International Journal of Advanced Technology in Engineering and Science www.ijates.com
Volume No.02, Special Issue No. 01, September 2014 ISSN (online): 2348 – 7550

USING TECHNOLOGY IN AGRICULTURE TO SAVE THE FALLING WATER TABLE IN INDIA

Ravinder Singh[1], Tripatjot Singh Panag[2]

[1]*Department of Electronics and Communication Engineering, B.B.S.B.E.C (India)*
[2]*Assistant Professor, Department of Electronics and Communication Engineering, B.B.S.B.E.C (India)*

ABSTRACT

Today India faces several problems and one of the major problems is the shortage of water for irrigation purposes. Ground water is an important source of irrigation mainly in Punjab. Due to irrational irrigation of paddy the utilization of ground water has increased manifold. So to save this underground water table we thought of designing a Wireless Sensor Network (WSN) based irrigation regulator system. The system uses the soil moisture level along with the weather forecast information to regulate the irrigation process. The weather forecast information is acquired from the mobile service provider (IDEA) using Weather Forecast Unit (WFU). This enquiry is made in response to a dry signal generated by Moisture Sensor Unit (MSU).After checking through the weather condition the Main Control Unit (MCU) of the system makes a decision whether to switch ON the motor or not. The system was deployed to regulate the irrigation process for the onion crop during the period Feb-2014 to May-2014. The results indicate that the system can reliably be used to regulate the irrigation process.

Keywords: Wireless Sensors, Soil Moisture, Weather Forecast, Irrigation Regulator, GSM Modem.

I. INTRODUCTION

"Water is not a commercial product like any other, rather a heritage that must be protected, defended and *treated* as such". A recent study based on satellite data conducted by NASA has found that ground water levels in northern India have been declining at an alarming rate, by as much as one foot per year over the last decade [1]. According to the report, it is being pumped and consumed by human activities principally to irrigate the cropland. Ground water is an important source of irrigation in our country. In the coming years the ground water utilization is likely to increase manifolds for expansion of irrigated agriculture and to achieve National targets of food production. The fall in water table in Punjab has been a serious issue. One of the main reasons for it has been the early transplanting of rice (before mid-June), which means severe withdrawal of groundwater, as the monsoon is still far away, temperatures are very high and evapo-transpiration rate (ETR) is maximum. Several water management strategies have been suggested e.g. drip irrigation and on-farm management practices, change in cropping pattern, banning early plantation of paddy etc. New technologies and practices based on WSNs are being developed and implemented in agriculture around the whole world, but their deployment in Punjab is still at the beginning stage. So there is a great challenge before us to implement these technologies practically in the

fields. In this paper, we have taken a step towards the deployment of WSN and Weather Forecast based irrigation regulator system practically in the fields to save the falling water table.

II. SYSTEM DESCRIPTION

In this system we make use of wireless network and sensors to know whether to **ON/OFF** the irrigation system to water the field. Here in addition to the sensor network a GSM system is also used to send and receive the weather report as per requirement. A wireless sensor network is a system comprised of radio frequency (RF) transceivers, sensors, microcontrollers and power sources. Wireless sensor networks with self-organizing, self-configuring, self-diagnosing capabilities have been developed to solve problems or to enable applications that traditional technologies could not address.

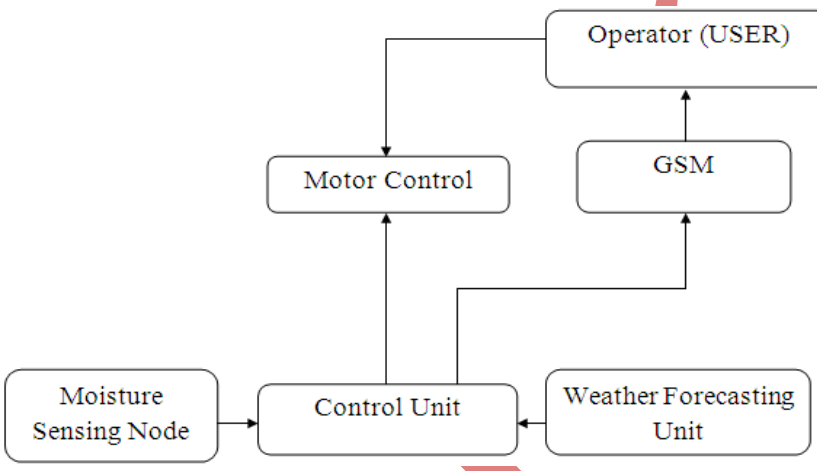


Fig. 1: Block Diagram of WSN and Weather Forecast Based Irrigation Regulator System

For The block diagram consists of the four basic parts i.e. MSN (Moisture Sensing Node), WFU (Weather forecasting Unit), Control unit and GSM, etc.

1. MSU (Moisture Sensing Unit)

This is the most important unit. In this two stainless steel rods are inserted into the soil acting as electrodes. Depending upon the moisture level in the soil, its conductivity will change. This variation shall be measured and used to make a decision.

2. WFU (Weather Forecast Unit)

This is a challenging block here it is intended to access the available weather forecast information. Using GSM, the weather information is obtained through an SMS from a telecommunication company or data can be received from some specific weather forecast station.

3. Control Unit

This unit will act as the brain of the complete hardware. The soil moisture sensed in the first unit plus the weather forecast information from the second unit is given to the control unit. Depending upon these two signals the control units makes a decision. The decision may be sent to the relay to switch the motor ON/OFF or it can be controlled manually by the user as it can cause chaos in the experimental setup.

4. GSM Module

This can be a mobile set or a special modem for sending an SMS to the user indicating the final decision of the control unit. This SMS would tell the user whether to switch the motor ON/OFF for irrigation process.

2.1 Working

The working of the whole system can be divided into three parts or steps. As soon as the system is turned ON, all the three parts starts working. These three parts work in the following manner:

2.1.1. Moisture Sensing Unit (MSU)

The continuous monitoring signals from all the sensors are received by the receiver at the Base Station. The signal received here indicates the soil condition i.e. wet or dry. If the wet signal is received from all the sensors then MSU further performs no action and it waits until the signal gets DRY. As soon as the DRY signal is received, the MSU sends a signal to the second unit i.e. control unit that the soil is DRY. The whole working is shown in Fig.2.

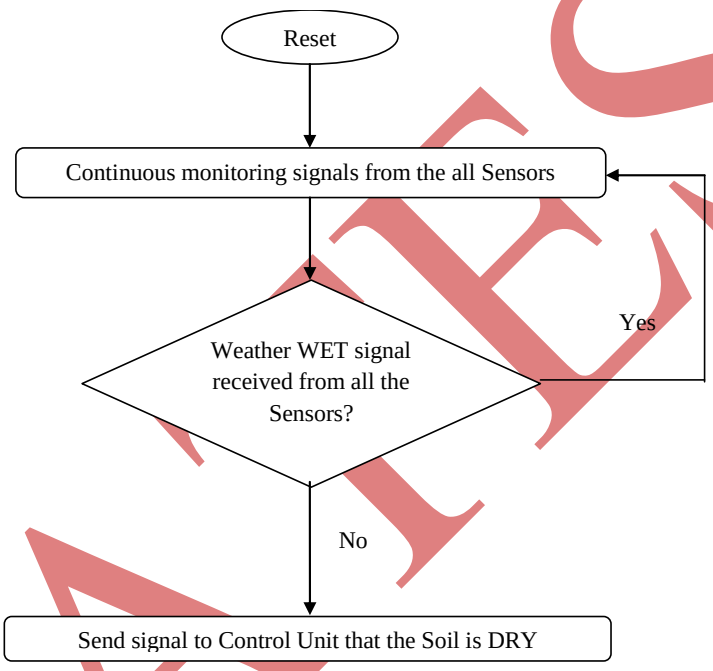


Fig.2: Working of Moisture Sensing Unit.

2.1.2. Control Unit

This unit acts as the brain of the complete hardware. It will check the signal from MSU. If the signal indicates the soil to be DRY, then it sends the signal to Weather Forecasting Unit (WFU) to update weather conditions. Along with this it will also send an alert message to the user regarding the weather enquiry made. In the mean time WFU will send weather information to the control unit. The control unit will interpret this message and carry out the decision making process. If the weather remains conducive for irrigation it will send a message to the user to turn ON the motor otherwise it will send a message "No Need". The working of the control unit is shown in Fig.3.

2.1.3 Weather Forecasting Unit (WFU)

The WFU will wait for the command signal from the control unit to update the weather condition. On receiving the command from the control unit for updating the weather, the WFU will send a SMS "Weather" to the Idea service centre for weather information. On receiving information, it will forward this information to the control unit otherwise it will wait for the SMS from the Idea service centre. The complete working of WFU is shown in Fig.4.

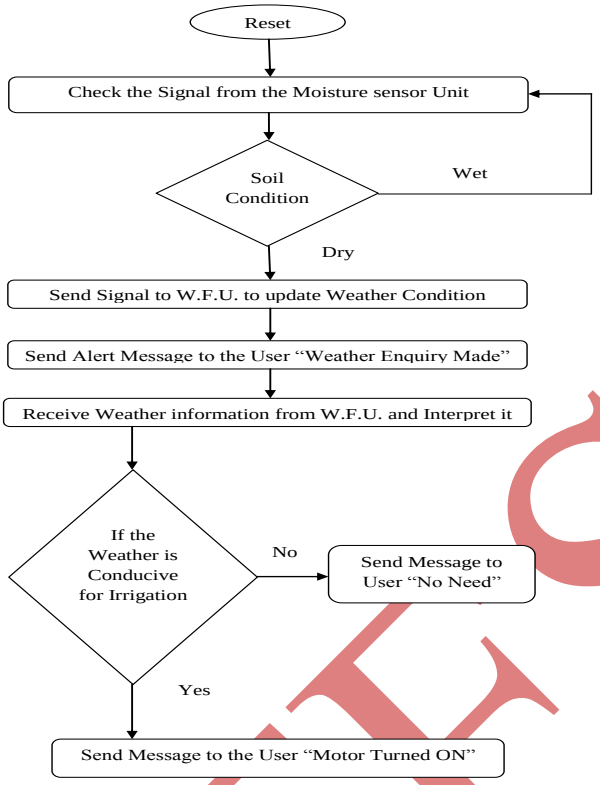


Fig.3: Working of Control Unit

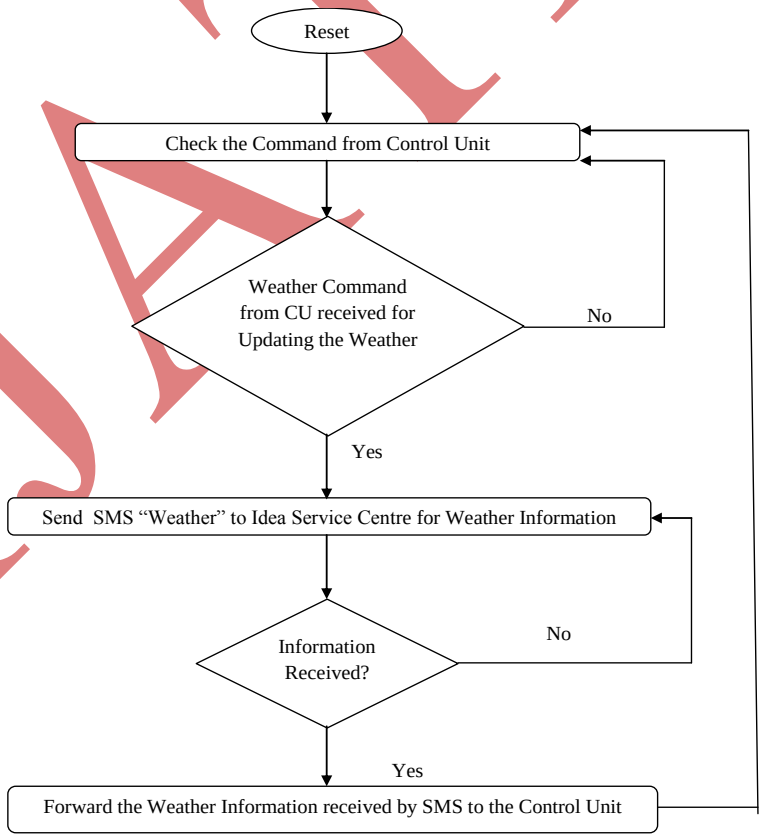


Fig.4: Working of Weather Forecasting Unit

2.2. Hardware

2.2.1. Moisture Sensing Unit (MSU)

It consists of light weight circuit comprising of two stainless steel rods inserted into the soil acting as electrodes. A comparator circuit is used for checking the moisture level in the soil as shown in Fig. 3.9. The TWS-434 and TWS-330 are used for transmitting the moisture level to the base station.

2.2.2. Base station (Control Unit and Weather Forecast Unit (WFU)

It is the unit where whole processing takes place. The signal from the sensors is received by the receivers (RWS-434 & RWS-330) working at different frequencies. The receiver forwards the signal to the controller. The controller AVR Mega series is interfaced with GSM module (SIM300AT) and LCD LMB162A. The GSM modem is used for sending and receiving the weather updates. Along with the weather information it also sends alert messages to the user. The LCD indicates the status of all the sensor units and final decision made by the control unit.

III. RESULT AND DISCUSSION

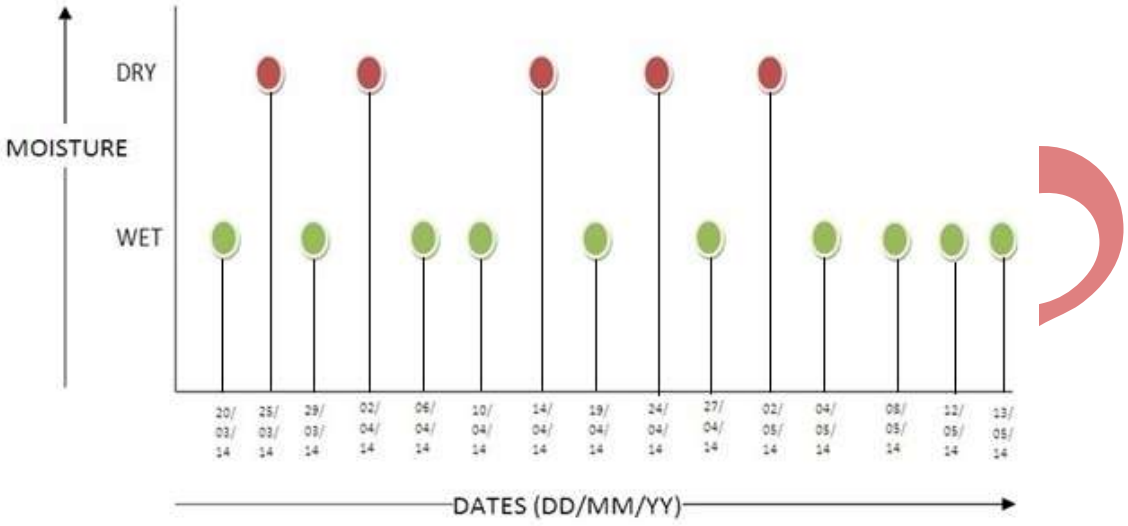
The project was installed to monitor the irrigation of onions in the current season. The crop was sowed in the month of February in 2014. The system was installed to regulate irrigation process of onions in the month of March in 2014. The system checked the moisture level of the soil. Whenever the soil was found to be dry, it went on to check the weather forecast. If the weather was found to be sunny for the day and also for the next couple of days, it recommended switching ON of the motor. Otherwise it suggested not switching ON the motor as rains were expected. Thus it helped us in saving underground water as well as the crop. The data thus obtained is presented in the table below. The decision made by the system was also verified by manual enquiring about the weather (using IDEA message services) whenever there was a need to water the crop. The manual verification was needed because the project was in the evaluation phase. The data thus obtained is presented in the last column.

S.No.	Date	Soil Condition	Alert Message Received	Decision made by the User	Manual Verification
1.	25-Feb-2014	Nil	Nil	No Need	Nil
2.	27-Feb-2014	Nil	Nil	Watering	Nil
3.	08-Mar-2014	Nil	Nil	Watering	Nil
4.	14-Mar-2014	Nil	Nil	Rain	Nil
Installation of Irrigation Regulator System					
S.No.	**Date**	**Soil Condition**	**Alert Message Received**	**Decision made by the System**	**Manual Verification**
1.	20-Mar-2014	Wet	No	Motor turned OFF	
2.	25-Mar-2014	Dry	Yes	No Need	Rain
3.	29-Mar-2014	Wet	No	Motor turned OFF	
4.	02-Apr-2014	Dry	Yes	No Need	Rain

5.	06-Apr-2014	Wet	No	Motor turned OFF	
6.	10-Apr-2014	Wet	No	Motor turned OFF	
7.	14-Apr-2014	Dry	Yes	Motor turned ON	Sunny
8.	19-Apr-2014	Wet	No	Motor turned OFF	
9.	24-Apr-2014	Dry	Yes	Motor turned ON	Clear
10.	27-Apr-2014	Wet	No	Motor turned OFF	
11.	02-May-2014	Dry	Yes	Motor turned ON	Sunny
12.	04-May-2014	Wet	No	Motor turned OFF	
13.	08-May-2014	Wet	No	Motor turned OFF	
14.	12-May-2014	Wet	No	Motor turned OFF	
15.	13-May-2014	Wet	No	Motor turned OFF	

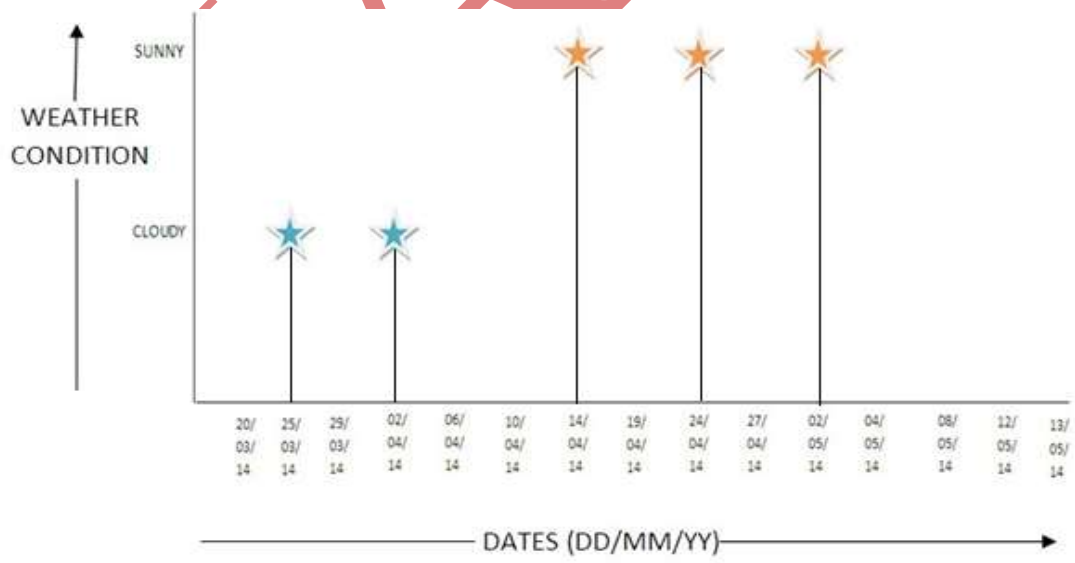
As can be observed from the table after the installation of system, the fields were found to be dry on five occasions. We will discuss each of these situations one by one. Firstly on 25 March 2014 the Moisture Sensor Unit of the system checks the soil to be dry. On detecting the soil to be dry, the system sends a message "Weather" to the Idea service centre for weather enquiry. In the meantime the system also sends another alert message to the user that the weather enquiry message has been sent. On receiving this alert message a manual verification was carried out by the user in the same way by sending a message "Weather" to the Idea service number 51115. In response to this message user receives a reply message from Idea describing the weather condition for almost a week. The manual verification was needed because the project was in the evaluation phase. The same message was received and interpreted by the system also. The decision made as per the weather conditions of 25 March 2014, 26 March 2014 & 27 March 2014 was sent to the user. It means it was decided by the system to keep the motor OFF during this period as rain was expected. And the rain was experienced on 26 March 2014, evening. Secondly the soil was found to be dry on 2 Apr 2014. Hence the same steps were carried out by the system as in previous case. Decision was made by the system as per the weather conditions on 2 Apr 2014, 03 Apr 2014 & 04 Apr 2014. The weather condition was again not suitable for turning the motor ON. Showers were experienced on 03 Apr 2014, morning. Thirdly the soil was found to be dry on 14 Apr 2014. Decision making process was carried

out by the system as per the weather conditions on 14 Apr 2014, 15 Apr 2014 & 16 Apr 2014. So here the decision was made to water the crop because the weather was felt conducive for irrigation process. Weather was sunny for these days. Then the soil was found to be dry on 24 Apr 2014. Decision making process was carried out by the system as per the weather conditions on 24 Apr 2014, 25 Apr 2014 & 26 Apr 2014. It was decided to water the crop because the weather was felt conducive for irrigation process. Last occasion when the soil was found to be dry was on 02 May 2014. On the basis of the weather forecast for 2 May 2014, 3 May 2014 & 4 May 2014, the system suggested to water the crop



Graph 1 Indicates Moisture Level on different dates

Graph 1 Indicates Moisture Level on different dates. The soil was found to be wet on all occasions except on 25/03/2014, 2/04/2014, 14/04/2014, 24/04/2014, 02/05/2014.



Graph 2 Indicates Weather conditions on different dates

Graph 2 Indicates the Weather conditions on different dates. The graph indicates the weather condition to be cloudy on 25/30/2014 & 02/04/2014, whereas it indicates the weather conditions to be sunny on 14/04/2014,

24/04/2014 & 02/05/2014. The system makes the final decision from graph 1&2. It suggests to water the crop when the weather condition is sunny and soil is found to be dry.

IV. CONCLUSION

Calculated The WSN and Weather Forecast based irrigation regulator system was used over a period of about six months to regulate the irrigation process for two crops – wheat and onion. The results thus obtained help us to conclude that the system can reliably be used to regulate the irrigation process. This automation has many advantages as listed below:-

4.1 It reduces human burden

During conventional agricultural practices one needs to visit the fields regularly. But by using this system there is no need to visit the fields on regular basis to check whether there is need to irrigate the crop or not.

4.2 Avoids misinterpretation

Sometimes by usually interpreting the top layer of the soil we take it as dry, but if we penetrate deep (about an inch) into the soil, we find it to be wet. In fact, it is the moisture content at the root level that matters. But by using the sensor electrodes that goes deep into soil up-to the root level, we come to know the exact moisture content. So there is no chance of wrong interpretation in this case. But there is moisture in the soil near to the roots of the crop.

4.3 Helps in saving Energy and Groundwater

In normal conventional practices we water the crop by making interpretation from the soil upper layer. And we don't have any knowledge about the weather forecast. If it rains within the next couple of days it may lead to loss of energy and groundwater. But by using this system we will have weather forecast information for next three days and proper soil moisture. The system won't water the crop unless the weather conditions are conducive. Therefore, it minimizes the energy and underground water loss.

4.4 Prevent Crop Damage

In conventional practices we water the crop without any weather information. If the weather gets turbulent within a couple of days from watering the crop, it may lead to the crop damage. As the system has weather forecast information therefore, the system saves the crop from being damaged.

4.5 Improves Crop Yield

Using this system the irrigation process is carried out only when it is required by the crop and along with that it also checks the weather forecast information for few couples of days. Therefore, it irrigates the crop with the exact amount of water required by the crop and also prevents irrigation when it may harm the crop. Hence the crop overall yield is improved.

V. FUTURE SCOPE

A WSN and internet based irrigation regulator system has been developed. Although a lot of efforts have been made for the development of the system; still it can be further improved with some small modification. Following points may be considered for the improvement of the system in future.

A. WSNs can be equipped with other specialized sensors and hence can also be used to regulate the use of Fertilizers, pesticides etc.

B. Sensor node can be made to work on solar energy.

C. Number of sensor nodes can increase to make the system more efficient.

D. High range RF module can be used to cover a larger area.

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