Smart Farming Using IOT

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Abstract: *India, whose GDP depends on the agriculture is not a developed nation in terms of modernization in agriculture. The high cost of labor, uncertainty in the production of crops, lack of knowledge about new methods, continuing with the same orthodox and traditional means to go about agriculture, the inefficient use of proper irrigational facilities results in low productivity. Due to this uncertainty in the irrigation process the crops may also dry up. About 14.7% of India's growth depends on the agricultural sector, so it's a huge cause of concern.*
With this project, the current problems related to farming are solved and practically implemented solutions are provided. Using IOT as well as GSM, a whole new concept of farming using networks is introduced reducing labor, updating farmer about the live conditions of farm on the mobile devices and presenting its graphical value using thing speak. It makes the process handy with the click a button reformation.
We evaluate the performance of our method in a simple temperature sensing application. In terms of reducing human efforts and ease of irrigation, our approach has been observed to outperform the existing conventional approach. We bring out the advantages and disadvantages followed by their applications. The paper concludes the work open for research.
Key words: *IOT (Internet of Things), GSM (Global System for Mobile), Arduino, Thing speak, ENC28J60.*

I.   Introduction

The biggest problem faced during production of crops, leading to wastage or below par production is non timely watering in the field or inaccurate amount of water being poured in the field. At times, due to the human tendency, either greater or lesser amount of water is allowed to enter the field thereby destroying thecrop.Thismarksthefirstmajorproblem.Alsowater-levelinthesourcetanksometimesgoesloworsometimes   get over-drained. Thus information regarding scarcity or abundance of water in the reservoir is the second major problem. Over sprinkling of pesticides and chemicals for large production of products lowers the life-span of field. Many times the farmer is far away from the field and is therefore unable to get the current status of the field. Hence his periodic visit is must on the field to take care of the water requirement, chemical requirement, and other production related issues. Thus for timely observation, automatic control over such parameters would ease the burden of any individual. Traditional methods of cultivation like manual ploughing, two crop pattern and old system of irrigation are mainly responsible for low productivity of agriculture. Due to the use of these old implements agriculture is backward. Lack of proper understanding of the need to grow crop sustainability will push farmers in to vicious circle of debts, heavy use of chemical (fertilizers), water mismanagement, and low productivity and thus more debts for the newcycle.

This problem is avoided by making the control of water automatic with the help of digital pins of any microcontroller. Basically any pump (automatic) can be controlled with the help of a microcontroller and a current amplifying device. In this project arduino is being used as a microcontroller and bc147 as a current amplifier and as a switching device. In order to read the information of all these activities on the field, GSM sim900 was implemented on the field. This GSM was a dual band module with features of message oriented (mo) and message terminated (mt). Finally, all these data was received and transmitted via ausb cable and enc28j60 to the thingspeak platform for futurepurposes.
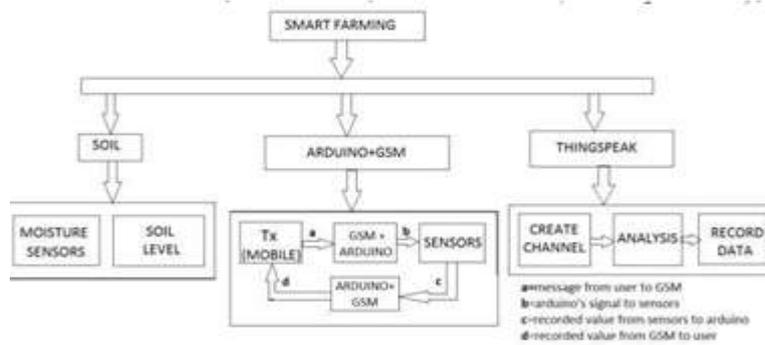
Figure 1 Block Diagram

II. Functionality

Depending on the crops to be cultivated, the water requirement of different crops can be determined by a standard chart and accordingly a minimum threshold value of water requirement and similarly maximum water holding capacity of the particular patch can be programmed on the already installed automatic irrigation system. If the value goes below that threshold level, then its respective water pipe will get ON and the water level in that patch of field will increase. Once the water level reaches the maximum water holding level, then the system will automatically stop. Similarly the chemical sprinkler for different crops on patch can be programmed and its timer can also be set as per needed, so not to lose the sustainability of farm. By using GSM+ARDUINO combination we can get all the on-going information of the farm on our mobile device by just texting the pre-programmed format of message to the sim card used in GSM module. Thus the field information will be on the device even if the farmer is not in the farm. In case the GSM+ARDUINO module fails to exchange data with the farmer, there is another substitute for this drawback. We can upload all the information on an open source platform called THINGSPEAK.

1. Objective

Different crops can be cultivated on a single field divided in the form of patches, by just installing the automatic plant irrigation system(consisting of soil sensors, water level indicators and chemical sprinkler) according to the requirements of the crops. On-field information can be simply achieved by just sending pre-programmed format of message to an already installed GSM+ARDUINO system which transmits the data of the field on the mobile phone in the form of a message. This data can also be plotted on a Things Speak, an open source platform for future records or if the GSM fails due to some technical errors.

2. Working

The field was divided into 4 patches, each was used for different crop cultivation. Different crops have different water requirement. This can be determined by analyzing standard water requirement table globally used. The problem of over-supply of water to the farm patch is avoided by making use of digital pins of ARDUINO and a voltage switching device BC547.
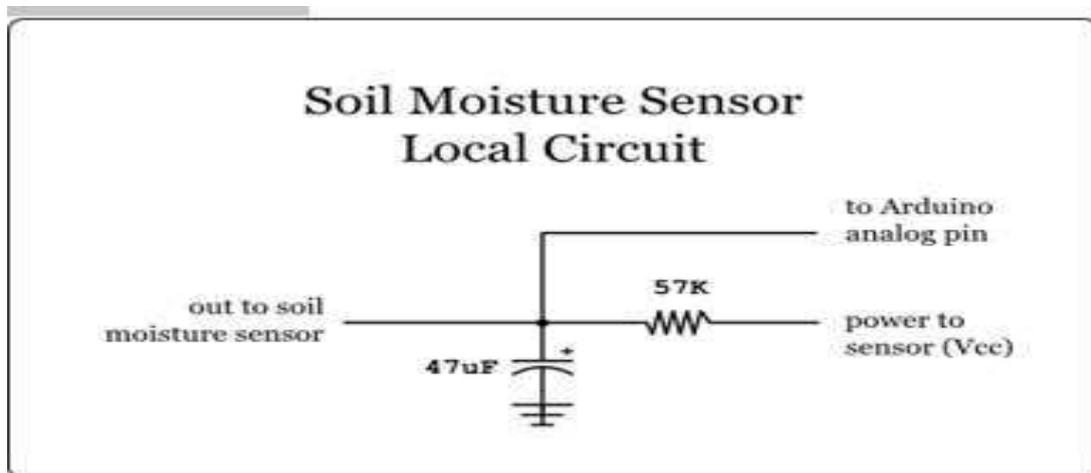

Figure 2 Soil Moisture Sensor Local Circuit

Input to the digital pin is the reading of moisture sensor which is installed in the patch of the farm. Depending upon the threshold value a HIGH or a LOW value is passed to the base of the transistor, if HIGH value is passed to the base then it gets switched ON and connection of pump with GND is established and thus water starts flowing in that respective patch and its moisture goes on increasing. Once it reaches the maximum water holding capacity value a LOW value is automatically reached towards the end thereby making pump OFF. The sensors were used to map the data on the open source platform and make it available for the farmer/user.

3. Observation

1) The intial reading suggests that both soils are expected to give the same reading (output value) on the arduino but RED soil provides the higher range of reading on same amount of water content. Thus for growing any particualr type of crop it is essential to determine the type of crop and accordingly the threshold value has to be modified.

2 The readings in the above table prove that saturation of brown soil reaches later as compared to the red soil, hence water holding capacity of brown soil is more.

3) Because of low water holding capacity of the red soil, the water penitration level of red soil is more than brown soil, thus red soil is more favourable for deep rooted crops as compared to the crops whose root depth is just few centimetres.

SOIL TYPE: BROWN SOIL		
WATER CONTENT IN SOIL	READINGS OBTAINED (Min to Max)	CONDITION OF THE SOIL OBSERVED
Up to 2 %	1022-1000	Dry and powered particle form, cannot be moulded into any shape.
Up to 25%	1000 - 800	Semi- dry and particle form, shape is not that rigid, can be moulded into any shape.
Up to 50%	700 to 600	Can be moulded, shape is rigid, can hold the shape for long time.
Up to 75%	600 to 500	Can be moulded, shape is not that rigid, cannot hold the shape for long time & soil is about to be saturated with water.
Up to 95%	500 to 300	Cannot be moulded & soil is saturated with water
Up to 100%	300 to 245	Cannot be moulded & soil is said to be oversaturated with water

** Min value obt: 1022 i.e. 0% water content in the soil

**Max value obt: 245 i.e. 100% water content in the soil

Figure 3 Observation table for BROWNSoil

SOIL TYPE: RED SOIL		
WATER CONTENT IN SOIL	READINGS OBTAINED (Min to Max)	CONDITION OF THE SOIL OBSERVED
Up to 2 %	1022 to 1015	Dry and powered particle form, cannot be moulded into any shape.
Up to 25%	1015 to 890	Semi- dry and particle form, shape is not that rigid, can be moulded into any shape.
Up to 50%	890 to 715	Can be moulded, shape is rigid, can hold the shape for long time.
Up to 75%	715 to 680	Can be moulded, shape is not that rigid, cannot hold the shape for long time & soil is about to be saturated with water.
Up to 95%	680 to 530	Cannot be moulded & soil is saturated with water
Up to 100%	530 to 245	Cannot be moulded & soil is said to be oversaturated with water

** Min value obt: 1022 i.e. 0% water content in the soil

**Max value obt: 245 i.e. 100% water content in the soil

Figure 4 Observation table for REDSoil

4. Automated Water Control(Awc)

In this project ARDUINO is being used as a microcontroller and BC147 as an amplifier. The connection of pump is as follows.

The base of the BC147 is connected to the digital pin of microcontroller and the emitter is connected to the common ground (common ground of power supply, micro controller, GSM module).

+Ve of pump	VCC
-Ve of pump	collector pin of BC147

Figure 5 Pin Connection

Input to the micro controller is the reading of the moisture sensor and depending upon the threshold value a high or a low is passed to the BC147. If a high value is received on the base of BC 147 then the transistor is switched on and the connection between collector and ground is made. In this case the negative of pump gets connected to the ground and thus turning ON the motor and allowing the water to be poured in the field. Whereas if, the moisture contents are above the threshold then the connection is terminated by passing a low value to the base of thetransistor.
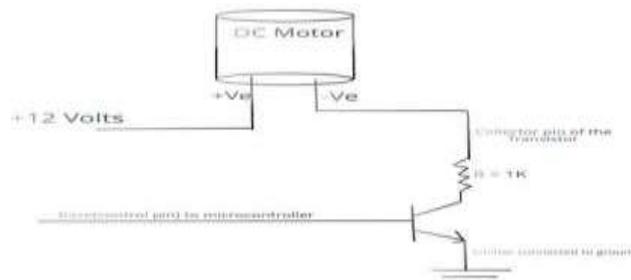

Figure 6 Connection with the motor

The pipes from the motor running through the field have outlets for the water to seep in the field.

Depending upon the type of crop, sprinklers can be placed at the outlets, if required so.

1) The second problem is the information regarding scarcity or abundance of water in the reservoir. Water level indicator with add-ons is the solution for this. In this project three different levels were indicated namely, scarcity (25%), plenty (70%), overflow (90%).

If the water was above 90% in the reservoir it could lead to overflow of water and thereby entering the field or any other place thereby destroying either the crops or the property. The solution for this was as follows

One motor is provided in the reservoir, if the water goes above 90% (sensed by the microcontroller) then it triggers this pump and lets the outward flow of water from the reservoir. This extra amount of water can be supplied to the other local reservoir in need for temporary amount of time as a credit and whenever required can be taken back.

In case of shortage of water (25%) another pump which will be at another river or lake would be triggered by the microcontroller and water starts to seep in the field reservoir.

In this way the amount of water in the field reservoir is maintained.

1) In order to read the information of all these activities on the field, GSM SIM900 was implemented on the field. This GSM was a dual band module with features of Message Oriented (MO) and Message Terminated(MT).

Values such as, moisture level in the field, amount of water in the reservoir, which pump is switched on can be monitored with the help of this module by just sending normal text message on the sim inserted in themodule.

The GSM module required 5 V supply and Tx , Rx control pins.

Two different 5V power supplies have to be provided for the GSM module, one for the hardware and the other for the software chip on the module.
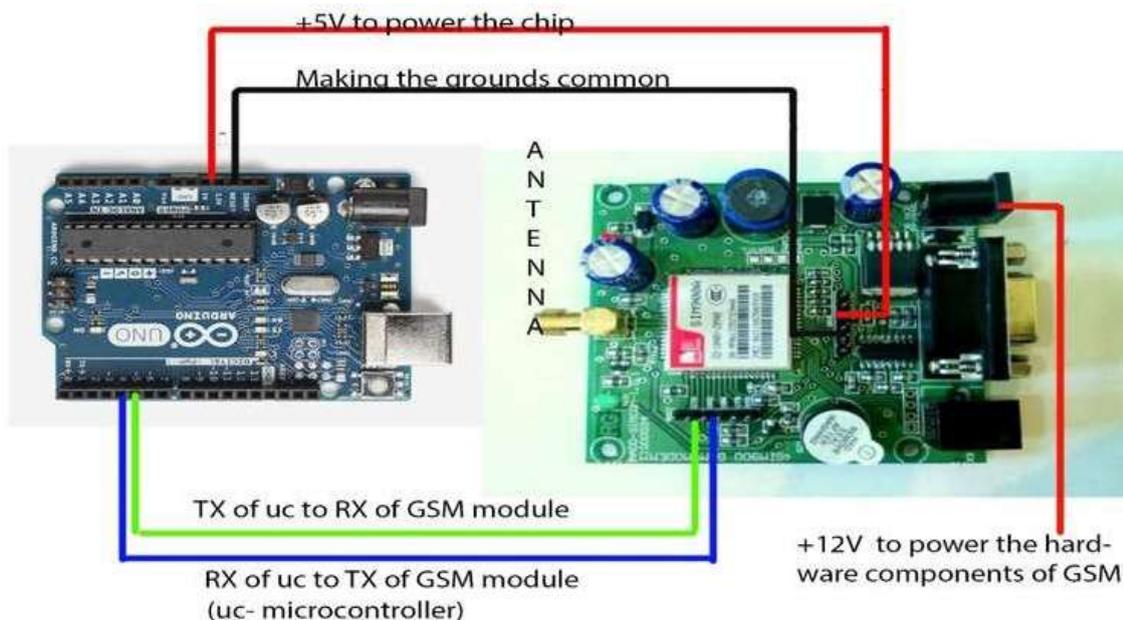
Figure 7 Arduino and GSM connection

In order to monitor the status of the field remotely from the farmer's house a GSM module is used [4]. All the parameters of the field can be monitored by sending a SMS in a specific syntax as described in the code. The different parameters which can be monitored are

a) Moisture content of a specific patch of afarm

b) Depending on the threshold value of the soil, whether the water pump of that patch is switched on or switchedoff.

c) Amount of water level in the watertank.

d) Status of the main water pump from theriver.

How GSM was used [3]: GSM module requires a +5V power supply for its components and +12V supply for the SIM card chip. A basic mini sim card is required with the facility of MO (message oriented) and MT (message terminated) messaging services [2]. The +5V power supply can be supplied from the microcontroller board (ARDUINO in this case) whereas, the +12V power supply has to be provided externally.

For the data transmission between the microcontroller and the GSM module, TX pin of microcontroller is connected to RX pin of GSM and vice-versa. Data received on the RX pin (i.e. from the microcontroller or sensor) is sent to the desired contact number mentioned in the code.

Also the message received on the GSM, to get the value of a particular parameter, is passed serially to the microcontroller where it is decoded and specific actions are undertaken as per the code.

Transmission media of GSM: This project was executed using a GSM-900, i.e. it uses 890 - 915 MHz to send information from the Mobile Station to the Base Transceiver Station (uplink) and 935 - 960 MHz for the other direction (downlink), providing 124 RF channels (channel numbers 1 to 124) spaced at 200 kHz. Duplex spacing of 45 MHz is used. The GSM specifications also describe 'railways GSM', GSM-R, which uses frequency range 876 - 915 MHz (uplink) and 921 - 960 MHz (downlink). Channel numbers 955 to 1023. GSM-R provides additional channels and specialized services for use by railway personnel. All these variants are included in the GSM-900specification.

5. Thingspeak

The primary element of ThingSpeak activity is the channel, which contains data fields, location fields, and a status field. After you create a ThingSpeak channel, you can write data to the channel, process and view the data with MATLAB® code, and react to the data with tweets and other alerts. The typical ThingSpeak workflow lets you [1]:
1. Create a Channel and collectdata.
2. Analyze and visualize thedata.
3. Act on the data using any of several Apps[3].

The ENC may draw up to 180mA[2], and dissipate about 600mW.It can be directly connected to a laptop for meeting its DC requirements over a USB cable.

There is an on-board voltage regulator. The signal pins support both 3.3V and 5V levels. The Ethernet Module has a standard RJ-45 connection, with an integrated line transformer.

In our project, we showcased this as a tool in case the GSM-Arduino connection fails or the GSM sim fails to have sufficient balance we can check the readings on the ThingSpeak portal. The data from the Arduino would be transmitted and made available on the channel for recording purposes. This was basically achieved by logging the soil sensors (moisture) reading over the LAN cable by using the ENC28J60 Ethernet Module. It utilizes the Microchip ENC28J60 Stand-Alone Ethernet Controller IC featuring a host of features to handle most of the network protocol requirements. The board connects directly to most microcontrollers with a standard SPI interface with a transfer speed of up to 20MHz [3].This module uses the W5100 chip which provides a set of TCP/IP protocols, MAC (Media Access) and PHY (Physical Interface) in one network chip, with support for the SPI businterface.

Figure 8 Water level indication over a period of 10 mins

This data logging helped us to analyse our results and thus we could find out the moisture content required by

Figure 9 Moisture level indication over a period of 4 days

the particular crop and how the moisture reading changes w.r.t days/weeks. The sensor readings are scaled, to a digital value between 0 and 1023. This is done by a circuit inside the microcontroller called an analog-to-digital converter or ADC. The analog Read () returns a number between 0 and 1023 that is proportional to the amount of voltage being applied to the pin. The person will just require to log into his account where he has created his/her channel and he/she would get the readings being far away from the field.

The data gets refreshed after a time period of 30 seconds. The reading can stay until the person himself/herself doesn't want to thrash the data out. The x-axis marks the time or days and the y-axis shows the sensor readings at any particular instant. The data can be kept private or it could be made available publicly. The recorded data can be viewed by any person but the changes in the particular channel can be made by the owner of that particular channel.

III. Results And Conclusions

As per plans we had to make the project a viable one. We were able to successively transmit, receive and record the data on our phones. The data was available for transmission due to the GSM which was sent after we would send a particular encrypted message. The data sent consisted the readings of the moisture, the patch on which the water was ON/OFF, the readings of the water level indicator. This same data was also recorded and made available in the form of graphs on ThingSpeak. Thorough comparision of the two soils: Red and Brown helped us to realize the water holding capacity of brown soil is more compared to redsoil.

Figure 10 Implemented Prototype of the Project

IV. Futurescope

1. Making use of non-conventional resources like the wind power, solar panel (12V,15-18W) which can effectively power the GSM module and can be used as a backup towards the end of theday.
2. Intruder alarm or buzzer can be used so that any human/animal intruder cannot disrupt the productivity of

thefarm.
3. A camera can be installed to monitor the live farm in real timesystem.
4. A study based on removal of excess rain water can be implemented aswell.

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