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Automated Intelligent Wireless Drip Irrigation Using Linear Programming

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Abstract— **Drip Irrigation is today's need because water is nature's gift to the mankind and it is not unlimited and free forever. World's water resources are fastly vanishing. The one and only one solution to this problem is automated Drip Irrigation system. 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 drip irrigation system, the farmer has to keep watch on irrigation timetable, which is different for different crops. In Automatic microcontroller based drip irrigation system irrigation will take place only when there will be intense requirement of water. Irrigation system uses valves to turn irrigation ON and OFF. These valves may be easily automated by using controllers and solenoids. The purpose of this paper is to provide more facility in agriculture field by using wireless sensor network along with linear programming. Paper describes an 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 as well as drip irrigation. use of linear programming help us to distribute available water to the crops if and only if there is immense need of water to the crop in order to get maximum profit with minimum cost. Also linear Programming helps us to do proper management of available water

Index Terms— **Irrigation- Surface, Drip, Wireless Sensor Network, Real Time Monitoring, Automation.**

I. Introduction

Agricultural irrigation is highly important in crop production everywhere in the world. In India, where the economy is mainly base on agriculture and the climatic conditions are isotropic and are not able to make full use of agricultural resources. The main reason is the lack of rains and scarify of land reservoir water. so efficient water management plays an important role in the irrigated agricultural cropping systems. The demand for new water saving techniques in irrigation is increasing rapidly right now. In order to produce "more crop per drop", growers in (semi) arid regions currently explore irrigation technique [1]. In the modern drip irrigation systems, the most significant advantage is that water is supplied near the root zone of the plants drip by drip due to which a large quantity of water is saved, at the present era, the farmers have been using irrigation technique in India through the manual control in which the farmers irrigate the land at the regular intervals. This process sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. This problem can be perfectly rectified if farmers use automated intelligent wireless drip irrigation system by using linear Programming [2].

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II. Objectives

- To save water, energy and man power in the agriculture sector
- Handle the system manually as well as automatically
- Detect water level
- To design, which will be efficient and effort reducing of the former.

III. Need Of The Project

Irrigation is an artificial application of water to the soil. An irrigation system is a system that delivers water to an area where water is needed but not normally present in the required amounts. Generally, it is used for agriculture and landscaping purposes. The effectiveness of the irrigation is determined by a number of different factors, including the type of irrigation system and the conditions at its time of use. Additionally, irrigation also has other uses in crop production, which include protecting plants against frost, suppressing weed growing in gain fields and helping in preventing soil consideration. In contrast, agriculture that relies only on direct rainfall is referred to as rain-fed or dry and farming. [2]

Types of Irrigation: *Surface Irrigation:* - Surface irrigation is defined as the group of application techniques where water is applied and distributed over the soil surface by gravity. It is

by far the most common form of irrigation throughout the world. Surface irrigation is often referred to as flood irrigation.

Drip Irrigation:- Drip irrigation, also known as trickle irrigation or micro irrigation or localized irrigation, is an irrigation method which saves water and fertilizer by allowing water to drip slowly to the roots of plants, either onto the soil surface or directly onto the root zone, through a network of valves, pipes, tubing, and emitter.

IV. Existing Automated Drip Irrigation System

In Existing Automated Drip Irrigation system it is not possible to operate it on decisions, it just operated only on single soil conditions like soil moisture, ph_value, and temperature, light. It operates on only one condition at a time like if we using soil moisture sensor to control automated drip irrigation then whenever soil moisture level is get decrease then & then only it direct the valve to change its position from OFF to ON, and if soil moisture level is go to the proper pre-setted level at that time system is get OFF automatically. This drip irrigation was performed by solar powered pumps. One of them (pump-1) carries water from Dam Lake to water tank, another one (pump-2) is used for achieving the required pressure for irrigation.

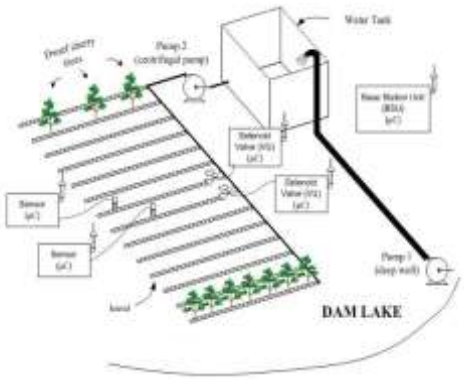

Fig: Overview of the Existing Automated Drip Irrigation System

V. Limitation of Existing Automated Drip Irrigation System

In Current / Existing Automated Drip Irrigation system it is not possible to operate it on decisions, it just operated only on single soil conditions like soil moisture, ph_value, and temperature, light. It operates on only one condition at a time.

VI. Proposed Automated Intelligent Wireless Drip Irrigation Using Linear Programming

It is somewhat similar to the existing automated drip irrigation system, but along with that my aim is to make my proposed system to be more intelligent that's why I am going to use linear programming in my proposed system. In Current/ Existing Automated Drip Irrigation system it is not possible to operate it on decisions, it just operated only on single soil conditions like soil moisture, ph_value, and temperature, light. It operates on only one condition at a time like if we using soil moisture sensor to control automated drip irrigation then whenever soil moisture level is get decrease then & then only it direct the valve to change its position from OFF to ON, and if soil moisture level is go to the proper pre-setted level at that time system is get OFF automatically. Here it is not going to check availability of water and requirement of water. But my system is going to check that and on that basis it is get operated. For that purpose I'm using linear programming approach in order to do proper use of available water all the available crops in the field where our system is get implemented to get maximum profit and also with the help of linear programming we easily identify available water and required water for the crops.

VII. Proposed System Architecture

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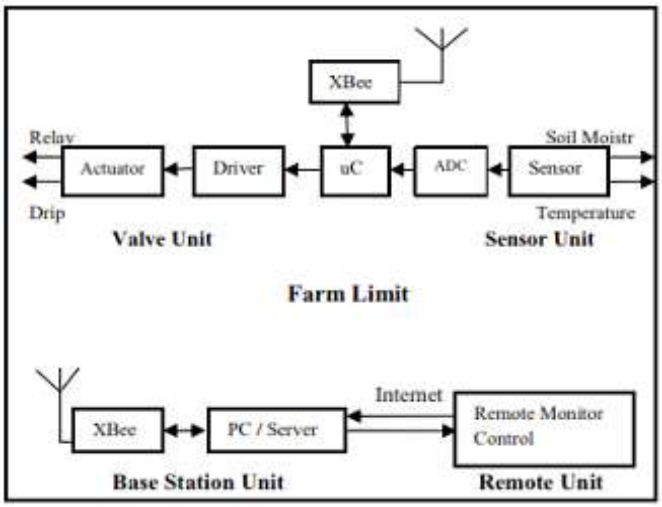

Fig: - Proposed System Architecture

The aim is to design a micro-controlled and PC driven automated drip irrigation system. 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 microcontroller 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.

A PC interface is provided for easy programming of the hardware (No traditional keypad-LCD interface for lame data entry).The 3D graphs generated from sensor values located across the entire field helps us to visualize, interpret and take decisive actions for the particular situation.

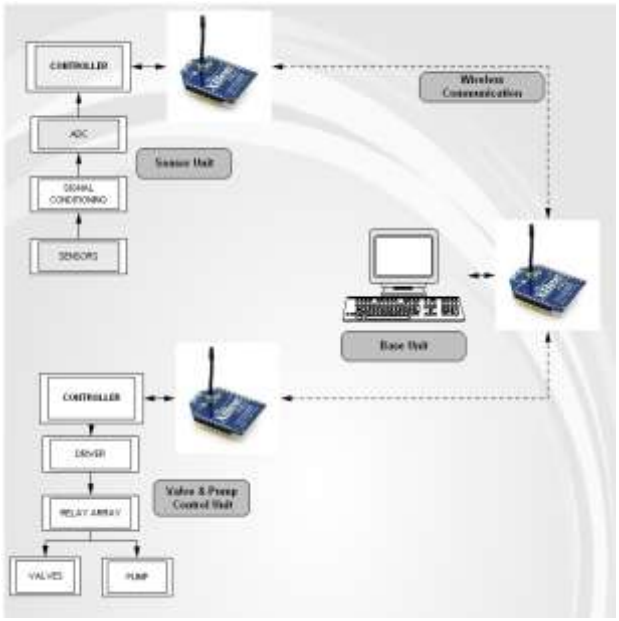

Fig: - Wireless Sensor Network for Drip Irrigation System

Sensors(Light,Temperature,PH_Value,Humidity): Sensor Sense the different physical parameters like light, ph_value of soil, temperature and humidity and converts these sense data into electrical signals (either voltage or current)

Signal Array: It is collection of various sensors basically it took input from sensor and fed that data as an input for the signal conditioning.

Signal Conditioning: It is very essential. Generally the signal obtained from sensors are weak hence we uses signal conditioning in order to keep signal in to its original state. That means it works as like amplifier.

ADC (Analog to Digital Converter): It Converts analog signal into digital signal and fed that digital signal to the micro controller as an input.

Micro-Controller: It is heart of the whole system, means it controls the all activities of the system. It has memory in which control programs are saved.

Sensor Unit: The SU acquires data given by the ADC, and the data sent to BSU. Value of ADC input which comes from the sensor is stored in a 10-bit register. Different type of sensors can be added easily for future developments.

Base Station Unit: The BSU is a master device that is programmed to read and to evaluate sensors data, to control valves and to communicate with other units.

PC (Personal Computer / Server): Basically for Data Acquisition as well as logging purpose we are going to use personal. The graphical visualization displays 3D Graphs generated from sensor values located across the field.

Darlington Drivers: It is control unit which controls relays, fan, heater and water pump according to the soil conditions and provides necessary conditions to the soil means humidity, ph_value, light, temperature.

Valve Unit: Valve unit has the same connection with wireless module and the same properties with SU. It has an output for controlling the valve. This valve was operated digital outputs on the microcontroller by transistor**.**

VIII. Wireless Sensor Network

A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location. The more modern networks are bi-directional, also enabling control of sensor activity. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on.

Wireless sensor networks (WSN) have recently been proposed for a large range of applications in home and industrial automation. It consists of many tiny nodes, which have several sensors and a radio interface that depends on the IEEE 802.15.4 standard that supports large number of embedded devices in one network. WSN can be used for many applications such as environment monitoring, medical applications, robotic systems and home and industrial automation.

IX. 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.

Problem: - 1000 liters of water

Profit :- 4 Rs/Liter for Crop 1

5 Rs/Liter for Crop 2

Let ‘x’ = liters for crop 1

‘y’ = liters for crop 2

Then PROFIT (P) = 4 x + 5 y (to maximize)

x + y <= 1000 ---------- (1)

Power required to send 1 liter of water for crop 1 = 2 watts

Power required to send 1 liter of water for crop 2 = 3 watts

Max power available = 2400 Watts

2x + 3y <= 2400---------- (2)

Solution:-

Constraints x>=0, y>=0

x+y<=1000----------(1)
2x+3y <=2400----------(2)

For Equation (1) put x=0 we get y=1000 and put y=0 we get x=1000 and for equation (2) put x=0 we get y=800 and put y=0 we get x=1200

Now solve these 2 equations we get the point where we get maximum profit

2x + 3y = 2400---------- (2)

-2x- 2y = -2000---------- (1) multiplies by -2

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y = 400

So put y=400 in equation (1) we get x=600

So now we have 4 points in graph

i.e. (0,0), (1000,0), (0,800), (600,400)

Now we have to calculate profit for that purpose we have to put these Values in equation (P = 4x + 5y)

For (0, 0) we get profit P = 0,

For (1000,0) we get profit P = 4000

For (0,800) we get profit P = 4000

For (600,400) we get profit P = 2400 + 2000 = 4400 = maximum profit

Hence

600 liters of water for crop 1

And

400 liters of water for crop 2

X. 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.

XI. Mathematical Model

System can be stated as set S that consists of

S = {N, Pr, Po, C, LP, X};

Where

N = number of crops,

Pr = {pr1, pr2…n}; Set of profits generated per liter for crop 1, 2…n (Input to the system),

Po = {po1, po2…n}; Set of values of power required to send 1 Liter of water to crop 1, 2…n (Input to the system)
C = {c1, c2…}; Set of constraints the system must follow. (Predefined).

LP = Liner Programming function that takes input Pr, Po and C and generates unknowns **X**= {x1,x2,…xn}; where x1,x2,…xn are optimal values of water that must be provided to each crop 1,2,..n

X = LP (Pr, Po, C);

XII. Advantages

1. Are relatively simple to design and install
2. This makes increase in productivity and reduces water consumption
3. This is safest.
4. No manpower is required
5. Reduce soil erosion and nutrient leaching.
6. Here we are using linear programming. it has also some advantages that are as follows:-

- LP is good for optimization problems involving maximizing profits and minimizing costs.
- The linear programming technique helps to make the best possible use of available productive resources (such as time, labor, machines etc.)
- In a production process, bottle necks may occur. For e.g. in a factory some machines may be in great demand while others may lie idle for some time. A significant advantage of linear programming is highlighting of such bottle necks.
- Relatively quick.
- Guaranteed to find optimal solution
- Provides natural sensitivity analysis (shadow prices)

XIII. Disadvantages

1. As compared to Conventional Irrigation system equipments are costlier.
2. Require frequent maintenance for efficient operation
3. Have limited life after installation due to the deterioration of the plastic components in a hot, arid climate when exposed to ultraviolet light.

4. Linear programming is applicable only to problems where the constraints and objective function are linear. In real life situations, when constraints or objective functions are not linear, this technique cannot be used.
5. Factors such as uncertainty, weather conditions etc. are not taken into consideration.
6. Reducing the world to a set of linear equations is usually very difficult

XIV. Conclusion And Future Scope

The Automated Intelligent Wireless Drip Irrigation System Using Linear Programming provides to be a real time feedback control system which monitors and controls all the activities of drip irrigation system efficiently as well as it helps us for to do the efficient water management in order to get more profit with less cost. Using this system, one can save manpower, as well as water to improve productivity and ultimately the profit.

In future if you modify it properly then this system can also supply agricultural chemicals like calcium, sodium, ammonium, zinc to the field along with Fertilizers with adding new sensors and valves.

Also it is possible to registered farmer to download drip control timings from agricultural universities website and control own drip irrigation system according to university

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