Automated Irrigation and Soil Nutrition Detection

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***Abstract*:** Agriculture is considered to be the backbone of India but it is facing exploitation. India's population depends only on agriculture. Nowadays the concept of automation goes on developing to a peak. The integration of Internet of Things (IoT) technology in agriculture has led to significant advancements in precision farming, particularly in smart irrigation systems that monitor and manage soil nutrients. To introduce a smart irrigation system using ESP32 for water management with the nutrient monitor. The paper begins by studying the core components and the technologies that support these systems such as temperature sensor, moisture sensor, nutrient detector sensor and automated irrigation controllers. The main objective of this project is to automate the irrigation system of crops and along with that monitor the essential soil nutrients such as potassium, nitrogen and phosphorous. The monitoring process of nutrients will help the farmers to chose the appropriate fertilizer for the health growth of the plant. In the traditional farming, water wastage is a major problem for the farmers and as well as supplying excess water to the plants can damage the crop. To overcome this major problem the project is designed in such a way that it automates the water supply depending upon the moisture level of soil. The switching of the water pump in this project can be done manually or switching ON/OFF in the mobile app (Blynk).

***Index Terms*:** Smart agriculture, Internet of things (IOT), Precision farming, Automated irrigation, Soil moisture monitoring, Soil nutrient monitoring, Water management sensor based system, Embedded system.

I. INTRODUCTION

Agriculture is plays vital role in the economic development of the globe, especially countries like India where large proportion of population is dependent on the agriculture for their livelihood. In the traditional farming practices, the water supply to the crops is given manually and there is no proper study of the soil health which leads to an inefficient growth of plant. Due to this, production of the crop is decreased which ultimately affects the economy of the farmer as well as the country. In addition, water wastage is also a major disadvantage in traditional farming. With increase in water scarcity and need of higher crop production the demand for smart and sustainable farming solution is increasing. In the recent year, the Internet of Things and Embedded system has developed in such a way that now using the technologies the farming can be upgraded to the automated level and can control the agricultural processes in real time. This technology enables integration of various sensors, relays, controllers are combined together in such a way that they process the real time data, analysis the data related to the soil nutrient and take the right action.

The project "Automated Crop Irrigation and Soil Nutrition Detection", focuses on building a smart system that automates the irrigation and simultaneously monitors the soil nutrients like nitrogen, phosphorous and

potassium. It makes sure that the crops receive the optimum water and also nutrient level of the soil is maintained. This project not only helps in conservation of the water but also improves the productivity and the overall health of the crop. In addition, farmers can receive real time updates through wireless communication enabling remote monitor and control. Because of this efficiency is enhanced and manual labor is minimalized. This project is a very perfect example of precision farming. Overall in this project by combining automation, modern technology and data analysis a system is built which supports sustainable farming and resolve the challenges faced in traditional farming.

It is very important to monitor the soil nutrition, our project detects the soil nutrient content using the NPK sensor which help the farmer to chose the right fertilizer to be added in soil to normalize the nutrient level. The farmers living in the remote location need to go to the soil lab for the soil testing, this task can be avoiding using this system. The farmers will receive the nutrients data on their mobile phones. This is a light weight compatible, low cost, fully equipped system with web framework. The agricultural production depends upon overall climate, soil nutrients, minerals etc. Out of this factor the climate and the minerals are unchangeable factors, the only factor that can be changed is the soil nutrient. The soil pH plays a very crucial role in monitoring the soil. pH is measure of acid and base content of the soil. Leaching is the main factor which changes the pH of the soil. Heavy rainfall is responsible for the leaching of the soil which in result decrease the soil pH. The main nutrient that can increase the pH of the soil is nitrogen. The nitrogen is the vital nutrient that has to be tested and monitored consistently to maintain the condition of the soil.

The another important nutrient that affects the soil is phosphorous. The excess amount of phosphorous dries up the plant. Potassium in the soil is responsible for the overall development of the soil. The deficiency of potassium can affect the fruit, leaf, color, taste of the plant. In addition, potassium also helps in the intake of the CO2 from the soil. All the above mentioned nutrients like nitrogen, potassium and phosphorous can be consistently tested and monitored using our system.

II. METHODOLOGY:

The proposed system uses the structured methodology to optimize farming practices by leveraging IoT and sensor technology. The system is based on three major sensors soil moisture sensor, DHT11 and NPK sensor. The soil moisture sensor measures the moisture of the soil, this information is needed for the automated crop irrigation. Soil moisture sensor acts as a measure for the moisture level present in the soil so that when the moisture content is low enough the irrigation is triggered accordingly. The NPK sensor traces the important nutrient level of the soil. DHT11 measures the temperature and relative humidity which are the very important environmental factors affecting the crop health and irrigation. The nutrients measured by the NPK sensor are nitrogen, potassium and phosphorous. The system heavily relies on the data collecting process. Each sensor regularly gathers the data and send it to the microcontroller.

- SYSTEM DESCRIPTION

The proposed system can be divided as :

1. Hardware module
2. Software module

- **Hardware module**

  Hardware components are soil moisture sensor, DHT11, NPK sensor, ESP32, water pump, relay, jumping wires, breadboard. ESP32 is the microcontroller with all the main features required in the

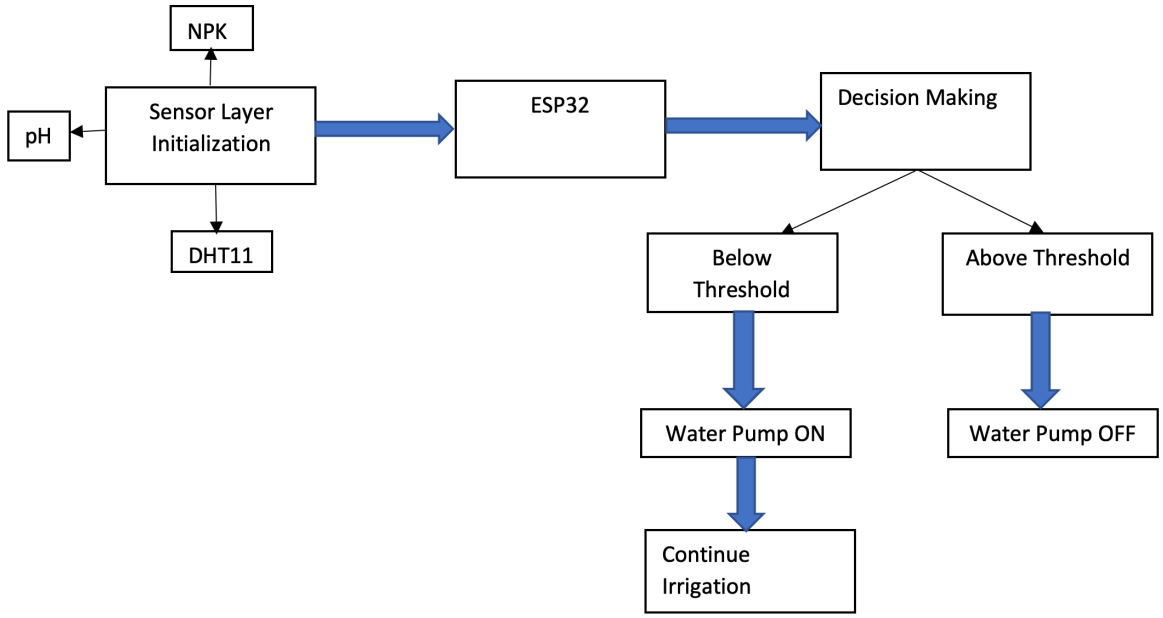
IoT. All the sensor data is received by the ESP32. ESP32 sends the obtained value from the sensor to Blynk using the protocol HTTP, MQTT, I2C.

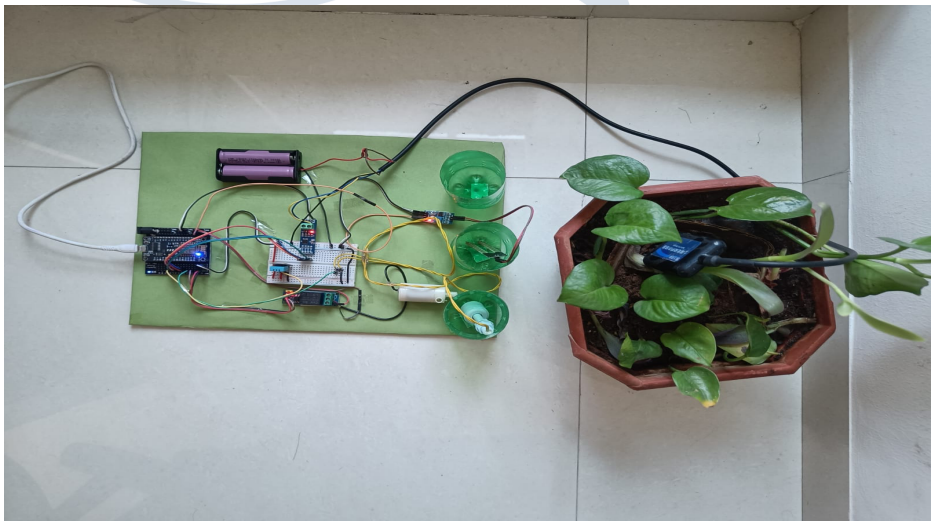
The soil moisture is SEN-13322 sensor which comes under capacitive type. It is very stable and reliable for measuring the water amount in the soil. This sensor measures the moisture by looking at the soil's dielectric permittivity. The soil moisture index (SMI) is calculated to determine soil water content and guide irrigation decision. The equation used is : (Poyen, F.B., et.al., 2020)

$$SMI = \frac{V_{moist} - V_{dry}}{V_{wet} - V_{dry}} \times 100$$

Where, V_{moist} is the current moisture reading, V_{dry} is the voltage for dry soil, V_{wet} is the voltage for wet soil. When the SMI falls below a certain threshold the irrigation system is activated. The condition for triggering irrigation is given by,

$$I_{on} = 1, \text{ if } SMI < SMIthreshold$$
$$0, \text{ if } SMI >= SMIthreshold$$

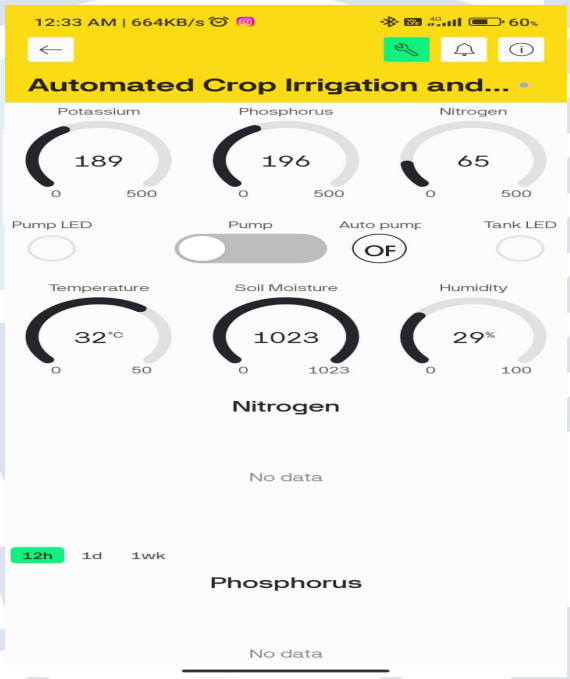




Software module

- Blynk Application

  Blynk IoT application used for monitoring and controlling the smart irrigation system remotely. It shows real time visualization of sensor data and it also allows users to interact with the system using mobile phones. Virtual pins are assigned to display parameters such as soil moisture, temperature, humidity and NPK values. Different widgets are used like gauges, labels and buttons to show the values and control the actions. Its supports both manual and automatic operation modes. Users can control the water pump using button widget in manual mode and while in automatic mode, the system operates based on predefined threshold values without user involvement. The ESP32 communicates with Blynk cloud server via Wi-Fi, enabling real time data transmission and remote access.

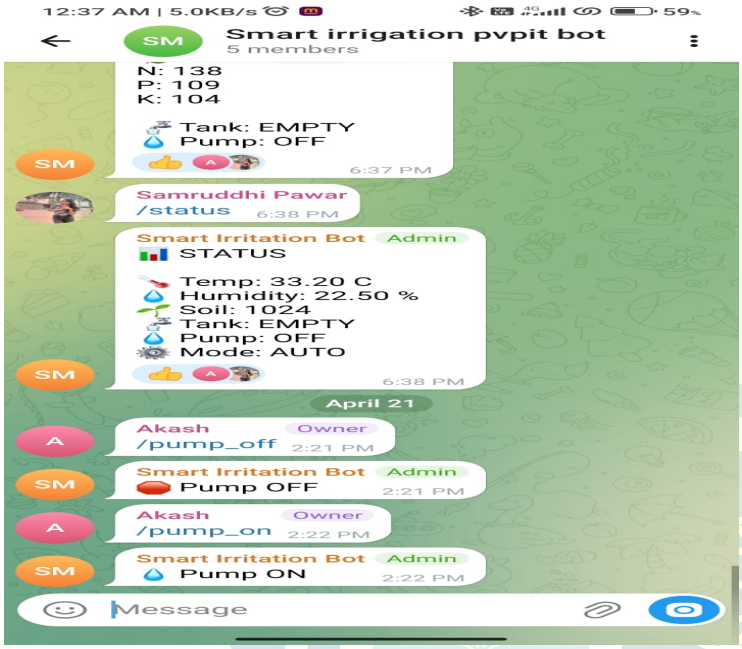


- Telegram Bot Integration

  Telegram bot provide an alternative method for monitoring and controlling the system using text based commands. User can interact with the system by using simple commands in a Telegram group. BotFather is used to create bot, the bot is added as a admin with required permissions. The bot can read all the group messages because privacy mode is disabled. The ESP32 processes user commands received through the Telegram bot and responds with real time system data.

  The bot supports multiple commands such as:

  - /status -> Displays temperature, humidity, soil moisture, tank level and pump status
  - /npk_status -> Shows Nitrogen, Phosphorous and Potassium values
  - /daily_report -> Provides a complete system report
  - /pump_on /pump_off -> Controls the water pump manually
  - /auto_on /auto_off -> Enables or disables automatic irrigation mode



III. CONCLUSION:

The automated crop irrigation and soil nutrition detection is a significant breakthrough in modern agriculture that helps to address critical aspects such as conservation of water, improve crop yield. The combination of IoT, Embedded system, modern technology, automation provides the farmer complete automated solution. With the real time monitoring and control system of Blynk App farmers can take data driven decisions and improve the efficiency and productivity of their farming technique. This technique minimize the water wastage, helps farmers to chose appropriate fertilizers which improves the farming ecology. Its scalability and versatility make it appropriate for variety of farming context.

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