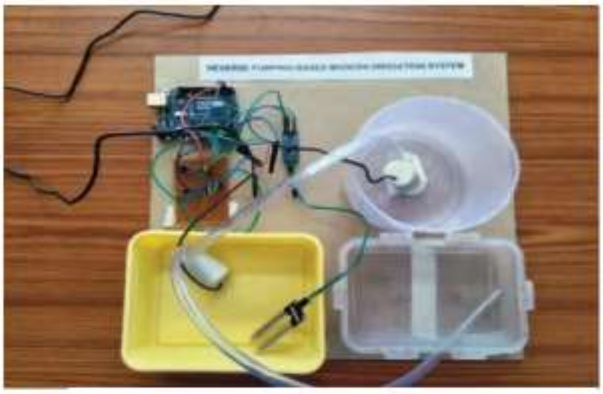

Fig. 5. Prototype developed for the proposed system

A brief about the working procedure along with a few scenarios are explained as follows:

The primary requirement is to determine the state of the rain drop sensor to know if it is heavily raining, moderately raining or not raining. If it is heavily raining, then the user is given frequent instructions to take some action or intelligent controller automatically ON, such that the crops do not get damaged.it is moderately raining, then no other action is taken until the rain gets heavier. if it is not raining, then the status of the soil moisture sensor is considered.

If the soil is dry, then the motor is turned ON for a specific time. When the sub-threshold time is reached, and the motor is still in ON state, a warning message is sent to the user asking to turn OFF the motor manually. When the threshold time is reached, and the motor is still in ON state, the device is automatically turned OFF and the user is notified about the action that is taken. If the soil is moist then no action is taken. Simultaneously the DHT sensor continuously monitors the temperature and warns if the temperature rises beyond the threshold value. Similarly, if the humidity increases it indicates that it is about to rain.

This cycle repeats for every defined amount of time. The process starts only when the appliance is manually turned ON by the user. This can be done by pressing the ON button on the website. Figure 5 shows a sample SMS screenshot that the user receives when the system takes action.

Fig.8 shows the image of the Arduino Uno esp8266 that is used in the proposed system. The microcontroller provides 32 pins including 17 GPIO pins, 4 ground pins, and 3 3volt output pins.

The notice is delivered to the user using Firebase Cloud Messaging (FCM). FCM establishes a secure data link between the server and the devices. It's a free, battery-friendly way to deliver alerts to users on iOS, Android, and the web.

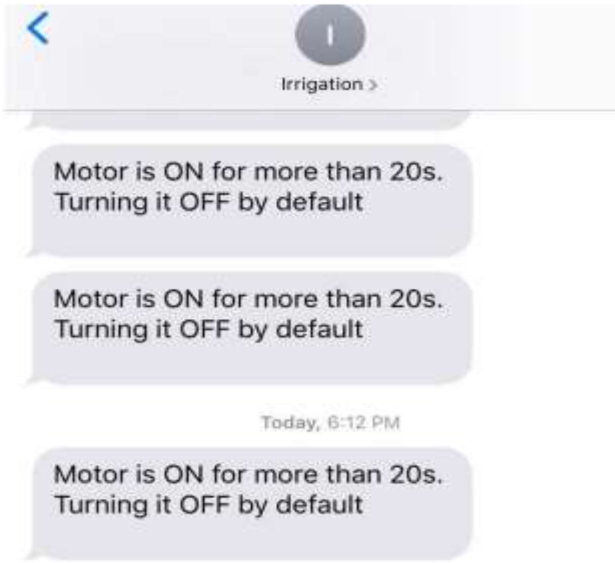

Fig. 6. SMS sent by system to user

Firebase is a cloud service supplier and backend as a service company. Firebase provides a special platform for building mobile and web applications. It can update and build applications in real-time. Firebase stores data in JSON format [13]. Google Analytics for Firebase is connected with notification messages, allowing users access to extensive engagement and conversion statistics.

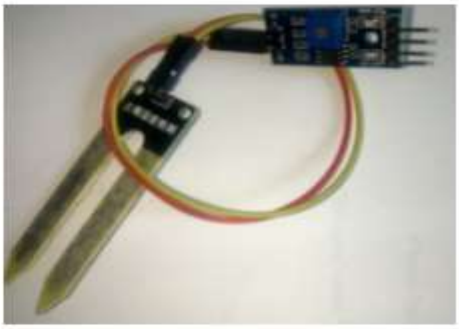

Fig. 7. Soil moisture sensor

Table 1 shows the reading of the soil at different points of time. The reading number 1 to 4 has been taken while the system was working in an automatic state whereas the reading 5 has been taken by keeping the system in manual to increase the water content in the soil and then shifting it to automatic.

The primary purpose is to acknowledge the user whenever there is a critical action taken by the system. Arduino’s built-in function “digitalRead()” helps track current status of sensors

Fig. 8. ArduinoUno esp8266

When the temperature is between 28-35 the motor is in off state, whereas when the temperature is between 40-46 the motor is in on state.

When the moisture is less than 1000, the motor will be in off state. Whereas when the moisture is greater than 1000, the motor will be in one state.

Table I. SENSOR VALUES

Time	Temperature	Moisture	humidity	Motor status
1	28	700	35	Off
1.10	30	1000	37	On
1.15	35	900	39	Off
1.20	40	1010	45	On
1.25	43	1050	47	On
1.30	45	1100	51	On

In this proposed model, we have taken the threshold value limit of 1000. The threshold value decides sprinkler status. A binary value of 1000 is set because it's a general case value for almost all the crops, i.e. a state at which the soil is neither too moist or too dry, this limit is not adequate for the plants that require stagnant water for instance rice. This means, if the reading of the sensor exceeds threshold value, sprinklers will be turned On. The threshold value is calculated using Eqn.(1)

$$(\Sigma_i^n S_i)/n = \tau \quad (1)$$

Where, S_i is reading the i^{th} sensor and n is the number of sensors.

The above formula will help the system in deciding the moisture value for multiple circumstances and also the average soil moisture value of the field.

Decision making statement for independent use of sensors: if (Sensor value is greater than 1000) set sprinkler pump pin to HIGH else set sprinkler pump pin to LOW.

5. Result and Discussion

The proposed system web application based Smart Irrigation System using Internet of Things is state-of-art and represents the new features that can help to ease the work of farmers. focuses on irrigation using IoT and GSM, this would increase the cost of the system significantly. Therefore, the proposed system uses Wi-Fi to operate the system.

The proposed system features are,

- Provides both automatic and manual control of sprinklers, so that the farmers can also operate the system manually with a touch button.

- Provides Past year's crop production data, so that farmers can give a better thought to what kind of product they need to harvest.

- Provides weather prediction, so that farmers can get to know the future weather and set their farming practice schedule accordingly.

- System switches from automatic to manual automatically, in case weather prediction is rainy. This feature saves the crops from overwatering.

- Provides timer-based irrigation, so in case farmers want to irrigate the field manually for a particular time they can set a timer for that amount of time.

- Wi-Fi based system. As the system is Wi-Fi based this would reduce the technology cost for farmers in case they are in the range.

- A cost-effective smart irrigation technique, which helps in saving the excess of water flowing in the land. This excess water can be saved in a separate storage tank, which can be utilized for multiple purposes.

The farmers are still using old methods of manually monitoring the crops. When this task is automated, it reduces the burden on farmers by a huge margin. The natural resources need to be supplied in a limit to the crops as excess supply or shortage of supply will damage the crops. The introduction of GSM shield which intimates the user about the status of the motor and sensors in a conditioned manner has eased the users' experience. In case the user turns OFF a motor and there is no acknowledgment received then it can easily be understood that the appliance is not working in the expected way. Also, the automatic turn OFF feature not only reduces the energy usage but also saves the additional cost that might be incurred and prevents the crops from getting damaged. The implementation of a web-based control for the entire setup has made the setup more accessible. It was also observed that the entire setup was very cost effective and reliable.

The soil moisture sensor is being used to detect the soil moisture from the soil and then it is compared with the threshold value that has been set. The threshold value is to be decided based on the agricultural database in the system that has been built based on the type of soil and crop. The soil type of the farm is detected based on the GPS location of the field that farmers have selected for crop harvesting.

The soil moisture sensors are used to detect the moisture from the soil and send the information to the microcontroller and so it is the function of temperature sensor and humidity sensor. The processing and decision-making tasks are performed in the micro-controller and the signal is sent to the relay to switch the water pumps on/off. The proposed system provides a one stop solution for farmers that resolves their problems with ease of use. The proposed system also provides farmers with updates and notifications regarding the latest government schemes related to farmers and farming. Thus, the system will ease farming practices and might improve the condition of farmers economically.

6. Conclusion

The proposed methodology helps the farmers in saving their crops cultivated in their fields from natural causes like heavy rain, excess flow of water from wells and also reduces the manual intervention, since the information related to the entire process will be sent as a message to the users' mobile number. In actual scenario, the dc motors have to be replaced by ac motors. This prototype has been designed in order to save the water, which is flowing in excess into the agricultural fields, which in turn saves the crop cultivated in the field. Due to this, the water scarcity can be eliminated to a larger scale.

That manual work is reduced, and watering is automated. Healthy plants can be grown with limited use of water and electricity. Even elderly people can easily do farming. IOT plays a major role in the agricultural field. This study mostly applies to the topic of agriculture. The paper has been used to grow plants and it was successfully grown by automatic process. It helps us to achieve a healthy farming system. Increasing agriculture also aids in improving the nation's economic situation.

The existing system works by collecting moisture data from the field using moisture sensors, then this data is sent to the server-side and on this data further processes are conducted based on this data. After being processed by the server, the system's final output is shown to the user. As a result of examining the existing systems, we have concluded that the suggested system would not only assist farmers, but will also assist them in digitizing their agricultural activities, allowing them to get the most out of their practices without being reliant on the weather. The proposed system will automate the farming practices, provide the farmers with weather prediction, and the suitable crop for harvesting based on the past year's data. The proposed system will not only help the farmers in irrigation practices but will also improve the condition of the current farming practices. The proposed system provides a feature of automatic and manual irrigation to the farmer. The system also provides suggestions of a suitable crop to the farmer based on their location and its last year's crop harvest quantity. It also uses prediction analysis to anticipate the quantity of each crop that will be harvested this year based on the previous year's data.

Also, the system provides a feature of the weather forecast and in case if it is "Rainy" the sprinklers will switch from automatic to manual mode this would prevent the overwatering of fields, saving them from getting rotten and increasing the efficient use of water. The proposed system also provides farmers with updates and notifications regarding the latest government schemes related to farmers and farming. Thus, the system will ease farming practices and might improve the condition of farmers economically. The future work and developments might improve the proposed system and be more fruitful to the farmers and studies related to the proposed work.

References

[1] Rajakumar, G., Saroja Sankari, M., Shunmugapriya, D. and Uma Maheswari, S.P. (2018). IoT Based Smart Agricultural Monitoring System. Asian Journal of Applied Science and Technology, 2(2): 474-480.

[2] Sarkar, P.J., and Satyanarayana, C. (2016). A Survey on IOT based Digital Agriculture Monitoring System and their impact on optimal utilization of Resources. IOSR Journal of Electronics and Communication Engineering, 11(1): 01-04.

[3] Sierra, J. E., Medina, B., and Vesga, J. C. (2017). Management system in intelligent agriculture based on Internet of Things. Revista Espacios, 39(8): 1-9.

[4] Anitha, R., Suresh, D., Gnaneswar, P. and Puneeth., M. M. (2019). IoT Based Automatic Soil Moisture Monitoring System using Raspberry PI. International Journal of Innovative Technology and Exploring Engineering, 9(2): 4375-4378.

[5] Vinita, T., Raman kumar., Gopal, F., Anant, G., Patel, J. B., and Manjeet, K. (2017). IOT Based Agriculture System. International Journal of Engineering Science and Computing, 7(5): 12446-12451.

[6] Yuvaraju, M., and Priyanga, K. J. (2018). An IOT Based Automatic Agricultural Monitoring and Irrigation System. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 4(5): 58-65.

[7] Mythili, R., Meenakshi Kumari., Tripathi, A., and Neha Pal. (2019). IoT Based Smart Farm Monitoring System. International Journal of Recent Technology and Engineering, 8(4): 5490-5494.

[8] Ali, T. A. A., Viraj, C., and Potdar, M. B. (2018). Precision Agriculture Monitoring System using Internet of Things (IoT). International Journal for Research in Applied Science & Engineering Technology, 6(4): 2961-2970.

[9] Sanjay, N. P., and Madhuri, B. J. (2019). Smart Agriculture Monitoring System Using IOT. International Journal of Advanced Research in Computer and Communication Engineering, 8(4): 116-120.

[10] Lashitha Vishnu Priya, P., Sai Harshith, N., and Ramesh, N. V. K. (2018). Smart agriculture monitoring system using IoT. International Journal of Engineering & Technology, 7(2.7): 308- 311.

[11] Sukumar, P., Akshaya, S., Chandraleka, GChandrika, D., and Dhilip Kumar, R. (2018). IOT based agriculture crop-field monitoring system and irrigation automation. International Journal of Intellectual Advancements and Research in Engineering Computations, 6(1): 377-382.

[12] Srishti, R. (2017). IOT based Smart Irrigation System. International Journal of Computer Applications, 159(8):7-12.

[13] Govardhan, S.D., Jancy Rani, S., Divya, K., Ishwariya, R., and Aegin Thomas, C. T. (2017). IoT based automatic irrigation system. International Journal of Recent Trends in Engineering & Research. 277-283.

[14] Bhagyashree, A., Tapakire., and Manasi, M. P. (2019). IoT based Smart Agriculture using Thingspeak.

[15] Laura, G., Lorena, P., Jimenez, J.M., Jaime, L., and Pascal, L. (2020). IoT-Based Smart Irrigation Systems: An Overview on the Recent Trends on Sensors and IoT Systems for Irrigation in Precision Agriculture. MDPI - Sensors, 20(1042): 1-48.

[16] William Isaac and Shashank Varshney, “An IoT Based System for Remote Monitoring of Soil Characteristics” presented in International Conference on IT(InCITe),2016.

[17] Joaquin Gutierrez and Juan Francisco, “Automated Irrigation System using Wireless Sensor Network and GPRS Module” presented at IEEE Transaction on Instrumentation and Measurement, 2013.

[18] Yunseop Kim and Robert G. Evans, “Remote Sensing and Control of an Irrigation System using a Distributed Wireless Sensing Network” presented at IEEE Transaction on Instrumentation and Measurement, Vol- 57, July-2008.

[19] William Isaac and Shashank Varshney, “An IoT Based System for Remote Monitoring of Soil Characteristics” presented in International Conference on IT(InCITe),2016.

[20] Joaquin Gutierrez and Juan Francisco, “Automated Irrigation System using Wireless Sensor Network and GPRS Module” presented at IEEE Transaction on Instrumentation and Measurement, 2013.

[21] Yunseop Kim and Robert G. Evans, “Remote Sensing and Control of an Irrigation System using a Distributed Wireless Sensing Network” presented at IEEE Transaction on Instrumentation and Measurement, Vol- 57, July-2008.