Internet of Things (IoT) for Smart Precision Agriculture and Farming in Rural Areas

Mr. Paithankar Amit Arun [1], Mr. Jadhav Sachin Ramesh [2], Mr. Kale Ganesh Jagannath [3], Mr. Jadhav Shubham Rajaram [4], Dr. Tapre P.C.[5]

[1234]Student, Department of Electrical Engineering, S.N.D. College of Engineering and Research Centre, Yeola, Nashik Maharashtra

[5]Prof & HoD, Department of Electrical Engineering, S.N.D. College of Engineering and Research Centre, Yeola, Nashik Maharashtra

---***---

Abstract - Precision Agriculture (PA) is a management strategy that utilizes communication and information technology for farm management. It is a key to improve productivity by using the best agricultural practices and optimal usage of resources. Agriculture faces diverse challenges due to soil degradation, climate variation, and increasing costs. To unfold these challenges, PA uses Wireless Sensor Networks (WSNs) and exploits acquisition, communication, and processing of the data as basic enabling technologies to amplify the crop yield. Also, many other multidisciplinary technologies are supporting PA in finding the most novel use cases for PA. The use of Machine Learning (ML) and Artificial Intelligence (AI) has transformed PA at almost every level. The fog/edge paradigm is mitigating many challenges such as network bandwidth and security by bringing computation closer to the deployed network

Key Words: Precision agriculture, Machine learning, WSN

1. INTRODUCTION

Agricultural irrigation always receives attention as an important application for the purpose of crop cultivation and production. A reliable and suitable irrigation water supply can significantly raise vast improvements in agricultural productivity and water savings. Clearly, traditional irrigation consumes not only bulk amounts of water, but electrical energy may also be required greatly, depending on the geographical location. The traditional irrigation practice involves applying water as uniformly as possible over every part of the field without taking the variability of soil and crop water needs into account. Consequently, some parts of the field are over-irrigated, meanwhile, other parts of the field are under-irrigated [1]. In addition, variable rate irrigation (VRI) provides the flexibility to manage spatial and temporal variabilities within different zones of a production field. However, the adoption of VRI is very limited, and it does not always guarantee the best irrigation [2]. Presently, water demands are continuously increasing, whereas water resources are unfortunately limited. With water scarcity, precision irrigation (PI) systems have been focused and enabled by the advancement of sensor technologies and the internet of things (IoT). Currently, the new paradigm of massive measurements is represented in terms of wireless sensor networks (WSN). As the rapid growth of IoT, low-power and low-complexity communications are one of the greatest challenges faced by practitioners today.IJSREM sample template format ,Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

2. LITERATURE REVIEW

Ritesh Kumar Singh et.al (IEEE 2021),"An Architecture for IOT and Emerging Technologies Based On a Precision Agriculture Survey" Precision Agriculture is a management strategy that utilizes communication and information technology for farm management. It is a key to improve productivity by using the best agricultural practices and optimal usage of resources.

Radhika Kamath et.al (IEEE 2020),"Raspberry Pi as Visual Sensor Nodes in Precision Agriculture sensor". Wireless sensor network applications in the agricultural sector are gaining popularity with the advancement of the Internet of Things technology. Predominantly, wireless sensor networks are used in agriculture to sense the important agricultural field parameters, such as temperature, humidity, soil moisture level, nitrite content in the soil, groundwater quality, and so on.

Chaowanan Jamroen et.al (IEEE 2020),"An Intelligent Irrigation Scheduling System Using Low-Cost Wireless Sensor Network Toward Sustainable and Precision Agriculture."Agricultural irrigation developments have gained attention to improve crop yields and reduce water use. However, traditional irrigation requires excessive amounts of water and consumes high electrical energy to schedule irrigations.

Pankaj Kumar Kashyap et.al (IEEE 2021) "Towards Precision Agriculture: IoT-enabled Intelligent Irrigation Systems Using Deep Learning Neural Network" Recently, precision agriculture has gained substantial attention due to the ever-growing world population demands for food and water. Consequently, farmers will need water and arable land to meet this demand. Due to

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 03 | March - 2024 SJIF Rating: 8.176 ISSN: 2582-3930

the limited availability of both resources, farmers need a solution that changes the way they operate. Precision irrigation is the solution to deliver bigger, better, and more profitable yields with fewer resources.

3. PROJECT OBJECTIVE

Data Driven Decision Making: Utilize IoT devices such as sensors, drones, and actuators to collect real-time data on various parameters including soil moisture, temperature, humidity, crop health, weather conditions, and pest infestations. This data empowers farmers to make informed decisions regarding irrigation, fertilization, pest control, and crop management.

Precision Farming Practices: Implement precision agriculture techniques enabled by IoT technologies to optimize resource usage. This includes precise application of water, fertilizers, and pesticides based on localized conditions, leading to reduced waste, lower costs, and improved crop yields.

Remote Monitoring and Management: Enable remote monitoring and management of agricultural operations through IoT-enabled platforms. Farmers can access real-time data and control systems from anywhere, allowing them to respond promptly to changing conditions, manage equipment, and troubleshoot issues without the need for physical presence on the farm.

Predictive Analytics and Ai: Harness the power of predictive analytics and artificial intelligence (AI) algorithms to analyze IoT-generated data and provide insights into future trends, risks, and opportunities. This enables proactive decision-making, early detection of potential problems, and optimization of farming practices for better outcomes.

4.BLOCK DIAGRM

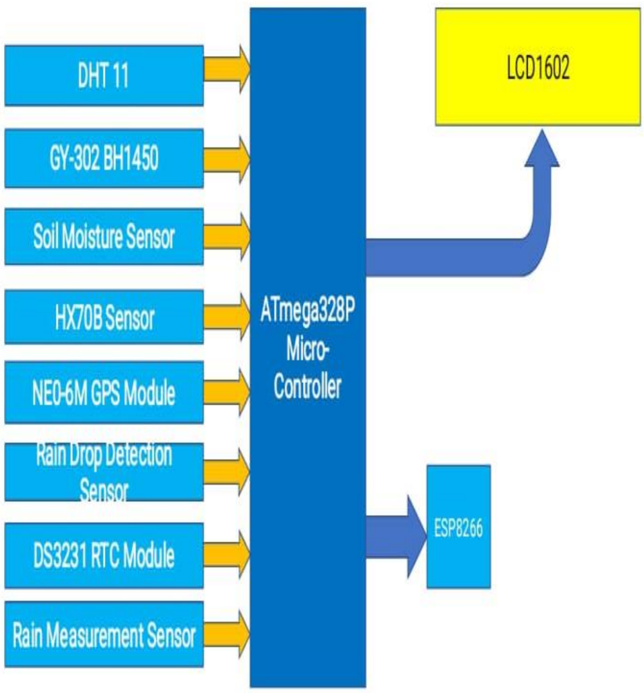

Fig-1.- Block diagram of Precision Agriculture Sensor.

5. CIRCUIT DIAGRAM

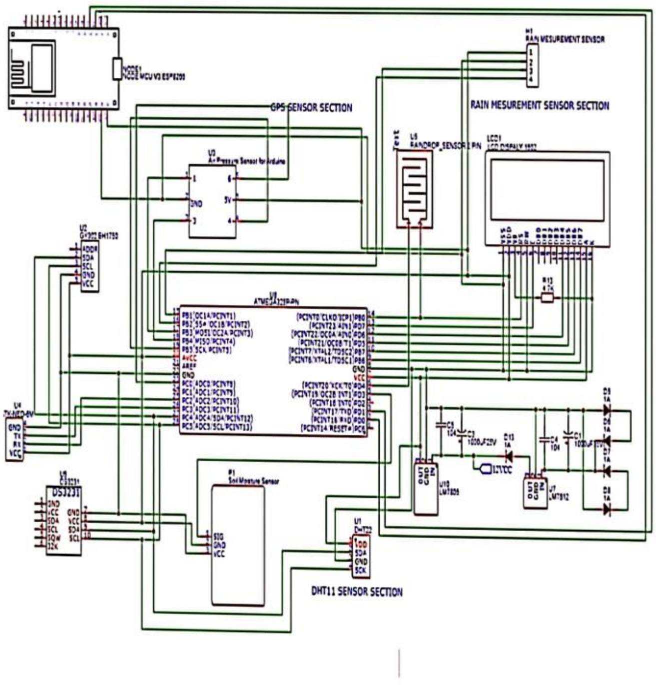

Fig -2. Circuit diagram of Precision Agriculture Sensor.

6. HARDWARE REQUIRED

1.ATmega328P Microcontroller

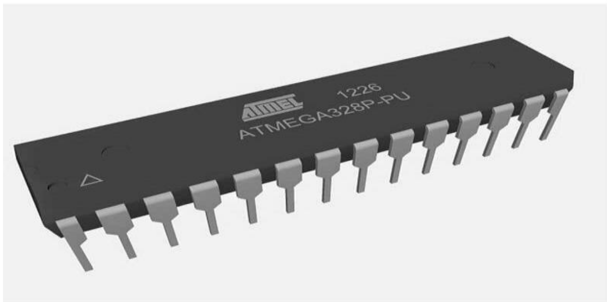

Fig 3. ATmega328P Microcontroller

The Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general-purpose I/O lines, 32 general-purpose working registers, 3 flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8 channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and 5 software-selectable power-saving modes. The device operates between 1.8 and 5.5 volts. The device achieves throughput approaching 1 MIPS/MHz.

2.ESP8266 WIFI Module

The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP protocol stack that can give any microcontroller access to your WiFi network. The ESP8266 is capable of either hosting an application or offloading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware, meaning, you can simply hook this up to your Arduino device and get about as much WiFi-ability as a WiFi Shield offers (and that's just out of the box)! The ESP8266 module is an extremely cost effective board with a huge, and ever growing, community

3.Temperature & Humidity Sensor (DHT11)

DHT11 is a low-cost digital sensor for temperature and humidity. This sensor can be used with Arduino Raspberry Pi, etc to instantly measure humidity and temperature easily interfaces with any microcontroller. DHT 11 humidity and temperature sensor is available as sensor and module the difference between the sensor and the turn on LED.DHT11is a relative humidity sensor to measure ambient or uses thermistor and capacitive humidity sensor

4.GY-302BH1450 Sensor

This sensor is specifically designed for accurately measuring ambient light levels and is commonly used to adjust the backlight power of LCD screens.

5. Soil Moisture Sensor :

A soil moisture sensor is a sensor used to measure soil water content. Direct gravimetric measurement of soil moisture requires removal, drying, and weighing of the sample. This sensor measures bulk water content without directly using several other soil parameters such as dielectric constant, electrical resistance, neutron interaction, and moisture exchange

6.NEO-6M GPS Module

If you are wandering to navigate the distance with a drone then this GPS Module is needed for you. GPS drones are equipped with a GPS module that allows them to know their location relative to a network of orbiting satellites. Connecting to signals from these satellites allows the drone to perform functions such as position hold, autonomous flight, return to home, and waypoint navigation.

7. HX710B Air Pressure

HX710B Atmospheric Pressure Sensor Module. This barometric pressure sensor is optimized for altimeters and variometers with an altitude resolution of 10 cm. The sensor module includes a high linearity pressure sensor and an ultra-low power; 24 bit ADC with internal factory calibrated coefficients. It provides a precise digital 24 Bit pressure and temperature value and different operation modes that allow the user to optimize for conversion speed and current consumption.

8. Raindrops Detection Module

It includes a printed circuit board (control board) that “collects” the raindrops. As raindrops are collected on the circuit board, they create paths of parallel resistance that are measured via the op-amp. The lower the resistance (or the more water), the lower the voltage output. Conversely, the less water, the greater the output voltage on the analog pin. A completely dry board, for example, will cause the module to output 5V.

9.DS3231 RTC Module Precise Real Time Clock

The DS3231 RTC module Precise Real-Time Clock Module is a low-cost, extremely accurate I²C real-time clock (RTC) with an integrated temperature-compensated crystal oscillator (TCXO) and crystal. The device incorporates a battery input and maintains accurate timekeeping when the main power to the device is interrupted.

10. Rain measurement sensor

The rain sensor works on the principle of total internal reflection. An infrared light beams at a 45-degree angle on a clear area of the windshield is reflected and it is sensed by the sensor-inside the car. When it rains, the wet glass causes the light to scatter and lesser amount of light gets reflected back to the sensor

7. WORKING OPERATION

1. Sensor Deployment: IoT sensors are strategically deployed across the farm to collect data on various parameters such as soil moisture, temperature, humidity, light intensity, nutrient levels, and crop health. These sensors may be placed in the soil, on plants, or on agricultural machinery

2.Data Collection: The deployed sensors continuously gather data from the environment and transmit it wirelessly to a centralized data management system. This data includes real-time information on soil conditions, weather patterns, crop growth stages, and other relevant factors affecting agricultural operations.

3.Data Transmission and Connectivity: IoT devices use wireless communication technologies such as Wi-Fi, Bluetooth, LoRa, or cellular networks to transmit data to a cloud-based or on-premises data storage and processing infrastructure. This ensures seamless connectivity and data transfer even in remote rural areas.

4.Data Processing and Analytics: The collected data is processed and analyzed using advanced analytics techniques, including machine learning algorithms and predictive models. These analytics generate valuable insights into crop performance, resource utilization, pest infestations, disease outbreaks, and other factors influencing farm productivity and profitability.

5.Decision Support Systems: Based on the insights derived from data analytics, decision support systems provide farmers with actionable recommendations and alerts to optimize their farming practices. This includes recommendations for irrigation scheduling, fertilizer application, pest control strategies, crop rotation planning, and harvesting timing.

8. APPLICATIONS

- Rural areas and agriculture sector.
- It used to control and monitor the temperature at home like in bedroom, kitchen.
- It also be used in agriculture farm and gardens.

9. Advantages

- Crop monitoring
- Condition assessment
- Recognizing crop emergence anomalies in near-real time
- Increased Yield
- Look through the clouds

10. Disadvantages

- High operating cost
- Security issues
- Not suitable for large areas
- Low spectral resolution
- Sensitivity to weather conditions

11. CONCLUSION

PA is becoming the absolute necessity to manage global food requirements. With the help of sensors, IoT collects vital information from the farms and forwards it to the cloud application over a secure network. The collected data is processed using different technologies such as big data, AI, and ML to look for any inconsistencies and use them for decisionmaking. Different applications such as a disease forecast alert system help to tackle uncertainties for the farmers. It forms the basis of Agriculture 5.0, the new set of frameworks for smart agriculture. This work reviews emerging technologies that power PA solutions. Several new technologies are being employed by different solutions to make PA more energy-efficient, adaptable, and precise. Solution architectures use different computation paradigms at edge, fog, and cloud for data processing. These architectures are further supported by ML, AI, big data, SDN, and other new technologies like nanotechnology and blockchains. The capabilities of remote sensing using UAVs are exploited in several use-cases to achieve optimal networks with high coverage and performance. Edge computing has a major role in sharing and bringing the computation load closer to the source of data. the IoT-based smart agriculture monitoring system offers a practical and effective solution for farmers to monitor and optimize the growth of their crops. By collecting and analyzing data on various environmental factors such as temperature, humidity, soil moisture, and light intensity.

12. Result

Precision agriculture sensors provide valuable data and insights to farmers. By monitoring factors like soil moisture, temperature, and nutrient levels, these sensors help farmers make informed decisions about irrigation, fertilization, and pest control. This leads to improved crop health, increased yield, and more efficient use of resources. Additionally, precision agriculture sensors can detect early signs of pests and diseases, allowing farmers to take prompt action and minimize crop damage. Overall, the result of using precision agriculture sensors is enhanced productivity and sustainability in crop production

REFERENCES

1) RADHIKA KAMATH et.al (IEEE 2020) , “Raspberry Pi as Visual Sensor Nodes in Precision Agriculture Sensor” (radhika.kamath@manipal.edu).
2) CHAOWAN JAMROEN et.al (IEEE 2020),” An Intelligent Scheduling System Using Low-Cost Wireless Sensor Network Toward Sustainable and Precision Agriculture,” (Chaowanan.@eat.kmutnb.ac.th)
3) Pankaj Kumar Kashyap et.al (IEEE 2021) “Towards Precision Agriculture: IoT-enabled Intelligent Irrigation Systems Using Deep Learning Neural Network”
4) RITESH KUMAR SINGH et.al (IEEE 2021),”An Architecture For IOT and Emerging Technologies Based On a Precision Agriculture Survey” (riteshkumar.sings@uantwerpn.be)