Irrigation System for Greenland using Soil Moisture Sensor

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Abstract-*The paper presents the use of correct soil moisture sensors which helps to ease out the pain to monitor and keep records about the changes in soil moisture starting form cultivation to harvesting period of crops. Using the Arduino-Uno microcontroller with hygrometer moisture sensor and temperature sensor, humidity and temperature are measured and analysed. The hygrometer is sensor which, when placed in a soil for a certain duration, provides information related to the moisture status of the soil. The Arduino-Uno will collect and process the data received from the hygrometer. When a threshold moisture level of the soil is reached, the water will supplied accordingly. This is essential because water must be provided to the plant at a particular time for a good yield. Timestamps and humidity levels will be recorded in a CSV (Comma Separated Values) file throughout the process using raspberry pi. Raspberry pi will then store this CSV file over the internet. User can access this file from any remote location to keep a track of his crops or plants. This system efficiently manages both, water and energy, as well as ensures the healthy growth of the plant without the presence of the user.*

Keywords-**Arduino-Uno; Hygrometer, Soil Moisture; Raspberry Pi; CSV file; Data Logging**

1. INTRODUCTION

Agriculture has been a major primary occupation in many countries since centuries. Despite there is a need for lot of development in this sector. The yield mostly depends on the amount of rainfall and its percolation. But, less rainfall has been a cause of concern for many farmers. Considering this issue, irrigation systems were introduced to manage the water efficiently. On today's date, modern drip irrigation system is the most efficient system to make sure that the water is reached at the root of the plant. Now the question arises

'When to water the plant?'. We must ensure that water is efficiently used by the plant as well. To decide if water is required by the plant at a certain point of time humidity of the soil is to be checked.

1.1 Hygrometer

Different types of sensors can be used for the measurement of soil humidity. In this system, hygrometer [1] is used as the soil moisture sensor. The hygrometer has both digital and analog outputs. Output from the sensor is given as input to Arduino Uno.

Fig. 1: Soil Humidity Sensor Hygrometer

1.2 Arduino Uno

The Arduino Uno is a microcontroller used to control the water supply according to the readings of the hygrometer. Arduino Uno acts as central controller. Arduino handles most of the on/off commands as received from raspberry pi. Arduino collects both analog data from sensors and using inbuilt ADC (Analog-to-Digital Converter), value is retrieved and stored in the variables. [4]

Fig. 2: Arduino Uno- Microcontroller

1.3 The Raspberry Pi

The Raspberry Pi is a cheap, rectangular, small sized computer that plugged onto a display, and uses standard input devices like keyboard and mouse. It is a little device but powerful enough that enables people of all age groups to explore computing, and to learn how to program in different languages like Scratch and Python. It is capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-

definition video, to making spreadsheets, word-processing, and playing games. [2]

Fig. 3: The Raspberry Pi

1.4 Data Logging

This complete process is tracked by keeping a record in a CSV file consisting of timestamp and humidity. For this purpose a python script known as grabserial is used. This CSV file is uploaded to cloud over the internet 'chrontab'. The user can access this file from any remote location and keep a track of his plant. In Raspberry Pi, python and php based server named 'Apache server' get this data file and show its data directly on webpage hosted by its localhost server. This CSV file can also uploaded to cloud over the internet ' chrontab' which is third party API based cloud storage and data analysis system which generates graphical diagrams and graphs according to CSV file uploaded by Raspberry Pi server. The user can access this file from any remote location and keep a track of his plant. Access to data in the cloud is secured and the information is shared only to the user. In case of any malfunction such as water is extinguished from the source and any circuitry issues, the user will be notified through an electronic mail.

2. CURRENT STATE OF PROBLEM

The on-farm irrigation practice prevailing in the country results in wastage leading to low irrigation efficiency. Most farmers still irrigate the way their forefathers did thousands of years ago flooding or channelling water through parallel furrows. The current gravity system, typically least expensive to install, fails to distribute water evenly. Farmers are forced to apply an excessive amount of water to ensure that enough water reaches the plants situated on higher ground or on the far side of a field. The adoption of field-to-field irrigation adds to the problem, as does poorly conceived irrigation scheduling. Controlling or monitoring humidity is of paramount importance in many domestic applications. Usually most farmers water their plants right after sunrise and before sunset. This cuts down evaporation rates but is not substantial as humidity of soil, air temperature, and plant growth rate factors are different during different times of the year. Due to this, plants do not get adequate amount of water at the proper time or get excess of it which gives an unhealthy plant and ultimately leads to lesser yield.

This problem can be solved if it can be known when to water and how much to water constantly for the better production of plants. Also, the user has to be unnecessarily present at the site for watering the plant. Considering recent global climate change and population growth, there is need for efficient management and utilization of water resource.

3. PROPOSED SOLUTION

Considering the current scenario and the need for automation, introduction of a computer controlled microcontroller system is inevitable. The proposed system uses a microcontroller Arduino Uno along with compact sized computer, Raspberry Pi. Hygrometer is used to sense moisture level of soil, and a temperature sensor is used to sense intensity of light, are attached to Arduino Uno.

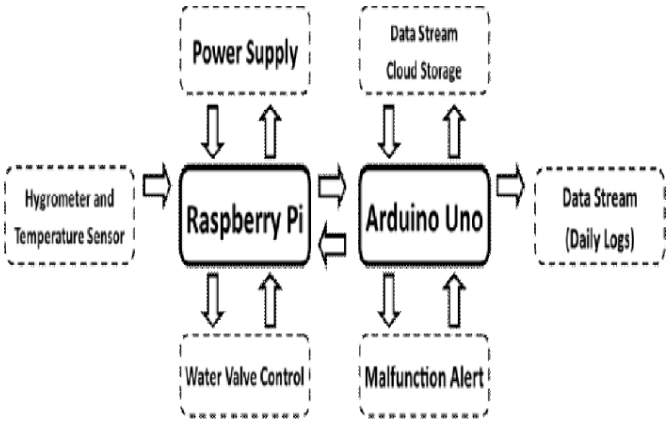

Fig. 4: Block Diagram

When moisture level of soil goes below particular value and temperature remains at low value, Arduino triggers water supply to the soil. These particular values (threshold values) are set after experimentation on different plants in different types of soil under varying temperature conditions. Raspberry Pi monitors the working of this system and keeps log of the moisture levels of the soil. Raspberry pi, when connected to the internet, uploads the log file to a server and hence, can be viewed from any remote location by the user.

Combination of automation of watering and keeping its tracks within one single system is more convenient financially than using separate systems for each task which tends to increase its cost and complexity. Using this system one can regulate the water supply according to needs of the plant depending on the type of plant and the type of soil. If we automate this process of watering and

irrigation, much of the water can be efficiently utilized and observation data can be very useful for future planning on plantation of new breeds or keep using traditional breeds of plants or crops.

4. IMPLEMENTATION

4.1 Hardware and Software Implementation

Data logging and remote accessing requires Raspberry pi. Raspberry pi is configured using commands in terminal when raspberry pi display is available through HDMI or Remote Desktop connection. To run and use Arduino Uno, Arduino IDE is installed on the raspberry pi. A program on Arduino IDE known as sketch is used to read i/p and prints required outputs. This program (sketch) has different variables to store the received input values.

Hygrometer senses moisture level of soil and maps output in 10 bits of data. Hygrometer is connected to the analog pin of Arduino Uno. Temperature sensor senses intensity level of light and maps output to another analog pin on Arduino Uno. Calibrations can be made after trialand-error attempts. A threshold value of moisture is set (different for different types of plants) for allowing the flow of water according to the reading of the hygrometer. If input reading is less than threshold value then water will be supplied whereas the supply will be cut when reading goes above threshold value. Since these values are numerical, program is written such that when desired inputs are received and suitable digital pins are used to give outputs. Output from the sensor is also printed over serial port to Raspberry Pi.

A motor pump or solenoid valve is connected to one of the digital pins using a relay circuit. The pump or valve is triggered according to our calibrated values. When the values sensed from sensors are different than desired values, digital output pins are made HIGH to start water supply. Again when suitable moisture values are reached, the digital output pins are made LOW to stop water supply. [12]

The received inputs from sensors are recorded from the serial port on Raspberry Pi using a python script known as ' grabserial' and this data is stored in CSV file. This file is used to keep a record of the logs and is used to know humidity and temp. Inputs at any given time. This CSV file can also uploaded to cloud over the internet by third party API based cloud storage and data analysis system which generates graphical diagrams and graphs according to CSV file uploaded by Raspberry Pi server.

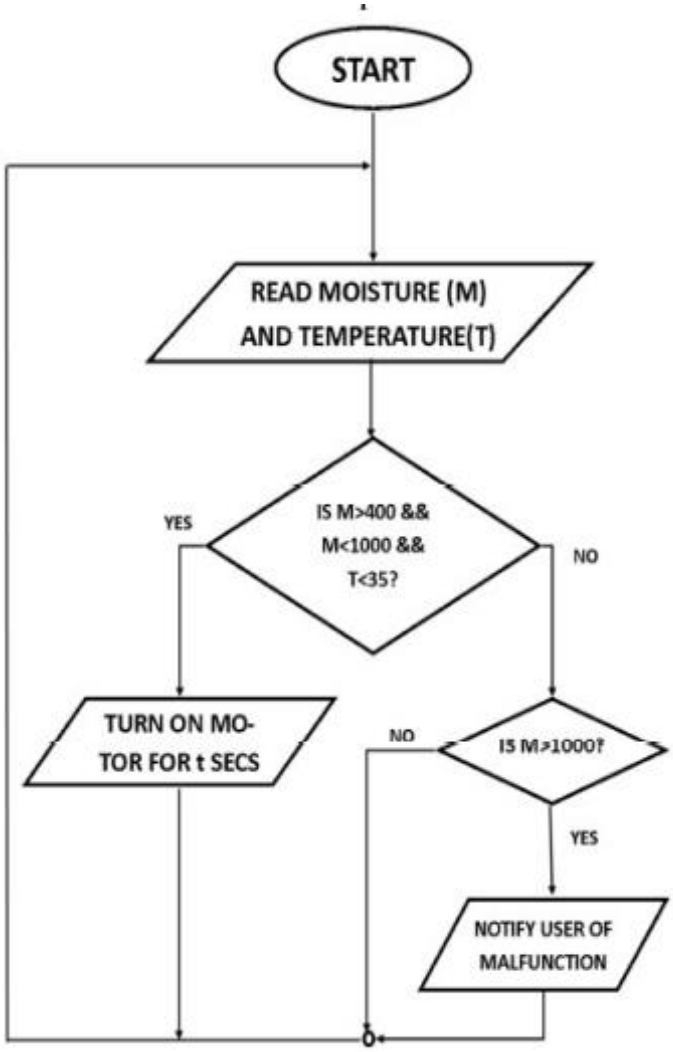

Fig. 5: Code Flowchart

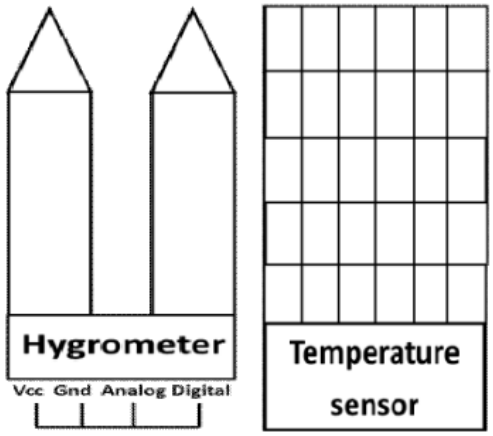

Fig. 6: Layout of Hygrometer and Temperature Sensor

The whole readings from process of temp .sensing, moisture sensing and regulation of running system is kept by a CSV file consisting of times tamp of process, temperature level , moisture level and water supply duration. This data file can be uploaded to webserver and

can be viewed or accessed from any place and from any device. User is also notified in case of any malfunction over the internet.

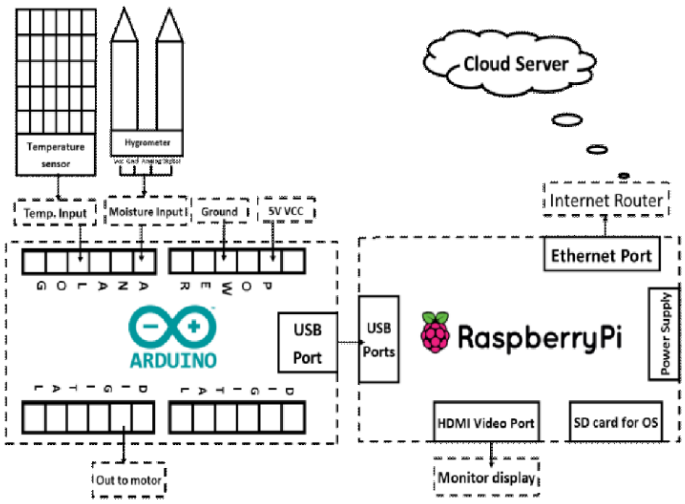

Fig. 7: Implemented Circuit

4.2 Data Logging

Arduino is programmed in such a way that it reads inputs from analog pins and also reads inputs from digital pins as well as print outputs from digital pins. Using the program, a simple sketch, input values are recorded then processed and according to the input values, output is given.

GrabSerial is an open-sourced python program. [6]

This program grabs the input from serial port (USB port), and logs it into a CSV file. In this file, timestamp is also included by using the ' ts' utility in the raspberry pi. The CSV (Comma Separated Values) file is preferred because it is easy to print output in proper format. Also file format is helpful in creating excel sheets as well as it is also supported by many websites, which can be used to convert received data into graphs. This data, when uploaded on the internet, can be accessed anytime from any place. Real time plot graphing can also be done. The data file can be transferred to any PC using win SCP or simply copy the file on USB drive.

TABLE 1: SENSOR READINGS OUTPUT

Time (in Hours)	Hygrometer Readings	Time (in Hours)	Hygrometer Readings
1	956	23	378
2	954	26	363
3	956	30	384
4	958	33	358
6	930	36	438
8	850	40	512
10	750	43	593
13	600	48	762
16	450	52	893
20	370	55	986

5. CONCLUSION

The need for automation and remote accessibility significantly increases the importance of this system in the field of research and greenhouse monitoring. This system requires only one time implementation per plantation. Also, user need not report at the site frequently for watering the plant. In case of any malfunction such as water in the reservoir is depleted and any fault in the circuitry, the user will be notified by an electronic mail.

Until then, it is ensured that the plant is supplied with adequate amount of water.

Thus, this system ensures the following:

- Efficient management of water
- Healthy growth of plant
- Very less frequency of human effort.
- Remote access and monitoring

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