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Effectiveness of Piecewise interpolation and Lagrange's interpolation in the implementation of Drip Irrigation system

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Abstract: Farmers are the backbone of Indian economy. Water supply is the vertebra of the crop yield. Both less and more water supply can directly impact on the crop growth. Drip irrigation is one of the best suited techniques for the same. For the proper water supply soil moisture must be taken into account. Soil moisture can be tracked with the help of interpolation. Soil moisture really helps in proper water utilization on the basis of the crop yield. The collected parameter values generating data set which can be used to point out the required new values. Thus leads for certain decisions for precision agriculture. Interpolation techniques save the efforts and amount of time needed for the proper water supply which helps for the best crop yield. The paper presents detailing about research carried out through interpolation techniques for water optimization. Two interpolation methods were used viz. Lagrange's and Piecewise interpolation which resulted in smooth functioning of the water supply to the crops through drip irrigation. The langrage's methods optimize 35% of water whereas Piecewise optimizes 24%. The detailed comparative analysis is given in the paper.

Key terms: Drip Irrigation, Lagrange's Interpolation, Piecewise Interpolation.

Introduction

Agriculture is largest sector where tremendous technological advancement are possible and in current date lots of new technologies are being introduced in this field from pre-harvesting to post harvesting processes. Irrigation is one of the promising area where technical advancement are necessary as available water utilizationwith accurate supply as per requirements is most important part to get proper yield.

They have to take the lots of efforts, and have to spend lots of time for the same. Drip irrigation system provides the proper water supply without water wastage. Automated Drip irrigation with the help of the interpolation technique gives the magical way for the crop water supply. Soil moisture considers the actual need of the water which varies according to the crop and is taken into account in drip irrigation system. It is free from the Manual interference which is really helpful for the framers where the most important part of the farming can be managed without taking any kind of efforts. Farmers will be able to focus on the different things as drip irrigation saves the lots of time. Efficient agricultural commodities extricate time and cost [1].
The observations are marked out for the proper water utilization without any kind of water wastage. The potato crop is observed for the two seasons for the implementation of the drip irrigations with the interpolation technique for water supply. Seasonable and adequate information gives the fruitful solution[2]. Wireless Nodes are used for the Drip irrigation system implementation with interpolation techniques which is easy to

implement and saves the cost too. Wireless sensor nodes are used for tracing the Cultivation atmosphere observations with respect to temperature and moisture [3].

The land atmosphere model working can be determined or predicted through Soil moisture readings and humidity [4][5][6]. The water utilization is the most essential criteria for the proper farming. Generalized spilt window was applied to get data related to TIR to measure soil moisture readings by Yang Gui and Si-Bo Duan [7]. Non linear interpolation technique is used to determine the superficial soil humidity ByDianjun Zhang with the help of LSTVI aspect for future calculations thermal infrared remotely sensed data is used [8]. Graph-Based interpolation technique is used to achieve the equitable soil moisture information by Johana Garcia-Cardona, Antonio Ortega [9]. For the immense verdict, Volkan Senyurek recommended Global Navigation Satellite System Reflectometry (GNSS-R) [10].
Soil moisture can also be determined with the help of the Lagrange's and piecewise interpolation technique, in the given paper the comparative analysis is included over efficient utilization of both algorithms. Lagrange's interpolation can regulate the moisture level for the proper growth of plant. Apart from this interpolation methods can be used for fertilizer distribution also where the fertilizer distribution can be regulated to maximize the crop yield also it helps to reduce the use of number of wireless sensor nodes [12, 13,14]. Lagrange's and piecewise interpolation technique can be easily used for the timely and the proper water supply for the crop yield. Even for horticulture both the Lagrange's and piecewise interpolation technique are efficient.

Lagrange's and piecewise interpolation techniques can really help for the automated drip irrigation system. Lagrange's interpolation technique is preferred for the crop yield where the timely and the proper water supply is the basic requirement for the crop yield. Lagrange's interpolation is helpful for the regular land and but does work effectively on uneven tillage. For the irregular lands piecewise interpolation technique gives near about same benefits.

1.1. Experimental setup

Crop analysis was done in autumn and springs both Seasons at Vigyan Ashram,Pabal in 10000 square feet area. Land is divided into two parts where one part with crop yield with the interpolation techniques and the other part without interpolation technique. As the wireless sensor nodes are used, it saves the wire cost and makes the installation easy. The main focus is on Interpolation, an intriguing smart, self-regulated Irrigation System. This system allows for standardized drip irrigation valve timings based on sensor knowledge from synchronized nodes. For an entire week or month, you can tell the computer what the limits are for all of the Valves. A microcontroller is handed down to save information gathered at versos. Using an ADC converter, the gathered analogue values are converted to digital values that can be easily understood by the GUI.

The system supports the tallied distribution of water across multiple crops. Values and readings collected from versos sensor nodes are used to reach a compromise. After collecting data, the gilt edge watering plan is initiated or predicted using both Interpolation to achieve maximum land cultivation with minimal water use and equitable profit distribution. A microcontroller initiates the commands that turn on or off commonplace devices like water pumping motors and valves. In order to relay information to the master node, each node sends its data to a neighbouring node. With both Interpolation, all data is compiled and interpreted at the server, making it the master node.

The three conditions that must be measured are heat, humidity, and luminosity. One node is placed in each of the tillage's smaller sections. LM35 is used to express temperature readings at each sensor node, while Torsiometer measures soil moisture levels in volumetric terms. The sensors are placed at a depth of 6-8 centimetres. When the humidity rises above a certain threshold, the sensor sends a signal to the microcontroller, which then decides whether or not to turn off the valve.

Fig 1*: Wireless sensor nodes deployed at experimental area

2. Result analysis

Lagrange's interpolation technique as it takes the data input in sequence it is better for the even cultivation surface. Piecewise interpolation can fetch the random values which in turn results in the

better performance in the uneven cultivation surface. Both the algorithms are considering the threshold values given by the agricultural department with the help of which water supply can be regulated in the proper way.

Table 1*: 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**

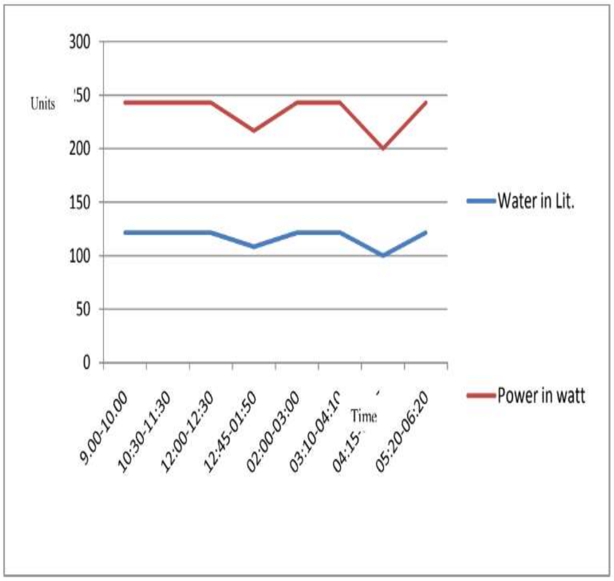

Fig 2*: Utilization of Water and power without Lagrange's interpolation

Table 2*: 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

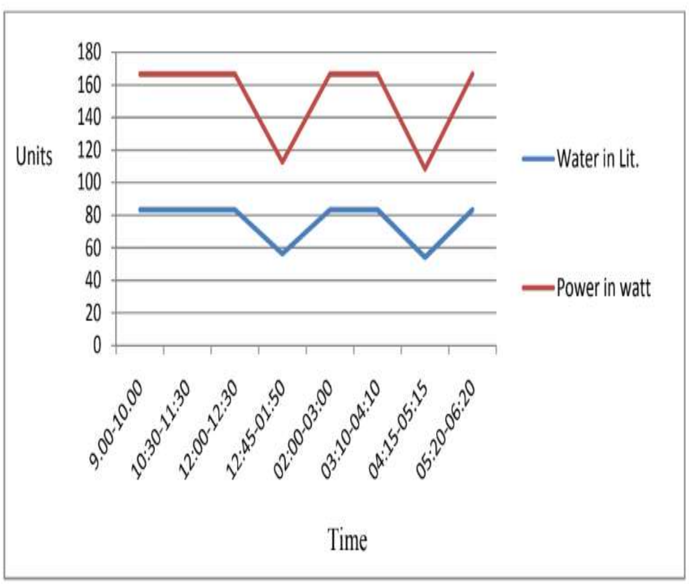

Fig 3*: Utilization of Water and power with Lagrange's interpolation

While performing the experiment 10 HP water pump and 6mm pipe were used and Potato crops are considered for the observations for entire month which needs to be considered at the 12 cubic inches' depth which gives appealing performance as hector inches about 24% less water. Piecewise interpolation saves up to 23% less power than without using the same.

Table 3*: Water and power consumption without piecewise interpolation technique

Time	Water Consumption In Liters	Power Consumption In Watts
9.00-10.00	121.5	243
10:30-11:30	121.5	243
12:00-12:30	121.5	243
12:45-01:50	108.33	216.66
02:00-03:00	121.5	243
03:10-04:10	121.5	243
04:15-05:15	100	200
05:20-06:20	121.5	243

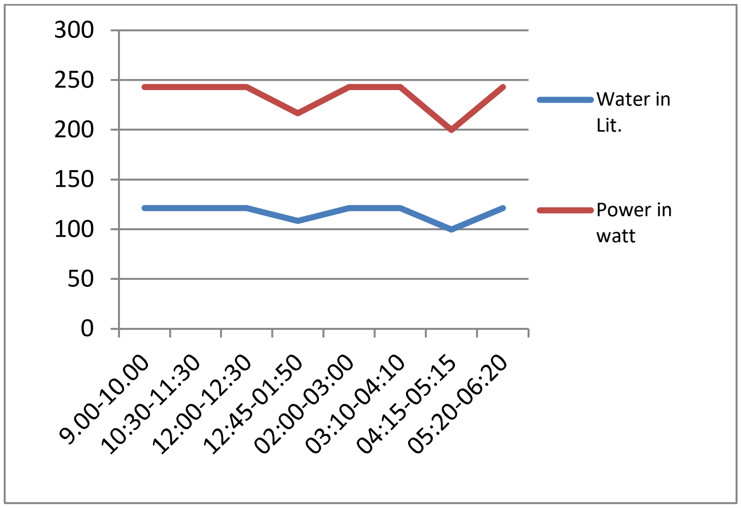

Fig 4 Consumption of water and power, day wise plot for one Acre cultivation land up to 12 cm without Piecewise Interpolationable 4*: Water and power consumption Withpiecewise interpolation technique

Time	Water Consumption In Liters	Power Consumption In Watts
9.00-10.00	95.34	187.4
10:30-11:30	92.67	183.3
12:00-12:30	90.23	179.1
12:45-01:50	93.56	184.5
02:00-03:00	92.87	183.3
03:10-04:10	91.39	182.8
04:15-05:15	73.11	167.7
05:20-06:20	92.14	182.9

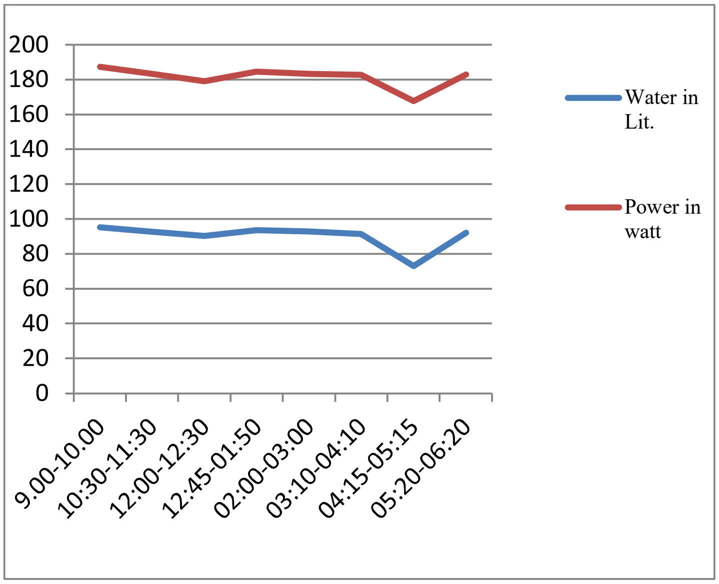

Fig 5 Consumption of water and power, day wise plot for one Acre cultivation land up to 12 cm without Piecewise Interpolation

Piecewise interpolation technique uses the three various sensors for data observations. For the proper water supply one smart technique is used in the piecewise interpolation technique. Threshold value is set by considering the crop type and its requirements taken from agriculture university standard database. If the soil moisture level is below the threshold value, then the solenoid valve will be switched on and if threshold value is at higher level it will be off.

Crop fruitage with piecewise interpolation is approximately same but saves (937-721 = 216) which is roughly 24% water and (1874-1451 = 423) which is roughly 23 % watts power at 12cm depth by using 6mm pipe and 10 HP water pump. With the same setup for the Lagrange's interpolation it saves (937-610 = 327) relatively 35 % water saving and (1874-1220 = 620) relatively 35% watts power saving.

The comparative analysis shows that Lagrange's interpolation technique is accurate and fast. Lagrange's method saves the water and electricity needed by 35 % in comparison with conventional drip irrigation process. This is around 11 % more than piecewise interpolation method.

2. Conclusion and future scope

In the implemented system, both Lagrange's and Piecewise interpolation method produces better results in comparison with conventional drip irrigation. Though both methods works on data collection from WSN nodes and based on threshold value comparison decisions are made by the system for water supply the efficiency can be considered through the process of data collection. Sequential data point selection makes the Lagrange's interpolation useful for the even tillage whereas due to the random selection of data point piecewise interpolation technique is better for uneven tillage.

For the same precision agriculture related to drip irrigation process, the environmental parameters such as soil moisture, soil temperature, soil texture and other fertilizer detailing can be identified with different technological advancements such as image processing. The current implemented system can be further improved using deep learning techniques.

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