Smart Agriculture Monitoring System Using IoT

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1 Introduction

Agriculture is the main occupation of rural people in our country. More than 50% of the rural population depends on agriculture for their survival. As per Central Statistics Office (CSO), our countries' cross value addition (GSA) is around 8%, which is an adequate figure. According to the current market survey, nearly 85% of the water resource are utilized for agriculture. Thus, water has to be saved, conserved and preserved, and better utilized besides improving the agriculture yield. Thermal imaging to monitor fields and check water status and irrigation scheduling are being developed earlier. The Internet of Things (IoT) has emerged and deployed in various sectors such as health, manufacturing, communications, and agriculture. The motive is to improve efficiency and performance across all markets.

The primary need of agriculture mainly depends on monsoon and the kind of soil for the particular crop. Second, the water supply to the crop and amount of water to the crop are essential. The majority of time is squandered by farmers and many other aspects for crop monitoring, timely availability of electricity, and many other

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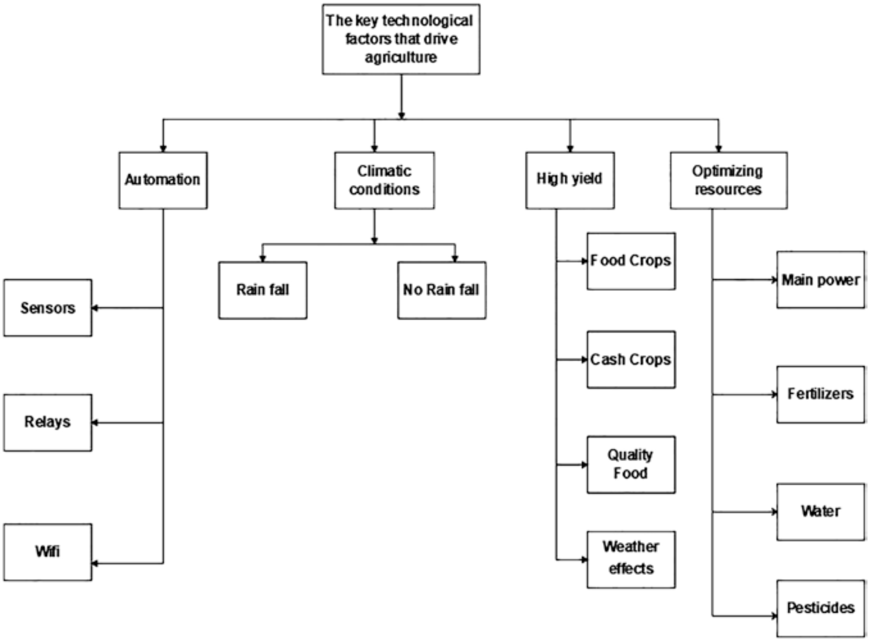


Fig. 1 The key technical factors that drive agriculture

problems. To overcome this, automation of agriculture becomes important. The key factors for good yield of agriculture depend on water, climate, soil nutrients, and proper monitoring. Climate is a natural phenomenon, which is not in the hands of the farmer. However, proper nutrition such as pesticides, fertilizers, herbicides, and chemicals may be added in proportion depending upon the nature of the crop. Availability of labor is also one of the setbacks in today's agriculture system.

The implementation of IoT in agriculture sector has led to the concept, namely "smart agriculture"—a method to improve agriculture yield with less resources and labor. This technology is helping the farmers in all stages of crop from sowing to harvesting. Thus, IoT in agriculture finds high potential and research challenges in future. The main challenges that drive this technology are shown in Fig. 1.

2 Literature Review

Smart farming is a new concept of managing the crop cultivation by making use of modern tools and technologies to enhance the quality of farming and agriculture harvesting [1–6]. Smart agriculture system addresses issues such as population growth, labor need, and climate changes. Starting from planting of the crop, watering it, and to the stage of harvesting the IoT-based smart agriculture system are being implemented using several sensors that control the crop yield. Sensors such as light sensor, humidity sensor, temperature sensor, and soil moisture sensor can support the process of automatic irrigation. This smart system also incorporates cameras, monitors, and other devices along with sensors to control every element involved in farming.

The advent of IoT brought several changes in various fields and one such being the agriculture [7, 8]. The system involved the monitoring of the environmental conditions such as light, rain, soil content, humidity, temperature, and then watering the crop. The systems also include water level indicator to look into the water content and that is needed for a particular crop and then water it. The whole system is automatically controlled to make the complete agriculture process smarter. Thus, smart agriculture using IoT has shown a way to the farmers to solve their problems and at the same time, monitor the agriculture system [8–13].

In reference [14], the authors have presented on technology assistance to agriculture related applications. In their work, they incorporated wireless sensor network to address problem like field water pumping and providing nutrients to the crop to make a better yield. Automation by observing field parameters like temperature, humidity, and rainfall are monitored using suitable sensors to control the pumping of water to the garden. They made use of microprocessor along with GSM module to demonstrate their experiment.

3 Existing System

The basic requirement of any irrigation system is to monitor temperature, humidity, moisture, and water level. To monitor, suitable sensors, relays, and control system with necessary hardware are essential. Smart agriculture makes use of temperature sensor to record the temperature requirements, the humidity sensor to observe the moisture and humidity contents, and automatic pump control circuitry to maintain the level of the water.

In the existing system, Arduino Uno is used as an interface module for controlling the smart agriculture process. The various sensors interfaced include temperature sensor, moisture and humidity detection sensors, and rain detection sensor with WiFi communication. WiFi communication is achieved using ESP 8266. These sensors control the switching ON and OFF of the motor to water the fields. Such a system implementation is shown in Fig. 2.

4 Proposed System

To make the agriculture system smarter with Wi-Fi and Cloud, the implemented circuit is shown in Fig. 3.

The system consists of an Arduino Uno board with WiFi interface, along with several other sensors for temperature, humidity, and rainfall monitoring. The DHT11 temperature sensor is incorporated for temperature measurement. A 16×2

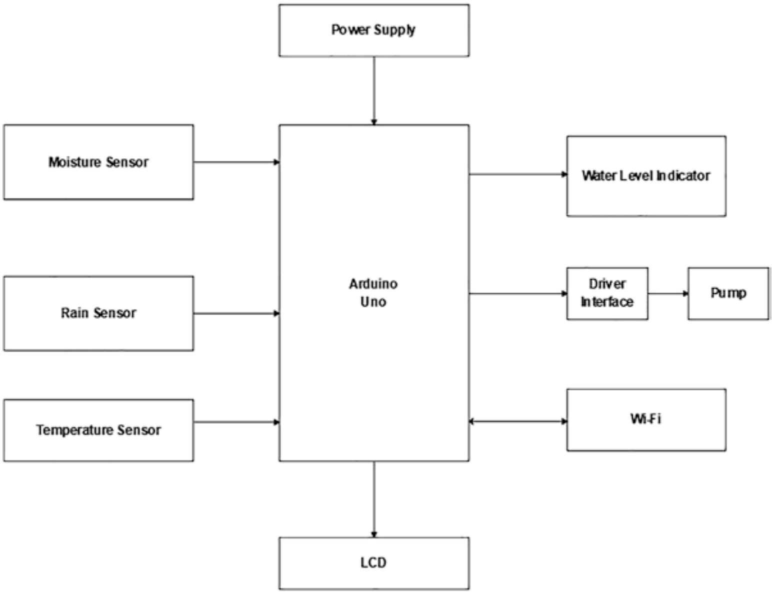


Fig. 2 Block diagram of basic system

LCD display is connected to Arduino for displaying water level and water pump status. ESP8266 connected to arduino board is used for wireless communication.

The developed module with associated sensors perform the following functions:

1. Temperature sensor for recording temperature
2. Humidity and moisture sensor to find the soil fertility
3. Water level sensor to sense the water level content and to switch ON and OFF the motor for maintaining the level of water to the plant.

The complete setup with WiFi supports the formers to ease their work and monitor the crop.

5 Hardware Requirements

The components required in the implementation are shown in Fig. 4a–f. They are water level sensor to maintain the required water level, humidity and moisture sensor to check the moisture content in the soil, a relay unit to control the ON/OFF of the pump, an LCD module to display the water level and the pump status, and an Arduino UnoModule.

The implementation makes use of the following hardware—water level sensor, humidity sensor, moisture sensor relay module, Arduino UnoModule, and 16 × 2 LCD display. The water level sensor (Fig. 4a) is interfaced to the water pump via a

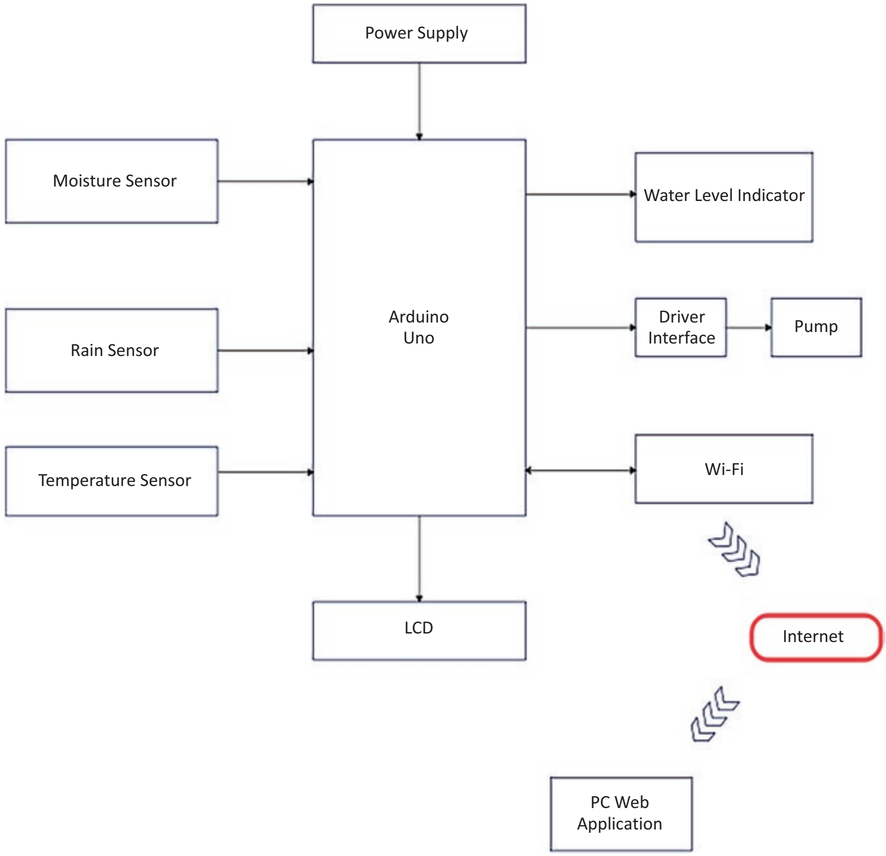


Fig. 3 Smart Agriculture with WiFi and Internet

relay. Depending on the water requirements to the crop, the motor is switched ON and OFF via relay depending upon the signal from the sensor. If the level of the water is low, the sensor signals so that the relay is closed switching the motor ON. In the event, if the required level of water is reached, the relay connects the motor to the power supply, switching the motor ON.

Humidity and moisture sensors are incorporated to check the humidity content and moisture content of the soil. Figure 4b, c shows an interface in the module for this purpose. The DTH11 is used to sense the humidity. The operating range of the sensor is 3–5 V with an accuracy of 1, humidity—5% and 2, and temperature—±2 °C.

Figure 4d shows a relay incorporated in developing the system. Figure 4e shows the Arduino Uno board, the heart of the system. It consists of CPU, Flash RAM, and I/O Built within it.

A 16 × 2 LCD Display is used in the developed module to display the level of the water in the tank, as shown in Fig. 4f.

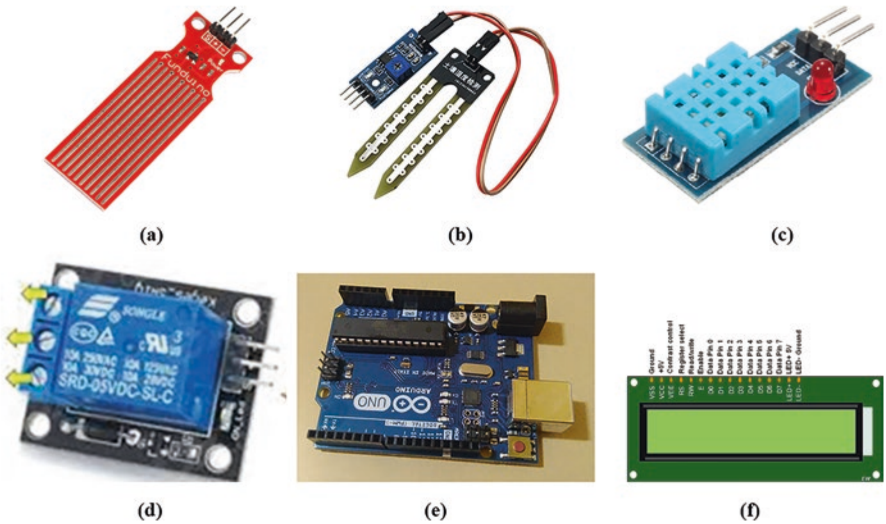


Fig. 4 Hardware components (**a**) Water level sensor (**b**) Moisture sensor (**c**) Humidity sensor (**d**) Relay Module (**e**) Arduino UnoModule (**f**) 16 × 2 LCD display

6 Flow Chart Implementation

The complete working of the smart system implemented is explained by a flow graph as shown in Fig. 5. Intially, the various monitoring parameters are intialized into the system.

From the flow graph, we infer that depending upon the parameters and the water level contents, the system controls the water requirements to the crop.

7 Results

Figure 6a presents the proposed model setup for smart agriculture monitoring system with real time monitoring of soil properties such as humidity, moisture, and temperature, using various control operations of the field using web application. The IoT is incorporated into the system to increase the yield of the crop by studying the various environmental parameters to the farmers remotely. The developed system can be implemented in any agriculture field crops and soil contents. The developed system is a low cost, simple in design, and implementation. The whole purpose of the project is to support formers for better irrigation and yield. This system reduces the need of labor, human intervention, and wastage of water. Once the level

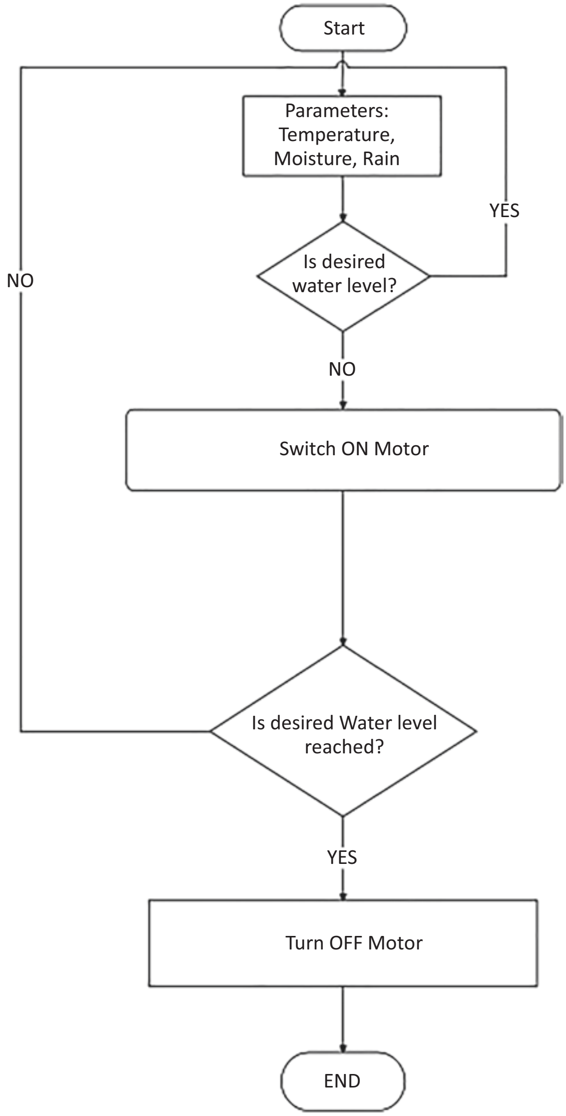
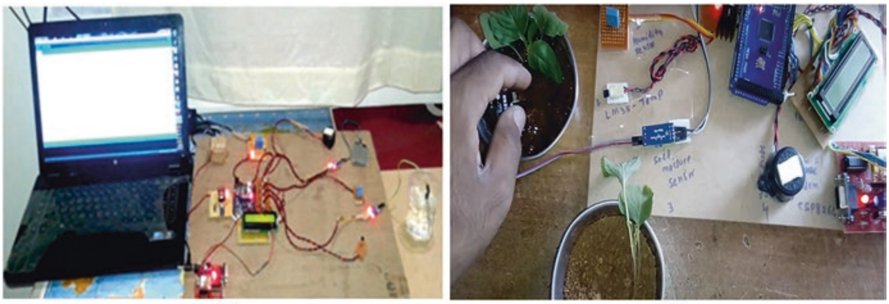


Fig. 5 Flow chart showing the working of Proposed system

of the water required for the crop is fixed, the sensor monitors the level of water requirements by controlling the water requirement. Whenever the level of the water goes below the desired level, the motor automatically switches ON and the water is supplied, and once the desired level is reached, the system automatically switches OFF by maintaining the desired water level. Figure 6b shows a vegetable plant with sensors for testability.

Watering the plants is also controlled depending upon the temperature and the humidity levels. So, as long as the desired level is maintained, the system remains OFF. Any deviation from the desired requirement switches OFF the motor. The monitoring of various parameters recorded on a particular day with varying parameters of temperature, humidity, rainfall, and water level content is tabulated in Table 1. The readings recorded are a prototype testing carried out on a plant as shown in Fig. 6b. However, this can be incorporated into the agriculture field for better yield and monitoring without any human intervention.

The graphical representation of soil parameters variations recorded on a particular day as shown in Table 1 and is graphically represented in Fig. 7.



(a) (b)

Fig. 6 (**a**) Smart agriculture monitoring system setup (**b**) Prototype testing

Table 1 Parameter Recording on a particular day

Date	Temperature	Humidity	Water level	Rainfall
20-01-21	36	59	53	2
20-01-21	36	60	53	2
20-01-21	37	53	50	2
20-01-21	35	60	30	2
20-01-21	36	59	62	1
20-01-21	35	53	38	2
20-01-21	37	58	43	0
20-01-21	37	59	69	2
20-01-21	37	53	52	0
20-01-21	36	53	51	0
20-01-21	36	54	23	0
20-01-21	37	54	48	1
20-01-21	35	56	25	2
20-01-21	36	53	58	2
20-01-21	35	60	36	1
20-01-21	36	59	35	2

(continued)

Table 1 (continued)

Date	Temperature	Humidity	Water level	Rainfall
20-01-21	37	53	51	0
20-01-21	35	59	58	1
20-01-21	36	59	51	1
20-01-21	37	52	71	2
20-01-21	35	59	23	1
20-01-21	37	57	48	2
20-01-21	36	58	55	2
20-01-21	35	59	35	2
20-01-21	37	58	62	0
20-01-21	35	52	69	2
20-01-21	37	60	41	0
20-01-21	35	55	60	2
20-01-21	37	58	26	2
20-01-21	36	59	60	2
20-01-21	35	53	28	1
20-01-21	36	52	57	1
20-01-21	36	58	42	1
20-01-21	36	53	31	0

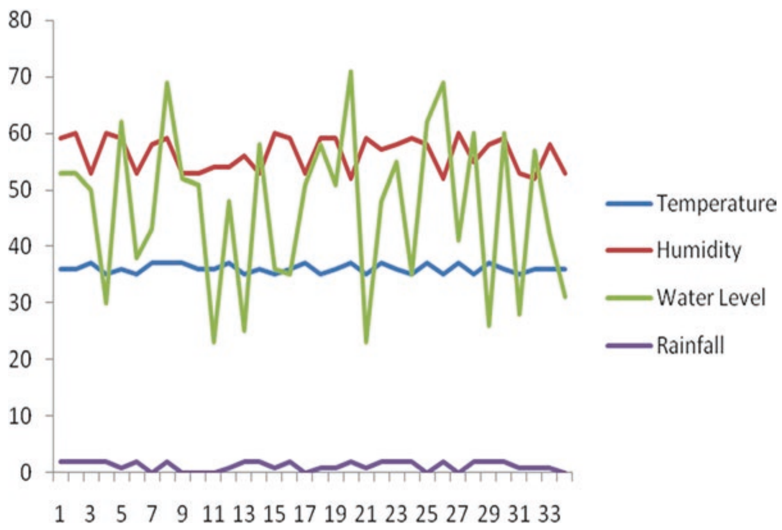


Fig. 7 Graph depicting the variations of the soil parameters

8 Conclusions

Smart agriculture system is an emerging concept wherein the IoT sensors are able to provide information of the agriculture field conditions. Remote monitoring of crop saves cost, time, and effort on the farmers. The proposed project is the implementation of this evolving technology to make smart agriculture using automation by monitoring the moisture content and temperature of the field. Monitoring environmental factors is the major factor to improve the yield of the efficient crops. With the implementation of the present system, the irrigation becomes practically easy and accurate. In the present system, the temperature moisture and rain sensors play an important role in obtaining the output. This smart agriculture monitoring system is prototype tested successfully. The action is performed depending upon the humidity of the soil. If the soil is dry, a signal is sent to Arduino, which automatically switches ON the motor and runs a pump for watering the plants. If the necessary humidity is available, the motor remains OFF, thereby automatically switching OFF. The module developed is economically efficient and affordable and can be extended for large-scale cultivation and support farmers.

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