Sensor Based Automatic Irrigation Management System

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Abstract— **In the field of agriculture, use of proper method of irrigation plays an important role for the economy and development of a country. In the conventional irrigation system, the farmer has to keep watch on irrigation timetable, which is different for different crops.**

This work makes the irrigation automated. With the use of low cost sensors and the simple circuitry this work aims low cost product, which can be bought even by a poor farmer.

This work is best suit for places where water is scarce and has to be used in limited quantity. Also, the third world countries can afford this simple and low cost solution for irrigation and obtain good yield on crops.PIC controller that is be used in this work. A 16×4 LCD is connected to the microcontroller, which displays the soil moistures level and switches are provided to set the limits of humidity for switching the individual solenoid valves controlling the water flow to the field. The humidity and temperature levels are transmitted at regular time interval to the LCD through a serial port for data display and analysis. The humidity sensors are constructed using aluminum sheets and housed in easily available materials. The aim is to use the readily available material to construct low cost sensors. Relays are controlled by the microcontroller through the high current driver IC and provided for controlling solenoid valves, which controls the flow of water to different parts of the field. Other relay is used to shut-off the main motor which is used to pump the water to the field.

Performance of sensors in terms of energy consumption has also been analyzed.

Keywords: automated irrigation system, WUE, sensors, PIC

I. INTRODUCTION

In Ethiopia, agriculture is one of the sectors that give profit to the economy of our country. Based on their motto, "agriculture is life for more than 85%",the government has invested more money to develop the technology in order to increase the productivity of agriculture. Saving water is most important issues in dry lands. It is also an important element for the plants to survive. Therefore, the humidity of the soil that determines the amount of water in soil must be checked regularly to prevent the plant from wilting otherwise in the worst case it might die. Besides, each species of the plant have its own characteristics. So, the consumption of water is different following their type. For example, cactus does not need a lot of water in order to survive. It just needs to be sprinkled once or twice of a week. To become part of the government effort on giving the new spirit to the agriculture sector, a system which monitors the humidity of the soil and temperature of the air will be developed so that the end user such as farmer, gardener and so on can use it to determine the exact time to sprinkle their plant.

Keeping these facts in mind, we decided to tackle part of the problem by trying to improve the efficiency of water use in irrigation systems. Common methods of water distribution can be enhanced or replaced by using recent technological advances. I hope to use it to improve the efficiency of water distribution, to automate the process of irrigation management, to provide an easy to use programming and reporting interface, and to provide a scalable, versatile base from which to expand or modify if needed.

One of the main drawbacks with the old fashioned farming system that is experienced by the farmers themselves is that they do not accommodate for changing environmental conditions. Temperature, wind, rainfall and other elements can dramatically affect the amount of water needed to sustain a plants health. If these elements were monitored and used to influence the watering cycles, then the water used should be more effective.

Once the basic requirements of our work had been established (sensor driven, high automation), the lengthy process of deciding what hardware to use and what software should tie it all together was undertaken.

Eventually a microcontroller was chosen for the heart of the system. A microcontroller based solution meant that the system was more independent and hopefully more reliable, with cheaper running costs. Versatility was also a requirement of the design and as the controller is based on a PIC16F887

.Most of the sensors needed for the system could be have been cheaply produced using discrete components in conjunction with an analogue to digital converter, but in this case I used sensors in the irrigation system which incorporated the following:

Soil moisture and humidity sensors, its serial port output meant it was able to send data directly to the controller for processing.

Hopefully this work can show that automation in the area of irrigation can lead to water regularly & automatically to the crops/plants/gardens how much water it requires. Therefore, this work is a suitable candidate for the irrigation of crops/plants it saves a lot of energy both human and electrical energy, maintains proper water regulation by preventing loss of water, it is not complex and easily controlled even by an illiterate persons within minutes of time, the maintenance cost is very low. Furthermore, in order to be placed anywhere system will need to be powered by batteries. Since plants have to be in the sun, solar plants could easily be used to recharge the batteries. This would reduce the number of batteries being thrown away by the user since they would last longer than the non-rechargeable batteries. The work also significantly reduces the electrical power consumptions.

Finally, productivity is improved due to regular and need based irrigation schedule. It provides timely information about the system and soil properties improves the resource managements and saves farmers time and efforts. The rest of the work is organized as follows. Section II discusses about basis of the proposed system. Section III presents methodology and components used in the system. In section IV the working principle of the system. In Section V, Simulation results and Numerical analysis are illustrated and explained. Finally, Section VI concludes our work.

II. The Proposed System

The system is a sustainable solution to enhance water use efficiency (WUE) in the agricultural fields. It provides water for plants according to the crop water requirement and operates according to the soil moisture condition of the root zone of plants. Thus it reduces excessive pressure on farmers to pay additional water tariff on water. In addition pump water irrigation also save additional cost for water pumping,

Further, automated irrigation system allows farmers to apply the right amount of water at the right time. Besides, human attention was reduced on irrigation significantly. Moreover, energy consumption on water pumps could be reduced by efficient water allocation based on the crop water requirement.

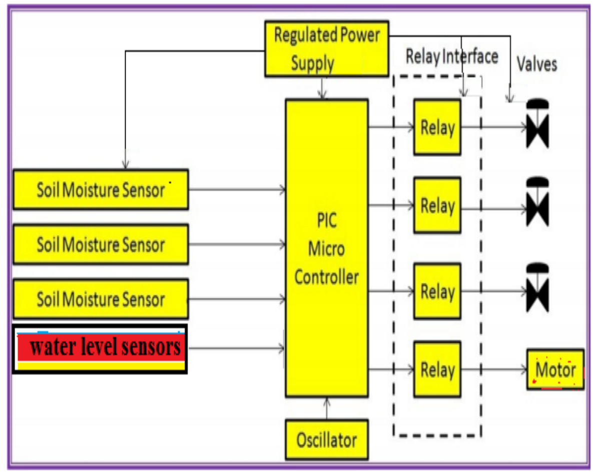

Figure 1: The Block Diagram of the System

III. Methodology and Components

The main hypothesis in regards to this work is that using sensor technology to automate irrigation in which it improves water usage efficiency. This is due to the fact that the sensors could provide information about the water content of the environment to an irrigation controller, and preset watering of plants could be adjusted to suit current conditions.

Experimental setups were arranged and experimented using relevant hardware components and software components.

A. *Hardware design*

When consider the main hardware components, PIC16F887 microcontroller was used to regulate the operation of solar battery and the water pump. Meteorological parameters and electrical parameters were taken as inputs for the microcontroller. Solar intensity and soil moisture levels were considered as the meteorological inputs which were detected by different sensors.

Soil moisture Sensor

A probe containing electrodes is used as soil moisture detector. For this work, the nails are used to act as soil moisture probe. The electrodes are inserted into the soil. When the soil is in damp condition, more current will flow between two electrodes because of the presence a lot of ion OH-andH2 from water molecule ($H2O$) and vice versa. The figures 2 & 3 show the connection setting on two electrodes, circuit diagram of the sensor and the picture of soil moisture sensor.

These include the use of a locally made moisture sensor. This is just as simple as a pair of probe made of stainless steel metal; this is preferable since it doesn't corrode easily. This sensor works on the principle of measuring soil conductivity which is proportional to the moisture content of the soil. The first half serves as the anode and the second half serves as the cathode, the soil conductivity forms a conductive path across the probe and the Voltage across the probe is read off.

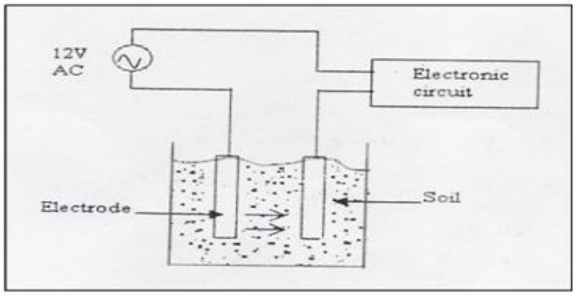

Figure 2: .Connection setting on Electrodes

B. Software Design

The system can be represented using algorithms and algorithms are designed using flowcharts.

Irrigation Algorithms

Referring to figure 5, the logics of the algorithm help to identify whether water is flooding to the field or whether water is below the minimum level in the tanker. Further, logics and decision making conditions help soil moisture condition of the soil and it always maintain of moisture in the field.

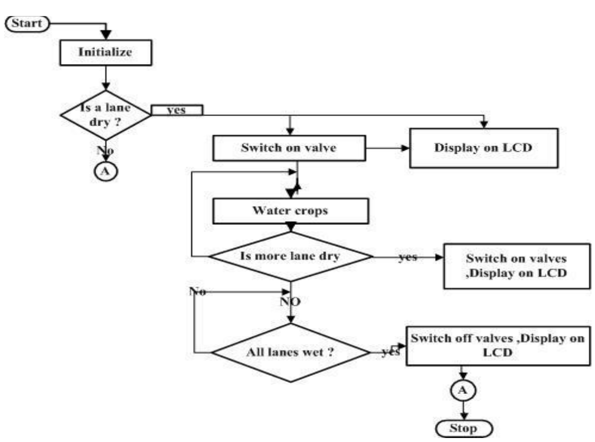

Figure 3: Flowchart for the soil moisture sensor

In the algorithm, when system starts a new clock cycle, it initialize and at the decision making point it evaluates whether current cycle all dry and it indicates as the field in the critical stage and intelligent system give a signals to operate the Valves. It needs further information to make a decision. Thus, it evaluates the stored data of the previous cycle. If previous cycle is low level, then pump will be activated operating to fill water into the tanker.

IV. WORKING PRINCIPLE OF THE SYSTEM

The system consists of Soil Moisture Sensor, a PIC Microcontroller and a Relay interface board. The irrigation system consists of Lanes through which each segment of the land is flooded and the flooding is controlled using valves as shown in the Figure 5. There is also a motor pump that is used to fill the water Tanker.

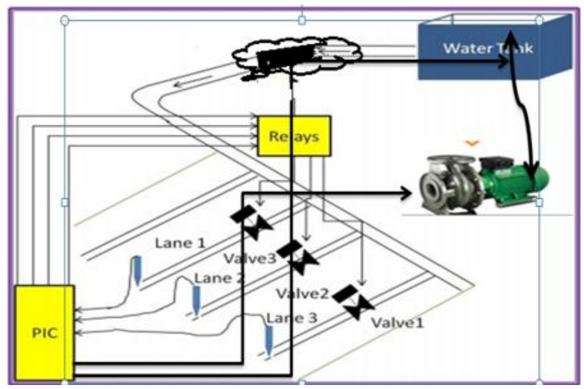

Figure 4: The Block Diagram of the irrigation System

V. SIMULATION AND NUMERICAL ANALYSIS

Simulation setups were arranged and experimented using relevant hardware components and software components. Sensor parts of the circuit was developed using locally. Soil probes used to detect soil moisture levels.

Soil sensors and actuators

PIC microcontroller was used for decision making process. Predefined operational conditions were used to operate the system without any failure. Algorithms were developed logically and it was used for software development of the system. C programming language was used to write the program in to the microcontroller.

From Figure 6, we can see the valves are currently on, the give this information to the MCU an input via Port B and their corresponding number is displayed on the LCD.

A sensor is the part of the developed measurement system that is in contact with the measured environment and transforms the measured entity into an electrical signal. In this work their principle operation, is represented by switches.

Liquid /water level sensors

Referring to Figure 7, Liquid (water) level sensors and motor mump here, unlike the field sensors, the interaction of tanker level and the motor pump is controlled by using two liquid sensors i.e. the lower sensor, which indicates insufficient of water and that of the upper sensor, which indicates full of water in the tanker. As per the level of the water in the tanker and the way how the sensors and the motor pump interact is shown in the following table 1.

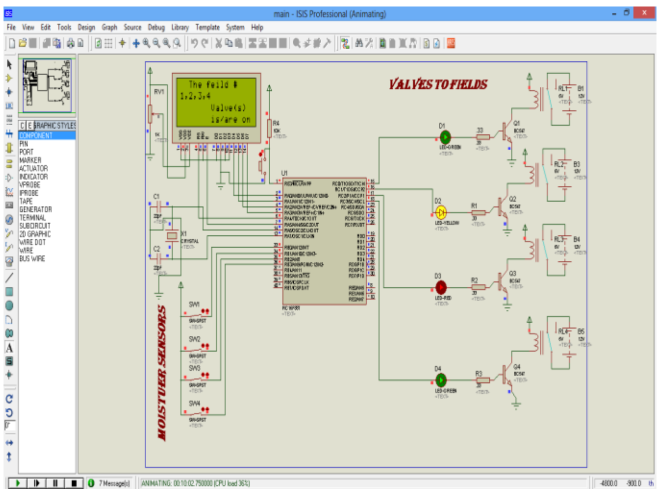

Figure 5: Conditional sensor and valves

TABLE 1: INPUTS AND OUTPUTS OF LIQUID SENSORS

Water level	Lower level(L)	Upper Level(U)	motor pump
Above both L & U	Off	Off	Off
Above L & below U	Off	On	Off
Below both L & U	On	On	On

VI. CONCLUSIONS

In this work, we successfully develop a system that can help in an automated irrigation system by analyzing the moisture level of the ground.

The grounded sensors all around the farming land will give notification about the need of water and accordingly it will be supplied. Simultaneously we configured an automated approach for the water tanker to be filled when it is empty.

In our future work we are planning to have an automated irrigation system with the help of wireless sensor network.

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