Volume 5, Issue 9, September 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Development of Low Cost Soil Moisture Sensor for Drip Irrigation System

[1]Ch. Apparao, [2]G.Ravi Babu, [3]A. Sambhaiah, [4]L.Edukondalu
[1, 2, 3] Soil and Water Conservation Engineering Department, ANGRAU, India
[4]Agricultural Process and Food Engineering Department, ANGRAU, India

Abstract: The recent irrigation techniques introduce automated irrigation using sophisticated equipments to supply water and nutrients to the plant as soon as they need it. Automated irrigation systems can increase crop yields, save water, energy and labor costs as compared with manual systems. Automatic irrigation systems presently available are costly and are not adopted by most of the small farmers. Therefore, appropriate low cost automatic irrigation technology has to be developed to facilitate high water use efficiency. In the present study low cost automated drip irrigation based on soil moisture has been developed. Soil moisture sensor was calibrated to switch off the motor when soil moisture reaches field capacity and switch on the motor when soil moisture reaches 80% of field capacity.

Keywords: Automated irrigation, field capacity, soil moisture sensor, drip irrigation, India.

I. INTRODUCTION

In addition to soil and seeds, water and nutrients are two important inputs to agriculture which are determining the whole gamut of agricultural productivity and production. In the changing climate scenario, the water resource has become very scarce and also being unscientifically used in the farming fields. India, consuming almost 80% of its total water resources for agriculture sector, needs to reduce the consumption of water and nutrients to substantial levels using advanced scientific methods of irrigation like drip and sprinkler irrigation systems and real time sensor based scheduling with electronic gadgets or sensors to enhance water use efficiency (WUE) and fertilizer efficiency. Automation of drip/micro irrigation system refers to operation of the system with no or minimum manual interventions.

These recent irrigation techniques introduce automated irrigation using sophisticated equipments to supply water and nutrients to the plant as soon as they need it (Sanjukumar and Krishnaiah, 2013; Kumar *et al.*, 2013; Luciana *et al.*, 2013; Agarwal *et al.*, 2014). Automated irrigation systems increase crop yields, save water, energy and labour costs as compared with manual systems (Kim *et al.*, 2009; Nyatume *et al.*, 2013; Sibomana *et al.*, 2013). The automation of the irrigation process is important for three main reasons: scarcity of water, timely irrigation and maximum crop profit. Automatic irrigation systems presently available are costly and are not adopted by most of the Indian farmers. Therefore, appropriate low cost technology has to be developed to facilitate high water use efficiency. The present study was carried out to development a low cost soil moisture sensor for drip irrigation system.

II. MATERIALS AND METHODS

2.1 Development of low cost soil moisture sensor

The soil moisture sensor works based on the fact that water is not pure water which is non-conductor, but it is impure which is slightly conductor. As the moisture content of the soil increases, the electrical conductivity of the soil increases. The electrical conductivity of the probes can be related to the soil moisture of the soil. Figure 1 shows the circuit diagram of low cost soil moisture sensor. The sensor works mainly on the principle of electrical conductivity.

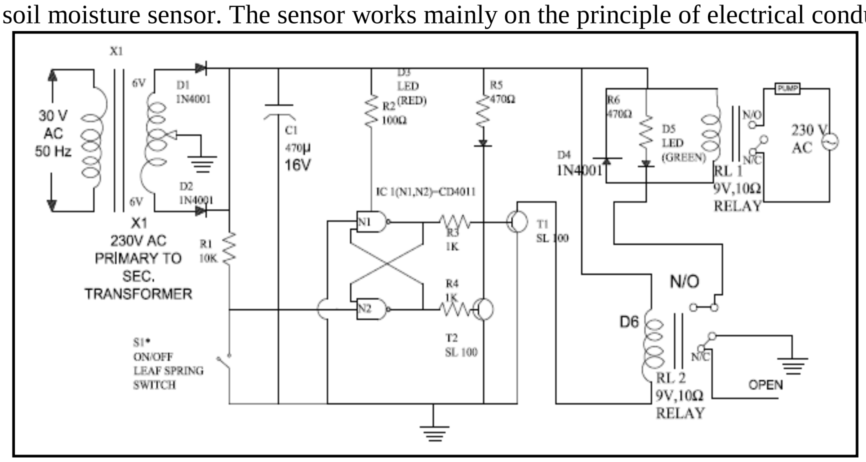

Fig. 1. Circuit diagram of soil moisture sensor

The circuit is prepared by using a transformer, diode, capacitor, integrated circuit, resistor, transistor, electromagnetic relay and a few active components. The transformer acts as step down transformer reducing AC 230 V TO AC 6V. Capacitors are used to store energy by producing a charge imbalance. The heart of the circuit is the CMOS latch CD4001.Integrated circuit CD4011 is the most commonly used complementary metal oxide Semiconductor (CMOS) chip. The working voltage range of the IC is 5V to 16V. Each output can deliver output current of about 10 mA at 12V. An electromagnetic relay is used which allows a relatively small electrical voltage or current to control a larger voltage or current. The circuit diagram is drawn on a board and the circuit components are fixed on the board by soldering using solder iron and soldering lead. A plastic box is used for covering the circuit board as shown in Figure 2. Two aluminum strings are used as probes and the probes are placed at effective root zone depth of crops at a distance of wetted diameter of dripper. The circuit given above will switch off the pump when the soil moisture reaches field capacity level and switch on the pump when the soil moisture reaches 80% of field capacity.

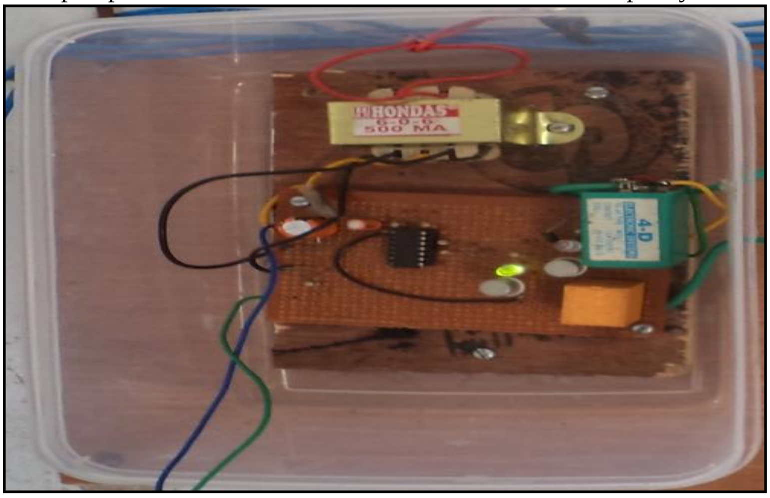

Fig. 2. Circuit board of soil moisture sensor

2.2 Calibration of soil moisture sensor

In order to determine the relationship between the sensor output voltage and soil moisture, soil samples at different moisture levels were collected. The soil moisture content was determined by using oven drying method. A digital multimeter (Fig.3) was used for measuring sensor output voltage for soils of different moisture contents.

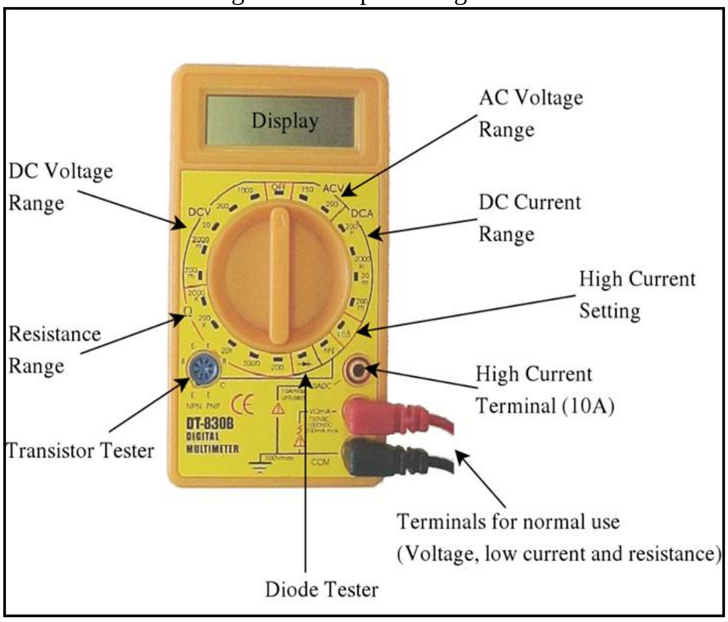

Fig. 3. Digital Multimeter

III. RESULTS AND DISCUSSION

3.1 Calibration of soil moisture sensor

Figure 4 shows a plot of sensor voltages against different soil moisture samples that yielded a linear relationship between voltage and soil moisture sensor. The gradient and intercept value from Figure 4 are -4.278 and 28.91 respectively. The moisture of the soil increased with a decrease in voltage value. The soil moisture sensor is calibrated to switch on the motor when soil moisture reaches field capacity and switch of the motor when soil moisture reaches 80% of field capacity.

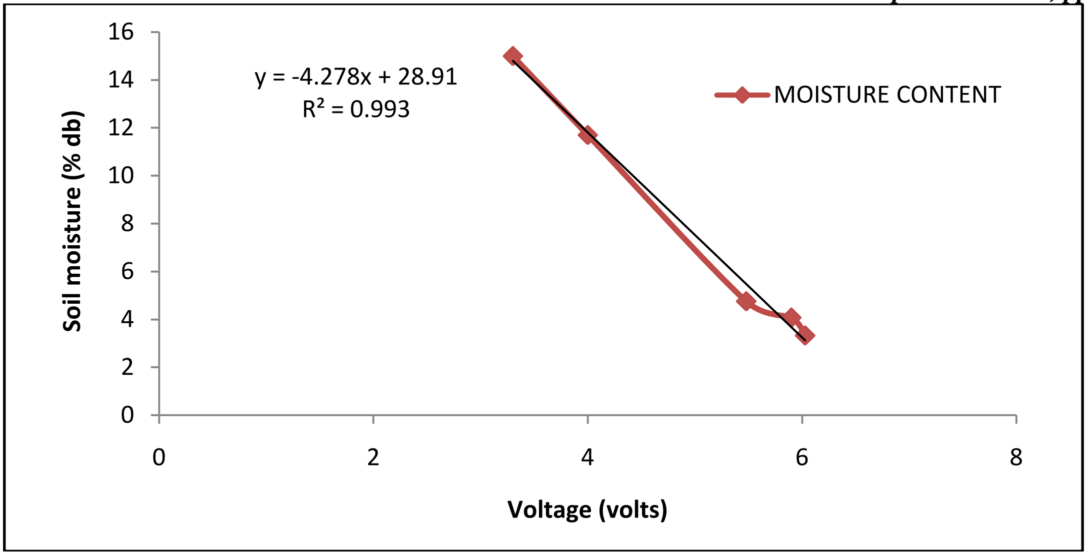

Fig. 4. Relationship between soil moisture and sensor output voltage

3.2 Cost of developed soil moisture sensor

Table.1 shows the list and cost of circuit components used in the developed low cost soil moisture sensor circuit. The total cost of the sensor was found to be Rs.536/- only

Table.1 List and cost of circuit components used in soil moisture sensor circuit

Item Number	Quantity	Description	Unit cost (Rs)	Total cost (Rs)
1.	1	Transformer 6-0-6 v	50	50
2.	4	Diode 4007	2	8
3.	1	Capacitor 470/16 v	15	15
4.	1	Integrated circuit CD 4011	50	50
5.	4	Resistors	1	4
6.	1	Transistor 7806	10	10
7.	2	Electromagnetic relay 9v	70	140
8.	2	Led indicator	2	4
9.	1	Pin base	10	10
10.	1	Flexible wire packet	100	100
11.	1	Connectors or sockets plastic	50	50
12.	1	Soldering lead bundle	5	5
13.	1	Paste bottle	5	5
14.	1	Solder iron	35	35
15.	1	Covering box	50	50
		Total cost		536/-

IV. CONCLUSIONS

A simple device functioning underneath the soil which can assist electronic circuit board to either switch off or switch on the motor as per the required moisture has been developed. The developed soil moisture sensor was calibrated to switch on the motor when soil moisture reaches field capacity and switch of the motor when soil moisture reaches 80% of field capacity

REFERENCES

[1] Abraham, N., Hema, P. S and Saritha, E. K. "Irrigation automation based on soil electrical conductivity and leaf temperature", *Agricultural Water Management*, 2000, Vol :45, pp. 145-157.

[2] Agarwal, S., Pandey, S., Kumar, S and Chaudhery, K. 2014. Automatic irrigation system. *International Journal of Advance Research and Innovation*, 2014, Vol:1, pp. 92-94.

[3] Anonymous. 2012. Micro irrigation technologies for enhanced crop and water productivity-experiences of Andhra Pradesh India (online). Available at:

https://docs.google.com/gview?url=http://www.irncid.org/GetFileArticles.aspx?FilePrm%3D3600_16230.pdf&chrome=true, (Accessed 15, June, 2013).

[4] Lailhacar, C.B., Dukes, P.E.M.D and Miller, G.L. "Sensor based automation of irrigation on bermudagrass during wet weather conditions", *Journal of Irrigation and Drainage Engineering (ASCE)*, 2008, Vol:134(2), pp. 120-128.

[5] Carpena, M. R., Bryan, H and Klassen, W. "Automatic soil moisture based drip irrigation for improving tomato production.", *Proceedings of the Florida State Horticultural Society*,2003,pp. 80-85.

[6] Cepuder, P and Nolz, R. "Irrigation management by means of soil moisture sensor technologies" *Journal of Water and Land Development*, 2007, Vol:11, pp. 79-90.

[7] Chandrasekhar, T and Chakravarthi, J.S. "Automatic drip irrigation system", *International Journal of Communications Networking System*.,2013, Vol: 2(1), pp. 153-157.

[8] Dukes, M.D., Simonne, H.E., Davis, W.E., Studstill, D.W and Hachmuth, R. " Effect of sensor based high frequency irrigation on bell pepper yield and water use", *International Conference on Irrigation and Drainage,Phoenix*, AZ. 2003, pp. 665-674.

[9] Dursun, M and Ozden, S. "A wireless application of drip irrigation automation supported by soil moisture sensors", *Scientific Research and Essays.* 2011,Vol:6(7), pp.1573-1582.

[10] Hameed, S.K.S.S., and Agarwala, A.K. "Computer aided design of soil moisture sensor and its measurements for agricultural water resources management" *International Journal on Design and Manufacturing technologies*. 2009, Vol: 3, pp: 38-44.

[11] Ingale, H and Kasat, N. N. Automated solar based agriculture pumping. *International Journal of Advanced Research in Computer Science and Software Engineering*. 2012, Vol:2(11), pp:407-410.

[12] Kim, Y., Evans, R.G and Iversen, W.N. "Evaluation of closed loop site specific irrigation with wireless sensor network", *Journal of Irrigation and Drainage Engineering (ASCE).* 2009, Vol:135(1), pp. 25-31.

[13] Kiran, M.S. "Studies on Laboratory Model of Automation in Irrigation and Agricultural Drainage". *An unpublished B. Tech thesis submitted to College of Agricultural Engineering, Bapatla*. 2012.

[14] Kumar, N.D., Pramod, S and Sravani, C.H. "Intelligent irrigation system", *International Journal of Agricultural Science and Research*. 2013, Vol:3(3), pp. 23-30.

[15] Luciana, M. L., Ramya, B and Srimathi, A. "Automatic drip irrigation unit using Pic controller", *International Journal of Latest Trends in Engineering and Technology.* 2013, Vol:2, pp. 108-114.

[16] Luthra, S. K., Kaledhonkar, M. J., Singh, O. P and Tyagi, N. K. "Design and development of an auto irrigation system", Agricultural *Water Management*. 1997, Vol:33, pp.169-181.

[17] Munyaradzi, M., Rupere, T., Nyambo, B., Makute, S., Chinyerutse, M., Hapanga, T and Mashonjowa, E. 2. "A low cost automatic irrigation controller driven by soil moisture sensors", *International Journal of Agriculture Innovations and Research..* 2013,Vol: 2(1), pp.1-7.

[18] Sanjukumar, R and Krishnaiah, R.V. "Advance technique for soil moisture content based automatic motor pumping for agriculture land purpose", *International Journal of VLSI and Embedded Systems*. 2013, Vol: 4, pp.599-603.

[19] Sweety, R.N and Vijaya, R.T. "Design of a soil moisture sensing unit for smart irrigation application", *International Conference on Emerging Technology Trends on Advanced Engineering Research*. 2012, pp. 1-4

[20] Wavhal, N. W and Giri, M. "Automated drip irrigation improvements using wireless application", *International Journal of Advance Research.*.2013, 1(5).

