A Study on Smart Irrigation System using IoT & Machine Learning

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Abstract - Irrigation intakes 70% of the world's fresh water supply and often due to errors in various management systems or carelessness, this investment gets wasted. With freshwater becoming scarce, proper planning must be done at the earliest for water management. Our proposed methodology for Smart Irrigation System solves this purpose to a much impact-able extent. The solar-powered system extensively uses the Internet of Things (IoT) as a medium to automate the procedure. From collecting data from the sensors that can be used in irrigation, it provides an end-to-end user interface. We are implementing Machine Learning algorithms to analyse the collected data on a real-time scenario and predict future tendencies accordingly. Augmented Reality can also be further used to show the analysed report for better user experience. This whole proposal is going to be a milestone controlling the whole process of irrigation thus minimizing human error, unwanted spills, damage charges and a lot of other harmful factors for the land thus increasing the overall revenue of the user. Smart Irrigation system targets boosting the industry of irrigation and cultivation with the use of modern developing technology on a grass root level of society.

Key Words*: IoT; Machine Learning; Irrigation; Feature Extraction; Sensors;*

1. INTRODUCTION

Irrigation and agriculture provide 80% of the food supplement to the world population. It is a vast ground level industry that needs more focus and attention than it is currently receiving. With an increased amount of water scarcity in the world, it is time that we plan for a regularized water intake of water in irrigation which currently uses 70% of the world's freshwater quantity. The proposed system provides a fully automated platform for irrigation that would make water proportions exact by elimination of human and machinery error. The main features that the model facilitates are i.) It provides an automated system as well as a manual backup, ii.) Levels all the specifications according to the needs of the land, iii.) Conserves energy, water as well as manpower.

The system uses several sensors extracting values of water levels, chemical levels, temperature, and several other features which in turn controls the water supply as per need. Techniques in Machine Learning algorithms helped to process predictions for water levels and several other notations. The system is not only functioning, but can be used by the farmers through their smartphones. The connection range in between their phones and the system is wide. All the sensors in the model are extremely cheap, thus making the whole idea economically-stable. High range sensors are specifically not used due to the presence of radiations which might harm the crops as bio-hazard cannot be compromised with the staple food industry.

This paper proposes several new features that were not considered previously. The classifications, predictions, and processing makes the whole proposal handy and cheap, thus making the system more viable for the agriculture industry.

2. LITERATURE SURVEY

Smart Irrigation System using IoT for surveillance of crop-field.[1]

A paper on this topic was published around September 2018. It widely covered many aspects. It used several sensors and even an android application to control the system. It proposed several future scopes that were brought to reality. The system did not have any beneficiary activity other than the inspection which we overcame and added several new features to it.

Smart Irrigation System: A Water Management Procedure.[2]

The paper published on January 8, 2019, discussed managing water consumption. It did have usage of a high range of sensors but it did not have a proper description of functioning. Moreover, the only point of connection of the user with the system was through an LCD display. Modification according to the need of the user was not possible. We have not only developed on that but with the help of Machine Learning, we have even brought the scope of prediction under focus as well.

A Smart Irrigation System using IoT.[3]

The latest study was published on April 16, 2019, this paper discussed sensing the conditions of the field but still was restricted with various limitations. The system used a very limited amount of sensors, thus inspecting the ground partially. Moreover, it interacted with the user through Bluetooth connectivity which has a very limited range of connections. Our modified system for irrigation has overcome most of the liabilities and can be used on a commercial level as well.

Through a detailed study of these papers and rigorous surveys, we have brought up this project considering minute pieces of information based on ground reality. With our system in hand, irrigation would get a factor of revolution and up-gradation as a whole.

3. COMPONENTS

Several small components have been used in the system to get the desired results. The real time application of all these components is vast to be discussed simultaneously. Thus, in the following section we focus only on the roles played by these components in our Smart Irrigation System.

Solar Panel

The component for main power supply is Solar panel. This transmits the solar energy into electrical energy for the system. With the help of this renewable source of energy, we have not only eliminated the factor of constant electrical power supply, but have also helped in lowering the economical effect of the system. The power is formed and stored in a cell attached to the system and then is used according to the need of the other components.

Fig 1. Solar Panel[4]

Arduino UNO Microcontroller

The whole system requires to be functional under one single controlling unit. Arduino UNO does the job in this case. The microcontroller takes the input of the sensors and gives output to the water motor when to start or not according to it. It also further sends the report of the sensors to the users via the LoRa module and further accepts order from the user according to it.

Fig 2. Arduino UNO Microcontroller[5]

LoRa

The name is the simple abbreviation of Long Range. Manufactured by Semtech, this medium of connection is far advanced than Bluetooth module or Node MCU. With higher range of connection, this device transmits signal as far as 50 km. It would enhance the point of contact of the microcontroller with the user far and wide.

Fig 3. LoRa Module[6]

Sensors

The main integral components for the system can be considered to be the sensors. They are the only medium through which live data gets transmitted from the field for further processing. Thus, the following sensors are being used for the required data.

1) Soil Moisture Sensor

The sensor is implanted in the soil with its two nodes acting as conductors inside the soil. Current is passed through these two heads and the resistance caused in between conduction due to presence of moisture helps in estimating the moisture level of the soil. Moisture level and resistance value is directly proportional in nature.

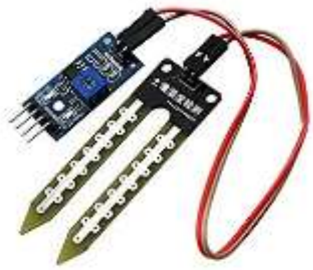

Fig 4. Soil Moisture Sensor[7]

2) Raindrop Sensor

This sensor will be used to detect occurrence of rainfall. Set-up in an uplifted place, to avoid any intervention from any other water sprinkles, this sensor gives the detailed report of when and how much is rain occurring. Like all other sensors, this too gives its input to the Arduino microcontroller which then further gives its further instructions as per required.

Fig 5. Raindrop Sensor[8]

3) Temperature and Humidity Sensor

This module is used to detect temperature and humidity simultaneously. This sensor, also known by its serial name, DHT11 is being used to receive better level of datasets for the user. All these reports from the sensor can be used by the user to tally and get a better perspective of his land

Fig 6. Temperature and Humidity Sensor[9]

4) pH Sensor

This module is being used to review the acidity level of the soil. It simply gets connected with the microcontroller and gives the pH level. The acidity level would be followed by the user to track down how much amount of fertilizers or any other chemicals is preferable for usage to the land. This dataset would also help in the machine learning algorithm as well.

Fig 7. pH Sensor[10]

5) LDR Sensor

The LDR Sensor would be used to detect light intensity present around the area. The sensor uses the principle of photo-conductivity and measures the intensity. The amount of light exposure is also a notable factor to be considered in irrigation and thus this sensor too has its own important role to play.

Fig 8. LDR Sensor[11]

Relay Module

This is considered to be a simple switching device that controls the flow of instruction or rather electrical charge from one component to another. In this case, the relay module restricts the water pump motor as when to start or when to stop according to the instruction given by the Arduino. Based on the principle of electromagnetic attraction, this device works as an automated switch in between the pump motor and the microcontroller.

Fig 9. Relay Module[12]

4. PROCEDURAL ALGORITHM

The whole system functions on two levels. Firstly, the components as explained is the IoT part of the system, that uses sensors and microcontroller to survey the ground on a real time basis. The data received from there is then transmitted to two different sections, the user and the second part of the system, i.e. the Machine Learning part. Initially, we discuss the part comprising of the IoT and have allotted a separate section for the Machine Learning Algorithm.

1) The system starts initially by obtaining power from the solar cell. The solar panel receives the solar energy which is then further used in the system. The solar energy is converted into electrical energy and stored in a voltage unit as well which helps the system in functioning at the time of sunlight deficiency as well.

2) After receiving power, the first action is performed by sensors as it senses the different factors from the land and reports it to the microcontroller. The electrical energy powers on all the sensors that are placed in the field for readings. These sensors sends their own sets of data which are received by the Arduino UNO microcontroller.

3) Arduino then functions according to its program. For example, if it is programmed to release water after the decrease of soil moisture to a certain level, it will do so. It would dictate the motor to start or stop according to the moisture content increasing or decreasing than the optimal level. The Arduino and the motor is linked with the relay module that acts as a switch between two of these components.

4) Arduino then also further sends these data via the LoRa module to the user as well. LoRa as discussed earlier has ahuge range and thus does not face any problem in connecting with the network of the user, thus sending the required data.

Fig 10. Screen display of the web server currently showing rainfall level and moisture content of the soil.

(i) In frame the soil moisture to be seen absent as the sensor is not in use.

Fig 10.(ii) In frame the soil moisture to be seen 46.24% as the sensor is in use.

5) User can get these live reports about his land from far away if his device stays connected with the LoRa Module in a web server named Adafruit[13] that displays these values. On simple modifications made in this server, one can connect the Google assistance of the smartphone with the system as well. Making the system to be manually function-able via commands given through Google Assistance.

Fig 11. A fully functioning prototype of the system made to check the viability and feasibility of the model. In frame we have the rainfall sensor and Soil moisture Sensor connected with the microcontroller and functioning according to the given commands.

Further functioning of the system is controlled by the Machine Learning Algorithms as it receives the dataset to analyse and predict further results accordingly.

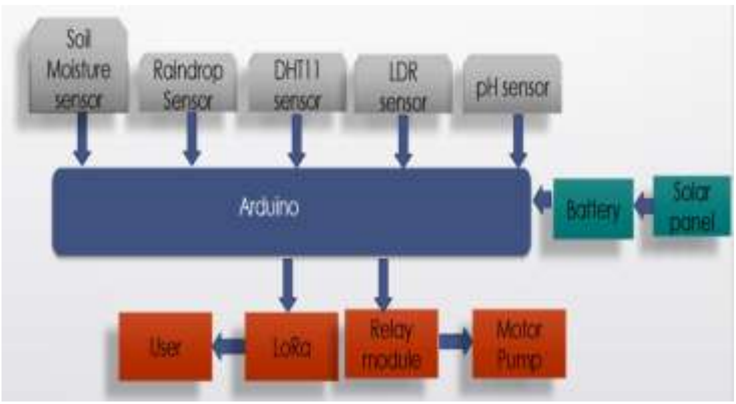

Fig 12. System Architecture for the IoT part.

5. MACHINE LEARNING ALGORITHM

The columns were extracted with respect to the sensors. They include: Moisture Level, Rainfall, Temperature record, Humidity, pH level and Light Intensity.

All of them are calculated from the hardware implementation. All these parameters contribute to finding out the exact level of water to be delivered, thus optimizing water resources.

We can use techniques like Multiple Linear Regression. This process will involve:

1.) Gathering the data from the sensors (columns) as mentioned above and scaling/normalizing them.

2.) Making the model which will have the previous training data to make the predictions.

3.) Predicting amount of water to be supplied, based on present column values and thus saving extra water from getting wasted.

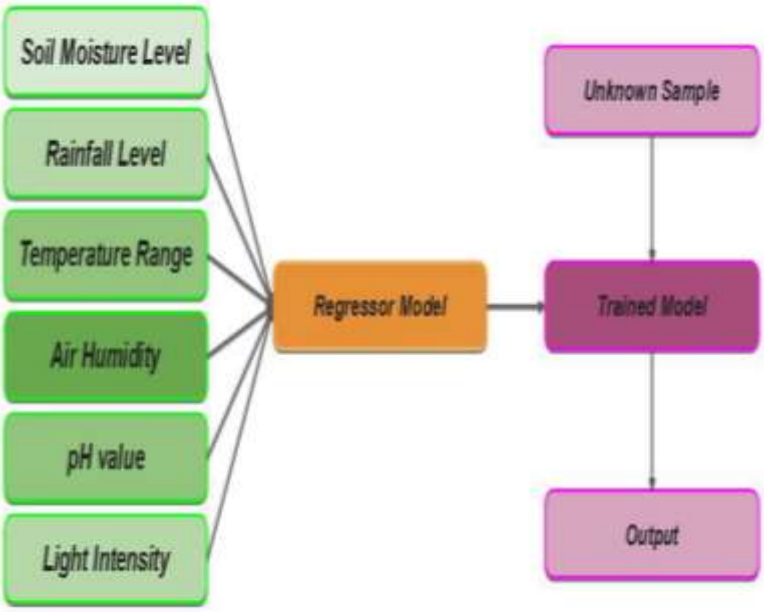

Fig 13. Flowchart for Multiple Linear Regression for Smart Irrigation proposed system.

6. CONCLUSIONS

The system was tested to be applicable on both economic and functioning levels. The water consumption was controlled to a great extent and real time updates about the ground is provided to the user. The Machine Learning algorithm helps in receiving all the data from the user and predicting the future tendency of the field accordingly.

Further works are planned on this system that can be persuaded via the section of Augmented Reality. The prediction as per given by the Machine Learning can be displayed on a smartphone on an interactive basis by the features of Augmented Reality. We are positive in making a breakthrough in this extension of the system as well making it all the more easy and handy in the respect of interaction with user.

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