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Smart Irrigation and Crop Health Prediction

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Abstract

The scarcity of clean water resources around the globe has generated a need for their optimum utilization Internet of Things (IoT) solutions, based on the application specific sensors' data acquisition and intelligent processing are bridging the gaps between the cyber and physical world. IoT based smart irrigation systems can help in achieving optimum water-resource utilization in the precision farming landscape. This paper presents an open-source technology based smart system to predict the irrigation requirements of a field using the sensing of ground parameter like soil moisture soil temperature, and environmental conditions along with the weather forecast data from the Internet. The intelligence of the proposed system is based on a smart algorithm, which considers sensed data along with the weather forecast parameters like precipitation, air temperature, humidity, and UV for the near future. The complete system has been developed and deployed on a pilot scale, where the sensor node data is wirelessly collected over the cloud using web-services and a web-based information visualization and decision support system provides the real-time information-insights based on the analysis of sensors data and weather forecast data. The paper describes the system and discusses in detail the information processing results of three weeks data based on the proposed algorithm. The system is fully functional and the prediction results are very encouraging.

Introduction

In India, where 60-70% economy depends on agriculture, there is a great need to modernize the conventional agricultural practices for the better productivity. Due to unplanned use of water the ground water level is decreasing day by day, lack of rains and scarcity of land water also results in decrement in volume of water on earth. Nowadays, water shortage is becoming one of the biggest problems in the world. We need water in each and every field. In our day to day life also water is essential. Agriculture is one of fields where water is required in tremendous quantity. Wastage of water is the major problem in agriculture . Every time excess of water is give to the fields. There are many techniques to save or to control wastage of water in agriculture. The objective of the system includes conserve energy and water resources, handles the system manually and automatically, detects the level of water. Due to the climatic

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Volume 11 Issue 1, 2023
pp: 1623-1636

changes and lack of precision; agriculture has resulted in poor yield as compared to population growth. Irrigation is mostly done using canal systems in which water is pumped into fields after regular interval without any feedback of water level in field. This type of irrigation affects crop health and produces a poor yield because some crops are too sensitive to water content in soil. For effective and optimum utilization of fresh water in irrigation, it becomes essential to develop the smart irrigation systems based on dynamic prediction of soil moisture pattern of the field and precipitation information of upcoming days. This paper presents an intelligent system that predicts soil moisture based on the information collected from the sensors deployed at the field and the weather forecast in- formation available on the Internet The field data has been collected through a self-designed sensor node.

Literature Review

Development of Smart Irrigation Using Adruino and Gsm

Irrigation can be automated by using sensors, microcontroller, Wifi module, android application as shown in Fi.The low cost soil moisture sensor continuously monitors the field. The sensors are connected to arduino board .The sensor data obtained are transmitted through wireless transmission and are reached to the user so that he can control irrigation .The mobile applicationcan be designed in such a way to analyze the data received and to check with the threshold values of moisture, humidity and temperature .decision can be made either by the application automatically without user interruption or manually through application with user interruption. If soil moisture is less than the threshold value the motor is switched ON and if the soil moisture exceeds the threshold value the motor is switched OFF. The sensors are connected to the Arduino. This hardware communicates through wifi module so that user can access the data through his mobile that has an android application.

Previous System Review

In the system uses arduino technology to control watering and roofing of the green house [1]. It uses statistical data acquired from sensors (like temperature, humidity,moisture and light intensity sensors) compared with the weather forecast for decision making. Kalman filter is used to eliminate noise from the sensors. Agriculture System (AgriSys) [2] uses temperature, pH, humidity sensors and the hybrid inference to input the data from sensors.The system monitors the sensors information on LCD and PC. Muhammad (2010), [3] Proposed a simple approach to “Automatic Irrigation control problem using Artificial Neural Network Controller”. The proposed system is compared with ON/OFF controller and it is shown that ON/OFF Controller based System fails miserably because of its limitations. On the other hand ANN based approach has resulted in possible implementation of better and more efficient control. These controllers do not require a prior knowledge of system and have inherent ability to ANN based systems can save lot of resources (energy and water) and can provide optimized results to all type of agriculture areas. Sanjukumar (2013), [4] Proposed “Advance Technique for Soil Moisture Content Based Automatic Motor Pumping International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181 for Agriculture Land Purpose”

The Ciência & Engenharia - Science & Engineering Journal
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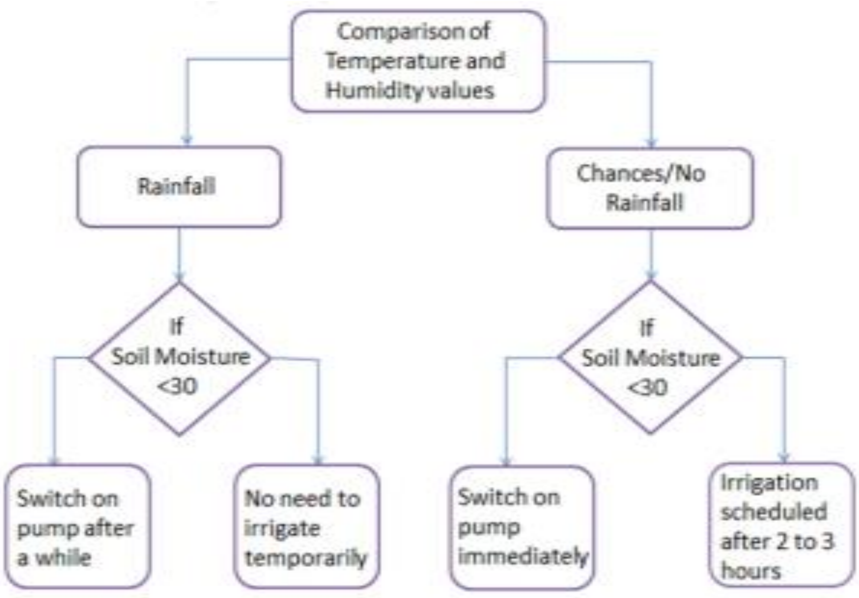
pp: 1623-1636

was developed and successfully implemented along with flow sensor. Salient features of the system are: Closed loop automatic irrigation system, temperature and water usage monitoring. User can easily preset the levels of the Moisture and is regularly updated about current value of all Parameters on LCD display. In future, other important soil parameters namely

soil pH, soil electrical conductivity will also be incorporated in the system.

Block Diagram



Chapter 3:

Proposed System

In the proposed system instead of normal irrigation type we use drip irrigation method where the water can be directed to the root in sufficient amount so that water as well crop management can be improved. Using IoT the drip irrigation method is automated with the help of sensors and pipe tubes. Various sensors such as temperature, soil moisture sensors are used in field monitoring and the ground water level can be monitored lively using the float switch where the fall in water level can be notified to the farmer SMS. If the field is dry it can also be notified to the farmer to his mobile and the motor will be switched ON and if the moisture level attains a certain level the motor is switched OFF automatically without manual instruction. The farmer can monitor the field and water level either through the web page which updates field information lively or through SMS in mobile phone. Thus, through the Web interfaced processor and relay switches the water management is controlled and information is delivered to the user

The Ciência & Engenharia - Science & Engineering Journal
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Volume 11 Issue 1, 2023
pp: 1623-1636

Block Diagram

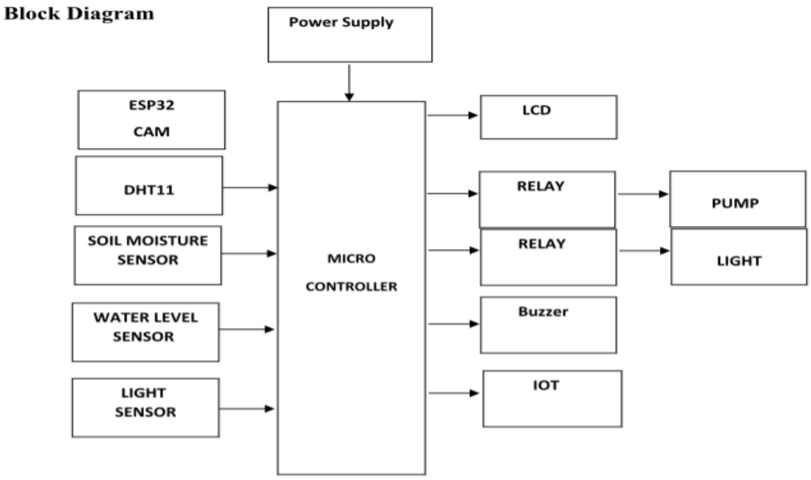

Figure 1 Proposed model

Hardware Components:

Power Supply:

The power supply section is the section which provides +5V for the components to work. IC LM7805 is used for providing a constant power of +5V. The ac voltage, typically 220V, is connected to a transformer, which steps down the ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation. A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

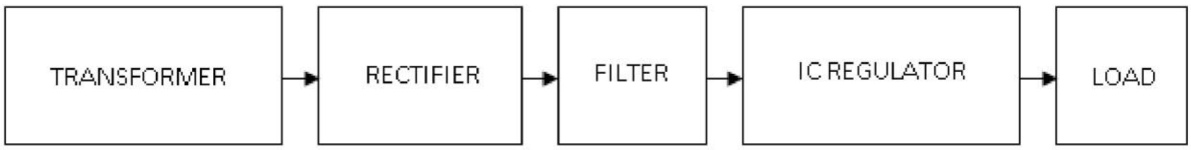

Figure 2 Block diagram of power supply

Voltage Regulators

Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustable set voltage. The regulators can be selected for operation with load currents

The Ciência & Engenharia - Science & Engineering Journal
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Volume 11 Issue 1, 2023
pp: 1623-1636

from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

Figure 3 Voltage Regulator

A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground. The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

Many of the fixed voltage regulator ICs have 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.

ESP32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. ESP32 is created and developed by Espressif Systems, a Shanghai based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

Figure 4 ESP32 Microcontroller

ESP32 Camera

ESP32-CAM is a development board module with a size of 27×40mm. It can be integrated into a camera system with an ESP32 module and camera. ESP32-CAM can be widely used in various IoT applications. It is suitable for home smart devices, industrial wireless control, wireless monitoring, QR wireless identification, wireless positioning system signals and other

IoT applications. It is an ideal solution for IoT applications.

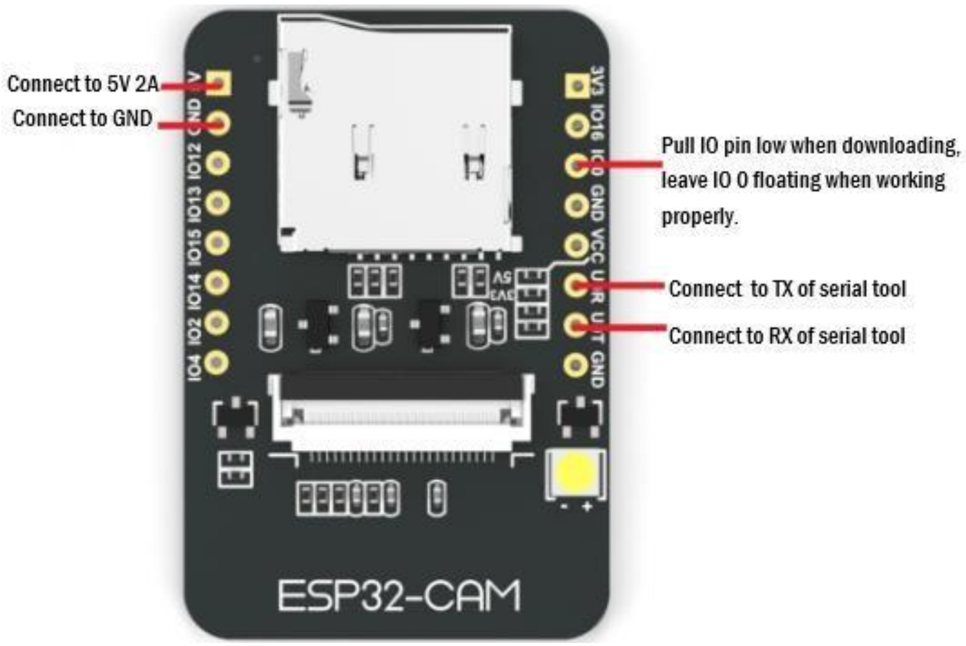

Figure 5 ESP32 Camera

● **4.5-DHT11:**

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1623-1636

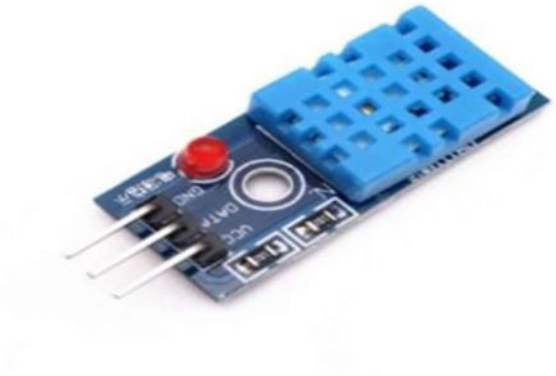

Figure 4.14 DHT11

4.5 DHT 11:

The DHT11 is a low-cost digital temperature and humidity sensor that is commonly used in electronic projects. It is a popular choice for hobbyists, students, and professionals alike because of its accuracy, reliability, and affordability. In this article, we will discuss the DHT11 sensor in detail, including its features, specifications, applications, and working principle.

Features:

● The DHT11 sensor can measure temperature between 0 to 50 degrees Celsius with an accuracy of +/- 2 degrees Celsius.

● It can also measure humidity between 20% to 90% RH with an accuracy of +/- 5% RH.

● The sensor is small in size and easy to use. Smart irrigation and crop health prediction

● It operates on a single wire digital interface, making it easy to connect to microcontrollers or other digital circuits.

● The DHT11 sensor has a response time of 2 seconds for humidity and 5 seconds for temperature.

● It consumes very little power and can operate from 3.3V to 5V DC.

● It has a built-in thermistor and a capacitive humidity sensor.

Specifications:

● Supply voltage: 3.3V to 5V DC

● Current consumption: 2.5mA max during conversion

● Operating range: 0°C to 50°C for temperature, 20% to 90% RH for humidity

● Accuracy: ±2°C for temperature, ±5% RH for humidity

● Sampling rate: 1 Hz

● Response time: 2 seconds for humidity, 5 seconds for temperature

● Output: Digital signal on a single wire

Applications:

● The DHT11 sensor is commonly used in weather stations, HVAC systems, and other applications where temperature and humidity need to be monitored.

● It is also used in incubators, greenhouses, and other environments where temperature and humidity need to be controlled.

● The sensor can be used in home automation systems to control heating, cooling, and humidity levels.

● It is also used in medical equipment, such as respiratory humidifiers and oxygen concentrators.

Working principle:

The DHT11 sensor works by measuring changes in capacitance caused by changes in temperature and humidity. The sensor has two electrodes - one for temperature and one for humidity. The humidity sensor consists of a thin film of polymer that absorbs water molecules from the air, causing its capacitance to change. The temperature sensor consists of a thermistor that changes its resistance with temperature. The sensor measures these changes and converts them into a digital signal that can be read by a microcontroller or other digital circuit. To read data from the DHT11 sensor, the microcontroller sends a start signal to the sensor, followed by a pulse that lasts for 18ms. The sensor responds by sending a pulse that lasts for 40us to acknowledge Smart irrigation and crop health prediction the start signal. The sensor then sends the data to the microcontroller in a series of 40 bits. The first 8 bits represent the integral part of the humidity, the next 8 bits represent the decimal part of the humidity, the next 8 bits represent the integral part of the temperature, and the last 8 bits represent the decimal part of the temperature. The microcontroller then calculates the temperature and humidity values from these bits.

In conclusion, the DHT11 sensor is a versatile and affordable sensor that is widely used in a variety of applications. It is easy to use and can be connected to microcontrollers or other digital circuits. With its accuracy and reliability, the DHT11 is an excellent choice for temperature and humidity sensing in electronic projects.

4.6-RELAY :

4.6.1 Relay

A relay is an electromechanical switch, which perform ON and OFF operations without any human interaction. General representation of double contact relay is shown in fig. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical

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Volume 11 Issue 1, 2023
pp: 1623-1636

isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

History

Fig. Relay Smart irrigation and crop health prediction

The first relay was invented by Joseph Henry in 1835. The name relay derives from the French noun relays' that indicates the horse exchange place of the postman. Generally a relay is an electrical hardware device having an input and output gate. The output gate consists in one or more electrical contacts that switch when the input gate is electrically excited. It can implement a decoupled, a router or breaker for the electrical power, a negation, and, on the base of the wiring, complicated logical functions containing and, or, and flip-flop. In the past relays had a wide use, for instance the telephone switching or the railway routing and crossing systems. In spite of electronic progresses (as programmable devices), relays are still used in applications where ruggedness, simplicity, long life and high reliability are important factors (for instance in safety applications)

Working

Generally, the relay consists a inductor coil, a spring (not shown in the figure), Swing terminal, and two high power contacts named as normally closed (NC) and normally opened (NO). Relay uses an Electromagnet to move swing terminal between two contacts (NO and NC). When there is no power applied to the inductor coil (Relay is OFF), the spring holds the swing terminal is attached to NC contact. Smart irrigation and crop health prediction

4.8-Soil moisture :

Precision soil moisture has chosen shown in which consists two probes that are inserted in to soil.

When the current pass through the probes, the soil contains low moisture offer a less resistance and

passes high current. That is variable resistance is the parameter to identify the level of soil.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 11 Issue 1, 2023
pp: 1623-1636

Features of Soil Moisture Sensor:

● Dual output module, analog and digital

● It is integrated with the LM393 module chip

● There are two led indicators,red (power indicator) and green (output indicator)

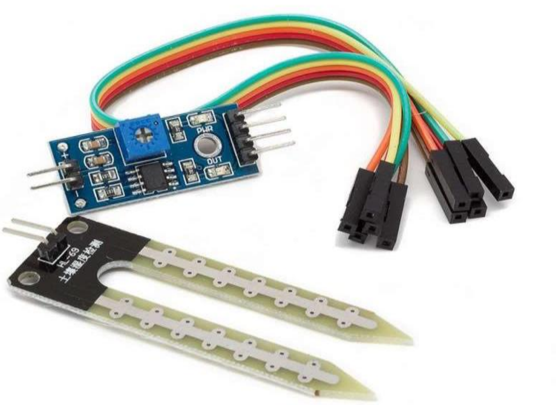

Figure 4.21 Soil moisturer

LCD Display

LCD Stands for "Liquid Crystal Display." LCD is a flat panel display technology commonly used in TVs and computer monitors. It is also used in screens for mobile devices, such as laptops, tablets, and smartphones.

LCD displays don't just look different from bulky CRT (Cathode Ray Tube) monitors, the way they operate is significantly different as well. Instead of firing electrons at a glass screen, an LCD has a backlight that provides light source to individual pixels arranged in a rectangular grid. Each pixel has a RGB (Red, Green, and Blue) sub-pixel that can be turned on or off**.** When all of a pixel's sub-pixels are turned off, it appears black.

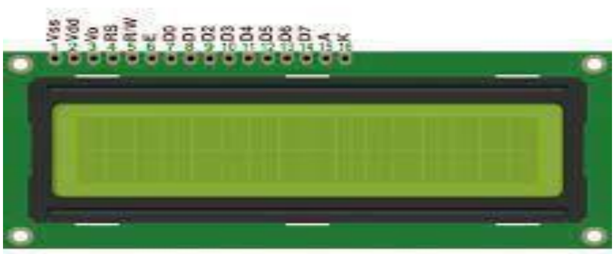

Figure 9 LCD Display

The Ciência & Engenharia - Science & Engineering Journal
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Volume 11 Issue 1, 2023
pp: 1623-1636

Result

Smart irrigation and crop health prediction can have several benefits for farmers and the agriculture industry as a whole. By using sensors and data analysis techniques, smart irrigation systems help farmers to control the amount of water used in irrig ating their crops, which can lead to significant savings in water usage and costs.

Cou pling smart irrigation with crop health prediction models can also help farmers to detect potential issues with their crops early on, allowing them to take corrective action before it's too late. This can result in higher crop yields, better quality produce, and ultimately increased profits for farmers.

Overall, the combination of smart irrigation and crop health prediction can help to improve the sustainability and efficiency of agricultural practices, while also reducing the environmental impact of farming.

Comparison of previous system and proposed system

Features	Child Safety Car Alert System by Arduino	Proposed System using ESP32 Microcontroller
Sensors Used	Force Sensitive Resistor (FSR) Sensor and Pressure Infrared (PIR) Sensor	Child Crying Sensor
Alert System	Sends message to driver's mobile phone	Rolls down windows and unlocks doors, sends message to mobile phone
Microcontroller Used	Arduino Board	ESP32 Microcontroller
Response Time	Short	Rapid
Camera Monitoring	Not implemented	Implemented
Data Storage and Transfer	Not mentioned	Data stored in a database, transferred to Android phone via IoT
Energy Consumption	Not mentioned	Energy consumption per bit lowered with GSM
Integration of Hardware	Integrated	Integrated

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Volume 11 Issue 1, 2023
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Conclusion

The project **"Implementation of Smart irrigation and Crop health predictions"** has been successfully designed and tested. In conclusion, the implementation of smart irrigation systems combined with crop health prediction tools can greatly benefit farmers and improve agricultural practices. These technologies allow farmers to optimize their water usage, leading to greater crop yields and profitability. Additionally, crop health monitoring and prediction tools help to identify potential issues before they become problematic, allowing for proactive rather than reactive responses. Overall, the integration of smart irrigation and crop health prediction technologies can enhance sustainability, reduce water waste, and ultimately increase food production to meet the growing global demand.

FUTURE SCOPE

- Scope in agricultural fields.
- Scope in indoor farming

1. Flood Irrigation: This is one of the oldest and simplest irrigation methods where water is applied to the fields by flooding the entire area. Water is typically diverted from a water source, such as a river or canal, and distributed through open channels or ditches. Flood irrigation is often used for large-scale agriculture but can be inefficient due to water loss through evaporation and runoff.

2. Sprinkler Irrigation: Sprinkler systems involve the use of overhead sprinklers that distribute water over the crops in the form of fine droplets. Sprinkler systems can be fixed or movable and are suitable for a variety of crops. While they provide more controlled water application compared to flood irrigation, they can still result in some water loss through evaporation and wind drift.

3. Drip Irrigation: Drip irrigation is a precise and efficient method that delivers water directly to the root zone of plants through a network of tubes or pipes with emitters placed near individual plants or along rows. Drip systems minimize water wastage, reduce evaporation losses, and allow for precise control over water application. T

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