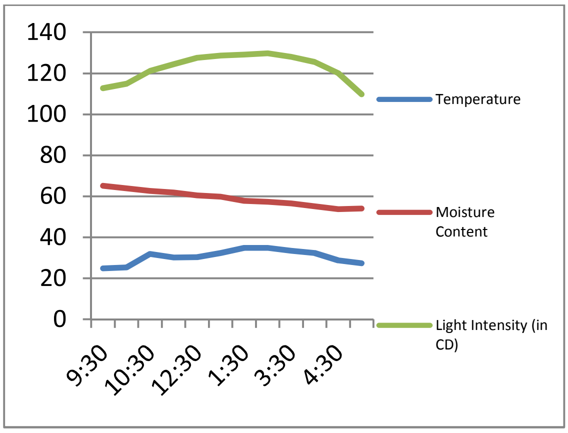

Fig. 4. Node 1 sensor values

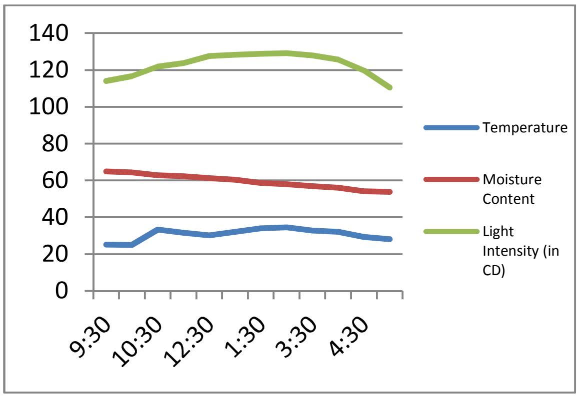

Fig. 5. Node 2 sensor values

Above figure shows the sensor values at node 1 and node 2. Likewise other node sensor values are noted for LP decision support system for optimal water utilization using linear Interpolation implementation. The water consumption and electric power consumption for farm field using LP and without LP is given below.

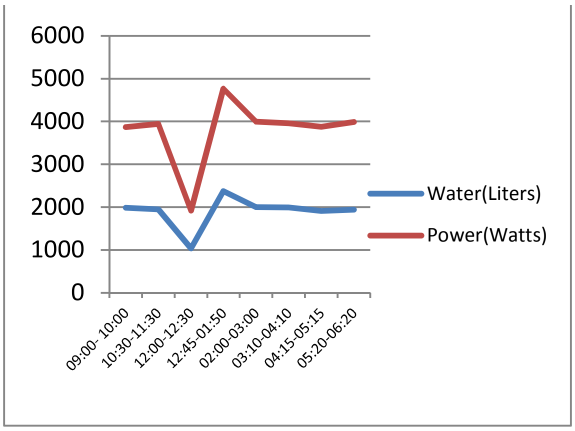

Fig. 6. Water and power consumption without linear interpolation programming (conventional irrigation method)

TABLE I. WATER AND POWER CONSUMPTION WITHOUT LINEAR INTERPOLATION PROGRAMMING

Time	Water (Liters)	Power (Watts)
09:00- 10:00	1986	3867
10:30-11:30	1950	3946
12:00-12:30	1038	1920
12:45-01:50	2375	4765
02:00-03:00	2000	3994
03:10-04:10	1990	3956
04:15-05:15	1910	3873
05:20-06:20	1938	3987
Total	15187	30308

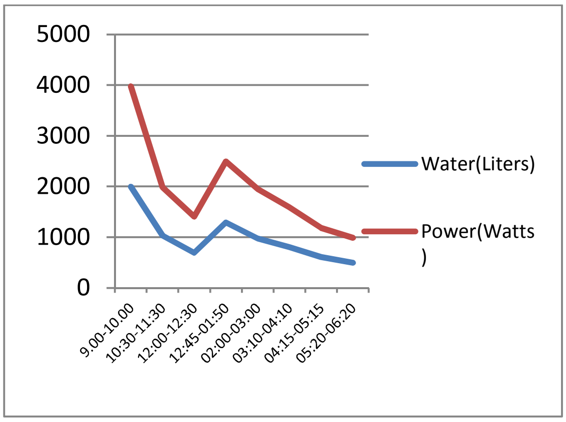

Fig. 7. Water and power consumption with linear interpolation programming

TABLE II WATER AND POWER CONSUMPTION WITH LINEAR INTERPOLATION PROGRAMMING

Time	Water (Liters)	Power (Watts)
9.00-10.00	1998	3978
10:30-11:30	1034	1987
12:00-12:30	689	1404
12:45-01:50	1291	2498
02:00-03:00	978	1954
03:10-04:10	805	1590
04:15-05:15	610	1183
05:20-06:20	493	986
Total	7898	15580

VI. CONCLUSION

By analyzing the two data tables it is observed that the water consumption with and without LP has a huge difference. 15187-7898 = 7289 which is almost 52 % water saving, and in power consumption 30308-15580=14728 which is almost 51 % power saving. All the values are calculated based on one hour continuous running 10 HP (1 H.P. = 745.7 W Energy consumed = Power × Time) water pump and consuming distributing water through 6 mm pipe.

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