Automated Watering System for Agricultural Fields

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***Abstract*—The objective of this paper is to develop one better method of watering agricultural field using automation applying basic physical properties of certain chemicals easily available around us. Water, which happens to be a great natural resource, is becoming a scarcity allowing very lean chance to waste it. The approach worked out over here, is a mere approach towards saving it, stopping it from wastage and utilizing it for other more needful purposes. The paper is inspired from the fact rendered that Gypsum suffers certain change in its electrical property in presence of water. We have worked further for the betterment of the response obtained done by some other workers in the same field.**

***Keyword*— moisture sensor; automated watering; quality control.**

I. INTRODUCTION

In current scenario, fresh water availability is creating a major concern across the globe looking towards the future generation for survival. India, which still happens to a predominantly agricultural based country is feeling the heat as well. Presently, major proportion of the fresh water consumed by the India, factually 70% of total annual water consumption(about 550 billion cubic metres) is spend for irrigation purpose as agricultural water, 90% of which is again spent only in watering the field. Every year India suffer a shortage of around 300 billion cubic metres of fresh water to water its fields arising to a situation of about 300 million hectres of drought stricken area further creating a shortage of about 150 billion kilograms of its potential yield eventually leading to starvation of millions and suicides of thousands. Due to the old irrigation techniques employed in India, the effective utilization ratio of irrigation water is only 40%, which is half of any other developing or developed country. In developed countries, the grain productivity rate is about 2 kilograms per cubic metre and that in India, it is only 0.87 kilograms per cubic metre. Only by increasing the water utilization rate by 10-15 %, about 40-50 billion kilograms of yield can be increased. Therefore, this sort of advanced irrigation methodologies is always welcome and high time needed at the present time, water resources getting exponentially reduced, water-saving methods have become the inevitable choice to assuage the water crisis. Catching up with the crop-water demand, water-saving routine in irrigation has to be the current issue of interest.

Sensing technology can be a great asset keeping in mind about how to alleviate the practicing trends in the field of irrigation as it can provide us with information regarding the quality, texture and water requirement about the kind of land under perusal. Quality information and active intelligent control by control engineering algorithms, activating the transducer and actuator parts can really boost the present scenario prevailing in India. The work will involve parameterization of the control algorithm and heuristic data base to suit different situation for kind of crops harvested, soil texture and climatic conditions prevailing in a particular area. Availability of non conventional energy sources and other factors if any can also come handy in the current approach.

II. SOIL MOISTURE SENSOR

There are quite a few very commonly used and easily available chemical compounds which show changes in their physical as well as electrical properties under the presence of different amount of water present in their amorphous as well as crystalline structure. Gypsum ($CaSO_4.2H_2O$) is one such basic compound which has been used as a sensor in this very current context. In principle gypsum block measures soil water apprehension. One elementary corporeal property of gypsum is that it offers immeasurable confrontation and therefore acts as an impedance material when dry, letting no current to flow through it. On being hydrated, the block allows electrons to pass between the probes efficiently plummeting the amount of resistance between the probes. On being inundated the block offers practically zero resistance.

Caring out heuristic analysis and putting those data in table, we can land down with a mathematical relationship that exists between water content and gypsum. The key success of the sensor viz. Gypsum is the number of hydrated molecules. The impedance property of the crystal is a function of the no. of hydrated molecules present. Therefore the uniqueness of the approach lies with the number of water of crystallization.

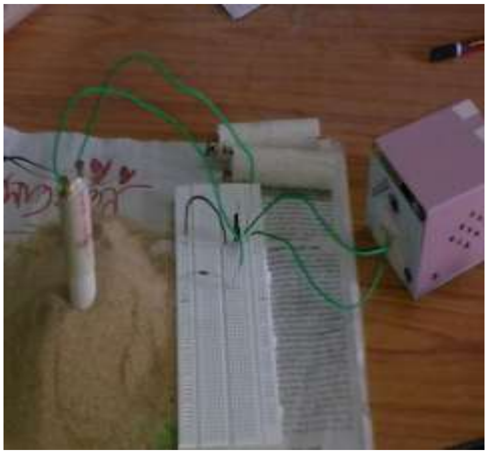

Figure1: Diagram of the soil moisture sensor

EXPERIMENTAL SET-UP: Probes (made up of Gypsum) are carefully positioned approximated 15 mm apart; the exact measurement is not of immense importance. Care should be taken producing all the probes as it is highly recommended to make all the probes as similar as feasible. However if an array of sensors is to be placed, a uniform gap is to be maintained to ensure consistency in measurements without requiring to individually calibrate each sensor. Then hot glue (insulator) is used copiously at the apex and the foot just enough to keep it in place while pouring the plaster and letting the mold to coagulate. Now the secured conjoint nails are inserted into the straw, ensuring that both metal probes are equidistance from the side of the straw. The next step is to mold the plaster of paris. The mold thus produced is dispensed into the straw affirming that the pipe is completely filled with the mold. The cast is allowed to dry for 24 hours and it is now ready testing. Next step is that their resistances under different conditions are measured to get the following block readings. Temperature was also a deciding factor which played a significant role as the output resistance was measured. Numbers of sensor probes used were eight (8) and sample taken were parched sand, semi wet sand, sand dipped in water, dry soil, semi wet soil and moist soil. Range of temperature within which the experiment was carried out was between 10°C and 60°C. Five temperatures were considered while taking the results viz. 10°C, 25°C, 40°C, 50°C and 60°C. Output resistances were measured using a potentiometer with accuracy as high as 0.5%. In order to have good response, repeatability and reproducibility, the entire process was carried out over a period of 3 weeks. Mathematical relation relating the factors viz. temperature, moisture content and resistance is yet to be completed and is under process. Other factors like humidity and pressure were not considered for the time being.

III. EXPERIMENTAL RESULT OF SENSOR ($CaSO_4.2H_2O$)

Sl. No.	Temperature	Type of material/sample	Resistance across probe (Ω)
1.	10 ° C	a. No sample	Above 10KΩ
	10 ° C	b. Sand (DRY)	Resistance 1500 Ω
	10 ° C	c. Sand (semi WET)	Resistance 1100 Ω
	10 ° C	d. Sand (dipped in water)	Resistance 300 Ω
2.	25 ° C	e. No sample	Above 13KΩ
	25 ° C	f. Sand (DRY)	Resistance 2300 Ω
	25 ° C	g. Sand (semi WET)	Resistance 1800 Ω
	25 ° C	h. Sand (dipped in water)	Resistance 800 Ω
3.	40 ° C	i. No sample	Above 16KΩ
	40 ° C	j. Sand (DRY)	Resistance 2900 Ω
	40 ° C	k. Sand (semi WET)	Resistance 1700 Ω
	40 ° C	l. Sand (dipped in water)	Resistance 1100 Ω
4.	50 ° C	m. No sample	Above 19KΩ
	50 ° C	n. Sand (DRY)	Resistance 4300 Ω
	50 ° C	o. Sand (semi WET)	Resistance 2700 Ω
	50 ° C	p. Sand (dipped in water)	Resistance 1900 Ω
5.	60 ° C	q. No sample	Above 24KΩ
	60 ° C	r. Sand (DRY)	Resistance 5500 Ω
	60 ° C	s. Sand (semi WET)	Resistance 3500 Ω
	60 ° C	t. Sand (dipped in	Resistance

		water)	2500 Ω

IV. PRINCIPLES OF THE CONTROLLER

Schematic block illustration of the automated watering system technique is shown in Figure 2.

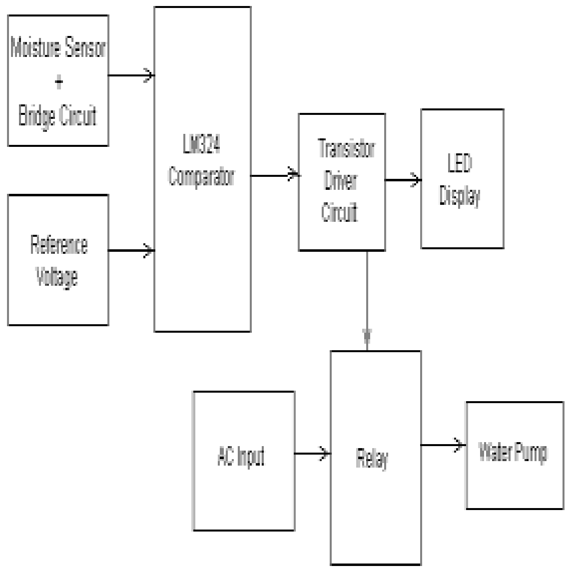

Figure2: Block diagram of the Set-Up

The prime components of the set-up comprises sensor parts built in using op-amp IC LM324.Op-amp is configured here as a comparator. Wetness sensors are inserted in the soil to sense the water level content of the field. The comparator screens the sensors and when sensors sense the dry condition then the control algorithm will instigate switching on of the motor and the motor will be turned off when the sensors find optimal moisture content in the soil. For satisfying this purpose, we need to organize some pre-assigned data set value in the comparator circuit. The comparator job only starts after receiving signals from the sensors upon which it works. The use of transistor is to drive the relay during the moist soil circumstance. 5V DPDT relay is employed to manage the water pump. LED has been used to indicate the relay/load status for visual inspection from at a distance. In order to neutralize the reverse EMF, switching diodes have been. This is how the experimental set-up has been organized within laboratory perspective.

In order to emulate the real life field situation, the set-up has been put in a broader scope of environment. As an artificial set-up, a pseudo field of 10'*10'=100 ft^2 has been framed with a depth of 1foot and such two sample set-ups were prepared, one using soil and the other using sand with different levels of water concentration at different times. Firstly, the sensors have to be buried to the appropriate depth of the soil. Secondly, it is to be assured that the controller's inlet is connected to the water source and its outlet is connected with the watering device like the nozzle, emitter, etc. Thirdly, cross checking needs to be done before carrying out the final proceedings before the soil is covered. After that the above steps are all set and done, the system can be made to work in a way that it opens the valve automatically while the soil is dry (i.e the lower set point is not reached) and closes the valve while soil moisture reaches the upper set point value. There are certain things to be kept in mind for agreeably working out of the set-up. The most remarkable notification is this whole process in that the impedance value of the mold in an inverse function of the water of crystallization. Changing the number of moles of water of crystallization is one more possibility for betterment to which we are thriving.

V. CONCLUSIONS

Innovative and new techniques and methodologies can quite significantly save a great volume of water from wasted which can further be used in some more appropriate manner and field. The technique that has been talked about over here also frees manual supervision, hence redundant man power wastage can also be taken care off from this technique. The proposal made in this paper is to go for this automated method of watering the agricultural fields using devices and sensors reactive towards the moisture content in the soil. While caring out the entire system laboratorial experimentation, it was found that the sensors used were temperature dependent i.e with increase of temperature resistance increases and vice-versa and also the resistance is inversely proportional to the content of water. One limitation found in the use of the sensor arrays is that the probes in the sensor corrode on constant dc voltage due to electrolysis. So one possible method of taking care of this issue is that the applied voltage should be made "on" only when the reading is required. Also, it has to be kept in mind while setting up the sensor array network that it should not be creating any problem while ploughing the fields which is definitely not an easy asking for doing. The result of the analysis of the automated watering scheme of the agricultural fields indicates that in addition to significant social benefits, the proposal can also obtain economic benefits. If this is implemented keeping in mind few minute details, it can be of great help in conserving water as well as human resource in irrigation. Future scope of advancement and prospect are many-fold and we look forward to working for the betterment of the proposal. One more issue that we are also considering is to look for other such easily and cheaply available chemical compounds which can significantly help us for future betterments. The actual role played by the water of crystallization is under severe observation.

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