Iot Based Automated Irrigation Scheduling System for Enhanced Crop Yieldand Water Conservation

Dr. S.M Shamsheer Daula[1],V.E Wilson David[2] and Dr G Amjad Khan[3]
[1]Associate Professor
Department of ECE, G Pulla Reddy Engineering College (Autonomous) ,Kurnool, Andhra Pradesh, India
[2]PG scholar, M. Tech VLSIES
Department of ECE, G Pulla Reddy Engineering College (Autonomous) Kurnool ,Andhra Pradesh India
[3]Associate Professor
Department of ECE, G Pulla Reddy Engineering College (Autonomous) ,Kurnool, Andhra Pradesh, India

Abstract

In the context of agricultural or horticultural daily routines, the act of watering stands out as a pivotal and labor-intensive task. Regardless of the prevailing weather conditions, be it excessively hot and dry or overly cloudy and wet, the control over the amount of water reaching plants remains crucial. Contemporary watering systems prove effective in delivering water precisely when plants require it. However, manual watering involves considerations of when and how much water to apply. To alleviate the manual burden on gardeners and streamline their tasks, we have developed an automated plant watering system. Integration of this system into gardens or agricultural fields ensures optimal growth for all plants while promoting water conservation. This study utilizes Raspberry Pi, programmed to monitor the moisture levels of plants at specific intervals. If the moisture content falls below a predefined threshold tailored to each plant's water requirements, the system autonomously dispenses the necessary amount of water until the threshold is reached.

Introduction

Agricultural and horticultural activities heavilyrely on the fundamental practice of watering, a task that demands substantial labor and attention.In the realm of farming and gardening, the precise control ofwater distribution to plants emerges as a critical aspect, irrespective of the prevailing weather conditions. Whether faced with scorching heat and aridity or damp, cloudy weather, the ability to regulate the amount of water reaching plants remains paramount for their well-being. This constant challenge under- scores the need for modern watering systems that can efficiently supply water to plants as and when they require it. While contemporary watering systems offer a solution to this challenge, the manual process of watering introduces complexities related to determining when and how much water to apply. These considerations pose a significant burden on gardeners, prompting the exploration of innovative approaches to alleviate their workload. In response to this, the present study introduces an automated plant watering system designed to replace manual interventions. The objective is to enhance the efficiency of watering practices, offering a seamless and precise solutionto the timing and quantity of water supplied to plants. In addressing the limitations of manual watering, our research focuses on the development and implementation of an automatic plant watering system. By integrating this system into gardens and agricultural fields, we aim to optimize the growth of plants while concurrently promoting water conservation. This paper delves into the use of Raspberry Pi, a versatile computing platform, programmed to assess the moisture levels of plants at specific intervals. When the moisture content falls below a predefined threshold tailored to each plant'sspecific water needs, the automated system dispenses the required amount of water, providing an efficient and sustainable solution to the challenges associated with manual watering. The introduction of automated plant watering systems represents a significant leap forward in agricultural and horticultural practices, offering a streamlined and efficient alternative to manual

watering. With the capability to precisely monitor the moisture levels of plants, these systems bring a new level of sophistication to the cultivation process. The utilization of technology, exemplified by platformslike Raspberry Pi, facilitates real-time assessments, enabling timely and targeted water supply based on the specific needs of each plant. As such, the integration of automated solutions not only enhances the productivity of agricultural endeavors but also contributes to resource conservation by ensuring that water is applied judiciously. Beyond the immediate advantages of labor reduction and water conservation, the automated plant watering system detailed in this study holds the potential to revolutionize sustainable agriculture. By providinga proactive and responsive approach to irrigation, the system contributes to the overall health and vigor ofplants, promoting optimal growth and yield. As we delve into the intricacies of this innovative approach, we anticipate that the findings will not only benefit individual gardeners and farmers but also contribute to broader discussions on how technology can be harnessed to address critical challenges in the realm of food production and environmental sustainability. The subsequent sections of this paper will delve into the methodology and results, offering a comprehensive understanding of the automated plant watering system's impact on agricultural practices

Related Works

Sanku Kumar Roy, an IEEE Student Member, Sudip Misra, an IEEE Senior Member, Narendra Singh Raghuwanshi, and Sajal K. Das, an IEEE Fellow titles "Agri Sens: A Dynamic Irrigation Scheduling System Utilizing IoT for Efficient Water Management in Irrigated Crop Cultivation "In this manuscript, we outline the conceptualization of an IoT-driven irrigation scheduling system named Agri Sens, designed to optimize water management in cultivated fields. Agri Sens introduces a real-time, automated, and dynamic irrigation framework, incorporating both remote manual control and automated treatments tailored to diverse growth stages within a crop's life cycle. Employing Internet of Things (IoT) technology, the system employs a cost-effective water-level sensor for field water level measurements. Our proposed algorithm seamlessly integrates automatic dynamic-cum- manual irrigation, aligning with the specific requirements of farmers. Agri Sens boasts a user- friendly interface tailored for farmers, disseminating field information through multiple modalities, including visual displays, mobile phones, and a web portal. The system exhibits noteworthy performance across various metrics, including data validation, packet delivery ratio, energy consumption, and failure rates, adapting effectively to diverse climatic conditions and dynamic irrigation scenarios. Experimentalfindings indicate that Agri Sens contributes to enhancing crop productivity by up to 10.21% com- pared to traditional manual irrigation methods. Additionally, it extends the network's operational lifespan by 2.5 times in comparison to existing systems, maintaining a commendable reliability rate of 94% even after 500 hours of continuous operation.

Sanku Kumar Roy University of Alberta Sudip Misra Indian Institute of Technology Kharag pur N. Raghuwanshi Indian Institute of Technology Kharagpur Sajal K. Das Missouri University of Science and Technology said that In this manuscript, we introduce the conceptual framework of an IoT- centric dynamic irrigation scheduling system named Agri Sens, aiming to enhance the efficiency of water management in irrigated crop fields. Agri Sens is designed to offer real- time, automated, and dynamic irrigation solutions, including remote manual control, tailored to different growth phases within a crop's lifecycle through the implementation of Internet ofThings (IoT) technology. A cost-effective water-levelsensor is devised to gauge the water level in the field. We propose an algorithm facilitating automaticdynamic-cum-manual irrigation, customizedaccording to the specific requirements of farmer. Agri Sens incorporates a user-friendly interface forfarmers, delivering field information through variousmodalities such as visual displays, mobile phones, and a web portal. The system demonstrates noteworthy performance across diverse metrics, encompassing data validation, packet delivery ratio, energy consumption, and failure rates, under varyingclimatic conditions and dynamic irrigation scenarios. Experimental findings underscore AgriSens' efficacy in enhancing crop productivity by upto 10.21% (backslash percent) /

compared totraditional manual irrigation methods. Furthermore, it extends the operational lifespan ofthenetwork by 2.5 times compared to existing systems, maintaining a reliable performance of94% even after 500 hours of continuous operation. K. Lova Rajuand V. Vijayaraghavan are affiliated with the Department of Electronics and Communication Engineering at Vignan's Foundation for Science, Technology and Research in Guntur, Andhra Pradesh, India, with the postal code522213. Wrote That this abstract addresses challenges in acquiring real-time agricultural data for effective field monitoring and crop yield predictions. Current smart agricultural systems, limited to measuring air temperature andhumidity with a 100-meter transmission range, failtoprovide comprehensive coverage for large fields. To overcome these limitations, we pro-pose an agri-field architecture utilizing open- source platforms, featuring a Wireless Smart Agriculture Monitoring Unit (WSAMU) that analyzes and transmits real-time data to a LoRa gateway. The gateway then forwards the information to a WirelessAgriculture Receiver Monitoring Unit (WARMU). Key experiments were conducted to validate the proposed architecture, including sensor deployment in agricultural settings, measuring current supply in operational and non-operational states, and estimatingthe WSAMU's life expectancy under hypothetical conditions. Additionally, a Measurement Index (MI) has been developed, utilizing all sensor data, to support smart agriculture monitoring and decision- making.

Proposed Methods

The proposed method involves monitoring field conditions through a soil moisture sensor, which detects whether the field is wet or dry. The main controller in this project is the Raspberry Pi, overseeing all aspects of the system. An RTC module is employed to establish specific timings, allowing the controller to assess moisture conditions at designated times and activate the pump accordingly. Additionally, an ultrasonic sensor is incorporated to gauge water levels in the tank, while a raindrop sensor determines whether it is currently raining. The system also employs a DHT11 sensor to monitortemperature and humidity levels. In the event that anyof these data points surpass pre- determined thresholds, a GSM module is triggered to send a message to the farmer. This comprehensive approachintegrates various sensors and the Raspberry Pi controller to auto- mate irrigation processes based on real- time field conditions, ensuring efficient water management and timely communication with the farmer in case of critical environmental changes.
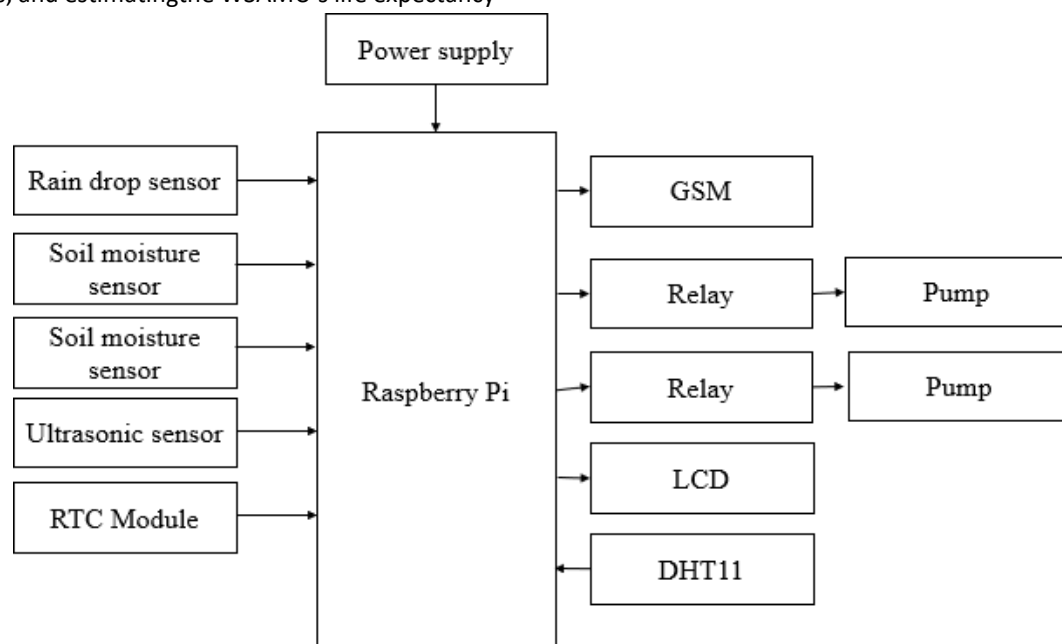
Fig. 1: Proposed/Methodology

Hardware requirements we use:

Raspberry Pi:

Raspberry Pi, a compact and versatile single- board computer, has gained widespread popularity for its affordability and adaptability. Developed by the Raspberry Pi Foundation, this credit card sized device has become a go-tos olution for diverse projects ranging from educational purposes to DIY electronics. Its open-source nature and a thriving community have contributed to its success, fostering a rich ecosystem of software, hardware, and community-driven projects. Equipped with various ports, including USB, HDMI, and GPIO(General Purpose Input/Output), Raspberry Pi is capable of running a range of operating systems, with Raspbian being the official and widely used distribution. Its GPIO pins allow forinterfacing with external sensors, actuators, and other hardware components, making it an ideal choice for projects involving automation, robotics, and IoT applications. With its accessible price point,energy efficiency, and user-friendly environment, Raspberry Pi continues to empower enthusiasts, students, and professionals alike to explore and innovate in the realm of computing and electronics.

Raspberry Pi, a compact and versatile single- board computer, has become a hallmark in the world of DIY electronics and computing. Developed by the Raspberry Pi Foundation, this credit card-sized device packs a punch with its affordability and open- source architecture. It has found applications in a myriad of projects, spanning educational initiatives, home automation, and even more complex endeavors like building custom media centers or retro gaming consoles.

One of the distinguishing features of Raspberry Pi lies in its GPIO (General Purpose Input/Output) pins, which enable users to interface with a wide array of external devices. With USB, HDMI, and GPIO ports, Raspberry Pi can run various operating systems, with Raspbian being the official and widely adopted distribution. Its popularity is further fueled by an enthusiastic community that actively contributes to an ever- expanding ecosystem of software and hardware projects. The versatility, accessibility, and affordability of Raspberry Pi have democratized computing, making it an invaluable tool for bothbe- ginners and experienced developers in realizing innovative ideas and projects.

**Fig. 2: Experimental setup**

Raindrop Sensor:

The raindrop sensor is a vital component in electronic systems designed to detect and measure rainfall. Typically composed of a series of conductivetraces on a PCB (Printed Circuit Board) and ahygroscopic surface, the sensor operates on

theprinciple that raindrops on its surface affect the electrical conductivity between the traces. As rainwater ac- cumulates on the sensor, the resistancebetween the traces changes, allowing the system tointerpret and quantify the rainfall intensity. This simple yet effective mechanism makes raindrop sensors widely used in weather monitoring systems,smart irrigation solutions, and other applications where precise rainfall data is crucial. One of the key advantages of raindrop sensors is their versatility.They come in various designs, allowing adaptation to different environments and use cases. Whether integrated into weather stations for meteorological observations or incorporated into smart home systems for automated control of irrigation, these sensors provide real-time data on rain- fall conditions. Their sensitivity and responsiveness make them valuable tools in enhancing water management practices, ensuring optimal resource utilization, andcon- tributing to the efficiency of various automated systems in response to changing weather patterns.
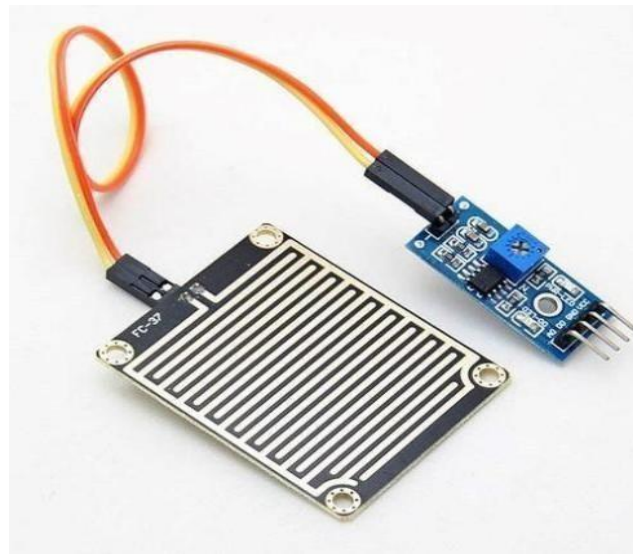

Fig. 3: Raindrop sensor

Soil Moisture Sensor:

Soil moisture sensors play a pivotal role in modern agriculture, providing farmers with crucial insights into the hydration levels of their fields. These sensors are designed to measure the volumetric water content in the soil, helping farmers determine the optimal timing and quantity of irrigation needed for crops. By directly assessing the moisture levels in the soil, these sensors contribute to water conservation efforts and efficient resource management, as farmers can avoid overwatering or underwatering their fields. This technology empowers farmers to make informed decisions, ensuring that water is applied precisely when and where it is needed, ultimately enhancing crop yield and sustainability in agricultural practices. Various types of soil moisture sensors exist, employing different technologies such as capacitance, resistance, or time domain reflectometry (TDR). Capacitance-based sensors, for instance, measure the dielectric constant of the soil, whichchanges with varying water content. These sensors are known for their accuracy and reliability in providing real-time data. With the integration of such sensors into modern agricultural systems and the rise of precision agriculture, farmers can adopt data-drivenapproaches to irrigation, minimizing water wastage and optimizing crop growth. The widespread use of soil moisture sensors under-scores their significance in promoting sustainable and efficient farming practices.
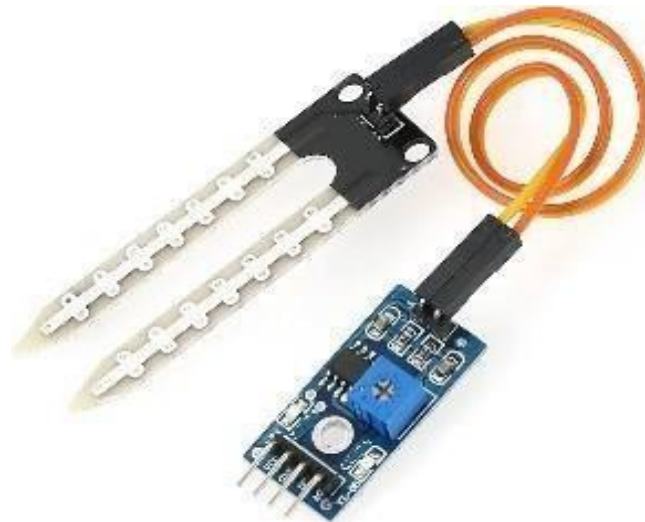
Fig. 4: soil moisture sensor

Ultrasonic Sensor:

Ultrasonic sensors have become integral components in various technological applications, leveraging the principles of sound wave reflections to measure distance or detect objects. These sensors emit ultrasonic pulses and calculate the time it takes for thesound waves to bounce back after hitting an object.In agriculture and industrial automation, ultra- sonic sensors play a crucial role in proximity sensing, object detection, and distance measurement. Their non- contact nature makes them particularly useful in situations where traditional contact sensors might be impractical or less reliable. For example, in auto- mated irrigation systems, ultrasonic sensors are employed to measure the water level in tanks, ensuring accurate and timely information for efficient water precision in a wide array of industries.

management. The versatility of ultrasonic sensors ex- tends to robotics, where they are utilized for obstacle avoidance and navigation tasks. One key advantage of ultrasonic sensors is their ability to operate in diverse environmental conditions, including darkness and ad- verse weather. The technology is based on the speed of sound, which remains relatively consistent in various atmospheric conditions. This resilience makes ultrasonic sensors suitable for outdoor applications, ranging from parking assistance systems in automobiles to monitoring fluid levelsin industrial settings. As these sensors continue to evolve and become more cost-effective, their integration into different fields demonstrates their significant impact on enhancing automation, safety, and

Fig. 5: Ultrasonic sensor

RTC Module:

The Real-Time Clock (RTC) module is a critical component in electronic devices and systems, providing accurate timekeeping functionality even when the main power source is offline. Essentially a timekeeping device, the RTC module incorporates a dedicated clock circuit that operates independently, often powered by a separate coin cell battery. Its primary purpose is to maintain precise time and date information, ensuring that devices can retain accurate time stamps for events andactivities. In applications such as data logging, automation, and scheduling, the RTC module ensures synchronization and chronological tracking of events, even in scenarios where the primary

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power supply is intermittently disrupted.

One of the key features of an RTC module is its ability to provide real-time clock information to microcontrollers or microprocessors, allowing them to execute tasks based on accurate time data. This is particularly beneficial in applications that demand time-sensitive actions, such as scheduled operations, alarms, or data logging with precise timestamping. By enabling devices to maintain an internal clock, RTC modules enhance the overall efficiency and re- liability of systems, ensuring seamless operation and synchronization across a wide range of electronic applications, from consumer electronics to industrialautomation

Fig. 6: RTC module

DC Water Pump:

Direct current (DC) water pumps are essential components in numerous applications, offering a re- liable and energy efficient solution for water circulation and transfer. These pumps are commonly utilized in various sectors, including agriculture, aqua- culture, and residential settings, due to their versatility and ease of use. DC water pumps operate by converting electrical energy from a DC power source into mechanical energy, driving the movement of water. Their adaptability makes them suitable for tasks such as irrigation in remote agricultural fields, maintaining water circulation in fish tanks, and supplying water to off-grid locations where access to conventional power

sources may be limited.

One notable advantage of DC water pumps is their ability to provide variable speed control, allowing users to adjust the flow rate based on specific requirements. This feature enhances their efficiency and makes them ideal for applications with varying water demand. Additionally, the portability of DC water pumps, often powered by solar panels or batteries, contributes to their popularity in off-grid and environmentally conscious setups. As technology advances, these pumps continue to play a pivotal role in promoting sustainable water management practices by delivering a reliable and energy efficient means of transferring water for different applications

Fig. 7: DC Pump

GSM:

Global System for Mobile Communications (GSM) is a widely used standard for digital cellular communication, providing a reliable and efficient means of voice and data transmission. Developed to enable seamless communication across borders and different mobile networks, GSM has become the dominant technology for mobile communication globally. One of its key features is the use of SIM (Subscriber Identity Module) cards, allowing users to easily switch devices while retaining their identity and data. GSM technology facilitates voice calls, text messaging, and data transfer, making it a funda- mental aspect of modern telecommunications infrastructure.

Beyond personal communication, GSM technology

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finds application in various sectors, particularly in machine-to-machine (M2M) communication and the Internet of Things (IoT). GSM modules, equipped with embedded SIM cards, enable devices to connect to cellular networks, facilitating remote monitoring and control. This capability is harnessed in applications like smart agriculture, where GSM- enabled sensors can transmit real-time data on environmental conditions, allowing farmers to make in- formed decisions. Additionally, GSM plays a critical role in security systems, asset tracking, and other M2M applications, demonstrating its versatility and reliability in enabling connectivity across a diverse range of devices and industries

Fig. 8: GSM

Relay:

Relays are crucial components in electrical and electronic systems, serving as switch mechanisms that control the flow of current between different circuits. Operating on the principle of electromagnetic induction, relays use a small amount of electrical current to activate a coil,

creating a magnetic field that, in turn, opens or closes the switch contacts. This functionality allows relays to act as remote-controlled switches, enabling the control of high-power devices with low- power signals. One of the primary advantages of re- lays is their ability to isolate the low-voltage control circuit from the high-voltage load circuit,

ensuring safety and preventing potential damage to

sensitive control components.

Fig. 9: Relay

Relays find applications in various industries and devices, from household appliances to industrial automation systems. In home automation, relays are employed to control lights, heating systems, and other electrical devices through remote or automated systems. In industrial settings, relays play a crucial role in process control, allowing the integration of automated sequences and enhancing the efficiency of manufacturing processes. With theirversatility and reliability, relays continue to be fundamental components in electrical engineering, providing an essential means for controlling and automating various electrical circuits and systems.

Buzzer:

The buzzer, as a crucial component in various Buzzersare simple yet versatile audio signaling devices that find application in a variety of contexts, ranging from electronics projects to everyday appliances. Essentially an electroacoustic transducer, buzzers generate sound through the vibration of a diaphragm or membrane. They are commonly used to provide audible alerts, signals, or notifications in electronic circuits, safety systems, and consumer electronics. Buzzers are designed to produce a distinctive buzzing or beeping sound, making them effective for drawing attention or indicating specific events. In electronic projects, buzzers are frequently incorporated to serve as indicators for various conditions. For instance, in alarm systems, buzzers emit a loud sound when triggered, alerting individuals to potential threats or unauthorized access. In home appliances like microwave ovens or washing machines, buzzers signal the completion of atask or indicate an error. The simplicity of buzzers, combined with their reliability and ease of integrationinto circuits, has made them a staple in electronic design. As technology advances, the functionality and design of buzzers continue to evolve, ensuring their continued relevance in diverse applications where audible alerts are essential for effective communication.

Fig. 10: Buzzer

Power Supply:

A power supply board that converts alternating current (AC) to direct current (DC) is a fundamental component in numerous electronic devices and systems. This conversion is crucial because many electronic devices, such as computers, routers, and electronic gadgets, requirea stable and controlled DCvoltage to function properly. The power supply board typically consists of a rectifier circuit, which converts AC to pulsating DC, followed by filtering components like capacitors to smooth out the pulsations. Additionally, voltage regulation components such as volt- age regulators may be included to ensure a steady and reliable DC output. This board plays a pivotal role in providing the necessary and regulated power for the optimal operation of electronic equipment. In various industries, from telecommunications to home appliances, power supply boards are tailored to meet specific voltage and current requirements. Switching power supply boards, known for their efficiency and compact design, have become prevalent due to their ability to convert AC to DC

with minimal energy loss. The continuous evolution of power supply board technologies contributes to enhanced energy efficiency, smaller form factors, andimproved overall performance in the diverse range of electronic devices we encounter in our daily lives.

LCD:

Liquid Crystal Display (LCD) technology has become ubiquitous in the realm of visual display systems, finding applications in a wide array of devices such as televisions, computer monitors, digital clocks, and portable electronic devices. At thecore of an LCD is a panel composed of liquid crystalmolecules that can be manipulated to control the passage of light. The ability to precisely regulate the orientation of these molecules allows LCDs to produce sharp, vi- brant images with high resolution. Compared to traditional cathode ray tube (CRT) displays, LCDs are known for their slim form factor, energy efficiency, and reduced electromagnetic radiation emission
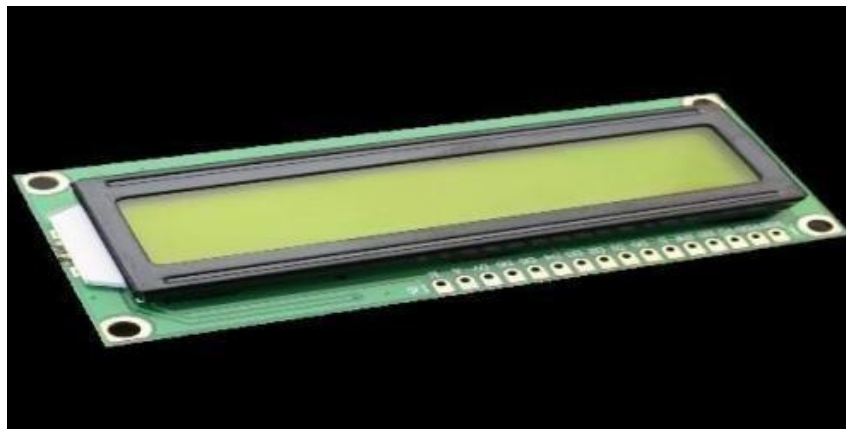
Fig11: LCD

One of the key advantages of LCD technology lies in its versatility and adaptability to different screen resolutions. LCDs are characterizedby their ability to display images with excellent clarity and color reproduction, making them suitable for a broad spectrum of applications. The widespread adoption of LCDs in consumer electronics is evident in the popularity of flat-screen TVs, computer monitors, and smartphones. As technology continues to advance, innovations such as LED-backlit LCDs andhigh-refresh-rate displays further enhance the performance and visual experience of LCD-based devices, ensuring their continued dominance in the display technology landscape.

Advantages and Applications

ADVANTAGES
• Labor-saving
• Automated
• Optimal
• Efficient

of our Iot based automated irrigation Scheduling System for enhanced crop yield and water sizes and

• Streamlined
• Sustainable
• Conserves water
• Autonomous
• Tailored

APPLICATIONS
• Agriculture
• Horticulture
• Irrigation
• Gardening
• Automation
• Watering
• Raspberry Pi
• Moisture Monitoring
• Sustainability
• Crop Growth

KIT FINAL RESULTS

In this section, we present the results conservation.

Fig. 12: Total kit

Fig. 13: Message update

Fig. 14: raspberry pi desktop
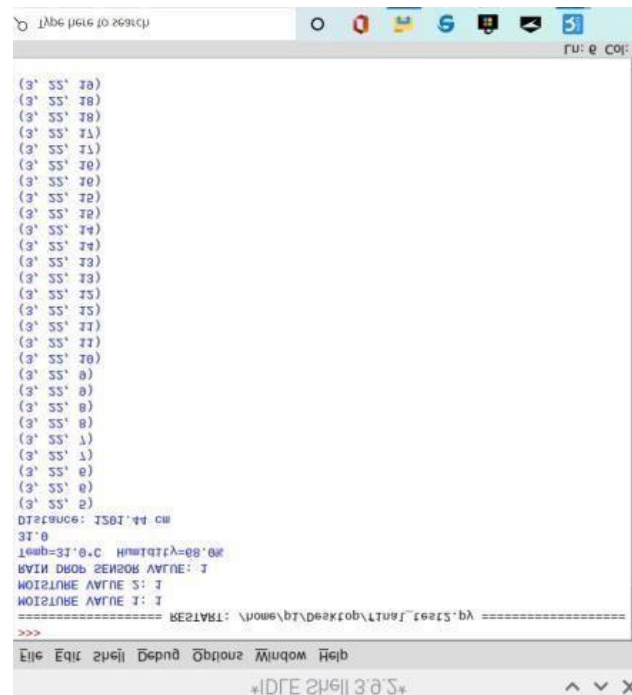

Fig. 15: real physical kit

Fig. 16: sensors working

Fig. 17: sever updates

Conclusion

In conclusion, the development and implementation of the automated plant watering system, utilizing Raspberry Pi technology, offer a transformative solution to the challenges associated with manual watering in agriculture and horticulture. The system's capacity for precise, autonomous watering based on real-time moisture

data addresses the labor-intensive nature of traditional practices. By integrating this innovative approach into gardens and agricultural fields, the study envisions optimal plant growth, re- source conservation, and streamlined tasks for gardeners. The emphasis on sustainability, efficiency, and tailored irrigation underscores the potential impact of this automated system on enhancing overall agricultural practices. As technology continues to evolve, such advancements contribute to a more sustainable and efficient future for the cultivation of crops and the maintenance of plant health.

References

1. In the paper authored by M. Ayaz, M. Ammad-Uddin, Z. Sharif, A. Mansour, and E. M. Aggoune, titled "Internet-of-Things (IoT)-based smart agricul- ture: Toward making the fields talk," published in IEEE Access, volume 7, pages 129551–129583, in Au- gust 2019.

2. O. Elijah, T. A. Rahman, I Orikumhi, C.Y. Leow, and M. N. Hindia, published a paperti- tled "A Comprehensive Examination of Internet of Things (IoT) and Data Analytics in Agricultural Practices: Advantages and Hurdles" in the IEEE Internet Things Journal, Volume 5, Issue 5, pages 3758–3773, in October 2018.

3. M. Mahbub, "A smart farming concept based on smart embedded electronics, Internet of Things and Wireless Sensor Network," Internet of Things, vol. 9, Mar. 2020.

4. M. Bhatia and S. K. Sood published a paper titled "Quantum computing-inspired network opti- mization for IoT applications" in the IEEE Internet of Things Journal, Volume 7, Issue 6, pages 5590-5598, in June 2020.

5. In the realm of smart farming utilizing the In- ternet of Things (IoT), A. P. Kale and S. P. Sonavane conducted a study titled "Feature subset selection for optimized high-dimensional data using an improved GA-based approach for ELM," published in the jour- nal "Computers and Electronics in Agriculture," Volume 161, pages 225-232 in June 2019.

6. S. K. Roy, S. Misra, and N. S. Raghuwanshi authored a paper titled "Sens pnp: Seamless integra- tion of diverse sensors with IoT devices," published in the IEEE Transactions on Consumer Electronics,Volume 65, Issue 2, pages 205–214, in May 2019.

7. Y. Kim, R. G. Evans, and W. M. Iversen au- thored a paper titled "Remote sensing and control of an irrigation system using a distributed Wireless Sensor Network," which was published in the IEEE Transactions on Instrumentation and Measurement. The article is found in Volume 57, Issue 7, with pages 1379– 1387, dated July 2008.

8. J. Gutierrez, J. F. Villa-Medina, A. Nieto-Garibay, and M.A. Porta-Gandara, presented a study titled "Automated irrigation system utilizinga wire- less sensor network and GPRS module," published in IEEE Transactions on Instrumentation and Measure- ment, Volume 63, Issue 1, pages 166–176, in January 2014.