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Design and development of an irrigation mobile robot

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ABSTRACT

Water plays a significant role among other existing natural resources. The daily demand for water supplies is increasingly on the rise as the population grows. To minimize the consumption of water in irrigation, several proposals were suggested. The currently existing system known as the automated irrigation system for effective water resource use with the prediction of the weather (AISWP) functions with a single farm that lacks the reliability in the precision of weather forecasting. So, a robot-based irrigation system has been proposed to improve the performance of the system. To minimize the water usage for crops, an automated irrigation system has been developed which irrigates the field in acres. An additional characteristic of the system has also been given for the soil pH measurement to allow the use of fertilizers accordingly. The solar-powered robot is managed wirelessly by a designated application. The robot is attached with various sensors and with a high-resolution camera that tests crop conditions and senses the soil state. The application has been created to provide information about the soil's condition such as temperature level, humidity level, water level, and level of nutrients to the PC/Laptop with the real-time values via the GSM module.

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1. INTRODUCTION

Irrigation is the mechanism by which plants are supplied with water by artificial means. Irrigation decreases the production of weeds and increases the growth of plants to conserve soil nutrients. Irrigation can support landscape conservation in growing crops, especially in periods of below average precipitation [1]. Water is slowly absorbed by plant roots; therefore, water consumption is minimized. Irrigation enables farmers and gardeners to use water effectively to ensure the growth of plants. The farmers of stocks use irrigation to ensure that their cattle can produce enough milk. Many new crops and varieties of plants need daily irrigation which leads to the increased irrigated demand. An autonomous irrigation machine runs a device without human intervention. With the assistance of electronic devices and detectors, such as processors, temporaries, sensors, and other mechanical equipment, any irrigation system such as drip, sprinkler, and the surface become automated [2, 3]. Besides minimizing the costs of water bills and ensuring the safety of farms, the required automatic irrigation system will also help maximize the value of our farm and save time. Today, the majority of new farmers foresee a greenhouse with plants such as the integrated irrigation system. Therefore, there is no need to spend from 2 to 5 hours a week cleaning the field.

As an important technology for the planting and development of crops, agricultural irrigation is often given importance. A sound and adequate supply of irrigation water can dramatically increase the efficiency of agriculture and water savings. It is clear that conventional irrigation not only absorbs wastewater but also resources, based on the local position, maybe much needed. The conventional irrigation technique entails using water in all areas of the field as evenly as possible without taking into consideration the complexity of soil and crop water needs [4]. Different closed-loop irrigation systems have been developed and applied in recent decades as they are responsive to real-time soil humidity factors. Agriculture is using 85% of worldwide available freshwater supplies, and because of the rising population and the increasing food demand, this figure might continue to dominate for water use. Water wastage is always a major concern of our society in daily life. Water availability varies drastically from region to region. Some regions have plenty of water available and some face scarcity of water. Managing water resources for agriculture is of extreme importance. Water wastage is to be minimized on an urgent basis as water consumption is increasing with the population growth rate. To overcome these losses, a robotics-based irrigation system has been designed in which the maximum field is irrigated. The field is distributed into different areas. The robot is gone through all these areas sequentially and senses the condition of the soil, which further communicates the message along with the global system for mobile communications (GSM) module through an application or mobile phone.

In [5], the authors reviewed the latest smart solar irrigation system in depth. The solar sustainable energy from solar panels to the groundwater tank is dependent on direct sunlight amount from the well to the purified water. While conventional methods involved pumping water from the pot to the pot through the pump, only a single phase of energy was absorbed by the device as the water was pumped into a ground-level tank that controls the water flow from a basic valve mechanism into the field [6, 7]. This saved an enormous amount of power generation and renewable energies. In order to monitor moisture content and height in the soil, they developed a network of wireless sensors. The design of the wireless sensor network was seen and the results of the sensor configuration and irrigation decisions were discussed in agriculture. In addition, they have created a sophisticated wireless irrigation system with real-life humidity information and expert data for precise farming and irrigation decisions. This system has been shown to save water and be feasible for precision farming [8-12]. With this solution, the authors recommended an improved automated irrigation method [13-15]. A sprinkler head was fitted to a water supply under load by a conduit with a valve. A moisture sensor was installed on the field next to the sprinkler head. The wires between the samples and the valves were changed for the wireless version. Additional valves were used for monitoring and installation of located areas in branch and riser pipes. The rechargeable battery solar powered by the preferred fuel was supplied.

Various other studies have demonstrated multiple designs to increase the intelligent irrigation system, but the main objective of the proposed project is to create an intelligent robot to capture the crop situation with a high-resolution camera for irrigation. Researchers have provided a wireless sensor network measuring temperature and humidity parameters related to the soil [16-18]. Under soil, sensors attached to relay nodes were designed using an advanced protocol to have an extremely short operating time to increase the life cycle of the soil monitoring device. During transmission, the system was developed with the use of a microcontroller, a universal asynchronous transmitter and sensors and was sampled every hour with the data buffering (UART). Because of their cost and the positioning of the sensor in the ground the system was unpleasant to reduce the RF signal. The authors suggested a photovoltaic panel system during this point, with a duplex communication channel that can be planned using a website for data management and irrigation using a portable internet interface [19-21].

In this way, Kim [22] proposed the remote sensing and control irrigation system using a mobile network of wireless contact sensors for variable irrigation rates, in-house real-time monitoring, and linear movement irrigation system control for precise information accuracy for maximum water usage. The machine supplied with in-depth information on the device and parameters of irrigation, the wireless network of sensors, and the field sensing and tracking for the applications concerned. The whole system was based on five sensor systems in the field which are capturing the data and transmitting it to the Base Station via the GPS. Rehman *et al.* [23] have thus suggested a basic cost-effective smart irrigation system. The device was implemented with wireless sensor motes from a network of wireless sensors. The machine was equipped with IRIS TINY OS motors to calculate the moisture level and set the threshold value in outdoor conditions. The moisture content was calculated. The plan used the Crossbow technology-developed MOTEVIEW 2.0f data visualization and surveillance platform. Compared to other manual operators, the planned scheme was simple to enforce and demanded less of the IRIS sensor motes. The project's authors suggested the implementation of a drip irrigation device based on the microcontroller. This device was a feedback control device in real-time that could track and control all the processes in a drip irrigation system very effectively. They also built an irrigation system that manages valves using an automatic controller, which enables farmers to use the necessary water's volume at the right time [24].

The authors suggested an integrated irrigation system that automatically waters and retains the necessary soil moisture content. The Arduino UNO framework was used for the development of the control unit with the ATMEGA328P microcontroller. The installation utilizes soil humidity sensors that determine the exact humidity level in the soil. This importance allowed the machine to use a suitable amount of water that prevents irrigation. IoT was used to brief farmers on sprinkler's status. The sensor details have been frequently updated on the GSM-GPRS SIM900A modem to ensure that the water sprinklers are ON/OFF at all times. The sensors are available on the website. The sensor readings have also been sent to a Thing Speech channel for study [25]. The work was carried out using the soil system using sensors based on this process [26]. Different soil sensors have been used to measure the values of temperature, humidity, and sun, moisture, and pH. The soil sensing information was then transmitted from the A/D converter to the cloud via Raspberry Pi to the MCP3204 A/D converter. The details were stored in the cloud on both cell and laptop computers. They understood that based on the knowledge, the increasing crop is acceptable for the parameter of the soil. This state-of-the-art equipment also makes land monitoring processes simple for farmers to remember the specific soil quality. All the projects carried out up to date consist primarily of IoT irrigation systems. In this phase [27], the authors have established an effective, inexpensive, and ready low-level discharge calculation to implement the vast water system in the GSM/GPRS irrigation channel network of the river basin of the Indus River as a suitable communication technology. Problems relating to power needs, and device operation have been discussed and resolved.

The authors suggested this approach, using soil humidity sensors, to prevent wastewater and improve irrigation productivity using a PLC-based irrigation system [28]. It is also upgraded the conventional irrigation method, which allows for high quality and low water utilization of the irrigation system. The best attribute was that of a PLC-based sprinkler irrigation scheme. In this approach, the authors suggested a cloud-based IoT agricultural greenhouse monitoring system. In greenhouses, sensors including light sensors, and others such as temperature, humidity, etc. for many environmental parameters have been efficiently regulated for the management. Periodically (30 seconds), sensors collected and stored data from the agricultural sector through cloud storage and the internet [29, 30]. The authors have talked about IoT-based crop surveillance and irrigation system [31]. A system was designed to track farmland with sensors and the method of irrigation was automated based on sensed data according to a decision of a server. The corresponding outcomes are transmitted via wireless technology to the Web server database. This automated irrigation guarantees that the humidity and temperature areas are below the maximum limit. The user can remotely monitor and manage the system using an application that provides a web interface to users. The researchers suggested an intelligent scheme of irrigation with this process. This proposed device used an Android mobile application to decrease human interference and to remotely monitor the crop field. With the drip irrigation system, we can save a lot of wastewater. A few more devices have been used to track the environment [32]. The advantages and disadvantages of existing irrigation models are summarized in Table 1.

Table 1. Pros and cons of various existing irrigation models

Ref	Model Designed	Advantages	Disadvantages
[1-3]	A cellular use of automation of soil moisture sensors for drip irrigation	Self-healing	Slow irrigation process
[4-8]	Remotely sensed data of a centralized WSN irrigation system	Flexible and easy to expand	Cannot irrigate the maximum area
[9-13]	A novel soil measuring wireless sensor network	Greater precision in maintaining soil moisture	Requiring labor
[14-19]	A review of wireless sensor and wireless network technologies	Reduced erosion	Periodic service is required
[20-22]	A design of a wireless sensor network for greenhouse analysis	Increased security	The initial and long-term costs are high
[23-25]	Solar powered irrigation for food crop production	Costs have fallen	High initial cost
[26-27]	Verification for smart devices with a lightweight anonymous source	Easy Installation	Slow response

The authors recommended that the automated weed detection and intelligent herbicide sprayer robot should be designed and built to detect the decrease in crops. In which photos of a plant have been obtained, the weeds of a field can accurately be recognized [33, 34]. In the method [35], the authors suggested a framework to recognize rats, crop decreases, and to submit information and image processing for up-to-date notification analysis. Sensors and electronic systems have been designed using Python scripts. Based on checked cases, 84.8% of the test cases were successful. An experiment with IoT and image recognition has been conducted to determine biological factors or human-produced, Smart Agriculture presented a strategy that merged IoT and image analysis that directly inhibited plant growth. The decision-making method was used to further evaluate the process of gathering information from the complicated environment structure, and the image of the lattice was performed using histogram analysis by MATLAB software [36, 37]. In this approach, the authors suggested a scheme that took into account Indian climate conditions specifications for a sugarcane crop [38]. New knowledge retrieval and processing technologies for sugarcane were developed at WSN in agriculture. It was better than conventional agricultural methods. The precise farm monitoring system was designed to capture sensor node data with wireless sensor nodes and ground stations. This was a low-cost device in which the stored information was sent through an SMS via a GSM network to a remote site. To monitor the parameters, the farmer will use the obtained information. The efficacy and reliability of used resources have been enhanced by this method of wireless sensing and control that results in better performance. The system's downside was its GSM network dependence. A detailed review of various irrigation models exploiting different model designs and wireless technologies has been demonstrated in Table 2.

Table 2. State of the art of existing irrigation models

Ref	Model Designed	Advantages	Disadvantages
[1]	A cellular use of automation of soil moisture sensors for drip irrigation	Self-healing	Slow irrigation process
[2]	Remotely sensed data of a centralized WSN irrigation system	Flexible and easy to expand	Cannot irrigate maximum area
[3]	a novel soil measuring wireless sensor network	Greater precision in maintaining soil moisture	Requiring labor
[4]	A review of wireless sensor and wireless network technologies	Reduced erosion	Require periodic service
[5]	A design of wireless sensor network for greenhouse analysis	Increased security	The initial and long-term costs are much higher
[6]	A field modular gate system smart sensor based farm monitoring system	Dedicated bandwidth	Lack of mobility and greater cost
[7]	Precision agricultural device architecture and implementation using a wireless communication	Self-healing	It lacked the cloud-based data storage
[8]	Automatic monitor and control system of water saving irrigation	Product higher crop yields	Time consuming
[9]	Automated IoT irrigation system dependent on the sensor	Smartly controlled	Data rate is low
[10]	Automated agriculture system based on WSN	Capable of detecting the moisture level	Lack of accuracy in sandy soils
[11]	A smart sensor array for executing irrigation in real time	Wirelessly controlled	Waste-full runoff
[12]	Field test remote sensing of infrared thermography for the assessment of crop water	No destructive sampling of the crop	Expensive for small areas
[13]	Cyber interactive networks lightweight safety compliance	Not limited to specific IoT services	Stable water supply need
[14]	Advanced and modern agricultural real-time automation and control system	Ability to save water	Rural areas cannot fulfill that requirements
[15]	Wireless vehicle speed with crop tracking and routing system sensor network	Ideal for first-time configuration	Limited to short distance
[16]	Green Roofs' intelligent irrigation scheme focused on expected transition	Wirelessly controlled	Waste-full runoff
[17]	A greenhouse technology integrated network/wireless system	Enhanced speed	Installation and replacement costs
[18]	An intelligent farmland measurement sensor driven by microbial fuel cells	It helps in the reduction of pollution	Consumption of oxygen by the bacteria
[19]	A smart and regulated agricultural climate	Flexible easy to expand	Slow response
[20]	Wireless networks and GPRS module automatic irrigation system	Preserves soil structure and nutrients	Runoff due to overwatering
[21]	Smart water performance: assessment and quantitative analysis of water management potential in desert areas	AI offers the potential for machine learning	AI can be used for destructive purpose by destructive people
[22]	Creation and deployment of a distributed IoT framework to track freshwater water quality	Enhanced speed	Not suitable as a receiver, on battery-based applications
[23]	In-situ wireless sensor network in Southern Finland for river basin tracking and farming	Lack of interference	Requiring periodic service
[24]	Discrimination against marijuana and crops by visual processing and artificial intelligence	Self-made decisions	Complex to understand
[25]	Develop smart agriculture, cameras, cloud infrastructure, mobile devices & big data processing	Avoids overuse of water in irrigation	Initial cost is high
[26]	Solar powered irrigation for food crop production	Costs have fallen	High initial cost
[27]	Verification for smart devices with a lightweight anonymous source	Easy installation	Slow response

2. RESEARCH METHOD

Firstly, the system is proposed in Proteus simulation. The functions of this system are:
- to measure the amount of NPK,
- to measure the percentage of humidity & moisture,
- to measure the temperature, and
- the circuit diagram of the system is shown in Figure 1.

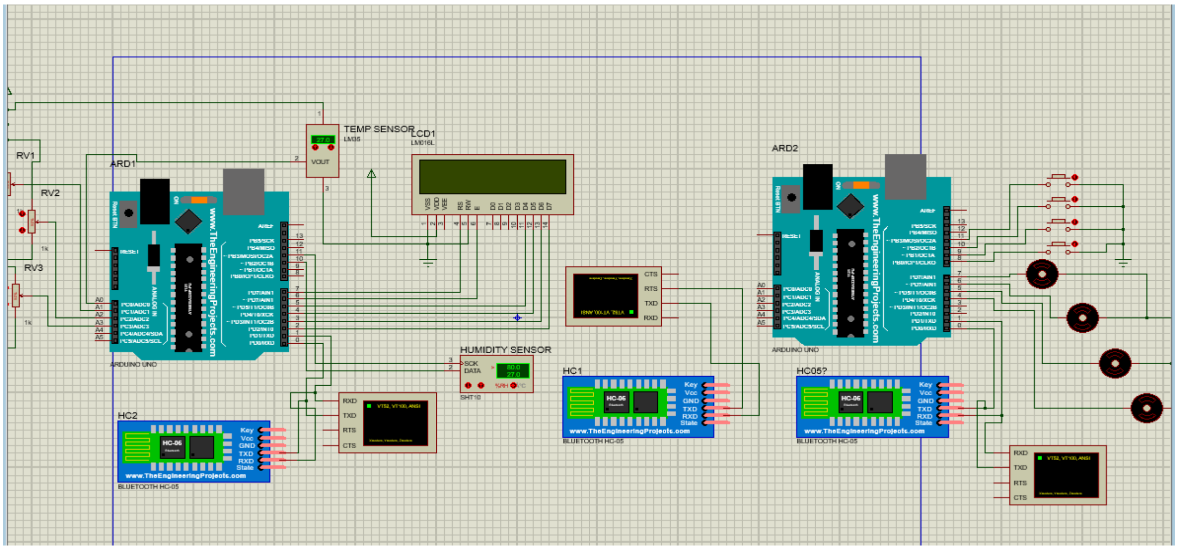


Figure 1. Circuit diagram of the proposed model

2.1. Case 1

In Case 1, we have given the condition of the dry soil and we get the suitable results accordingly on the software. The soil nutrients are monitored, and the other information is shown on the virtual terminal. The result of Case 1 of the system is also shown in Figure 2.

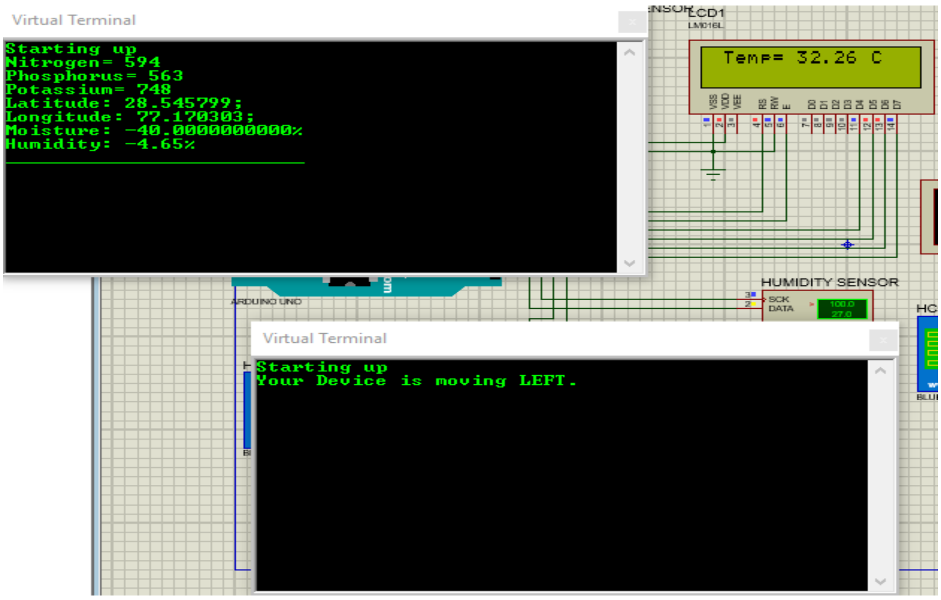


Figure 2. Results of Case 1

2.2. Case 2

In Case 2, we have given the condition of the moist soil and we get the suitable results accordingly to the software. The soil nutrients are monitored, and the other information is shown on the virtual terminal. The result of Case 2 of the system is also shown in Figure 3.

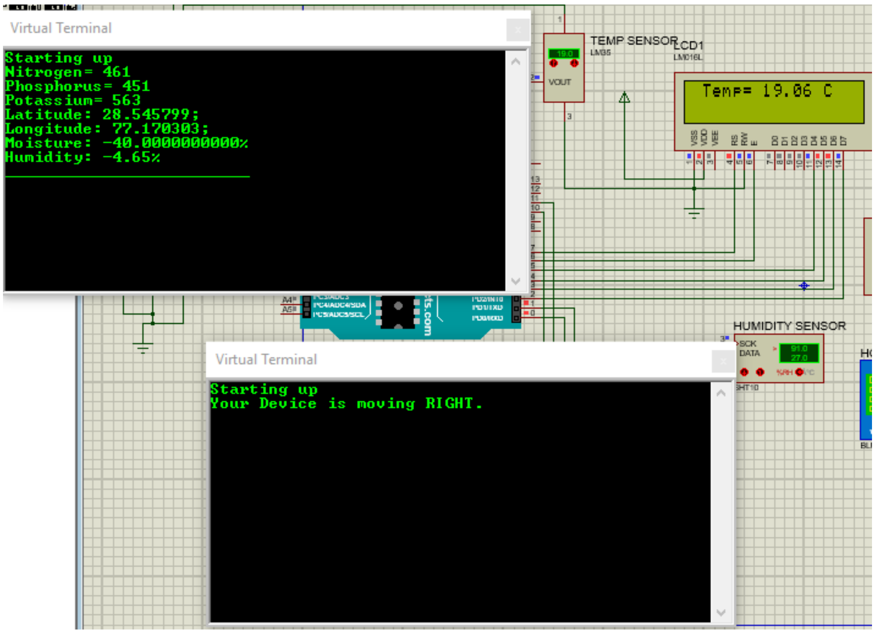


Figure 3. Results of Case 2

2.3. Case 3

In Case 3, we have given the condition of the wet soil and we get the suitable results accordingly on the software. The soil nutrients are monitored, and the other information is shown on the virtual terminal. The result of Case 3 of the system is also shown in Figure 4.

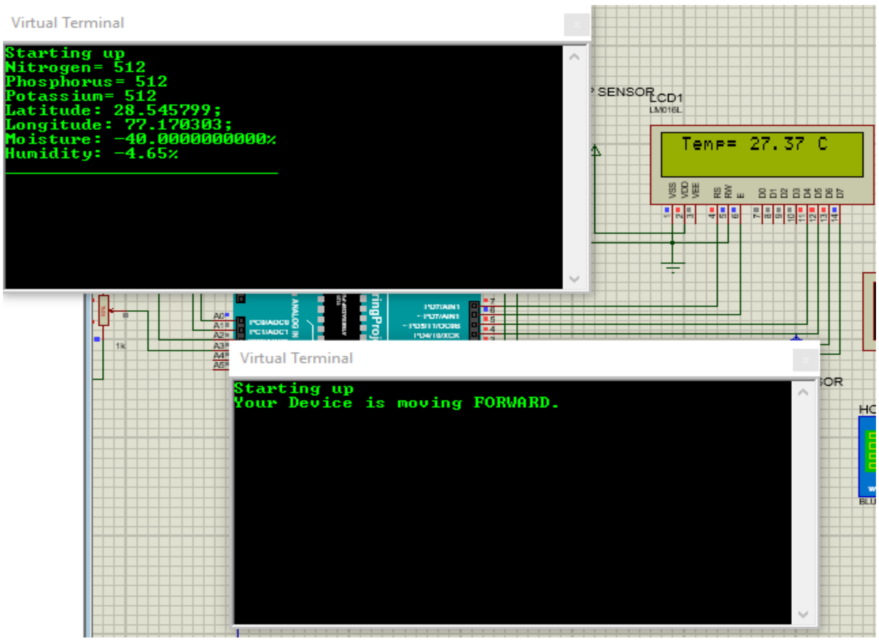


Figure 4. Results of Case 3

2.4. Flowcharts of remote and robot

According to Figures 5 and 6, the motors and sensors are attached to the required pins. The Arduino board reads each signal to check if it is one of the rules defined by the user. The motors will start when the signal is applied from the designated application. The robot will move in the direction given by the application. The HC-05 Bluetooth module is used for the communication between the remote and the DC motors. The servo motor is used to dip the soil sensors. The sensors are attached to the arm of the servo motor. If the servo motor gets the pulse, it operates, and the sensors are dipped in the soil. If the sensors are dipped in the soil, then the reading will be shown on the LCD. The Bluetooth module is used to communicate the data between the mobile application and sensors and show the data on the PC/Laptop.

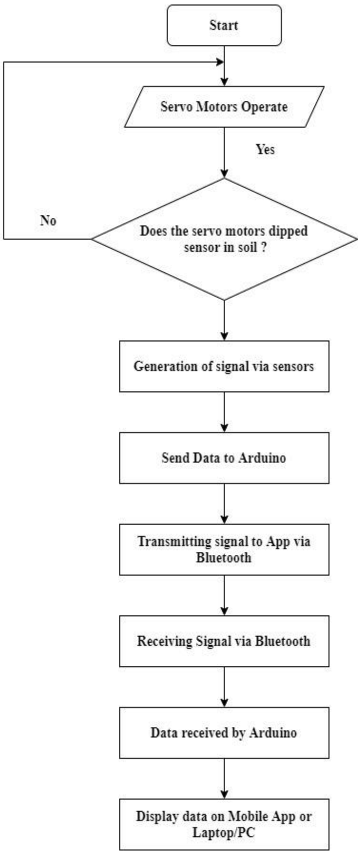


Figure 5. Flowchart of the remote deployed in the proposed model

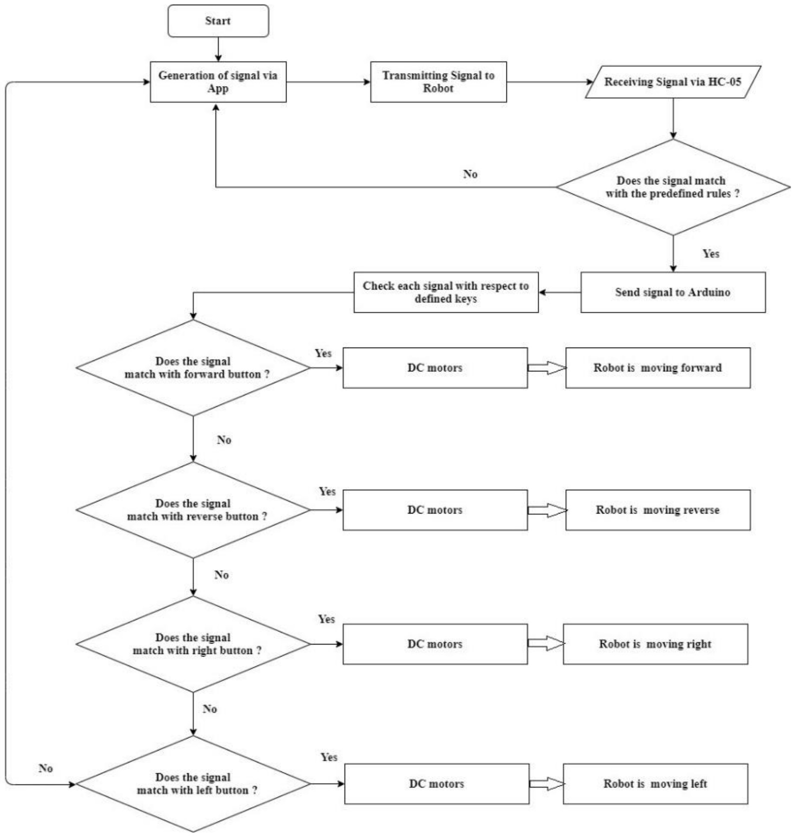


Figure 6. Demonstration of the robot's flowchart

3. RESULTS AND ANALYSIS

Figure 7 describes the methodology for our proposed system. The approach of the methodology is given as:

3.1. GSM module

The wireless modem GSM stands for the global mobile communication system. In 1970, Bell Laboratories invented the notion of GSM. The mobile communication system is widely used worldwide. GSM is a free, digital cellular platform that works in the 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz frequency ranges to deliver mobile voice and data services.

GSM was developed as a digital system using the time division multiple access (TDMA) technology for communication. A GSM decodes and reduces data, and then sends them down to its specific time slot via a channel of two separate sources of client data. The optical system can hold 64 kbps to 120 Mbps of data rates [39].

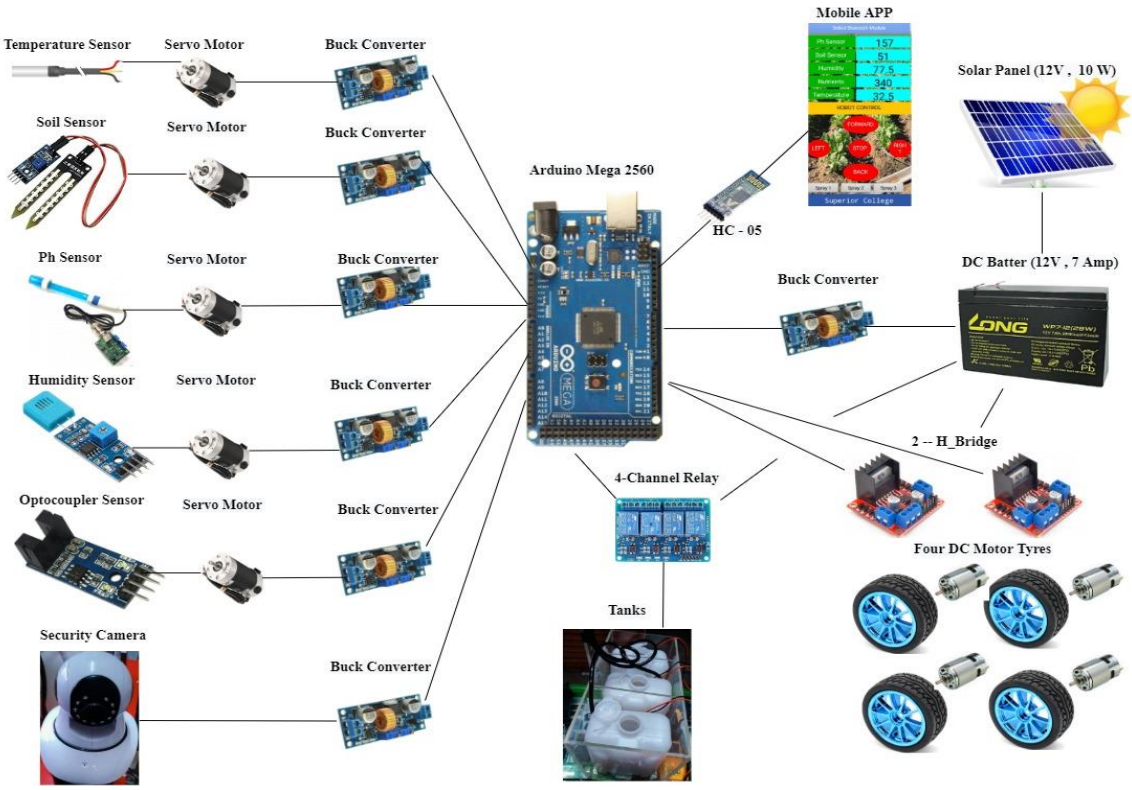


Figure 7. Functional diagram of the proposed system

3.2. Bluetooth module

This module can be used to either interface with two microcontrollers like Arduino or connect with any Bluetooth computer such as a phone or laptop. There are already numerous Android applications that make this process much easier [40]. Therefore, it is easy to communicate with any microcontroller assisted by the USART with a 9600 baud-rate.

3.3. Relay module

As the relay has a 12V voltage source, so the +12V DC supply on one end of the coil and a switch on the other edge of the pitch is used. A transistor, as a switching device, is used here. A diode is attached through the relay belt, which is known as the flyback diode. The diode is designed to protect the switch from high voltage spikes that can be created by the relay coil [41]. As seen, the load end of the typical pin may be connected with the other end of the NO or the NC. If the charge is connected to NO, then it is already disconnected before firing it, and it is connected to NC before triggering it.

3.4. H-bridge

The L298 (H-Bridge) is a high-power L293 IC engine unit [42]. It is a powerful, full-bridge dual-driver designed to support normal TTL (control logic) logic levels and drive inductive loads such as relays, solenoids, DC, and stepper. The interface may be activated or disabled separately from the input signals by two active inputs.

3.5. Opto-coupler

Opto-isolators prohibit the device from receiving the signal from impacting high voltages. An opto-isolator of the typical form consists of the same transparent pack of LED and phototransistor [43]. Opto-isolators usually pass digital (ON-OFF) signals, although some techniques allow analog signals to be used.

3.6. Camera

The wireless security camera is chosen due to the easy intuitive installation, and the covered area is very clean and 100% wire free. In addition, the camera has a 130° view angle large monitoring range as shown in Figure 8. We are using this camera for checking the condition of our crops and for security purposes. A buck-converter is connected to the camera to step down the 12 V battery voltages to 5 V because of the operating voltages of the camera are 5 V. The chosen camera has the following specifications in Table 3.

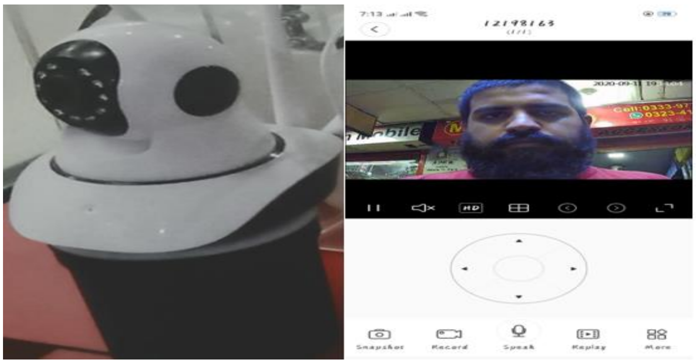


Figure 8. Security camera

Table 3. Specifications of camera

Specifications	Camera
Power supply (V)	12 V
Technology	Infrared
Sensor	CMOS
Audio compression	PCM/G.726, Two Way Audio
Connectivity	IP/Network Wireless
Power consumption (W)	DC 5 V
Communication	Two-Way

3.7. Temperature sensor

The DS18B20 is a digital temperature sensor with an embedded one wire which is used often in harsh conditions such as pesticides, soil mines, etc. as shown in Figure 9 [44].

Case 1: When we dip the temperature sensor in soil remotely, it gives the temperature of that soil area to a mobile application or PC as provided in Figure 10. The normal temperature is from 30 to 45℃.

Figure 9. Temperature sensor (DS18B20)

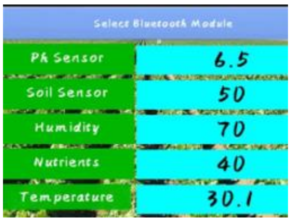


Figure 10. Temperature reading on application

Case 2: When we dip the temperature sensor in warm soil remotely, it gives the temperature of that soil area to a mobile application or PC as shown in Figure 11(a). Now, in this case, temperature exceeds 40℃, when the temperature of soil exceeds its limit, then we will be notified through SMS that irrigation process is required as mentioned in Figure 11(b).

By substituting values from the Table 4, the amount of heat absorbed is calculated in (1). For dry soil, we have:

$$Q = mc\Delta T \tag{1}$$

$$Q = 0.19 \text{ cal/g}\,°\text{C} \times 100 \text{ g} \times 45°\text{C} \tag{2}$$

$$Q = 855\, J \tag{3}$$

$$Change\ in\ Temp = \frac{Q}{m} \times c \tag{4}$$

$$Change\ in\ Temp = \frac{855}{0.19\ J/g°\text{C} \times 100g} \tag{5}$$

$$Change\ in\ Temp = 45°\text{C} \tag{6}$$

For wet soil, we have the following:

$$Q = 0.35 \text{ cal/g}\,°\text{C} \times 100 \text{ g} \times 45°\text{C} \tag{7}$$

$$Q = 854\, J \tag{8}$$

$$Change\ in\ Temp = \frac{Q}{m} \times c \tag{9}$$

$$Change\ in\ Temp = \frac{854}{0.35J/g°C \times 100g} \tag{10}$$

$$Change\ in\ Temp\ = 24.4°C \tag{11}$$

where
ΔT : change in temperature
Q : heat absorption or release amount
m : mass of the body
c : specific heat of the body

(a) (b)

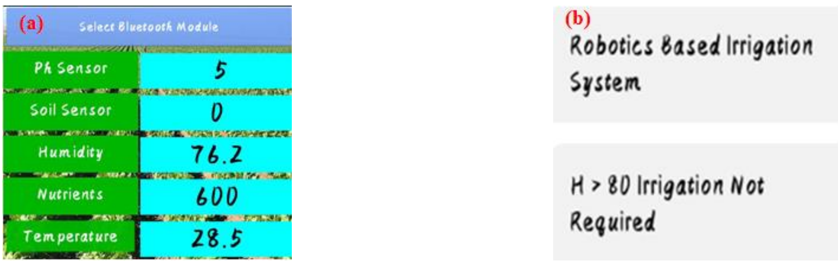
Figure 11. (a) Notification of temperature and (b) Temperature sensor case

Table 4. Specific heat [45]

Substance	Specific Heat- c_p -	
	(cal/gram°C)	(J/kg°C)
When soil is dry	0.19	800
When soil is wet	0.35	1480

3.8. Humidity sensor

Humidity sensor describes the moisture level of the atmosphere. During rainy or winter seasons when there is an increase in humidity level temperature, it starts decreasing as shown in Figure 12(a). The normal range of humidity is 65–79%. Now, in this case, humidity exceeds 79%, when the humidity exceeds its limit, then we will be notified through SMS that the irrigation process is not required. When humidity exceeds its normal range, we will get notified by SMS through the GSM module to our mobile or PC as revealed in Figure 12(b).



(a) (b)

Figure 12. (a) Humidity level on application and (b) Notification of humidity

For finding relative humidity [46]:

$$Relative\ Humidity\ \% = \frac{E}{E_S} \times 100 \tag{12}$$

where
E: Actual vapor pressure
E_S: Saturation vapor pressure

$$E = 6.11 \times e^{\left(\frac{17.67 \times T_{Dew}}{243.5 + T_{Dew}}\right)} \quad (13)$$

where
T_{Dew} = 24°C (at 6am)

$$E = 6.11 \times e^{\left(\frac{17.67 \times 24℃}{243.5 + 24℃}\right)} \quad (14)$$

$$E = 29.8 \quad (15)$$

Now, we have:

$$E = 6.11 \times e^{\left(\frac{17.67 \times T}{243.5 + T}\right)} \quad (16)$$

where T: 28℃.
By substituting values in the above equation, we obtain (17) and (18).

$$E = 6.11 \times e^{\left(\frac{17.67 \times 28℃}{243.5 + 28℃}\right)} \quad (17)$$

$$E = 37.7 \quad (18)$$

According to (12), we have:

$$Relative\ Humidity\ \% = \frac{E}{E_S} \times 100 \quad (19)$$

by substituting values of ‘E’ and ‘E_S’ in (14), we get (20) and (21).

$$Relative\ Humidity\ \% = \frac{29.8}{37.7} \times 100 \quad (20)$$

$$Relative\ Humidity\ \% = 79.0\ \% \quad (21)$$

3.8.1. Soil sensor

The soil sensor displays the level of humidity in the soil. The range for moisture content in soil is18–23°C. Initially, it will show 0°C. We performed this experiment by dipping the sensor in wet soil. Therefore, the sensor reads the moisture level which is up to 50°C as shown in Figure 13(a). After that, we were notified by SMS to mobile or PC that no irrigation is required as mentioned in Figure 13(b).

(a) (b)

Figure 13. (a) Soil moisture level on application and (b) Soil sensor case

In (22), the moisture content is calculated in (22) [47]:

$$\frac{Weight\ of\ moist\ soil - Weight\ of\ dry\ soil}{Weight\ of\ dry\ soil} \quad (22)$$

Pecentage moisture content (MC) calculations:
Let M = 92 g and D = 58 g solution:

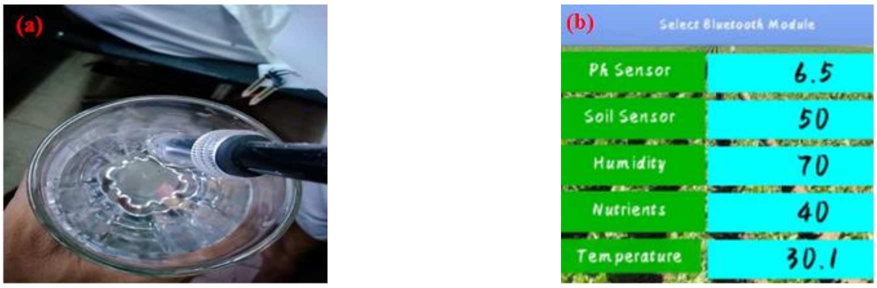
$$\%MC = \frac{92 - 58}{58} \tag{23}$$

$$\%MC = 58.6\% \tag{24}$$

3.8.2. pH sensor

The normal range of pH is 7.0 (alkaline). Below pH 7, soil is acidic; and above pH 7, soil is basic.

Case 1: First, we test the pH level of mineral water as shown in Figure 14(a). The results show that the pH level of water is alkaline and approximately equals to normal range as mentioned in Figure 14(b).



(a) (b)

Figure 14. (a) pH Level and (b) Results of mineral water

Case 2: In this case, we checked the pH level of contaminated water as shown in Figure 15 (a). Figure 15 (b) shows the result of contaminated water which means it is acidic.

(a) (b)

Figure 15. (a) pH level and (b) Result of contaminated water

Significancy of our System

The irrigation systems are applied in many of the foreign countries because of the wastage of water. The scope of our proposed system is:

- to irrigate the maximum amount of field as much as we want (remotely),
- to capture the condition of crops through a high pixel camera,
- to add the soil nutrients through the irrigation pipeline,
- to spray the field that kills pesticides/insects,
- robotics-based, and
- to develop an application along with the GSM module.

3.8.3. Real-time picture

This phase comprises the complete hardware equipment described with real figures. The general pin configurations of equipment are also described in detail. The purpose of this phase is to make easy for the reader to understand the required work for conducting this research study. Hardware results are also included. The real-time picture of the research study is shown in Figure 16. This figure showed thoroughly the working technique of our irrigation system based on robotics. The Arduino Mega 2560 manages the whole operation by 'C' programming through a Bluetooth connection between a smartphone application and Arduino. This relation is often called the serial communication method that involves transmitting one-bit data at a time. We also used Arduino mega since it runs 62.5 ns and also has a flash storage 256 kb in a very short time.

A 12 V DC dry battery charged by solar energy is used, and four 12 V DC motors are attached to robot tyres in which robot tyres are fed directly from the battery. The speed and movement of robot tyres often referred to as H-bridge (full bridge) are regulated by two L298 drivers. Each sensor has a servo motor, the buck converter is attached to both sensors and a safety camera because the working voltages of the sensor have a voltage of just 5 volts, the buck transformer is down to 5 DC volts on 12 DC volts. The tanks of the robot are controlled with a 4-channel relay system.

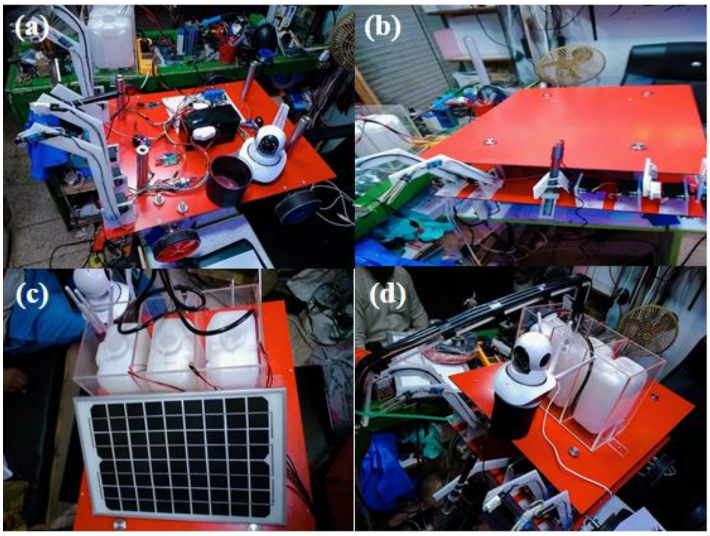


Figure 16. The designed robot process

4. CONCLUSION

A comprehensive strategy for the agricultural system was established in this work. The proposed robot-based irrigation mechanism can be deployed to achieve the high yield of crops by the minimum use of water. We have attempted to make this analysis more practical and consistent with the current agricultural market, which takes into account numerous suggestions. Compared to other traditional tracking devices, the Bluetooth-based security system is very useful and effective when sensors are integrated. These sensors detect the ground conditions at various points and then monitor the readings on the mobile application and transmit data to farmers through the GSM module to the mobile phone or PC.

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