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CONTROL AND ANALYSIS OF DRIP IRRIGATION SYSTEM

Mehwish Mirza
Department of Mechatronics Engineering
Mehran University of Engineering and
Technology
Mehwimirza34@gmail.com

Abstract

The word irrigation is defined as "the purpose of water supplementary to the supplied directly by rainfall for the production of crops". Globally, agriculture sector uses major share of accessible freshwater. Pakistan is a Farming nation and its significant economy relies on agribusiness. In Pakistan, fresh water sacristy rate is rising due to poor sanitation and water management system, increase in population and food demands and use of fresh water flood irrigation system to irrigate the agricultural land. About 73% of Fresh water resource is consumed for the irrigation purpose in Pakistan. The increase in population and the food demand is important to adopt irrigation system at large in the country. In such circumstances, controlled trickle water system framework serves the reasonable procedure to constrain the water provided to the yields at consistent interim for farming and replaces the surge water system frame work. Besides ordinary drip irrigation system, the controlled drip irrigation system monitors and controls the soil moisture and temperature of the crops using sensors. In this paper Controlled stream water framework structure serves the sensible strategy to oblige the water gave to the yields at predictable interval for cultivating and replaces the flood water framework system. Now-a-days Pakistan has experiencing a huge wastage of water especially here in Nasarpur. The old methods of irrigation are still being used by the farmer in which the wastage of water is about 50% to 60% of water. In many parts of the world, a new system of irrigation has been introduced called drip irrigation system. In this framework cascades drop by drop at the situation of roots. Water is conveyed at or close to the root zone of plants, drop by drop. This technique can be the most water-proficient strategy for water system. Fundamentally in the dribble water system framework, the stickiness, dampness and temperature of plants are checked and controlled by sensors. The large quantity of fresh water is utilized by the farming business for irrigation purpose. By help of controlled drip irrigation system the water utilization will be minimized. This can be done by the help of water maintained at the constant level. In drip irrigation system the water will transfer through proper pipe line, operated by pump and water will be taken from the water tank. In our paper we design a controlled drip irrigation system for the field placed in Nasarpur city. The aim of this paper is to design an automatic drip irrigation system for the field at Nasarpur then analysis the working of automated drip irrigation system using Arduino. Then we calculate the pressure drops in pipelines using Matlab. In last we have to compare the values of water consumption taking by our controlled drip irrigation system and convention drip irrigation system.

In this research designed a drip irrigation system that is controlled by Arduino UNO and we also calculate and simulate the pressure drop in pipelines of the drip irrigation system by using Matlab. The controlled drip irrigation system is another strategy in which water is conveyed close to the root zone of plants drop by drop. In this technique water drippers gradually to the fundamentals of the plants either onto the dirt surface or straightforwardly onto the root zone through a system of valves, channels, tubing.

The results reveals that the controlled drip irrigation system is most efficient, accurate and water saving as compare to the conventional method of irrigation.

Keywords:
Arduino UNO; Controlled drip irrigation; Matlab; Drippers; Moisture sensor.

1. INTRODUCTION

Remaining of the paper is organized as follows. Section 2, presents Literature Background, Section 3, proposed Methodology of the project. Section 4 proposes Mathematical Analysis. Section 5 presents the Results and paper is concluded in section 6.

2. Literature Background

Tupe Alok R. [1] says in his study that the intelligent drip irrigation system is remote monitoring as well as controlling. An android mobile sends commands to computer to control drip irrigation system, here different sensors like humidity, temperature, light, and soil-moisture will be use for detection purpose. These sensors send the real time values to micro-controller and micro-controller send these values to computer via serial communication. According to the sensor values graph will show on computer or mobile and by using this graph user can switch on or off drip device. By this system farmer can easily control the drip device form anywhere at any time. According to M. Lincy Luciana [2] the moisture and temperature are used to measure soil condition and weather conditions of agricultural field. The sensor sensed moisture and temperature from the field to the micro-controller and these values are compared with predefined values. The required amount of water is supplied to field on the basis on these values the sensed temperature and moisture values will be displayed on liquid crystal display. The study shows that this automated drip irrigation system can be used for different season conditions and more parameters such as plant growth rate, weather conditions can be taken into account to determine the water requirement for crops. Anket.H Hade [3] says in his research that in remotely checked implanted framework for water system purposes have turned into another basic for rancher to aggregate his vitality, time and cash and will occur just when there will be necessity of water. In this methodology, the dirt test for substance constituents, water substance, and saltiness and manure necessity information gathered by remote sensor and prepared for better dribble water system Plan. This proposes a mechanized checking and controlling framework demonstrate by utilizing Remote Sensor System (WSN) which causes the agriculturist to enhance the water system.

According to Dursun [4] 85% of the freshwater is used in the agricultural industry for the cultivation of the crops, food and plants. Due to rapid increase in the population growth and food demand this level of freshwater will increase worldwide. Automation technology and its apparatus have provided the optimal usage of water resources. Many problems are faced in the traditional system of irrigation. Best way to control this irrigation problem is provide sensor network for low cost controlled irrigation and real time monitoring of water content in soil. Apparao, C [5] stated in his research that as compare to manual system, automated drip irrigation can save water, money and time as well as can increase crop profit. Many automated drip irrigation system are available but they are costly. The principle reason for this investigation is to configuration ease robotized water system framework. A straightforward gadget working under the dirt which can help electronic circuit board to either turn off or switch on the engine according to the required dampness has been produced. Kulkarni, A. [6] States that in the automated drip system, the water is supplied near the root zone of the plants drop by drop. To develop, pilot and promote the use of web-based application tools along with software apps for mobile devices. So we can have, automatic remote irrigation systems which will help farmers to raise crops with proper knowledge about it and by saving large amount of water. The modern sensor technology is used to get the real time environment values like temperature, moisture and humidity for the particular soil.

The system will automatically flow the water to field based on these environment values. Paramewaran [7] states in his paper that the Drip irrigation framework causes the ranchers to flood the farmland in a productive way with mechanized water system framework dependent on soil dampness. Dampness sensor is utilized to discover the dirt stickiness and dependent on this microcontroller drives the solenoid valve. Water system status is refreshed to the server or neighborhoods have utilizing PC. Java stage is utilized here for getting data by means of sequential correspondence from microcontroller and to refresh in the server.

3. METHODOLOGY

This study was conducted with the objective of designing and analysis of automated drip irrigation system .The data was collected from a drip irrigation system at the site placed in a Nasarpur city Sindh. Firstly the installation and design an automatic drip irrigation system using Arduino. Then calculate the pressure drops in pipelines. In last the comparative study of drip irrigation system and conventional irrigation system also compares the theoretical data and actual data. The whole research Methodology is given in flow chart.

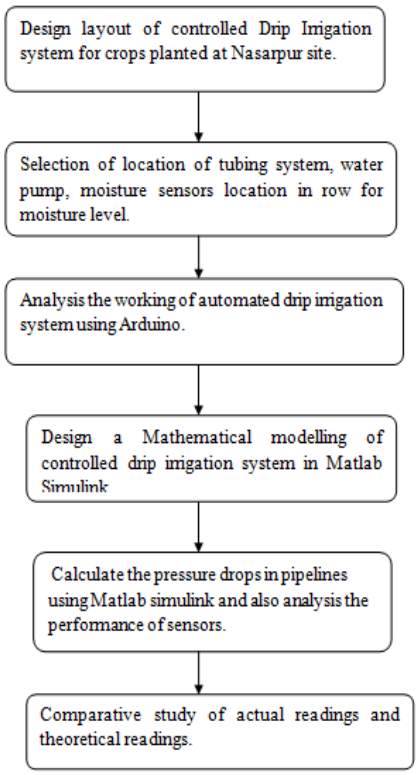


Fig.1 Flow Chart of research Methodology

This designed controlled drip irrigation system was applied for controlling water crops planted in field of 200 sq-yards. The area of implementation is a small town named “Nasarpur” and is located 45 kilometers towards the west Hyderabad. In this area 6 lateral pipelines are installed in the half of total area, which are irrigated by separate control valves for each lateral lines and half of total area is irrigated by manual irrigation method. A parallel separate setup based on manual drip irrigation system is also developed for comparative analysis. The schematic diagram of the installed controlled drip irrigation system (not as whole, only 2 lateral pipelines) and manual drip irrigation system is shown in Fig.2.

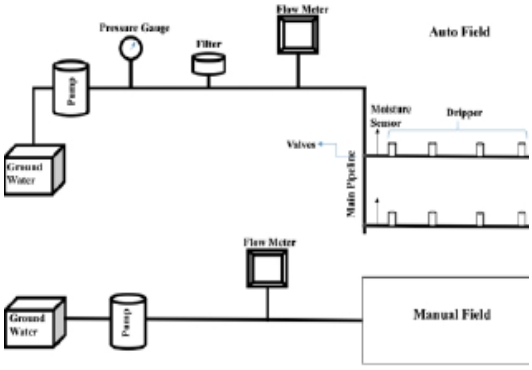


Fig.2 schematic diagram of controlled drip irrigation system and manual irrigation system

The system is developed for the controlled and analysis of drip irrigation system in on two ways.

a) System hardware
b) System software

3.1 SYSTEM HARDWARE

The hardware system was developed for the controlled drip irrigation system. It consists of soil moisture sensor, valves, pumps, Arduino UNO. This system can be used for the various types of crops but here we have used this system for only three crops named cluster beans, apple gourd and okra. We use in this project the soil moisture sensor YL-69 shown in Fig.3. This is an Electrical opposition sensor. The sensor is comprised of two cathodes. This dirt dampness sensor peruses the dampness content around it .A current is passed over the terminals through the dirt and the protection from the current in the dirt decides the dirt dampness. It has been located 4 inches below the ground at the radius of 8 inches of crops. The Arduino UNO controller is used here to write and upload the computer code shown in Fig.4. It is the heart of the whole drip irrigation system, which means it controls all the activities of the system. It has a memory where all the programs are saved. For connection of Moisture sensor to Arduino First connect vcc wire of sensor to the vcc port of the Arduino, then connect ground to the GRD, and pin 3 connect to the pin three port of Arduino. The Arduino is an open source system it allows us to one to write code and then load it to Arduino board's memory. We connect our soil moisture sensor to the Arduino board and then load the program in laptop then write Analog read to the command window, click examples then go in basics and then click analog serial and select com8 port and dip moisture sensor in the field then run program so it will show you the water consumption values. The piping system is laid using a low density polyethylene (LDPE) pipe. For the main pipe line, the pipe of 2 inches diameter is used which is placed 60 cm below the ground level. The internal LDPE pipe with diameter of 13mm and length of 42 feet is used for the 6 lateral lines. The spacing between the lateral lines is 3 ft and the dripper spacing on the one lateral line is 1.25 feet. In the Fig.5 shows the position of main pipeline at field and Fig.6 shows the lateral pipelines at field. The drippers used in this system are pressure compensating diaphragm with discharge of 4 L/hr. Fig.7 shows the dripper on lateral pipeline.

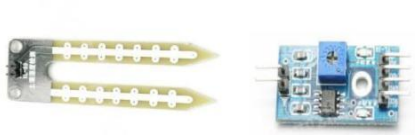


Fig.3 Moisture sensor

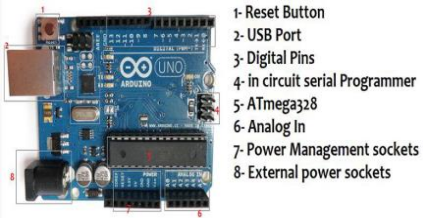


Fig.4 Arduino UNO

Fig.5 Main pipeline

Fig.6 Lateral pipelines for dripping

Fig.7 Dripper installed at the lateral piping

3.2 SYSTEM SOFTWARE

The system software we use in this paper is Matlab software for the simulation and analysis of the project. We use Matlab simulink for calculate the pressure drop in pipelines of the drip irrigation system. Analysis of spreading of horizontal stream rate, examination of head misfortune, investigation of producer release for each dripper along the pipe length.

4 MATHEMATICAL MODELING AND SIMULATION

In this paper we design a sub-system in simulink Matlab for the simulation and analysis of drip irrigation system. We use these three equations given below for the analysis and modeling of distribution of lateral flow rate, pressure head, head loss, emitter discharge for each dripper along the pipe length in Simulink Matlab.

$$\frac{dQ}{dx} = -q = \frac{-k}{s} h^{k_1} \quad \text{.....eq (1)}$$

$$g = \frac{dh}{dx} - g\sin\theta - \frac{1.6\alpha Q}{D^4 S}\left[Kh^{ki}(2-\delta)\right] + \left(\frac{\Delta h_f}{l} + \frac{\Delta h_{loc}}{l}\right) g = 0 \quad \text{.....eq (2)}$$

$$\frac{\Delta h}{l} = k_\circ D^{-4} \quad \text{.....eq (3)}$$

4.1 Matlab Modeling

Using these equations we design a sub-system in Matlab simulink as shown in fig.8, 9, 10, and 11.

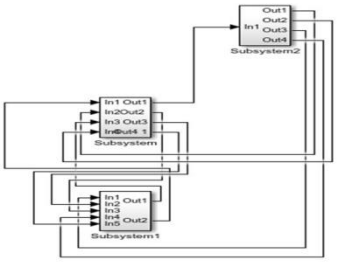


Fig.8 Block scheme of a sub-system of model

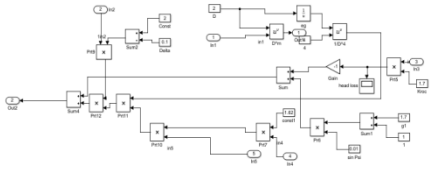


Fig.9 Block scheme of a sub-system solving eq (1)

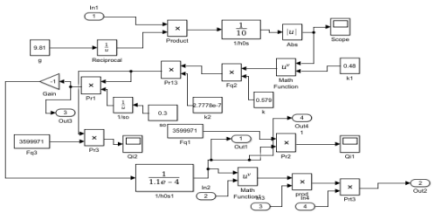


Fig.10 Block scheme of a sub-system solving eq (2)

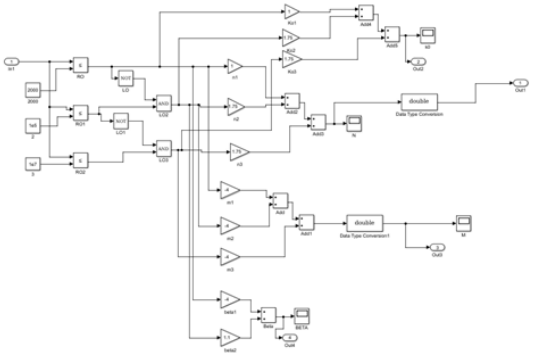


Fig.11 Block scheme of a sub-system solving eq (3)

5. RESULTS

As we know the paper is consists of two sections hardware and software work. So, we have also results in two section hardware results as well as software results.

5.1 Hardware Results

The data present here was collected during the growing season from month May, 2017 to August, 2017. The controlled drip irrigation system yielded significantly more than the manual irrigation technique.

The consumption of freshwater used for manual irrigation and drip irrigation from May, 2017 to August, 2017 is given Table 1 and Table 2.

Table 1 Manually water consumption in milliliter from May to August.

Date	Month			
	May	June	July	August
1	3195	3359	3550	3380
2	3059	3400	3400	3256
3	2850	3495	3550	3020
4	2960	3380	3550	2993
5	2905	3265	3410	3270
6	3065	3060	3320	Rainfall
7	3070	2975	3450	0
8	3189	3155	3080	0
9	3155	3069	3595	2500
10	3300	3293	Rainfall	2900
11	3150	3268	Rainfall	2985
12	3068	3389	Rainfall	3050
13	3098	3198	Rainfall	2990
14	3250	2905	Rainfall	2890
15	3285	3290	Rainfall	2979
16	3000	3300	Rainfall	3060
17	3390	3460	0	3200
18	3060	3485	Rainfall	3375
19	3085	3460	Rainfall	3295
20	2690	3575	0	2970
21	2975	3600	0	3098
22	2800	3699	2500	Rainfall
23	3269	3675	2500	0
24	3375	3605	3000	2500
25	3305	3579	3550	2500
26	3379	3485	3580	Rainfall
27	3385	4120	3500	Rainfall
28	3020	3490	3480	Rainfall
29	3329	3408	3400	0
30	3650	3300	3400	Rainfall
31	3300	-	3580	Rainfall

Table 2 controlled water consumption in milliliter from May to August.

Date	Month			
	May	June	July	August
1	2040	2040	2273	2079
2	2060	2060	2368	1905
3	2000	2200	2298	1889
4	1980	2280	2145	1847
5	1836	1936	2048	1748
6	1800	1000	1990	Rainfall
7	1910	1910	1990	0
8	1887	2087	2098	0
9	1910	1910	2150	1500
10	2139	2239	Rainfall	2065
11	2469	2469	Rainfall	2089
12	2394	2394	Rainfall	2107
13	2040	2689	Rainfall	2398
14	1973	2478	Rainfall	2200
15	2030	2390	Rainfall	2200
16	1870	2389	Rainfall	2240
17	1860	2560	0	2278
18	2085	2285	Rainfall	2130
19	2190	2090	Rainfall	2040
20	1972	1975	0	1960
21	2005	2005	0	1899
22	1890	1990	1500	Rainfall
23	1873	1875	1500	0
24	1705	1805	2300	1500
25	1779	1779	2280	1500
26	1985	1985	2280	Rainfall
27	1920	1920	2369	Rainfall
28	2029	2329	2300	Rainfall
29	2095	2295	2160	0
30	2130	2400	2200	Rainfall
31	1983	-	2265	Rainfall

The results shown in Table 1 and Table 2 That the designed controlled drip irrigation system saves about 20-25% of fresh water as compare to manual irrigation system.

5.2 SOFTWARE RESULTS

The Developed model and the program in Simulink-Matlab give a chance for more accurate design of drip irrigation system. The model is hypothetically based and the program is open for substituting with various sidelong parameters. From Fig.12

shows the distribution of pressure head h along lateral l. Fig.13 shows the distribution of Pressure head along lateral length, Fig.14 shows the distribution of drip line flow rate along the lateral length l. Fig.15 shows the Distribution of Emitter discharge along the lateral length l and in the end the total head loss h between drippers.

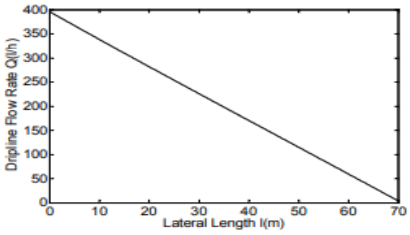


Fig.12 Distribution of pressure head h along lateral l

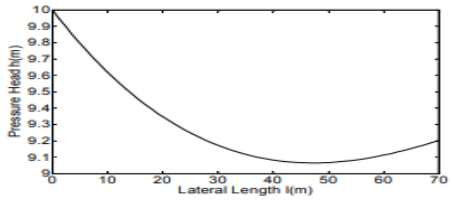


Fig.13 Distribution of Pressure head along lateral length l

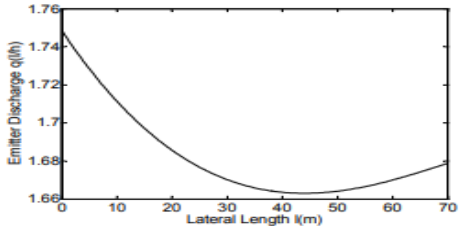
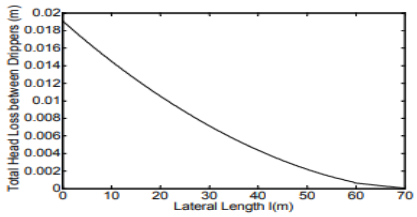


Fig.14 Distribution of drip line flow rate along the lateral length l.



Distribution of Emitter discharge along the lateral length l and in the end the total head loss h between drippers.

6. CONCLUSIONS

The purpose of designing this controlled drip irrigation system was to minimize the water consumption for the irrigation purpose. The installed controlled drip irrigation system based on soil moisture sensors. Further this study has also revealed that using controlled drip irrigation system, the crop yield has also increased due to proper supply of water. The study shows that there will be also many advantages of electrical, electronic and mechanical systems for good agricultural output. Also the water requirements, the use of excess fertilizers and other inorganic materials can be minimized if the fertilizer is dissolved in the irrigation water before supply. A Model of design of controlled drip irrigation on the basis of theory spatially varied flow is derived in this paper. The developed model and the program in SIMULINK-MATLAB give a chance for more exact water powered plan of stream laterals. The model is hypothetically based and the program is open for substituting with different lateral parameters. The good agreement between the model data and the experimental data prove the suitability of the model in the drip irrigation system practice.

REFERANCES

[1] Tupe Alok, R., Et al. (2015).”Intelligent Drip Irrigation system”. International journal of innovative Research in advanced Engineering (IJIRAE) 2(2):120-125.

[2] Luciana, M.L., Et al. (2013).”Automatic Irrigation unit using PIC controller”. International journal of latest trends in Engineering Technology. 2(3): 108-114.

[3] Hade, A. H. and M. K. Sengupta (2014).”Automatic control of drip irrigation system and Monitoring of soil by wireless”. IOSR journal of Agriculture and veterinary science. (JQSR-JAVS) 6(4):1573-1582.

[4] Dursun, M. and S.Ozden (2011).”A wireless application of Drip Irrigation automation supported by soil moisture sensors”. Scientific research and Essays 6(7):1573-1582.

[5] Apparao. R., Et al. (2015).”Development of Low cost soil moisture sensor for drip Irrigation system”. International Journal of advanced Research in Computer Science and Software Engineering 5(9): 714-717.

[6] Kulkarni, A, Et al. (2016).”Automated Smart Drip Irrigation System using wireless Medium and Sensors. International Journal of Emerging Technology and Computer Science. 1(2):35-38.

[7] Parameswaran, G., K., (2016). ”Arduino Based Drip Irrigation system using Internet Of Things”. International Journal of Engineering science, 5518.

[8] Prathyusha, K., and Suman, M.C. (2012).”Design of Embedded systems for the Automation of drip Irrigation system”. International Journal of Application or Innovation Engineering and Management.[JAIEM](2319-4847).

[9] Er. Sukhjit Singh, Er. Neha Sharma. Research paper on “Drip Irrigation Management wireless Sensors “. IRACST, Volume 2, No.4, August 2012.

[10] Sandhyasree Thaskani and Rammurthy. “Application of Topology under Control wireless Sensor Networks in Precision Agriculture”. International Institute of Information and technology, Page(s): 1-14, April 2010.

[11] Jyothipriya, A., Dr. Saravanabava T.P (2013).”Design of Embedded For drip Irrigation Automation”. University Of Chennai, International Journal of Engineering Science Invention ISSN 2319-6734.2(4)34-37.

[12] Iqbal Singh, Meenakshi Bansal.”Monitoring water level in Agriculture using Sensor Networks”. International Journal of Soft computing and Engineering (IJSCE) ISSN: 2231-2307, Voluke-1 Issue-5, November 2011.

[13] Agarwal, S., Paney, S., Kumar, S., and Chaudhry (2014). “Automatic Irrigation System”. International Journal of Agriculture. 291), 92-94.

[14] Kim, Y.m Evans, R.G., and Iversen, W.M (2009).”Evaluation of Closed –Loop site specific Irrigation with Wireless Network Sensor “. International Journal of Irrigation and drainage Engineering, 135(1), 25-31.

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