Efficient Management of Drip Irrigation using Sensors

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***Abstract*— Drip irrigation is a technique of artificial application of water to agricultural field or soil by allowing water to drizzle slowly either on soil surface or directly to the roots of plants. At present era, where there is dearth of water, this technique is the most efficient way of water management where almost no water is lost over surplus water or evapotranspiration and soil particles have plenty of opportunity to ingest and hold water for plants. This paper proposes a method for more efficient management of water by making use of soil moisture sensors, rain sensor and microcontroller for the supervision of drip irrigation. The agricultural field is partitioned into 'n' number of areas, soil moisture sensors are placed at each area and then irrigating one area by one through solenoid valves and this cycle repeats. Rain sensor and soil moisture sensors are used to get the values of water conditions and fed to microcontroller to regulate irrigation in a circular fashion. The importance of the proposed method is to ensure proportionate water supply for whole agricultural field, avoid water loss, eliminate soil erosion, scarcity of water and power consumption.**

Keywords*— Drip irrigation; Rain sensor; Soil moisture sensor; evapotranspiration; GSM; ON/OFF system; arm7 microcontroller.

I. INTRODUCTION

Food and water are the basic needs of a human being, every person needs food to survive on earth. In our country where population is high, sufficient food for the whole population can be incurred only when there is high crop productivity, water plays a main role in crop production and action of supplying water for dry land is known as irrigation. Irrigation is the fourth stage of crop production and it is important because water is required for fertilization of seeds and helps roots to imbibe minerals and fertilizers. There are two types of irrigation – drip irrigation and sprinkler irrigation. Drip irrigation is very powerful and fruitful.

Antecedently irrigation was carried out manually in which farmers used to irrigate the land at regular intervals. Farmers had to predict weather conditions, soil moisture conditions themselves each time before irrigating the agricultural field. Although manual irrigation is effective, in manual operation farmers fall short of time to irrigate agricultural field as and when needed and due to lack of proper planning regarding irrigation schedules they fail to achieve better crop production, excess of irrigation leads to soil erosion and scarcity of water allows a farmer to irrigate land at abnormal intervals, this leads to decease of plants. Today's world is totally polluted and deforestation is the main reason for the lack of pure oxygen and water resulting in global warming due to which water is getting polluted beneath the earth and scarcity of water results due to endless extraction of water. So to minimize the risk associated with water requirement, drip technique of irrigation got introduced.

In case of drip irrigation water flows through small width pipeline associated with ducts and the placement of pipeline is such a way that ducts come in contact with the soil surface or the roots of plants or crops. The main advantage in this type of irrigation is that water is emitted via ducts directly on the roots of plants or crops by eliminating whole agricultural field from getting wet, thereby terminates diffusion of water. Drip irrigation is most appropriate for lined up crops like vegetables, fruits. Drip technique of irrigation is flexible to install on any slope [9].

In modern era, to get over the troubles faced in manual drip irrigation with human intervention, automatized drip irrigation system is developed to provide ample water for crops which results in high crop production. This automatic drip irrigation system is best suited when available labors are limited or expensive to employ. The automatic system is executed with the help of microcontroller and mainly soil moisture sensors to irrigate agricultural field where there is large requirement of water. Sensor values are analog, analog to digital converter is used to obtain decimal value of it and fed to microcontroller, then microcontroller will make decision to irrigate the land or not based on comparison between the current value of soil moisture and threshold soil moisture value. This is ON/OFF system where motor gets ON when soil moisture value is less than threshold value, and motor gets OFF when soil moisture value is equal to or higher than threshold value. This automatized drip irrigation system

altogether eliminates man power, avoids water wastage, reduces power consumption, increases crop productivity.

II. RELATED WORK

A. *Automatic drip irrigation system using GSM*

In this technique though drip irrigation is performed automatically using soil moisture sensors, temperature sensors that predicts current soil conditions, the decision whether to irrigate the agricultural field or not is left to the farmer. The sensors provide analog values and are converted to digital values using analog to digital converter and fed to microcontroller to determine whether obtained sensor values are less than, equal to or greater than threshold value, if obtained sensor values are less than threshold value then motor should go ON, else if value is equal to or greater than threshold value, the motor should go OFF. Whatever comparison is done by microcontroller for the decision to be taken is sent to farmers mobile via GSM. Farmer will then send command to ON/OFF the system. So this system is not completely automated, it requires human intervention [1].

B. *Fully automated drip irrigation system*

In this system, microcontroller is the heart of drip irrigation system. Soil moisture sensors, temperature sensors and other sensors as desired by farmers are implemented. Sensors provide analog values of present soil condition, it is converted to digital value using analog to digital converter. The digital value is fed to microcontroller to compare sensors provided value with threshold value and microcontroller itself makes decision based on comparison done to ON/OFF the system. Therefore this system is completely independent without human intervention. This system completely eliminates labor cost [2].

C. *Automatic drip irrigation system with data mining techniques*

In this system sensors are placed in the agricultural field along with a control station and a base station. Data obtained from different sensors are provided to the base station by wireless transmission using zigbee. Once the data is received at the base station, data processing and computation necessities for decision making are carried out by using data mining algorithm. The result of data processing and computations are utilized for regulation of automated drip irrigation system. Data processing task provides all real time data in the combined form and generates data or observations such a way that are convenient for farmers or to other end users and this data is broadcasted for web applications so that observations can be remotely supervised. When real time data is delivered, farmers would be able to achieve intellectual crop irrigation system [7].

D. *Raingun irrigation system*

In this technique, pipe is connected from one side of water pump and the other opening is kept near the root of the plant, with raingun irrigation mechanism attached to it. The flow of water from the pipe is regulated by a solenoid valve. The opening and closing of solenoid valve is controlled by microcontroller. Microcontroller sends signal to the valves which causes it to get open. The water is directly supplied to the roots of the plant drop by drop, and when the moisture of the soil becomes sufficient, the sensor senses this and sends back the signal to the microcontroller and the motor goes OFF [8] .

E. *Greenhouse drip irrigation system*

Greenhouse is a complex microclimate system control structure. Greenhouse crops are irrigated by applying water to the crop surface via drip pipelines or tapes with the help of hand using a hose, sprinklers or by applying water through the bottom of the container through sub irrigation, or by using a combination of all these. In subirrigation systems, water and nutrient solution provided at the base of the container rises by capillary action through holes in the bottom and is absorbed by the growing medium. These systems are adaptable to crops grown in pots or flats. Crops that cannot be grown in open field conditions have to be grown in green houses. To construct a green house is expensive. Therefore only important crops which require climatologically control are mostly grown in green houses [10].

III. SYSTEM DESIGN

The proposed method mainly focuses on efficient water management for irrigating agricultural field via drip pipelines. The agricultural field is partitioned into ‘n’ number of areas, each area is associated with a soil moisture sensor and a solenoid valve, one rain sensor for whole agricultural field. Relays are used for driving each solenoid valve. Program is dumped into microcontroller with a logic that describes complete regulation of irrigation system. A threshold value is set, motor should go ON and solenoid valve associated in each area gets open when sensor values fall below threshold value, solenoid valve gets closed when particular area reaches equal to or greater than threshold value, motor goes OFF when rain is detected irrespective of soil moisture value. Once rain stops motor goes ON and completes irrigation cycle. There are ‘n’ number of soil moisture sensors placed one for each area but only one rain sensor to whole agricultural field. When power supply is provided, the first area sensor values are retrieved and compared with threshold value, microcontroller will give out the result whether sensor values are less than or equal to or greater than threshold value. If system is operated in manual condition then result given by microcontroller is sent to farmer for decision to irrigate first area or not. If system is operated in automatic condition then microcontroller itself takes decision to irrigate first area or not. The first area sensor values are read, if values are less than threshold value then solenoid valve associated in first area gets open. Once the value reaches equal to or greater than threshold value, solenoid valve associated in first area gets closed. Now second area sensor

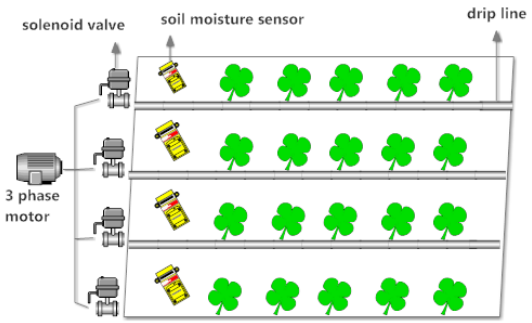

Fig. 1. Basic Design of Drip Irrigation System

values are read and compared with threshold value, decision is taken in same way as taken for first area if values are less than threshold then solenoid valve in second area gets open. After the values reache equal to or greater than threshold value the solenoid valve in second area gets closed. Similarly irrigation process is done for all areas. When last area decision is over the cycle repeats again from first area. Initially motor is off, farmer is provided with option to switch between manual control or automatic.

In case of automatic, when power is supplied, rain sensor and first soil moisture sensor value is retrieved and fed to analog to digital converter(ADC) to get digital value, this value is passed to microcontroller which executes program logic and itself makes decision to irrigate first area or not and water flows through first solenoid valve driven by first relay associated with it. Once the soil moisture sensor value in first area reaches equal to or greater than threshold value then automatically solenoid valve at first area closes and immedia-tely rain sensor value along with second soil moisture sensor value is retrieved and fed to ADC. The digital value is passed to microcontroller and decision to irrigate second area will be taken by microcontroller itself and second relay drives second solenoid valve that gets open and water is supplied to second area and valve gets closed once the value reaches equal to or greater than threshold. In this way process continues till last area and then cycle repeats from first area.

In case of manual control, when power is supplied, rain sensor and first soil moisture sensor value is retrieved and fed to analog to digital converter(ADC) to get digital value, this value is passed to microcontroller which executes program logic and decision to be made is sent to user desktop or laptop via zigbee, if farmer gives command to ON the solenoid valve of first area then water flows through first solenoid valve driven by first relay associated with it. Once the soil moisture sensor value in first area reaches equal to or greater than threshold value then information about this is sent to farmer. Farmer may then give command to either stay in same state(ON) or to close solenoid valve at first area and start reading rain sensor value along with second soil moisture sensor value and fed to ADC. The digital value is passed to microcontroller and decision to irrigate second area will be again sent to farmer, if the command given by farmer is yes then second relay drives second solenoid valve that gets open and water is supplied to second area. In this way process continues till last area and cycle repeats from first area.

A. *Advantages*

1. Water is used more efficiently.
2. Clogging of water can be easily rectified.
3. Agricultural land is completely irrigated even power cut occurs, none of the area is left unirrigated.

B. *System architecture*

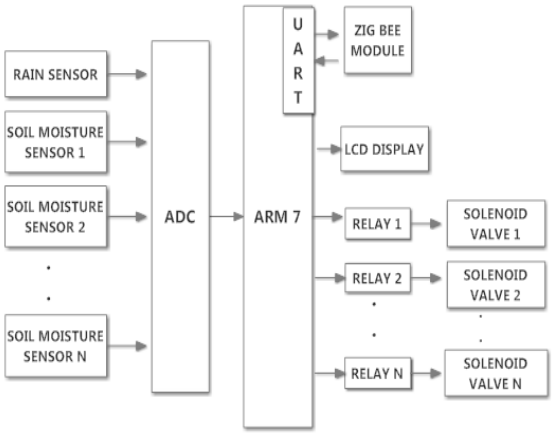

Fig. 2. Architecture of Drip Irrigation System

The architecture consist of following sections :

1. Rain Sensor : it is used to detect rain.
2. Soil Moisture sensor : used to predict moisture level in soil.
3. ADC (analog to digital converter) : used to convert analog values provided by sensors to digital value.
4. ARM 7 : is a microcontroller with 64pins. Program to be executed is dumped into it.
5. Relay : used to mechanically operate a switch.
6. Solenoid valve : valve is regulated by an electric current via solenoid through which water flows.

C. *Algorithm*

1. Motor = off;
2. Provide input to control irrigation automatically or manually.
3. Initialize LCD (liquid crystal display).
4. Read values from rain sensor and each individual soil moisture sensor (i).
5. Convert analog values of sensors to digital.
6. Compare set threshold value with obtained values.

```
For ( i=1; i<=n; i++ )
{
If (soil moisture of i < threshold && rain = not detected)
        {
                Motor = on;
                Solenoid valve i = open;
        }
Else if (soil moisture of i > threshold && rain = not detected)
```

```
        {
                Solenoid valve i = close;
        }
    Else if (soil moisture of i < threshold && rain = detected)
        {
                Motor = off;
        }
}
```

7. Repeat step 6 once rain = not detected.
8. Repeat from step 4 to 6.

IV. CONCLUSION

In this proposed efficient water management technique, water is proportionately supplied to each area in a cyclic manner one area after another. This technique has more advantage when compared to existing automated drip irrigation system that make use of only one soil moisture sensor for whole agricultural land. The proposed method is very helpful in case of power cuts, farmer can easily rectify which area is completely irrigated, partially irrigated or not at all irrigated and can manually control the system by irrigating the areas which remain unirrigated. The proposed system with 'n' number of soil moisture sensors saves more water, reduces power consumption, increases crop productivity.

V. REFERENCES

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