ISSN: 2454-9940

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

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www.ijasem.org

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT
ISSN 2454-9940
www.ijasem.org
Vol 19, Issue 2, 2025

Precision farming using an intelligent irrigation system

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ABSTRACT:

The Internet of Things (IoT) is mostly used in agriculture to monitor and evaluate soil conditions, such as temperature and nutrient levels, in real-time via the use of sensors. In order to analyze the data, it is delivered over IoT connection. With the use of machine learning algorithms, this initiative deciphers sensor data and suggests crops that would do best in certain soil types. In order to provide farmers with easy access to data interpretation and crop suggestions, a user-friendly interface is being designed. Farmers will have no trouble using it because of its intuitive design. Improved agricultural efficiency via better crop planning, more informed decision-making, and the promotion of sustainable farming practices for a more resilient agricultural ecosystem is the goal of this project.

Agriculture, machine learning, sensors, and the Internet of Things are some of the key terms.

EMBEDDED SYSTEMS

A computer system that is purpose-built to carry out a single or limited set of tasks, often under the restrictions of real-time computing, is known as an embedded system. As with other physical and mechanical components, it is often integrated into a whole device. A personal computer or other general-purpose computer, on the other hand, may be programmed to do a wide variety of functions. These days, many of the everyday items we use rely on embedded systems to function. Design engineers may improve the embedded system to decrease product size and cost while boosting reliability and performance since it is devoted to certain functions. Because of their mass production, certain embedded systems are able to take advantage of cost savings. From small, handheld gadgets like digital watches and MP3 players to massive, permanently installed systems like those managing nuclear power plants, traffic lights, and industrial controls are all examples of physically embedded systems. From simple systems using a single microcontroller chip to complex systems housing several modules, peripherals, and networks in a massive chassis or enclosure, complexity may range greatly. The phrase "embedded system" lacks a precise definition because the majority of systems have programmability in some form. While they share some components with embedded systems, such operating systems and microprocessors, handheld computers are not technically embedded systems as they enable the loading of multiple programs and the connection of peripherals. Computer hardware and software, either fixed in capability or programmable, particularly intended for a certain sort of application device—this is what's called an embedded system. Embedded systems may be found in a wide variety of objects, including but not limited to: vehicles, medical devices, cameras, home appliances, aircraft, vending machines, toys, and, of course, cellular phones and personal digital assistants. A programming interface is given to programmable embedded devices, and programming for embedded systems is a niche field in and of itself. Embedded Java and Windows XP Embedded are two examples of embedded-specific operating systems and language platforms. On the other hand, certain budget consumer goods include integrated application and operating system components, employ very cheap microprocessors, and have limited storage space. Instead of being loaded into RAM (random access memory), as applications on personal computers are, in this situation the program is written permanently into the system's memory.

CHARACTERISTIC OF EMBEDDED SYSTEM

- Speed (bytes/sec): Should be high speed
- Power (watts): Low power dissipation
- Size and weight: As far as possible small in size and low weight
- Accuracy (%error): Must be very accurate
- Adaptability: High adaptability and accessibility
- Reliability: Must be reliable over a long period of time

APPLICATIONS OF EMBEDDED SYSTEMS

Here, in the Embedded World, we are living. The smooth operation of the various embedded goods that surround you is crucial to your day-to-day existence. In your living room, you have a TV, radio, and CD player; in your kitchen, you have a washing machine or microwave oven; and at your office, you have card readers, access controllers, and palm devices that let you do a lot. In addition to all of this, your automobile has a plethora of built-in controls that handle functions between the bumpers, most of which you probably don't give a second thought to.

- **Robotics:** industrial robots, machine tools, Robocop soccer robots
- **Automotive:** cars, trucks, trains
- **Aviation:** airplanes, helicopters
- Home and Building Automation
- **Aerospace:** rockets, satellites
- **Energy systems:** windmills, nuclear plants
- **Medical systems:** prostheses, revalidation machine.

MICROCONTROLLER VERSUS MICROPROCESSOR

When comparing microprocessors and microcontrollers, what are the key differences? Any general-purpose microprocessor, such an 8086, 80286, 80386, 80486, or a Pentium from Intel, or a 680X0 from Motorola, etc., is considered a microprocessor. In addition to lacking on-chip I/O ports, these microprocessors also lack random-access memory (RAM). Because of this, they are often called general-purpose microprocessors. Designing a working system around a general-purpose CPU like the 68040 or Pentium requires the addition of extra components like as RAM, ROM, I/O ports, and timers. Though these systems are more costly and cumbersome due to the inclusion of external RAM, ROM, and I/O ports, they provide the benefit of being versatile in that the designer may choose the quantity of RAM, ROM, and I/O ports required for the work at hand. Microcontrollers are an exception to this rule. On a single chip, you'll find a microprocessor, random access memory (RAM), read/write (ROM), input/output (I/O) ports, and a timer in a microcontroller. So, since the CPU, random access memory (RAM), read/write memory (ROM), input/output (I/O) ports, and timer are all integrated into a single chip, the designer is unable to include any more memory, I/O ports, or timer into the product. Because of its set quantity of on-chip ROM, RAM, and number of I/O ports, microcontrollers are perfect for many applications where space and cost are important considerations. It is not necessary to have a 486 or even an 8086 CPU for many applications; for instance, a TV remote control. Typically, these programs will need some kind of input/output function in order to read signals and toggle bits.

INTRODUCTION

An essential factor in the progress of human civilization has been the expansion of agriculture. This is why the agricultural goods industry is still considered a major player on a worldwide scale [1]. Despite their significance, most agricultural methods still rely on conventional farming techniques. It is widely considered that farmers may greatly benefit from the knowledge and assistance provided by information and communication technology (ICT), which in turn increases their total productivity. The agriculture and food sectors have been greatly enhanced by modern technology like cloud computing, the internet of things (IoT), and machine learning. The practice of agriculture, one of the first things humans did, laid the groundwork for our modern society. It has evolved significantly over the years to accommodate a changing global population, adjust to new climate realities, and solve issues with sustainability. Interactions between agriculture and key variables including population increase, climate change, sustainability, and the size of the global market have significantly impacted the agricultural landscape. The agriculture industry has to generate enough food to meet the demands of a rapidly expanding global population. Modern crop management methods and other state-of-the-art agricultural technology are essential for increasing yields. Strict mitigation strategies are required to sustain agricultural production in the face of climate change risks, to which farmers are particularly vulnerable. Finding a middle ground between meeting the growing demand for food and the pressing concerns about environmental degradation and resource depletion has taken on more significance. Crop management systems and other state-of-the-art agricultural technology are essential for increasing production. Due to the increased vulnerability of farmers to climate change-related risks, it is imperative that stringent measures be implemented to sustain agricultural production.

LITERATURE SURVEY

Monitoring of weather conditions

Smart farming is greatly affected by weather conditions. A change in the weather could have an impact on the quantity and quality of food crops.

ISSN 2454-9940
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Another option would be for farmers to utilize the Internet of Things to set up sensors in their fields that could measure things like humidity, temperature, and water levels in real-time [2].

2. Agricultural Sensors

Among the many qualities that may be measured by a sensor are pH, moisture content, pressure, and many more. Most of the time, a sensor will provide an electrical signal to a microcontroller, which will then utilize that signal to do further network analysis [5]. The advent of Industry 4.0 is having an impact on every part of the global economy. Digital farming, smart farming, or assmart agriculture may provide farmers with a variety of resources to address challenges in agriculture, such as crop damage, sustainability, environmental effect, and sufficient nutrition [6].

Thermostat No. 3

Temperature sensors collect data about the surrounding environment in real time in IoT agriculture. Distributed over fields are these temperature-tracking devices. Using the data gathered, farmers may make more informed judgments on crop selection [7]. Along with these sensors

EXISTING SYSTEM

The present agricultural system still heavily relies on traditional practices, which include manual observations and little integration of technology. Too often, farmers depend on historical performance to inform their choices, leading to wasteful application of water, fertilizer, and pesticides. Pest control, fertilizer, and irrigation cannot be effectively managed due to the lack of insights provided by consistent data collection. Problems like crop health difficulties or altering weather patterns are best addressed reactively rather than proactively due to the obvious absence of automated systems and remote monitoring. For productive and sustainable farming, the current system is characterized by its reliance on conventional practices, its inadequate data use, and its lack of technological breakthroughs [12].

PROPOSED MODEL

The proposed agricultural Internet of Things (IoT) system completely integrates a wide variety of sensors, including those for temperature, weather, and soil moisture. This solution seamlessly integrates a sophisticated database architecture with an intelligent mobile application, enabling real-time monitoring and control. To make communication work, microcontrollers—also called gateway devices—gather data from the sensors and transmit it wirelessly over Bluetooth, Wi-Fi, or LoRa networks. A cloud-based database is meticulously organized with tables and timestamps to hold the information, which comprises crucial elements like soil content, temperature, and moisture. A dynamic backend server processes, validates, and implements security measures for data, while APIs provide communication between the mobile app and the backend infrastructure. To help farmers make educated choices, the smartphone app has an intuitive interface, displays sensor data in real-time, analyzes trends over time, and allows for remote operation. Secure user identification and permission are system priorities to safeguard sensitive agricultural data. Graphs and charts are examples of data visualization tools that help users better understand patterns in sensor data. This smart and networked approach improves farming operations for higher efficiency and output by using Internet of Things (IoT) technology to provide farmers precise monitoring and control capabilities.

BLOCK DIAGRAM

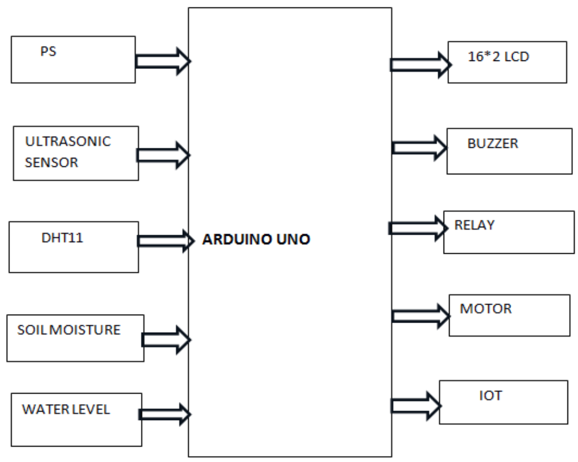

Figure 1: Block Diagram

Microcontroller:

A tiny controller, or microcontroller, as the name implies. Often used as a processing or controlling unit, they are similar to single-chip computers. For instance, microcontrollers that do decoding and other regulating operations are likely integrated into the control you are using. They find further use in vehicles, home appliances, microwaves, toys, and any other area requiring automation.

Arduino Uno Microcontroller:

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

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One such microcontroller board is the Arduino Uno, which uses the Atmega328 (datasheet). It has a 16 MHz crystal oscillator, 6 analogue inputs, 14 digital input/output pins (6 of which may be used as PWM outputs), a power connector, an ICSP header, a reset button, and a USB connection. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.
A key difference between the Uno and all previous boards is the absence of the FTDI USB-to-serial driver chip. Rather of that, it has an Atmega8U2 that has been configured to convert USB to serial. To celebrate the impending release of Arduino 1.0, the name "Uno"—which means "One" in Italian—has been chosen. The Uno and Arduino version 1.0 will serve as the foundational versions for future Arduino releases. For a comparison with prior generations, see the index of Arduino boards. The Uno is the newest in a series of USB Arduino boards and the standard model for the Arduino platform.

ARDUINO UNO BOARD:

One board that uses the Atmega328 microprocessor is the Arduino Uno. A 16 MHz ceramic resonator, 6 analog inputs, 14 digital I/O pins (including 6 PWM outputs), 1 USB port, 1 power connector, 1 ICSP header, and 1 reset button are all part of it. All you need is a USB cable, an AC-to-DC converter, or a battery to get it going; it comes with everything you need to support the microcontroller.

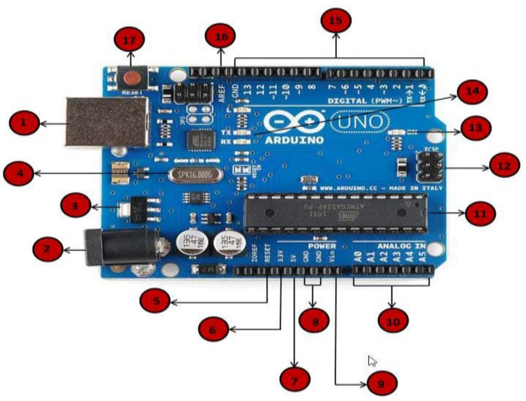

Figure 2: Arduino uno board

In contrast to all of its predecessors, the Uno does not have the FTDI USB-to-serial driver chip. As an alternative, it makes use of USB-to-serial converters coded into the Atmega16U2 (Atmega8U2 up to version R2).

HARDWARE COMPONENTS

POWER SUPPLY UNIT

The power supply for this system is shown below.

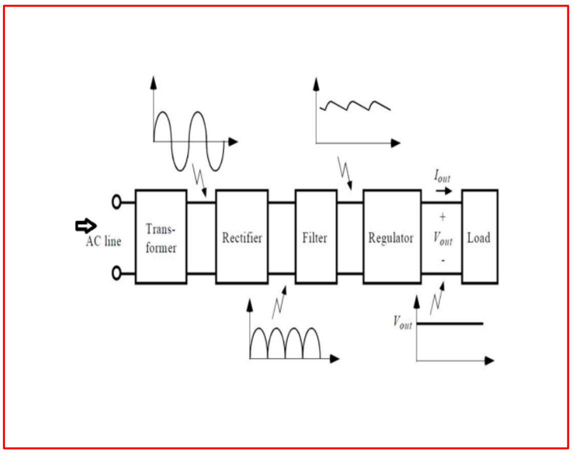

Figure 3: power supply

Diodes:

Only one path of electrical current may pass through a diode. Current may flow in either direction, as shown by the arrow in the circuit symbol. Originally termed valves, diodes are essentially an electrically enhanced version of the mechanical component.

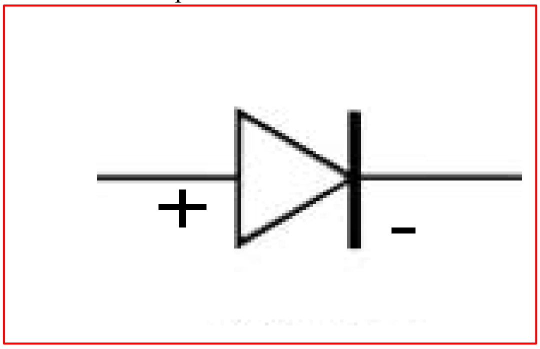

Figure 4: Diode Symbol

One kind of electrical component that restricts current flow is the diode. A voltage loss of around 0.7V will be the sole influence on the signal when the diode is "forward-biased" in this way. No current will flow through a diode that is "reverse-biased" when the current is applied in the other direction.

Rectifier

A rectifier's job is to change the phase of an alternating current (AC) waveform so that it appears as a direct current (DC) waveform. Both "half-wave" and "full-wave" rectifiers are used for rectification. Diodes are used in both devices to convert AC current into DC current. The Half-Wave Resettable

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The graphic shows that the half-wave rectifier is the simplest rectifier type since it only employs one diode.

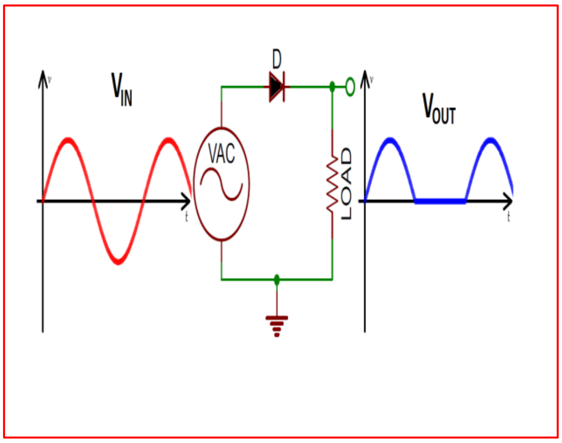


Figure 5: Half Wave Rectifier

LIQUID CRYSTAL DISPLAY

An array of color or monochrome pixels arranged in front of a light source or reflector makes up a liquid crystal display (LCD), a thin, flat display device. Two polarizing filters, with their polarity axes perpendicular to one other, and a column of liquid crystal molecules hanging between two transparent electrodes make up each pixel. Light would not be able to travel through them if the liquid crystals weren't interposed. To make light flow through two filters, the liquid crystal changes the polarization of the light entering the first filter.

A program's ability to communicate with the outside world depends on its input and output devices, which in turn rely on human communication. An LCD display is a typical accessory for controllers. 16X1, 16x2, and 20x2 LCDs are among the most popular types of displays that are often linked to the controllers. Which works out to sixteen characters on a single line. The first set has 16 characters on each line while the second set has 20 characters on each line. The use of "smart LCD" displays allows for the visual output of information by many microcontroller devices. Affordable, user-friendly, and capable of producing a readout utilizing the display's 5X7 dots plus cursor, LCD displays built on the LCD NT-C1611 module are a great choice. They use mathematical symbols and the usual ASCII set of characters. The display needs a +5V power and 10 I/O lines (RS, RW, D7, D6, D5, D4, D3, D2, D1, D0) for an 8-bit data bus. The only additional lines needed for a 4-bit data bus are the supply lines and six more (RS, RW, D7, D6, D5, D4). The data lines are tri-state and do not affect the microcontroller's function when the LCD display is disabled.

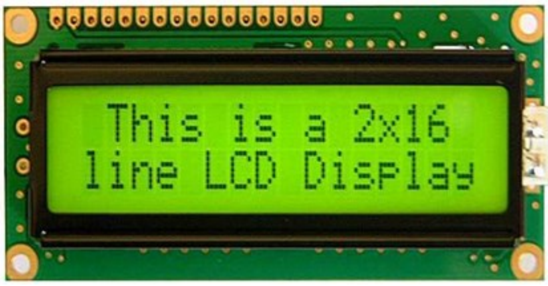
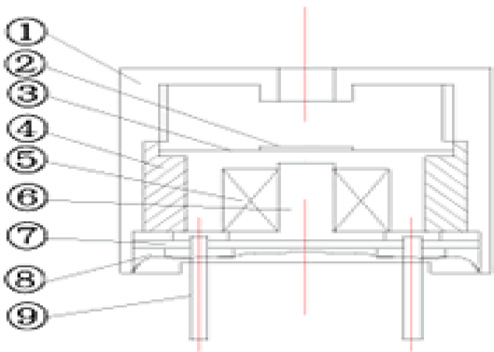


Figure 6: 2x16 LCD Display

BUZZER

In a magnetic transducer, the circuitry includes an iron core, a yoke plate, a wound coil, a permanent magnet, and a vibrating diaphragm that can be moved. The magnet's field gently draws the diaphragm up nearer the core's surface. A positive alternating current (AC) signal causes the diaphragm to move up and down, which in turn vibrates the air. This is achieved by the current passing through the excitation coil, which forms a fluctuating magnetic field. A resonator, which is composed of a cavity and one or more sound holes, may amplify vibrations in order to generate a loud sound.



ESP8266 Wi-Fi Module

This project revolves on this. Because the project relies on WIFI control of appliances, the module is a crucial part of it.

One remarkable feature of this tiny board is the integrated MCU (Micro Controller Unit), which allows for the control of I/O digital pins via a simple programming language that is almost pseudo-code like. Another benefit is that the ESP8266 Arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability. The Chinese company Es press if Systems is situated in Shanghai and makes this gadget.

In August 2014, this chip made its debut in the ESP-01 version module manufactured by the third-

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

ISSN 2454-9940

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party company AIThinker. The MCU can establish basic TCP/IP connections and connect to WiFi networks with the help of this little module. He was His tiny size and cheap pricing (1.7–3.5$) enticed a lot of hackers and geeks to look into it and utilize it for all sorts of projects. Because of its enormous success, Espressif now offers a wide variety of models with varying size and technological specs. Its replacement includes ESP32.

RELAYS:

Industrial controls, automotive systems, and home appliances all make extensive use of electrically controlled switches called relays. By using a relay, two independent voltage sources may be isolated from one another; in other words, a little quantity of voltage or current on one side can manage a big amount of current or voltage on the other side, and vice versa.

Inductor

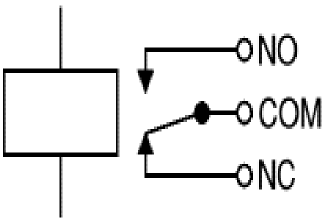


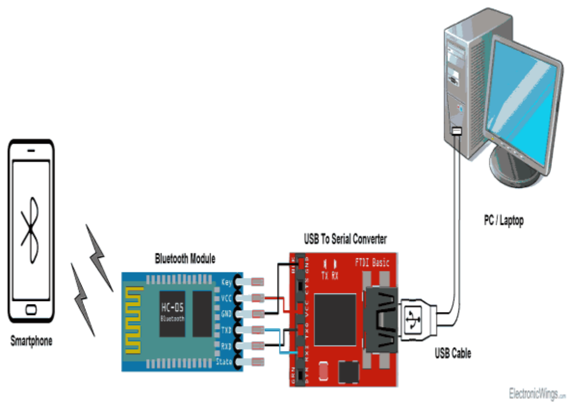
Fig 7 : Circuit symbol of a relay

DRIVING A RELAY:

Two of the SPDT relay's five pins are used by the magnetic coil, one serves as the common terminal, and the other two are typically closed and normally connected. The coil is activated when a current passes across it. At the beginning, when the coil is deenergized, the usually closed pin and common terminal will be connected. A new connection will be formed between the common terminal and usually open pin when the coil is activated, breaking this connection. Therefore, the relay will be activated whenever the microcontroller sends an input signal to it. You may drive the loads connected between the common terminal and typically open pin while the relay is on. Consequently, the high-current loads are driven by the relay, which receives 5V from the microcontroller. This means the relay may be used as a means of isolation. The microcontroller and digital systems do not have enough current to operate the relay. In contrast to the 10 milliamps required to activate the relay's coil, the microcontroller's pin can only provide 1 or 2 milliamps. This is why the microcontroller and the relay are separated by a driver, like ULN2003, or a power transistor. By connecting ULN2003 to the relay and microcontroller, it is possible to activate many relays simultaneously.

Bluetooth communication between Devices

One use case is communicating between a smartphone and an HC-05 Bluetooth module; the other is seeing the data from the module on a PC serial terminal.
A Bluetooth terminal app is necessary for data transmission and reception on smartphones in order to connect them to the HC-05 Bluetooth module. Apps for Bluetooth terminals are available in the app stores for both Android and Windows.



Bluetooth Module Serial Interface

Therefore, in order to establish a connection between the HC-05 Bluetooth module and a smartphone, we must first connect the module to a personal computer using a serial to USB converter. We need to pair the HC-05 module with the smartphone before we can set up Bluetooth communication between the two devices.

SOFTWARES

The Arduino platform is an open-source, user-friendly hardware and software environment for prototyping. It is comprised of a programmable circuit board (also called a microcontroller) and an Integrated Development Environment (IDE) called Arduino that is pre-made for writing and uploading code to the physical board.
The main characteristics are:
• Many sensors can send signals in digital or analog formats to Arduino boards, which may then be used to activate motors, control LEDs, establish connections to the cloud, and much more.
• The Arduino IDE (also called "uploading software") allows you to command your board's operations by communicating with the microcontroller on the board.

INTERNATIONAL JOURNAL OF APPLIED SCIENCE ENGINEERING AND MANAGEMENT

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• A separate device, known as a programmer, is not required to load fresh code into an Arduino board, in contrast to most prior programmable circuit boards. The usage of a USB connection is all that is required. • The Arduino IDE employs a streamlined version of C++, which facilitates programming learning. Last but not least, Arduino offers a standardized form factor that simplifies the microcontroller's tasks.
Now that we know what the Arduino UNO board is and how it works, we can go on to setting up the Arduino IDE. As soon as we figure this out, we can upload our software to the Arduino board.

RESULTS

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ISSN 2454-9940

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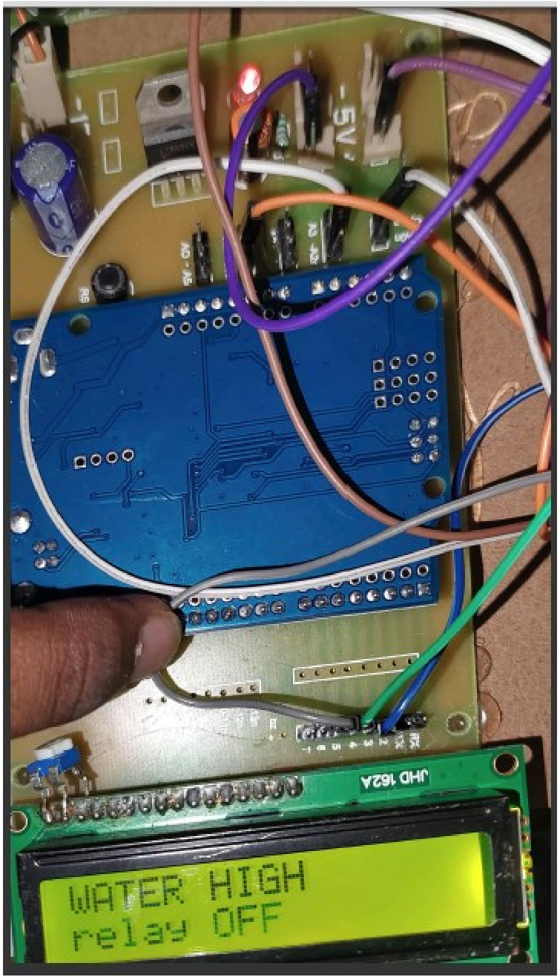

CONCLUSION

By making it more efficient and precise, the use of the internet of things (IoT) in farming alters conventional farming methods. Data analytics and smart sensors let farmers make the most of resources like water and fertilizer, which helps with sustainability. By providing information into crop conditions and soil health, precision agriculture might potentially boost yields with the use of the Internet of Things (IoT). Automation and remote monitoring simplify procedures, while data-based decisions enhance operations. Despite challenges like data security and remote accessibility, the Internet of Things (IoT) is reshaping agriculture with the potential for greater sustainability and production.

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