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RESEARCH ARTICLE

Innovative Irrigation Using Humidity and Soil Moisture for Efficient Usage of Water in Agriculture Field Compared to Drip Irrigation

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ABSTRACT

Aim: The storage of clean water assets around the world has produced a requirement for their ideal use. Innovative irrigation is the advance method which can overcome the drawbacks of traditional drip irrigation. **Materials:** In this proposed system two soils, sandy soil with average moisture content 60% and clay soil with average moisture content 76% are taken; A total of 20 samples are taken from 2 groups. The sample size was estimated to be 5 in each group using Gpower with the input soil samples with alpha error of 0.95, threshold value of 0.05, confidence level of 95%, pretest G- power is 80%. Significance of this proposed system is 0.05. **Result:** Comparing the two soils, the soil which can maintain a low percentage of moisture content appears to be suitable for the irrigation. Minimum percentage of moisture can be achieved by using the smart irrigation system which appear to be better than the traditional drip irrigation. The moisture content in sandy soil is 83% and the clay soil is 63%. Since moisture content is inversely proportional to water content. **Conclusion:** Clay soil appears to be better than sandy soil, traditional issues in drip irrigation is overcomed by innovative irrigation system.

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Introduction

Smart irrigation technology is a method which unlike the traditional irrigation that operates on a preset programmed schedule and timers, smart irrigation system monitors weather, soil moisture, humidity and the water usage by the plants. (Gutierrez et al. 2014). It is important for the farmers to overcome their hard work and to water to overcome 80%of water wastage. By considering the humidity, the amount of water to be supplied is also programmed in this smart irrigation system (Priya, Siva priya, and ECE AND EGS Pillay Engineering College 2017). Smart irrigation system can optimize water levels based on the weather predictions and monitored parameters can be stored (Ravichandran et al. 2018). Automated watering systems are used to replace manual irrigation with automatic weather predictions, It does away with the human error element (Dhanekula and Kiran Kumar 2016).

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A large amount of research has been carried out in the recent years. In the last 5 years 283 journals have been published in the IEEE database. Low cost wireless monitoring and decision support for water saving in agriculture. Water scarcity has been one of the major problems nowadays on this planet. So overflow of water in fields is also the major problem for scarcity of the water. By smart irrigation this problem can be rectified to some extent. (A et al. 2018). Internet of things based on smart agriculture towards making the field comfortable in maintaining sufficient water content. Maintaining 80% water content in the soil is very much useful to the crop. This automated watering system can be useful for the crop to maintain 80% of water content in the soil. (Fatma et al. 2018). Monitoring the water content in the soil according to temperature. Here operation of motor is based on the temperature of the surroundings. If the temperature is less than 35 degrees the motor will stop supplying the water, otherwise the motor pump starts supplying the water to the crops and maintains 80% of moisture content. (Juca et al. 2018). Measuring the soil moisture content in the soil and supplying the water accordingly, until 80% of moisture is gained by the soil. Controlling the water supply to the crops based on the weather conditions. If it is cloudy automatically the water supply to the crops is stopped. So by this rain water can be utilized for harvesting. (Agarwal and Agarwal 2017).

Previously our team has a rich experience in working on various research projects across multiple disciplines (Sathish and Karthick 2020; Varghese, Ramesh, and Veeraiyan 2019; S. R. Samuel, Acharya, and Rao 2020; Venu, Raju, and Subramani 2019; M. S. Samuel et al. 2019; Venu, Subramani, and Raju 2019; Mehta et al. 2019; Sharma et al. 2019; Malli Sureshbabu et al. 2019; Krishnaswamy et al. 2020; Muthukrishnan et al. 2020; Gheena and Ezhilarasan 2019; Vignesh et al. 2019; Ke et al. 2019; Vijayakumar Jain et al. 2019; Jose, Ajitha, and Subbaiyan 2020). Now the growing trend in this area motivated us to pursue this project.

In the existing system, monitoring the moisture content of soil according to temperature has been done. The rain water can be utilized during the rainy season. Monitoring the temperature fall during winter and rainy season. 80% of the moisture content is maintained. if moisture level is less than 80% then by using motor pump water is supplied to the field, when the soil reaches 80% moisture the supply of water is stopped automatically. But, Actually % of moisture content differs from soil to soil. So, soils should be tested and according to that water should be provided for example alluvial soil minimum soil moisture content is 78% and whereas for sandy soil is 76%. It differs from soil to soil and also the time taken for the absorption of water by soil to reach its respective moisture content also should be monitored by the smart irrigation system. The aim of the proposed system is comparison of two different soils according to the moisture content suitable for the respective soils and according to the humidity level in the surroundings, water supply is provided. The time taken by each soil to reach their respective soil moisture content.

Materials and Methods

The research was performed in the Department of Electronics and Communication Engineering, Saveetha School of Engineering. This study is about comparison of two soils based on their soil moisture content according to humidity level. A total of 20 samples are taken from 2 groups. The sample size was estimated to be 5 in each group using Gpower with the input soil samples with alpha error of 0.95, threshold value of 0.05, confidence level of 95%, pretest power is 80%., are taken from different places. However, sample size is increased to 10 in each group. There are many types of soils on this planet, only few soils are suitable for irrigation. Here two soils, sandy soil and clay soil are taken for the comparison. (Agarwal and Agarwal 2017) Group1: Sandy soil is considered because it is created by erosion of rocks and minerals. Sandy soil is important for growing vegetables and fruits. Sandy soil falls in a steady stream when held in the hand. It feels gritty to touch and it is not sticky. It contains 85-100% of sand size mineral particles.

Group 2: Clay soil is considered because it has a large specific surface, often predominantly negatively charged. The clay soil itself may be a source of plant nutrients when it degrades. No soil is completely made of clay; soil is a mixture of clay and other soil types that varies by location. These unique characteristics of sandy soil and clay soil are the main reasons for considering these soils for the comparison. 10 samples of each soil are taken for the testing, totally 20 samples are taken into consideration.

The test setup requires the following components for the testing of soil samples: Arduino, soil moisture sensor, humidity sensor. Arduino board design uses a variety of microprocessors and controllers. The board is equipped with a set of digital and analog input and output pins that may be interfaced to various expansion boards or breadboards and other circuits. The boards feature serial communication interfaces, including USB on some models, which are also used for loading programs. The soil moisture sensor works on the basic principle that pretty straight forward, the fork-shaped probe with two exposed conductors, acts as a variable resistor whose resistance varies according to the water content in the soil. A humidity sensor senses, measures and reports both moisture and air temperature. The ratio of moisture in the air to the highest amount of moisture at particular air temperature is called relative humidity. The Connections are made as per according to the block diagram. The Arduino IDE is installed. The sensors are connected to sense soil moisture and humidity to the arduino. Ultrasonic sensor is connected to the arduino. Motor pump is connected to the soil moisture sensor.

Testing Procedure

Figure. 1 represents the workflow. The arduino program is entered in the arduino IDE. Connecting arduino to the computer. The moisture sensor is kept in the soil. The readings of soil moisture and humidity are monitored. The program is uploaded in the arduino board. The motor pump switched ON/OFF according to the soil moisture. The parameters (soil moisture, humidity, motor (on and off) are monitored.

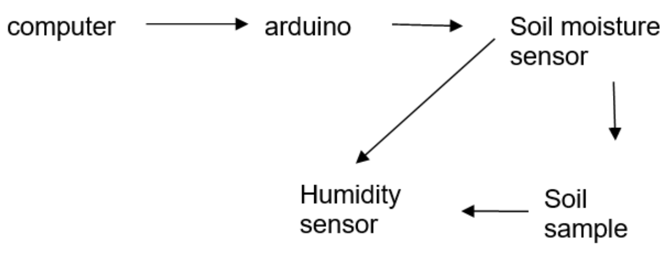

Fig. 1. Block Diagram of the Proposed System

Data is collected by varying two different types of soils: their soil moisture, fertility, amount of water required to maintain their soil moisture. Comparing soil moisture of two soils (sandy soil and clay soil) according to humidity. Here independent variables are groups(soils), dependent variables are soil moisture and humidity.

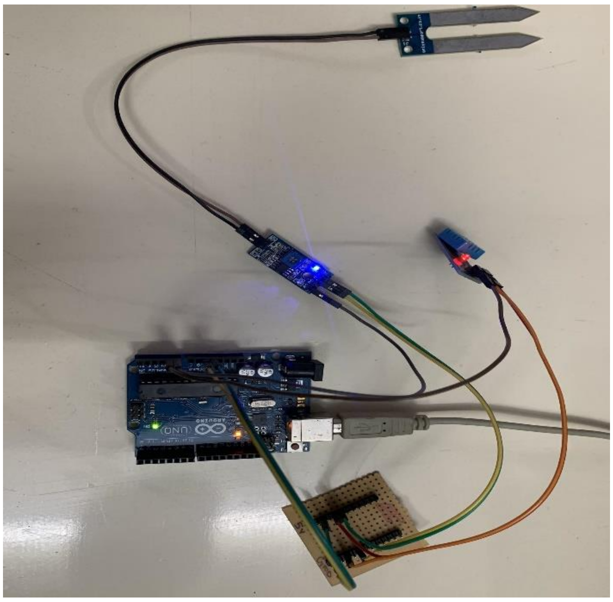

Fig. 2. Circuit Connection of the Proposed system

Results

In Fig. 3 the comparative analysis of two soils are given. X-axis represents soil moisture value and the Y axis represents the mean of the groups. It is observed that the maximum soil moisture content maintained is 1025 for sandy soil and 888 for clay soil. It is analysed that soil moisture content differs from soil to soil. In Fig. 4 depicts the change of soil moisture content with the change in the humidity. Here X-axis represents soil moisture and y-axis represents humidity. Soil moisture level varies with respect to the humidity level. In Table 3, it is observed that the mean value of soil moisture of group 1 is 833.2490 and group2 is 687.4890. Here group 2, mean value is lesser compared to group 1. From the Table 4, It is observed that significance of the soil moisture is 0.134 and significance of the humidity is 0.147. The Fig. 5, shows the mean moisture difference of sandy soil and clay soil. The moisture content in sandy soil is 83% and the clay soil is 63%. Since moisture content is inversely proportional to water content, clay is slightly better than sandy soil.

Table 1. Identified Soil Moisture of Sandy Soil with respect to Humidity. (Mean 83.3%)

Samples	Soil moisture	humidity
Sample 1	1023.00	151
Sample 2	1022.00	150
Sample 3	1023.63	151.5
Sample 4	886	150
Sample 5	884	152
Sample 6	1024.86	151
Sample 7	786	150
Sample 8	777	151.9
Sample 9	455	152
Sample 10	450	151

Table 2. Identified Soil Moisture Clay Soil with respect to Humidity. (Mean 63.55%)

Sample	Soil moisture	humidity
Sample 1	887	156
Sample 2	888	153
Sample 3	885.89	156
Sample 4	832	156
Sample 5	826	155
Sample 6	440	148
Sample 7	556	150
Sample 8	558	151
Sample 9	448	152
sample10	348	149

Table 3. Statistical analysis of Sandy and Clay Soil. Mean, Standard Descriptive Values of Soil Moisture and Humidity are obtained for 10 samples

	N	MEAN	Std. deviation	Std error	Lower bound	Upper bound	minimum	maximum
Soil moisture 1	10	833.2490	222.53168	70.37070	674.0594	992.4386	450.0	1025.86
2	10	687.4890	191.46303	60.54593	550.5246	824.4534	440.00	888.00
total	20	760.3690	215.43541	48.17282	659.5421	861.1959	440.00	1025.86
Humidity 1	10	150.9400	0.88343	0.27936	150.3080	151.5720	150.00	152.00
2	10	152.5000	3.13581	0.99163	150.2568	154.7432	148.00	156.00
total	20	151.7200	2.38076	0.53235	150.6058	152.8343	148.00	156.00

Table 4. Independent sample test for significance Mean square, significance values of soils

		Sum of squares	df	Mean square	F	sig.
Soil moisture	Between groups	106229.888	1	106229.88	2.465	0.134
	Within groups	775605.997	18	43089.222		
	total	881835.885	19			
humidity	Between groups	12.168	1	12.168	2.293	0.147
	Within groups	95.524	18	5.307		
	total	107.692	19			

Table 5. Comparison of Soil Moisture of Sandy soil and Clay Soil

SOIL	Moisture
Sandy soil	83%
Clay soil	63%

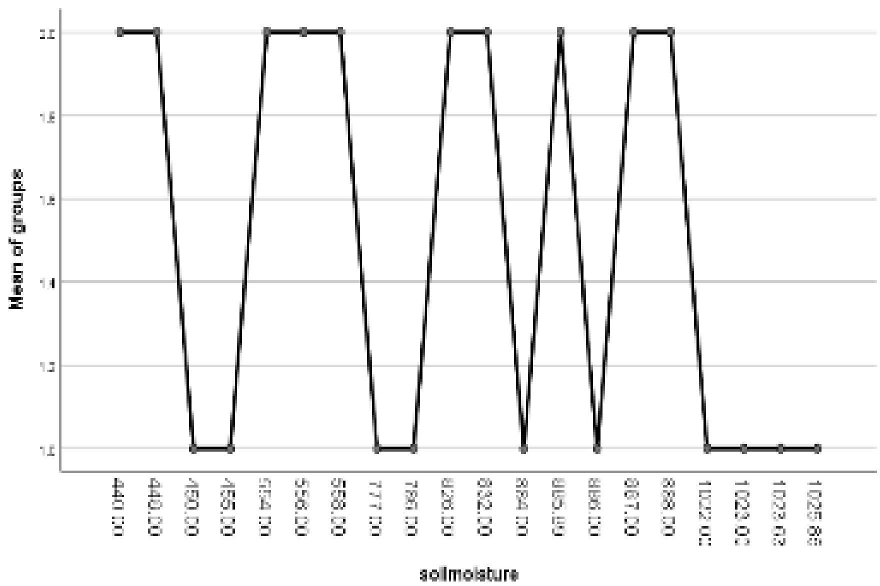

Fig. 3. The mean of the soil moisture of two groups (Sandy soil and Clay Soil)

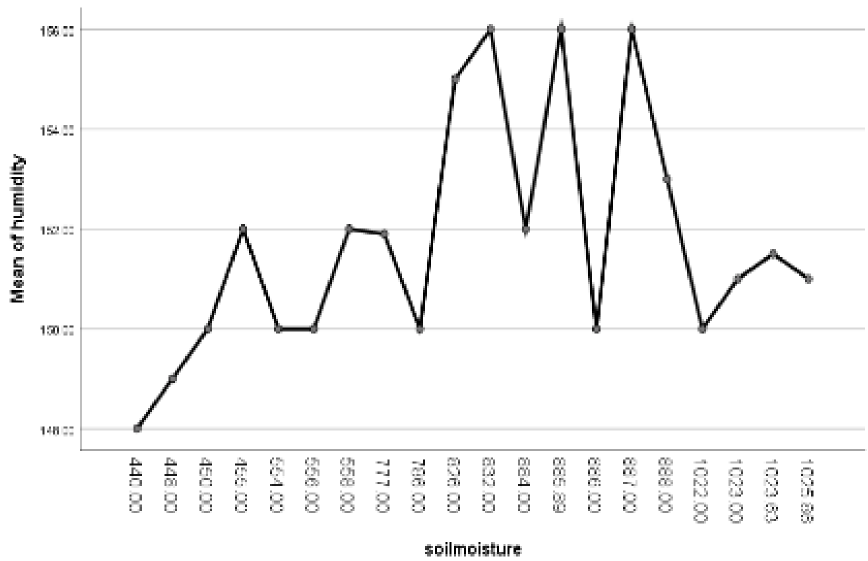

Fig. 4. The change of soil moisture content with respect to humidity

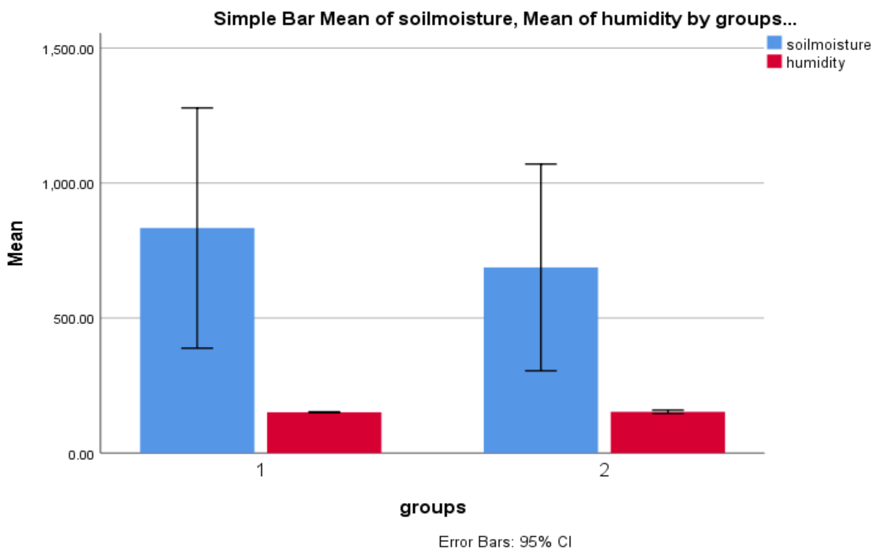

Fig. 5. Comparison of sandy and clay soils in terms of mean accuracy. The mean accuracy of clay soil is slightly better than sandy soil with an error bar of 95%. The standard deviation of clay soil is slightly better than sandy soil X-axis: sandy soil vs clay soil. Y-axis: mean of soil Moisture and humidity of soil with ± 1SD.

Discussion Framework

From the analysis done, Clay soil appears to be better than sandy soil, and issues traditional in drip irrigation are overcomed by innovative irrigation systems.

As per the outputs, clay soil can gain 63% of moisture content. Sandy soil can gain 83%of moisture. The soil moisture is low whereas water content is low soil moisture is high. When water content increases in the soil moisture content decreases and vice versa. So from the above analysis and the discussions, clay soil is 20% more efficient than the sandy soil. For the smart irrigation system, the potential co-founders are, soil moisture sensor, humidity sensor, soil that is suitable for irrigation, motor pump, measurement moisture content. Maintenance of soil moisture content in the soil can be done more efficiently by using smart irrigation systems than traditional irrigation systems. Measuring the soil moisture according to the humidity is achieved using this smart irrigation system.

Measuring the soil moisture content by monitoring the humidity level, sufficient water is provided to the soil using automated water supply. Grundl has given an overview about measuring the soil moisture according to the weather conditions. (Sparks, Grundl, and American Chemical Society. Division of Geochemistry 1998). Anand has given information about the featuring highlights of this venture incorporates keen GPS based distant controlled robots to perform assignments like weeding, showering, dampness detecting, bird and creature terrifying, keeping carefulness, and so on. Furthermore it incorporates a brilliant water system with shrewd control and keen dynamic dependence on exact continuous field information (Anand et al. 2015). Ms. Divani Specified that soil moisture varies less than 300 and greater than 300 for selected soils. Monitoring the moisture level less than 300 (Divani, Patil, and Punjabi 2016). Avoiding the traditional drip irrigation, the field is provided with automated sufficient water supply to compare the soils. Not only the wastage of water but also overflow of the water in fields can be avoided. Moisture level in soil should be maintained according to the humidity level and the temperature. (150/27degree celsius). Motor operation should be controlled according to the soil moisture of certain soil. (Sandy-83%, clay soil-63%). Comparison is done among the sandy soil and the clay soil to identify the soil which requires less water to attain its respective moisture level [sandy-83%; clay-63%]. The parameters monitored are humidity, soil moisture and operation of the motor pump.

Our institution is passionate about high quality evidence based research and has excelled in various fields ((Vijayashree Priyadharsini 2019; Ezhilarasan, Apoorva, and Ashok Vardhan 2019; Ramesh et al. 2018; Mathew et al. 2020; Sridharan et al. 2019; Pc, Marimuthu, and Devadoss 2018; Ramadurai et al. 2019). We hope this study adds to this rich legacy.

The proposed calculation utilizes sensors' information of late past and the climate gauge information for expectation of soil dampness of forthcoming days. The anticipated estimation of the dirt dampness is better as far as their precision and mistake rate. Further, the expectation approach is coordinated into an independent framework model. The framework model is practical, as it depends on the open standard advances. The auto mode makes it a brilliant framework and it very well may be additionally tweaked for application explicit situations. In future, intending to lead a water saving examination dependent on proposed calculation with various hubs alongside limiting the framework cost.

Conclusion

From the comparison done in this proposed system, Clay soil appears to be more suitable than sandy soil. Soil moisture of clay soil is 63% and soil moisture of sandy soil is 83%. As soil moisture content is inversely proportional to the water content. Here according to the comparison clay soil maintains more water content for a longer time. This proposed system intends to lead a water saving examination dependent on proposed calculation with various hubs along the limiting framework cost.

Declarations

Conflict of Interests

No conflict of interest in this manuscript.

Author Contribution

Author PJ is involved in data collection, data analysis, manuscript writing. Author PK was involved in conceptualization, guidance and critical review of manuscript.

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