IOT Based Smart Water Distribution With RFID System

Submitted By

Sojib Hosen	EEE2102023103
Md Moshiur Rahman	EEE2102023045
Md. Nahid Hossain	EEE2102023037
Modhusudon Sharma	EEE2102023061
Subir Nandi	EEE2102023030

Supervisor

Mirza Rabiul Hasan
Lecturer (SU)
Department of Electrical & Electronic Engineering
Sonargaon University

Department of Electrical & Electronic Engineering
Sonargaon University (SU)
147/I, Panthapath,
Dhaka-1215,
Date of Submission: January, 2025

Declaration

We hereby, declare that the work presented in this project is the outcome of the investigation performed by us under the supervision of Mirza Rabiul Hasan Department of Electrical & Electronics Engineering, Sonargaon University. We also declare that no part of this project report and thereof has been or in being submitted elsewhere for the award of any degree.

We further undertake to identify the university against any loss or damage arising from breach of the forgoing obligation.

…… ……..

Sojib Hosen **Md Moshiur Rahman**

…… ……..

Md. Nahid Hossain **Modhusudon Sharma**

……

Subir Nandi

Certification

This is to certify that the project report on "**IOT Based Smart Water Distribution With RFID System**" is the bonafide record of the work done by-

for partial fulfillment of the requirement of their degree of B.Sc. in Electrical and Electronic Engineering at Sonargaon University.

The project report has been carried out under my guidance and is a bonafide record of the successful work. I wish them success in future.

Supervised By

.....

Mirza Rabiul Hasan
Lecturer, Department of EEE
Sonargaon University

Acknowledgement

First, we express our heartiest thanks and gratefulness to almighty for his divine blessing makes mine possible to complete this project successfully. We would like to express our gratitude to our Head of Department for providing mine a congenial environment for engineering studies and also for having showed mine the way to out the project. We feel grateful to and wish our profound our indebtedness to **Mirza Rabiul Hasan Department of Electrical & Electronics Engineering** , Sonargaon University. Deep knowledge and keen interest of our supervisor influenced mine to carry out this project. His endless patience, scholarly guidance, continual encouragement, constantan energetic supervision, constructive criticism, valuable advice at all stage made it possible to complete this project. We would like to thank our entire course mate in Sonargaon University, who took part in this discuss while completing the course work. Finally, we must acknowledge with due respect the constant support and patients of our parents.

Abstract

The IOT Based Smart Water Distribution with RFID System project integrates modern technology to provide a more efficient, secure, and automated method of controlling access to a water distributor unit. This system uses an RFID (Radio Frequency Identification) tag to allow authorized individuals to access the water distribution, ensuring better management of resources in shared spaces, such as offices, schools, or public areas. The project combines hardware components like an RFID reader, microcontroller (such as an ESP32), water flow sensors, and relays with software to create a seamless user experience. The IOT Based Smart Water Distribution with RFID System project is a practical application of RFID technology that brings automation, security, and convenience to everyday water distributor processes. By controlling access and monitoring usage, this system can reduce water wastage, ensure fair usage, and enhance user convenience. Additionally, it introduces an efficient method for monitoring resource consumption in shared environments, making it an ideal solution for institutions and businesses.

Table of Contents

Content Page No.

Declaration 1
Certification 2
Acknowledgement 3
Abstract 4
Table of Contents 5
Table of Contents 6
List of Abbreviation 7
List of Figure 8

Chapter 1 Introduction

1.1 Introduction 9
1.2 Background 10
1.3 Objectives 11
1.4 Methodology 12
1.5 Advantage of the Project 12-13
1.6 Project Layout 13

Chapter 2 System Architecture

2.1 Introduction 14
2.2 System Circuit Diagram 15
2.3 System Block Diagram 16
2.4 Working Principle 17

Chapter 3 Hardware Devlopment

3.1 ESP32 10
3.2 RDM6300 10-12
3.3 16x2 LCD Display 12-14
3.4 12C LCD Module 14
3.5 2 Channel Relay Module 15
3.6 12v DC Water Pump 16-17
3.7 MP1584 Module 17-19
3.8 3.7v Li-ion Batteries 19-20
3.9 Power Switch 20-21
3.10 12v Adapter 21-22

Chapter 4 Software And Working Principle

4.1 Introduction 23
4.2 Key Feature of The Arduino IDE 23-24
4.3 Key Components of the Arduino IDE 24
4.4 Application of ESP32 24-25
4.5 Physical Characteristics 25
4.6 Google Sheets API 25
4.7 Flowchart 26

Chapter 5 Discussion, Conclusion and Recommendations

5.1 Discussion 27
5.2 Application 27
5.3 Future Scope 27
5.4 Conclusion 27-28
5.5 Advantage And Disadvantage 28

List of Abbreviation

ESP32 – Espressif Systems 32-bit

RDM6300 – Reader Module

P.S –Power Switch

LCD –Liquid-Crytal Display

R.M –Relay Module

List of Figures

Figure: 2.2: Circuit Diagram of the system
Figure: 2.3 : Block Diagram of the system
Figure: 3.1 : ESP32
Figure: 3.2 : RDM6300
Figure: 3.3 : 16x2 LCD Display
Figure: 3.4 12c LCD Module
Figure: 3.5 2 Channel Relay Module
Figure: 3.6 12v Dc Water Pumps
Figure : 3.7 MP1584 Module
Figure: 3.8 3.7v Li-ion Batteries
Figure : 3.9 Power Switch
Figure: 3.10 12v Adapter
Fig.4.1 Espressif Systems 32-bit (ESP32)
Fig.4.2 Physical configuration ESP32

CHAPTER 1

Introduction

1.1 Introduction

The IoT-Based Smart Water Distribution With RFID System exemplifies how technology can address daily challenges by automating water management and promoting efficiency. Water is a vital resource, and traditional Distributors often lack smart features such as usage tracking, automated refilling, and payment systems, leading to inefficiency and wastage. This project integrates IoT to bridge these gaps, enabling efficient water disspening, accurate billing, and real-time tracking.

At the core of this system is the ESP32 microcontroller, which handles tasks like RFID-based authentication, relay control, and cloud communication. Users access the distribution using RFID cards, which function as digital wallets, deducting the cost of water consumption in real-time at 3 TK per second. Transactions are seamlessly logged in a Google Sheet, ensuring transparency.

The system features two pumps: one for dispensing water and another to refill the main tank from a reserve tank, ensuring continuous operation even when the main tank is empty. A 16x2 I2C LCD display enhances user experience by showing the user's balance, transaction status, and system alerts.

Power is managed using two 3.7V lithium-ion batteries in series, regulated by an MP1584 step-down module for the ESP32, while a 12V adapter powers the pumps. This setup ensures reliable performance and efficient energy use.

The IoT-Based Smart Water Distribution highlights how automation, IoT integration, and resource optimization can revolutionize traditional systems, offering a sustainable and user-friendly solution to water management challenges.

1.2 Background

In today's world, efficient management of resources and ensuring hygiene are critical considerations, especially in public or shared spaces like offices, schools, hospitals, and commercial areas. Water distribution are commonly used in these environments, but many of these systems rely on manual control, such as pressing a button or turning a knob, which can cause hygiene concerns, inefficiencies, and misuse[7] As technology advances, the need for automation and contactless systems has become more important to ensure convenience, security, and improved user experience.

The **IOT Based Smart Water Distribution With RFID System** integrates **Radio Frequency Identification (RFID)** technology with water distribution to address these challenges. RFID technology is widely used for tracking and identification purposes due to its ease of use, efficiency, and security. By incorporating RFID into the water dispensing process, this system allows for automatic user identification, access control, and hygienic, contactless operation.

1.3 Objectives

- ❑ Automate water distributing using RFID for user identification.
- ❑ Enable cashless transactions by deducting the bill from RFID card balances.
- ❑ Maintain water level in the main tank using a reserve tank.
- ❑ Log transaction history to a Google Sheet for transparency and monitoring
- ❑ By using RFID tags, the system ensures that the user can operate the distribution without direct contact, reducing the risk of contamination and promoting better hygiene, especially in public spaces or offices.
- ❑ The system can keep track of how much water each registered user distribution, providing usage data that can help in billing or monitoring consumption.
- ❑ The system can include features like automatic refill alerts, maintenance reminders, and status indicators, making it easier for management to maintain the distribution and ensure continuous service

1.4 Methodology

- Planning for design and configuration
- Collecting spare parts
- Assembling
- Calibration for absolute performance
- Result

1.5 Advantage of the Project:

The **IOT Based Smart Water Distribution With RFID System** offers a variety of advantages that make it a highly efficient and innovative solution for managing water distribution, particularly in environments with multiple users such as offices, schools, hospitals, and public spaces. The integration of **RFID (Radio Frequency Identification)** technology with water distribution brings about numerous benefits in terms of hygiene, automation, security, and resource management. Below are the key advantages:

1. Enhanced Hygiene and Contactless Operation

- **Advantage:** One of the primary benefits of the RFID system is the **contactless operation**. Users can simply scan their RFID tags to activate the water distribution, eliminating the need for touching shared buttons or levers.

- **Impact:** This reduces the risk of **cross-contamination** and **germ transmission**, which is particularly important in public spaces or during health crises like the COVID-19 pandemic.
- **Example:** In high-traffic areas like offices or hospitals, users can get water without coming into contact with common touch points, maintaining better hygiene.

2. User Authentication and Access Control

- **Advantage:** The system allows for **user authentication** through unique RFID tags, ensuring that only authorized users can operate the water distribution.
- **Impact:** This provides an **access control mechanism**, preventing unauthorized access and ensuring that only registered users, such as employees or members, can use the distribution.
- **Example:** In office environments, an organization can limit water distribution r usage to employees, preventing misuse by non-authorized individuals.

3. Efficient Water Usage Tracking

- **Advantage:** The RFID system can track each user's **water consumption**, helping to monitor how much water each individual distribution.
- **Impact:** This helps in preventing **water wastage** and allows for **usage tracking** for billing purposes or resource optimization.
- **Example:** For companies or organizations that charge for water usage, each employee's consumption can be tracked, providing accurate billing or usage statistics.

4. Automated and Time-Saving Operation

- **Advantage:** The system automates the operation of the water distribution, eliminating the need for manual switches or buttons, making the entire process more efficient and time-saving.
- **Impact:** Users can simply scan their RFID tags, and the water is dispensed automatically, enhancing convenience and saving time.
- **Example:** In busy office environments, employees do not have to waste time searching for buttons or switching between modes, making the process faster and more seamless.

5. Improved Resource Management and Maintenance

- **Advantage:** The RFID system can send alerts for **maintenance requirements**, such as low water levels, filter replacements, or any system malfunctions.
- **Impact:** It simplifies **maintenance management**, ensuring the distribution remains functional and reducing downtime.
- **Example:** The system can automatically notify the maintenance team when the water level is low or when it's time for maintenance, improving operational efficiency.

6. Energy Efficiency

- **Advantage:** The system can be configured to automatically **shut off** the distribution after a certain time or once a set amount of water is dispensed.
- **Impact:** This prevents the water dispenser from being left on unnecessarily, thus saving both water and energy.
- **Example:** In settings where water distribution are often left on, the automatic shutdown ensures that energy is not wasted, and water is dispensed only when needed.

7. Scalable and Expandable

- **Advantage:** The RFID-based system is scalable, meaning it can be extended to multiple water distribution in larger environments such as corporate offices, schools, or public facilities.
- **Impact:** Multiple dispensers can be connected and managed through a central system, making it easier to monitor and control access across a large area.
- **Example:** In a large office with several floors, each floor could have an RFID-controlled water distribution, all of which can be centrally monitored and controlled.

8. Real-Time Data and Analytics

- **Advantage:** The RFID system can provide real-time data and analytics on water usage, user activity, and distribution performance.
- **Impact:** This data can be used for **informed decision-making** on resource allocation, maintenance schedules, and even cost analysis (if billing is involved).
- **Example:** Managers can view real-time water usage data from all connected distribution in the building, helping them make decisions on water refills, maintenance, or user behavior.

9. Secure and Traceable

- **Advantage:** The system's use of RFID technology ensures that each action is **traceable**, providing a record of who used the distribution and when.
- **Impact:** This enhances **security** and accountability, as every use is logged with the RFID tag ID, timestamp, and water dispensed.
- **Example:** In a shared office, managers can track which employee used the distribution and how much water was dispensed, ensuring no one is misusing the system.

10. Cost Savings in the Long Run

- **Advantage:** The system can help save costs by reducing **water wastage**, **manual intervention**, and **maintenance downtime**.
- **Impact:** By improving efficiency and resource management, organizations can reduce their overall operational costs.
- **Example:** Businesses can track water consumption accurately for billing or resource optimization, preventing unnecessary water wastage and improving budgeting.

11. User-Friendly and Convenient

- **Advantage:** The system is simple for users to operate—just scan their RFID tags to start the water distributing process, and the distribution does the rest.
- **Impact:** The system eliminates complex interfaces or manual controls, making it convenient and easy for everyone to use.
- **Example:** Employees in an office or members in a gym can simply swipe their RFID cards to get water without needing any instructions or technical knowledge.

12. Increased Reliability

- **Advantage:** RFID systems are generally reliable and can function in a wide range of environments without being affected by wear and tear from physical contact.
- **Impact:** Unlike mechanical switches or push-buttons, RFID technology is more durable and less prone to malfunctions, leading to higher system reliability.

Chapter 2

System Architecture

2.1 Introduction

The IOT Based Smart Water Distribution With RFID System is an innovative approach to automate and secure the process of water distributig using Radio Frequency Identification (RFID) technology. This system provides a user-friendly and efficient method for controlling access to water distributior in various environments such as offices, schools, public places, and homes. By integrating RFID-based authentication with automated water distributing, the system ensures that only authorized users can access water, thus improving resource management, reducing waste, and preventing misuse.The architecture of the IOT Based Smart Water Distribution With RFID System is composed of several interconnected components, both hardware and software, that collaborate to facilitate seamless operation. The architecture includes hardware components such as the RFID reader, microcontroller (ESP32), water flow sensors, relay modules for controlling water dispensing mechanisms, and the user interface for feedback. Additionally, the system supports remote monitoring via a mobile app or web interface, allowing administrators to track usage, refill status, and user activity.This project leverages RFID for access control, ensuring that only those with registered RFID tags can distribution water, thus preventing unauthorized access. The ESP32 microcontroller serves as the brain of the system, managing data from the RFID reader, water flow sensors, and controlling the water distributing hardware. The system can also interact with a mobile app or web interface to enable remote monitoring and management, making it ideal for environments where water usage needs to be tracked and controlled.By integrating modern IoT technologies such as Wi-Fi communication and RFID, this architecture enhances the security, automation, and efficiency of water distribution, making it a significant advancement over traditional manual-operated distribution.In summary, the IOT Based Smart Water Distribution With RFID System architecture combines advanced hardware with user-centric design to offer a smart solution for water distributing, which not only ensures fair access but also promotes responsible water usage in shared spaces.

2.2 Circuit Diagram

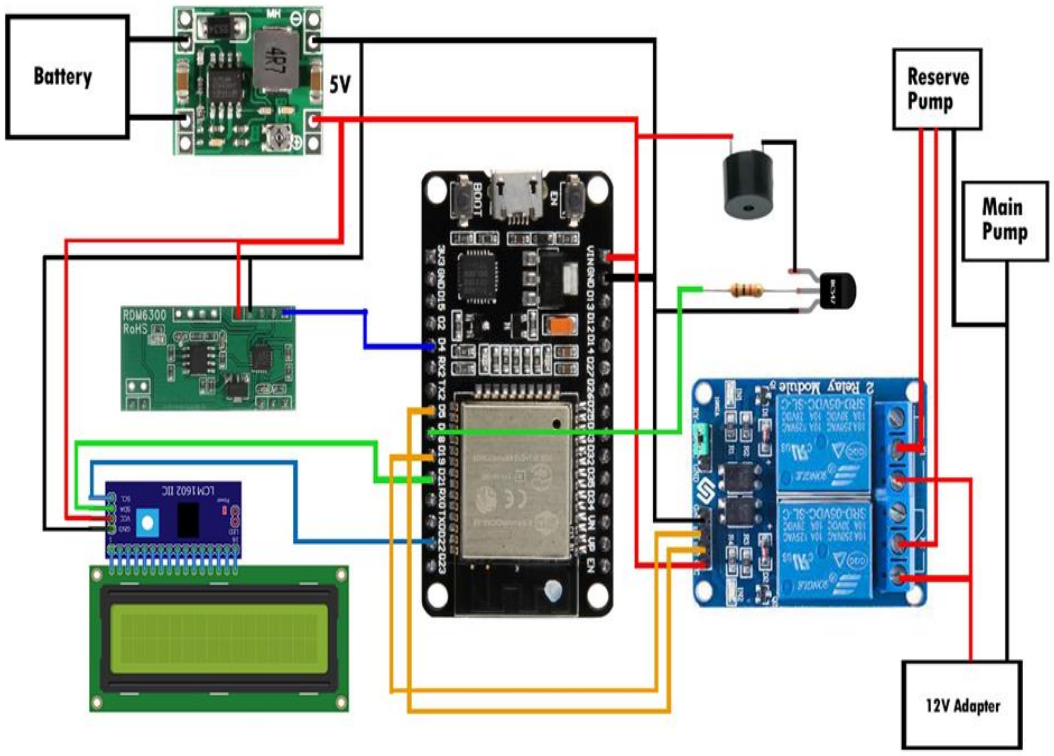
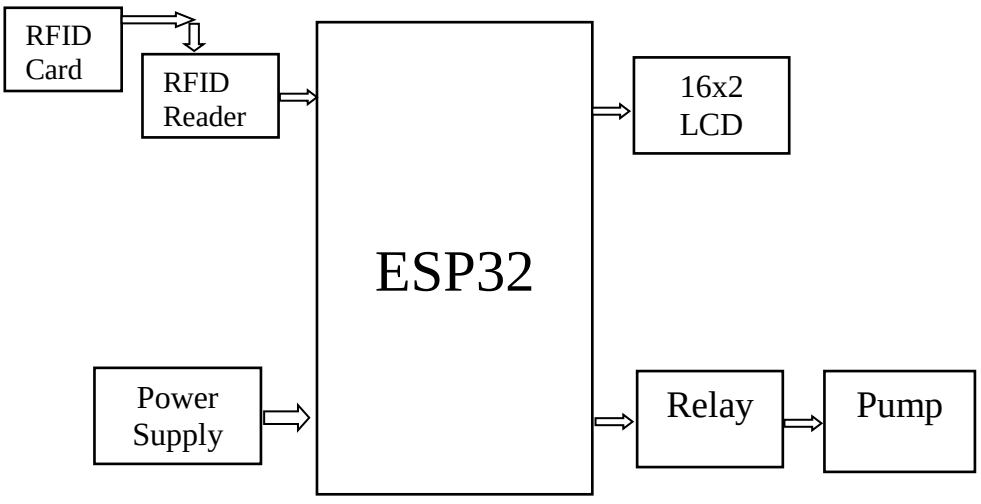


Figure:2.3 Circuit diagram of the system

2.3 Block Diagram



2.4 Working Principle

The RFID-based water distribution system is an innovative and efficient way to manage and control the distribution of water in various settings, such as offices, homes, or public places. It utilizes RFID (Radio Frequency Identification) technology to authenticate users, monitor water usage, and ensure fair and efficient dispensing. Here's a breakdown of the working principle and the architecture of an RFID-based water distribution system.[1]

1. **User Identification**:Each user is assigned a unique RFID card or tag. These cards are typically embedded with a microchip that stores the user's details, such as their ID, name, and account balance for water usage.When a user wants to access water from the distribution, they scan their RFID card or tag near the RFID reader.
2. **RFID Reader**:The RFID reader, typically mounted on the water distribution, sends out a radio frequency signal to detect and read the RFID tag in the user's card.The reader captures the unique ID from the card and sends it to the system's controller for verification.
3. **User Authentication and Verification**:The controller system checks the data received from the RFID reader by comparing it against a database that contains valid user IDs and their associated details (e.g., credit, water usage history).If the user is authorized (e.g., they have sufficient balance or water credits), the distribution will proceed to dispense the water.If the user is unauthorized, the system will deny access to water.
4. **Water Dispensing Control**:Once the user is authenticated, the system activates the distribution mechanism to allow water flow[2] Depending on the system, water distributing can be either continuous or metered (based on user preferences or account balance).The water distribution might also track the amount of water dispensed, recording this data for future reference or billing.
5. **Account Management**:In some systems, the RFID card is linked to a preloaded account, and each time the user distribution water, the system deducts an appropriate amount from their balance.Users can refill their balance by adding funds through an online payment system, at a kiosk, or via other methods.The system may also provide real-time data to users on their water usage and balance via an app or display screen.

Chapter 03

Hardware Development

3.1 ESP32

Integrating an RFID system into a water distribution using an ESP32 is an excellent way to implement controlled access. With this system, users need an RFID tag or card to dispense water.



Figure: 3.1 : ESP32

3.2 RDM6300

The RDM6300 is an affordable 125 kHz RFID reader module that can be easily integrated into a water distribution project for user authentication.[4] Here's how you can use the RDM6300 module with an ESP32 for a controlled water distribution.

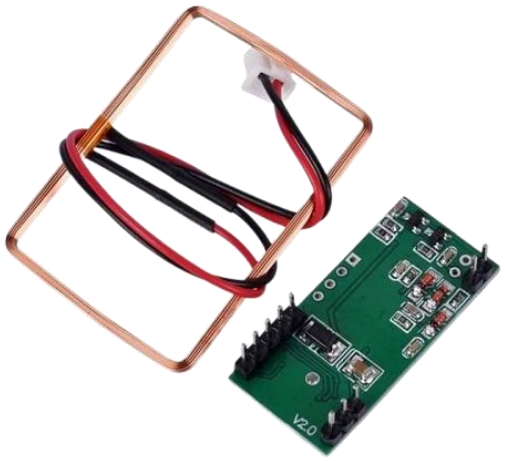


Figure: 3.2 : RDM6300

Working Principle of RDM6300 RFID Reader

The RDM6300 is a popular RFID (Radio Frequency Identification) reader module, typically used for reading 125 kHz passive RFID tags. This module communicates via the serial UART interface (TTL) and can be integrated into various projects where identification and tracking via RFID are required. Here's the working principle of the RDM6300 RFID reader:

1. RFID Tag Communication:

- **125 kHz RFID Tags:** The RDM6300 operates at a frequency of 125 kHz and reads passive RFID tags that work in the LF (Low Frequency) range[9] These RFID tags don't have a battery and rely on the radio signal sent by the reader to get powered (they are passive tags).
- The RFID tag has a unique identifier code (UID), which is transmitted when the tag comes within range of the reader.

2. Signal Transmission:

- **Antenna:** The RDM6300 has an onboard antenna that transmits a radio frequency (RF) signal at 125 kHz to the nearby RFID tags.
- The RFID tags, upon receiving the signal, are powered by the RF energy and respond by sending back their unique ID number to the reader[9]

3. Receiving the Signal:

- When an RFID tag comes within the read range of the RDM6300, the tag transmits its UID (Unique Identifier) via modulation (a method to encode data on a carrier wave) of the RF signal.
- The RDM6300 receives this signal from the RFID tag, decodes it, and processes the data.

4. Data Conversion and Communication:

- **Demodulation:** The signal from the RFID tag is demodulated by the RDM6300. This process extracts the unique identifier or data encoded in the RFID tag's response.
- The RDM6300 then converts this raw data (UID) into a serial data format that can be sent over the UART (Universal Asynchronous Receiver-Transmitter) interface.

5. Output to Microcontroller or Computer:

- The RDM6300 transmits the RFID tag's unique ID via the UART serial interface to an external device such as a microcontroller (e.g., Arduino) or a PC for further processing.
- The serial data output consists of a stream of data that corresponds to the tag's unique ID.
- A typical output might be something like:
- The microcontroller or computer then processes the ID for authentication, logging, or triggering specific actions based on the tag's ID.

6. Powering the Module:

- The RDM6300 is powered by a 5V DC supply and can communicate over a 3.3V or 5V UART interface with a microcontroller or other processing unit. The 125 kHz RFID tags, however, do not require their own power source (they are passive).

7. Working with Passive RFID Tags:

- **Passive RFID Tags:** These tags do not have batteries. They get powered by the electromagnetic field generated by the RDM6300. When the tag is within the electromagnetic field of the RDM6300's antenna, it activates and transmits its stored unique identifier to the reader.
- The process of energy transfer and communication happens without the need for a direct physical connection, making RFID technology ideal for non-contact identification and tracking.

3.3 16x2 LCD Display

To use a 16x2 LCD display to show the real-time status of a water distribution and its balance status, you'll likely want to display information about the water flow, or remaining water amount (balance).

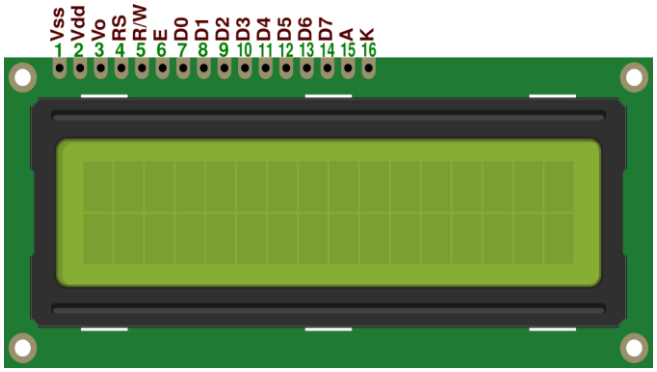


Figure: 3.3 :16x2 LCD Display

Working Principle of a 16x2 LCD Display

A 16x2 LCD display is one of the most commonly used displays in electronics projects. It has 2 lines, and each line can display 16 characters, which makes it a 16x2 matrix of characters [8] The most common type of 16x2 LCD is based on the HD44780 controller, which is a popular character-based LCD controller. Here’s the working principle of a 16x2 LCD display:

1. Power Supply:

- When the display is powered on, it requires a 5V DC power to operate. The ground pin (VSS) is connected to the ground, and the VCC pin is connected to 5V.
- The contrast pin (VO) is used to adjust the contrast of the LCD display (so characters can be visible based on the user's preference).

2. Sending Commands to the Display:

- The RS (Register Select) pin is used to switch between two modes:
  - RS = 0 (Command Mode): When the RS pin is set to 0, the LCD interprets the data sent as commands.
  - RS = 1 (Data Mode): When the RS pin is set to 1, the LCD interprets the data as characters (or data) that should be displayed on the screen.
- RW (Read/Write): The RW pin is used to specify whether the operation is a read or write operation:
  - RW = 0 (Write Mode): To send data or commands to the LCD.
  - RW = 1 (Read Mode): To read data from the LCD (usually for more advanced usage).
- E (Enable): The enable pin is used to latch data or commands into the LCD. When the enable pin is pulled high (1), the data present on the data pins is transferred to the LCD.

3. Data Transmission:

- 4-bit Mode vs. 8-bit Mode: The data to be sent to the LCD can be sent in 4-bit or 8-bit mode, depending on how the data pins (D0-D7) are connected. In 8-bit mode, all 8 data pins are used, while in 4-bit mode, only 4 data pins (D4-D7) are used to send data.
- Sending Commands: Commands are sent in a series of 8-bit values that control the functionality of the LCD, like clearing the screen, setting the cursor position, and turning on/off the display.
- Sending Data: When sending data (characters to be displayed), each 8-bit value corresponds to a character code (according to the ASCII table). The microcontroller sends this code to the LCD, which then displays the corresponding character.

4. Displaying Characters:

- The LCD uses a matrix of 5x8 dots to represent each character. The character codes that the microcontroller sends are mapped onto this grid of pixels to form readable characters[8]
- The LCD controller maps the character data to the corresponding pixels, which are either on (visible) or off (invisible) depending on whether they are part of the character.

5. Backlight Control:

- The backlight is typically controlled by the A (anode) and K (cathode) pins.
- When the display is powered, the backlight can be turned on to illuminate the screen. In some configurations, the backlight intensity can be controlled by adjusting the voltage across the anode and cathode.

3.4 12C LCD Module

Using an I2C LCD module in a water distribution project is a great way to simplify wiring, as the I2C interface reduces the number of pins needed to communicate with the LCD. Here's how you can use a 12C LCD module in a water dispenser project to show real-time status such as water level, valve status, and balance.



Figure: 3.4:12C LCD Module

Working principle of 12C LCD Module

The **I2C LCD module** is a popular and efficient way to interface an LCD (Liquid Crystal Display) with a microcontroller, especially when there is a need to save on the number of GPIO pins used. The **I2C (Inter-Integrated Circuit)** is a two-wire serial communication protocol, and the I2C LCD module uses this protocol to communicate with a microcontroller or other devices.

3.5 2 Channel Relay Module

In a water distribution project, a 2-channel relay module can be used to control two devices, such as pumps for distributing water and possibly a solenoid valve to control water flow. Using the relay, you can automate the water distributing process by turning the pumps on and off based on specific conditions such as water level or user input.

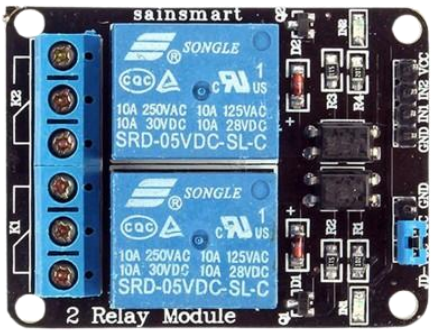


Figure: 3.5 Channel Relay Module

Working principle of Relay Module

A **relay module** is an essential component used in electronic systems to control higher power devices using low power control signals, typically from microcontrollers or logic circuits. It functions as an electrically operated switch that can open or close a circuit based on the input signal, allowing for control of devices that require more current or voltage than the control circuit can supply.

Here's a detailed explanation of how a relay module works:

1. Basic Components of a Relay Module:

- **Relay**: The main switching element of the module. It consists of an electromagnetic coil, a set of contacts (Normally Open - NO, Normally Closed - NC, and Common - COM), and an armature that moves to open or close the contacts.
- **Diode**: A flyback diode (usually placed across the relay coil) is used to protect the control circuit from voltage spikes generated by the inductive load when the relay is turned off.
- **Transistor or MOSFET**: This is used to drive the relay coil from a low-power control signal. It acts as a switch that amplifies the control signal to a level sufficient to activate the relay.
- **Control Pins**: These are input pins that connect to the microcontroller or logic circuit to provide the control signal.

3.6 12v Dc Water Pums

In a water Distribution project with 12V DC pumps where one pump is used for Distributing water and the other for refilling, the 2-channel relay module can be used to control both pumps based on the water level. One pump will activate when the water level is low to refill the tank, and the other will be used to Distribution water when required.



Figure: 3.6 Water Pump

Working principle of Solar Pump

Essentially, solar-powered water pumps work by converting the sun's rays (photons) to electricity that will operate the water pump. It uses solar panels to collect the photons (units of light) from sunlight, producing the direct current (DC) that provides the energy for the motor to pump water out from its source.

Advantage of Solar Pump

The main advantage of the solar water pump is that it uses sunlight no cost . Just as solar water pumps reduce dependence on electricity or diesel, once installed, there is no recurrence cost of electricity or fuel. Compared to conventional water pumps, solar water pumps require very little maintenance.

Disadvantage of Solar Pump

Although solar water pumps are eco-friendly to use, there are various disadvantages of them, in terms of technology as well as usage. The various disadvantages of solar water pumping systems are:
The capital expenses of solar water pumping systems are often greater than those of comparable diesel alternatives. The cost of systems is, however, currently declining.
Most applications require higher water storage than required by comparable diesel systems.Risk of panel theft since they are still seen as valuable goods in some places.
Such systems are very dependent on solar radiation.
Usually, the capital level is the only level where spare parts and skilled technicians are available.

3.7 MP1584 Module

Using the MP1584 DC-DC step-down module to convert 7.4V to 5V is a straightforward way to power low-voltage components (such as microcontrollers, relays, and sensors) in your water dispenser project. Here's how you can incorporate it into the system:



Figure : 3.7 MP1584 Module

Working Principle of MP1584 Module

The **MP1584** is a **DC-DC buck converter** integrated circuit (IC) designed to step down a higher input voltage to a lower output voltage efficiently. It operates using the principle of pulse-width modulation (PWM) to regulate and control the output voltage. Here's a detailed look at its working principle:

Working Principle of MP1584

1. **Input Voltage (Vin):** The MP1584 is designed to work with a wide input voltage range, typically from 4.5V to 28V, making it useful for various applications.

2. **Switching Operation:**

    - The IC contains an internal power switch (usually a MOSFET) that operates at high frequencies (typically in the range of 200kHz to 1MHz).

    - When the input voltage is supplied to the converter, the internal switch is periodically turned on and off. During the "on" state, current flows through the inductor, storing energy in its magnetic field.

    - When the switch is turned off, the stored energy in the inductor is released to the output through a diode or synchronous rectifier, which is typically controlled by the IC.

3. **Inductor:**

    - The inductor plays a key role in energy storage. When the internal switch turns on, the current increases linearly in the inductor, storing energy as a magnetic field.

    - When the switch turns off, the inductor releases this stored energy to the output through the diode or synchronous rectifier.

    - The inductor smooths out the current, helping maintain a stable output voltage.

4. **Capacitors:**

    - The output capacitor smooths out the ripple in the output voltage, which is caused by the switching process. The capacitor stores charge and releases it when necessary to provide a stable DC output.

    - There is also an input capacitor that helps to reduce input voltage fluctuations and noise from the power supply.

5. **Pulse Width Modulation (PWM):**

    - The MP1584 uses PWM to regulate the output voltage. The duty cycle of the PWM signal (the ratio of "on" time to the total cycle time) is adjusted by a feedback mechanism to ensure the output voltage stays constant despite changes in load or input voltage.

- If the output voltage decreases, the controller increases the duty cycle (keeping the switch on for a longer period) to supply more energy. If the output voltage increases, the controller reduces the duty cycle.

6. **Feedback Control:**

- A feedback loop monitors the output voltage and compares it to a reference voltage (typically an internal fixed value like 0.8V).

- The IC adjusts the duty cycle of the PWM signal to keep the output voltage close to the desired value, ensuring regulation even with changes in load or input voltage.

7. **Output Voltage (Vout):**

- The output voltage is lower than the input voltage (buck operation). By adjusting the duty cycle of the PWM, the output voltage is controlled and stabilized, providing the desired voltage level for the load.

- For example, with an input voltage of 12V, the MP1584 can output a regulated voltage of 5V (depending on the external components and settings).

3.8 3.7v Li-ion Batteries

Using two 3.7V Li-ion batteries as the main power source for a water Distribution project is a feasible solution. These batteries can efficiently power both the pumps (via a boost converter) and low-power electronics (via a buck converter). Below is a step-by-step guide for setting this up:



Figure : 3.8 3.7v Li-ion Batteries

Working Principle of 3.7v Li-ion Batteries

The working principle of 3.7V Li-ion (Lithium-ion) batteries revolves around the movement of lithium ions between the anode and cathode during the charge and discharge cycles. This technology provides a high energy density, which is why it is widely used in portable devices like smartphones, laptops, electric vehicles, and more.

Key Components of a Li-ion Battery:

1. **Anode (Negative Electrode):** Typically made of graphite or other carbon-based materials.
2. **Cathode (Positive Electrode):** Made from a lithium metal oxide, commonly $LiCoO_2$ (Lithium Cobalt Oxide), $LiFePO_4$ (Lithium Iron Phosphate), or other lithium compounds.
3. **Electrolyte:** A liquid or gel-like substance (usually a lithium salt dissolved in an organic solvent) that allows the movement of lithium ions between the anode and cathode.
4. **Separator:** A permeable membrane that prevents physical contact between the anode and cathode, while allowing ions to pass through.

5. **Current Collectors:** These are typically made of copper (for the anode) and aluminum (for the cathode), which conduct electrons into and out of the battery.

3.9 Power Switch

A DC power switch in a water dispenser is typically used to control the electrical flow within the device, ensuring safe and efficient operation. Here's how it is commonly used in a water dispenser:

Power Control:
The DC switch is used to turn the water dispenser on or off, managing the flow of power from the power source to the internal components like the heating and cooling systems..



Figure: 3.9 Power Switch

Working Principle of Power Switch

he general principle of a DC power switch is to interrupt or establish the connection between the power source (such as a battery or DC power supply) and the load (such as an electronic device or motor). The switch either opens (disconnects) or closes (connects) the circuit, allowing or cutting off the flow of current.

1. Mechanical DC Power Switch:

In a mechanical switch, the principle relies on physical movement of contacts to open or close the circuit.

- **Normally Open (NO) Contact:**
  - In this type of switch, the contacts are normally open, meaning that there is no current flow when the switch is in its default position.
  - When t he switch is activated (pressed, flipped, or rotated), the contacts close, completing the circuit, and allowing current to flow from the DC power source to the load.

- **Normally Closed (NC) Contact:**
    - In this type, the contacts are normally closed, allowing current to flow by default.
    - When the switch is activated, the contacts open, breaking the circuit and stopping the current flow.

3.10 12v Adapter

Using a **12V adapter** to power a pump depends on several factors, including the pump's voltage, power requirements, and the specifications of the adapter. Here's a breakdown of how to determine if a 12V adapter can be used to power a pump, and what considerations you need to take into account.



Figure: 3.10 Adapter

The working principle of 12v Adapter

A 12V adapter is a device used to convert electrical power from one form to another, typically from AC (Alternating Current) to DC (Direct Current), to power devices that require a 12V DC supply. The working principle of a 12V adapter involves several stages of conversion, regulation, and filtering to ensure that the output meets the necessary voltage and current specifications.

1. Input (AC Power Source):

- The input to a 12V adapter is typically AC power from a wall outlet (110V or 220V AC depending on your region). This is the power that the adapter will convert into usable DC power.

2. Step-Down Transformer:

- The first component in most adapters is a transformer. A transformer is used to step down the high AC voltage (e.g., 110V or 220V) to a lower AC voltage (e.g., 12V AC).
- The transformer consists of two coils (primary and secondary) wound around a magnetic core. When AC voltage is applied to the primary coil, it creates a magnetic field, which induces a corresponding AC voltage in the secondary coil.

- The voltage ratio between the primary and secondary coils is determined by the number of turns in each coil. For a 12V output, the secondary coil is designed to produce 12V AC.

3. Rectification (AC to DC Conversion):

- After the voltage is stepped down, it is still in AC form. However, most electronic devices require DC (Direct Current) to operate.
- To convert AC to DC, rectifiers are used. The most common method involves a diode bridge rectifier, which is made up of four diodes arranged in a bridge configuration.
- When AC is fed into the rectifier, the diodes only allow current to flow in one direction, effectively converting the AC signal into pulsating DC. This process is called half-wave or full-wave rectification.
- The output of the rectifier is still not smooth DC; it is a series of pulses that follow the AC waveform.

4. Filtering (Smoothing the DC Output):

- The rectified DC output is pulsating and needs to be smoothed to provide a stable, continuous DC voltage.
- This is done using filter capacitors. Capacitors smooth the ripples in the DC signal by charging and discharging, effectively flattening the output and reducing voltage fluctuations.
- The filtering stage ensures that the output voltage is as steady as possible and can be used by sensitive electronics.

5. Voltage Regulation:

- The final stage in a 12V adapter is voltage regulation, which ensures the output voltage is precisely 12V.
- The voltage regulator (often a linear regulator like the LM7812 or a switching regulator) adjusts the voltage and compensates for variations in input voltage and load current to maintain a constant 12V output.
- If the adapter is a linear regulator, it works by dissipating excess power as heat. It does this by controlling the difference between the input and output voltage.
- In switching regulators (buck or step-down type), more efficient voltage regulation is achieved through high-frequency switching, where the input is rapidly switched on and off to control the output voltage.

6. Output (12V DC Power):

- The regulated, filtered DC voltage is then available at the output terminals (typically a barrel jack or DC plug), providing a steady 12V DC that can power devices like routers, LED lights, small motors, and other 12V devices.

Chapter 4

Software And Flow Chart For Working Principle

4.1 Introduction

The Arduino Integrated Development Environment (IDE) is a software platform used to write, compile, and upload code to Arduino microcontroller boards. Arduino is an open-source electronics platform, popular for building projects involving sensors, actuators, and other embedded systems. The Arduino IDE simplifies the process of programming these boards, making it accessible for beginners and professionals alike.

4.2 Key Features of the Arduino IDE

1. **User-Friendly Interface**: The IDE has a simple interface with a text editor for writing code, buttons to verify and upload programs, and a built-in console to display messages.
2. **Cross-Platform Compatibility**: The Arduino IDE works on **Windows**, **macOS**, and **Linux**, allowing a broad range of users to develop applications for Arduino.
3. **Programming Language**: It uses a simplified version of C++ with specific libraries tailored to interact with the Arduino hardware. This makes it relatively easy to learn and use, even for those with little programming experience.
4. **Code Editor**: It provides syntax highlighting, auto-indentation, and error checking to make coding easier.
5. **Libraries**: The IDE includes a rich set of libraries that help interact with various components like LEDs, motors, sensors, and displays, making it easier to create complex projects without having to write low-level code.
6. **Serial Monitor**: A built-in tool to send and receive data between the Arduino board and your computer. It's crucial for debugging and testing your projects.
7. **Support for Multiple Boards**: Arduino IDE supports a wide variety of Arduino boards such as Uno, Nano, Mega, and even other compatible microcontrollers (like ESP8266 and ESP32).

4.3 Key Components of the Arduino IDE

1. **Sketch**: A program written for the Arduino board. It consists of two main functions:
    - **setup()**: Runs once when the board is powered on or reset.
    - **loop()**: Runs repeatedly after setup() to continuously control the board.
2. **Verify/Compile Button**: This button checks the code for errors and compiles it into machine code that the microcontroller can understand.
3. **Upload Button**: Sends the compiled code to the connected Arduino board.
4. **Tools**: Includes options like board selection, programmer selection, and port selection. These tools help set up the correct environment for uploading code to the board.
5. **Serial Monitor**: Allows communication between the Arduino board and your computer to display data, troubleshoot, or interact with sensors.

Programming Device: The **ESP32** is a powerful microcontroller with Wi-Fi and Bluetooth capabilities, widely used in IoT (Internet of Things) projects. It has more processing power, memory, and connectivity options than the traditional Arduino boards

(like the Arduino Uno). The **Arduino IDE** can be used to program the ESP32, just as it can with other Arduino boards, but the setup process for the ESP32 differs slightly due to its advanced features and support for Wi-Fi and Bluetooth functionalities[5]



Fig.4.1 Espressif Systems 32-bit (ESP32)

4.4 Applications of ESP32

1. **Smart Home Automation**:The ESP32 is frequently used in smart home applications, such as controlling lights, thermostats, security cameras, and other home appliances via a smartphone or voice
2. **Smart Sensors**:ESP32 can be used in IoT sensors that monitor environmental conditions such as temperature, humidity, air quality, or motion. These sensors can send data to the cloud for monitoring and control.
3. **Smart Locks**:ESP32 is used in smart locks that can be controlled remotely via a smartphone or through an automated system. It can interface with a variety of actuators such as servos or motors to lock/unlock doors.
4. **Robotic Control**:ESP32 is used in robotics for controlling motors, servos, and sensors wirelessly. The ESP32 can communicate with other systems like a smartphone or a computer to control the robot's movement or actions.

The ESP32 is an incredibly versatile microcontroller that finds application in a wide range of fields, from home automation and IoT devices to wearables, healthcare, robotics, and smart agriculture. Its built-in Wi-Fi and Bluetooth capabilities, combined with its powerful processing power, make it an ideal choice for both hobbyists and professionals in creating connected devices and innovative systems. With its flexibility, low cost, and a large community of developers, the ESP32 is set to continue its widespread adoption in the tech industry.

4.4 physical characteristics

The ESP32 is a highly versatile and compact microcontroller developed by Espressif Systems. It combines Wi-Fi and Bluetooth capabilities with powerful processing power, making it suitable for a wide range of applications.

Summary of Key Physical Characteristics

Feature	Description
Chip	ESP32 (Dual-core 32-bit Xtensa LX6 processor)
Clock Speed	160 MHz (up to 240 MHz)
RAM	520 KB (SRAM)
Flash Memory	4 MB (up to 16 MB on some modules)
GPIO Pins	34 pins (depending on module)
Wi-Fi	802.11 b/g/n, 2.4 GHz
Bluetooth	Bluetooth Classic (BR/EDR) and BLE 4.2
Power Supply	3.3V (5V via onboard voltage regulator)
Power Consumption	Active: 160 mA to 500 mA, Deep Sleep: 10 µA
Size	~18mm x 25.5mm (for ESP32-WROOM-32 module)
Temperature Range	-40°C to +125°C
Integrated Sensors	Capacitive touch, Hall effect, ADC, DAC
Development Boards	ESP32 DevKit, WROVER, WEMOS, etc.

Fig.4.2 Physical configuration ESP32

4.6 Google Sheets API:

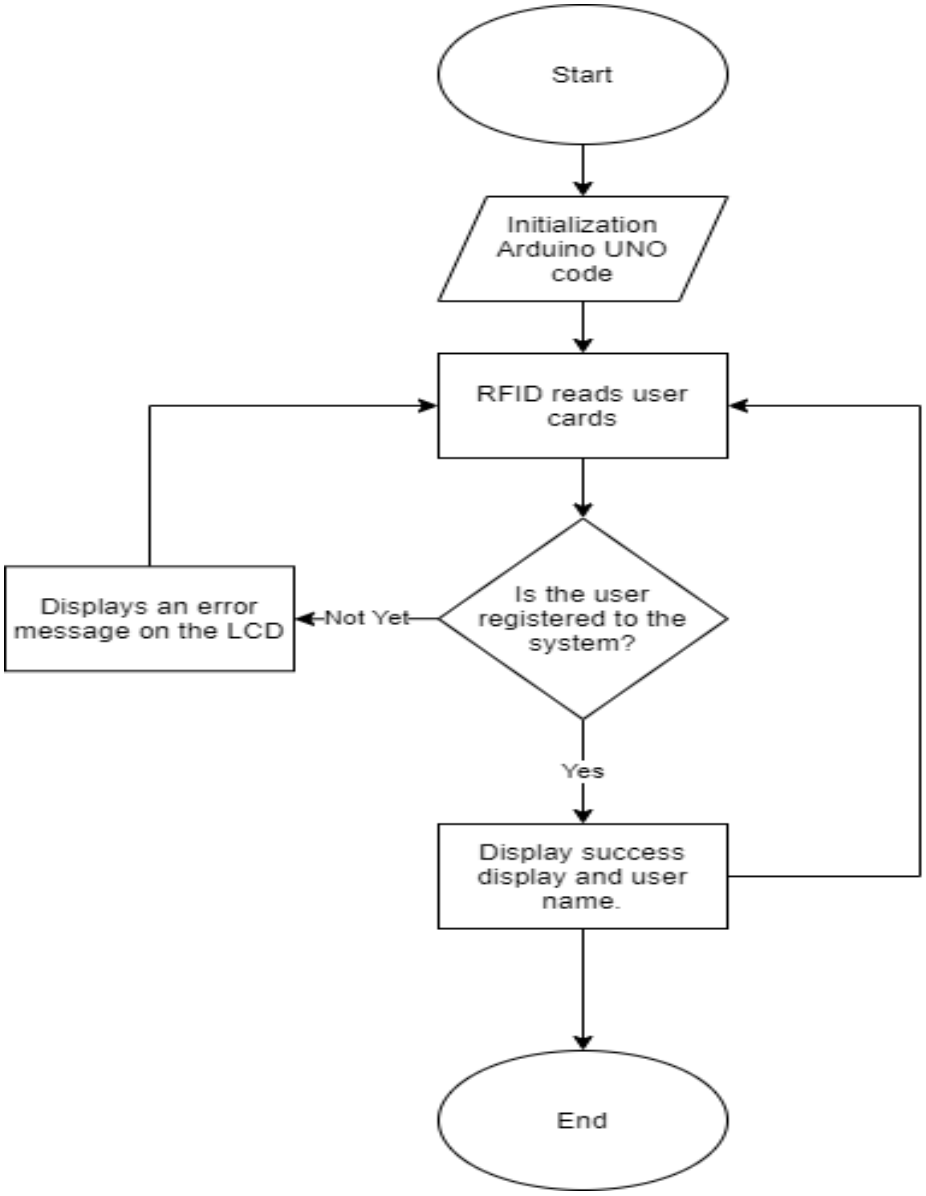
Google Sheets integration ensured a transparent record of transactions.

1. **Google Sheets API Logs**: These are logs related to interactions with the Google Sheets API, such as reading from or writing to a sheet using the API[3] The logs can be generated for debugging or tracking purposes.
2. **Transcription History**: If your goal is to track or log transcription activities (e.g., transcription of audio files into text using Google services), you'd need a method of logging that specific activity. For example, if using **Google Cloud Speech-to-Text** or another transcription service, you might want to log the transcription results into a Google Sheet.

E18 fx

	A	B	C	D	E	F
1	Date	Time	ID	Watering Time	Bill	Balance
2	11/28/2024	2:55:27	7626393	11	33	527
3	11/28/2024	2:55:59	7626393	8	24	503
4	11/28/2024	2:56:24	7637594	10	30	200
5	11/28/2024	2:56:57	7384063	23	69	381
6	11/28/2024	2:57:58	7637594	12	36	164
7	11/28/2024	2:58:53	7384063	12	36	345
8	11/28/2024	2:59:17	7384063	9	27	318
9	11/28/2024	2:59:33	7626393	10	30	473
10	11/28/2024	3:00:54	7626393	16	48	425
11						

4.7 Flowchart



Chapter 5

Discussion, Conclusion and Future Scope

5.1 Discussion

A IOT Based Smart Water Distribution With RFID System typically integrates Radio Frequency Identification (RFID) technology with a water dispenser to manage access control, automate usage tracking, or facilitate payment systems. This system can be used in both residential and commercial settings to streamline operations, improve user experience, and enhance security. Here's an in-depth discussion of the components, functions, and benefits of such a system.

5.2 Application

- Public water Distribution.
- Schools and colleges.
- Corporate offices.
- Parks and recreational areas.

5.3 Future Scope

- Add mobile app integration for live monitoring.
- Implement a water quality sensor.
- Enhance billing with multi-currency support.
- Introduce solar charging for power backup.

5.4 Conclusion

The IoT-Based Smart Water Distribution stands as a practical and innovative solution to modern water management challenges. By seamlessly integrating IoT technology with user-centric features, the system not only enhances convenience but also promotes the sustainable use of a critical resource. This project addresses key inefficiencies in traditional water dispensers by incorporating smart features such as real-time billing, automated refilling, and cloud-based transaction tracking.

One of the standout aspects of this system is its ability to integrate cashless payment through RFID technology, providing a secure and efficient user experience. Each RFID card acts as a digital wallet, dynamically deducting charges based on water usage and logging the transactions in real time to a Google Sheet. This transparency ensures accountability and makes the system suitable for deployment in public spaces, offices, and residential areas.

The inclusion of two water pumps—a primary pump for Distributing and a secondary pump for refilling from a reserve tank—ensures uninterrupted operation even during resource constraints. This feature highlights the project's practical utility, particularly in areas with inconsistent water supply. Moreover, the user-friendly interface provided by the 16x2 I2C LCD display simplifies interaction by presenting real-time balance updates, transaction details, and system status.

Power management is another critical achievement of this project. The dual-power approach, combining 3.7V lithium-ion batteries for the control system and a 12V adapter for the pumps, ensures reliable operation while optimizing energy consumption. The use of the MP1584 step-down module to regulate voltage demonstrates the project's focus on efficiency and sustainability.

Overall, the IoT-Based Smart Water Distribution exemplifies how technology can be harnessed to improve traditional systems, making them smarter, more efficient, and environmentally friendly. Its scalable and modular design makes it adaptable for various applications, from

individual households to large-scale public installations. By fostering responsible water usage and offering a modern, automated solution, this project contributes to the broader goals of resource conservation and smart living, showcasing the transformative potential of IoT in everyday life.

5.5 Advantage And Disadvantage

Advantages:

1. **Efficient Water Management:**
    - Real-time monitoring of water consumption and distribution helps optimize water usage, reducing waste.
    - Smart sensors and RFID provide accurate, up-to-date data on water flow, pressure, and usage patterns, enabling better planning and distribution.
2. **Leak Detection and Prevention:**
    - The system can detect leaks or pipe bursts immediately by monitoring abnormal flow patterns, pressure drops, or sudden changes in water usage.
    - Early detection of leaks helps minimize water loss and costly repairs by addressing issues before they escalate.
3. **Reduced Water Wastage:**
    - Automated systems can adjust water flow, reduce supply during low-demand periods, and prevent over-supply to areas where water is not needed.
    - Alerts and notifications help users and operators be more conscious of their water consumption and take corrective actions, promoting conservation.
4. **Predictive Maintenance:**
    - IoT sensors can track the health and performance of water infrastructure, predicting when pumps, valves, or pipes might fail.
    - This reduces downtime, optimizes the maintenance schedule, and lowers the risk of unexpected outages.
5. **Cost Savings:**
    - Through efficient water usage and reduced maintenance costs due to early fault detection, the system can lead to significant cost savings over time.
    - Lower operational costs for water utilities due to automated processes and better resource management.
6. **Data-Driven Insights:**
    - Data analytics can be used to generate reports and trends, such as water consumption patterns, usage peaks, and efficiency metrics.
    - Decision-makers can use this data for better resource allocation, planning, and improving system performance.
7. **Remote Monitoring and Control:**
    - System operators can access real-time data remotely, improving decision-making and enabling them to take swift actions from anywhere.
    - Remote control of valves and pumps can also be implemented, reducing the need for physical interventions and improving system efficiency.
8. **Customer Engagement:**
    - Consumers can access their own water usage data through a mobile app or online dashboard, empowering them to take control of their consumption.
    - Customers can receive alerts for issues like leaks or abnormal usage, which can help them save water and reduce their bills.

Disadvantages:

1. **High Initial Setup Costs:**
   - The implementation of IoT sensors, RFID tags, and associated infrastructure can be costly.
   - The installation of smart meters, RFID readers, and communication networks requires significant upfront investment for both hardware and software.
2. **Technical Complexity:**
   - The system requires integration between various technologies, including IoT sensors, RFID systems, cloud computing, and communication networks.
   - This complexity might require specialized technical skills to develop, deploy, and maintain the system.
3. **Data Privacy and Security Concerns:**
   - The system involves collecting and transmitting sensitive data about water usage, which could potentially be exploited by malicious actors if proper security measures are not in place.
   - Protecting data from cyber threats and ensuring compliance with privacy regulations is a challenge.
4. **Dependence on Internet Connectivity:**
   - IoT-based systems rely heavily on continuous and reliable internet connectivity to function properly. In areas with poor or unstable network connections, data transmission and remote monitoring may be disrupted.
   - Any disruption in connectivity could impact system performance and cause delays in response times for leaks or other issues.
5. **Maintenance and Support:**
   - The system requires ongoing maintenance to ensure that the sensors, RFID tags, and network infrastructure remain operational.
   - Over time, wear and tear on physical components (e.g., RFID tags, sensors) may require replacement, leading to ongoing operational costs.
6. **Interference and Signal Issues:**
   - RFID systems can be affected by interference from other electromagnetic sources, which may disrupt data transmission or cause misreads.
   - In areas with dense metal structures, water tanks, or other potential sources of interference, RFID performance may degrade, reducing system reliability.
7. **Scalability Issues:**
   - While the system can be deployed in small-scale projects, scaling up to larger cities or regions may present challenges related to infrastructure, sensor deployment, and data management.
   - Large-scale systems may require extensive resources, including more sophisticated data management platforms and higher bandwidth for data transmission.
8. **Limited Battery Life (for IoT Devices):**
   - Many IoT sensors and RFID devices rely on battery power, which could require frequent maintenance or replacement of batteries, especially in hard-to-reach areas.
   - Battery life may be reduced in extreme weather conditions or environments with high levels of interference, leading to increased operational costs and maintenance challenges.
9. **Resistance to Change:**
   - There may be resistance from consumers or water utility employees to adopt new technologies, especially in areas where traditional water distribution methods are well established.

Appendix A : Code

```
#include <WiFi.h>
#include <HTTPClient.h>

// Wi-Fi credentials
const char* ssid = "iot";
const char* password = "12121212";

// Google Apps Script URL
const String scriptURL = "https://script.google.com/macros/s/AKfycbz-
Qo7vfp8o3QrwXH1VEpFygw7TimGPEsyE8HhBr1gWILei9dLmQ0P1py1uKm7Lwa6L/exec"
;


#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <HardwareSerial.h>
#include <rdm6300.h>

// Initialize LCD (adjust address if needed)
LiquidCrystal_I2C lcd(0x27, 16, 2);

// RFID Reader (using rdm6300)
#define RDM6300_RX_PIN 4  //
Rdm6300 rdm6300;

// Relay pin
#define RELAY_PIN 19 // main tank
#define reserveMotor 5
#define buzzer 18

bool isWatering = false;
String authorizedRFIDs[] = { "7637594", "7384063", "7626393" };  // List of authorized RFID
tag UIDs
unsigned long wateringStartTime = 0;                    // Stores the start time of watering
unsigned long wateringDuration = 0;                     // Stores the duration of the last watering
session

int card1 = 230;
int card2 = 450;
int card3 = 560;

String scannedRFID;

#define maintank 25     // Main tank sensor pin
#define reservetank 33  // Reserve tank sensor pin

void setup() {
  // Initialize Serial
  Serial.begin(115200);

  // Configure pins as input with pull-up resistors
```

```
  pinMode(maintank, INPUT_PULLUP);
  pinMode(reservetank, INPUT_PULLUP);



  // Initialize LCD
  lcd.begin();
  lcd.backlight();
  lcd.setCursor(0, 0);
  lcd.print("Connecting WiFi");

  // Initialize relay
  pinMode(RELAY_PIN, OUTPUT);
  pinMode(reserveMotor, OUTPUT);
  digitalWrite(RELAY_PIN, HIGH);  // Relay OFF initially
  digitalWrite(reserveMotor, HIGH);
  pinMode(buzzer, OUTPUT);
  digitalWrite(buzzer, LOW);  // Relay OFF initially

  // Initialize rdm6300 RFID reader
  rdm6300.begin(RDM6300_RX_PIN);
  Serial.println("\nPlace RFID tag near the reader...");

  WiFi.begin(ssid, password);

  Serial.print("Connecting to Wi-Fi");
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("\nConnected to Wi-Fi!");

    // Create a task to run the logic on Core 1
  xTaskCreatePinnedToCore(
    sensorTask,    // Function to implement the task
    "Sensor Task", // Name of the task
    2048,          // Stack size in words
    NULL,          // Task input parameter
    1,             // Priority of the task
    NULL,          // Task handle
    1              // Core where the task should run (0 or 1)
  );


  // Initialize LCD
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Water Dispenser");
  lcd.setCursor(0, 1);
  lcd.print("Scan Your Card !");
}
```

```
bool checkStableState(int pin, int expectedState, int checks = 5, int delayBetweenChecks = 50)
{
  for (int i = 0; i < checks; i++) {
    if (digitalRead(pin) != expectedState) {
      return false; // State is not stable
    }
    delay(delayBetweenChecks); // Wait before next check
  }
  return true; // State is stable
}

void sensorTask(void *parameter) {
  while (true) {
    // Read sensor states
    int mainTankState = digitalRead(maintank);        // Initial read for main tank
    int reserveTankState = digitalRead(reservetank); // Initial read for reserve tank

    // Print sensor states
    Serial.print("Main Tank State: ");
    Serial.println(mainTankState);

    Serial.print("Reserve Tank State: ");
    Serial.println(reserveTankState);

    // Check stability for reserve tank
    if (reserveTankState == HIGH) {
      if (checkStableState(reservetank, HIGH)) {
        digitalWrite(reserveMotor, HIGH);
        Serial.println("Motor OFF.");
      } else {
        Serial.println("Reserve tank state unstable. Skipping action.");
      }
    }

    // Check stability for main tank
    if (mainTankState == HIGH) {
      if (checkStableState(maintank, HIGH)) {
        if (reserveTankState != HIGH && checkStableState(reservetank, LOW)) {
          digitalWrite(buzzer, HIGH);
          delay(100);
          digitalWrite(buzzer, LOW);
          Serial.println("Motor ON.");
          digitalWrite(reserveMotor, LOW);
        } else {
          Serial.println("Both tanks are HIGH or Reserve tank state unstable. Motor OFF.");
        }
      } else {
        Serial.println("Main tank state unstable. Skipping action.");
      }
    } else {
      Serial.println("Main tank is not HIGH. No action taken.");
    }
```

```
    delay(1000); // Delay before the next iteration
  }
}

void loop() {


  // Check for RFID data using rdm6300
  if (rdm6300.get_new_tag_id()) {
    scannedRFID = String(rdm6300.get_tag_id(), DEC);
    Serial.println("RFID Scanned: " + scannedRFID);
    lcd.clear();

    if (isAuthorized(scannedRFID)) {
      startWatering();
    } else {
      lcd.print("Unauthorized");
      delay(2000);

      // Reset LCD
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Water Dispenser");
      lcd.setCursor(0, 1);
      lcd.print("Scan Your Card !");
    }
  }

  // Update live watering time if watering
  if (isWatering) {
    updateLiveTime();
  }

  // Stop watering if tag is removed
  if (isWatering && !rdm6300.get_tag_id()) {
    stopWatering();
  }
}

// Function to check if the RFID tag is authorized
bool isAuthorized(String tag) {
  for (String authorized : authorizedRFIDs) {
    if (tag == authorized) {
      return true;
    }
  }
  return false;
}

void startWatering() {
  digitalWrite(buzzer, HIGH);
  delay(100);
  digitalWrite(buzzer, LOW);
```

```
  if (!isWatering) {
    isWatering = true;
    digitalWrite(RELAY_PIN, LOW);  // Turn ON relay
    wateringStartTime = millis();  // Record start time
    lcd.clear();
    lcd.print("Dispensing Water");
    Serial.println("Watering started.");
  }
}


// Modify stopWatering to include HTTP request
void stopWatering() {
  digitalWrite(buzzer, HIGH);
  delay(100);
  digitalWrite(buzzer, LOW);
  if (isWatering) {
    isWatering = false;
    digitalWrite(RELAY_PIN, HIGH);                    // Turn OFF relay
    wateringDuration = (millis() - wateringStartTime) / 1000;  // Calculate duration in seconds

    int bill = wateringDuration * 3;  // Bill based on duration
    int balance;

    // Determine balance based on scanned RFID
    if (scannedRFID == "7637594") {
      balance = card1 -= bill;
    } else if (scannedRFID == "7384063") {
      balance = card2 -= bill;
    } else if (scannedRFID == "7626393") {
      balance = card3 -= bill;
    } else {
      Serial.println("Unknown card. Cannot send data.");
      return;  // Exit if unknown card
    }

    // Send data to Google Apps Script
    if (WiFi.status() == WL_CONNECTED) {
      HTTPClient http;
      String url = scriptURL + "?cardnumber=" + scannedRFID + "&second=" +
wateringDuration + "&bill=" + bill + "&balance=" + balance;

      http.begin(url);                  // Initialize HTTP connection
      int httpResponseCode = http.GET();  // Send GET request

      if (httpResponseCode > 0) {
        String response = http.getString();
        Serial.println("HTTP Response: " + response);
      } else {
        Serial.println("Error on HTTP request: " + String(httpResponseCode));
      }
      http.end();  // Close connection
    } else {
```

```
    Serial.println("Wi-Fi not connected.");
   }

   // Display billing information
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Your Bill: ");
   lcd.print(bill);
   lcd.print("tk");
   lcd.setCursor(0, 1);
   lcd.print("Balance: ");
   lcd.print(balance);
   lcd.print("tk");

   delay(2000);

   // Reset LCD
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Water Dispenser");
   lcd.setCursor(0, 1);
   lcd.print("Scan Your Card !");
  }
}



// Function to update live watering time on LCD
void updateLiveTime() {
  unsigned long elapsedTime = (millis() - wateringStartTime) / 1000;  // Calculate elapsed time
in seconds
  lcd.setCursor(0, 1);                                  // Move cursor to the second row
  lcd.print(" ");
  lcd.print(elapsedTime);
  lcd.print("s ");
  lcd.print("Bill: ");
  lcd.print(elapsedTime * 3);
  lcd.print("tk");
}
```

Java Scrip:

```
function doGet(e) {
Logger.log(JSON.stringify(e) );
var result = 'Ok';
if (e.parameter == 'undefined') {
result = 'No Parameters';
  }
else {
var sheet_id = '1LiytU_cb4E9u16udiVy3u6wWyM8e-hi8m3QyAKfp7eA';          //
Spreadsheet ID
```

```
var sheet = SpreadsheetApp.openById(sheet_id).getActiveSheet();
var newRow = sheet.getLastRow() + 1;
var rowData = [];
var Curr_Date = new Date();
rowData[0] = Curr_Date; // Date in column A
var Curr_Time = Utilities.formatDate(Curr_Date, "Asia/Dhaka", 'HH:mm:ss');
rowData[1] = Curr_Time; // Time in column B
for (var param in e.parameter) {
Logger.log('In for loop, param=' + param);
var value = stripQuotes(e.parameter[param]);
Logger.log(param + ':' + e.parameter[param]);
switch (param) {
case 'voltage':
rowData[2] = value; // voltage in column C
result = 'voltage Written on column C';
break;
case 'current':
rowData[3] = value; // current in column D
result += ' ,current Written on column D';
break;
case 'power':
rowData[4] = value; // power in column C
result += 'power Written on column D';
break;
case 'units':
rowData[5] = value; // units in column C
result += 'units Written on column E';
break;
default:
result = "unsupported parameter";

     }
   }
Logger.log(JSON.stringify(rowData));
var newRange = sheet.getRange(newRow, 1, 1, rowData.length);
newRange.setValues([rowData]);
  }
return ContentService.createTextOutput(result);
}
function stripQuotes( value ) {
return value.replace(/^["']|["']$/g, "");
}
```

Appendix B: Reference

1. "Internet of Things: Architecture and Applications" by Rajkumar Buyya, Satish Narayana Srirama
2. "Smart Water Networks: Big Data Analytics and IoT Applications" by Konstantinos M. K. and Panagiotis D. T.
3. "Practical Internet of Things with JavaScript: Build exciting IoT projects using JavaScript and Node.js" by Darran R. McNally
4. "RFID Handbook: Fundamentals and Applications in Contactless Smart Cards, Radio Frequency Identification and Near-Field Communication" by Klaus Finkenzeller
5. "Water Distribution Systems Handbook" by Larry W. Mays
6. "Smart Water Grids: A Comprehensive Overview" by George S. M. L. and M. A. Z.
7. "Designing the Internet of Things" by Adrian McEwen and Hakim Cassimally
8. "Water Quality Monitoring and Treatment" by D. A. Y. and J. M. K.
9. "Sustainable Water Management" by R. K. D. and S. K. J.

Project Outlook

