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Automation Irrigation System for Floriculture, Vegetable and Cereal Crops

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ABSTRACT

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Water which forms the most important ingredient in the process of photosynthesis is desired for its unobstructed growth. It should be supplied to the soil just to satisfy its field capacity above which the water being supplied is a waste. To save water during the growing rainy season and to make use of this saved water during the other seasons at farm level gives scope to development of various water saving technologies. One such further development is the use of automation in drip irrigation system which overcomes the problem of water wastage especially in areas where there is water scarcity. The equipment employed makes use of sensors to sense the moisture and supply water only when the moisture is deficient in soil.

Introduction

Agriculture is the basic source of livelihood and allied activities for over 55% people in India (censuses 2011). It accounts for 14% of nation's GDP and about 11% of its export. It is the backbone of Indian economy which is improving in terms of mechanization in various areas including irrigation technology. Accelerating the growth of production in agriculture is necessary so as to achieve a target of 8% during the 12th plan and to reach the objectives of food security.

The combined efforts of central, state government and the farming community have successfully achieved a record production

259.32 million tonnes of food grains of which 131.27 million tonnes was during kharif season and 128.05 million tonnes during rabi during 2011-12, which was the highest ever food grain production. However during 2012-13 India managed to produce 255.36 million tonnes (124.68 million tonnes, during kharif and 125.47 during rabi). The 5.02% decline in kharif production has been due to late onset of monsoons and reduced rainfall in various like Andhra Pradesh, Bihar, Gujarat, Karnataka, Haryana, Maharashtra, Tamil Nadu, Rajasthan and West Bengal. Hence in order to feed 1,210.6 million (2011) population of India, technology has to be adopted to keep the production high even in unsuitable circumstances. A large scale minor and major

development has been taken place over the years keeping in mind the ease of farm operations and its economy. Various regions in India have been facing acute shortage of water mainly due to unequal distribution of rainfall covering various seasons. Due to this the rain fed crops can be recovered to some extent; however substantial decline is observed in the yield of short duration crops.

A wetted profile developed in the plant's root zone is as shown in Figure 1. Its shape depends on soil characteristics. Drip irrigation saves water because only the plant's root zone receives moisture. Little water is lost to deep percolation if the proper amount is applied.

From conventional to modern irrigation

The history of irrigation goes back to over 5000 years when 'free flooding' or 'wild flooding' where water is brought at right angles to the direction of natural slope and in head ditches and let out over the fields. This is considered to be the most inefficient method.

The border irrigation where fields were divided into long strips and a thin sheet of water was let out across the slope of the strip.

It has advantages like it can be adapted to a wide range of soil texture excepting those having extremely high or low infiltration rates and suitable for close growing crops but has disadvantages that it does not use water economically. Then came various other methods of irrigation like the check basin method, ring method, furrow irrigation and sprinkler irrigation system which has its own advantages and disadvantages.

Drip irrigation / trickle irrigation which is the latest of them all is one in which water is given to the crops in drops to meet the requirements. It was developed by Simca Blass, a hydraulic engineer in 1959 in Israel.

A well-controlled irrigation system is one which optimizes the spatial and temporal distribution of water. Optimization does not necessarily produce the highest yield or use the least water, but maximizes the benefit-to-cost ratio (Hillel, 1980).

According to Phene (1986) control systems are usually divided into open loop systems or closed loop systems. An open loop control system is defined as one in which the results of operations are independent of the input and an operator is needed to make decisions. In a closed loop control system the input is directly dependent on the output through a feedback mechanism from the output to the input. The feedback allows for the comparison of the output to some reference input signal, thus achieving precise control.

Van Bavel (1995) presented a closed-loop control for micro irrigation systems that continuously monitored the transpiration of individual plants using sap flow sensors, and delivered a matching amount of water using a pump controller. However, the system still required some soil moisture monitoring to prevent soil saturation, and measurement of the soil moisture level at the beginning of the planting period for the crop.

Materials and Methods

In this chapter, methods followed to determine the soil moisture sensor, temperature and humidity sensor are explained in detail. The automation irrigation carried out by incorporating additional microcontroller, relay, solenoid valve, GSM (Global System for Mobile Communications) to operate the system.

Soil moisture sensor

The irrigation controller developed in this project is programmed to measure the soil

water potential, and make a decision every 15 min about starting or stopping irrigation. This sampling interval was chosen because the system that is being controlled does not change quickly, and a sampling interval of 15 min is adequate for detecting soil water potential changes, even for high frequency irrigation (Wessels *et al.*, 1995). Each irrigation controller monitors three soil water potential sensors. That number of sensors was chosen to keep the cost of the system low while providing enough data for reliable irrigation decisions. When two of the sensors indicate that the soil water potential in the root zone is more negative than the threshold set by the user, the irrigation controller opens a solenoid valve, starting the irrigation of that zone. Irrigation continues until two of the soil sensors indicate that the soil water potential exceeds the threshold level (plate.1).

Temperature and humidity sensor

The LM35 series are precision integrated-circuit 2 temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^{\circ}\text{C}$ at room temperature and $\pm 3/4^{\circ}\text{C}$ over a full -55°C to $+150^{\circ}\text{C}$ temperature range. The device is used with single power supplies, or with plus and minus supplies. As the LM35 draws only 60 μA from the supply, it has very low self-heating of less than 0.1°C in still air.

While the LM35C is rated for a -40°C to $+110^{\circ}\text{C}$ range (-10° with improved accuracy).

Relays are used where it is necessary to control a circuit by a low-power signal or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit.

The solenoid valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.

SMS approach

GSM is a cellular network, which means that cell phones connect to it by searching for cells in the immediate vicinity. SMS is store and forward way of transmitting messages to and from cell phones. The major advantage of using SMS is provision of intimation to the sender when SMS is delivered at the destination and ability of SMSC to continue efforts for delivery of message for the specified validity period if network is presently busy or called user is outside the coverage area. Using CMGS command the text message is sent to cell phone.

The data processing unit is centered on PIC16F887A microcontroller. The PCB for the microcontroller has been developed. The Circuit connection and actual image of microcontroller are shown below in Figure 2.

Software description

MPLAB IDE is the software used for programming PIC microcontroller through embedded C. TINY Boot loader is used to download the program in to the flash of the PIC.

MPLAB IDE is a Windows Operating System (OS) software program that runs on a PC to develop applications for Microchip microcontrollers and digital signal controllers. It is called an Integrated Development Environment, because it provides a single integrated "environment" to develop code for embedded microcontrollers. A development

system for embedded controllers is a system of programs running on a desktop PC to help write, edit, debug and program code - the intelligence of embedded systems applications - into a microcontroller. MPLAB IDE runs on a PC and contains all the components needed to design and deploy embedded systems applications.

Selection of switches for crops

Four switches are connected to the PORTD of the controller. PORTD is configured as the input port. Based on the switch input to the port the program enters the corresponding loop where the current temperature and moisture will be compared with the predefined values. When switch 1 is pressed, the crop-1 is selected. The predefined values set for the crop-1 will be taken as the reference values and comparison is made. Similarly a switch 2 is dedicated to crop-2 and switches 3 for crop-3 and switch 4 for crop-4.

Results and Discussion

Automation in drip irrigation serves as a useful tool in saving water especially in places where there is scarcity of water. Practically it involves various benefits more than disadvantages as a result overall benefits are obtained.

The above table 1 shows the results obtained when automation was applied to rose plantation. In day 1, 14.50 cm height of rose plant at 0.79 cm diameters, same in both automation and without automation.

Repeated daily, in day 8, 14.75 cm height of rose plant at 0.85 cm of diameter in automation irrigation and 14.60 cm height of rose plant at 0.84 cm of diameter in without automation irrigation. A considerable faster growth was seen and the size of the flower and productivity was increases compare to without automation.

Plate.1 Soil moisture sensor



Plate.2 Temperature and humidity sensor

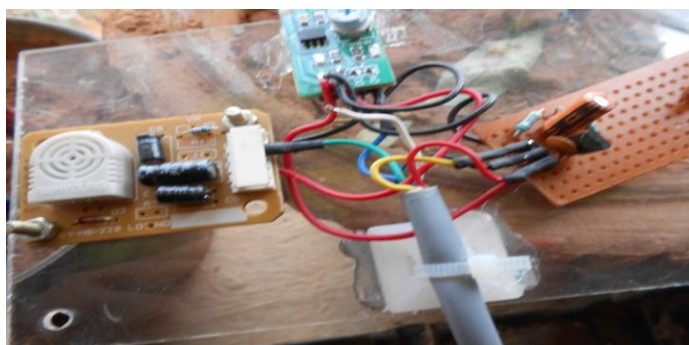


Plate.3 Relay and power supply for relay

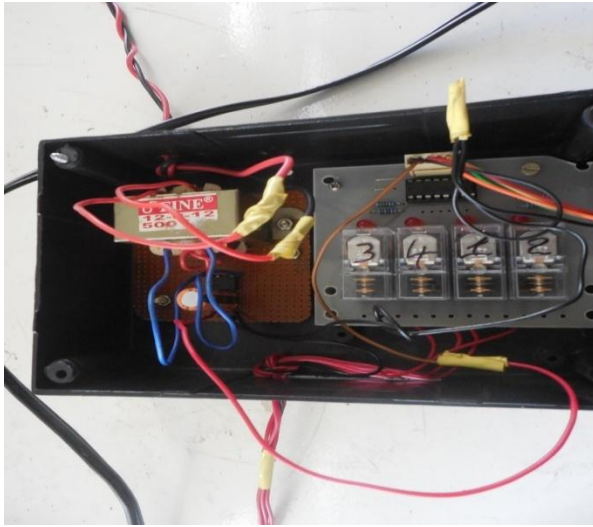


Plate.4 Solenoid valve

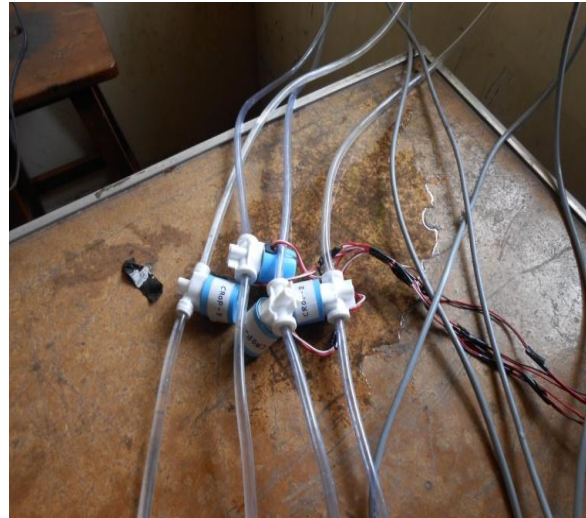


Plate.5 Window of MPLAB IDE

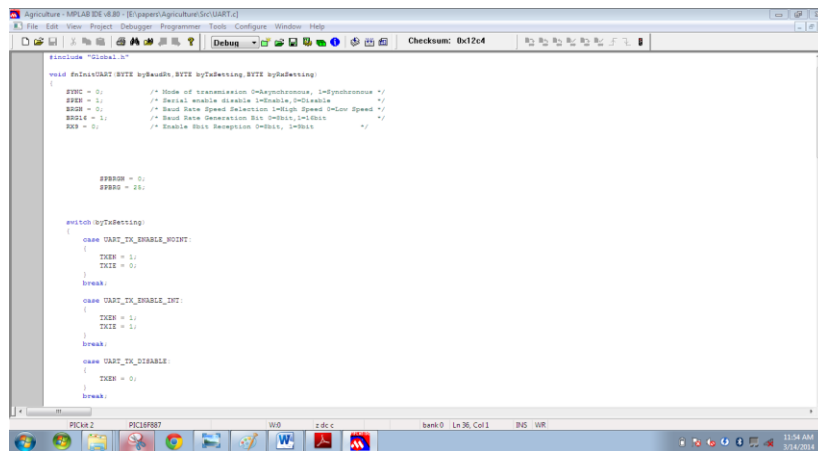


Plate.6 Selection of switches for crops



Fig.1 Wetted profile at root zone

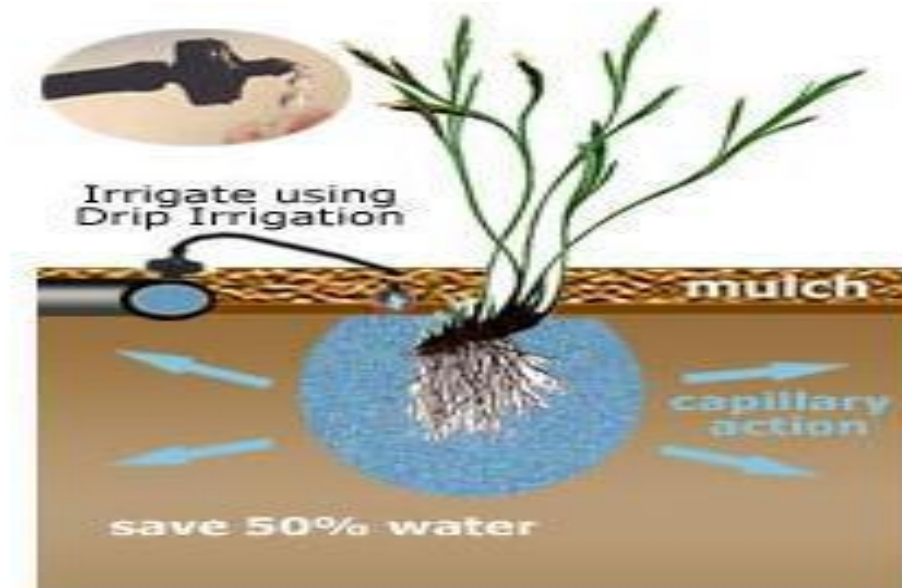
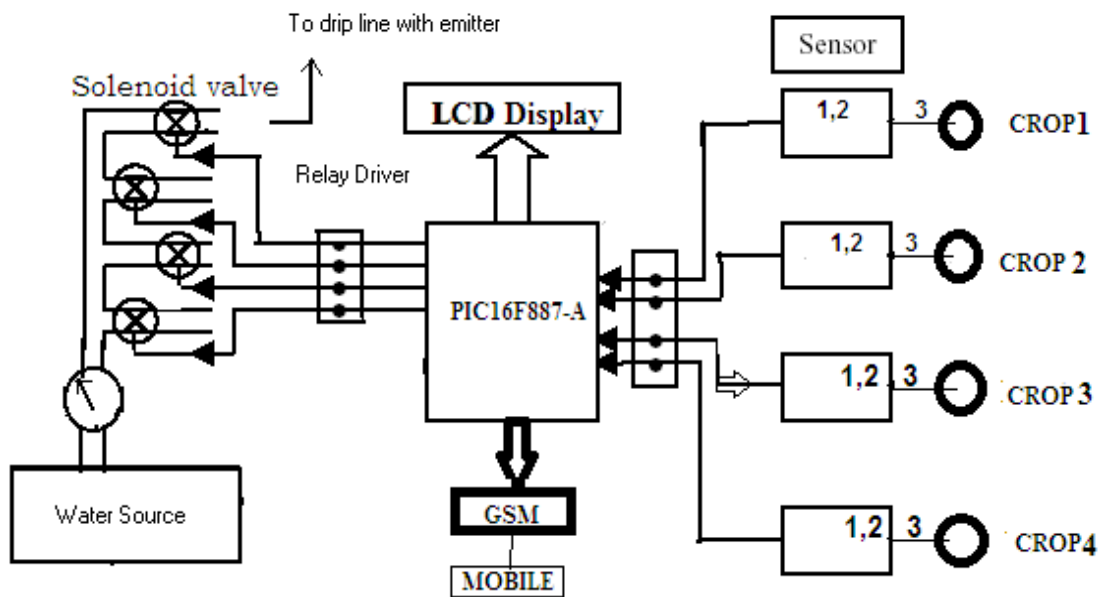


Fig.2 Block diagram of automation system



- 1-Temperature Sensor
- 2-Humidity Sensor
- 3-Moisture Sensor

Table.1 Rose plantation

Day	With automation		Without automation	
	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)
1	14.50	0.79	14.50	0.79
2	14.50	0.80	14.50	0.79
3	14.55	0.81	14.50	0.79
4	14.60	0.82	14.51	0.80
5	14.61	0.82	14.53	0.81
6	14.65	0.83	14.55	0.82
7	14.70	0.84	14.56	0.83
8	14.75	0.85	14.60	0.84

Table.2 Chilly crop

Day	With automation		Without automation	
	Height (cm)	Diameter (cm)	Height (cm)	Diameter (cm)
1	21.00	0.54	21.00	0.54
2	21.10	0.54	21.00	0.54
3	21.10	0.55	21.00	0.54
4	21.30	0.55	21.10	0.55
5	21.30	0.56	21.10	0.55
6	21.30	0.56	21.20	0.56
7	21.40	0.57	21.20	0.56
8	21.40	0.58	21.30	0.57

Table.3 Maize crop

Day	With automation		Without automation	
	Height (cm)	Diameter(cm)	Height(cm)	Diameter(cm)
1	34.00	1.75	34.00	1.75
2	34.20	1.76	34.00	1.75
3	34.20	1.76	34.00	1.75
4	34.50	1.77	34.10	1.76
5	34.50	1.78	34.10	1.76
6	34.50	1.78	34.10	1.76
7	34.60	1.78	34.10	1.76
8	34.70	1.79	34.20	1.77

The above table 2 shows the results obtained when automation was applied to chilly crop. In day 1, 21.00 cm height of chilly crop at 0.54 cm diameters, same in both automation and without automation. Repeated daily, in day 8, 21.40 cm height of chilly crop at 0.58 cm of diameter in automation irrigation and 21.30 cm height of chilly crop at 0.57cm of diameter in without automation. A considerable faster growth was seen and the size of the plant and productivity was increases compare to without automation.

The table 3 shows the results obtained when automation was applied to maize crop. In day 1, 34.00 cm height of maize crop at 1.75 cm diameters, same in both automation and without automation. Repeated daily, in day 8,

34.70 cm height of maize crop at 1.79 cm of diameter in automation irrigation and 34.20 cm height of maize crop at 1.77cm of diameter in without automation. A considerable faster growth was seen and size and productivity was increases compare to without automation. Due to the automation irrigation we can save 25-50% of water, time, labours and fertilizer application and mainly increases the productivity and quality of crop.

Use of automation makes a closed loop irrigation system which periodically monitors and controls the various parameters of farming such as soil moisture water flow, temperature etc. so as to optimize the application of various resources such as water, fertilizers etc. for maximum

production. The soil moisture level is one of the critical parameters of agriculture which controls the quality of crops in any type of field. The yield is increased, water saved and labor requirement is reduced.

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