A Smart Irrigation System to Automate Irrigation Process Using IOT and Artificial Neural Network

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Abstract—**In the today's world we are growing towards the automation of day to day daily life task in which we are focused on creation of smart cities, smart home etc. which includes a lot of work which deals with automation of task using Artificial Intelligence, Internet of Things and machine Learning. These technologies are widely used to creates a system for automation of different tasks. In this technology driven society there is a need of creation of a system to automate the process of irrigation of crops to help farmers. The currently used system includes a lot of human efforts, money and time which will not be required after the development of an automated irrigation system. In this there is a need of creating a system which can collect data then analyze that date and generate results in real time. also, the overall cost should be low enough so that a farmer can afford it. In this paper we are focusing on creating a low-cost smart device which can be used to collect the data of moisture in soil at different places, pH and temperature of soil. We focus of creating a device with Arduino along with some sensors and modules to collect these data at different places in farm. After collecting this data this device will send this data to server with the help of a Wi-Fi module attached to the device. At the same time, we are using an Artificial Neural Network model for the analysis of this data for generating high accuracy results. Finally based on the results the device triggers a valve to automatically start and stop the flow of water in the farm.**

Keywords-Internet of things, Artificial Neural Network, Sensors, WEB App, Android App, Machine Learning.

I. INTRODUCTION

In most of the countries the major problem in irrigation of crop is that it requires a lot of human efforts to irrigate a farm also, it the major problem is that if one portion of farm need water then the farmer irrigates the whole farm whether its required or not. The main problem here is that farmers are not able to track which particular portion of farm is actually needs to be irrigated. Globally, the 70% of fresh water is used for agriculture which needs to reduce by avoiding unnecessary irrigation of farm which also help farmers to avoid problems related to over irrigation and less irrigation of crop. The traditional approach to solve this problem includes a lot of human efforts and use of costly sensors which are unaffordable for the farmers.

The solution of such problem is that to create a low-cost automated irrigation system which can track and automatically irrigate the correct portion of the farm. Installation of a device which includes geo-tagged sensors so that it can keep track of moisture content in soil at various critical control points in the farm with continuous streaming of data and analysis which can help in monitoring as well as controlling the irrigation process more efficiently. Currently there are lot of techniques which are used to perform this task and but the problem in those technique is that it doesn't includes any real-time collection of data and it's analysis which again comes to the same problem and that's why these approaches are not efficient enough for scheduling of irrigation process also it doesn't include any automated technique to irrigate the farm.

In this paper we have focused on creation of a system which will not only help the farmers, but it will also help in the collection of data related to a crop like humidity, soil moisture level, temperature and pH value of soil which will help in many ways for better growth of crop. In this we are creating a device made with Arduino and sensors to collect this data and it will be sent to the server for its analysis and after that it will be analyzed with the help of an Artificial neural Network model so that the model will be able to generate results with a very high accuracy. Once these results are generated it will be used by the device to trigger a valve which will start or stop the flow of water in the required section of the farm. Finally, the collected data will be available to be checked by a user with the of Web app and an Android app so that anyone can use it for some research purpose.

This paper is divided in 5 sections which are organized in the following sections. In the 2nd section we have described previous work analysis, in section 3 we have presented the models proposed by us while in the section 4 we have presented the dependencies of our proposed model, in section and in last section we have presented the conclusion and future direction of this area.

II. RELATED WORK

In [1] the author has proposed to develop a model in which they create an embedded system for a system which includes

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an off-grid irrigation system will automatically irrigate the farm when the farmer sends a SMS to the device which will be received by it with the help of a GSM shield attached to the device. This will automate the process but for a limited extend as it will always need a farmer to guide the whole system also this paper is more focused on saving of energy in irrigation system.

In [2] this the main focus of author is on the creation of a model in which fuzzy logic will be used to take decision for performing different task to irrigate the farm. The author proposed to manage a control on irrigation which will be decided by the fuzzy logic model. This model was very useful in saving crops from over raining, but this model was not efficient in automating the whole process of irrigation.

In [3][4][5] this the author presented a model to use a wireless sensor network for the automated irrigation of farm and for the automation of tasks in agriculture sector. The main problem with these models was it doesn't use any model which can perform the whole task in real-time with the use of any forecasting model.

There was another method which includes the use of a webpage which was made to deliver all the information to the farmers where a person has to manually access to the internet so that they can check the data which is available on that webpage [6]. These kinds of a systems will need a separate web server which will be continuously required so that it can be used to keep an eye on the data which is being received on the server [7]. Based on the different data received and its interpretation, the motor used for irrigation is automatically turned 'ON' or 'OFF' [8]. Furthermore, there are separate systems that make use of sensors to detect fires in the field and notify the farmer about the same. A continuous monitoring by the farmer is required in all the previously proposed systems. Moreover, these systems are not able to judge the weather conditions in time and vary the irrigation scheme accordingly.

In this the main problem which was identified in the above discussed model was that it doesn't include a safety system. There is no system or mechanism which can be used to notify farmer (user) when the device fails to do any task. The second main problem with these systems is that they include some human effort in some or the other way. Third problem was that none of these models includes a real-time result generation which is very important for all these kinds of models but none of these models is based on real-time collection of data and analysis. In our proposed solution So, there is always a need for a system which is efficient enough to collectively utilize all the benefits related to an existing system and it should eliminate all the drawbacks of that system, either by employing a forecast model or a Hargreaves equation as supplements. In order to achieve this we have focused to solve all these problems by using different techniques for example we have used an alarm system to notify a farmer for any problem in the device.

III. PROPOSED MODEL

This purposed model is a system which is divided into three sections. In which the first section will be dealing with the creation of an IOT based device which will be used to collect all the data at different locations in the farm. In the second section we are using an Artificial Neural Network model which can be used to analyze the collected data in previous section, and it will be used to generating results and based on these result the device automatically decide and irrigate the correct section of the farm. Finally, in the last section this system includes a Web App and an Android App which will be acting as a frontend for those who wants to check the data collected by the device and it will help them for a better usability. This system is also very helpful in the collection of data related to different crops which will help researchers to develop models for creating more efficient ways to grow a specific crop with high productivity. The Figure 1. shows the overall task and process which will occur in this proposed model. This section of this paper is divided in three part in which the details of each model is explained further, with all the process and benefits related to each section in proposed system.

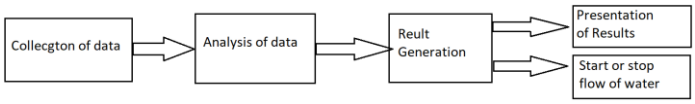

Figure 1. This figure shows the 4-step process which will occur in the proposed model for the monitoring of water quality

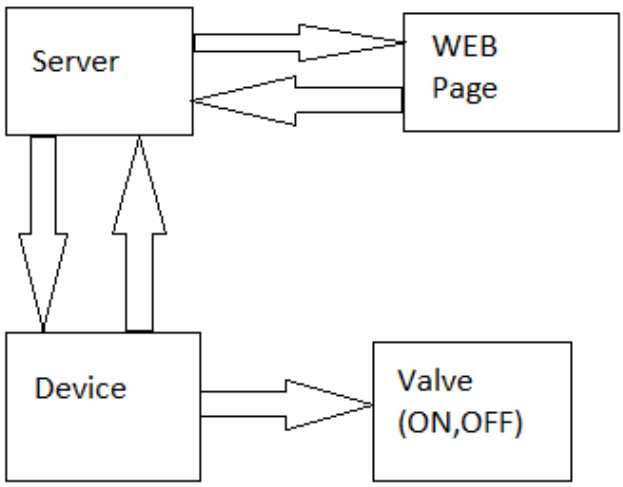

Figure 2. This figure shows the tha how the different sections will communicate with each other to carryout the whole task.

A. IOT decice to collect data and irrigate farm

This section of this paper is focused on creation of an IOT based device which is low in cost and it can be used for multiple purpose. Once, this device is installed then it will be used for continuously sending data to the server so that a real-time data can be used for the analysis in the next section. This such type of device can be made with the help of different micro controllers but in this paper, we are focused on using Arduino Mega which can be used to control a lot of sensors at the same time. This microcontroller is three times cheaper than the other microcontroller like Raspberry pie so, the Arduino M Mega is affordable for common farmers and t is also available in various models. This helps to make a device which can use different sensors so that it will allow the device to collect data

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of multiple parameters to grow crop of high productivity. The next main issue in such type of device is of power supply and for the solution of this problem we have proposed to use a solar panel with a battery to power this device so that it could work independently. In this we are using sensors like soil moisture prob, pH sensor prob, humidity sensor, Temperature (DS18B20), light intensity sensor, Real Time Clock (DS3231), WI-FI module(ESP8266) etc. These are some of the sensors which can be used to monitor some of the most important parameters for a crop. This device will also be used in the second section where it will be used for to switch on or switch off a valve based on the results generated by the analysis so that it can start or stop the flow of water in a section of farm. This process as very useful as it will be very use full for the automation of whole irrigation process. This type of device has wide application and it can be used for the collection of data related to a specific crop. In the Figure 3. we have demonstrated the design of the model discussed above which shows an overall layout of the device.

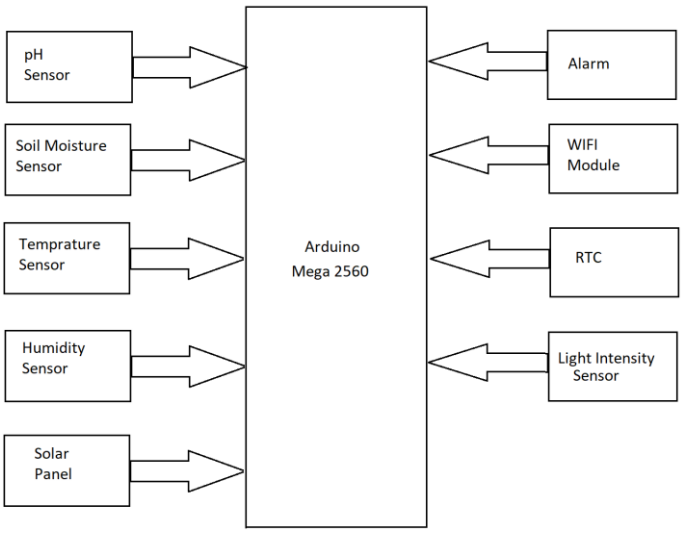

Figure 3. This figure shows the overall model of device which will be used for the collection of data

B. Artificial Neural Network model to analyze data

This section of this proposed model is focused on creation of a Machine Learning model which is made with the concept of Artificial Neural Network which will be used for the analysis and generation of results based on the data collected by the device in the last section. This model includes Artificial Neural Network because it can generate results very accurate and it can analyze and process a large amount of data very fast which is very important for all such kind of systems to generate instantaneous results. This model will be used to find out all the patterns after which a particular section of farm will needs to irrigate with a correct amount of water, and it will be able to detect such situation in advance which will be very beneficial. This model made in such a way that it will identify such patterns and it will use it to guide the hardware device irrigate the correct portion of farm with a correct amount of water without the use of any human effort. The use of Artificial Neural Network model offers a wide advantage. The major advantage of this model is accuracy and this Artificial Neural Network model works with a very high accuracy. The Table 1 shows a sample of the collected dataset which will be analyzed with the help of this Artificial Neural Network model.

TABLE I. SAMPLE DATASET USED BY THE IN THE ANALYSIS TASK

id	*pH*	*Temperature*	*Day*	*Year*	*Month*	*Soil Moisture*
1	7	26	12	2018	10	10
2	7.1	26	12	2018	10	20
3	7.31	25	12	2018	10	15
4	7.21	26	12	2018	10	18
5	7.11	27	12	2018	10	10
6	7.21	27	12	2018	10	19
7	7.31	26	12	2018	10	17
8	7.21	25	12	2018	10	13
9	7.3	26	12	2018	10	14
10	7.21	27	12	2018	10	19
11	7.31	26	12	2018	10	17
12	7.21	25	12	2018	10	13
13	7.3	26	12	2018	10	14
14	7.11	26	12	2018	10	11
15	7.11	26	12	2018	10	11
16	7.21	26	12	2018	10	18
17	7.11	27	12	2018	10	10
18	7.21	27	12	2018	10	19
19	7.31	26	12	2018	10	17
20	7.21	25	12	2018	10	13
21	7.3	26	12	2018	10	14
22	7.21	27	12	2018	10	19
23	7.31	26	12	2018	10	17
24	7.21	25	12	2018	10	13
25	7.3	26	12	2018	10	14
26	7.11	26	12	2018	10	11
27	7.3	26	12	2018	10	14

C. Web App and Android App for better usability

In this section we have discussed the frontend of the all work which was done in the previous sections. In this we have proposed to make something which will be easy to use, and it must be easily available to everyone. In order to achieve this, we have proposed to create a Web App and an Android App which will are available to almost everyone. It is easy to create a very user-friendly user interface in this technology and it can be easily access anywhere at any time. The tasks which will be performed in this section includes proper authentication of a person with the help of a mobile OTP system so that only authorized person will be able to access this data which will provide security to the whole system. In the next part the user will be able to view all previous and currently collected data by the device which will help to analyze it easily and based on this

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a farmer can take corresponding action to grow a crop with high productivity. In the Figure 4. we have shown a sample of the data collected by the devise which will be stored on ThingSpeak server and shown in the form of graphs.

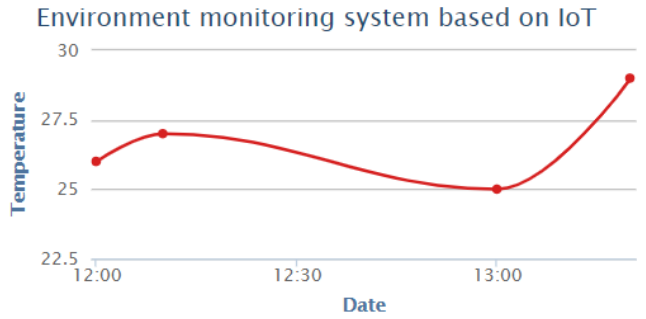

Figure 4(a). This image shows the data collected of temperature on the form of graphs on ThingSpeak Server.

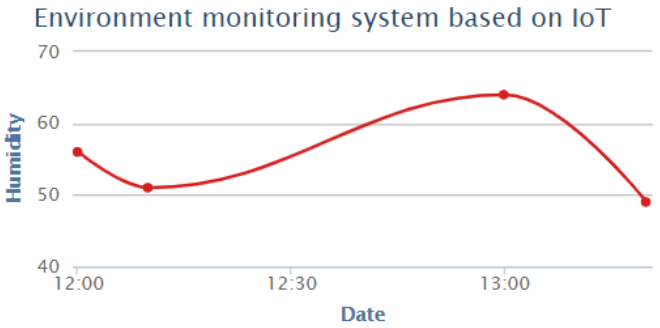

Figure 4(b). This image shows the data collected of humidity on the form of graphs on ThingSpeak Server.

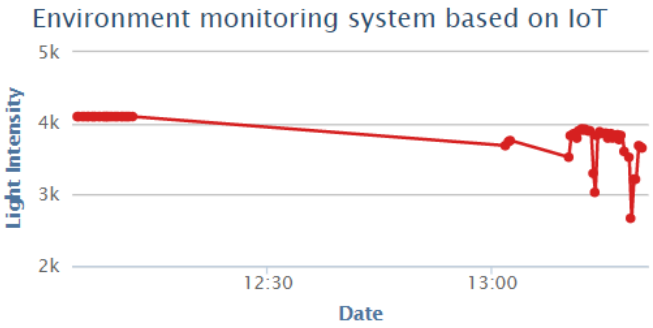

Figure 4(c). This image shows the data collected light intensity on the form of graphs on ThingSpeak Server.

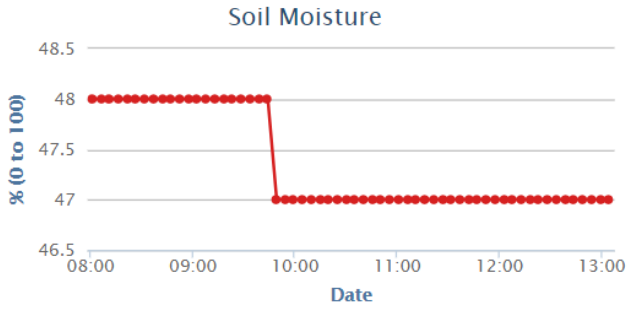

Figure 4(d). This image shows the data collected of soil moisture on the form of graphs on ThingSpeak Server.

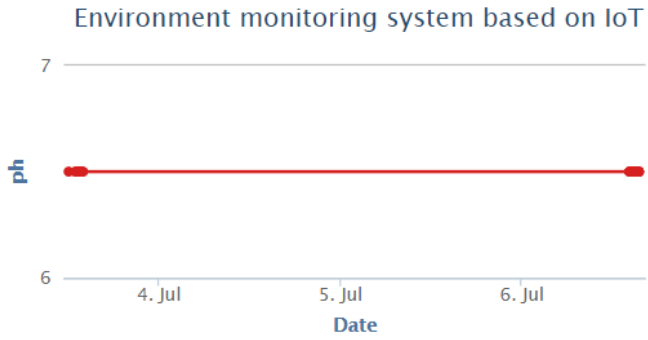

Figure 4(e). This image shows the data collected of pH on the form of graphs on ThingSpeak Server.

IV. DEEPENDICIES

The quality of water is determined by continuously taking the values recorded by the device to get real-time analysis of this data. In this whole proposed system this task of collection of data and analysis is very important which must be performed perfectly as it can affect the whole process in very negative manner if this task is not done properly. So, the use of Artificial Neural Network modal will solve the problem analyzing the data but, the other problem of collection of data is even more complicated as this whole model is depending on this task and it includes many cases where the whole device fails due to any issue or even a sensor may stop working properly. To handle such situation, we propose to use an alarm system in this whole model which will monitor the working the main model and if any problem occurs it will close the primary device so that it will not perform wrong action along with this it will trigger a small alarm which will notify the person nearby it and corresponding actions will be taken. The device will use an RTC to store date and time so that the person who is checking the data on server will be able to know when and where that value is taken by the device. Finally, the device will be able to analyze the data from different portions of farm in a best and most convenient way.

V. CONCLUSION AND FUTURE DIRECTION

The automation of irrigation process with the help of IOT and Artificial Neural Network always offers a lot of advantages. It can be used to monitor the data related to a farm (soil moisture, humidity level temperature etc.) which can be used for better productivity so that it can be used to increase profit. This type of system can be used to automatically irrigate the whole farm without the need of any human efforts also the cost of this device is very low as it is made of low-cost open source hardware technology. This type of system can perform all task in real-time so that it can provide best results for the whole irrigation process. These types of system have good flexibility and it can be used for different tasks with where similar functionality is required.

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This device and this overall system can be used in many places only by replacing some corresponding sensors for that purpose and with a minor change in the relevant software programs, this system can be used to monitor the water quality parameters for the use of good quality water for the irrigation of farm. The operation of this device will be very simple to implement and extend. For the implement of such systems we just need to deploy this type of devices in the environment which will collecting the data and analysis. By installing this type of devices in the environment, we can bring the environment into real life which means it will be able to interact with other objects through the network and it will finally help in the automation of various systems.

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