Smart Drip Irrigation System Using PLC for Effective Water Management

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Abstract:- While thinking of farming the very first thing comes into mind is management, let it be of seed sowing, irrigation and soil health till post harvesting activities. Farming will not be a profitable business unless it will be management smart. After successful implementation of farm mechanization, researchers are now working on farm automation. There are lot of problems are faced by farmers especially in India irrigation infrastructure is not so strong that it will fulfil agricultural need. Due to natural causes rainfall has been decreased and density of rainfall is effected, here comes importance of smart irrigation management. In this paper an attempt is made to address this issue by implementing sensor and actuator network controlled by LC. Due to monitoring and controlling of farm irrigation using smart sensor, crop yield will be improved as exact watering requirements will be fulfilled without any error & waste of fertilizers will be eliminated by supply fertilizers through water channel.

Keyword: - Smart Irrigation System, Soil Moisture Sensor, Relay, Solenoid Valve, Drip irrigation

1. INTRODUCTION

According to 2010 report only 35% of total agricultural land in India was provided with irrigation infrastructure and about 2/3rd of total cultivation land is dependent on monsoons in India. Groundwater resources seems to be very useful for fulfilling irrigation needs but again level and availability of groundwater in India are limited to monsoon. This result in unsustainable extraction of water at different parts of country for crop irrigation, domestic use, industrial use etc. which in turn depleting ground water level at very greater rate than natural recharge rate.

Due to inappropriate ways of irrigation like excess and unequal water supply causes problems like water logging, wastage of water, degrading PH level of soil, taking away soil micro nutrients etc. Also there are problems like drain and filtrate of mobile nutrients due to which bacteria that changes organic matter into plant food cannot get necessary warm temperature and air in soil, thus plant gets affected by diseases, pest attack etc. in traditional ways of farming water use was limited as watering of plants/ farm irrigation was very time consuming and hardworking process. In older times animals or humans were involved in irrigation process causing exertion due to hard work, hence irrigation was quite appropriate and limited.

Farm mechanization was treated as evolution in traditional farming styles as it helps save time required for pre & post harvesting activities. But due to era of farm mechanization abrupt changes in farming style have been done. Most of the changes were good but some changes result in water wastage, soil health degradation & people's laziness & carelessness about their surroundings. Now farmers are using water pumps which are capable of supplying thousands of litre of water within a minute or few. There is untold race between peoples to suck groundwater using mechanized devices but peoples are not taking appropriate care for recharging water sources and groundwater. Hence here is a need to use appropriate amount of water as required by variety of crop/plant and it can be achieve only using smart controller.

To deal with this problem there are various method, drip irrigation is one such method, which is implemented using modern technology using various sensors and control mechanism [2]. This smart and advanced irrigation technologies help in reducing crop wastage, which in turn prevent excessive and scarce watering to crops and thereby increase the crop yield. In this method water is supplied to crops in form of water droplets that are dripped directly to the root of the plants as per convenience over a period of time. Irrigation cycle is crop dependent i.e. it depends on type of crop cultivated. This method helps to reduce water consumption and limits excessive supply of water. Drip irrigation system have his own limitations like it can't be used for crop like Rice, Wheat where crop density is very high and need abounded amount of water indeed, it can be very effective for vegetable farming, fruit farming, gardening, nursery and for seasonal crops.

This paper proposes an intelligent and automated irrigation system for watering crop where drip irrigation is possible. The system concentrates on controlling the irrigation process automatically using the PLC device. The automation part is controlled through Ladder circuit diagram. The system consists of soil moisture sensors

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which monitor the moisture content of the soil and humidity sensor to measure humidity in surrounding. The PLC is powered up with 24V power supply which can altogether control the complete system. The main aim of this system is conservation of water resources, human intervention can be reduced, also managing water resources where it is not available easily will result in good yields and it also helps in maintaining good performance of plant.

II. SYSTEM DESIGN

As an integrated part of product design and development products effectiveness is depending on system design. We have done some field trails in order to find optimum sensor and actuator positions. For trial purpose open pit is used with pre planted Polianthes tuberose trees, the spacing is equally distributed and is of approximately 30 cm. the schematic of layout is as shown;

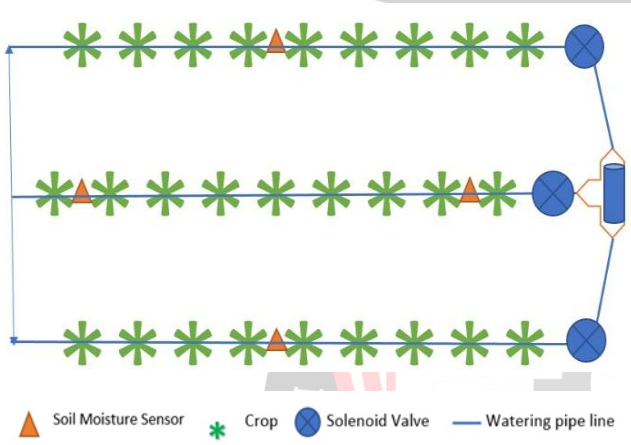

Fig. 01 System Layout

Fig. 02 Field photo

Soil moisture sensor is placed approximately 10-15 cm deeper and at a distance of 50 – 60 cm. the dripping line (watering line) is supplied nearby root of every tree for proper water supply. Dripping line are directly connected to water tank through solenoid valves.

Need of controller;

Now a days farming is a very big challenge though it is fully mechanized, the main problem most of the farmers face are supply of skilled labour, availability of electricity and water. Hence need of involvement of alternative brain is developed, that need can be fulfilled by using Microcontroller, Programmable logic controllers for data processing. Now in the era of farm automation PLC will play very governing role and lot of research is going on worldwide for such systems. PLC will serve as a smart brain for decision making based on conditional analysis and pre-programming.

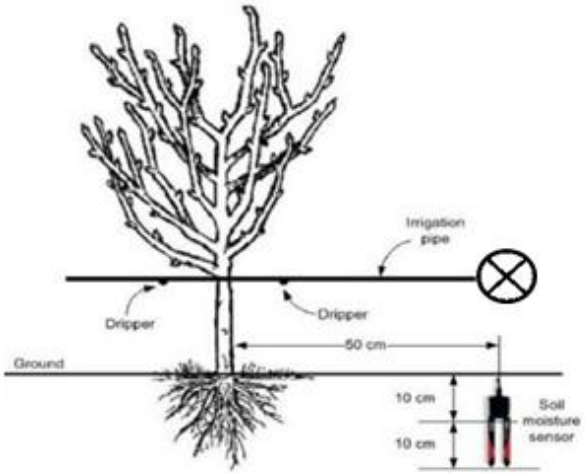

Fig. 03 Sensor & Dripper Positioning

Drip Irrigation is a progressing technology in Agriculture field, it is an irrigation method that saves water and fertilizer by allowing water to drip slowly to the roots of plant. During the growth season crop water does not remain constant and varies depending on the climate conditions such as temperature, humidity and solar radiation [5].

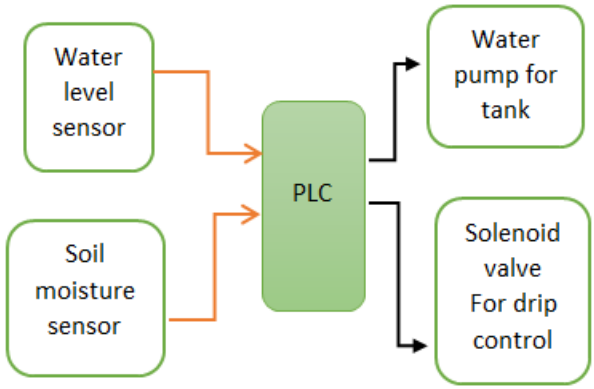

Fig. 04 Block diagram of system

System Components;

I. PLC (Programmable Logic Controller)

Overall structure of automated irrigation depends on Programmable Logic Circuit (PLC). The main aim of PLC is to read input from sensor and generate output according to the logic created in the program. It is easy to add & substract input/output modules or communication modules, without any hardware modifications. So it would be easy for farmer to change the number of solenoid valves or pumps and the system easily though input and output connections are limited, but are not limited because Xbee & Zigbee systems are there to integrate more number of inputs

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without making system complicated. Indraworks engineering is the platform for PLC project planning and configuring. The software used in PLC is called the Indralogic. It is the complete development environment in PLC

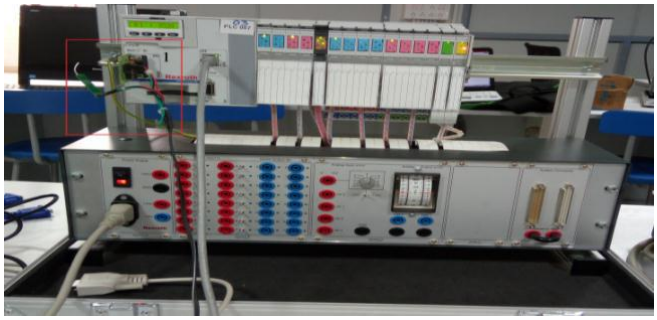

Fig. 05 PLC setup

II. Soil Moisture Sensor

It is used to measure moisture content in soil. Sensor is interfaced with PLC (Programmable Logic Controller) and two probes are inserted into soil [3]. These probes are used to pass current in the soil, if soil has moisture then the value of resistance will be low hence more current will flow, if soil is dry then value of resistance will be more then less current will flow. Thus the value of resistance will help to find the value of moisture content in the soil & the module used is YL-69.

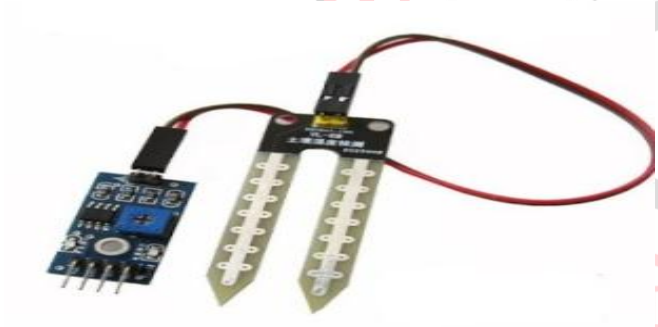

Fig. 06 Moisture sensor

III. Humidity Sensor

It is used to measure amount of vapour in the air i.e. Humidity, relative temperature is also calculated because change in temperature causes change in humidity [4]. Changes occur before and after irrigation. It helps in notifying the user about present condition of field. Humidity sensors work by observing different changes in temperature or electrical currents in the air and send signal to PLC accordingly. DHT11 digital temperature and humidity sensor comes 04 pins inline packaging is used for study. Some salient features of this sensor are long-term stability, fast response, Low cost, long distance signal transmission, relative humidity and temperature measurement and strong anti-interference ability. It is smaller in size and power consumption is low. The signal transmission is up to 20 meter.

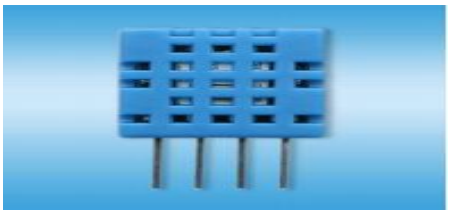

Fig. 07 Humidity sensor

IV. Solenoid valve

It is electromechanically controlled switch i.e. it is controlled by an electric current used for regulating the flow of current [5]. Main task of this valve is to shut off, distribute, or mix fluids. In two ways solenoid if the valve is open the two ports will connected and fluid flows within the ports, when valve is closed both ports will isolated from each other [6]. If valve is normally open when not energised then it is called normally open (NO) and when it is closed when not energised then it is called normally closed (NC). The valve has been installed in tank line so that one valve is interfaced with one moisture sensor, when moisture sensor will give high input to PLC it will open solenoid valve for that particular dripping line.

Fig. 08 Humidity sensor

III. PROPOSED SYSTEM

The Praposed system is based on PLC which acts as a main controller of the system. It's main aim is to read sensor data and generate output as per logic diagram created for the system. It is programed using ladder logic which is easy to develop and understand. In this syetem only one motor of single phase is used to fill the tank accorging to need. The single phase motor operate on nominal ac voltage and controlled by PLC using relays. The contactor type relays are used which are based on energizing signal from PLC that either turns on or off the motor. Water is fed to plants by the pressure created by the head and it is controlled by solenoid valve. Solenoid valve is operated using elctric current from output port of PLC. It is switch on and off to cut or open the flow of water into the farm.

Soil moisture sensor is used to measure the content of moisture in the soil and connected to the input port of PLC , when the moisture level is below threshold value then solenoid valve is made open and when it reaches the set value then solenoid valve is closed. Similarly the humidity sensor work to measure humidity which is important to increase crop yield. When the humidity is below threshold value then it open the solenoid valve and when it reaches threshold value it is closed.

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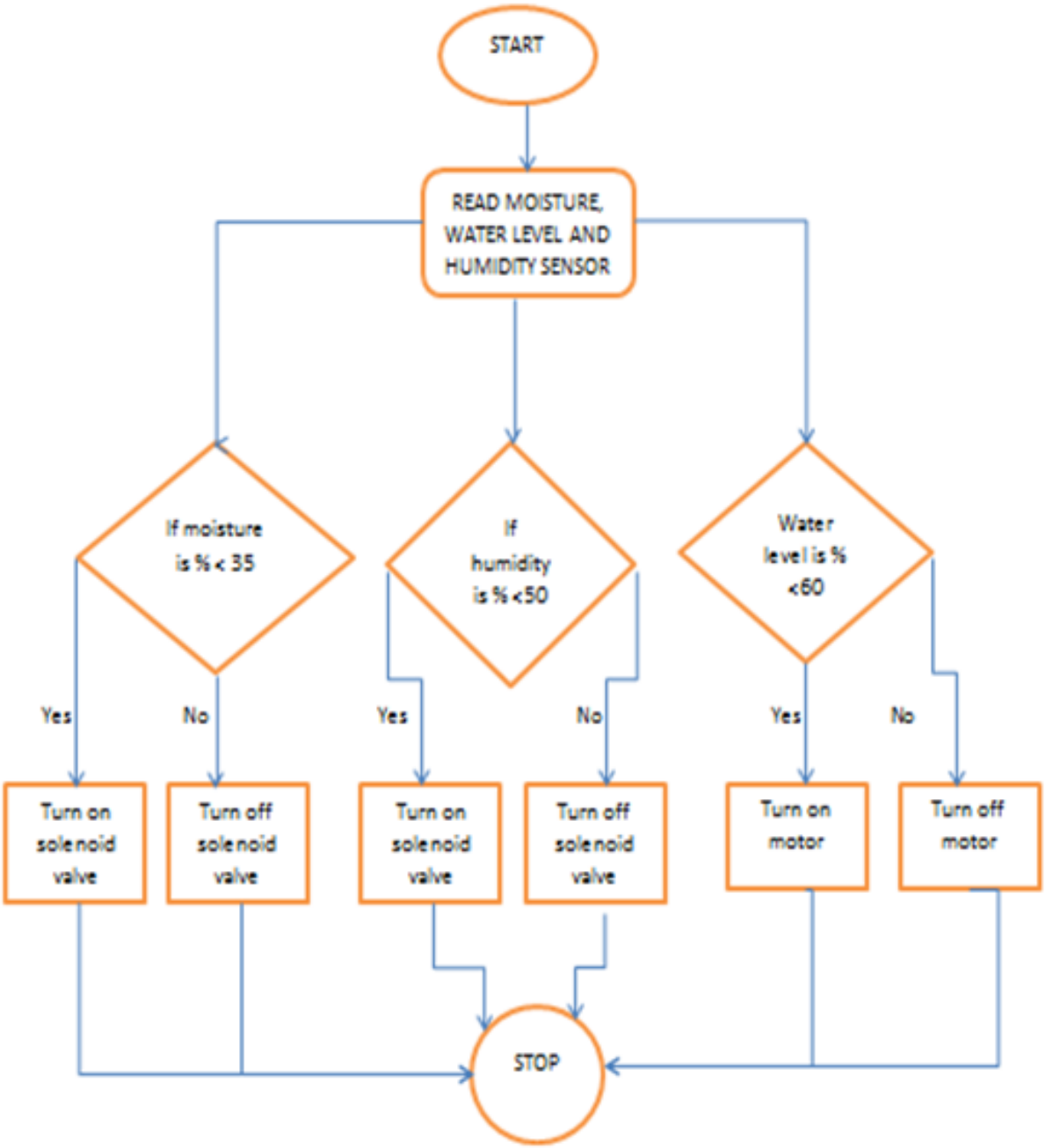

Fig. 09 Block Diagram

Humidity sensor is also used to measure the temperature; temperature is relative to moisture. With change in temperature causes change in moisture. For simulation of the system LOGIX-PRO was used which is a PLC based simmulator. Circuit was made using Normally open (NO) & Normally close (NC), Output elements and results were observed according to truth table underprovided.

Table 01 Logic Table

Soil Moisture Sensor	Humidity Sensor	Solenoid Valve
0	0	1
0	1	1
1	0	1
1	1	0

The table below shows simulation of system for which ladder programme has been developed in simulation software. Whenever there is an input either from humidity sensor or soil moisture sensor or from both the solenoid valve gets open supplying water in the water deprive fields. We deployed the same smart irrigation system in 8×8 (64 sq. ft.) with 4 similar solenoid valve equally spaced. All the PLC based connections were according to logic diagram and different sensors were placed accordingly. The drip irrigation tubes were spread around the selected field to cover maximum area and all the wired connections were intact within the PVC tube to reduce complexity of the system. The deployed system was tested for 04 months and it worked fine with good results.

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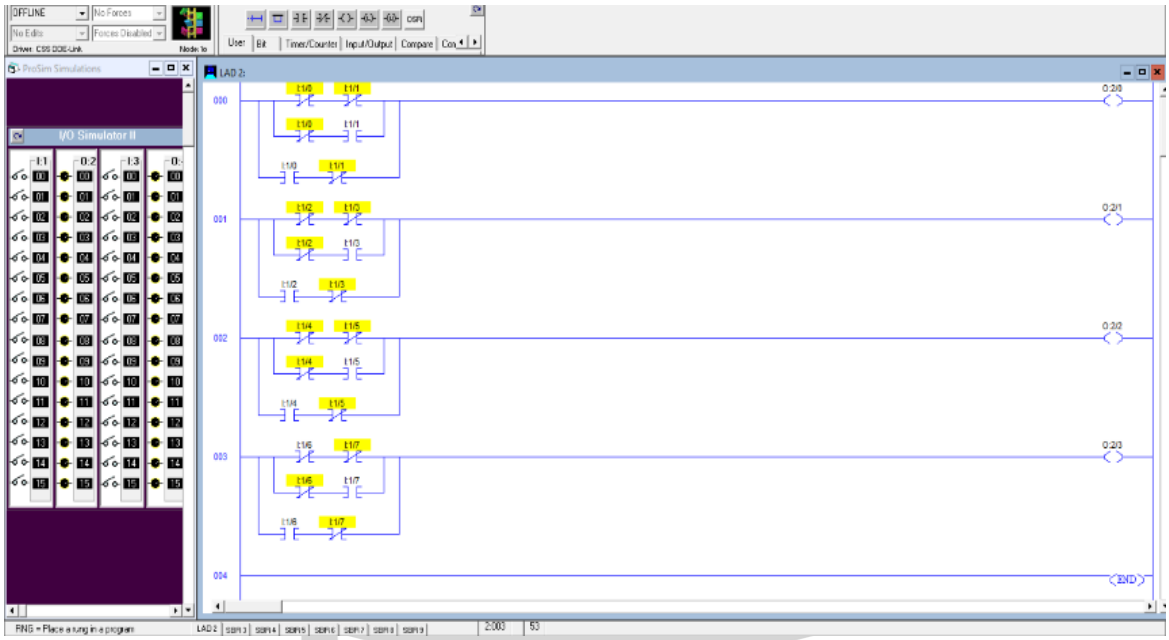

Fig. 10 Ladder Programming

Comparison between existing irrigation system and smart irrigation system

a) Existing irrigation system depends upon fixed schedule of municipalities and commercial owners, they set run time of water supply irrespective of season [8]. In smart irrigation the availability of water supply does not depend upon electricity schedule supply. Water it is stored in tank during the regular electricity schedule and supplied to farm when needed (Load shedding).

b) In existing system large amount of ground water and surface water is wasted whereas if smart irrigation system is employed in such a manner that there will be little chance of water wastage. Proposed system supplies specific amount of water to the plant according to their correct level of moisture.

c) Smart irrigation system can be controlled automatically without any physical presence of human skilled labor at field. Considering different features, cost and long life of smart irrigation system it can be easily accepted by farmers, municipalities and commercial green area authorities.

d) Using smart system, we can collect data of moisture content of soil region wise and according to weather report we can analyse the data and accordingly supply the resources in the region of scarcity, which is not possible in existing system.

e) Though study for effectiveness is going on analysis of past 04 months of 2018 has been tabulated below using sprinklers to run in the field for approx. 1 hr on every alternate day during winter and rainy session and once in a day during summer, discharging 7.57 lit/min;

Table 02 Water consumption analysis on 64 sq. ft pit

Month (2018)	Sprinkler irrigation water consumption (lit / hr.) / day	Smart irrigation system water consumption (lit / hr) / day	Approx. Saving (lit / hr.)	Average Temperature
January	227.1 - 300	95-110	132.1	Min. 10 – Max. 27
February	227.1 - 300	120-150	107.1	Min. 12 – Max. 32
March	454.2 - 550	305-330	149.2	Min. 21 – Max. 38
April	454.2 - 550	355-390	99.2	Min. 24 – Max. 42

IV. CONCLUSION

Technical analysis for amount of water required for specific type of plant considering various session and temperature conditions are under process. Till publishing his work we have receives good results on water consumption and system compact ability and easiness of use have been proved. The effectiveness analysis have been started in January of 2018 and will be continue till December 2018 as % change in humidity & plant water requirement will vary with it. As per our study we utilized approx. 95-110 lit of water per day in the month of January, approx. 120-150 lit of water per day in the month of February, approx. 205-330 lit of water per day in the month of March, approx. 355-390 lit of water per day in the month of April by implementing this project on 64 sq. ft. field. The amount of water saving have been calculated from total water discharge through

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pipe w.r.t. time. Previously sprinklers used to run in the field for approx. 1 hr on every alternate day during winter and rainy session and once in a day during summer, discharging 7.57 lit/min. This project help reducing water consumption as we replaced sprinkler system with drip irrigation system and by supplying metered amount of water strictly as per demand put from humidity sensor processes through PLC.

It helped in reducing human interference in the field by automatic irrigation. This type of irrigation helps in reducing problems like water logging and wastage of water. Using this method power consumption is reduced and it can also be used in green house. This method is very beneficial where water scarcity is a major problem. The system and technology used is very economical, reliable and is timesaving.

V. Future Scope

1. IOT implementation for remote monitoring and controlling
2. Pre-programmed channels for variety of crops
3. Fertilizers supply through water channels
4. Solar operated system can work during power cut off hours
5. Can generate data base according to the moisture content region wise which can be used for forecasting, analyzing and improvising future irrigation time period.

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