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Design and Implementation of IOT Based Smart Agriculture (ATM) System

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ABSTRACT

Agriculture plays vital role in the development of agricultural country. In India about 70% of population depends upon farming and one third of the nation's capital comes from farming. Issues concerning agriculture have been always hindering the development of the country. The only solution to this problem is smart agriculture by modernizing the current traditional methods of agriculture. Hence the project aims at making agriculture smart using automation and IoT technologies. The highlighting features of this project is Analyzing, Testing, and Monitoring (ATM). Analyzing site-specific crop depending upon the water and weather condition with the help of pre-defined parameter as well as with correct testing data's. Testing soil fertility which includes parameter like pH level, Temperature, Moisture, Light, Humidity, and Percentage of the essential mineral elements like Nitrogen, Phosphorus, and Potassium. Monitoring crop growth involved several process, by using electrochemical sensor system monitors the Moisture, Temperature and even essential minerals. Secondly it includes smart irrigation with smart control and intelligent decision making based on accurate real time field data. Thirdly it gives importance on crop protection tasks like weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance, etc. Controlling of all these operations will be through any remote smart device or computer connected to Internet and the operations will be performed by interfacing electrochemical sensors, IoT, Wi-Fi or ZigBee modules, camera and actuators with micro-controller and raspberry pi, smart water management.
Keywords : Electrochemical sensor, IoT, Actuators, Micro-controller, Raspberry Pi, Smart water management technique, solar panel.

I. INTRODUCTION

Agriculture is considered as the basis of life for the human species as it is the main source of food grains and other raw materials. It plays vital role in the growth of country's economy. It also provides large ample employment opportunities to the people. Growth in agricultural sector is necessary for the development of economic condition of the country.

Unfortunately, many farmers still use the traditional methods of farming which results in low yielding of crops and fruits. Hence there is need to implement modern science and technology in the agriculture sector for increasing the yield.

To make the sustainable and efficient agriculture production accurate measurement of soil nutrients are needed, including site-specific crop and water managements are essential. Soil fertility refers to the ability of the soil to supply essential plant nutrients, soil water in adequate amounts and proportions for plant growth and reproduction. Fitness of seedbed, impedance to seedling emergence and root penetration by providing nutrients and suitable soil structure in the absence of toxic substances which may inhibit plant growth.

Soil fertility can be calculated by parameters like pH level, temperature, Moisture, Percentage of Nitrogen, Phosphorus and Potassium. With the help of electrochemical sensor we are able to obtain the values of nitrogen, phosphorus, temperature, pH, Light Humidity etc. So with the combination all these electrochemical sensor we can acquire necessary information for testing process. Most of the papers signifies the use of wireless sensor network which collects the data from different types of sensors and then send it to main server using wireless protocol. The collected data provides the information about different environmental factors but it has to be monitored and analyzed now and then because environmental behavior changes drastically.

The newer scenario of decreasing water tables, drying up of rivers and tanks, unpredictable environment present an urgent need of proper utilization of water. To cope up with this use of temperature and wireless moisture sensor node at suitable locations for monitoring moisture level of soil and smart water management technique will be integrated.

II. RELEATED WORK

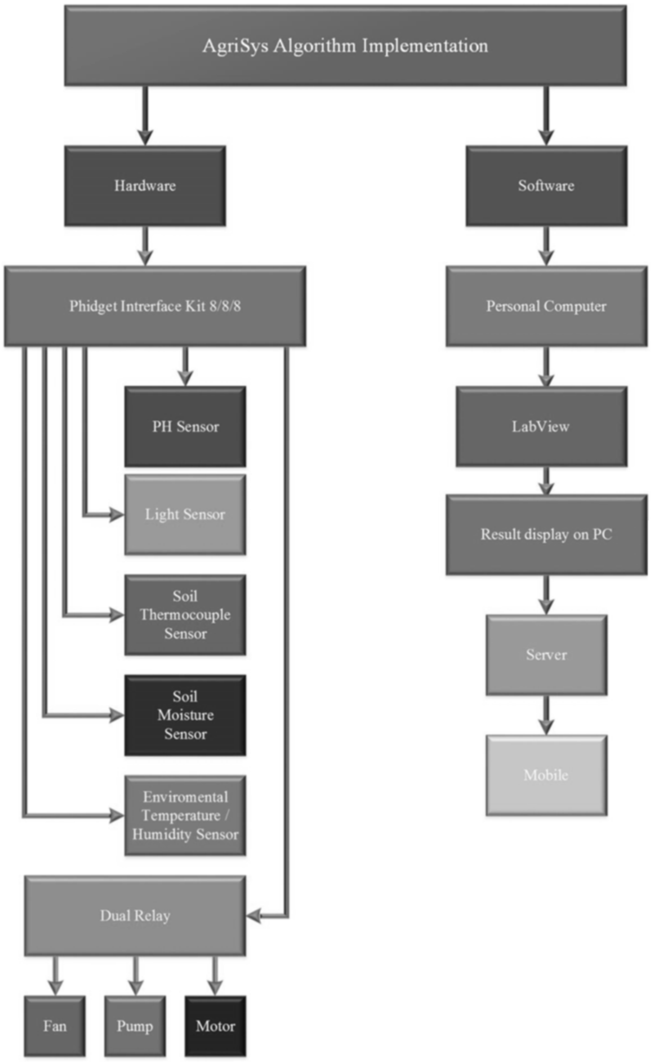

Figure 1. AgriSys Block Diagram [1]

In [1], the author designed and implemented Agri system by using both hardware and software especially hardware specification like Sense Temperature, Sense Humidity, Sense the water level, Sense the light, Sense the PH, Response to sensor readings to turn the pump or the fan on or off, Response light sensor by closing or opening the shutter all this sensor are interfaced to controller using Phidge interface kit 8/8/8. Figure 1 shows the system block diagram. Most of the sensor used in this system is analog in nature in order to check the soil fertility as well as soil moisture wire has to run through the field mobility of the system is considerably nil.

Drawbacks

System not having proper power management.
Irrigation system management not done.
Analog sensor consumes more power and it's also contribute system delay

III. SMART ANALYZING, TESTING AND MONITORING SYSTEM

The paper consist of three major parts Analysing, Testing, and Monitoring (ATM) system.

A. Analysing

First process is to check the water resource taking into consideration the rainfall pattern, soil types, texture, depth and physio-chemical properties, elevation, topography, major crops and the type of vegetation.

Input dataset consist of 6 year data with following parameters namely: year, State-Karnataka (28 districts), District, crop (cotton, groundnut, jowar, rice and wheat.), season (kharif, rabi, summer), area (in hectares), production (in tonnes), average temperature (°C), average rainfall (mm), soil, PH value, soil type, major fertilizers, nitrogen(kg/Ha), phosphorus (Kg/Ha), Potassium(Kg/Ha), minimum rainfall required, minimum temperature required [7].

- Dataset in agricultural sector
  https://data.gov.in/,
  http://raitamitra.kar.nic.in/statistics,
- Agriculture data of different districts
  http://14.139.94.101/fertimeter/Distkar.aspx,http://raitamitra.kar.nic.in/ENG/statistics.asp,

After doing Karnataka state agricultural big data analysis some of the valuable information acquired 70% of Karnataka's geographical area is classified as arid or semi-arid. 32% of the cultivated area is irrigated. The cultivable area of the state is 66.1%. This includes the net sown area (55.1%), cultivable wasteland (2.3%), current fallow lands (6.7) and other fallow lands (2.1%).

Agriculture is mainly dependent on the southwest monsoon but spreads well over three seasons:

Kharif: July to October; Accounting for 70% of the annual food grain and oilseed production; Major crops are millets, paddy, maize, pulses, groundnut, red chillies, cotton, soybean, sugarcane and turmeric; Cultivated area about 70 lakh hectares;

Rabi: October to March; Accounting for 22% of the annual food grain and 15% of the oilseed production; Major crops are wheat, barley, mustard, sesame, and peas; Cultivated area about 30 lakh hectares;

Summer: Accounting for 8% of the annual food grain and 15% of the oilseed production; Cultivated area about 6 lakh hectares.

Big data set has to load-ed in cloud ones enter a particular area code or pin code system displays proper analgised data to crop.

B. Testing

After analysing particular land, set of information displayed but all this data which is taken from cloud so real testing has to be done especially for pH as well as chemical comment present in particular land before start agriculture.

In order to do so different sensors and devices they are interconnected to one central server via wireless communication modules.

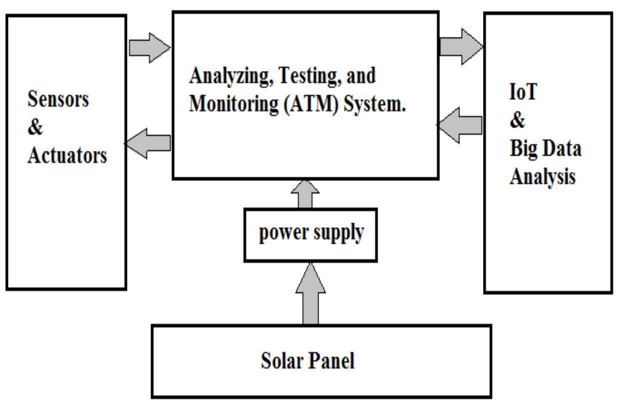

Figure 2. Smart Analysing, Testing and Monitoring (ATM) System

Wireless sensor measures soil moisture as well as temperature depending upon data it will start monitoring. Sensor, motor and actuators is connected to micro-controller more over all this devise powered by power supply which is charged by solar panel.

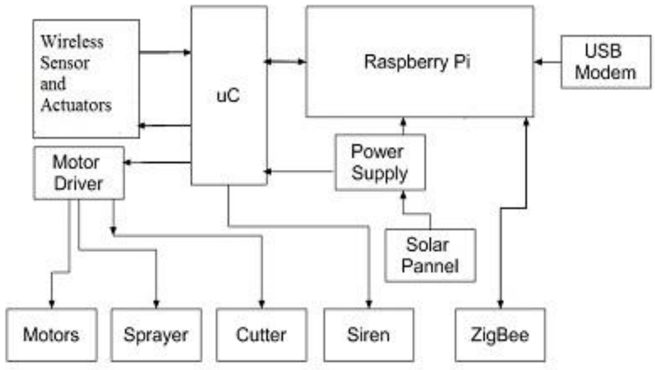

Figure 3. Smart (ATM) System Internal Architecture.

C. Monitoring

Agriculture is effected by external parameter any variation in the temp, pH and fertility it will directly effects on yields. It is very much essential to monitor all the parameter which is effecting.

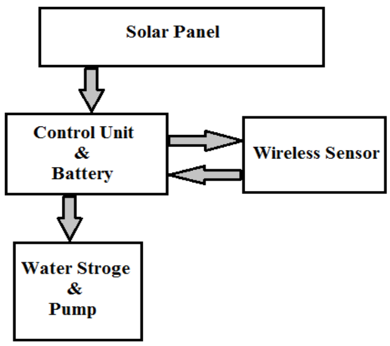

Figure 4. Smart water management

The conventional methods of irrigation like surface irrigation consumes lot of water now a day's water is truing into big issue in India. Smart irrigation system is very much essential to manage burring issues of water.

Few methods which has to be adopted for the better yield as well to overcome water problem.

- Drip Irrigation
- Sprinkler Irrigation
- Rainwater harvesting

In [4] Sprinklers of overhead type, flood type irrigation systems wets the lower leaves and stem of the plants. When irrigation is done by using such methods the soil surface is often saturated and stays wet for long time after irrigation is completed. These conditions leads to infections by leaf mould fungi. The flood type methods consume large amount of water and the intermediate area between crop rows remains dry and receives water only from incidental rainfall. In order to solve this problem the drip or trickle irrigation is used which is a type of modern irrigation technique that slowly applies small amounts of water to part of plant root zone.

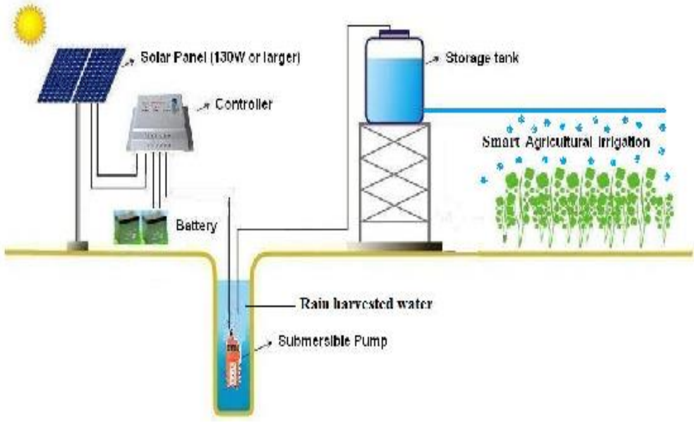

Figure 5. Rainwater Harvesting and Monitoring Technique

Rainwater harvesting and management is newly introduced to agriculture technically it has to be monitored and controlled. This system is nature friendly where zero power is consumed to operate because solar energy is used and solar energy is a renewable free source of energy that is sustainable and totally inexhaustible, unlike fossil fuels that are finite. Motor is operated through solar energy to pump water and it can be stored in over tank and depending upon the moisture sensor data water management unit will be activated this system is fully automatic.

IV. EXPERIMENTATION AND RESULTS

FAO addressed the relationship between crop yield and water use in the late seventies proposing a simple equation where relative yield reduction is related to the corresponding relative reduction in evapotranspiration (ET).

Specifically, the yield response to ET is expressed as:

$$\left[1-\frac{Ya}{Yx}\right] = Ky \left[1-\frac{ETa}{ETx}\right]$$

Where

- Yx and Ya are the maximum and actual yields,
- ETx and ETa are the maximum and actual evapotranspiration, and Ky is a yield response factor representing the effect of a reduction in evapotranspiration on yield losses.

The Ky values are crop specific and vary over the growing season according to growth stages

- Ky >1: crop response is very sensitive to water deficit with proportional larger yield reductions when water use is reduced because of stress.
- Ky <1: crop is more tolerant to water deficit, and recovers partially from stress, exhibiting less than proportional reductions in yield with reduced water use.
- Ky =1: yield reduction is directly proportional to reduced water use.

Based on the analysis of an extensive amount of the available literature on crop-yield and water relationships and deficit irrigation, Ky values were derived for several crops (Table 1).

Table.1. Seasonal Ky values from FAO Irrigation and Drainage

Crop	Ky	Crop	Ky
Alfalfa	1.1	Pepper	1.1
Banana	1.2-1.35	Potato	1.1
Beans	1.15	Safflower	0.8
Cabbage	0.95	Sorghum	0.9
Cotton	0.85	Soybean	0.85
Groundnuts	0.7	Spring wheat	1.15
Maize	1.25	Sugarcane	1.2
Onion	1.1	Sunflower	1.05
Peas	1.15	Tomato	0.95
watermelon	1.1	Winter wheat	1.05

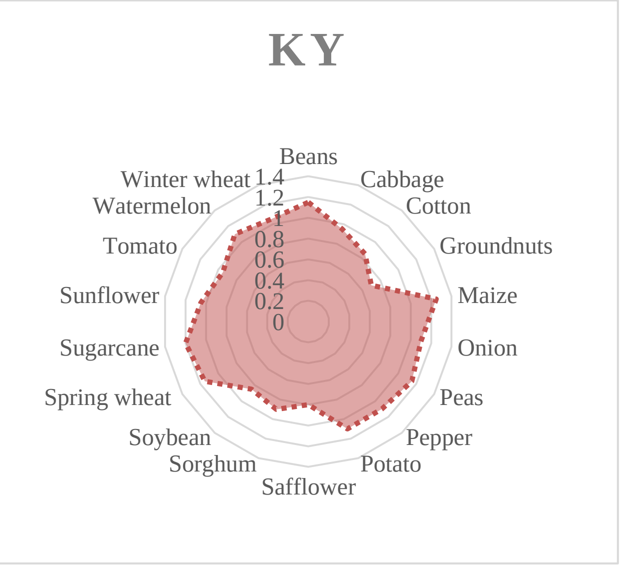

Figure 6. Crop vs yield response

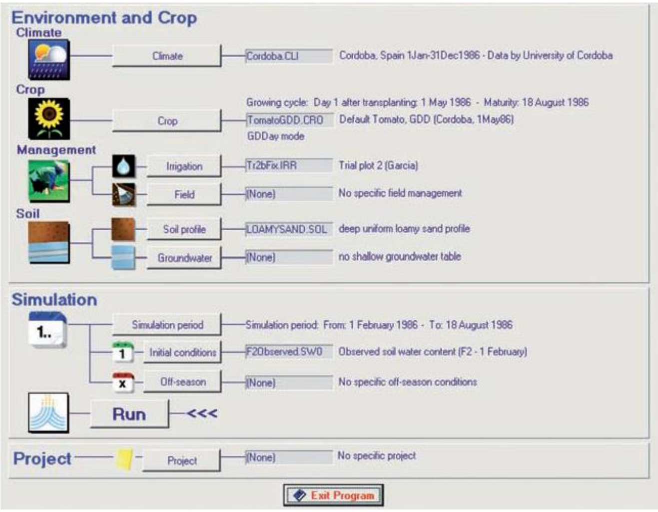

Figure 7. over view of Environment and Crop

Simulation result is shown in below fig after the complete analysis we come to the consultation which is noted below.

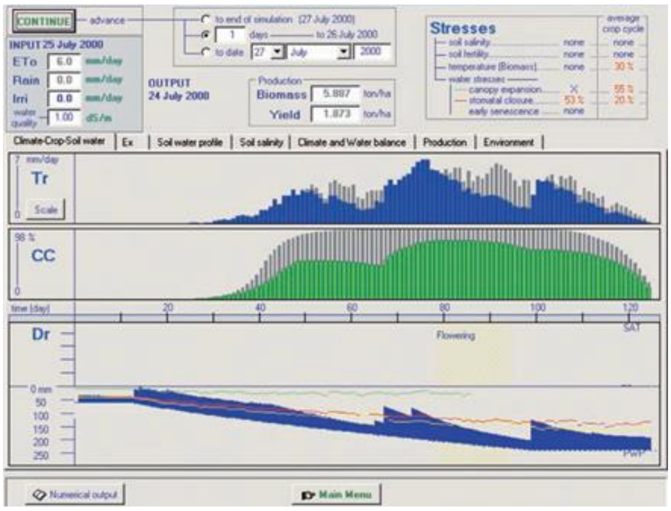

Figure 8. over view of Environment and Crop

- Yield increases by 5 - 10 times or even more.
- Uniform and better quality.
- Reduction in labour cost.
- Zero power consummation due to renewable energy.
- Less fertilizer requirement, thus reduction in fertilizer cost.
- Low water requirement thus saving in water.
- Less chances of disease attack, thus reduction in disease control cost.

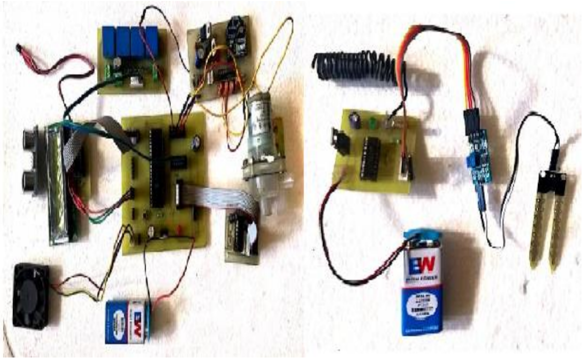

Figure 9. Implementation of IoT Based Smart Agriculture (ATM) System

- Higher Efficiency of Water & Fertilizer Use.
- Cultivation in problematic soil conditions.
- Cultivation in problematic climate conditions.
- Requires less area to get maximum yield and benefits.

Figure 10. Field View of Crops in Initial Stage

Figure 11. Field View of Crops

V. CONCULSION

IoT based fully Automated Analyzing, Testing, and Monitoring (ATM) system helps to choose the site-specific crop. System will test the soil fertility like essential minerals as well as moisture, humidity, temperature, pH level and gives correct feedback to the automatic system and as well as farmer. The aim of farmer is to produce “more crop per drop”, hence the system provides a real time feedback control module which monitors and controls all the activities of drip irrigation system efficiently. The system valves are turn

ON or OFF automatically depending upon the moisture content. Implementation of this system in the field improves the yields of the crops and overall production. Efficient way of using water will helps to overcome the water issues in agriculture. As agriculture productivity increases which directly influence on capital income. System uses natural resource-able energy so this system stepping stone to “zero defect zero effect system”.

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