ORIGINAL ARTICLE

A Novel Predictive Machine Learning Approach in Agricultural Field Monitoring

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Abstract:

Modern methods of farming are to increase the crop production through implementation of various sensors that help detecting the soil moisture, climatic conditions and effective utilization of water resources under limited and unforeseen conditions. The aim of this model is to focus on modernising the agricultural monitoring procedure by analysing the geographic conditions, implementing a low-cost device that requires no knowledge for the laymen farmers but yet increase their productivity and reduce the farming cost. The agricultural monitoring activities comprise of machine learning technique that accumulates data from sensors and can use for predictive analysis to perform field watering, remote motor on-off, detection of rainfall in the location site.

Keywords: modern farming methods, dht11, crops, agriculture

Introduction:

In the current circumstances the effective utilization of the resources[1,2] and to minimize the human efforts are more considered without impacting the farming. Succeeding cultivation of different crops in a specified order in a same field and depending upon the topographical changes and environmental conditions for producing more effective yield is always desired. The revolution of technology implementation in the farming industry is increasing the demand to develop more and more new gadgets that comply with the traditional standard's[3,4] that are usually followed in farming have been devised for the past 10-15 years different researches have been effectively contributing and inverting new farming methods[3] and models.

In Indian environment, the different types sessional crop have been listed in the table 1

Table 1 Different types of crop seasons

DESCRIPTION	KHARIF	RABI	ZAID
Season	June to July(Monsoon) Harvested in September, October	Oct, Nov Harvested in April, May	March to June (Between rabi and Kharif)
Example of crops	Rice, Jowar, Maize, Cotton, Groundnut, turmeric, pulses etc	Wheat, Oat, Grams, Pea, Barley, Potato, Onion ,Oil seeds etc	Cucumber, bitter guard, watermelon, Pumpkin, Muskmelon etc..
Temperature	20-26	20-26	24-35
Humidity	75%	60%	79%
Rainfall	75-150 cm	75-150 cm	125-200 cm
Type of soil	Loamy soil, black cotton soil,	Loamy soil, black soil	Sandy and Clay loam

The major crops In India are classified as Food crops, Cash crops, Plantation Crops and Horticulture crops.

The plantation crops and Horticulture crops requires special attention as they provide good yield depending upon the climatic conditioning and regional growth. Usually the temperature variations, fertility of the soil, humidity and moisture conditions are the main leading factors that impact the growth of the plants as well as yield. For example, Tea requires a temperature of around 20-30C and soil type should be in acidic nature with rich organic matter and the estimated rainfall usually should be between 150-300cms.Hence these crops are majorly produced by States like Assam, Darling, Kerala, Tamilnadu, Karnataka. The table 2 shows the water requirement for different crops

Table 2 Water requirements

Crop	Water requirement
Rice	900-2500
Sugar cane	1500-2500
Pine apple	700-1000
Banana	1200-2200
Cabbage	380-500
Gingelly	350-400
Ragi	400-450
Onion	350-550
Tobacco	400-600

To calculate crop water use $Et_a=K_c*PET$

where K_c is crop coefficient,

Et_a is acquiral evaporation

PET is potential evapotranspiration.

Soils supply the essential nutrients [5], water, oxygen and root support that our food-producing plants need to grow and flourish. They also serve as a buffer to protect delicate plant roots from drastic fluctuations in temperature. Table 3 gives the idea of moisture levels for different soils.

Table 3 Soil moisture levels

Soil type	No Irrigation	Irrigation to be applied	Dangerously low soil Moisture
Fine(Clay)	80-100	60-80	Below 60
Medium(Loamy)	88-100	70-88	Below 70
Coarse(Sandy)	90-100	80-90	Below 80

Soil organic matter - the product of on-site biological decomposition - affects the chemical and physical properties of the soil and its overall health. Its composition and breakdown rate affect: the soil structure and porosity; the water infiltration rate and moisture holding capacity of soils; the diversity and biological activity of soil organisms; and plant nutrient availability.

Nutrient exchanges between organic matter, water and soil are essential to soil fertility and need to be maintained for sustainable production purposes. When the soil is exploited for crop production without restoring the organic matter and nutrient contents[6], the nutrient cycles are broken, soil fertility declines and the balance in the agro-ecosystem is destroyed.

Basing on the type of the crop and its requirements the initial setup values will be logged into the program using a mobile numeric pad values and accordingly the device will be set for the initial setup

Proposed Model: The main purpose of this model is to modernise the agricultural environment and to overcome the traditional farming and location dependent. To monitor the field using different sensors that sense the field parameters like temperature, humidity, soil moisture, rain alert in the farm. To check all field conditions and in case of extreme conditions the SMS will also be sent to farmer mobile number through GSM SIM900A Module.

The figure 1 represents the integration of components that are implemented in this agricultural monitoring system. Here Sensors like Temperature, Humidity, Soil moisture, Rain sensor are integrated on same platform using Atmel arm cortex as a Micro controller which helps in monitoring the field and alerts the farmer during the severe conditions.

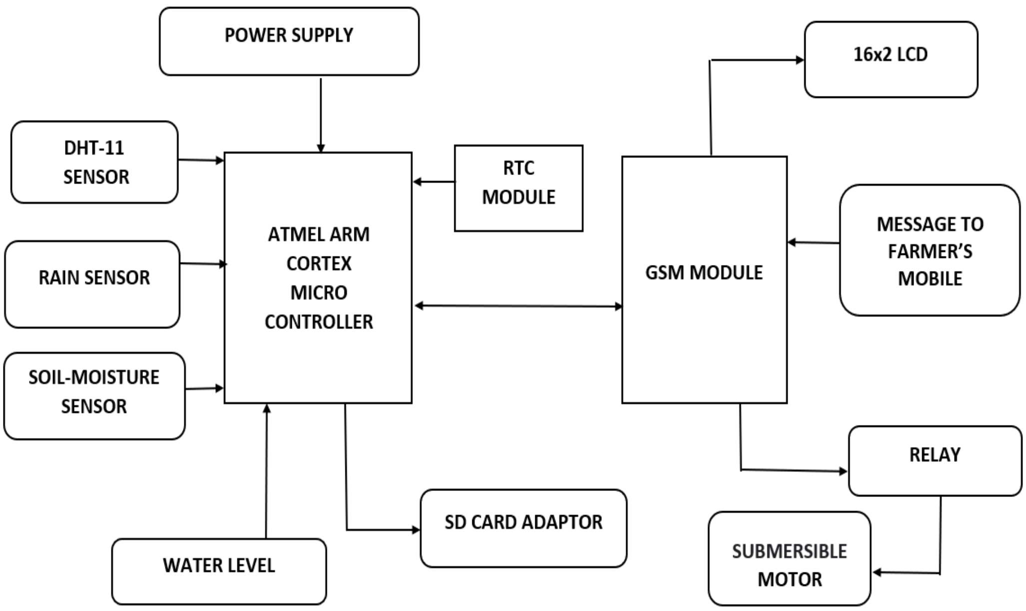


Figure 1 Block Diagram of the proposed model

PREDICTIVE MACHINE LEARNING APPROACH:

For example: when no rainfall detected condition for the consequent 3 days then the motor ON condition will be set for 3 minutes during peak period and nearly 1 minute during off peak period.

If the rain fall is moderate then the time duration for the motor ON state is limited to one minute and thirty seconds (1:30) during peak hours and less than a minute during of peak time(Evenings or early morning).
If the rain fall is high then the motor should be in OFF State.

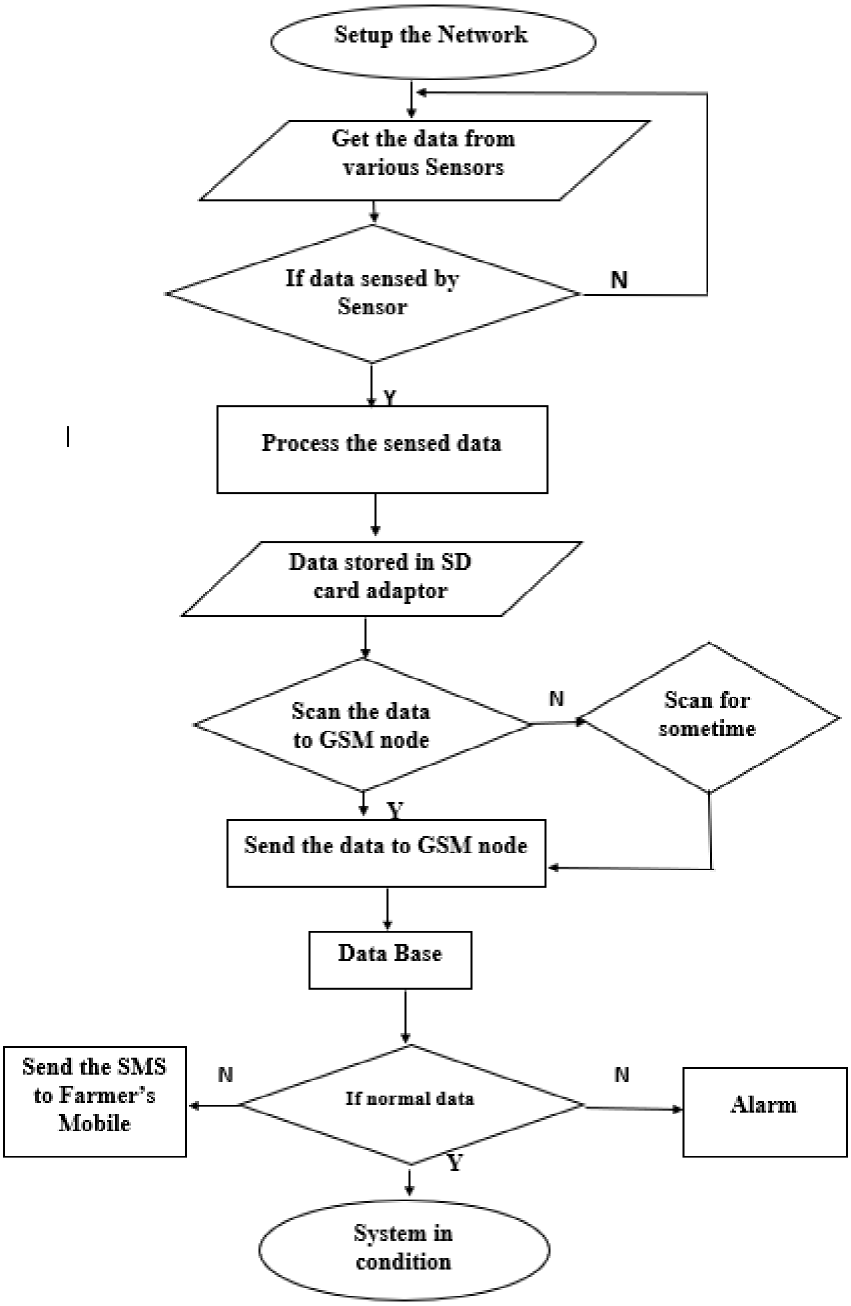


Figure 2 Flow Chart demonstrating steps for measurement

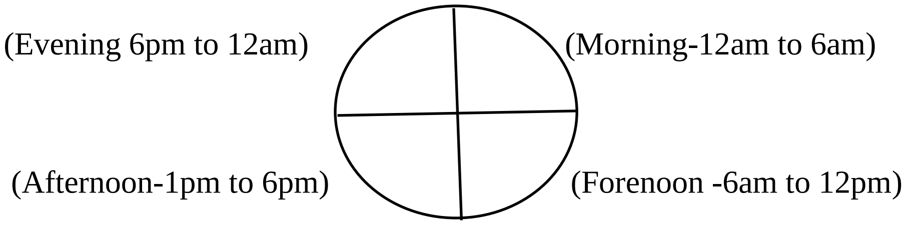
RAINFALL DETECTION

A rain drop sensor is basically a board on which nickel is coated in the form of lines. It works on the principle of resistance. When there is no rain drop on board. Resistance is high so we get high voltage according to V=IR. When rain drop present it reduces the resistance because water is a conductor of electricity and the presence of water connects nickel lines in parallel so reduced resistance and the reduced voltage drop across it.

The sensing pad with series of exposed copper traces, together acts as a **variable resistor** (just like a potentiometer) whose resistance varies according to the amount of water on its surface. This resistance is inversely proportional to the amount of water[6]:

- The more water on the surface means better conductivity and will result in a lower resistance.
- The less water on the surface means poor conductivity and will result in a higher resistance.

In this criteria, the rainfall is absorbed at 4 different time zones.



The rainfall sensor module is detecting a signal in three different steps.

1)Maximum Rainfall-indicated with H

2)Moderate Rainfall-indicated with M

3)Low/No Rainfall-indicated with L

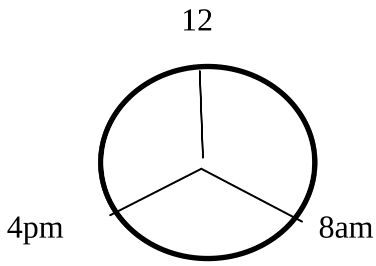
- ❖ If Rainfall is indicated as H, then the motor should be in off state. On the subsequent days, if variation in temperature/Humidity happens and Moisture sensor attached to the plant is indicated low then it has to trigger the motor to 'ON' state and a message need to send.
- ❖ If Rainfall is indicated as M, then motor – ON state but for shorter duration within a specified time limit.
- ❖ If Rainfall is Low/ No rainfall , then motor is ON state for default time.

Under Ideal Conditions,

- o High rainfall the motor runs for 0sec
- o Moderate rainfall the motor runs for 30sec
- o Low rainfall the motor runs for 1min

Assume, the motor will pump up to 1-3lit of water per day.

SOIL MOISTURE DETECTION



Under ideal condition/not rainy season, the plants are to be watered depending upon the temperature and humidity in the outside environment[7] and the motor level needs to be triggered depending upon moisture sensor threshold.

Within 3 time zones of operation depending upon moisture values the motor on/off status are to be maintained as below

Low moisture/complete dry-1.5 min

Moderate Moisture-30sec

The figure 3, 4 & 5 below is the graph plotted between Time, Temperature and Humidity any 2 consecutive days:

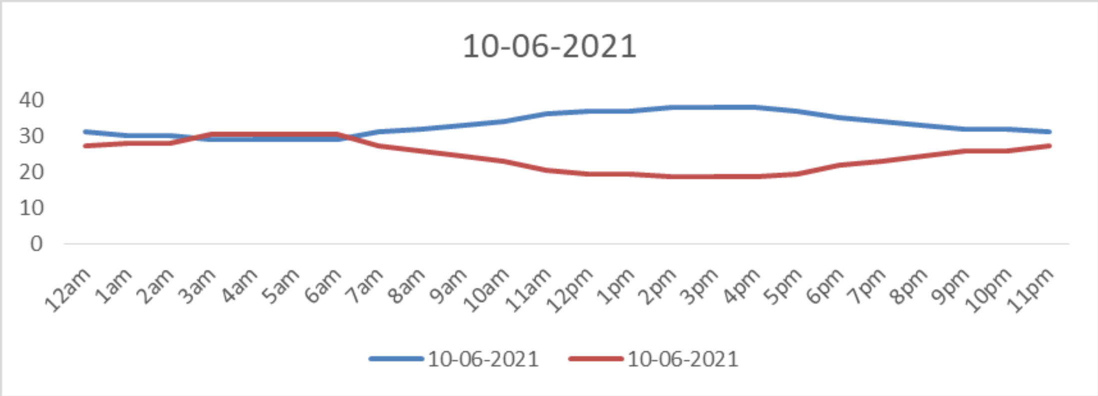


Figure 3. Temperature & Humidity measurement chart (day 1)

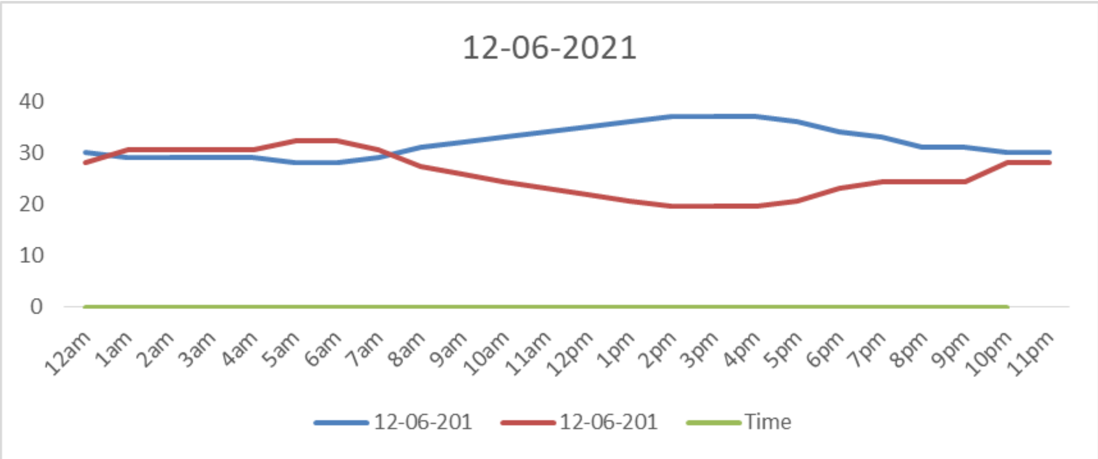


Figure 4. Temperature & Humidity Measurement (day 2)

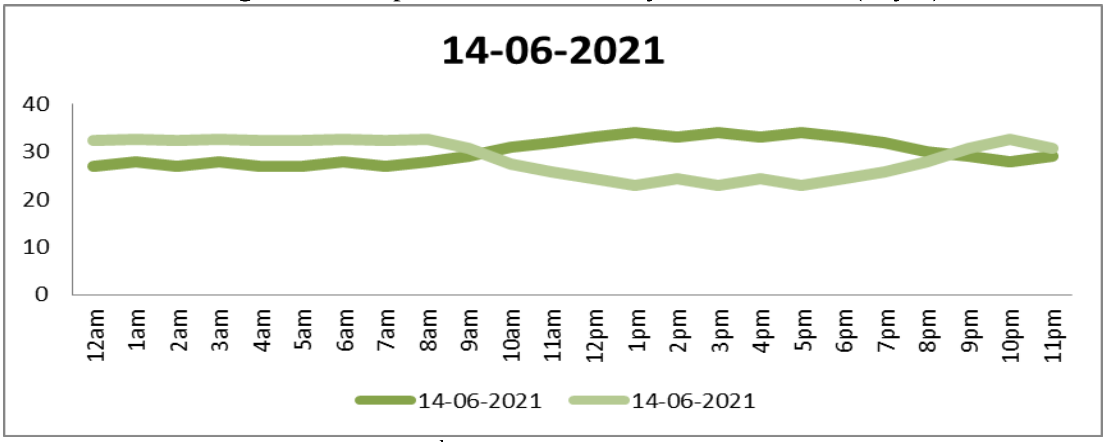


Figure 5 Predicted 3rd day value for motor condition ON or OFF

From these graphs an average value of temperature, humidity and rainfall(if any) triggers the motor module to water the crop. In figure 5, the thick green line indicates the motor ON state when no rainfalls to up keep the soil moisture. Thus parameters vary depending upon the placement of the module in the outdoor locations. Thus making the data collection to be independent of location and do the machine reading and make its own decision making in maintaining the threshold's.

CONCLUSION:

Based on above mentioned system setup, different levels of soil moisture and temperature value were sensed and based on predefined threshold value of soil moisture and temperature, Controller controls the high voltage farming equipment's without human intervention. In the absence of human being in the agriculture field, this system provides continuous field monitoring and triggers the appropriate events according to the requirement. The efficiency of the system can be increased by improving the machine reading, by increasing or decreasing the number of days data for more accuracy and updating the threshold values depending upon the crop and locality. The scope of the work can be extended to establish multiple modules that can share and interconnect with each other thus forming a sensor-based farming. It can share the data to the nearer weather station to know the up-coming weather changes. The module can be enhanced for supporting special sensors like biotic factors such as fungi, monera etc. whose early detection and eradication provide a better growth of the crop.

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