# Smart Agricultural System: Better Accuracy and Productivity

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***Abstract- Agriculture is the root to country's economic development. In recent times, huge scientific advancement has been implemented in various agricultural fields for the betterment of the future. Despite of various researches, proper assessment and productivity couldn't be reached. We have tried to focus on different scientific applications which could be put together in agricultural field for better accuracy with better productivity using less man-power. Moreover we include a method for monitoring the agricultural fields from any remote location and assess the basic condition of the field. We also use solar tracking system to generate the required renewable power supply in agriculture fields that could lead to an eco-friendly way of energy production, leading to proper step towards next green world.***

***Keywords—AVR Microcontroller, Sensors, GSM, Renewable Energy, IOT.***

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## I. INTRODUCTION

Agricultural lands are the heart of any country for economic development. Thus it is the primary duty of the Government to preserve and protect the fields by any means. Science and new technologies have evolved but nothing could replace the dependency on agricultural farm lands. New technologies have been proposed for the betterment of the farmers, so that they can get a better result with more accuracy and less effort but with some limitations. [1, 2]

At present, India holds the 2nd positionin the farm output. Over 70% of the rural households depend on agriculture as their principal means of livelihood [3]. But the pressure on farms increased due to increase in population. Thereby, Per Capita availability of food grains went up to 528.77g per day, which was 395g in early fifties [4], which leads to more consumption of non- renewable energy.

Keeping in mind the practical problem faced by the farmers, we have tried to put forward an alternative agricultural model for the betterment of the next generation. We have implemented various modules like soil moisture sensor, pH sensor, humidity sensor, temperature sensor, electronic scarecrow (PIR sensor), GSM under a single agriculture system to make it smarter. We have also tried to use solar tracker power system as an alternative energy source. We have also incorporated remote monitoring of the system, control of water pump through cell phones, keeping track of more than one field and assessing the records of each field for future study, under a single system. As it may be a smart move towards the next generation agriculture, thus it can be called as 'Smart Agriculture System'.

## II. PROBLEMS FACED

Nearly 80% of the 140 million Indian farming families holds 2 acres of land. As land holdings are small, more people invariably work on the farms in rural areas and coupled with the obsolete technology of traditional manual methods, thus productivity gets limited and farm incomes come down.

### *A. Inefficient Soil & Surrounding Condition Testing*

Sometimes it happen when the seeds failed to germinate properly or abnormal growth or dysfunction of a plant (ex. white mole). The reasons could be improper soil preparation, planting in cold soil, extremes of watering, improper use of fertilizer etc. It is very much disappointing to have prepared the soil and sown the seed, only to have a partial or complete failure of germination or dysfunction. That's the reason it is very much essential to test the soil before seeding. Only by seeing the field or by experience it is quite difficult to get an accurate assumption of the soil moisture, pH level, temperature and humidity. It is impossible for the farmers to keep update about the conditions of the agricultural lands all the time.

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### *B. Poor Irrigation System*

Water has a huge impact on the on food production. Farmers has to manually control the water pump at regular interval. They may have to travel a long distance only for switch ON the pump and wait until the pump has to be switched OFF. Which results in waste of time.

### *C. Non-Reliable Power Supply*

Throughout India, the supply of electric power falls short of the country's needs. The supply of power to Indian agriculture, vital for successful irrigation, is in particularly grave condition. Due to the erratic electric power and maximum of the farm land are out of electricity service, farmers have to purchase unnecessarily high-powered electric pumps and alternate diesel pumps results in increase of the maintenance cost.

### *D. Incompetent Scarecrow*

Many crops are damaged by birds, with a little knowledge available of actual economic loss is done by House Sparrows, House Crow etc. Often animals are derided as pests as they cause damage to agriculture by feeding on crops or parasitizing livestock. Farmers generally keep a scarecrow in the land to distract the birds but birds getting cleverer and they ignore those scarecrows as they don't take any action, and also it is impossible for the farmers to remain all the time in the field to them away from the farms.

### *E. Lack of Data Management System*

When a farmer have to manage more than one field, due to the lack of proper technology he/she has to memorize all the condition (or status) of the fields and take appropriate decisions but there is a chance that farmer may not memorize properly and takes a wrong decision.

## III. METHODOLOGY& SYSTEM DESIGN

To solve the above mentioned problems and to reduce the manual effort of the farmers we took a step towards automation and develop these smart system and here, we address each and every module as a component of the "Smart Agricultural System".

### *A. Development Board*

Instead of using the popular and common Arduino boards, we have design and implemented a "Development Board", having the same features as of the market available microcontroller boards but with some extra facilities such as almost double the number of input and output pins compatible with Arduino IDE as well as it is cost efficient.

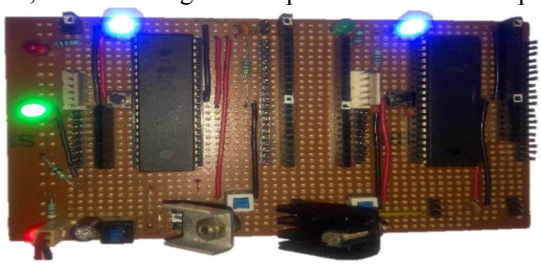

*Fig.1: Development Board*

The Development Board is made with 2 microcontrollers (ATMEGA 16 AVR microcontroller) and having 12volt and 5 volt exact output with individual power control. We named it as *'Individual Power Controlled Dual µ-controller Facility based Development Board'*. Security of the board is high as we have used high watt components instead of SMD components. More than 10 peripherals can be added to our Development Board**.** We can also burn the programs by parallel programming using USBASP programmer.

### *B. Soil & Surrounding Testing Module*

A solution to resolve the difficulty of manual soil testing and the surrounding environment as discussed in the previous section (i.e., II. A) will be very much helpful for the farmers. An automated analysis can be done by this module with which a farmer will be aware of the soil moisture level, pH, temperature, humidity. It will be further helpful for the farmer to make the decision that if seeds can be sprout or more water and fertilizer is required or not. The module will show every details of the soil condition on a LCD screen. The module is made of different sensors like moisture sensor (YL69), temperature sensor (LM35), pH sensor (SEN0161), humidity sensor (DHT11).By pressing a button a farmer can know about various conditions of the soil. It helps the farmer to increase the knowledge of the environment.

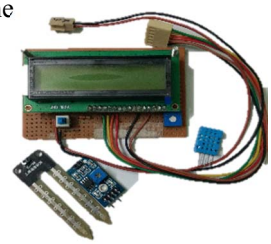

*Fig.2: Soil and Surrounding testing Module*

### *C. Water Pump ON/OFF via Phone Call*

In recent times, the farmers have been using irrigation technique through the manual control in which the farmers irrigate the land at regular intervals by turning the water-pump ON/OFF when required. In this condition, they have to face many difficulties as we have discussed earlier. To deal with this immense problem we figure out a module by which water-pump on the field can be controlled (ON/OFF) by a simple phone call from a remote location [6, 7].

*Fig.3: GSM Module (SIM 900A)*

It will become an effective helping hand for the farmer as this module can reduce so much of manual hard work. Using the soil testing module (Section III. A), a farmer can get exact knowledge about the detail conditions of the agriculture field of concern, and then if it is required to feed water on the land at that time, just a call to the given number can switch on the water-pump and another call can switch it off when it is

done. In a much more practical and complicated scenario, if a farmer has more than one field to serve and the different fields need to feed water on different time with different amount of requirements, then also this module performs that kind of job perfectly with great efficiency. This module has a text receiving capability. A text message to the module can switch ON/OFF the pump depending upon the content of the message. If the text message contents a '1' then the water pump on land '1' will be started and the remaining pumps will be off. Similarly if the message is '2' then the water pump on land '2' will be started and so on. A '0' text to the module can switch off all the pumps simultaneously. In near future this module will iron out many problems and will be a huge help to the field workers.

### *D. Solar Tracking System (Renewable Power Supply)*

As discussed in the previous section (i.e., II. C) about the power supply problem in villages and farm lands. An alternative energy source is badly required. Now a day, the best alternative is to use a renewable energy source and more precisely is the 'Solar Energy'. Solar energy technology is not yet mature enough to be widely accepted as a primary energy source for the general population, it does have some unique advantages.

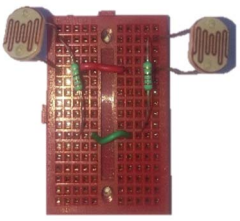

*Fig.4: LDR Sensor*

Considering the need of renewable energy source we develop this module known as the solar tracker to supply the electricity required for the farmland and perform as an alternative power source. A solar tracker is a device that orients a solar panel towards the direction of the Sun. For flat-panel photovoltaic systems, trackers are used to minimize the angle of incidence between the incoming sunlight and a photovoltaic panel. This module, we have made, is basically an automatic single axis solar tracker. Here Light Dependent Resistance (LDR) is used for sensing the sun light direction. The panel will automatically rotate towards the sun to get the maximum intensity of light and is able to concentrate as much energy as possible.

### *E. Electronic Scarecrow*

Problems caused by the birds as discussed in the previous section (i.e., II. D), pretty strong equipment is required to help the farmer to get rid of this unsustainable problem. So, when it comes to keep birds, raccoons and other pests away from the farmland, the Electronic Scarecrow (PIR sensor) Unit is one of the best ideas we have encountered.

*Fig.5: PIR Sensor (HC-SR501)*

Electronic scarecrow can be used to keep pests off from farmland. It is not like an ordinary scarecrow, used to distract or to scare the birds or animals, but a unique module to keep the threats away from the crops. PIR sensors is made of pyro-electric material which has two slots in it. When a object like bird passes by, it first intercepts one half of the sensor which causes +ve differential change between the two halves and when the object leaves the reverse happens which generate a –ve differential change, thus change of pulses are detected. HT-7133 voltage regulator, BIS0001 micro power PIR motion detector IC, Fresnel lens helps for the operation. When any object is detected the unit will perform some actions to keep them away from the crops. A buzzer may be used in this module to make a noise to keep the unwanted species away.

### *F. Automatic Field Light*

There are many people having hobby gardening and farming, for those beautification is a must have matter. In recent time we are habituated with automatic devices. That is why we develop lights that are able to turn on automatically when there is no light in the surroundings and it will switch off automatically when there is another source of light. It can be turn ON/OFF manually also. This light has light detecting sensors build in so that they can track the presence of light. It is very much useful, cost efficient.

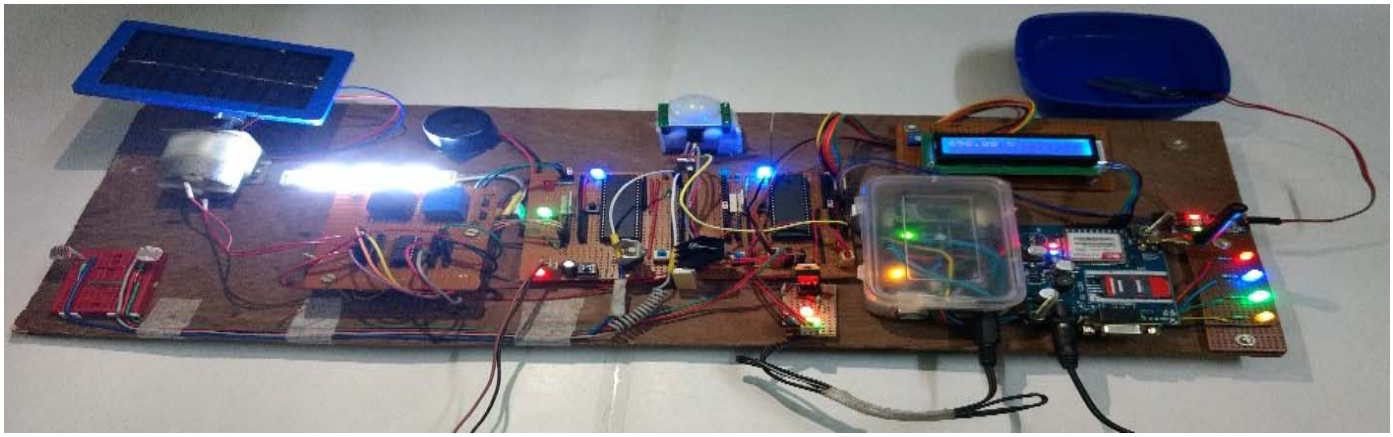

*Fig.6:Small-Scale Experimental Model setup of "Smart Agriculture System"*

## IV. EXPERIMENTAL ANALYSIS

An experiment was conducted using the soil testing module to investigate some essential factors in our test field. Measurements were performed by the system and the variation of temperature; soil moisture level and humidity were observed over an approximately 24 hour time period. Figure 7 (a), (b) & (c) show the plots of temperature, dryness level and humidity variation with time and its sixth degree polynomial curve fitted plots respectively. The coefficients of the corresponding polynomials are given below the curve fitted equations (1), (2) & (3) respectively.

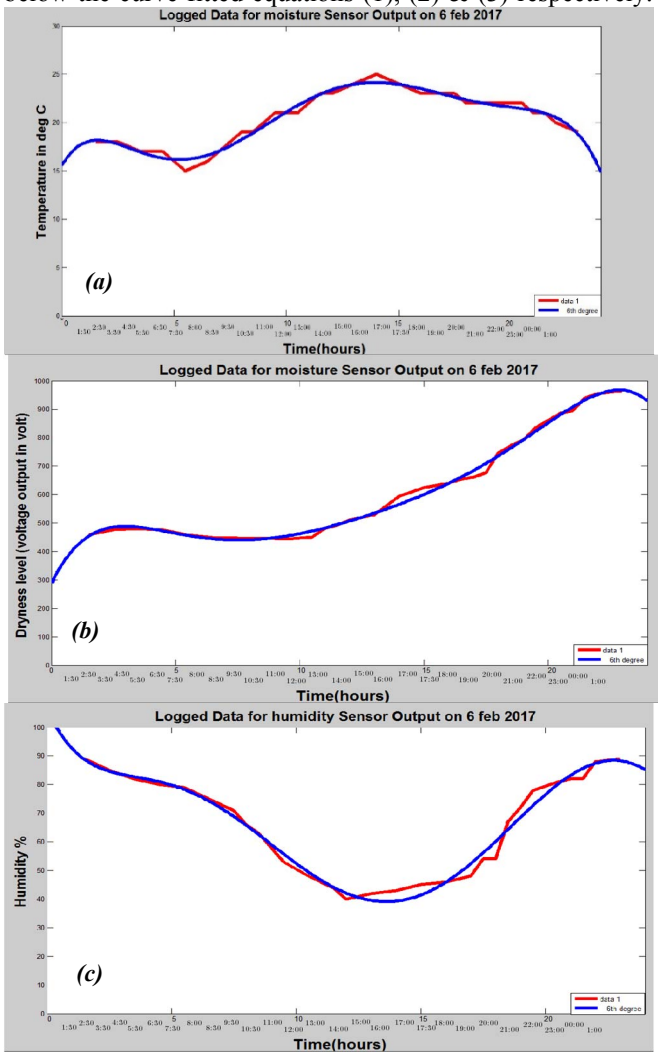


*Fig.7: Experimental measurements and sixth order fit to (a) temperature, (b) dryness level and (c) humidity verses time*

$$\text{Temp (y)} = (p1 \times x^6) + (p2 \times x^5) + (p3 \times x^4) + (p4 \times x^3) + (p5 \times x^2) + (p6 \times x^1) + p7 \quad \ldots.(1)$$

Where, coefficients are: p1 $= -1.369e-005$, p2 = 0.0010094, p3 = $-0.028021$, p4 = 0.35539, p5 = $-1.9697$, p6 = 4.0112, p7 = 15.508 and x=time.

Similarly dryness level and humidity can be approximated using the following curve fitted equations:

$$\text{Dryness level} = (p1 \times x^6) + (p2 \times x^5) + (p3 \times x^4) + (p4 \times x^{3)}) + (p5 \times x^2) + (p6 \times x^1) + p7 \quad \ldots.. (2)$$

Where coefficients are: p1 $= 2.4881e-005$, p2 = $-0.0021949$, p3 = 0.070192, p4 = $-0.99135$, p5 = 6.2068, p6 = $-19.06$, p7 = 106.5 and x=time.

$$\text{Humidity } (y'') = (p1 \times x^6) + (p2 \times x^5) + (p3 \times x^4) + (p4 \times x^3) + (p5 \times x^2) + (p6 \times x^1) + p7 \quad \ldots. (3)$$

Where coefficients are: p1 = $2.4881e-005$, p2 = -0.0021949, p3 = 0.070192, p4 = -0.99135, p5 = 6.2068, p6 = -19.06, p7 = 106.5 and x=time.

## V. MODES OF OPERATION

The modules have different modes of operation and application based on their necessity and ease of use. It is quite obvious that in every aspect and situation there are many unavailable resources to use modern technology.

### *A. Wired System*

The very basic way to develop any electronic device and connect it to the peripherals is to use wires. Every module in this project can be coupled with the peripheral machines which is necessary in the villages as there is no advanced technologies which can be used.

### *B. Wireless System*

21st century is the era of advance technology. Therefore those who want to use this system without the complexity of wires, our modules can be used through devices like Bluetooth, Wi-Fi as a mean of communication.

### *C. Smart Phone Application*

Today's consumers are spending over 85 percent of their time on their smart phones using native application. On account of that scenario our modules can be very helpful for the modern day consumers whose hobby is gardening and also farmers. As they are habituated with the use of smart phone application, counting that we have developed an application for android that can control all the modules simultaneously and with ease of use. This application is associated with all the modules and any user can easily control and track down the components [6, 7].

### *D. Internet of Things (IOT) System*

Internet is the medium that connects the whole world together. This system is connected to the open source platform so that all the data that is gathered from the farmland can be stored to a database for future use. Based on the data stored any expert can give advice to the farmers what to do next for the improvement of their land. Remembering that in our country, the agriculture systems are too old fashion; it is the high time to use the technologies available for betterment of our society. Considering that we combine the IOT system with the smart agriculture system for future development [6,7]

**Table – 1: Overall view of the "Smart Agriculture System"**

| Sl.No. | Modules | Cost* (INR) | Covering Area | Productivity | User Feedback** |
|---|---|---|---|---|---|
| 1 | Without the system | | | Normal | |
| 2 | With temperature & humidity testing | 300+ | Area around the sensors | Better than above | Helpful & accurate |
| 3 | With soil moisture & pH testing | 300+ | Soil with a radius of 10cm, semi spherically downward of the sensor | Better than above | More helpful & accurate |
| 4 | With electronic scare-crow system | 250+ | Range is up to 10 meters at an angle of ± 15 degrees. | High | Very helpful & crops are safe from birds |
| 5 | With water pump start via a call or text | 900+ | Depends on the used Sim card service area | High | Very much helpful as it has reduced the manual effort & saves useful time |
| 6 | With two or more field study setup | 100 to 500+ | Depends on Mode of operation | Better | Helps to reduce the dependency on memorization |
| 7 | Solar tracking system | Depends on no of solar panels | | Indirectly help for better production | Helpful , removed the electricity & non-renewable energy problem |
| 8 | With the complete system | 2000+ (Panels are not included) | Depends on every modules of the system | Maximum | Most popular as it makes the process very efficient with minimum man-power requirement |

* Cost can be effectively reduced with industrial implementation.
** System installed in Nurseries and feedbacks are collected from there. [8]

## VI. CONCLUSION

There are many reasons to implement a smart agriculture solution into commercial and local farming as well as in different agriculture related institutions and organizations. In a world where the Internet of Things (IOT) is accelerating adoption of automation and data gathering, an important industry such as agriculture can surely be benefited and our project of making agriculture in a smarter way will definitely help in the growth of this industry.

- By testing the soil with our module, farmers and gardeners will have an accurate data on the condition of the soil i.e. the temperature, pH, moisture level and also the humidity of the surrounding.
- Testing soil helps to increase the productivity by identifying soil nutrients or soil chemical factors that are limiting plant growth and increases fertilizer use efficiency by indicating appropriate rates for different soils and crops.
- The Electronic Scarecrow is an Effective Deterrent for several reasons such as it can work day and night without chemicals and can be linked to other Scarecrows. The animals and pests will be far away from the farm land.
- One Scarecrow covers around 5 meters and can operate up to 6 months on a single 9 volt battery.
- The GSM module in this smart system will help the farmers to reduce their work load, water pumps can be controlled via Phone calls or texts. There is no need to walk to the field just to start the pump, and wait until the time when it has to be stopped.
- Solar tracking device and the auto garden light control will help to save energy and use the renewable energy source. The electricity problem of villages can be solved up to some extent.
- 'Smart Agriculture Solution' can be used in so many platforms or organizations related to agriculture or cultivation. Ex- Farmers, Gardeners, Institute of Food and Agricultural Sciences, Ministry of agriculture, Horticulture: Greenhouse Cultivation, Nursery Cultivation.

'Smart Agriculture System' will help the agriculture industry in direct likewise indirect way. This system includes the smart phone application and IOT integration will help to use the advanced technology.

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