American International Journal of Research in Science, Technology, Engineering & Mathematics

Available online at http://www.iasir.net

ISSN (Print): 2328-3491, ISSN (Online): 2328-3580, ISSN (CD-ROM): 2328-3629

AIJRSTEM is a refereed, indexed, peer-reviewed, multidisciplinary and open access journal published by International Association of Scientific Innovation and Research (IASIR), USA
(An Association Unifying the Sciences, Engineering, and Applied Research)

Water Management System for Agricultural Sector

Prof. Dnyaneshwar Natha Wavhal[*], Prof. Sneha Ghumatkar [#], Prof. Manish Giri [##], Prof. Nikhil Kumar B.S.[###]
[*]Dept of Computer Engineering Jaihind College of Engineering Kuran,
University of Pune, Maharashtra, INDIA

ABSTRACT: *In the field of agriculture, use of proper method of irrigation is important and it is well known that irrigation by drip is very economical and efficient. In the conventional water management system, the farmer has to keep watch on irrigation timetable, which is different for different crops. The application of a wireless sensor network for low-cost wireless controlled and monitored irrigation solution. The developed irrigation method removes the need for workmanship for flooding irrigation. Efficient water management plays an important role in the irrigated agricultural cropping systems. This project defines the implementation of an internet driven intelligent and completely automated water management system. The software and hardware combined together provide a very advanced control over the currently implemented manual system. The implementation involves use of water management system control using a microcontroller based board. PC based software is used to interface the board and control the valve on/off timings. The software is capable of downloading the on/off timings for drips from websites hosted by agricultural universities. Farmers can get instant assistance from universities to change the drip on/off timings based on current climate, soil condition, fertilizers used, etc. The microcontroller based unit can operate in standalone mode since and only needs to be connected shortly to the PC in order to download the new valve on/off timings. A software module will also be designed for agricultural universities to upload the drip on/off timings for particular farm layout. The Wireless Sensor Network for Agriculture is an innovation of improving current water irrigation system. The scopes of this project consist of hardware and software. The basic idea is to provide user-controller of the hardware receiver board from the transmitter board that contains sensors that will send current condition of the plant to the receiver.*
KEYWORDS: *ATMega-32 Microcontroller, Drip Irrigation, Interpolation, Light Sensor, Linear Programming, Soil Moisture Sensor, Temperature Sensor, Wireless Sensor Nodes.*

I. INTRODUCTION

It has been ten years since drip irrigation was introduced in California to be used on commercial agricultural crops. The initial work was started in an avocado orchard in San Diego County, and from this small five-acre experimental orchard the acreage has increased tremendously. Many crops are under test with drip irrigation. Equipment used in drip irrigation systems is very important. There are many pieces of equipment required. They include 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. One of the most important items in the hardware for drip irrigation systems is the filter. An automated management of green house brings about precise control needed to provide the most proper condition of plant growth. The five most important parameters to consider when creating drip irrigation are humidity, temperature, ground water, carbon dioxide, light intensity [6].
In this paper an advance microcontroller LM3S5T36 which is 32-bit ARM® Cortex™-M3 with features of 32kb single flash memory, 12kb RAM and three 32 bit timers and two 10 bit analog to digital converter is used. A timer for the automation of drip irrigation is set, which works accordingly to the sensors and combining all this features the flow of water in fields will be automatically controlled rather than manually. It also contains the temperature and moisture sensor.
Sensors are installed in the root zone at the undisturbed soil. The soil moisture sensor is a sensor connected to an irrigation system controller that measures soil moisture content in the active root zone. Soil moisture sensor can reduce irrigation application by 50%. Water saving have been measured between 5% to 88% over typical timer-base irrigation system. Sensors are placed at least 5 ft from the downspouts for avoiding the high moisture areas. Tensiometer can be used as the moisture sensor to detect moisture contents of soil. The sensor will not be damaged by temperatures as low as -40°C (-40°F); it is safe to leave the sensor in the ground year-round for permanent installation. These sensors are buried in the ground at required depth. Once the soil has reached desired moisture level the sensors send a signal to the micro controller to turn off the relays, which control the valves. RTD like PT 100 can be used as the temperature sensor. [7]

II. OBJECTIVES

- Resource Optimization in Water Management System for agricultural sector.
- To Provide the Decision Support System for Water Management System.
- To save the water, energy and man power in the agriculture sector.
- To design, build and test the system which will be economical, efficient and effort reducing of the farmer.

III. LITERATURE SURVEY

A. Design of Micro controller Based Drip Irrigation System

The key elements that should be considered while designing a mechanical model:

a) Flow: You can measure the output of your water supply with a one or five gallon bucket and a stopwatch. Time how long it takes to fill the bucket and use that number to calculate how much water is available per hour. Gallons per minute x 60=number of gallons per hour.

b) Pressure (The force pushing the flow): Most products operate best between 20 and 40 pounds of pressure. Normal household pressure is 40-50 pounds.

c) Water Supply & Quality: City and well water are easy to filter for drip irrigation systems. Pond, ditch and some well water have special filtering needs. The quality and source of water will dictate the type of filter necessary for your system. .

d) Soil Type and Root Structure: The soil type will dictate how a regular drip of water on one spot will spread. Sandy soil requires closer emitter spacing as water percolates vertically at a fast rate and slower horizontally. With a clay soil water tends to spread horizontally, giving a wide distribution pattern. Emitters can be spaced further apart with clay type soil. A loamy type soil will produce a more even percolation dispersion of water. Deep-rooted plants can handle a wider spacing of emitters, while shallow rooted plants are most efficiently watered slowly (low gph emitters) with emitters spaced close together.

e) Timing: Watering in a regular scheduled cycle is essential. On clay soil or hillsides, short cycles repeated frequently work best to prevent runoff, erosion and wasted water. In sandy soils, slow watering using low output emitters is recommended. Timers help prevent the too-dry/too-wet cycles that stress plants and retard their growth. They also allow for watering at optimum times such as early morning or late evening.

f) Watering Needs: Plants with different water needs may require their own watering circuits. For example, orchards that get watered weekly need a different circuit than a garden that gets watered daily. Plants that are drought tolerant will need to be watered differently than plants requiring a lot of water. The below is the system architecture for the automation of the drip irrigation. From figure 1 it can see that the sensors send the signal to the microcontroller here in this there is an inbuilt timer and PC is used to display the readings. From microcontroller it sends to the water pump and from there it goes to the irrigation lines.

B. Concept of Modern Irrigation System

The conventional irrigation methods like overhead sprinklers, flood type feeding systems usually wet the lower leaves and stem of the plants. The entire soil surface is saturated and often stays wet long after irrigation is completed. Such condition promotes infections by leaf mold fungi. The flood type methods consume large amount of water and the area between crop rows remains dry and receives moisture only from incidental rainfall. Water is supplied frequently, often daily to maintain favorable soil moisture condition and prevent moisture stress in the plant with proper use of water resources.

Figure 1: Drip Irrigation

Drip irrigation requires about half of the water needed by sprinkler or surface irrigation. Lower operating pressures and flow rates result in reduced energy costs. A higher degree of water control is attainable.

Plants can be supplied with more precise amounts of water. Disease and insect damage is reduced because plant foliage stays dry. Operating cost is usually reduced. Federations may continue during the irrigation process because rows between plants remain dry. Fertilizers can be applied through this type of system. This can result in a reduction of fertilizer and fertilizer costs. When compared with overhead sprinkler systems, drip irrigation leads to less soil and wind erosion. Drip irrigation can be applied under a wide range of field conditions. A typical Drip irrigation assembly is shown in figure (2) below. Drip irrigation is popular because it can increase yields and decrease both water requirements and labor.

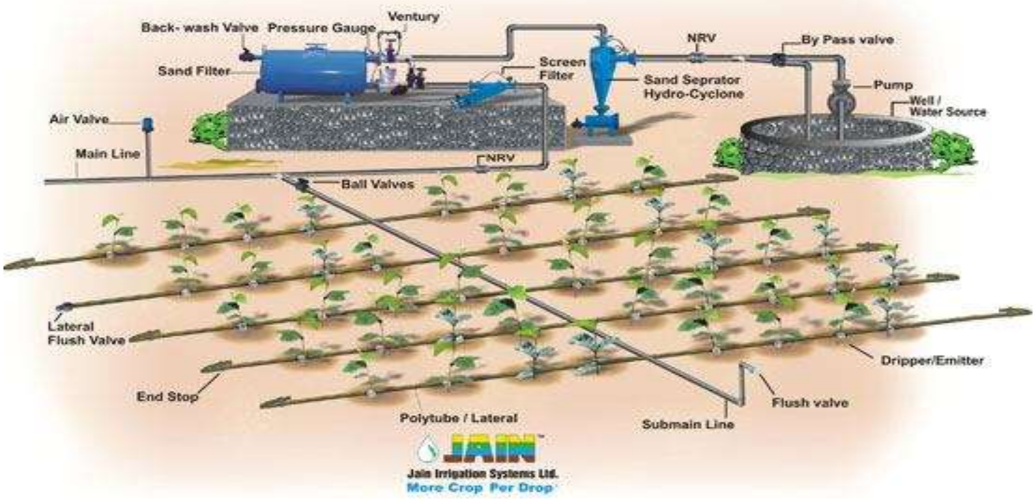

Figure 2: Typical Drip Irrigation

C. Components of Microcontroller Drip Irrigation

The components of micro controller based drip irrigation system [1] are as follows:

I) Pump
II) Water Filter
III) Flow Meter
IV) Control Valve
V) Chemical Injection Unit
VI) Drip lines with Emitters
VII) Moisture and Temperature Sensors.
VIII) Micro controller Unit (The Heart of the system).

IV. METHODOLOGY

A. Use of Linear Programming in System

Linear programming (LP or linear optimization) is a mathematical method for determining a way to achieve the best outcome (such as maximum profit or lowest cost) in a given mathematical model for some list of requirements represented as linear relationships. Linear programming is a specific case of mathematical programming (mathematical optimization).

- To evaluate control parameters like how much total water we have and what quantities of different crops must be used to give optimum throughput (production).
- E.g. How to divide drip water timings in order to attain best possible throughput.

B. Use of Interpolation in System

To map the physical parameter readings for areas in farm where taking manual readings is not possible. E.g. If we have a reading at 1 point and then directly at 2nd point 25 meters away. Then we shall interpolate the values for points at every meter between the two measured points

Interpolation: Interpolation is a method of constructing new data points within the range of a discrete set of known data points.

Extrapolation: The term extrapolation is used if we want to find data points outside the range of known data points.

V. SYSTEM ARCHITECTURE AND WORKING

The aim is to design Intelligent Irrigation System Using Linear Programming. This system must be able to control the Valve timings of drips automatically based on pre-programmed timings. The time intervals for all the Valves can be fed into PC for an entire week or month. Regional language based GUI must be developed so that novice users must be able to feed in the timings or program the hardware. An ADC connected to micro controller must gather the humidity values for soil at various points. These values must be visualized in software using 3D plots to assist the user in deciding valve timings.

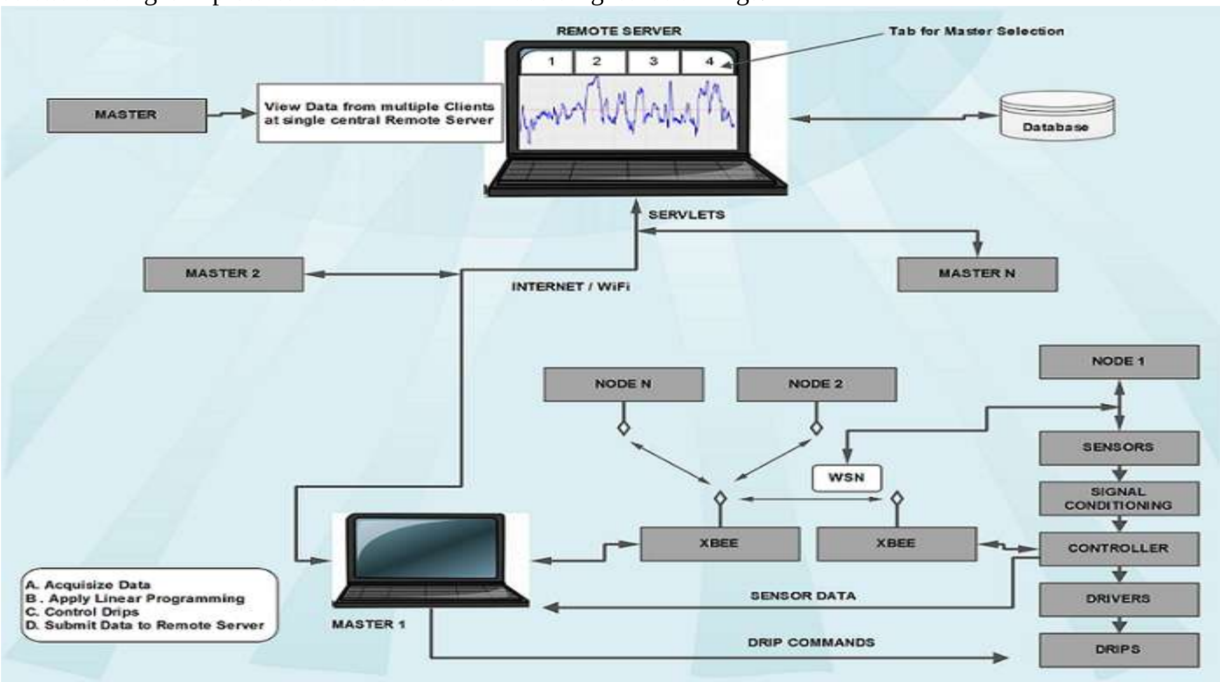

Figure 3: True Drip Irrigation System

In this system Computer Can read the ADC values also receives sensor data and on the basis of ADC values and Sensor data we can apply linear programming in order to generate optimum watering plan i.e. Minimum Water → Maximum Productivity →Maximum Profit . on the basis of values that we have read from ADC and Sensor we can easily apply linear programming in order to generate optimum watering plan through which we can generate drip control commands and later on we transmit that drip commands to the Hardware Device. Hardware device is totally operated on wireless network. i.e. Computer can communicate with hardware device through WSN

VI. ALGORITHMS INVOLVED IN INTELLIGENT DRIP IRRIGATION SYSTEM

In this system there are three Main Algorithms
1) Mater Side Algorithm
2) Node Side Algorithm
3) Remote Side Algorithm
The algorithms are as follows

Master Side Algorithm	***Node Side Algorithm***	***Remote Side Algorithm***
1) Start 2) Initialize i=1 3) Select Xbee Node i 4) Send Adderess 5) Send ADC Read Command 6) Read Sensor Value at Node i 7) i=i+1 8) Repeat steps 3 to 7 for all Nodes. 9) Evaluate sensor values 10) Apply Linear Programming 11) Generate control data 12) Send Xbee Address 13) Send H/W relay/pump control command 14) Submit log to Remote Server. 15) Goto step 2	1) Initialize Micro-Controller 2) Read Self Address 3) Wait for XBee Commmand 4) Read Xbee Command 5) If ADC Command, read ADC value send back to Xbee Else if DEVICE Command Control Drips. End 6) Goto step 3	1) Start 2) Initialize Server (Tomcat Apache) 3) Wait for Client request 4) Read client request 5) Read latest submitted drip data 6) Send data to client as response 7) Goto step 3

These are the main algorithms on which my system runs.

VII. RESULTS AND DISCUSSION

In this system, we have designed a control system by using soil moisture sensor, temperature sensor and light sensor. That means drip it will be getting ON and OFF on the soil moistures sensors reading, if soil moisture is below pre-setted threshold value in that case Water pump it will get ON and also respective Drip or Valve is get ON and release particular amount of water to the soil. Once soil reaches to its presetted moisture level then the Valve as well as Water Pump will OF automatically. Apart from that have combine temperature sensor and light sensor. If temperature of the air t will get increases and it exceed the pre-setted limit of threshold values at that time automatically Fans will be get ON, it temperature remains below the threshold values at that time Fan Remains OFF. Also if light intensity is below the threshold values at that time bulb will ON automatically and if it equal or above the threshold value at that time bulb remains OFF. When this system is get used in control environment then we get all the results from this system. But when this system is get used in uncontrolled environment then it works as usual but by using linear programming though it will be get used in uncontrolled environment it water distribution will done properly. Thereafter have recorded temperature and light readings on ordinary day. All the recorded readings are as follows.

Time	Temperature		Soil Moisture		Light	
	Node 1	Node 2	Node 1	Node 2	Node 1	Node 2
09:30	25.1	24.3	64.1	65.4	114.8	115.1
10:00	25.8	24.9	64.3	64	117.8	118.1
10:30	33.5	32.9	63.5	62.7	120.5	120.4
11:30	31.6	30.9	62.9	62.8	123.3	123.7
12:30	28.3	28.1	61.3	61.6	128.0	127.5
01:00	32.3	32.1	60.5	60.8	128.0	128.0
01:30	34.8	34.6	59.2	59.1	128.0	128.0
02:30	30.9	30.5	58.6	58.3	128.0	128.0
03:30	32.6	32.1	57.2	57.9	127.3	127.6
04:00	31.4	31.0	56.6	56.2	126.1	126.3
04:30	29.2	30.0	55.1	55.5	115.3	114.7
05:54	28.5	28.1	54.3	54.2	110.4	111.1

Table 1: Live Readings (Recorded Reading on Ordinary Day)

Time	Drip Irrigation Without Using L.P.		Drip Irrigation Using L.P	
	Water(Liters)	Power(Watts)	Water(Liters)	Power(Watts)
09:00- 10:00	2000	4000	2000	4000
10:30-11:30	2000	4000	1000	2000
12:00-12:30	1000	2000	700	1400
12:45-01:50	2400	4800	1300	2600
02:00-03:00	2000	4000	1000	2000
03:10-04:10	2000	4000	800	1600
04:15-05:15	2000	4000	600	1200
05:20-06:20	2000	4000	500	1000
Total	15400 Liters	30800Watts	7900 Lietrs	9000 Watts
	15400-7900=7500 Liters Water Saved=48.7%		30800-15800=15000Watts Power Saved=48.7%	

Table 2: Statistical Analysis of Result Values

Thus by using this system one can save water and power/energy upto 50%.

VIII. CONCLUSION

Thus The Water Management System for Agricultural Sector provides regularly updated soil moisture and ground water data at different spots and different depths in the field, along with that it also provides to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently, and by using this system one can save up to 50 % of water and power. The present system is model to modernize the agriculture industries at the mass scale with optimum expenditure. This is the first of its kind in using linear programming for drip irrigation systems. Using this system, one can save manpower, water, energy/power to improve production and ultimately profit. Also for future enhancement it is possible to registered farmer to download drip control timings from agricultural universities website and control own drip irrigation system according to university. Also in future enhancement it is possible to control all the activities of same drip irrigation system with the help of android platform supported mobile.

REFERENCES

[1] Dnyaneshwar Wavhal and Manish giri "Intelligent Drip Irrigation System Using Linear Programming and Interpolation Methodology" International Journal of Computer (IJC), ISSN 2307-4531, pp.1-11

[2] Microcontroller based drip irrigation, technical paper on Drip Irrigation www.engineers .com April 30, 2010

[3] Stellaris LM3S5T36 Microcontroller Data Sheets, Texas Instruments Publication (January 15, 2011)

[4] WIRELESS SENSOR NETWORKSAGRICULTURE: FOR POTATO FARMING, Kshitij Shinghal et. al./ International Journal of Engineering Science and Technology Vol. 2(8), 2010, 3955-3963

[5] Maximize drip irrigation benefits by automating By Inge Bisconer, Toro Micro-Irrigation (March 12, 2008)

[6] "Controlling water use efficiency with Irrigation Automation: cases from drip and center pivot Irrigation of Corn and Soybean" Steven R. Evett,, R. Troy Peters,, and Terry A. Howell Southern Conservation Systems Conference, Amarillo TX, June 26-28, 2006 57

[7] "Irrigating basics" published in American nurseryman, December 1, 2007

[8] "Design and simulation of an automated system for green house using lab view ", American Eurasian J. Agric. & Environ. Sci., 3(2): 279-284, 2008.

[9] Intelligent Humidity Sensor for - Wireless Sensor Network Agricultural Application. International Journal of Wireless & Mobile Networks (Ijwmn) (Vol. 3, No. 1, February 2011) Doi: 10.5121/Ijwmn.2011.3111 118

[10] Program for resource efficient communities, university of floridia, 2008

[11] Dnyaneshwar Wavhal and Manish giri "Automated intelligent wireless drip irrigation using linear programming" International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 1, January 2013, ISSN: 2278 – 1323, pp.1-5

[12] Dnyaneshwar Wavhal and Manish Giri "Automated Drip Irrigation Improvements Using Wireless Application", International Journal of Advance Research, IJOAR .org, Volume 1, Issue 3, March 2013, Online: ISSN 2320-9194, pp.65-73

[13] Dnyaneshwar Wavhal, Manish Giri and Sneha Ghumatkar "Decision Support Support System for Drip Irrigation ", International Journal of Emerging Technology and Advanced Engineering, Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal,Volume 4, Issue 4, April 2014, pp.463-470

[14] Mahir Dursun and Semih Ozden "A wireless application of drip irrigation automation supported by soil moisture sesors", Scientific Research and Essays Vol. 6(7), pp. 1573-1582, 4 April, 2011 .Available on- line at http://www.academicjournals.org/SRE ISSN 1992-2248 l2011 Academic Journals of Exclusive Management Science - June 2012-Vol 1Issue 6 – ISSN 2277 - 5684.

[15] Shiv Sutar, Swapnita-Jayesh, Komal-Priyanka MIT-COE, Pune, Mahrashtra. "Irrigation and Fertilizer control for Precision Agriculture using WSN: Energy Efficient Approach", International Journal of Advances in Computing and Information Researches, ISSN: 2277-4068, Volume 1 No.1, January 2012

[16] Anurag D, Siuli Roy and Somprakash Bandyopad- hyay, Indian Insttute of Management Calcutta, Kolkata, India "Agro-Sense Precision Agriculture using sensor based wireless mesh networks".

[17] J.Panchard, P.R.S.Rao, M.S. Sheshshayee, P. Pa- padimitratos and J.-P. Hubaux ,"Wireless Sensor Networking for Rain-fed Farming Decision Support".

[18] "Irrigating basics" published in American nurseryman, December 1, 2007

[19] Ayman Sleman and Reinhard Moeller, Automation and Process Control Engineering, "Integration of Wireless Sensor Network Services into other Home and Industrial networks using Device Profile for Web Services (DPWS)".

[20] P.Raghuram, and Veeramuthu Venkatesh, School Of Computing, SASTRA University, Thanjavur, Tamil Nadu, India, "Enhancing Mine Safety with Wire- less Sensor Networks using Zigbee Technology". Journal of Theoretical and Applied Information Tech- nology 31st March 2012. Vol. 37 No.2, ISSN: 1992 -8645,www.jatit.org, E-ISSN: 1817-3195

[21] Meijering, Erik (2002), "A chronology of interpolation: from ancient astronomy to modern signal and image processing", Proceeings of the IEEE 90 (3):319-342, doi:10.1109/5.993400.