Smart Cultivation

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***Abstract*— Agriculture is considered as the backbone of any country's economy. It is instrumental in providing employment to a large section of the society, especially in India. A large part of agricultural related work is still carried out manually and is subject to evaluation of various aspects based on experience of farmers which at most times result in decreased yield in terms of quality as well as quantity. In today's era, with a proliferated growth in the field of wireless sensor networks and IoT, precision agriculture is a promising approach to reduce human labor while providing increased crop yield. The project aims to design a system to incorporate precision agriculture as well as automation of certain farm processes using wireless sensor networks and IoT technology. This system will provide reliable guidelines to farmers as to which crop to grow and approximate yield expected. It caters to monitoring soil moisture and thereby automatic operation of irrigation pumps. It also enables the farmer to keep a check on farm intrusion by animals or unauthorized persons. Additionally, the farmer will be intimated about the various actuations that take place on the farm using Global System for Mobile communication (GSM) module.**

Keywords— ***Irrigation, Intruder detection, IoT, Agriculture, Arduino, Smart farming***

I. INTRODUCTION

Agriculture is regarded as the basis of life for the human species as it is the main source of food grains and other raw materials. Growth in the agricultural sector is necessary for the overall improvement of the economy of a country. It is instrumental in providing employment opportunities to a very large proportion of the population, especially in India. The manual collection of data and human intervention in the field is labor-intensive. Automation of data collection at regular and frequent intervals reduces labor requirements and costs. Unfortunately, many farmers still use the traditional methods of farming which leads them towards low yielding of crops and fruits.

The use of technology or more specifically precision agriculture can aid in improved yield of higher quality while parallelly enabling farmers to be more aware of critical aspects such as choice of crop, administering fertilizer and pesticides, etc. Systems developed typically use wireless sensor networks to collect data from different types of sensors and then send it to the main server using wireless protocol. The collected data provides information about different environmental factors which in turn helps to monitor the system by operating certain actuators. Monitoring environmental factors are not a sufficient solution to improve the yield of the crops. Several other factors affect productivity to a great extent. These factors include the adequate water supply and the attack of wild animals and birds, which needs to be checked.

II. LITERATURE REVIEW

In [1], IoT and wireless technology are used to create a network of sensors, actuators, GPS system which detect moisture level of soil to automatically turn on/off the motor, to detect the motion of animals. System includes the Remote-controlled robot who performs tasks like; Keeping vigilance, Bird and animal scaring, Weeding, and Spraying. Along with all this temperature sensor and Humidity sensor senses the temperature and humidity respectively and if the value is above the threshold value then room heater or cooling fan will automatically be switched ON/OFF providing temperature and humidity maintenance..

In [2], the authors have proposed a system to collect field data at regular interval with the help of Raspberry-Pi IoT based system. Network of soil moisture sensor, PIR sensor and brightness sensor is built to continuously monitor the field. Open CV is installed on Raspberry-Pi for the purpose of image detection and its programming is done in Python language.

In [3], Iot based wild animal IDS have been used with the help of PIR sensor, camera and Image Processing. This system works when a wild animal tries to enter a field then the PIR sensor detects the motion of animal/bird which further sends signal to the camera via microcontroller which then classifies it as a wild animal or not. If yes then a repellent technique is applied which results in emitting a bright light or a irritating noise simultaneously sending SMS to the forest officials and the farmer.

In [4], the authors have proposed a system that detects the motion of the intruder using PIR senor. Once the motion is detected using PIR sensor an alert SMS is generated which is sent with the help of GSM module-ESP8266, this data is then sent to ThingSpeak which is a public server for an IoT application. A graph is generated with the help of ThingSpeak which displays the time interval and PIR sensor value. ZigBee here is used to create a wireless sensor network (WSN).

In [5], the system explains the importance of recycling the rain water and also the intruder detection by using buzzer/alarm. This execution will be completed by interfacing WiFi module, GSM and sensors with Arduino. Which in returns reduces the human efforts, wastage of water and updates the farmer about the field's condition through mobile device.

In [6], the proposed system will act as substitute to the current classical method of farming. The authors have developed a system which mainly focuses on the temperature and soil moisture. It will help the farmer to retrieve the field's status from any part of the world. Using Smart Irrigation Decision Support System (SIDSS), which estimates the weekly irrigation needed by the crops. It also allows us to control the water motor automatically by giving us live updates on mobile devices using WiFi.

III. COMPONENTS OF PROPOSED SYSTEM Hardware requirements:

1. Arduino Uno: Microcontroller: Microchip ATmega328P, Operating Voltage: 5 Volts, Input Voltage: 7 to 20 Volts, Flash memory: 32KB

2. Soil Moisture Sensor: Operating Voltage: 3.5V to 5V, Operating Current: 0.3mA, Humidity Range: 20

3. 1-Channel Relay Module-10A: Control Voltage: 5V DC, On-board LED to indicate the working status, Max Control Capacity:10A@250VAC or 10A@30VDC.

4. Submersible Mini Water Pump: Operating Voltage: 3V to 6V, Operating Current: 130mA to 220mA, Outlet Outside Diameter: 7.5 mm, Outlet Inside Diameter: 5 mm, Flow Rate: 80L/H to 120 L/H.

5. PIR Motion Detector Sensor Module: Operating Voltage: DC 4.5V- 20V, Detection Distance: 15 to 20cm (can be adjusted), Detection Angle: less than 140 degree.

Software requirements:

1. Arduino IDE 1.8.9 Software: The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X and Linux. The environment is written in Java and other open-source software.

IV. BLOCK DIAGRAM OF PROPOSED SYSTEM

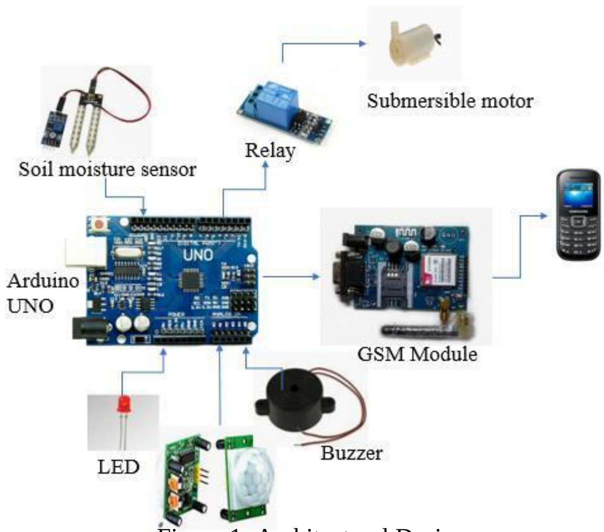

Figure 1: Architectural Design

The architecture design consists of following components-

- Sensors
- GSM module
- Arduino UNO
- Motor
- Relay
- Buzzer

The soil moisture sensor or the hygrometer is usually used to detect the humidity of the soil, it is a setup of two pieces: the electronic board and the probe with two pads that detects the water content. The soil moisture sensor has a built-in potentiometer for sensitivity adjustment of the digital output, a power LED and a digital output LED. The PIR sensor (Passive Infrared sensor) is made of a pyroelectric sensor which can detect levels of infrared radiation, it has two slots in it, each slot is made of a material that is sensitive to IR, when the sensor is frivolous both the slots detect the same amount of IR. When a warm body like a human or animal passes by it first seizes one half of the PIR sensor, which causes a positive differential change between the two halves, when a warm body leaves the sensing area the reverse happens whereby the sensor generates negative differential change these changes pulses are detected. Fresnel lenses are used to increase the detection area.

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A motor (submersible mini water pump) have an outlet through which pipe can be connected and the motor should be submerged in water. A relay is an electrically operated device containing an actuator module that can energize or de-energize the connection of a controlled circuit.

In the system, the soil moisture sensor and PIR sensors are connected to Arduino UNO to get the data. The obtained data is then processed and the status of a buzzer, relay changes based on the inputs from sensors. Soil moisture sensor senses the moisture of the soil- if it is not adequate then with the help of the relay, the motor will be turned on till the requisite amount of water is supplied. PIR sensor detects the motion around the field and on the detection of any intruder buzzer buzzes to agitate the intruder. Farmer gets a notification about the status of the motor and the appearance of an intruder by the GSM module.

To determine the detection area range, the experimental setup was done. By gradually increasing the distance of the intruder to get the maximum distance the border was drawn from both the side of the detection slots of the sensor. After getting the maximum distance the angle was noted down. The range of the PIR sensor was determined to know the number of sensors required to be deployed to fully cover the boundaries of the field. It helps to get the maximum accuracy as well.

V. METHODOLOGY

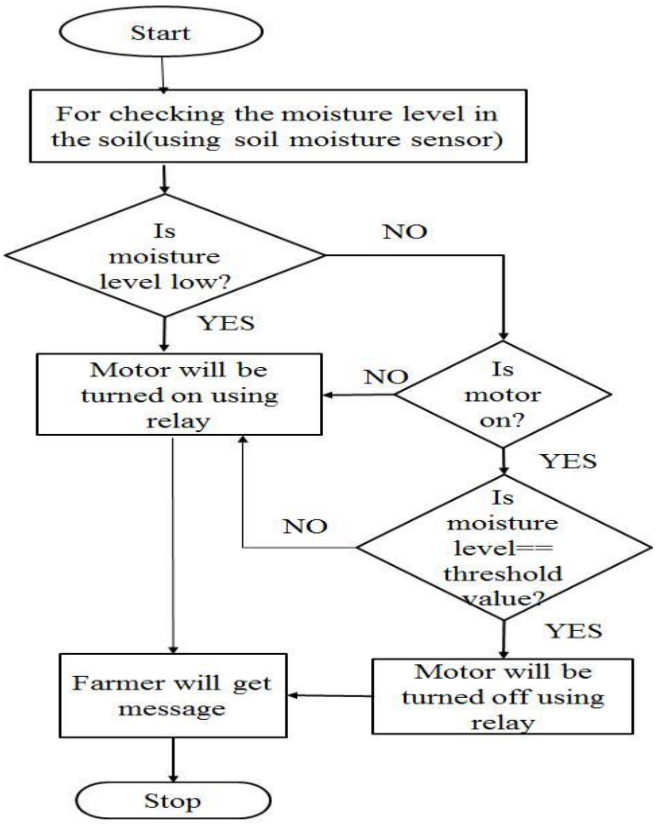

Figure 2: Flowchart for working of soil moisture sensor

Using soil moisture sensor, the moisture level of the soil is measured and if it is below threshold values set in the program then the motor will be turned on by relay; when the moisture level reaches normal level motor will be turned off automatically and the farmer will receive message accordingly via SendSMS subroutine.

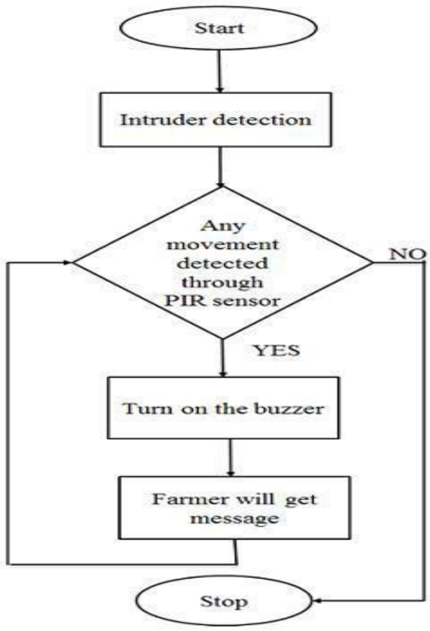

Figure 3: flowchart for working of PIR sensor

PIR sensor detects intruder around the field and if any movement is sensed then buzzer buzzes and the farmer will get a message stating that intruder is found around the field.

VI. RESULTS

On Detecting the low moisture level in the soil, the motor was turned on till it was sufficient for the crop alongside when the movement of any intruder has been detected the buzzer bombinated and LED was illuminated. All these actions were notified to the farmer through the GSM module.

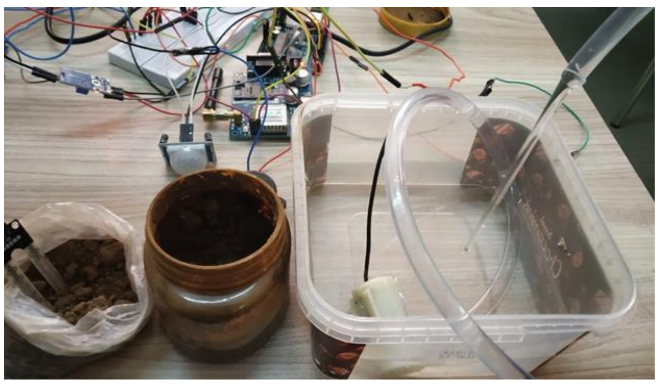

Figure 4: Status of motor when the moisture level in soil is not adequate

In figure 4, the soil moisture sensor is in the dry soil and it senses the low moisture level. On detecting the low moisture level, the motor is turned on using relay thereby supplying water till the sufficient moisture level is retained.

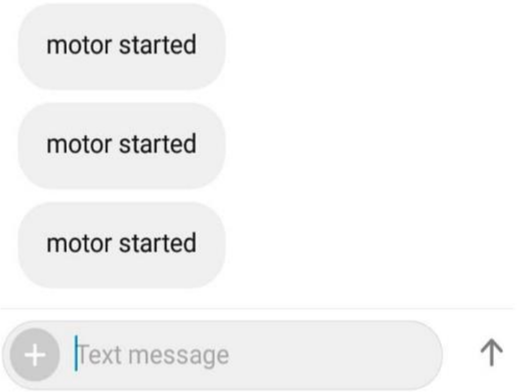

Figure 5: Notification about the status of motor (turned on)

As the motor is turned on and it is supplying the required water, the farmer should be notified regarding the same. So, via GSM module he will get a message saying motor started as shown in figure 5.

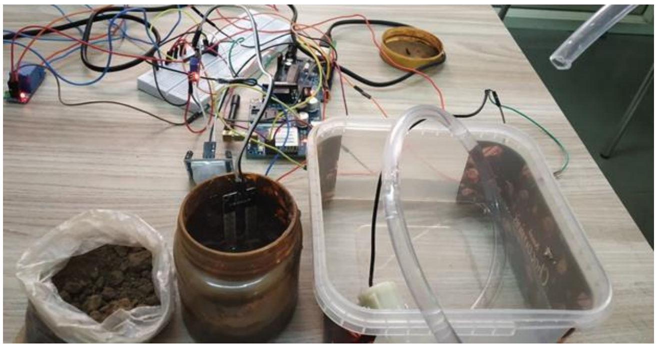

Figure 6: Status of motor when moisture level in the soil is sufficient

In figure 6, after enough water is supplied to the soil moisture senses that the threshold value is reached. So, the motor is turned off using the relay to control the flow of excess water and thereby saving the plants from getting damaged.

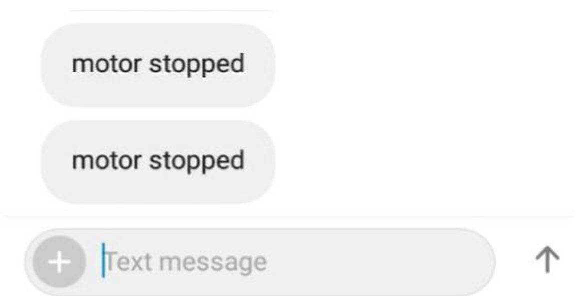

Figure 7: Notification about the status of motor (turned off)

As the motor is turned off after it has supplied the required water, the farmer should be notified regarding the same. So, via GSM module he will get a message saying motor stopped as shown in figure 7.

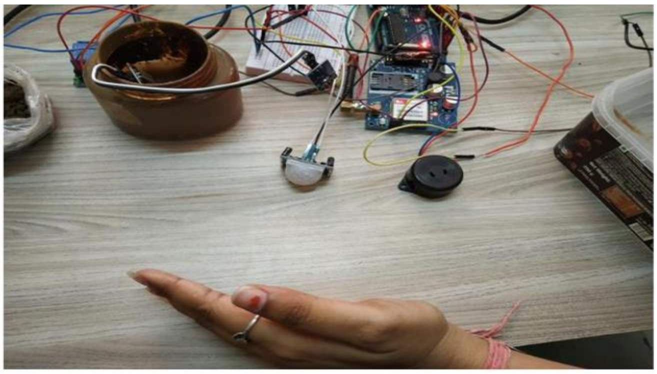

Figure 8: Intruder's movement around the sensor

In figure 8, the PIR sensor senses the motion around it. As soon as any intruder comes in the vicinity of the PIR sensor range, the motion is detected and buzzer connected to it will buzz, alerting the intruder and thus preventing unwanted and harmful intrusion.

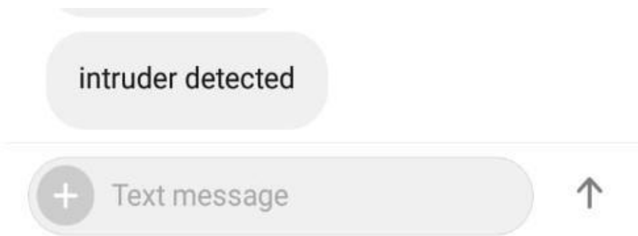

Figure 9: Intruder detection notification

As the PIR sensor detects the motion in its range turning the buzzer on, the farmer should be notified regarding the same. So, via GSM module he will get a message saying intruder detected as shown in figure 9.

Figure 10: Determination of the range of the PIR sensor through experimental set up

As to get the range of detection area of a PIR sensor, the experimental set up was done and the distance from where the

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intruders were being detected was noted. After the successful experimentation, the area shown in figure 10 was noted to be the range of detection.

Figure 11 (a): Intruder detection range from left side of the slots.

Figure 11 (b): Intruder detection range from center of the slots.

Figure 11 (c): Intruder detection range from right side of the slots.

Through the experiment, the range of the detection area of the PIR sensor was noted. As shown in figure 11 (a, b, c), A single PIR sensor can detect the intruders present at 3.42 meters from the left and right slots of the sensor at the angle of 135 degree.

VII. CONCLUSION

Precision agriculture involves the use of wireless sensor networks and IoT in order to enhance productivity in terms of yield and quality. Further, automation of certain farming operations, like irrigation, intrusion detection, etc. relieves the farmers' labor and efforts to a great extent. Thereby enabling corrective actions destruction of crops is prevented.

A system incorporates precision agriculture as well as automation of certain farm processes using wireless sensor networks and IoT technology. The parameters considered in the project include automating the irrigation process and intrusion detection. The range of detection area was obtained through an experiment. Through this range, the number of sensors required to cover the field was calculated for the enhanced results.

VIII. FUTURE ENHANCEMENT

Reliable guidelines can be provided to farmers as to which crop to grow and approximate yield expected. The project can be extended to factor a larger set of crops for diverse climatic conditions and can incorporate more precision agriculture aspects. Diseases detection through image processing can also be incorporated to prevent crop damage.

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