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Development of a Soil Moisture Detector System for Effective Water Management and Agricultural Productivity Based on Smart Irrigation

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Abstract: **-- Agricultural sector is playing vital role in Indian economy, in which irrigation mechanism is of key concern. Our paper aims to find the exact field condition and to control the wastage of water in the field and to provide exact controlling of field by using the drip irrigation. It describes an application of soil moisture detector and gypsum block sensor (developed by AEC&RI) for controlled irrigation and real time monitoring water content of soil. Soil moisture detector is made up of two electrode probe to pass current through the soil, so we tend to read that resistance to induce the moisture level. Once the soil is dry condition the soil moisture detector measure the resistance and convert into volts. Soil moisture detector and relay actuates the solenoid valve. If solenoid valve open the pump is ON then the flow can happen by pressure sensor, whereas the soil is wet condition, the solenoid valve closes. Gypsum soil moisture sensor is the electrical resistance between electrodes embedded in a porous medium (block) is proportional to its water content, which is related to the soil water matric potential of the surrounding soil. Automation of irrigation systems has the potential to provide maximum water productivity by maintaining soil moisture in the field at optimum levels. This automated irrigation system works without wire and wireless technology. Hence the farmers can use the low cost automated system in the field with the help of soil moisture detector and gypsum block..**

Keywords **- Arduino, Automation, Gypsum block, Pressure sensor and Soil Moisture detector**

I. INTRODUCTION

Precision agriculture is an agricultural system that can contribute to the sustainable agriculture concept. If installed and programmed properly, can even save us money and help in water conservation. Automatic agricultural system will be programmed to discharge precise amount of water within the field, which promote water conservation. At present labor saving and water saving technology may be a key issue in agriculture. There hasn't been any effective technology advancement being created in agricultural sector as compared to other sectors. Agricultural system must be monitored on regular basis (Sophie, 2001). The use of this project is to reduce the wastage and ensure soil quality by atomizing the complete agricultural system. A low cost solution for effective water management currently in use is drip irrigation system that consists of an automated controller to turn ON and OFF the control valve, which in turn helps the farmers by managing the water supply to the crop fields and further maintain the moisture level of soil (Yoder et al., 1998). Hence the objective of the research is to develop and test an automatic system having a low cost soil moisture detector for an irrigation system.

II. NEED OF THE PROJECT

It is mainly due to lack of rain in several part of India and scarify of land water. The demand for new water saving technology in irrigation is growing immediately without delay. At the present situation, the farmers have been using irrigation technique in India through the manual control in which the farmers irrigate the land at the usual interval. This method generally consumes more water or sometime the water reaches delayed due to which the crops get dehydrated.

III. PROPOSED SMART IRRIGATION

The system is tenable solution to enhance water productivity in the agriculture field. It provides water for plants according to crop water demand and operates according to soil moisture condition of the root zone of crop. Thus it reduces stress on

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farmers to pay additional water tariff on water. Further automated irrigation system allows farmer to supply the precise amount of water at the right time. Besides human activities were reduced on irrigation effectively, more energy consumption in water pumps could be required by effective water allocation based on crop water demand.

IV. MATERIALS AND METHODS

The main hypothesis with reference to the current work is that using soil moisture detector technology to automate irrigation in which it improves water productivity. This is due to the fact that the detector could provide information about the water content of the environment to an irrigation controller, and predetermined watering of plants could be arranged to suit current condition.

Soil moisture detector

Soil moisture probe is most sensitive to the ambient humidity is generally used to detect the moisture content of the soil. Probe to reach the threshold value in set in the soil moisture, Digital Output (DO) interface port output high, when the soil humidity exceeds a set threshold value, the module Digital output interface output is low. A current is passed across the electrode through the soil and the resistances to the current in the soil determine the soil moisture (Zhang, 2011). This detector has made digital and analog output. Features of soil moisture detector presented in Table 1 and soil moisture detector are presented in Figure1.

Table. 1 Features of soil moisture detector

Working Voltage	5V
Working Current	20ma
Interface	Analog
Depth of deduction	80 mm
Working Temperature	100 C – 300 C
Weight	5g
Size	150 x 30 mm
Software	Ardino Compatible Interface
Output Voltage Signal	0 – 4.2 V
Sensitivity	High
Power consumption	Low

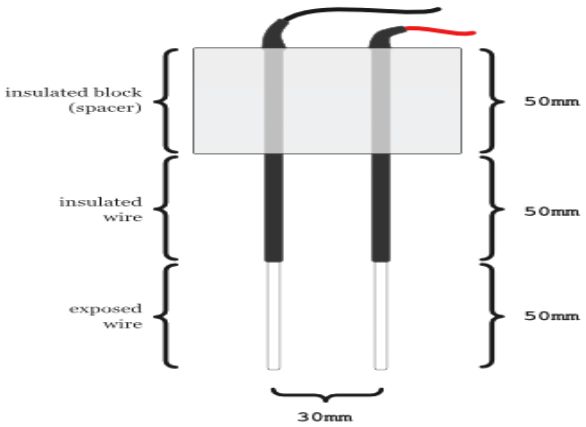

Fig. 1 Soil moisture detector

Gypsum soil moisture sensor:

It is the electrical resistance between electrodes embedded in a porous medium (block) is proportional to its water content, which is related to the soil water matric potential of the surrounding soil. GSM based controller has been linked with sensor unit for switch on and off the agricultural pump sets.

Relay:

The relay is the device that opens or closes the contacts to cause the operation of the other electric control. It works on the principle of an electromagnetic attraction. When the circuit of the relay senses the fault current, it energizes the electromagnetic field which produces the temporary magnetic field. This magnetic field moves the relay armature for opening or closing the connections. The small power relay has only one contact, and the high power relay has two contacts for opening the switch. The inner section of the relay is shown in the figure below. It has an iron core which is wound by a control coil. The power supply is given to the coil through the contacts of the load and the control switch. The current flows through the coil produce the magnetic field around it. Due to this magnetic field, the upper arm of the magnet attracts the lower arm. Hence close the circuit, which makes the current flow through the load. If the contact is already closed, then it moves oppositely and hence opens the contacts. Relay image and circuit diagram are presented in Figure 2

Solenoid valve:

The medium flows through a small orifice which can be closed off by a plunger with a rubber gasket on the bottom. A small spring holds the plunger down to close the valve. The plunger is made of a ferromagnetic material. An electric coil is positioned around the plunger. As soon as the coil is electrical energized, a magnetic field is created which pulls the plunger up towards the centre of the coil. This opens the orifice so that

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the medium can flow through. This is called a Normally Closed (NC) valve. A Normally Open (NO) valve works the opposite way: it has a different construction so that the orifice is open when the solenoid is not powered. When the solenoid is actuated, the orifice will be closed. Principle of solenoid valve are presented in Figure 3

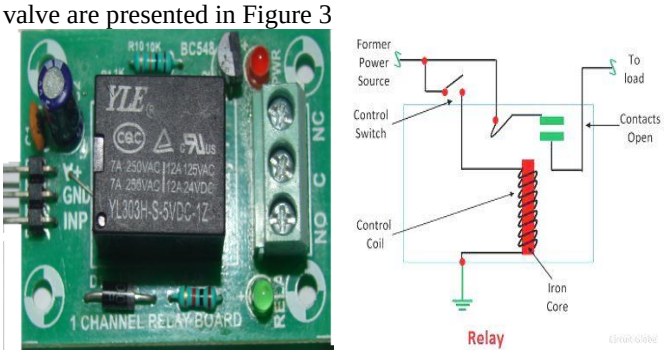

Figure. 2 Relay image and circuit diagram

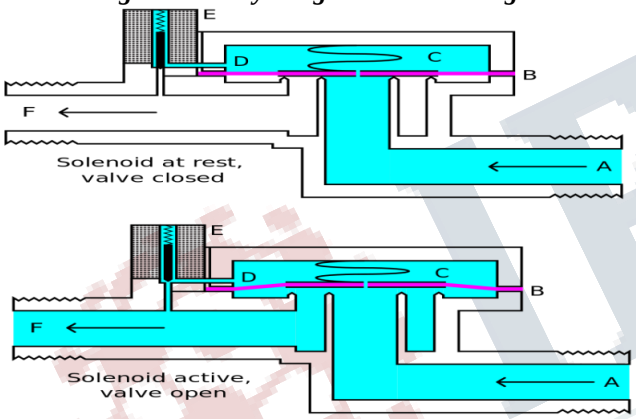

Figure. 3 Principle of solenoid valve

Pressure sensor:

It is designed to maintain constant pressure. It does not permit the pump to operate without water and avoids water hammering. It requires no preloading of air or adjustment. It has a water reserve to prevent the unit from being started by a dripping tap. If water consumption is more than 1l/m, the pump will operate continuously. When the pump reaches the maximum pressure the unit automatically switches the pump off. Unit selection must take into account the fact the differential must be over 0.7 bar. Pressure sensor with self priming pump are presented in Figure 4

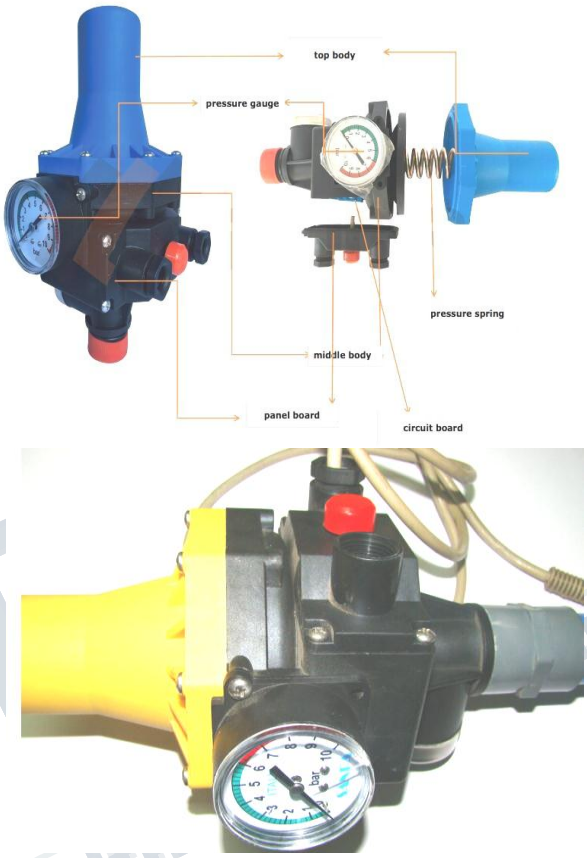

Figure. 4 Pressure sensor with self priming pump

Arduino

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino projects can be stand-alone or they can communicate with software running on a computer .The boards can be built by hand or purchased pre assembled; the software can be downloaded for free.

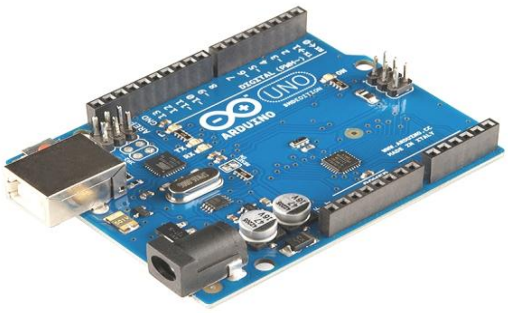

Figure. 5 Arduino

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V. RESULTS AND DISCUSSION

Results and discussion the following sections are i) Working principle of irrigation automation, ii) Arduino programming language and iii) Comparative study of soil moisture detector, gypsum block sensor and gravimetric measurement

Working Principle of the system

A system is proposed for automatic irrigation system based on soil moisture requirement. This system uses three nodes which communicate each other and irrigate agricultural field automatically. The system consist of soil moisture detector to detect the moisture level and automatically irrigate the field by means of solenoid valve to control the flow of water from source to field and pressure sensor to control the power supply to water pump. The obtained irrigation system not only prevents the moisture stress on crops, but also provides an efficient use of water productivity. The proposed technique can help in automatic ON/OFF the motor by using soil moisture detector at fields. Automation of irrigation systems has the potential to provide maximum water productivity by maintaining soil moisture in the field at optimum levels. In addition, the developed irrigation method removes the need for workmanship for flooding irrigation. This automated irrigation system works without wire and wireless technology. Hence the farmers can use the low cost automated system in the field with the help of soil moisture detector.

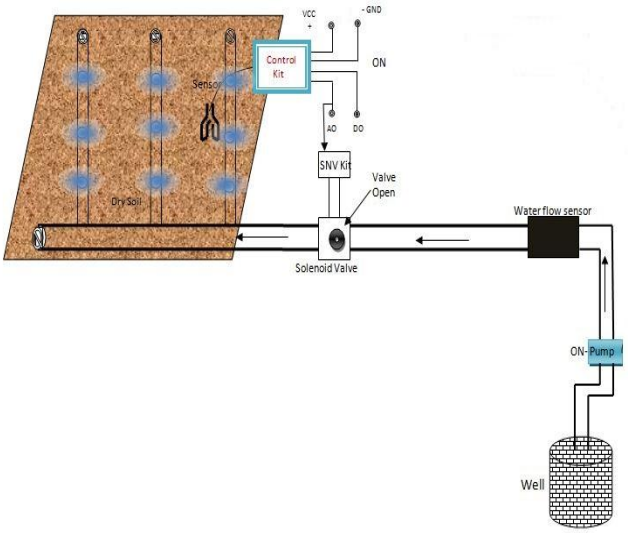

Figure.6 Overview of system installation in pump ON position

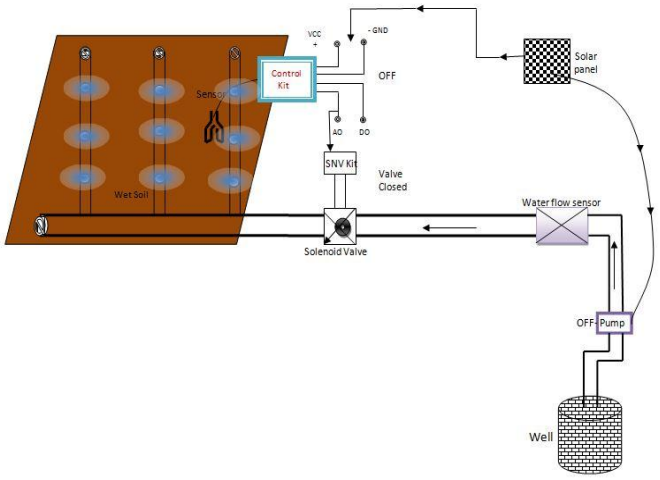

Figure.7 Overview of system installation in pump OFF position

Comparative study of soil moisture detector and gravimetric moisture content Gypsum block soil moisture sensor was calibrated in Agricultural Engineering college and Research Institute, Kumulur. The electrical resistance values for the corresponding soil moisture were observed for one day at every two hours interval. The developed gypsum block sensor (AEC&RI) and soil moisture detector was tested in sandy loam soil with the field capacity of 15 per cent and wilting point at 8 per cent in laboratory condition. The experimental field was sandy loam soil with the field capacity of 15 per cent and permanent wilting at 8 per cent with the help of pressure plate. The soil moisture content was arrived gravimetrically by keeping the soil samples in oven for 1050 C. Comparative study of soil moisture detector, Gypsum block sensor and gravimetric moisture content are presented in Figure 8

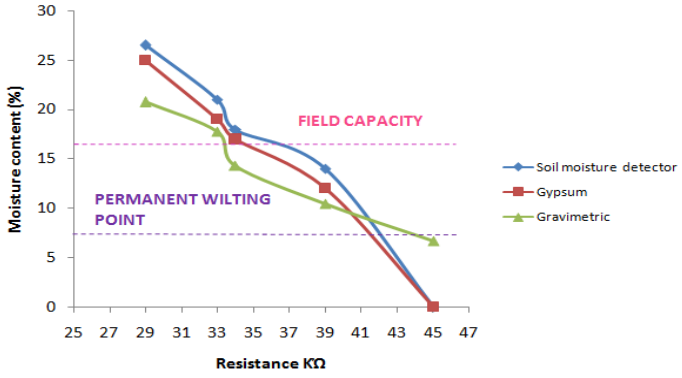

Figure 8. Comparative study of soil moisture detector, gypsum block and and gravimetric moisture content

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Programming Language

```
void setup ()
{
Serial.begin (9600);
}
if (analogRead (5) < 300)
{
Serial.println ("I am thirsty, please give me water");
}
if (analogRead (5) > 300 && analogRead (5) < 700)
{
Serial.println ("I feel so comfortable");
}
if (analogRead (5) > 700)
{
Serial.println ("Too much of water, I might get hurt");
}
delay (200)
}
```

VI. CONCLUSION

In present days, especially farmers are facing major problems in watering their agriculture fields, it's because they have no proper idea of when the power is available so that they can pump water. Even after then they need to wait until the field is properly watered, which makes them stop doing other activities. The proposed technique can help in automatic ON/OFF the motor by using soil moisture detector at fields. In addition, the developed irrigation method removes the need for workmanship for flooding irrigation. The major advantage of the system is work without wire and wireless technology. Hence the farmers can use the low cost automated system in the field with the help of soil moisture detector and gypsum block sensor

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