Comparative analysis of Linear and Lagrange's Interpolation for the implementation of drip irrigation technique

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Abstract: India is one of the agrarian countries. Most of the farmers use the traditional way for the water supply for plant growth. Neither less nor more water is good for plant growth. One of the most suitable and feasible techniques for the plant's proper cultivation is drip irrigation. But in conventional drip irrigation water supply is regulated but not properly monitored as per crop requirements. So sometimes it may be more than or less then what crop actually need. The presented paper does comparative analysis of linear and Lagrange's interpolation used for water regulation in drip irrigation projects. Several automated drip irrigations are undertaken for water regulations, while working on the same, Drip irrigation considers the parameters such as soil moisture before water supply so that farmers must be able to provide the necessary amount of water to the plants. Interpolation technique can be used for soil moisture readings and necessary actions based on threshold values. The aim of interpolation is to determine unknown values with the help of the distinct known values. One of the easiest interpolation techniques is linear interpolation. Lagrange's Interpolation is the faster interpolation technique in comparison linear interpolation.

Keywords: Automated Drip Irrigation, Linear Interpolation, Lagrange's Interpolation, water regulation for drip irrigation.

1. INTRODUCTION

Most of the farmers in India are dependent on the electricity for water supply which usually leads to the improper water supply to the plants leading the improper plant growth. One of the solutions for this problem is regulating the water supply automatically by considering the plant water requirement [1]. Water is supplied to the plant root in the Drip Irrigation technique which saves the big amount of water. Drip irrigation technique uses humidity, temperature, light intensity as parameters. Water requirement varies from crop to crop. The automatic drip irrigation technique is free from human interference.

Currently a huge research work is carried out in precision agriculture process. They are several methods are being applied to measure the environmental parameters like soil moisture, soil surface temperature, humidity and so many. Land surface temperature is one of the parameter which can be used land-atmosphere model [2] [3] [4]. TIR data usage was proposed by Yang Gui and Si-Bo Duan, using generalized spilt window (GSW) [5].

Dianjun Zhang proposed a nonlinear interpolation method to determine the surface soil moisture. He used nonlinear interpolation to determine soil moisture from LST-VI feature space based where thermal infrared remotely sensed data is used for further calculations [6]. Johanna Garcia-Cardona, Antonio Ortega has provided a novel method to determine the soil moisture accurate information over temporal and spatial scale against the highly vulnerable data readings. Author has used graph based interpolation to get accurate information [7]. Volkan Senyurek proposed Space borne Global Navigation Satellite System Reflectometry (GNSS-R) for high resolution soil moisture measurements

[8]. Along with these methods for soil moisture estimations interpolation is used, so in this presented paper the comparative analysis is provided in detail.

Drip irrigation requires the hose, emitters, pressure gauges, valves, fertilizer thanks, time clock, Tensiometer, evaporator pans, meters, filter [9]. It is able to consider only one soil condition at a time. In Automated irrigation timer will control the water flow automatically no manual interference is required. Temperature and moisture sensors are also included which are enrolled at the crop root. Tap gets on when soil moisture is dropped. Linear programming regulates acquirable water to all acquirable crops increasing the crop yield. Linear programming track acquirable water for plant[10] .

Soil moisture plays an important role in the determination of the water supply. Soil moisture can be measured with the help of the interpolation technique which determines the new values from the distinct data sets we have. Interpolation gives the easy way of data reading System is able to tranquilize and reverse data in sending warning message used in the process of decision [11].Linear and Lagrange's are the two interpolation techniques. Linear is simple and the Lagrange's is the fast interpolation technique. Linear interpolation is used to even up the tap timing of the drip. Lagrange's interpolation can regulate the moisture level for the proper growth of plant. Regular method for fertilizer dissemination leads less crop profit whereas Lagrange's interpolation leads less sensor nodes reducing cost. [12, 13,14]

1.1. Environmental setup

Reading arrangement is done at the actual farming in the village pabal dist Pune. Endurance of the observation is in both autumn and spring season. Vigyan Ashram is a center of Indian Institute of Education (IIE) Pune started by Dr. S.S. Kalbag in 1983 at Rajguru nagar -Shirur Road for solving problems in the education. http://vigyanashram.com

Fig1. Actual Experiment site at Vigyan Ashram, Pabal,Pune.

Data is transferred from source to sink node using the multi hoping technique. Two Master and four slaves are accustomed. Every node accommodates four sensors Soil moisture, Temperature, Light and humidity. Xigbee trans-receiver with open air range of 400 mtrs, closed environment range of 250 mtrs , every node with 20 mtr node distance from each other, sensor reading scope of 5*5 mtr is used for data sending. Routine and Deliberate environment is used for Observations.

Result analysis

The work is obtained for the potato crop in various seasons. Change in Environment affects the soil moisture. Soil moisture plays the vital role in water requirement of the crop. Interpolation is used to circulate the available water into number of crops to achieve the maximum crop yield. Water and power requirement is measured by considering different time slots for the same crop in different season for marking out the crop yield with respect to the different parameters.

Table 1. Water and time consumption without linear interpolation

Time	Water consumption (Liters)	Power consumption (Watts)
09:00-10:00	1985	3868
10:30-11:30	1951	3945
12:00-12:30	1037	1921
12:45-01:50	2376	4764
02:00-03:00	2001	3993
03:10-04:10	1992	3957
04:15-05:15	1911	3874
05:20-06:20	1937	3988
Total	15188	30307

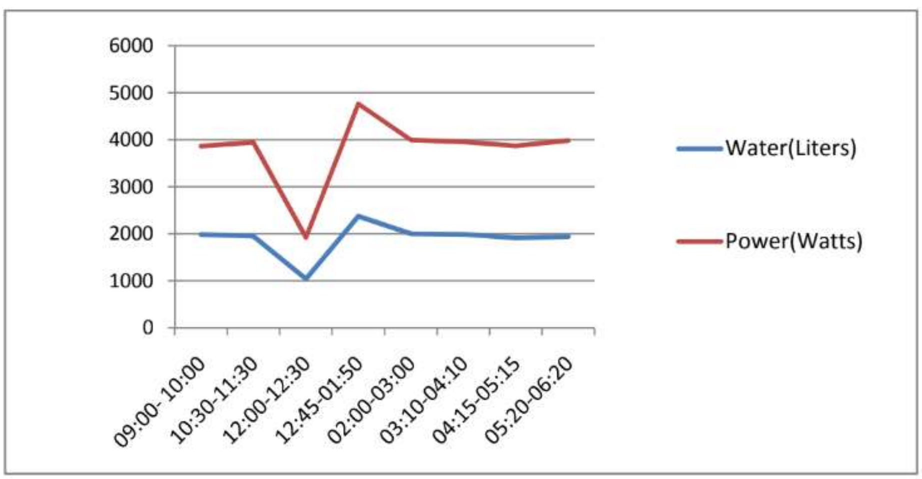

Fig 2: Water and power consumption without linear interpolation

Table2*: Water and Power consumption with linear interpolation technique

Time	Water Consumption In Liters	Power Consumption In Watts
9.00am-10.00am	121.3	243
10:30am-11:30am	121.7	242
12:00pm-12:30pm	121.3	243
12:45pm-01:50pm	108.3	216.3
02:00pm-03:00pm	121.5	242
03:10pm-04:10pm	121.4	243
04:15pm-05:15pm	100.2	203
05:20pm-06:20pm	121.2	242

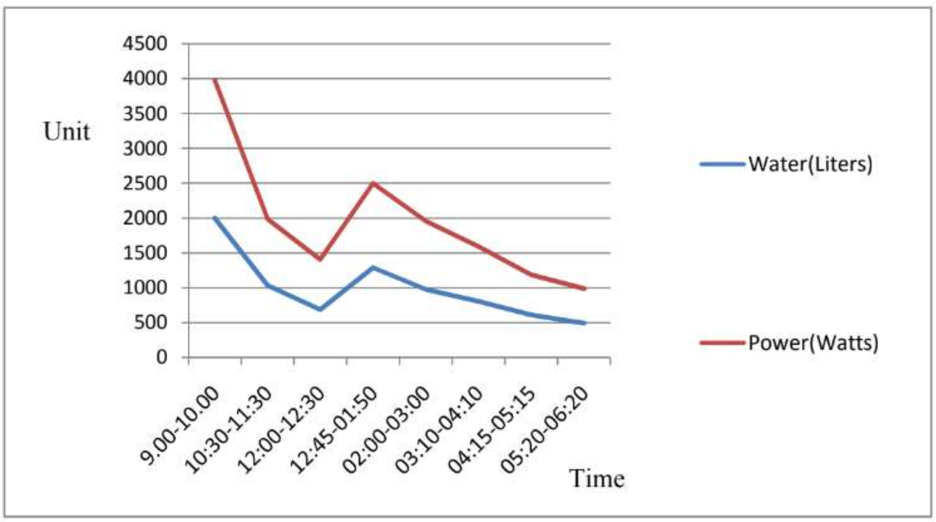

Fig 3. Water and power consumption with linear interpolation

Table 1 and Table 2 above clearly show that the water utilization without linear interpolation is 15,187 and with linear interpolation is 7898. If we calculate the difference then it is 15,187-7898 = 7298 approximately 49% water saving. Power consumption without linear interpolation is 30308 and with interpolation is 15580. If we calculate the difference then it is 30308-15580 = 14728 approximately 48.7% power saving. All the values are calculated by considering water distribution with 6mm pipe, running 10 HP with 1H.P = 745.7 W water pump and with the energy consumed = Power x time formula.

Table 3*: Water and power consumption without Lagrange's interpolation

Time	Water Consumption In Liters	Power Consumption In Watts
9.00am-10.00am	121.5	243
10:30am-11:30am	121.7	241
12:00pm-12:30pm	121.5	244
12:45pm-01:50pm	108.1	216.5
02:00pm-03:00pm	121.3	243
03:10pm-04:10pm	121.7	245
04:15pm-05:15pm	100	201
05:20pm-06:20pm	121.3	244

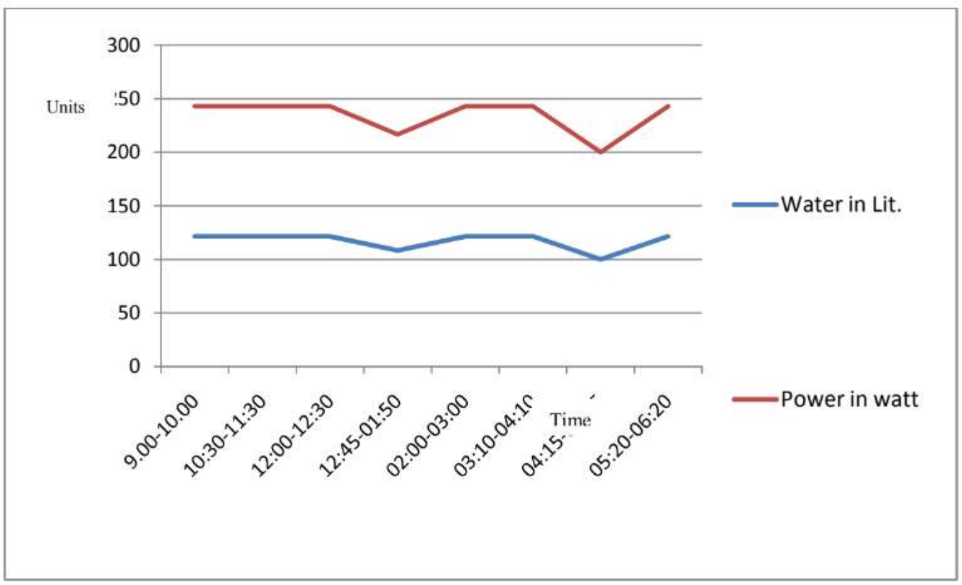

Fig 4*: Utilization of Water and power without Lagrange's interpolation

Table 4*: Water and power consumption with Lagrange's interpolation technique

Time	Water Consumption In Liters	Power Consumption In Watts
9.00am-10.00am	83.04	165.08
10:30am-11:30am	84.02	167.01
12:00pm-12:30pm	84.16	166.69
12:45pm-01:50pm	56.34	111.98
02:00pm-03:00pm	82.98	165.62
03:10pm-04:10pm	84.01	166.95
04:15pm-05:15pm	53.96	108.93
05:20pm-06:20pm	84.01	167.03

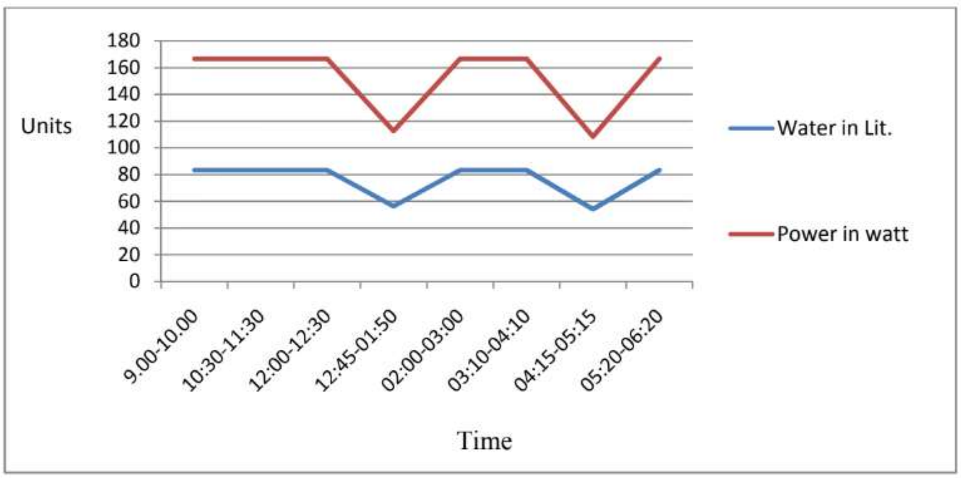

Fig 5*: Utilization of Water and power with Lagrange's interpolation

From table 3 and table 4 helps us to examine that water utilization without Lagrange's interpolation 937. And with the Lagrange's interpolation it is 610. If we calculate the difference then it is 937-610 = 327. Approximately 35 % water saving. Power consumption without Lagrange's interpolation is 1874 and by using Lagrange's interpolation it is 1220. If we calculate the difference then it is 1874-1220 = 620. Approximately 35% power saving All the values are calculated by considering water distribution with 6mm pipe, running 10 HP with 1H.P = 745.7 W water pump and with the energy consumed = Power x time formula.

Table 5*: Lagrange's interpolation technique with 12 cm depth tillage

Time	Water Consumption InLiters	Power ConsumptionIn Watts
9.00am-10.00pm	2916	5826
10:30am-11:30am	2915	5829
12:00pm-12:30pm	2916	5833
12:45pm-01:50pm	2600	5203
02:00pm-03:00pm	2917	5826
03:10pm-04:10pm	2914	5830
04:15pm-05:15pm	2404	4799
05:20pm-06:20pm	2916	5831

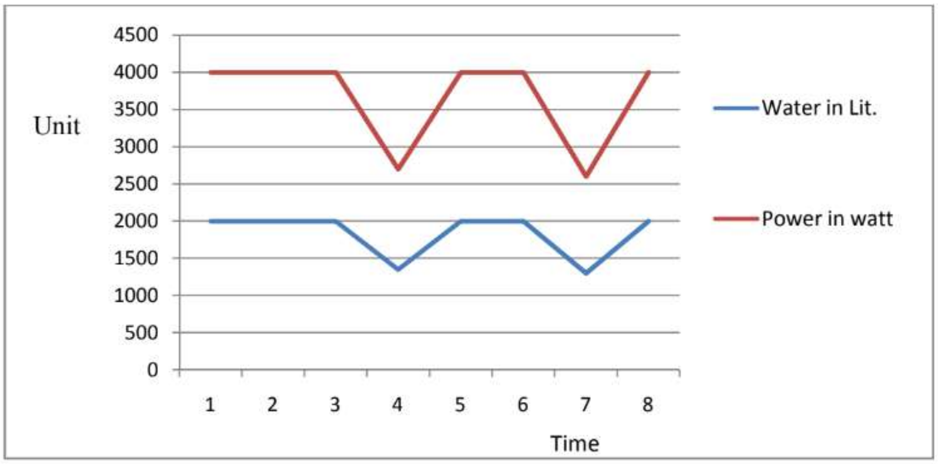

Fig 6*: Lagrange's interpolation technique with 12cm depth tillage

Land should be watered at 12cm depth. So measuring the requirement of water and power with respect to soil moisture farmer will be in a position to understand the crop yield.

CONCLUSION

From the above result graphs of linear and Lagrange's interpolation technique, the Lagrange's interpolation technique saves the ample amount of water as well as the power consumption in comparison with linear interpolation technique. The Lagrange's Interpolation is faster and accurate interpolation technique as compared to the linear interpolation. Lagrange's interpolation is more efficient for irregular and jagged surface than that of the linear interpolation technique .Lagrange's Interpolation technique gives the better results for the crop yield at the depth of 12 inches irrigating tillage as it considers the soil moisture and the water availability and the requirement of water according to the crop need.

Linear interpolation technique approximately saves 49% of water and 48.7 % of power. Whereas the Lagrange's interpolation technique saves approximately 35% of water and power too. From above conclusion, the Lagrange's interpolation can be used for crop yield where exact precision agriculture is expected and if farmer need overall automation where time delay is permissible then linear will be more useful.

FUTURE SCOPE

Though the Linear interpolation saves the water and power in ample amount results are less accurate than that of the Lagrange's interpolation technique. Lagrange's interpolation is faster than that of the Linear interpolation technique. For irregular cultivation Lagrange's interpolation is more beneficial but for regular cultivation different technique can be considered.

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