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Effective Crop Selection and Conservative Irrigation Using IoT

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Abstract: ***Agriculture remains the sector which contributes the highest to India's GDP. 60-70% of Indian population depends on agriculture. Automation of farm activities can transform agricultural domain from being manual and static to intelligent and dynamic leading. New technique concerns on crop selection based on soil parameters like Humidity, Temperature, Moisturization, Light intensity and efficient automated irrigation system. Irrigation system uses mentioned parameters calculates the amount of water to be released and displays the values using an android application. New technique uses sensors which measure the exact moisture level in the soil, its humidity, temperature and Raspberry pi board as control unit. Android application helps the farmer to obtain the information anywhere, anytime, thereby reducing water wastage and perform smart farming.***

Keywords: Humidity (H), Temperature (T), Moisture (M) and Intensity of light (I) in cloud

1. Introduction

Soil sensing and crop guiding system has been used to assist in the growing of agricultural crops, maintenance of landscapes, and re-vegetation of distributed soils in dry areas and during periods of inadequate rainfall. In the crop production, irrigation helps in protecting plants against frost, suppressing weed growth in grain fields and preventing soil consolidation. Automated irrigation systems are also used for dust suppression. The old method used for irrigation was the use of watering cans, water channels that have to be opened and closed manually or backup sprinklers. In this case, a lot of water is wasted in this process. There is need for improvement on the existing or old forms of irrigation. An automated irrigation system needs to be developed to optimize water use for agriculture crops. The system also includes storing of Humidity (H), Temperature (T), Moisture (M) and Intensity of light (I) in cloud, these values can be used in the future and also to predict the behavior of the crop. Data stored in the cloud by continuous monitoring of moisture, humidity, temperature and Light intensity, these values helps to predict the suitable crops for the future years.

At the time of summer season, adequate supply water to the farm is difficult due to unavailability of water at the right time, this project estimates how much water is need for the entire crop cycle, by knowing this sufficient amount of water can be stored when water is available.

2. Literature Survey

"Drip Irrigation System using Wireless Sensor Networks" [1] by Bennis, H. Fouchal, O. Zytoune, D. Aboutajdine, The Model includes soil moisture, temperature and pressure sensors to monitor the irrigation operations. Specifically, we take into account the case where a system malfunction occurs, as when the pipes burst or the emitters block. Also, we differentiate two main traffic levels for the information is transmitted by the WSAN, and we use an adequate priority-based routing protocol to achieve high QoS performance. Simulations conducted over the NS-2 simulator show promising results in terms of delay and Packet Delivery Ratio (PDR), mainly for priority traffic.

"Automated Irrigation System Using a Wireless Sensor Network and GPRS Module" [2] by Joaquín Gutiérrez, Juan Francisco Villa-Medina, in this paper the System has a distributed wireless network of soil-moisture & temperature sensors placed in root zone of plants. Gateway unit handles sensor information, triggers actuators, and transmits data to a web application. An algorithm was developed with threshold values of sensors that was programmed into a microcontroller-based gateway to control water quantity.

"Smart Drip Irrigation System using Raspberry Pi and Arduino" [3] by Gajjala Ashok, Gogada Rajasekar. Proposes a design for home automation system using ready-to-use, cost effective and energy efficient devices including raspberry pi, Arduino microcontrollers, xbee modules and relay boards. Use of these components results in overall cost effective, scalable and robust implementation of system. The sensor data were uploaded in to cloud by raspberry pi using python programming language. Arduino microcontrollers used to transmit the sensor data to the raspberry pi using ZigBee protocol. Star ZigBee topology serves as backbone for the communication between raspberry pi and end devices. Raspberry pi acts a central coordinator and end devices act as various routers. Low-cost and energy efficient drip irrigation system serves as a proof of concept. The design can be used in big agriculture fields as well as in small gardens and water plants. The use of ultrasound sensors and solenoid valves make smart drip irrigation system.

"Smart Drip Irrigation System using Raspberry pi and Arduino" [4] by Nikhil Agrawal, Smita Singhal., This paper proposes a design for home automation system using ready-to-use, cost effective and energy efficient devices including raspberry pi, Arduino microcontrollers, xbee modules and relay boards. Use of these components results in overall cost effective, scalable and robust implementation of system. The commands from the user are processed at raspberry pi using python programming language. Arduino microcontrollers are used to receive the on/off commands from the raspberry pi using ZigBee protocol. Star ZigBee topology serves as backbone for the communication between raspberry pi and end devices. Raspberry pi acts a central coordinator and end devices act as various routers. Low-cost and energy efficient drip irrigation system serves as a proof of concept. The design can be used in big agriculture fields as well as in small gardens via just sending an email to Raspberry Pi and Arduino Based Automated Irrigation System.

3. Methods

3.1 Materials used

1) Raspberry Pi 3 with CPU RAM 1 GB, power 1.2GHz 64 - Bit quad-core ARMv8 Cortex-A53.
2) Water Pump.
3) LED
4) Moisture, Humidity, temperature and light intensity
5) Sensors compatible to Raspberry Pi 3.
6) Mobile phone.
7) Soils (Laterite, Black, Silt, Loamy and alluvial soil).

3.2 Experimental Setup

An experimental setup is developed in this study to conduct soil tests on five types of soils and data is taken with 15 min time interval.

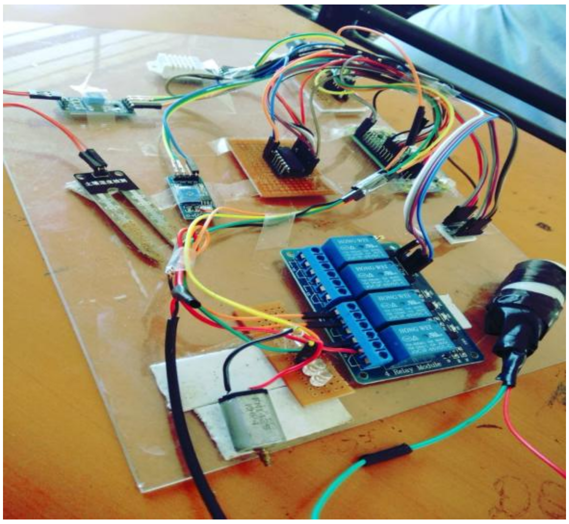

Figure 1: Experimental setup

3.3 Methodology

The efficient crop selection and automatic irrigation system was designed to continuously sense the moisture level of the soil. The system responds appropriately by watering the soil with the exact required amount of water and then shuts down the water supply when the required level of soil moisture is achieved. The moisture sensors were designed using probes made from corrosion-resistant material which can be stuck into soil sample. Voltage levels corresponding to the wet and dry states of the soil sample were computed by measuring. The resistance between the moisture detector probes and matching them to output voltages of a comparator circuit. A submersible low-noise micro water pump was developed to deliver the water to the appropriate parts of the soil.

The setup also interacts with the smart phone to continuous updating the values of humidity, temperature and moisture values to cloud storage, these values are comparing with each other and by taking a value as reference. The algorithm will generate new value, by this value user can observe the difference in the irrigation and water usage. Initially it takes the information of user like name, area of land in terms of acres and about agriculture type of soil, crop they like to grow, water source. Taking all these information it keeps tracks daily irrigation status and sends SMS or notification to user. For all these activity system requires active internet facility through mobile data or Wi-Fi.

3.3.1 Architecture

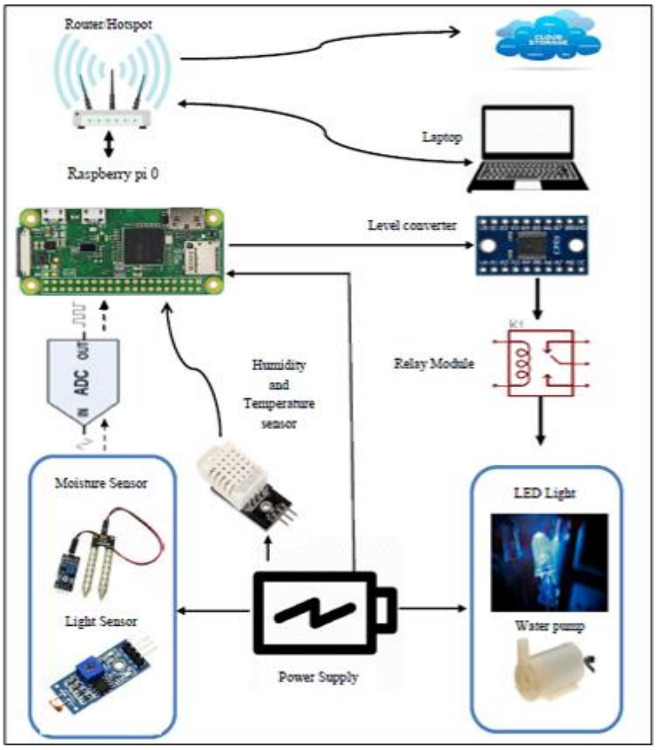

Figure 2: Architecture diagram of Effective Crop selection and Conservative Irrigation using IoT**.**

3.3.2 Modules

Three modules are used for the study of soils and selecting efficient crop for specific soil:

1) Crop guider:

Crop is monitored on the basis of humidity and temperature. Sensor provides information about moisture that indicates the sufficient amount of water is available for growth of crop. Deviation of crop cycle and type of crop is essential information for growth of crops.

2) Soil detector

Soil is the basic requirement for our project, data like moisture, soil type, provides a way to guide farmer for maintenance of their farm. Continues information about farm will send to farmers.

3) Farmer

An Android application is provided for farmers for receiving data from controllers. Farmer does not involve directly in the process of irrigation, he can observe overall system process anywhere and everywhere. While supplying water to the farm if there is insufficient amount of water in the tank, farmer can immediately refill the tank.

3.4 Implementation

Steps for Implementation

Step 1: Start and run the process by executing the backend application.
Step 2: Initialize From and to e-mail addresses.
Step 3: Check for the server if it is online go to step 4 else display error message and terminate the process.
Step 4: Initialize input and output port/pin numbers.
Step 5: If keyboard interrupt occurs go to step 14 otherwise go to step 6.
Step 6: Get the sensor values.
Step 7: If the light_sensor_value is greater than required light then turn the lights on (as of sensor value is inversely proportional to light intensity), else turn off.
Step 8: Send an e-mail and SMS to the initialized mail and phone number.
Step 9: If the temperature_sensor_value is greater than required temperature then turn on fan else turn off.
Step 10: Based on moisture_value and humidity_value create certain conditions to select crops.
Step 11: Display all the sensor values.
Step 12: Upload the data to the cloud.
Step 13: Sleep for 15 seconds and go to step 5.
Step 14: Stop.

4. Results and Discussions

4.1 Laterite soil test

Soil name: Laterite soil
Soil Quantity: 150gm
Water: 15ml
Note: Data taken with 15 min time interval.

Table 1: Experimental results of Laterite soil

S.No	Humidity	Temperature	Light	Moisture
1	64.4	29.0	173.94	173.62
2	63.2	29.1	172.01	177.81
3	62.9	29.0	169.11	181.36
4	62.9	28.89	167.19	186.19
5	62.9	28.8	167.49	189.10
6	63.8	28.9	170.72	189.16
7	64.3	28.8	170.40	191.35
8	64.1	28.8	171.69	193.61
9	64.5	28.7	170.4	194.58
10	64.3	28.8	172.97	195.87
11	64.3	28.8	167.49	198.12
12	64.1	28.7	168.43	199.58
13	64.2	28.75	171.25	200.98
14	64.3	28.8	172.24	202.14
15	64.1	28.7	170.56	204.56

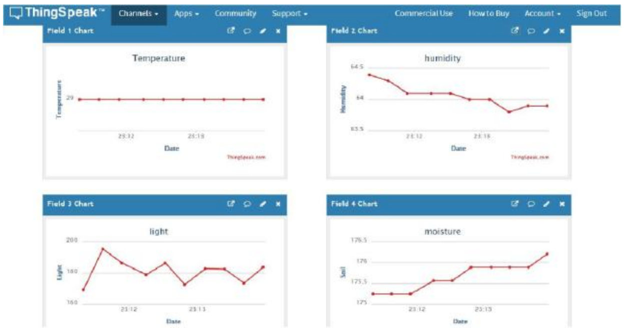

Figure 3: Snapshot showing variation of graph of sensor values of Laterite soil using ThinkSpeak application.

From the above values obtained from graph, it is clear that Temperature remains constant, Humidity decreases and Moisture increases with respect to time. Laterite soil is suitable for the cultivation of Tea, Coffee and Rubber. From the Table 1 moisture value is changing from 173.62 to 204.56 the difference is 31 hence there is increasing absorption in soil, laterite soil has good absorption property and average changes in every time interval is 2.28. For Humidity 63% and Temperature 28° C.

4.2 Black soil test

Soil name: Black soil
Soil Quantity: 150gm
Water: 15ml
Note: Data taken with 15 min time interval.

Table 2: Experimental results of Black soil

S.No	Humidity	Temperature	Light	Moisture
1	64.69	28.5	168.24	138.15
2	64.5	28.70	168.46	145.25
3	66.5	29.0	167.17	148.53
4	63.0	29.1	168.46	153.31
5	63.79	29.0	168.46	156.53
6	63.70	29.1	168.46	160.70
7	63.09	29.1	169.11	163.70
8	63.09	29.30	169.43	164.27
9	62.79	29.39	171.46	164.59
10	63.09	29.2	172.97	163.3
11	63.48	29.5	172.65	162.39
12	63.84	29.4	173.62	162.76
13	63.73	29.4	172.33	161.37
14	62.89	29.5	171.36	160.19
15	63.07	29.3	172.33	160.33

Figure 4: Snapshot showing graph of different sensor values of Black soil using ThinkSpeak application.

From the above values obtained from graph, it is clear that Temperature remains constant for certain extent and then

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decreases, Humidity constant initially and varies. Moisture remains constant initially and then decreases with respect to time. Black soil is suitable for the cultivation of Cotton, Jowar, Maize and Wheat.

From the Table 2 moisture value is changing from 138.15 to 164.59 the difference is 28 hence initially there is great increase, then decrease in absorption and average changes in every time interval is 2.28. For Humidity 63% and Temperature 28° C.

4.3 Silt soil test

Soil Quantity: 150gm
Water: 15ml
Note: Data taken with 15 min time interval.

Table 3: Experimental results of Silt soil

S.No	Humidity	Temperature	Light	Moisture
1	62.90	27	167.17	174.88
2	60.20	28.1	166.53	187.166
3	58.79	28.2	172.66	185.22
4	59.9	28.2	164.27	183.61
5	59.5	27.7	181.04	182.33
6	59.59	28.10	175.23	180.71
7	56.59	28.39	181.04	180.73
8	56.29	28.01	167.17	188.13
9	55.90	27.7	169.11	188.77
10	56.59	27.0	180.1	182.33
11	57.09	27.10	179.10	182.65
12	59.2	26.70	178.46	181.68
13	59.42	26.8	175.33	180.56
14	59.84	26.8	173.26	179.02
15	60.11	26.7	174.52	178.63

Figure 5: Snapshot showing variation of graph of sensor values of Laterite soil using ThinkSpeak application.

From the values obtained from graph, it is clear that Temperature remains constant. Humidity constant initially and varies. Humidity value increases and Moisture value increases with respect to time.

From the Table 3 moisture value is changing from 174.88 to 188.77 the difference is 13 hence initially there is increase, then decrease in absorption and average changes in every time interval is 2.5. For Humidity 63% and Temperature 28° C. Silt soil is suitable for the cultivation of Mahonia and Barley.

4.4 Loamy soil test

Soil Quantity: 150gm
Water: 15ml
Note: Data taken with 15 min time interval.

Table 4: Experimental results of Loamy soil

S.No	Humidity	Temperature	Light	Moisture
1	48.60	32	39.91	145.57
2	47.59	32	38.20	160.08
3	47.5	32	38.52	164.27
4	47.7	32	39.49	162.34
5	48.4	32	39.81	160.40
6	47.5	32	40.46	159.11
7	44.7	32	43.68	154.27
8	44.59	32	46.26	152.66
9	44.09	32	49.49	151.70
10	44.9	32	50.45	150.73
11	44.72	32	51.05	149.62
12	44.82	32	51.63	148.24
13	45.01	32	52.04	147.21
14	45.53	32	52.69	146.48
15	60.11	26.7	174.52	178.63

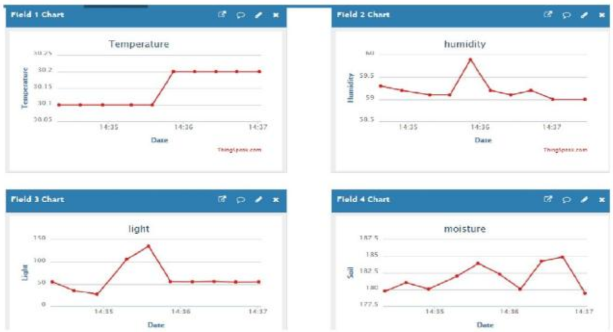


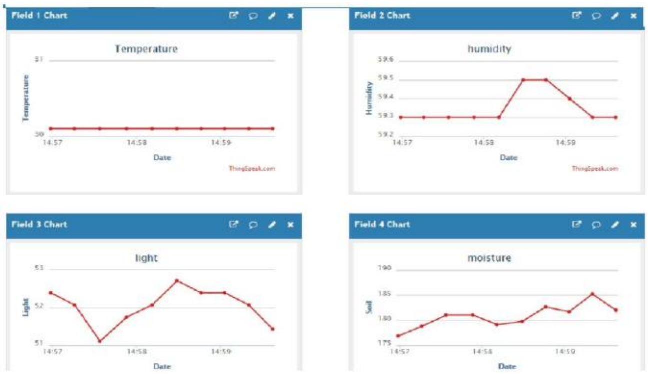
Figure 5: Snapshot showing variation of graph of sensor values of Laterite soil using ThinkSpeak application.

4.5 Alluvial soil test

Soil Quantity: 150gm
Water: 15ml
Note: Data taken with 15 min time interval.

Table 5: Experimental results of Alluvial soil

S.No	Humidity	Temperature	Light	Moisture
1	60.5	26.7	172.33	218.44
2	61.4	26.6	168.46	221.02
3	59.29	26.8	173.62	222.31
4	59.9	26.7	163.62	223.27
5	60.0	26.7	175.26	219.40
6	61.0	26.7	172.01	213.06
7	61.7	26.29	169.11	212.63
8	62.4	26.7	174.91	205.22
9	64.4	26.2	162.98	212.22
10	63.2	26.3	177.62	210.05
11	62.1	26.2	171.38	212.48
12	62.5	26.3	168.46	210.08
13	62.8	26.4	175.12	209.36
14	63.1	26.3	173.26	207.05
15	62.4	26.4	165.86	206.08



From the values obtained from graph, it is clear that Temperature remains constant. Humidity value increases and Moisture value increases with respect to time.

From the Table 5 moisture value is changing from 206.08 to 223.27 the difference is 17 hence there is gradual decrease in absorption of soil, absorption capacity is low and average changes in every time interval is 2.85. For Humidity 63% and Temperature 28° C. Alluvial soil is suitable for the cultivation of Rice, Chilies, and Groundnut.

4.1 Comparison of the experimental result values of soils

Moisture variations for Humidity 63% and Temperature 28° C						
Name	Minimum value	Maximum value	Difference (Max - Min)	Average difference between time interval	Variation from maximum to minimum	Absorption Property
Laterite	173.62	204.56	30.94	2.28	Increasing	Good
Black Soil	138.15	164.59	26.44	2.28	Increasing	Good
Silt Soil	174.88	188.77	13.89	2.5	Increases then Decreases	Average
Loamy Soil	145.57	164.27	18.7	2.64	Increases then Decreases	Average
Alluvial Soil	206.08	223.27	17.19	2.85	Decreasing	Poor

5. Conclusion

Adoption the new technique will boost the growth of agriculture in. IoT technology offers real-time monitoring and analytics for smart farming. It would help farmers in decision making and take immediate decisions for events happening. Its increased productivity, profit as well as better food production. The obtained results

- Determines the type of crop that can be grown in the field, based on the sensors values. If the temperature value is less, the fan will be turned on to cool.
- If the light intensity value is less, lights will be turned on.
- Continuously generated data stored in cloud is used for analysis.
- Wastage of water is completely avoided by automatic turning the motor on and off.
- SMS and mails are received by farmers through android mobile.

6. Future Scope

The scope for future study is by conducting the test on a various types of soil samples with different features and environmental conditions, lot of data will be available and which can be stored on cloud and mined for prediction and forecasting nature of soil on different environmental conditions over a period of time Implementation ML will make rapid changes in the field of Agriculture that monitor by itself for the greater supply of plant needs for health and efficient yield.

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