GSM Based Remote Irrigation Control and Management System with Yield Prediction using Machine learning

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Abstract:- ***Agriculture is the main occupation of the majority of people in this country. Agricultural efficiency can be increased by its integration with advanced technology such as machine learning .This Paper is about how irrigation in agriculture can be remotely managed and monitored using Android application backed by GSM services .User can remotely control the irrigation equipment .User can also use automatic irrigation mode where user can select a moisture level and system will take care that required level of moisture is achieved and then pump is turned off. It has yield prediction algorithm and live monitoring feature of conditions in field with SMS request .The machine learning algorithm hosted on Amazon cloud will use those parameters to predict the yield .The parameters will be sent to Amazon cloud using HTTP***

Keywords- SMS,Machine learning,GSM,HTTP, Cloud computing

•1. Introduction

India is an agrarian country. History of Agriculture originates from Indus valley civilization .India is number two worldwide in the farming product,But the contribution of agriculture in the Indian GDP is constantly declining. Agriculture has been ignored with its integration with technology,if we integrate agriculture with technology its efficiency can be increased. The labor cost can be decreased and output efficiency can be increased.
During the season the farmers have to go to field ,water the field ,monitor the water level in the field,all of these have to be done manually but can be done remotely through our system . This will save the time of farmers as well as save the cost of employing a person to manage the irrigation in the field.

The three automatic irrigation modes on the system "Low","Medium","High" modes can give the farmer the freedom to just switch on the irrigation device and forget. Once the irrigation pump is switched on the system will turn on the moisture sensor and will allow the irrigation pump to run till the required moisture level is not achieved in the field. Once the required moisture level is reached the system will turn off the pump.
The system will allow the farmer to monitor the the parameters such as soil moisture, Temperature,sunlight level,Humidity remotely .Once requested the user will receive the live parameters via SMS which will be shown in the app itself.
The user can use those parameters to predict that those conditions will lead to which kind of yield "Low" ,"medium", or "high" yield,What will happen in background is that app will send the parameters to the Amazon cloud . The data will be used as an input for the machine learning algorithm that will run using cloud computing on Amazon cloud.

Amazon web services provide cloud hosting and cloud computing facilities for free it is used within the free limit. Our algorithm's use of amazon computing resources lies within the free limit tiers.

Salient features of the project are:

- Commands to turn ON and OFF the irrigation pump.
- Android interface for ease of access.
- Automatic irrigation modes for "Low" "medium" ,"high" soil moisture/Level.
- Live monitoring of the field conditions on request through SMS
- Yield Prediction with the current field condition parameters using machine learning and cloud

2. Background

Remote irrigation has been recently picking up in India,but it can be made more effective if we provide additional features with cutting edge technologies such as machine learning and cloud computing .All of these features can be packed behind an Android interface so that user can use all these features seamlessly.

The normal remote irrigation system use GSM network to send and receive SMS commands . They don't provide any automatic irrigation mode, user has to send commands explicitly to turn ON and OFF the pump.

Live monitoring of field parameters is not possible on the trivial remote irrigation systems .You have to rely on your instincts and time calculation to know when to turn OFF the motor.

Moreover, They don't have any yield prediction mechanism which tells that current conditions in field can lead to which type of yield low ,medium,or high yield.

All those above features which can improve the efficiency and productivity in agriculture are absent in trivial remote irrigation system.

Our Project incorporates all these features and have been implemented successfully .

•3. Project Description

A. *Hardware Components used :*

1.ESP32 Dual core microcontroller
2.Sim 900A GSM module
3.dht11 temp and humidity sensor
4.Light sensor
5.Soil moisture sensor

B. *Software Technologies used:*

1.Scikit-learn machine learning libraries
2.Python for implementing Scikit-learn library
3.Android application
4.Embedded C programming for ESP32
5.AT commands (Attention) for Sim 900A
6.Amazon lambda serverless cloud computing

C. *Integration of Components:*

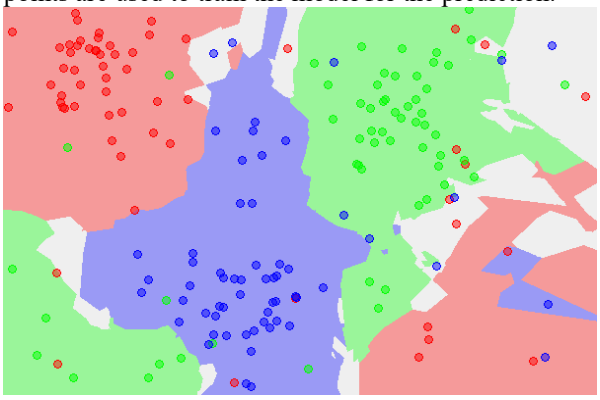
The switch of the irrigation device is attached to the the microcontroller through a relay device . The microcontroller is a connected to the GSM module through serial ports. The microcontroller is also connected to the 4 sensors ie temperature , humidity,hygrometer and sunlight sensor. A sim card is inserted inside the GSM board. The GSM board is powered by a 12V adapter. The GSM board is capable of receiving and sending SMS.

When a button is pressed on the android app , the phone sends a SMS to the GSM board .The board receives the messages and sends the content to the microcontroller. The microcontroller compares the code in the message against the template code provided .The microcontroller is programmed with C code which performs such actions.

When the code matches against a template the microcontroller does whatever is programmed for that code. For example when the code to turn ON the pump is received the the GSM sends the message to the micrcontroller via the serial ports.The microcontroller will read the message code in the text and will set high the pin which is configured to be connected to the irrigation pump.

D. *Prediction algorithm:*

The prediction algorithm used in this system uses the K-Nearest Neighbors classification algorithm.150 data points are used to train the model for the prediction.

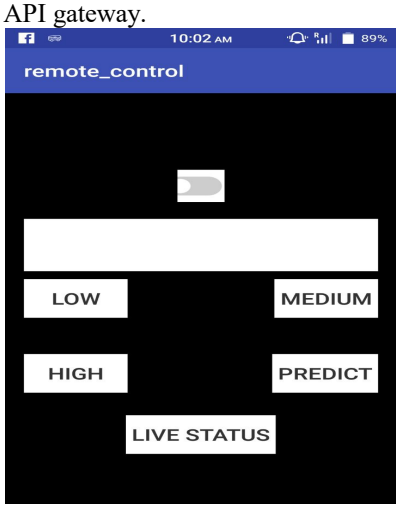


This is an example of 5 Nearest Neighbor classification of 2D vector space, intuitively what this algorithm does is plots the points in n dimensional vector space where n is the number of parameters in data set. After plotting this algorithm classifies each point in the vector space according to the n- nearest neighbors. This is what happens when we train the model . After training when some data is entered for prediction the model plots that data in the vector space and simply finds in which classified area that point lies and gives the output as prediction. The formulae for estimation of distance of points form its neighbors can be found in the links given.

E. *Amazon lambda serverless cloud computing platform:*

The prediction algorithm is computationally very resource exhaustive .Such algorithms require high computing power and it cannot be embedded inside an android application because a phones don't have such

high computing power. The only solution to this problem is that the algorithm has to hosted on some cloud computing platform. Amazon lambda provides such services it offers high computing power and a url to access the algorithm to give input and get the output. In our case the url to access the prediction algorithm is **Amazon lambda url : "https://si0bzuoiaf.execute-api.us-east-2.amazonaws.com/Neel"** This url is obtained after interfacing the Amazon lambda with amazons API gateway.



The android application simply hits this url with a POST request .Inside the Post request the sensors data are added as payload .The url takes the payload,runs the algorithm on this data,fetches the output and sends it back to the mobile client .Hence in this way we are basically we are outsourcing out computational load to amazon cloud and simply we are getting the output of the algorithm from the cloud.

F. *Android Application for user interface:*

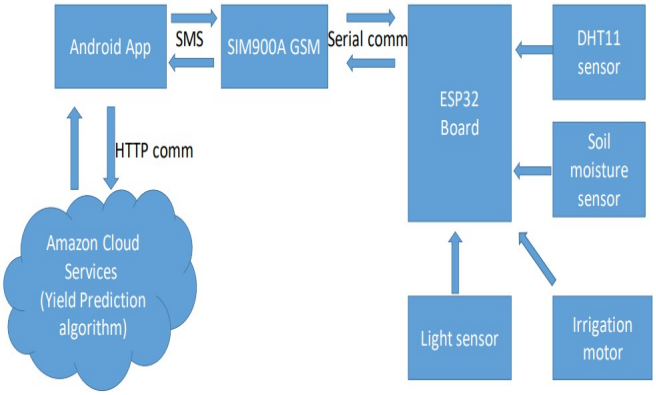
The Android application above has 5 buttons and 1 toggle switch. Each button and toggle switch sends a SMS to the Gsm board with a different code in the content of SMS for example 'h' to turn ON the pump and 'f' to turn OFF the irrigation pump. The toggle switch is used to turn the irrigation pump On and OFF. The Low button is for Automatic Low soil moisture mode, similarly the medium and high buttons are for medium and high soil moisture modes.

The Live status mode is for monitoring the live temperature,humidity,soil moisture,and sunlight level. When the user will touch that button a SMS will go to the Gsm board and the Gsm boards will collect the data from microcontroller and will send the SMS back to the users phone,The App will read the SMS and it will show it to the user.

The Predict button will do the same thing as Live status button,the extra thing it will do is that it will collect the data from received SMS and it will send the data to the amazon cloud through the url where the lambda will run the prediction algorithm on the received data and it will send back the result of the algorithm to the Android application through the API gateway .The prediction result will be shown on the white space in the Application.

•4. Working

A. *Flow chart:*



The android app serves as an interface to the user for all the features implemented in the project .The android app is meant to receive commands from user and show the output to the user.

B. *Working of Automatic irrigation modes:*

When one of the automatic irrigation modes are selected the app sends an sms with the code of that irrigation mode to the GSM board .The GSM board forwards the sms to the ESP32 through serial communication. The ESP32 checks the sms code and turn on the function related to that code as a result the pin connected to the irrigation pump relay is set high and the irrigation pump gets switched ON,simultaneously the soil moisture sensor is also switched ON so that It can monitor the soil moisture while the irrigation pump is ON .When the required moisture level is achieved the pump is turned OFF automatically by the ESP32,thus user don't need to take the responsibility of manually watching the soil moisture.

Similarly the medium and high moisture level function . Low moisture mode keeps the moisture to 30%,medium mode keeps the moisture at 50% and high mode keeps the moisture level at 70%.

C.Working of Live status feature:

The live status feature provides the user the live conditions of the field ie temperature,humidity,light level,soil moisture .When the user gives that command through the android app,the app sends a sms with the code of this feature. When the Gsm boards receives the sms it forwards the sms to the ESP32 board serially. The ESP32 reads the command and executes the function corresponding to that command . As a result all the sensors are activated and the ESP32 collects the live data from the sensor and then deactivates the sensor .The collected data is sent to GSM board from where its is sent to the users phone by the GSM board .The app on the users phone reads the sms and displays the user the live readings of the sensor.

D. *Working of yield prediction algorithm:*

The yield prediction algorithm works when the user gives predict command through the android app .This function works similarly to the live status until the message is received on the phone containing the data of the moisture, when the message is received on the phone. The App reads the data inside the sms and sends the data to the url through the API gateway. When the data is received on the amazon lambda, it feeds the data into the algorithm provided by me. The algorithm runs on the cloud and gives the result which is sent back to the android application on users phone. Hence the result of the prediction is shown on the screen.

5.Results

The project was tested successfully .All the features were executed .When the command to turn on and off the irrigation motor was given, proper responses were observed from the system .

When the Live status was checked the system the system gave the out put as:

Temperature : 35 *degree Celsius* *Humidity :*60%
Soil moisture: 50% *Sunlight*: :60%

To test the Prediction feature above data was given to the yield prediction algorithm .The Yield Prediction algorithm predicted that in above conditions we will have "*Medium Yield*".

6.Conclusion

we can conclude that if agriculture is integrated with cutting edge technologies such as machine learning cloud computing,GSM , the input cost can be decreased as well as the efficiency can be highly increased .This can increase the productivity of agriculture and also the share of agriculture in the Indian GDP.

7. Future developments

In future this technique can be integrated with drip irrigation thus making the drip irrigation system fully automated and highly efficient.

Also the data collected by amazon lambda will become large eventually, after that big data algorithms can be applied on the data collected to find the cropping patterns and other patterns in the data which can be further used to increase the efficiency of the agriculture.

8.References

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