Real-Time Smart Monitoring System Using IoT

Mr. Ajinkya V. Bhatkar[1], Mrs. Jayshree N. Balinge[2], Ms. Rutuja J. Deshmukh[3], Ms. Kalyani P. Barabde[4]
[1,2,3,4]*Assistent Professor, College of Engineering and Technology, Akola.*

Abstract - In irrigation systems, many problems occur due to the lack of information about soil temperature, moisture, and humidity. Because of this, farmers face difficulties in selecting suitable crops and there is a high possibility of water wastage. Traditionally, farmers manually irrigate their fields without accurate knowledge of soil conditions.
Using modern technology, it is possible to collect real-time data related to soil conditions and provide water and fertilizers according to the requirements of the crop and soil. In this project, we design a flexible, real-time, and low-power consumption monitoring system that collects soil data using ZigBee, IoT, and cloud technology.
This system allows farmers to monitor soil parameters remotely. The collected data is stored in the cloud, enabling users to access it from anywhere in the world. Therefore, farmers do not need to be physically present in the farmland to observe soil conditions and can easily track changes in soil parameters for better irrigation management.

I. INTRODUCTION

The Internet of Things (IoT) is an important development in the fields of computer science and communication technology. It represents a technological revolution that will shape the future of computing and communication systems. The growth of IoT depends on continuous innovation in several areas such as wireless sensor networks, communication technologies, and nanotechnology.

IoT is widely used in many different fields, and therefore security in IoT systems has become very important. Proper security measures are necessary because IoT devices are connected through the internet and handle large amounts of data, which can greatly impact the IoT industry.

Through IoT technology, various devices and objects can be connected to the internet, allowing them to communicate, share data, and be controlled remotely. Many applications can be monitored and controlled using IoT technology.

IoT has several important applications in different sectors. In the medical and healthcare field, IoT can help solve many medical problems. For example, it can help monitor babies at home or remind patients to take their medicines on time.

In home automation, IoT enables users to control lights and electronic devices efficiently and operate home appliances from anywhere.

In environmental monitoring, IoT helps track water levels to provide flood alerts and monitor pollution levels in the environment.

IoT is also widely used in agriculture, where it helps in monitoring and controlling environmental conditions such as soil moisture, temperature, and humidity to improve farming efficiency and crop production.

II. DEFINITION OF RELATED CONCEPTS

A) IoT in Agricultural Environment

Agriculture provides livelihood and business opportunities for a large portion of the population and contributes significantly to the national income. In India, about 83% of farmers consider agriculture as their main occupation, and around 79% earn their primary income from farming to support their households. Approximately 60% of farmers prefer farming as their main profession, and nearly 73% of farmers use mobile phones, which makes the use of modern technology in agriculture more feasible.

Adaptation to climate change has become necessary for agricultural producers. Therefore, the use of IoT technology in agriculture can help farmers improve farming efficiency and productivity. In this system, IoT technology is used for soil monitoring, allowing farmers to collect important data related to soil conditions such as moisture, temperature, and humidity.

It is often difficult and time-consuming for farmers to manually analyze soil and crop-related data. IoT technology helps by automatically collecting and storing this data, making it easier to monitor agricultural conditions and take timely decisions.

The main concept of this system is to monitor soil conditions using IoT technology so that farmers can make quick and informed decisions. This approach helps in the efficient use of agricultural resources and provides a low-cost solution that can be used even by small-scale farmers. With this technology, farmers can access farm-related data and monitor their fields from anywhere in the world. Additionally, IoT-based solutions can be adapted according to local environmental conditions to address the challenges caused by climate change.

B) Benefits of IoT in Agriculture

The following are the major benefits of IoT applications in agriculture:

1. Improvement in the efficient use of inputs such as soil, water, and fertilizers
2. Reduction in production costs
3. Increase in farmers' profitability
4. Sustainable agricultural practices

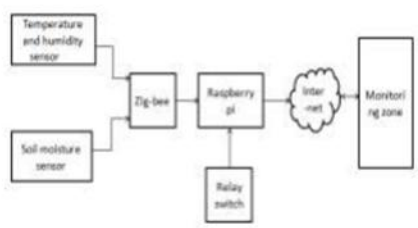

Fig1. Conceptual Diagram of system

An agricultural environment involves the use of pervasive and ubiquitous technologies to provide different types of services for efficient farming. Wireless technologies enable the real-time transmission of data about crop and soil conditions directly to farmers.

In this system, the IoT concept and cloud technology are used to monitor soil conditions effectively. Various sensors such as temperature, humidity, and soil moisture sensors are used to collect environmental data from the farm.

The system consists of several components including ZigBee (IEEE 802.15.4) for wireless communication, a Raspberry Pi board for data processing, cloud storage (a type of data center) for storing collected data, and end monitoring devices such as laptops, mobiles, or desktop computers for accessing the information.

Using this system, farmers can easily monitor soil conditions and farm data remotely. The conceptual diagram of this system is shown in Fig. 1.

III. HARDWARE

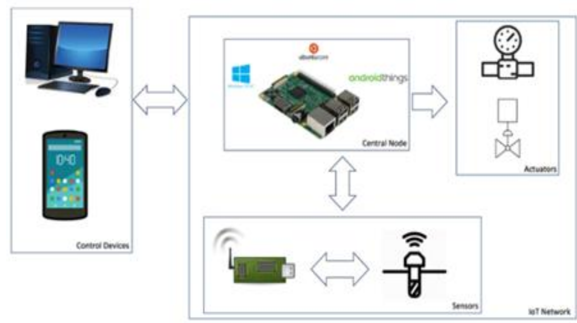

Figure2: block diagram of system

The hardware architecture of the proposed system is shown in Fig. 2. The system consists of a 32-bit ARM processor with a Raspberry Pi board acting as a gateway. The architecture also includes temperature and humidity sensors, a soil moisture sensor, ZigBee transmitter and receiver modules, cloud technology (IoT platform), and monitoring devices such as mobile phones, laptops, and desktop computers.

In this system, sensors collect environmental and soil-related data. The collected data is transmitted using ZigBee wireless communication to the Raspberry Pi gateway, which processes the data and sends it to the cloud platform. From the cloud, the information can be accessed by users through various monitoring devices such as smartphones, laptops, or desktop computers.

A) Temperature and Humidity Sensor

The temperature and humidity sensor is used to measure relative humidity and temperature in the environment. This sensor provides output through a simple serial interface. The output data can be viewed on a PC terminal software at a baud rate of 9600 bps.

Microcontrollers can read the sensor data using a serial shift interface through general I/O pins. The sensor is capable of measuring relative humidity in the range of 1% to 100% and temperature from 2°C to 60°C. If the supply voltage exceeds +5.5V, the sensor may get damaged.

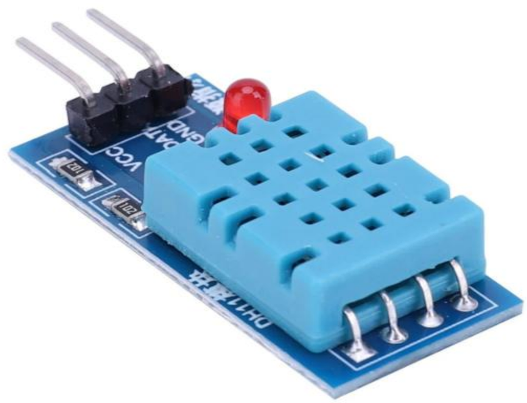

Figure3: Temperature Humidity Sensor

B) Moisture Sensor

The soil moisture sensor is used to measure the water content present in the soil. It determines the volumetric water content (VWC) by measuring the dielectric constant of the soil. This measurement is performed using frequency domain technology.

The dielectric constant of water is much higher than that of air or soil minerals. Therefore, by measuring the dielectric constant of the soil, the sensor can accurately estimate the amount of water present in the soil.

The sensor operates on a +5V power supply and provides readings at regular intervals. It reads and transmits output every 100 milliseconds, which allows for quick monitoring of soil moisture conditions.

The sensor has a fast response time and sends the output in the form of serial data at a baud rate of 9600 with 8 data bits, no parity, and 1 stop bit. Each reading is transmitted as four ASCII bytes of data.

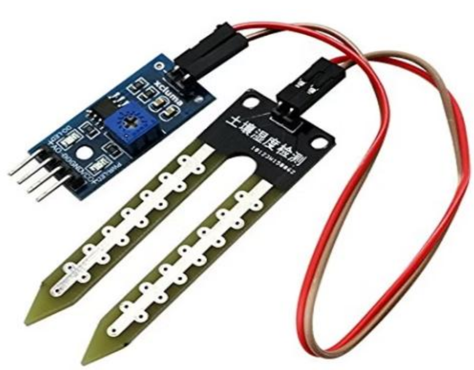

Figure4: Moisture Sensor

C) ZigBee

ZigBee is a wireless communication technology that follows the IEEE 802.15.4 standard. It operates in the ISM 2.4 GHz frequency band and provides a communication range of approximately 10 to 100 meters in line-of-sight conditions.

ZigBee is an open global standard designed to meet the requirements of low-cost, low-power wireless machine-to-machine (M2M) networks. It is widely used in applications where devices need to transmit small amounts of data with minimal power consumption.

The ZigBee protocol supports different network topologies such as point-to-point, point-to-multipoint, and mesh networks. It offers long battery life and a low data transmission rate of about 250 kbps, which makes it suitable for intermediate data transfer from sensors or other input devices in IoT-based systems.

D) Raspberry Pi

The Raspberry Pi is a credit-card-sized single-board computer developed in the United Kingdom. It is based on the BCM2835 System-on-Chip (SoC), which is designed as a cost-effective full HD multimedia processor for embedded and mobile applications.

The Raspberry Pi includes an ARM1176JZF-S processor running at 700 MHz. The Raspberry Pi B+ model contains 512 MB RAM and several connectivity options including four USB ports, one micro-USB port for power supply, and one HDMI port for display output.

It also features a MicroSD card slot used for booting the operating system and storing data. The board provides 40 GPIO (General Purpose Input/Output) pins, which allow easy interfacing with sensors and other electronic components.

The Raspberry Pi mainly supports Linux kernel-based operating systems, and it is generally not designed to run Microsoft Windows in its standard versions.

ARM1176 Processor

ARM stands for Advanced RISC Machine. The ARM11 family, including the ARM1176 processor, is based on the ARMv6 instruction set architecture. It supports bi-endian operation, meaning it can work in both little-endian and big-endian formats, although most modern systems use little-endian format.

The processor supports two instruction sets:

- 32-bit ARM instruction set

- 16-bit Thumb instruction set

The ARM1176 processor is often integrated with other Intellectual Property (IP) blocks to improve the performance, security, and power efficiency of the System-on-Chip (SoC).

This processor is widely used because it offers:

- High performance
- Low power consumption
- Low implementation cost
- Low design risk
- Strong support from third-party design tools and libraries

Due to these features, the ARM1176 processor is commonly used in embedded systems and IoT applications.

IV. CONCLUSION

An IoT-based agricultural monitoring system provides great potential for improving efficiency in farming. By designing and implementing a soil monitoring system, it becomes possible to achieve automatic networking, real-time data collection, processing, and transmission of agricultural data.

This system allows farmers to monitor important soil parameters continuously and receive real-time information about soil conditions. The system has several advantages such as low cost, low power consumption, flexible networking, wireless communication, and easy interfacing, making it affordable and suitable for farmers.

Using IoT technology, data can be connected through a network and accessed remotely. This enables remote monitoring of agricultural fields, allowing farmers to observe soil conditions and make proper decisions from any location without being physically present in the field.

VII. FURTHER RESEARCH

Further research can be carried out to improve the IoT-based agricultural monitoring system by integrating additional technologies and sensors. Advanced sensors can be used to monitor more soil parameters such as soil pH, nutrient levels, and light intensity to provide more accurate information about crop conditions.

Future systems can also include automated irrigation systems that use the collected data to automatically control water supply based on soil moisture levels. This will help in reducing water wastage and improving crop productivity.

Another area of research is the use of machine learning and data analytics to analyze the collected data and predict crop growth patterns, weather conditions, and irrigation needs. This will help farmers make better decisions for crop management.

In addition, improving network security, communication range, and power efficiency of IoT devices can make the system more reliable and suitable for large-scale agricultural applications. Future developments can also focus on creating user-friendly mobile applications so that farmers can easily monitor and control their farms from anywhere in the world.

REFERENCES

[1] Green Computing and Communications and IEEE Internet of Things and IEEE Cyber, Physical and Social Computing construction and strategies in iot system and security, 2013 IEEE International Conference.

[2] Yu Jun, Wang Yang "Internet of Things: System Framework, Applications and Attentions in Program Operation", IEEE 2011.

[3] V.C. Patil1, K.A. Al-Gaadi2, D.P. Biradar3 and M. Rangaswamy1 "Internet Of Things (IOT) And Cloud Computing For Agriculture: An Overview", Agriculture 2012 (AIPA 2012).

[4] Prahlada Rao B. B, Payal Saluja, Neetu Sharma, Ankit Mittal, Shivay Veer Sharma "Cloud Computing for Internet of Things & Sensing Based Applications" 2012 Sixth International Conference on Sensing Technology (ICST).

[5] Ji-chun Zhao, Jun-feng Zhang; Yu Feng ; Jian-xin Guo "The Study and Application of the IOT Technology in Agriculture", 978-1-4244-5540-9/10/$26.00 ©2010 IEEE.

[6] Yunseop (James) Kim, Member, IEEE, Robert G. Evans, and William M. Iversen "Remote sensing and control of an irrigation system using a distributed wireless sensor network", Ieee Transactions on Instrumentation and Measurement, Vol. 57, No. 7, July 2008.

[7] Liu Yumei, Zhang Changli , Zhu Ping “The Temperature Humidity Monitoring System Of Soil Based On Wireless Sensor Network” ,978-1-4244-8039-5/11/$26.00 ©2011.

[8] Yiming Zhou, Xianglong Yang, Liren Wang, Yibin Ying “A wireless design of low-cost irrigation system using Zig-Bee technology”, 2009 International Conference on Networks Security, Wireless Communications and Trusted Computing.