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# Leveraging Innovation for Smart Agricultural Field

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***Abstract:* -- Indian culture is agriculture and is the backbone of more than 60 percent people of India, who are highly dependent on monsoon. Drastic increase in India's population will lead to food and animal feed problem in next 20 to 30 years. Food is the basic need for the survival of one's life. The main objective of this paper is to provide a smart technique to create interest in the farmers to grow crops and to increase the yield by incorporating several smart techniques and the data is uploaded to cloud and the necessary actions are taken dynamically by the controller without the intervention of the farmer with the help of Internet of Things (IOT). Sensors and Actuator reading are processed and driven by Arduino Mega Microcontroller.**

***Keywords:* -- Smart field, Internet of Things (IOT), Moisture sensor, cloud storage, Irrigation, Arduino Mega Microcontroller**

## I. INTRODUCTION

Agriculture plays a vital role in the development and growth of countries economy. Agriculture has a significant role in the socio-economic fabric of India. India is the 7th largest agricultural exporter worldwide. Indian agriculture is gamble with rain, which is not a stable source of water. And the population growth in India is dragging the development of agriculture and it may lead to a serious food crisis in future [1]. To overcome these difficulties several techniques have been incorporated till date, one of the best techniques is to make use of IOT, to perform smart irrigation.

Nowadays many farmers are losing interest in growing and cultivation of crops due to several natural hurdles and lack of support from the government to the farmers in terms of financial support or by providing them with enough pesticides and proper water supply for cultivation of crops [2]. As many farmers' tries to get good yield in the crops which increases the wealth of the family and also helps in countries economic conditions. Opening and closing of solenoid valves limits the wastage of water and pesticides. Arduino Microcontroller is used to open/ close the valves based on controlled action and moisture sensor readings [3] [4].

This technique will reduce the risk taken by the farmers during irrigation, such as water supply, distribution of fertilizer, sprinkling of pesticides etc. For example, a human may not be able to distribute fertilizers and water to a perfect amount required. He may supply more or less, whereas a robot can supply exactly the amount of fertilizer and water that is been required. And through IOT one can get updated what is exactly happening in their farm.

Arduino microcontroller is preferred as it is a open-source physical computing platform with a development environment for writing software for the board and also a open source extensible hardware. It is a tiny computer which can be programmed and is having completely standalone features. It is also used to communicate with other devices. The microcontroller is an open source and extensible software and hardware with simple clear programming environment. The board is inexpensive and offers cross-platform and programming is easy and it supports lot many features when compared to other vendors available in the market. The soil moisture sensors readings are fetched by the

Arduino microcontroller through the analog pins as shown in Fig. 1. When the sensor reading is less than the threshold value, the Arduino microcontroller opens the corresponding solenoid valve making the water to flow inside it. The same data is displayed on the serial monitor and is uploaded to the cloud which can be accessed from any part of the worlds.

Most of the crop is spoiled by rodents, birds, or intervention of intruder persons. To detect it PIR sensor is used to detect living beings with the help of heat detection estimation. Whenever an intruder is detected, noisy sound is produced which cause irritation in birds/ animals ears, and hence intruders can be avoided in the agricultural field. Similarly to increase yield and to avoid crop damage pesticides need to be sprayed often at some particular stages as per the plant growth. Even upon using the masks by the farmers at the time of spraying the pesticides, some particles may enter into the human eyes or nose or inside the mouth, which may cause several health issues in the farmer. To spray the pesticides according to the need of the plant, Quadcopter is used which will spray the pesticides whenever there is a need and the pesticides are sprayed when the solenoid valve is closed. The number of solenoid valves depends on number of soil moisture sensor placed in the field. It was estimated that for every 8 seconds, 1 liter of water moved out of solenoid valve, by this calculation mechanism, Arduino microcontroller can estimate the number of liters/ gallons of water being consumed in the field when the solenoid valve is kept open. Ardunio microcontroller is preferred as it supports open source software and open source hardware platforms. It is a tiny computer with inextensible hardware, completely stand alone, talk to other devices. IOT programs can be easily programmed in Arduino. It acts like a stand-alone PC. It supports cross platform and is inexpensive.

Arduino Mega Microcontroller has abundant digital pins, analog pins and has several PWM pins. Atmega328 is used as an IC and is used for progamming the controller. Voltage given to it is of the order of 3.5V to 12V. The DC available voltage is 3.3V and 5V. Similarly the currnet through the microcontroller should not exceed more than 500mA for the circuit to operate in safe condition. The microcontroller can be powered up by USB powered or by external DC power supply. Reset pin is internally connected to pin2 of the microcontroller and for testing purpose pin13 can be used. Sprinkling of water, spraying of pesticides will be carried out by Quadcopter automatically. The total amount of water that flows into the field is the absolute sum of m solenoid valves, where m is the number of solenoid valves that were installed in the field.

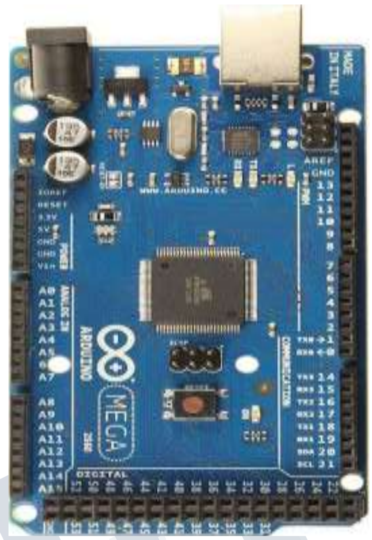

*Figure 1 Arduino mega Microcontroller*

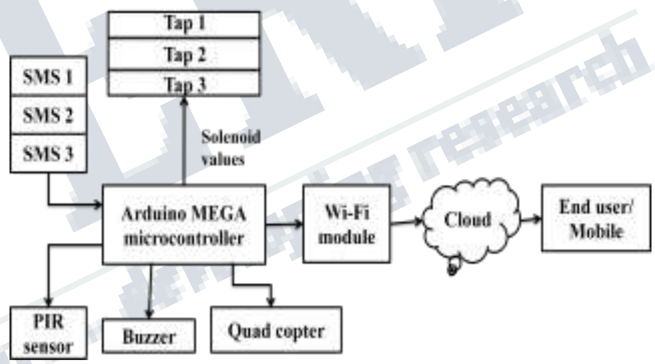


*Figure 2 Block Diagram of Smart field Implementation*

The Soil moisture sensor is connected to analog pins of Arduino Microcontroller, from which continuously the data is polled. Whenever the sensor data is less than the specified threshold value, it tells us that water level in the soil is less (dry soil). Then the microcontroller triggers corresponding solenoid valve, thereby supplying the water for limited amount of time. The microcontroller correspondingly updates the data onto the cloud and the same is informed to the end user as shown in Fig. 2. When timed out, microcontroller informs the Quadcopter to spray the pesticides, thereby spraying of pesticides is carried out automatically without the intervention of the end user. Quadcopter communicates to microcontroller via Wi-Fi. Depending on the voltage level that is applied, solenoid

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During night time PIR sensor monitors the intruder intervention in the field, when it detects, buzzer is turned ON, thereby it causes irritation in the intruder's ears. The message is passed to the end user via cloud storage (Wi-Fi device). For Demo purpose in this project three sensors data have been incorporated, similarly to implement in the smart field, few hundreds of sensors need to be placed. Thereby multiple controllers are used which forms a controller HUB in the field. The essential need for this process to happen is internet connectivity without which the information can't be shared to the end user.

## II. RELATED WORK

Plants can be planted on the specified location in the field based on Smart card or by RFID tags, for accurate locations one can make use of GPS sensor. For precision farming above techniques can be incorporated. Apart from precision farming, location tracking, monitoring and management of plants can be planted. Remote automatic control system of planting trees consists of integrated control system, wireless networking system, intelligent terminal devices can be controlled through end user [1].

As the population is drastically increasing, number of building are raised up more resulting in deforestation and resulting in lesser pond/ lake area which results in water scarcity for growing crops by the farmers. As the monsoon in India can't be predictable and most of the farmers are excessively dependent of natural rainfall, their crop yield is entirely dependent on the rainfall. To overcome this problem, soil sensor is used, whenever the land is dry, immediately the water is pumped into the field by the microcontroller via motors/ pump set [4]

The threshold values of soil moisture and temperature is programmed using microcontroller for controlling water flow, the system is powered up with photo voltaic panels which has a duplex communication through internet on a webpage as explained in [5].
IOT concept became popular in late 1999 at MIT for market analysis. Estimation of water that is used for irrigation is estimated in this paper [6] which makes use of wireless Bluetooth technology. The main disadvantage is the wireless communication is limited to 10m range and hence this technology couldn't raise popularity. In late 2009, scheduling policy in power supply to the sensor raised popularity. As explained in [7]

However the technology shows lack of interoperability which is the essential method when considering the large agricultural fields and is explained in [9]. The concept of gathering data aggregation and computing the sensor data via zigbee technology as explained in [10]. To improve accuracy and precision more sensors and high quality sensors are used. However incorporating this method consumes more power as many nodes need to be deployed. The data about the crops, land and water being consumed will be sent to end user at real time as explained in [11].
Implementation design

### 1) *Soil Moisture sensor*

Soil moisture sensor is used to measure the water content that is present in the soil (field) based on electrical resistance or by dielectric constant. Depending on the environmental conditions, moisture sensor needs to be calibrated for determining the moisture data. Practically soil moisture sensor is placed into the soil, whenever the sensor readings are below the calibrated threshold level, controlling action is chosen in such a way that microcontroller commands the solenoid valve and hence water is made to flow until the soil gets wet completely. Simultaneously water flow is estimated in liters consumed per unit time and the data is uploaded onto the cloud. For 10 seconds of duration, one liter of water is made to flow. Suppose, if the water is made to flow for N minutes. Total water flowing through solenoid valve is given by,Amount of water being flowed per solenoid valve = 6 * N ltr $min^{-1}$ slot $^{-1}$

### 2) *Internet of Things (IOT)*

IOT is an upcoming technology where things are connected to internet. IOT is an intelligent technology which includes interfacing sensors and actuators with the product. IOT is a combination of ubiquitous network, intelligent sensing network, cloud computing. A Ubiquitous network includes GPS, WLAN, 3G/ 4G, Zigbee, RFID, Bluetooth and many other wireless technologies.

### 3) *Flowchart*

Initialize all the hardware peripherals (controller, PIR sensor etc), PIR sensor is interfaced with analog pins of Arduino microcontroller. Continuous monitoring of intruders helps the farmers to save his

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crops. The controller continuously monitors for intruders. If intruder found, buzzer is made to blow, this causes irritation in intruders ears and the same is updated in the cloud and also conveyed to the end user as shown in the Fig. 3.

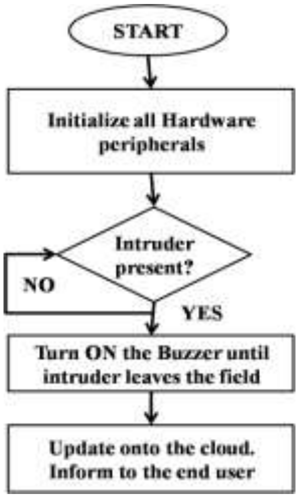


*Figure 3 Flowchart to detect an Intruder*

Initialize all the hardware peripherals; supplying water to the field has to be planned properly. Soil moisture sensors data are accessed for every unit intervals of time, when soil moisture sensor specifies the reading that is below threshold value, this indicates to the microcontroller that the water quantity in the soil is less. To overcome it, water is supplied through the corresponding solenoid valve.

A counter is kept to monitor the duration of the water flow, the microcontroller upon closing the solenoid valve determines the amount of water that is flowed out of the tap into the field. This decision is also taken based on Soil moisture sensor reading which indicates the degree of wetness in the soil and is explained in the Fig. 4 If moisture in the soil is less, soil moisture sensor is indicated with the signal value Pr and if moisture in the soil is more, soil moisture sensor is indicated with the signal value AB. The cost of implementing the above mechanism is simple and more effective when compared to other agricultural/ irrigation techniques as our modules make use of low cost Soil moisture sensors, PIR sensors, buzzer as actuators which are readily available in the market at lower cost. Hence, to implement it farmers need financial support from the government so that these techniques can be adapted in their field.

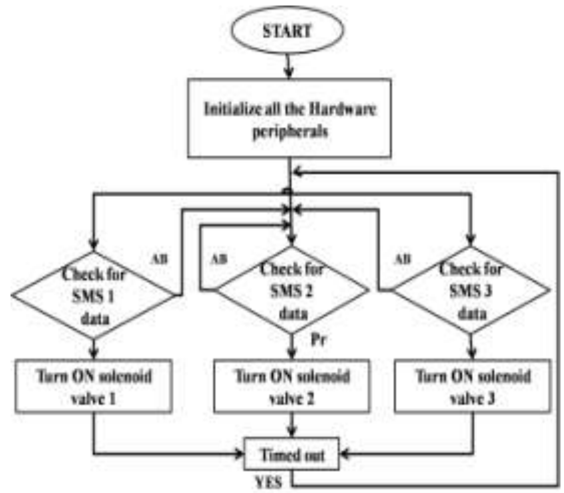


*Figure 4 Flowchart to detect whether the soil is dry or not*

## III. SIMULATION RESULTS

The PIR sensor readings are fetched from the Arduino microcontroller's Serial monitor platform. The data is recorded as a .txt file and is computed in MATLAB for plotting the graph.

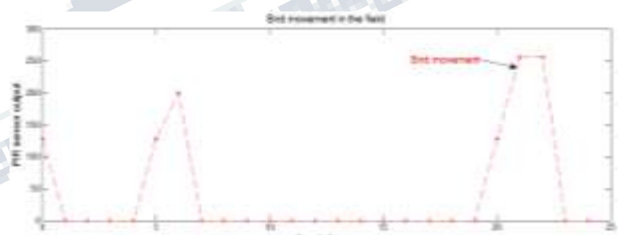

*Figure 5 Birds or Animal movement in the field*

The Fig 5 shows the bird movement in the field that was extracted throughout the day from PIR sensor. The graph shows that the birds/ animals enter into the field after 7'0 clock (AM) and stays in the field up to late 11'0 clock. At morning time, birds enter into the field early in the morning by 4.00 AM and stays over their till the farmer arrives.

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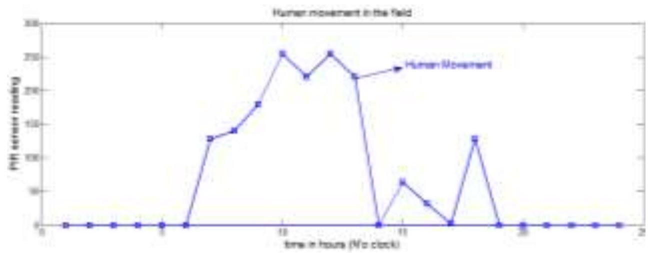

*Figure 6 Human movement in the field*

Fig 6 shows the movement of farmer in the field and the figure shows that the farmer arrives to the farm early in the morning by 6.00 AM and stays over there throughout the day. The degradation curve indicates the farmer moving apart from the specified area/ location.

*Figure 7Bird movement as well as Human movement in the field*

Fig. 7 represents the combined graph of human movement as well as trespassers (Birds/ animals) movement inside the farm/ field. The blue colored line indicates the human movement, and the red colored line indicates the bird movement. The X axis of the graph represents the time in hours (in a day).

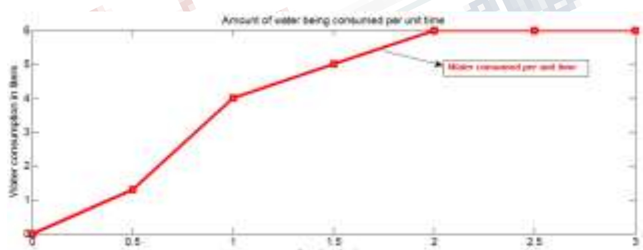

*Figure 8 Amount of water being consumed when the solenoid valve was kept open*

Fig. 8 describes the amount of water that was consumed or let into the field when the solenoid valve was kept open. Amount of water that flows into the field is estimated depending on the type of crop and the type of soil.

## IV. CONCLUSION AND FUTURE SCOPE

The main purpose of this paper is to help the farmers to increase the yield of the crop. This also explains about the need of smart field technology and its working. It also explains the merits of using smart field technology. This idea can be further enhanced by incorporating smart plantation with the help of cameras and microcontrollers. And for power constraints one can make use of solar panels, solar batteries.

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