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Soil Moisture Irrigation System

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***Abstract*- Now -a-days, water management has become the most difficult and primary task faced by the farmers of any area. Due to improper seasonable rains, deforestation, industrial gases, the rains are affected either directly or indirectly. Due to which fortunately farmers are effected pre dominantly.**

This project aims to solve the farmers' problems in the aspect of water management. This gives flexibility to farmers from the following

(i) Regular operation of water pumps in their farms

(ii) Saves their time which is been wasted in farms for water supply they spend.

(iii) Yields good profits due to proper water management.

I. INTRODUCTION

This project basically works on Relay and comparator circuit. No microprocessor is required. This indirectly reduces the cost and makes it economical and effective to farmers.

Irrigation is a dominant consumer of water. This calls for the need to regulate water supply for irrigation purposes. Fields should neither be over-irrigated nor under-irrigated. Over time, systems have been implemented towards realizing this objective of which automated processes are the most popular as they allow information to be collected at high frequency with less labour requirements. Bulk of the existing systems employ micro-processor based systems. These systems offer several technological advantages but are unaffordable, bulky, difficult to maintain and less accepted by the technologically unskilled workers in the rural scenario.

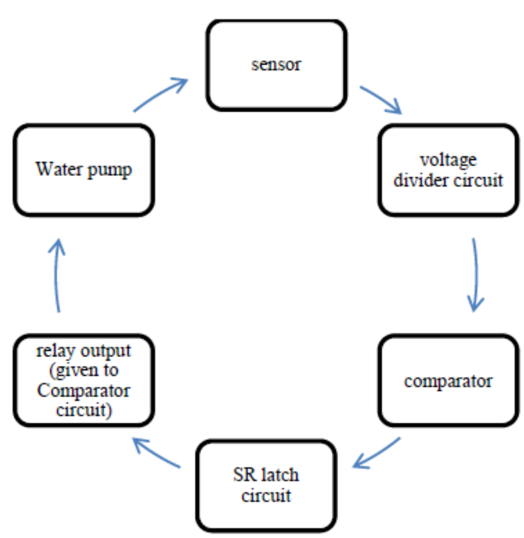
Objective:

The objective of this project is to design a simple, easy to install methodology to monitor and indicate the level of soil moisture that is continuously controlled in order to achieve maximum plant growth and simultaneously optimize the available irrigation resources. A simple Operational amp based comparator circuit is used coupled with relay units which control the water pumps. The use of easily available components reduces the manufacturing and maintenance costs. This makes the proposed system to be an economical, appropriate and a low maintenance solution for applications, especially in rural areas and for small scale agriculturists.

Model:

This model proposed was works on the Comparator circuit as mentioned earlier and it could be termed as the heart the circuit. The other important part was the sensor block which detects the moisture levels from water wherein that gives some resistance values.

Block diagram:



sensor

The sensors are made of plaster of Paris, which has the capability of sensing the resistance levels from soil. These can be made at home using readily available materials appendix (i).

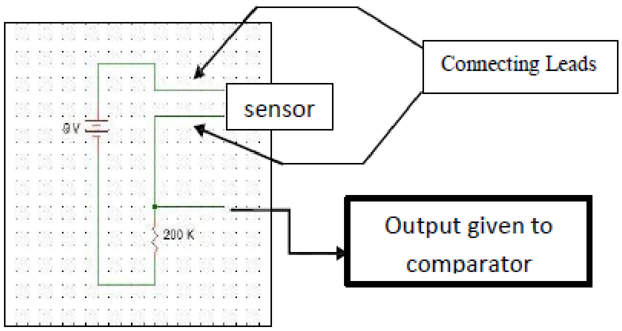


fig (2). Sensor connected to potential divider arrangement to provide a voltage output in relation with soil moisture levels.

(i) Connecting Leads
The connecting Leads are the conducting materials. This prettily helps sensors in reading the values. The output of the sensor is the Resistance value.
(ii) Voltage divider Circuit:

The Sensor output resistance is fed across 9V battery and 200k resistance. Using the voltage divide principle, the output is the voltage and is less than 10V. This voltage output is given to the comparator network.
The parameter which is of importance is moisture content in the soil. A reliable indication of soil moisture levels is provided by electrical resistance blocks. These are a cost-effective tool for effective management of irrigation. They evaluate soil moisture tension by measuring the electrical resistance between the two electrodes emerging out of the block. The blocks absorb and release moisture as the soil wets and dries respectively. This electrical resistance is recorded with the help of a portable meter that is attached to the wire leads coming out from the moisture sensors.
Instead of using commercially available sensors, effort has been made to build indigenous sensors with the objective to make the project cost effective. For this model, we have used gypsum for making the sensors. The complete process of making of soil moisture sensors is outlined in Appendix A.
Functional description of Sensors:

For conversion of *change in resistance* to *change in voltage*, the sensor is connected with a 200KΩ resistor in series to form a potential divider arrangement.

2. It gives a voltage output corresponding to the conductivity of the soil
The conductivity of soil varies depending upon the amount of moisture present in it. It increases with increase in the water content of the soil. ***The higher the water contents of the blocks, the lower the electrical resistance.***
3. The voltage output is taken from the *output terminal* of this circuit.
The moisture sensor is immersed into the specimen soil whose moisture content is under test.
The soil was examined under 3 conditions
(i) **Dry condition:**

The sensor is placed in the soil under dry conditions and embedded up to a fair depth of the soil. In dry condition, as there is no conduction path between the two copper leads the sensor gives a high resistance value (nearly 700 kΩ). The voltage output of the potential divider in this case ranges from 2.2 V to lower optimum level (3V).
(ii) **Optimum condition:**

When water is added to the soil, it percolates through the successive layers of it and spreads across the layers of soil due to capillary force. This increases the moisture content of the soil. Thus a conductive path is established between the two copper leads. This leads to a decrease in resistance of sensor. The optimum condition of the soil can be set manually depending on the type of soil.

Excess wet condition:
With the increase in the water content beyond the optimum level, there is drastic increase in the conductivity of the soil and the sensor resistance is further decreased around 70 kΩ. The voltage output in this case ranges from 5V to 10V.
Comparator:

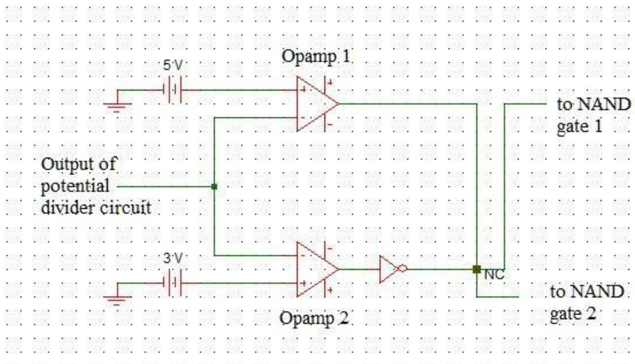


fig (3). Comparator block

For the comparator circuit, we are using IC LM 358 which has two opamps. We have selected two thresholds: 5 V for logic high and 3 V for logic low. These two levels are set at the positive terminal of each opamp. The output of the potential divider is given to the negative terminals of the opamps. The two opamps are arranged such that when the output of the potential divider circuit falls below the preset value of lower opamp the lower opamp gives logic 0 and the upper opamp gives logic 1. When the output of potential divider circuit is in between range (5 V and 3V), then both opamps give logic 1 and when output of potential divider circuit is above the set value of upper opamp, then the upper opamp gives logic 0 and lower opamp gives logic 1. The output of the comparator circuit is fed into a SR Latch.

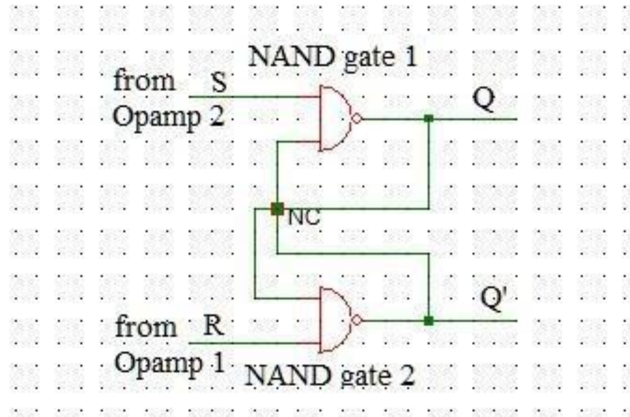
The various opamp outputs with varying soil conditions have been modulated as below.

Table 1: Comparator logic

Sl No.	**Range of voltage**	**Soil condition**	**Logic of Opamp 1** (upper)	**Logic of Opamp 2** (lower)
1	> 5V	Excess wet	0	1
2	> 3V & < 5V	Optimum	1	1
3	< 3V	Dry	1	0

(**NOTE**: - Here upper preset level is taken as 5 V and lower preset level is taken as 3 V)

SR latch:



fig(4). SR latch circuit

It is constructed using two NAND gates. Each gate has two outputs Q and *Q'*, and two inputs, named *set* and *reset* respectively. This type of memory element is referred to as an *SR flip-flop* or *SR latch*. When Q=1 and Q'=0, it is in the *set state* (or 1-state). When Q=0 and Q'=1, it is in the *clear state* (or 0-state).

The outputs Q and Q' are compliments of each other and are named as the normal and complement outputs, respectively. The binary state of the flip-flop is taken to be the value of the normal output.

When the potential divider output is above higher level the flip flop output will be zero. When the potential divider output is in between two set levels the output of flip flop will not change. When the potential divider output is below lower level then output of flip flop will be 1.

The output of each latch is tabulated below.

Table 2: SR logic

Sl.no	Voltage ranges	Soil conditions	S	R	Q	state	Q'
1	>5v	Excess wet	1	0	0	reset	1
2	>3v & >5v	optimum	1 1	1 1	0 1	no change	1 0
3	<5v	dry	0	1	1	set	0

Relay:

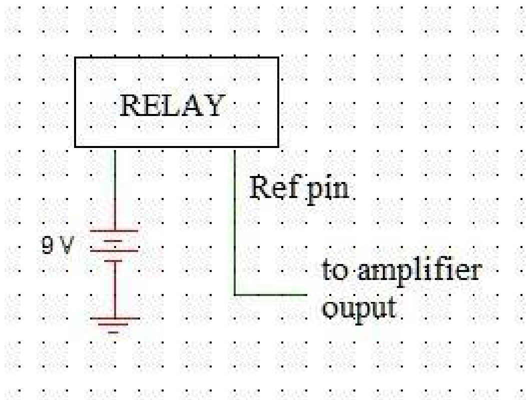


Fig (5). Relay pin connections

A relay is an electrical switch that opens and closes under the control of another electrical circuit. The output of flip flop is connected to a relay. The '*NO'* contact of the relay is connected with the power supply to water pump. When this relay will be on, then the water pump will start and when it is off then the power supply to water pump will be cut and hence it stops.

Table 3: Relay logic

Q	Amplifier output (digital)	Relay reference pin voltage	Relay 'NO' contact	Water pump operation
0	1	1	open	OFF
0	1	1	open	OFF
1	0	0	closed	ON
1	0	0	closed	ON

Results:

By varying the resistance (700 kΩ) in the potential divider circuit as a representation for the dry/wet condition of the sample soil, the circuit was tested and the results are tabulated below:

Fig (a) in appendix.

Conclusion:

A methodological approach has been followed in designing the opamp based system for measurement and control of the plant growth parameter, i.e. soil moisture. The results obtained from the measurement have shown that the system performance is quite reliable and accurate.

Field experience has shown that soil moisture sensors are very useful in diagnosing the changes needed and to fine-tune irrigation practices. Relatively minor regulations in irrigation practices can pay large dividends in terms of increased yields or water savings. The key to proper irrigation management using soil moisture sensors is regular monitoring of the sensors to track the soil moisture level and provide irrigation when the readings are in the determined range for the particular soil type.

Thus, this system eliminates the drawbacks of the existing set-ups mentioned in the previous section. Also a cost analysis report has been prepared to compare the effective costs of the proposed model and microprocessor based system. Thus it has proved to be easy to maintain, flexible and low cost solution.

Cost analysis Report:

Table 4: Results

Sl. No.	Component	Quantity	Amount (in Rs.)
1	LM 358 with base pin	1	15
2	4011 with base pin	1	20
3	4049 with base pin	1	20
4	Miscellaneous		150
5	Relay	1	20
6	Water pump	1	200

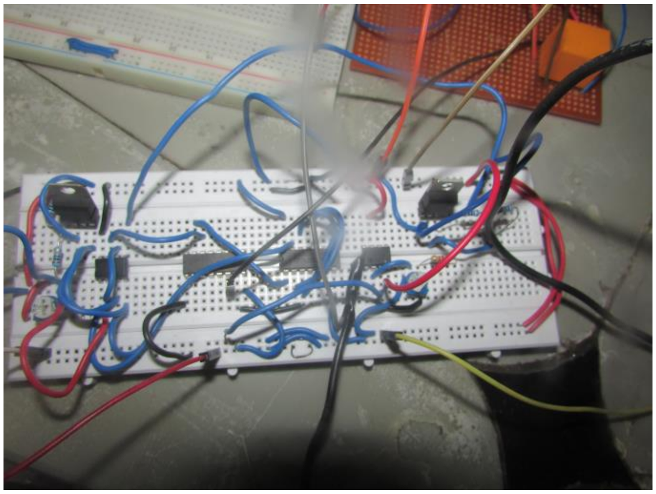
Total 425/-

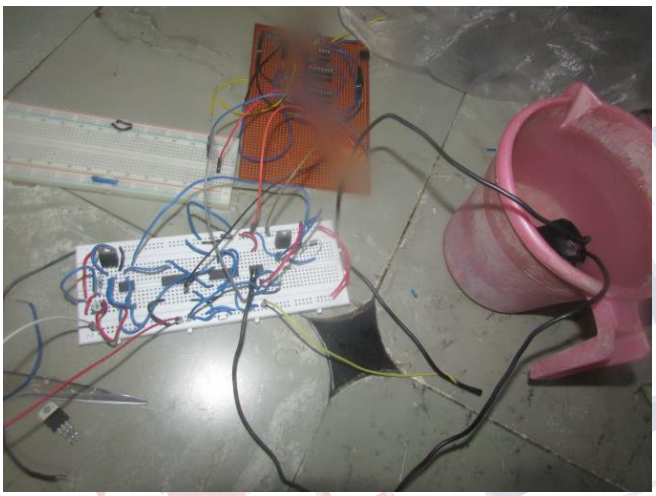
Total cost of the project = Rs. 450 (approx.)

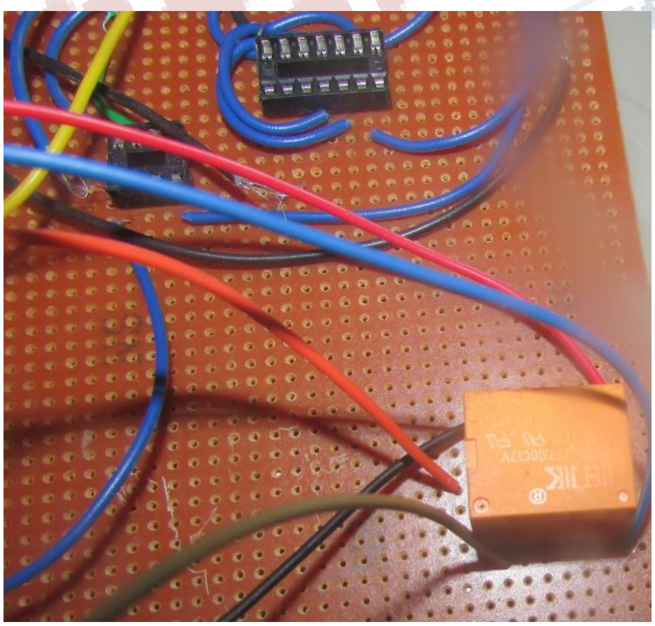
Cost of soil moisture monitoring system based on microcontroller/microprocessor (approx.) = Rs. 3000

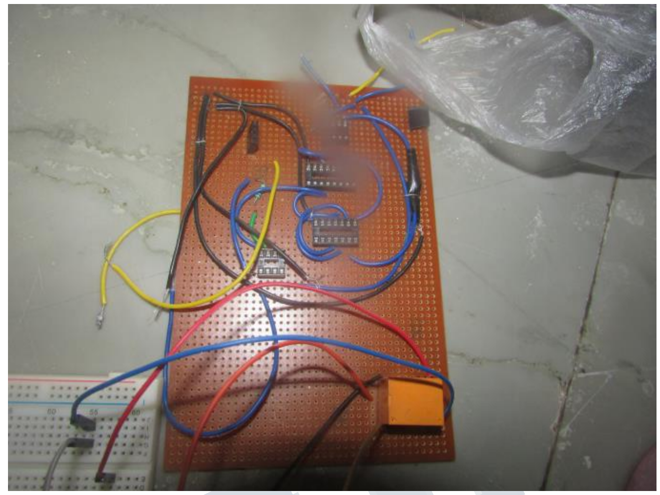
Thus the cost of the proposed model is nearly 9.5 times less compared to an equivalent embedded system based model.

HARDWARE DESIGN SNAPS:









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