Rain Water Harvesting and Smart farming using IoT

Rahul H K(1), Rakesh M(2), Manjula R B(3), Rakesh C G(4) Rahul R(5)

School of Electronics and Communication Engineering
REVA University, Bangalore, Karnataka, India

Abstract—Scarcity of water has become a predominant problem all over the world. Water plays an important role in agriculture. With majority of the Indian population dependent on farming for their daily needs, it's important to find a solution for scarcity of water. This paper mainly focuses on rain water harvesting. The secondary objective of this paper is to provide farmers with an option of automating the irrigation process by equipping him with a smart IoT network which notifies him about the status of his crop and it also regulates the supply of water to the crops with the help of the pre-feed information about the crops to the processor. Sometimes when there is a thunder storm the farmer will have to come out in the storm to stop excess rain water. We intend to solve this problem using a convertible roof which is controlled by a processor. This will prevent excess rain water from damaging the crops and it will also protect the crops from hailstorms. During these situations the status quo of the crops is sent to the farmer through the internet.

Keywords—Rain water harvesting, convertible roof, Automated irrigation, smart farming, Internet of Things, Agriculture.

1. INTRODUCTION

Although the major factors that inflict extensive damage to crops have been insects, pests and flooding of rivers, the effect of weather on crop damage has been underestimated and widely ignored by the global community.

Agfax an American agricultural news website reported that they find weather to cause the lion's share of crop loss in every year and every region in the United States .It has been observed that 85% of the overall crop loss was caused due to extreme weathers. Other factors include economic factors (10% of crop loss), natural disasters (2%) and other cause less than 1%.

At this point of time, people in India might consider the losses in agriculture caused due to excessive rainfall to be insignificant, but with increase in global warming and increase in acid rain, this problem has the potential to evolve into a crisis. In order to prevent such a devastating effect on crops we have put forward the use of convertible roof in this paper.

21st century has seen massive improvements in the field of IoT and automation across varied domains including defence and medicine, but agricultural domain is lacking modern infrastructure and it still depends on conventional means for harvest gains. This is one of the major reasons which impedes the economic development of a farmer. Therefore there is a need for IoT infrastructure to be deployed so that farmers can communicate and get to know about the condition of their crop by just scrolling through their phone rather than stepping out and walking long distances to their farm to monitor the crops.

In this paper we are using a soil moisture sensor to detect the amount of moisture that is present in the soil. This soil moisture sensor is an analog sensor which contains a pre-defined value with which it compares the soil moisture and sends the report back to the processor. The value used to compare depends on the each model of the sensor. The output of sensor is thus used by the processor to control the working the servo motors which in turn controls the convertible roof. This convertible roof performs the functions shielding the crops from extreme weathers. It also performs the functions of rain water harvesting. The convertible roof is placed at a 30 degree inclined angle with one end of the roof used to collect the water. This water can further be redirected to a man-made or a natural reservoir and the harvested water can be used as a source of water supply during droughts.

During thunderstorms there will be an increase in the water current that flows from the convertible roof to the reservoir. This current can be increased using pipes with gradually decreasing diameters. This increased current can be tapped in with the use of a turbine. By making the water current flow through the turbine electricity can be generated which in turn can be used to run the processor. In case there is excess production of electricity the farmer can share with a grid network from which he will be economically benefitted. This provides a sustainable environment for crop growth. In order to establish a communication line between the system and the user, we use an ESP8266 processor which establishes a connection with mobile phone of the user which is interfaced using the inbuilt Wi-Fi module that is present in the ESP8266 processor.

In conclusion we want to equip the farmer with a technology which he can use, to know the condition of his crop without physically monitoring it. This technology will also help us to achieve the goal of sustainable and efficient method, to protect the crop from the ill effects of global warming such as excessive rain, acid rain, hailstorms and extreme temperatures. This project can also be used in barren lands where rainfall is not of much use. Thus we can conserve water from such places and transport the water to fertile lands where it can be used for various purposes.

In this paper we discuss literature survey in section II, Proposed work in Section III, present the results in section IV and conclusion in section V.

2. RELATED WORK

Precision irrigation is crucial in decreasing water demands of irrigated agriculture, which account for the largest source of water withdrawal in most regions. One necessity of precision irrigation is the knowledge of soil moisture content in the root zone of irrigated crops. Dielectric soil moisture sensors can provide this information at a relatively low cost compared with other techniques [1].

Dielectric sensors have been widely used for non-destructive determination of volumetric soil water content. Since the output of such sensors is influenced by soil temperature, the calibration for the dependence is indispensable for accurate determination [2].

An increasing number of electromagnetic sensors are deployed to measure volumetric soil water content for agricultural, ecological, and geotechnical applications .In general, lower frequency sensors are less expensive but more sensitive to confounding effects of salinity, temperature, and soil textural variations. To simplify sensor application, factory-supplied calibrations are often provided for different porous media types such as mineral, organic, and saline soils, or soilless-substrates [3].

Water level controllers switch the motor on whenever the water level drops below a certain level and shuts the motor off when the water rises well above a fixed level. The motor will also switch off when the sump water is exhausted before it fills the over-head tank, or if the pump is running dry as well as maintains voltage fluctuations [4].

In the present backdrop of agriculture scenario the fruits of farming are not being enjoyed by the producer due to various obstacles that come up in the process. Hence in order to get rid of these obstacles and to see that farming becomes smart and friendly, by using the technology advancements, the present work proposed has been prepared [5].

Automated systems have less manual operations, so that the flexibility, reliabilities are high and accurate. Hence every field prefers automated control systems. For utilization of appliances, the new concept has been thought to manage them remotely by using GSM, which enables the user to control switching ON/OFF of agricultural equipment's remotely [6].

Efficient water management is a major concern in many cropping systems. Distributed in field sensor based irrigation systems offer a potential solution to support site-specific irrigation management that allows producers to maximize their productivity while saving water. This paper describes details of the design and instrumentation of variable rate irrigation, a wireless sensor network, and software for real-time in-field sensing and control of a site-specific precision linear-move irrigation system [7].

Analysis conducted showed that metal roof with a 0.95 run-off coefficient grossed the highest water and energy savings as well as carbon dioxide reduction when paired with a 30m 3 tank in all three commercial buildings. Gravel in contrast yielded the least amount of water savings resulting in a low amount of energy savings and carbon dioxide reduction due to a small run-off coefficient of 0.25. The metal roof portrayed significant difference at an average of 11.6 percent rise in water savings as the tank size is increased, whereas gravel could barely show noticeable difference[8]

Now days, water expenditure in households has increased due to the improper use of water in various activities such as: gardening, car washing or household cleaning. This causes water scarcity and an increase in household economic expenditure. In order to deal with this problem, a mathematical model was established, in which the amount of water collected during the year is calculated in order to carry out all the aforementioned activities, in which variables such as catchment area, Rainfall, expenditure on a house-room and the size of the tank. [9]

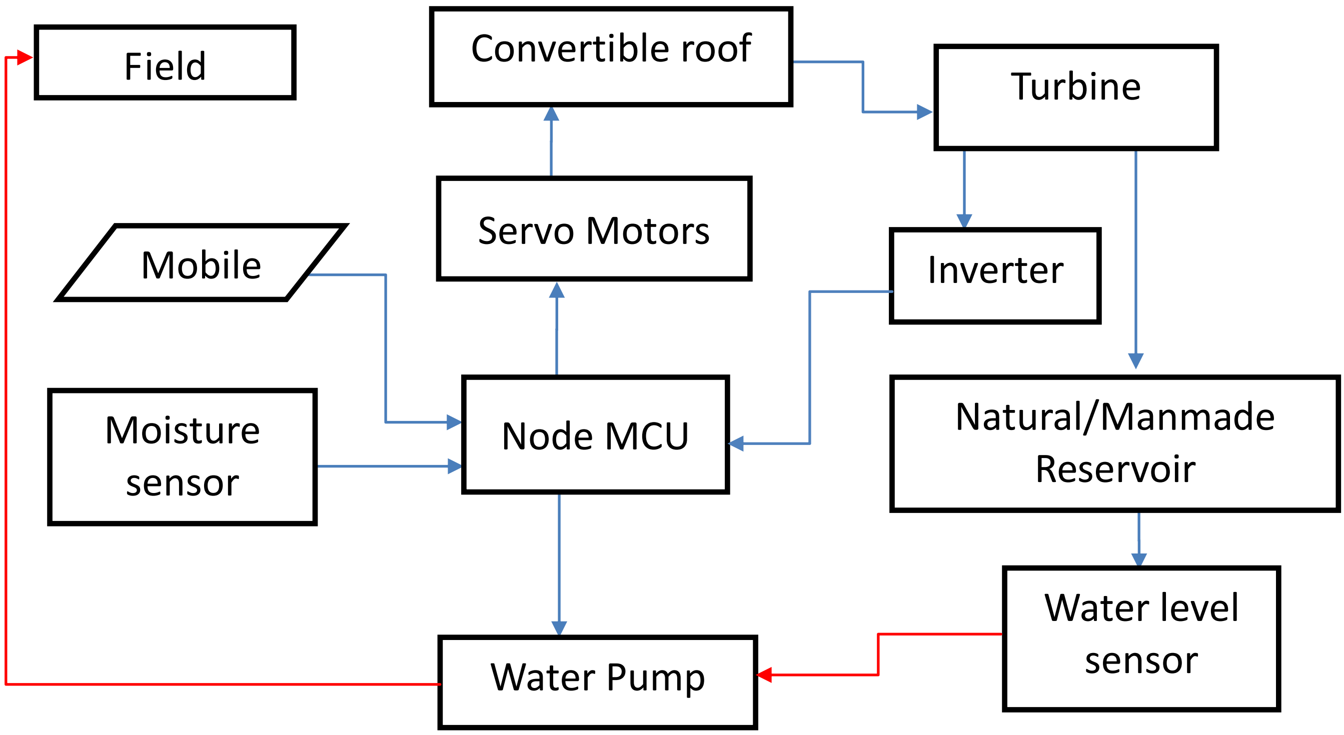


Fig .1 Block diagram conceptualizing the working

3. PROPOSED WORK

In this section we will discuss the proposed block diagram for achieving our objective. The proposed block diagram shown in Fig.1 corresponds to the complete overview of building the project. The nodal point or the heart of the project is depicted with the help of a block diagram referring to the Node MCU.

The project starts from the moisture sensor block and ends with the mobile block. The mobile block indicates the phone of the user over which he receives the information from the processor. The project can be divided into mainly three parts.

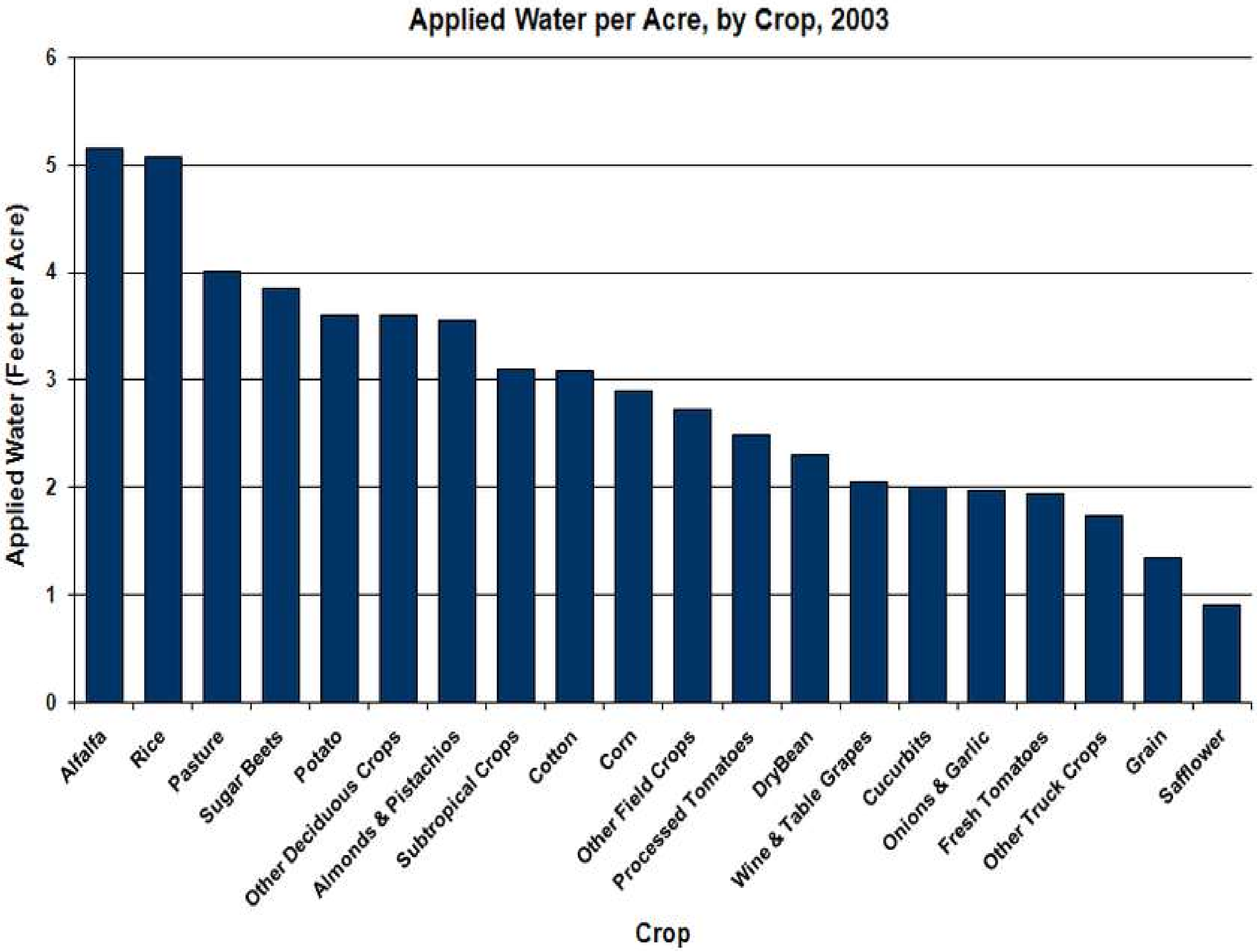


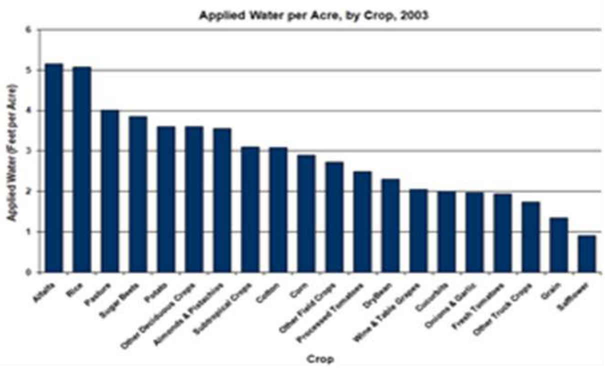
Fig. 2 Moisture requirements of various crops

A. Moisture Sensing

The moisture sensors are spread over the field in accordance with area of the field. These moisture sensors are pre-programmed in order to meet the moisture requirements of a particular field.

In the case of tomato crops, the moisture content required by the crop for healthy growth is just 1inch of water above the soil level which is substantially low. In case of crash crops like alfalfa and rice, require a lot more water. The total water requirements of rice ranges from 1000mm - 1600mm depending on the region of growth and climate of the area. Therefore we are required to program each moisture sensor of separate fields in a unique manner. Fig. 2 shows us the water requirements of various crops that are sown across the state of California.

Moisture sensors operate and produce the output in terms of binary bits. The resolution of various moisture sensors varies with application. The moisture sensor used in this experiment will be able to produce the output in terms of 1024 binary bits, because the resolution of the moisture sensor is 2^10 bits.



The moisture sensors present in the field record the moisture level, the output in terms of binary data is sent to the processor, the processor processes the data in such a way that it converts the binary data into percentage the formula used for converting the binary data into percentage is given by:

moisture_percentage=(100.00 (analog Read (sensor_pi n)/1023.00) * 100.00));

After converting the value into percentage, the processor compares the value with a pre-set moisture percentage set for the crop.

- If the moisture level is optimal no action is taken.
- If the moisture level is above pre-set, the convertible roof is opened
- If the moisture level is below pre-set water pump is turned on.

Convertible roof and IoT using NodeMCU

On receiving the appropriate signal from the moisture sensor the convertible roof is opened up.

The convertible roof consists of

- Four pillared support structure
- Water-proof biodegradable flex material

The roof is opened in such a way that it forms a 3 degree angle; this angle causes the rain water to flow through roof into a pipe which is placed at the end of the slope. This pipe collects all the water and allows it to fall from a particular height. This causes the potential energy possessed by the water as a virtue of its position to be converted into kinetic energy. We can tap in on this energy and use it for various purposes.

By placing a turbine in the path of the flow of water current, we can convert this kinetic energy into electric energy

This electric energy can further be used to charge an Inverter. This saved energy is used to sustain the energy requirements of the NodeMCU processor. If there is an increase in the flow of water current, then it can be shared to the grid or can be used for household appliances.

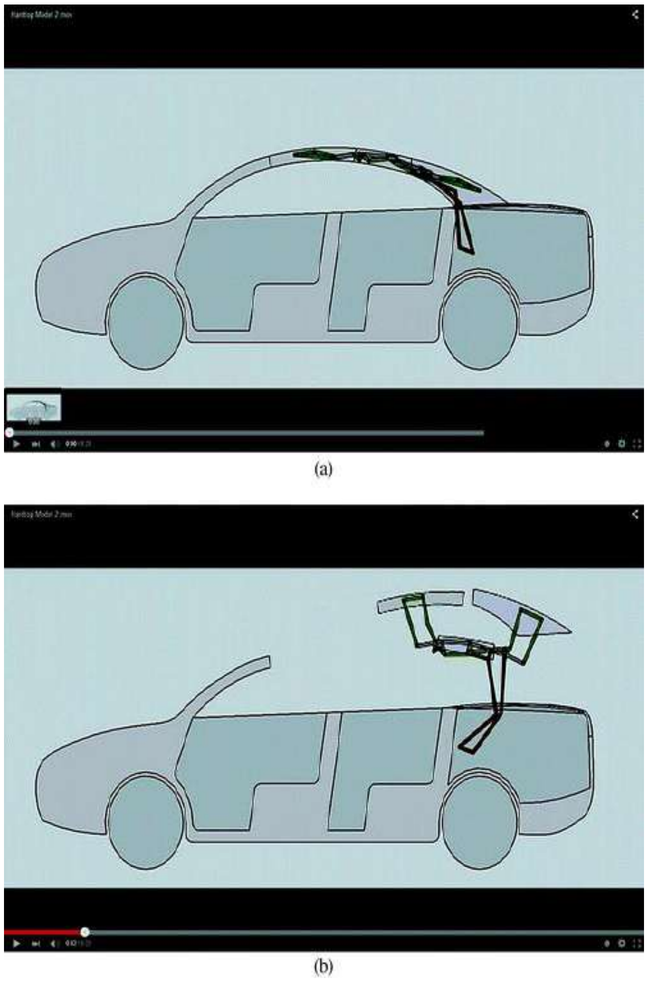


Fig.3 Convertible roof mechanism of a car

Since the inception of Convertible roofs, it has always been implemented in automobiles, but we feel a lot more can be done with it.

Fig.3 depicts the working mechanism of a convertible roof in a car. We plan of using a similar technology in terrace farming and traditional farming. The only difference in the working would be, in cars the roof moves linearly where as in our application it would be rolled.

Since, the material that we are using is flexible and biodegradable. It can be rolled up. The opening and closing mechanism can be controlled with help of servo motors.

While the roof is open it will act as a barrier for both hail storms and heavy rainfall. It will also shield the crops from excess heat and reduce the damage on the crops which in turn will affect the harvest in a positive way.

This application of convertible roof can be implemented

- By dividing the area to be covered into small units, where each unit will be covered by a single four pillared convertible roof.

In this way we can integrate a large number of four pillared convertible roof and make it act as a single unit. This would enable maximum efficiency in crop protection and water conservations.

In a similar way we can arrange large units of such four pillared convertible roofs over a barren land. When there is monsoon in this region the water would be wasted. By installing these units we can conserve the water by either storing it a man-made reservoir or by guiding it to a man-made reservoir

While we use the same technology in small lanes which are present in the city. The convertible roof will open up during extensive rain. Under this situation, the roof would open up after the processor senses that the water level in the lane has crossed the pre-set limit stored in the processor. The excess rain water can be stored and used the benefit of the community.

Reverting back to the agricultural application, the water from the roof is sent to the man-made reservoir, in order to prevent the overflow of this reservoir a water level sensor is placed in it. The water level analyser alerts the processor to open the valve of the reservoir when the water level crosses the limit. The water from the valve us then guided to a natural reservoir.

Fig.4 shows the working of a water turbine. When the shaft rotates there is relative motion between stator and rotor. This change in magnetic flux produces electric current. If the current produced is of a smaller magnitude then it can be stored in a small rechargeable Li-ion battery. If large magnitude of current is produced an inverter is used. If surplus amount of electricity is produced it can be shared with the grid.

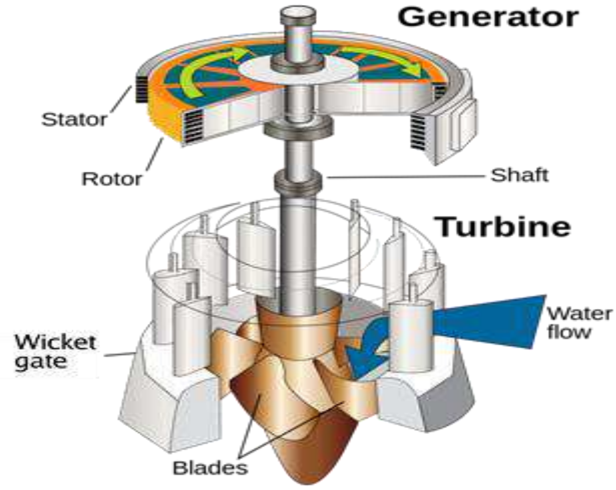


Fig.4 Schematic of a turbine

C. WIRELESS COMMUNICATION

In all the above sections the working of the project on the field was seen. This section will deal with the process of sending the information regarding the process on field to the user.

Considering the current scenario, a farmer has to go and monitor his field manually irrespective of the weather condition, but this might not be necessary with the help of NodeMCU.

NodeMCU has an inbuilt Wi-Fi module the farmer's phone can be connected to the module by turning on his hotspot .We can establish this connection with the help of an mobile application called blynk.

Blynk is an application which is extensively used for implementations of IoT experiments. When the projected is composed in the blynk app and is interfaced with NodeMCU, a communication channel is established within the two. Two parameters are set on the blynk app with the help of Arduino IDE. Thus there is notification widget enabled. This widget notifies the farmer about the

Water pump, when the moisture content is below threshold it notifies that the moisture content is low and water pump is turned on else it notifies that the water pump is turned off. The second widget is a meter that shows the moisture content of the soil. This will help the farmer to monitor the moisture content of the crop continuously without moving from his home.

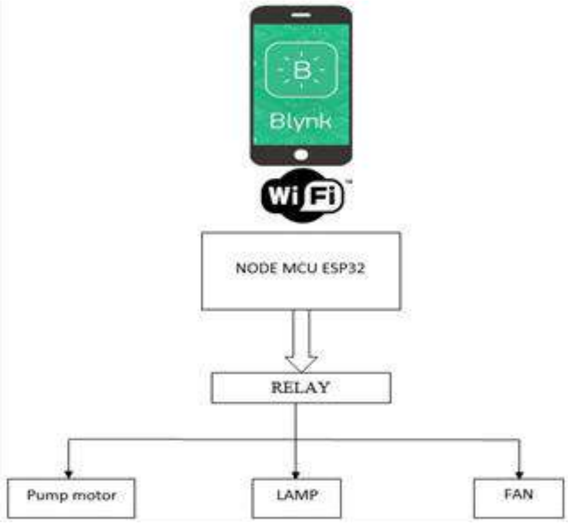


Fig.5. Blynk Interfacing

NodeMCU provides access point to all the stations, enabling the creation of IoT environment. Blynk provides reliable and efficient communication between user and the server. It is cross platform messaging solution where a user can get the regular update on his crop condition.

The Hardware requirements and software requirements are discussed below

Hardware Requirements

The various hardware requirements are:

(1) NODE-MCU:

NODE-MCU is an open source firmware Kit, which incorporates a Wi-Fi-module, it is a programmable, interactive and smart module used to set-up IOT, we can connect to the Wi-Fi by few line of code, it is basically used to provide access to the internet which create IOT environment. Since it is compatible with C and C++ language it provides multiple coding options to the programmer. The only disadvantage with the NodeMCU ESP8266 is that it provides the user with a single analog pin. This limits the use of multiple analog sensors. However this problem can be overcome by using a multiplexer circuit to the analog input. [28]

(2) Moisture sensor:

Soil moisture sensors measure the volumetric water content in soil. Since the direct gravimetric measurement of free soil moisture requires removing, drying, and weighing of a sample, soil moisture sensors measure the volumetric water content indirectly by using some other property of the soil, such as electrical resistance, dielectric constant, or interaction with neutrons, as a proxy for the moisture content. [29][30].

(3) Turbine:

A turbine is a device that harnesses the kinetic energy of some fluid - such as water, steam, air, or combustion gases - and turns this into the rotational motion of the device itself. These devices are generally used in electrical generation, engines, and propulsion systems and are classified as a type of engine. We are using a turbine to generate hydroelectricity from the water current. [31]

Software Requirements

The various software requirements for arriving at the objective are:

1. Arduino IDE:

The Arduino is an integrated development environment [32]. We have implemented Arduino sketch to establish configuration for NodeMCU, which is used to setup the loop between the user and technical person to achieve IOT environment. It is also used for designing the widgets in the Blynk app. The conversion of binary data to percentage is also achieved by using Arduino IDE.

2. Blynk

Blynk is a platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins on and off or display data from sensors.[33]

4. RESULTS

In this section we will discuss the results obtained stepwise starting from acquiring on-field data

To transmitting it to the end user.

Fig. 9 represents the simulation of the working of the automated irrigation system on the Arduino IDE. The output represents the soil content present in terms of moisture percentage and holds a notification for the farmer.

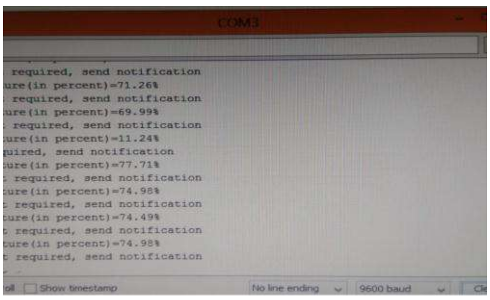


Fig.6. Data Set

This notification will help the farmer to understand and analyse the condition of his crops.

This will also help him monitor the working of the system by checking if the motor is switched on or off by the processor at the right time.

Fig.7. Moisture above pre-set

Fig. 7 represents the moisture content when the soil moisture is above the prescribed level, under this condition the soil moisture sensor informs the processor to switch the water pump off and to close the convertible roof for the protection of the crops.

Primarily the status of the water pump is notified to the farmer.

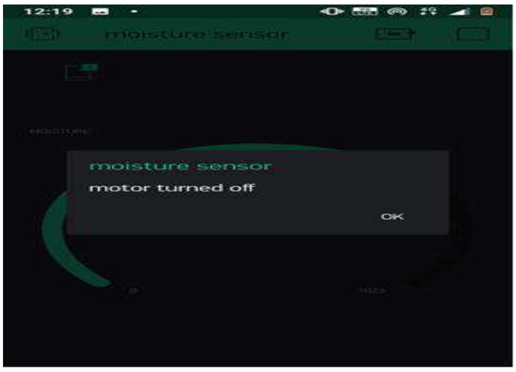


Fig. 8: Motor status notification

Fig.8 shows the motor notification sent to the farmer via NodeMCU. The famer will receive this notification on his blynk app on a regular basis.

Fig. 9: Moisture below pre-set

Fig.9 represents the moisture content when The soil moisture is below the prescribed level, under this condition the soil moisture sensor informs the processor to switch the water pump on and to open up the convertible roof.

Fig.13. Output on firebase

Fig .13 shows the motor notification sent to the farmer via NodeMCU. The famer will receive this notification on his blynk app on a regular basis.

This entire process is continued for different data input obtained. To test the performance of our developed process different input crops were tested and the output was verified are applied. Thus upholding the experimental validity of the project

5. CONCLUSIONS

Present day requirements of the farmers have not been met by modern technology. Through this paper we intend to help farmers to manage their water resources effectively and also to prevent damage to the crop.

This project will also help people who are interested in setting up a mobile farming area in their respective apartment or home. In this modern era, people find it difficult to manage their gardens and terrace farms. This project can make their gardens and terrace farms almost self-sufficient and it will only require a small amount of the user's attention.

Underground water levels have seen a massive downfall in recent times, this paper through intends to conserve water to prevent future crisis.

In India it can be noticed that during heavy rainfall the roads get damaged, this damage to roads can be prevented with the use convertible roofs in small lanes.

In this paper we have integrated the concepts of smart irrigation, water conservation, prevention of damage to crops due excessive rainfall, hailstorms and extreme temperatures.

In conclusion, we have made an attempt to bring agriculture and technology further. The goal is to provide the farmers with a solution to effectively harvest their crops and make use of water conservation to their advantage.

In, we have developed a model which can detect cancers in lung using deep convolutional neural network with good accuracy and share result directly with patients using GSM and Firebase cloud messaging. However, there is a scope to enhance our work to suggest the survival time of cancer patient.

ACKNOWLEDGEMENT

The authors would like to acknowledge that the tools used for this project is supported by Vision Group on Science and Technology (VGST), Govt. of Karnataka, India for sanctioning research work vide ref. No. KSTePS/VGST/GRD-684/KFIST(L1)/2018. Dated 27/08/2018 to principle investigator Dr.G.Seshikala.

5. REFERENCES

[1] D. Spelman, K. Kinzli, and T. Kunberger. Calibration of the 10HS Soil Moisture Sensor for Southwest Florida Agricultural Soils. Journal of Irrigation and Drainage Engineering, June 2013

[2] T. Saito, H. Fujimaki, H. Yasuda, K. Inosako, and M. Inoue. Calibration of Temperature Effect on Dielectric Probes Using Time Series Field Data. Vadose Zone Journal, 12(2):0, May 2013

[3] C. Vaz, S. Jones, M. Meding, and M. Tuller. Evaluation of Standard Calibration Functions for Eight Electromagnetic Soil Moisture Sensors. Vadose Zone Journal, 12(2):0, May 2013.

[4] Pamidi Srinivasulu , R Venkat , M. Sarath Babu ,K Rajesh "Cloud Service Oriented Architecture (CSoA) for agriculture through Internet of Things (IoT) and Big Data", 2017 International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE2017)

[5] "Working principle of automatic water level controller",website: http://waterlevelcontrols.com

[6] A.D.Hadge,, J.D.Gawade. "Wireless Control System for agricultural motor". IEEE Computer Science: 722-25, 2009.

[7] Yunseop(james) Kim et al, "Remote Sensing and Control of an Irrigation System using a Distributed Wireless Sensor Network", IEEE transactions on instrumentatiation and measurement, vol.57,no.7, pp.1379-1387, July 2008. "

[8] Abinav Rajpal, Sumit Shah, Nishta khare and Anil Kumar Shukla. Microcontroller based Automatic Irrigation System and Moisture Sensors. (it Proc. Of the International Conference on Science and Engineering) ICSE 2011.

[9] M.S.Nasif, G.A.Kumar, R.Roslan."An effective optimization of rainwater harvesting system in hotel and hospital buildings". 4th IET Clean Energy and Technology Conference (CEAT 2016)

[10] Bento, Antonio Carlos. "IoT: NodeMCU 12e X Arduino Uno, Results of an experimental and comparative survey." International Journal 6, no. 1 (2018)

[11] Anchith Garg, Priyamitra Munoth, Rohit Goyal, "Applications of soil moisture sensors: a review". roceedings of International Conference on Hydraulics, Water Resources and Coastal Engineering (Hydro2016), CWPRS Pune, India 8th – 10th December 2016

[12] https://en.wikipedia.org/wiki/Soil_moisture_sensor

[13] Energy education, University of Calgary; energyeducation.ca/encyclopaedia/Turbine

[14] Tutorial on Arduino IDE

a. www.arduino.cc/en/guide/Environment

[15] Tutorial on "Blynk App "https://roboindia.com/tutorials/blynk-introduction-nodemcu/

[16] "Crop damage due to weather in America" Agfax (American agricultural news broadcaster)

[17] "A study on the Crop Water Requirement for Agriculture in a Typical River Basin of India". Rijwana Parwin (National Institute of Technology Rourkela)

[18] Kofi Adjaman, Micheal O'Neil "Crop Evapotranspiration, Irrigation Water Requirement and Water Productivity of Maize from Meteorological Data under Semiarid Climate".

[19] S.R.Bhaskar, A.B.Joshi. "Crop Water Requirement of Major Crops of Udaipur Region". International Journal of Advance Research, Ideas and Innovations in Technology, www.IJARIIT.com.

[20] "Water requirement of wheat crop for optimum production using CROPWAT model". Krishna Deo, SR Mishra, AK Singh, AN Mishra. Journal on plant studies.