ABSTRACT

Water is a precious resource that want to be stored effectively. Effective water usage demands computerized home water supply management in a culture where water tanks, motors and pumps are ubiquitous. Water management is crucial for the government and the citizens in countries like Saudi Arabia. The issue is providing a constant, high-quality, low-cost water supply. This study introduces a smart water management (IoT-SWM) system that may be used in structures that do not have access to a constant water supply but instead have water stored in enormous tanks underneath.

The ESP32 module collects water use data from each home in a community and transmits it to the cloud, where it is analysed. A smart water grid is a hybrid application that uses an inspection mode to identify leaks and measure the resulting height differences to keep track of the tank's water level. The system automatically deactivates the affected section after detecting any water shortage or malfunction in the system mechanism, such as broken valves, pumps, or pipes. It sends an emergency signal to building managers. And the system also ensures the level of tank indication to the user

It monitors essential water quality elements regularly, and if they fall below acceptable levels, it sends warning signals to the building management, who can take action. Over an extended period, the system monitored and recorded all water quality metrics. The system restarts when the water pump has been reconnected and sends an emergency alert. As a result, the suggested system has been an excellent replacement for Saudi Arabia's mechanically operated system.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE NO.
	ABSTRACT	III
	TABLE OF CONTENTS	IV
	LIST OF FIGURES	VI
	LIST OF TABLES	VI
1.	**INTRODUCTION**	**1**
	1.1 Introduction	1
	1.2 Overview of Smart Water Management System	1
	1.3 Organisation of chapters	1
2.	**LITERATURE REVIEW**	**4**
	2.1 Introduction	4
	2.2 Smart Water Management System	4
	2.3 Conclusion	5
3.	**SYSTEM DESIGN**	**6**
	3.1 Introduction	6
	3.2 Components Used	6
	3.3 Conclusion	9
4.	**DESIGN CALCULATION**	**10**
	4.1 Introduction	10
	4.2 Electrical Circuit Diagram	11

	4.3 Calculation	11
	4.4 Conclusion	13
5.	**SYSTEM ARCHITECTURE**	**14**
	5.1 Introduction	14
	5.2 Architecture Diagram	14
	5.3 Conclusion	15
6.	**COMPONENT SPECIFICATIONS**	**16**
	6.1 Introduction	16
	6.2 ESP32 NodeMCU	16
	6.3 Ultra Sonic Sensor	17
	6.4 12V DC Relay	18
	6.5 YF-S201 Water Flow Sensor	19
	6.6 Conclusion	36
7.	**PROGRAMMING**	**37**
	7.1 Introduction	37
	7.2 ESP32 Programming	37
	7.3 Program	38
	7.4 Conclusion	40
8.	**COST OF THE PROJECT**	**41**
	8.1 Cost Table	41
	8.2 Conclusion	41

9.	**CONCLUSION**	**42**
	9.1 Introduction	42
	9.2 Advantages	42
	9.3 Disadvantages	43
	9.4 Application	44
	9.5 Conclusion	44
10.	**REFERENCE**	**45**

LIST OF TABLES

CHAPTER	**TITLE**	**PAGE NO**
1.1	ORGANISATION OF CHAPTERS	3
6.1	ESP32 NODEMCU	15
6.2	12V DC REALY SPECIFICATIONS	17
8.2	COST TABLE	30

LIST OF FIGURES

CHAPTER	TITLE	PAGE NO
3.1	Image of esp32 Microcontroller in Node MCU	6
3.2	ULTRASONIC SENSOR	7
3.3	12V DC RELAY	8
4.1	CIRCUIT DIAGRAM	10
5.1	ARCHITECTURE LAYOUT MODEL	13
6.1	Ultrasonic Sensor Specification	16
6.2	Water Flow Sensor	18
6.3	12V DC Solenoid Valve	19

CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION

Smart Water Management Systems is one of the essential elements in the universe is water. Nowadays, consumers continuously seek methods to simplify their lives. Monitoring water quality is critical to ensuring the planet's health and long-term viability. Water is the source of many infectious illnesses, and garbage thrown by residents and environmental disasters from industrial enterprises pollute most of the nearby freshwater supplies in SA. Drinking water can be stored in an overhead tank. The principal causes of water quality deterioration in residential buildings are the development of microbes in overhead tanks and distribution networks, corrosion of pipe material, and the non-replacement of existing pipes. To avoid catastrophic health implications, it is necessary to continuously and remotely check the quality parameters of the water system in real-time

1.2 Overview of Smart Water Management System:

Smart water management is a way to collect, share and Analyze data from water equipment and water networks. It is used by water managers to find leaks, lower energy use, predict equipment failure, and ensure regulatory compliance. Smart water management involves connecting intelligent equipment, smart networks and digital solutions. These three components enable water utilities to find out exactly what is happening in their systems. They also enable utilities to shift resources from expensive emergency interventions – such as infrastructure repairs, water quality alerts, or flood management – to data-driven, preventative maintenance

1.3 ORGANISATION OF CHAPTERS

1. **Introduction:** The concept of smart Water Management System using IOT is explained here.
2. **Literature Review:** Research on various journal is made to know different technologies implemented in designing smart Water Management System.

3. **System Design:** In this chapter the existing system design is illustrated along with all the ways in which the existing system can be auto adaptive, and the system proposed.

4.**Design Calculation:** Here the selection of components has been made according to the calculation values and verified.

5.Bill of Materials and Design: In this chapter all drawings of the material with parts and sub-assemblies along with bill of materials are listed.

6.Cost Estimation: The overall cost estimation is made including all factors like purchase of required items, etc.

7.Conclusion: This chapter wraps all the benefits of the machine being manufactured.

TABLE 1.3 ORGANISATION OF CHAPTERS

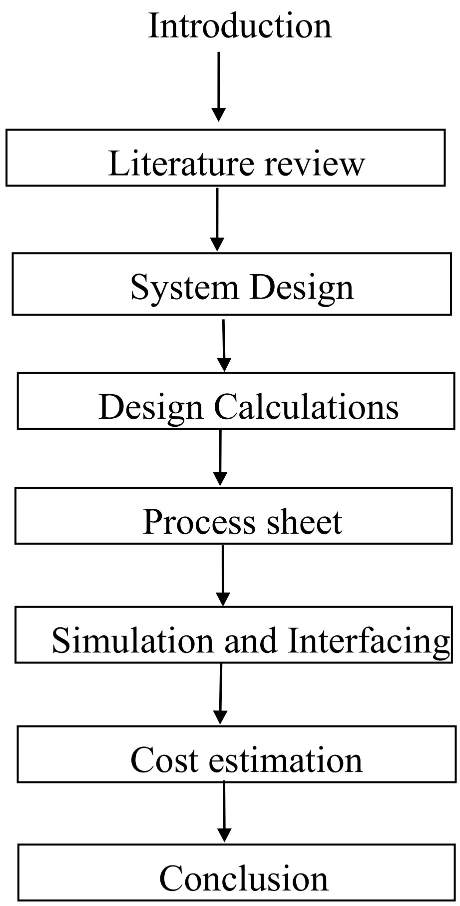


Table 1.1 ORGANISATION OF CHAPTERS

CHAPTER -2

LITERATURE REVIEW

2.1 INTRODUCTION

Before starting the project, it is important to research the existing technologies regarding our project. This will help us to understand any existing problems and try to find solutions for these problems in such a way that it can be implemented in our project. Going through the literature also helps us to understand the working and functions of the mechanisms and the other components takes part in our project.

2.2 SMART WATER MANAGEMENT SYSTEM

- 1.Steffelbauer, D.B.; Blokker, E.J.M.; Buchberger, S.G.; Knobbe, A.; Abraham, E. "Dynamic Time Warping Clustering to Discover Socioeconomic Characteristics in Smart Water Meter Data". J. Water Resourse. Plan. Manag. 2021, 147, 04021026.

- 2. Koo, K.-M.; Han, K.-H.; Jun, K.-S.; Lee, G.; Yum, K.-T. "Smart Water Grid Research Group Project": An Introduction to the Smart Water Grid Living-Lab Demonstrative Operation in YeongJong Island, Korea. Sustainability 2021, 13, 5325.

- 3. Di Mauro, A.; Cominola, A.; Castelletti, A.; Di Nardo, A. "Urban Water Consumption at Multiple Spatial and Temporal Scales". A Review of Existing Datasets. Water 2021, 13, 36.

- 4. Ewing, G.; Demir, I. An ethical decision-making framework with serious gaming: "A smart water case study on flooding". J. Hydroinformatics 2021, 23, 466–482.

- 5. Ghadami, N.; Gheibi, M.; Kian, Z.; Faramarz, M.G.; Naghedi, R.; Eftekhari, M.; Fathollahi-Fard, A.M.; Dulebenets, M.A.; Tian, G. "Implementation of solar energy in smart cities using an integration of

artificial neural network”, photovoltaic system and classical Delphi methods. Sustain. Cities Soc. 2021, 74, 103149.

- 6. Pimenta, N.; Chaves, P. “Study and design of a retrofitted smart water meter solution with energy harvesting integration”. Discov. Internet Things 2021, 1, 1–15.
- 7. Howell, S.; Beach, T.; Rezgui, Y. “Robust requirements gathering for ontologies in smart water systems”. Requir. Eng. 2020, 26, 97–114.
- 8. Alkatheiri, M.S.; Chauhdary, S.H.; Alqarni, M.A. “Seamless security apprise method for improving the reliability of sustainable energy-based smart home applications. Sustain”. Energy Technol. Assess. 2021, 45, 101219.
- 9. Jan, F.; Min-Allah, N.; Dü¸stegör, D. “IoT Based Smart Water Quality Monitoring: Recent Techniques, Trends and Challenges for Domestic Applications”. Water 2021, 13, 1729.
- 10. Iqbal, M. “Smart City in Practice: Learn from Taipei City”. J. Gov. Public Policy 2021, 8, 50–59.

2.3 CONCLUSION

Thus, Smart water management systems optimize water usage using advanced technologies. They reduce wastage, detect leaks, and provide decision-making insights. They're crucial for sustainable development and responsible water management.

CHAPTER-3

SYSTEM DESIGN

3.1 INTRODUCTION

The smart water management system uses an ultrasonic sensor for data collection, a solenoid valve for water flow control, and an ESP32 microcontroller for data processing. It also includes AI for data analysis and user interfaces for monitoring. These components ensure efficient and sustainable water management.

3.2 COMPONENTS USED

ESP32 Microcontroller:

- At the heart of our smart energy meter system lies the ESP32 microcontroller. Renowned for its versatility and robust performance, the ESP32 serves as the central processing unit responsible for orchestrating the various functionalities of the meter.
- With built-in Wi-Fi and Bluetooth capabilities, the ESP32 facilitates seamless connectivity to the internet and other devices, enabling remote data transmission and control.
- Its low power consumption and ample processing power make it an ideal choice for IoT applications, ensuring efficient operation and long-term reliability.

Fig 3.1 Image of esp32 Microcontroller in NodeMCU

Ultra Sonic Sensors:

The ultrasonic sensor is a key component in a smart water management system. It uses sound waves to measure distance, which can be used to monitor water levels in real-time. Here are three detailed points about its role:

- Real-time Data Collection: The sensor measures the water level in a tank or reservoir by emitting sound waves and calculating the time it takes for the echo to return.

- Leak Detection: Any discrepancies in the expected and actual water levels can indicate a leak, enabling early detection and prevention of water wastage.

Fig 3.2Ultra Sonic Sensor

12V DC Relay:

- The 12V relay is a crucial component in a smart water management system. Here are three key points about its role:
- Switching Mechanism: The 12V relay serves as a switching mechanism that controls the power supply to other components, such as the solenoid valve1. It can turn these components on or off based on the signals it receives.
- Voltage Compatibility: The relay operates at 12V, making it compatible with many other components and power supplies used in the system2.

- Control of Water Flow: In conjunction with the solenoid valve, the relay plays a critical role in controlling the water flow. When the relay is activated, it opens the solenoid valve, allowing water to flow through. When the relay is deactivated, it closes the solenoid valve, stopping the water flow1.

Fig 3.3 12V DC Relay

Blynk IoT Platform:

- Facilitating seamless integration and remote-control capabilities, the Blynk IoT platform serves as the backbone of our smart energy meter system.
- With its intuitive interface and customizable widgets, Blynk enables users to visualize energy consumption data in real-time, set alerts for abnormal usage patterns, and remotely control connected devices for optimal energy management.
- By leveraging Blynk's cloud-based infrastructure, our smart energy meter system gains scalability, flexibility, and accessibility, empowering users to monitor and manage their energy usage from anywhere, at any time.

3.3 CONCLUSION

The water sector has been grappling with creating an efficient and long-lasting water system. It is included in the IoT-SWM. People intend to broadcast more data to the cloud and analyze it further to construct some algorithm to determine the tank’s lifespan and the proper aspects of leaking. Procedures and actions are determined depending on the threshold, capital cost, and the accessibility of equipment and materials. Even though statistically minimal water savings can be achieved using in-line flow restrictors, they can be much more cost-effective than water-efficient taps in certain situations. If they have been installed as part of normal maintenance visits, the expenses would be lower. They are a lowcost alternative to outdated toilets and are unlikely to save a lot of water. When it the time comes to renovate restrooms, installing water-saving toilets should be considered. To better understand the workings of a crisis-stricken metropolis, this urban crisis feedback analysis tool should be used. With this approach, municipal stakeholders affected by a natural disaster can better plan for a future occurrence of a comparable hazard. We have compiled a list of the most important features of advanced water management systems. There are still barriers to real-time measurement that need minimal energy use. With this in mind, we propose as future work an IoT-based design for a smart water management system that takes into Account all of these crucial characteristics and makes use of IoT-based predictions to boost the smart management system's efficacy. As a bonus, future research can use the Internet of Things coverage factor while calculating measurement uncertainty. The authors offer recommendations for the next steps and research groups to join to improve IoT security, lessen the impact of organisms, implement AI/ML approaches, and reduce the entire system's cost. The numerical outcome of the proposed method increases the stormwater quality (98.7%), the efficiency ratio (95.1%), water demand ratio (93.6%), the leakage detection ratio (97.5%), and non-revenue water ratio (98.4%).

CHAPTER-4

DESIGN CALCULATIONS

4.1 INTRODUCTION

This chapter will include the electrical design calculation required for design and component selection for smart energy meter

4.2 ELECTRICAL CIRCUIT DESIGN

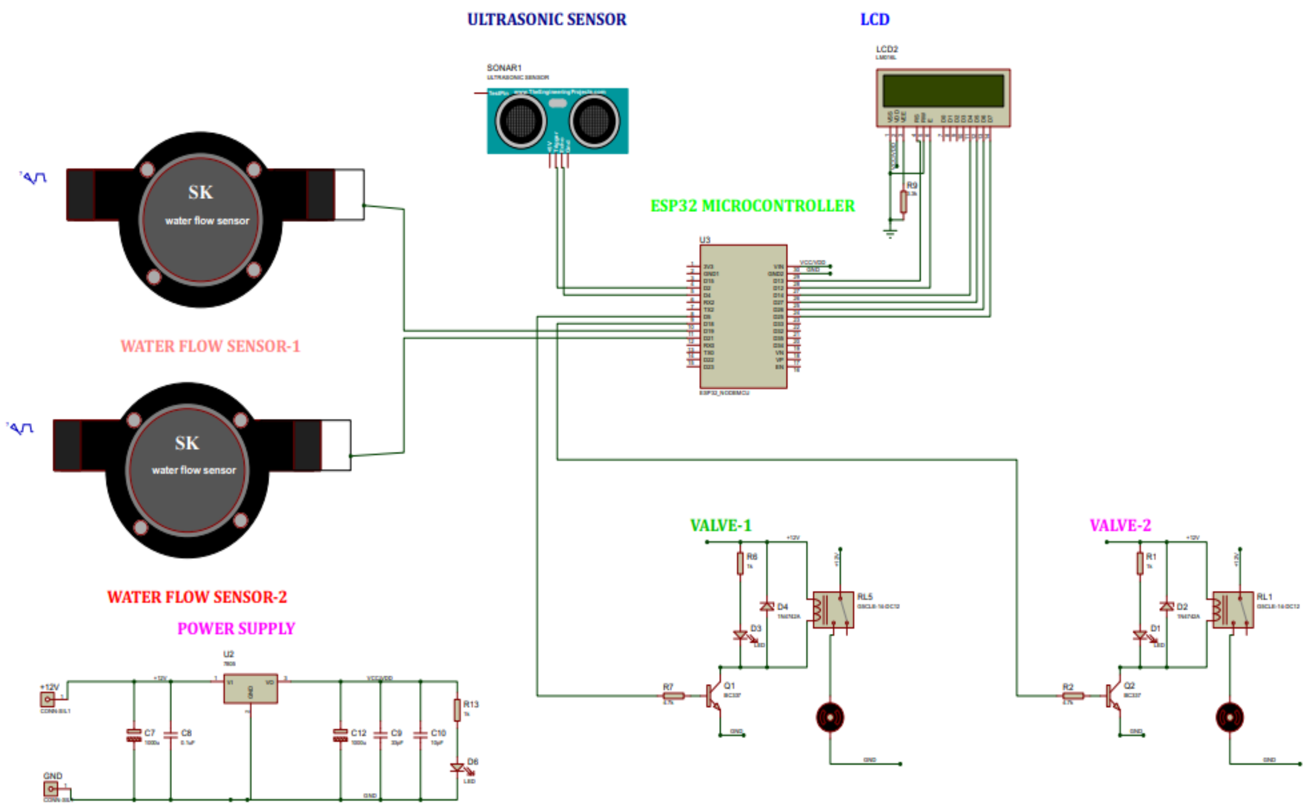


Fig 4.1 CIRCUIT DIAGRAM

4.3 DESIGN CALCULATIONS

Water Pump

Pmech = Q H ρ g / c

To Find

H – High water nuds to be lifted = 1m

ρ = Density of water= 1000 kg/m^3

g = acceleration due to gravity = 9.81 m/S^2

η = 0.75 Power = 0.5 Hp motor 1Hp = 0.7457 kw

Q = Pmech * η / ρ.g.H

= 0.5 X 0.745 X 0.75 / 1000 X 9.81 X 1

= 0.27928 / 9810

= 2.85X10^-5 m^3/S

Volume of water used (or) Intake

V = Q*t

t = 4 mins = 4*60 = 240 sec

Q = 2.85*10^-5 m^3 / S

V = 2.85*10^-5 * 240 = 0.00684 m^3

1 cubic meter = 1000 lit

Vlit = V * 1000 = 0.00684 * 1000

V = 6.84 litres

Under Surveillance

Flow rate $Q = A * V$

A = area of the pipe , V = velocity

Venturi meter calculation :

$P1 + 1/2 * \rho V1^2 = P2 + 1/2 * \rho V2^2$

Rearranging equation :

$P1 - P2 + 1/2 \rho V1^2 = 1/2 \rho V2^2$

$2(P1-P2) = \rho V2^2 - \rho V1^2$

$V2^2 - V1^2 = 2 (P1 - P2) / \rho$

$V = \sqrt{} [2 (P1 - P2) / \rho]$

$= \sqrt{} [(2/1000) * (200 - 150)*10^3]$

$= \sqrt{} 100V = 10$ m/S

$Q = A*V$

$A = \pi d^2 / 4$

$= \pi (0.1)^2 / 4$

$A = 7.85*10^{-3}$ m^2

$Q = 7.85*10^{-3} * 10$

$= 0.0785$ m^3/S

$V = Q.t$

V = volume , Q = flow , t = time

$V = 0.0785 * 10 * 60$

$= 0.0785 * 600$

$V = 47.124$ m^3

CHAPTER-5

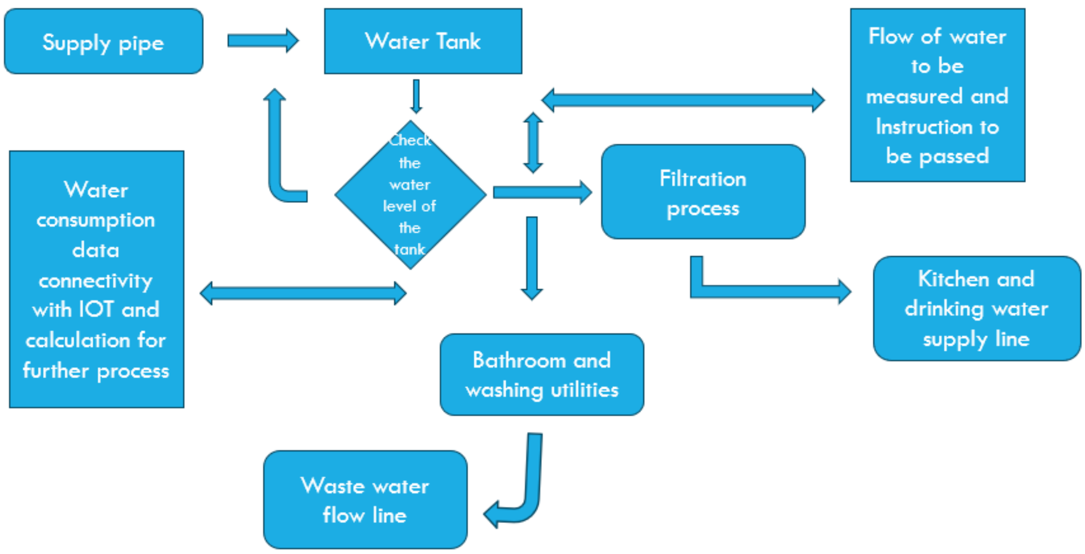
SYSTEM ARCHITECTURE

5.1 INTRODUCTION

This chapter consists of the complete system architecture. The system architecture shows the layout of the unit and the communication cables used for the interconnection of various parts of the system.

5.2 ARCHITECTURE - LAYOUT MODEL

Fig 5.1 ARCHITECTURE LAYOUT MODEL



5.3 CONCLUSION

In conclusion, the smart energy meter system architecture presents a comprehensive and efficient solution for monitoring, managing, and optimizing energy consumption. By integrating components such as the ESP32 microcontroller, SCT-103 current sensor, and ZMPT101B voltage sensor, along with the utilization of platforms like Blynk for IoT connectivity, the architecture enables real-time data collection, analysis, and visualization. This architecture offers several advantages, including accurate measurement of electrical parameters, seamless connectivity for remote monitoring and control, and user-friendly interfaces for data visualization and management.

By leveraging IoT technology, the system enhances energy efficiency, reduces wastage, and empowers users to make informed decisions about their energy consumption patterns. Furthermore, the scalability and flexibility of the architecture allow for future expansions and enhancements to meet evolving needs and requirements. Whether deployed in residential, commercial, or industrial settings, the smart energy meter system architecture holds the potential to revolutionize energy management practices, paving the way towards a more sustainable and environmentally friendly future.

CHAPTER-6

COMPONENTS SPECIFICATION

6.1 Introduction

In the realm of smart energy meter systems, the effectiveness and efficiency depend significantly on the specifications of its core components. Each component plays a crucial role in ensuring accurate measurement, seamless connectivity, and user-friendly operation. Let's delve into the key specifications of some essential components such as the ESP32 microcontroller, Ultra Sonic sensor, and 12V DC Relay.

6.2 ESP32 NODEMCU

Categories	Items	Specifications
Certification	RF certification	FCC/CE/IC/KCC/SRRC/NCC/TELEC
Wi-Fi	Protocols	802.11 b/g/n (802.11n up to 150 Mbps)
		A-MPDU and A-MSDU aggregation and 0.4 μs guard interval support
	Frequency range	2.4 ~ 2.5 GHz
Bluetooth	Protocols	Bluetooth v4.2 BR/EDR and BLE specification
	Radio	NZIF receiver with –97 dBm sensitivity
		Class-1, class-2 and class-3 transmitter
		AFH
	Audio	CVSD and SBC
Hardware	Module interfaces	SD card, UART, SPI, SDIO, I^2C, LED PWM, Motor PWM, I^2S, IR, pulse counter, GPIO, capacitive touch sensor, ADC, DAC
	On-chip sensor	Hall sensor
	Integrated crystal	40 MHz crystal
	Integrated SPI flash	4 MB
	Operating voltage/Power supply	2.7 ~ 3.6V
	Minimum current delivered by power supply	500 mA
	Operating temperature range	–40°C ~ +85°C
	Package size	(18±0.2) mm x (25.5±0.2) mm x (3.1±0.15) mm

Table 6.1 ESP32 NODE MCU FEATURES

6.3 ULTRA SONIC SENSOR

This performance of the ultrasonic sensor distance measuring module is stable, measure the distance accurately. The module is with High precision, blind spots (3cm) super close. This module provides a full set of ranging process.

Parameter	Specification
Working Voltage(DC)	5 V
Working Current	15 mA
Working Frequency	40 Hz
Max Range	4 m
Min Range	2 cm
Measuring Angle	15^0
Trigger Input Signal	10 uS TTL pulse
Echo Output Signal Input	TTL lever signal

Fig 6.1 Ultra Sonic Sensor specification

Features

- Working voltage : 5V(DC)
- Static current: Less than 2mA.
- Output signal: Electric frequency signal, high level 5V, low level 0V.
- Sensor angle: Not more than 15 degrees.
- Detection distance: 2cm~450cm.
- High precision: Up to 3mm
- Mode of connection: VCC / trig(T) / echo(R) / GND

Working

- Adopt IO trigger through supplying at least 10us sequence of high level signal
- The module automatically send eight 40khz square wave and automatically detect whether receive the returning pulse signal

- If there is signals returning, through outputting high level and the time of high level continuing is the time of that from the ultrasonic transmitting to receiving

6.4 12V DC Relay

relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are double throw (changeover) switches. Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

Specifications

Item			Specifications
Contact data	Contact arrangement		2 Form A, 2 Form A 1 Form B (2a1b)
	Form A contact	Contact resistance (initial)	Max. 100 mΩ (by voltage drop 6 V DC 1 A), Max. 3 mΩ (by voltage drop 6 V DC 20 A, reference value)
		Contact material	$AgSnO_2$ type
	Form B contact*3	Contact resistance (initial)	Max. 100 mΩ (by voltage drop 6 V DC 1 A)
		Contact material	Au flashed AgNi type
	Form A contact	Contact rating (resistive)	35 A 277 V AC
		Max. switching power (resistive)	9,695 VA
		Max. switching voltage	480 V AC, 110 V DC
		Max. switching current	35 A
		Min. switching load (reference value)*1	100 mA 5 V DC
	Form B contact*3	Contact rating (resistive)	1 A 277 V AC, 1 A 30 V DC
		Max. switching power (resistive)	277 VA
		Max. switching voltage	277 V AC, 30 V DC
		Max. switching current	1 A
		Min. switching load (reference value)*1	10 mA 5 V DC

Table 6.2 12V DC RELAY SPECIFICATION

6.5 YF-S201 Water Flow Sensor

Fig 6.2 Water Flow Sensor

Measure liquid/water flow for your solar, water conservation systems, storage tanks, water recycling home applications, irrigation systems and much more. The sensors are solidly constructed and provide a digital pulse each time an amount of water passes through the pip. The output can easily be connected to a microcontroller for monitoring water usage and calculating the amount of water remaining in a tank etc.

Features:

- Model: YF-S201
- Working Voltage: 5 to 18V DC (min tested working voltage 4.5V)
- Max current draw: 15mA @ 5V
- Output Type: 5V TTL
- Working Flow Rate: 1 to 30 Liters/Minute
- Working Temperature range: -25 to +80?
- Working Humidity Range: 35%-80% RH
- Accuracy: ±10%
- Maximum water pressure: 2.0 MPa
- Output duty cycle: 50% +-10%
- Output rise time: 0.04us
- Output fall time: 0.18us

- Flow rate pulse characteristics: Frequency (Hz) = 7.5 * Flow rate (L/min)
- Pulses per Liter: 450
- Durability: minimum 300,000 cycles
- Cable length: 15cm
- 1/2" nominal pipe connections, 0.78" outer diameter, 1/2" of thread
- Size: 2.5" x 1.4" x 1.4"

6.6 SOLENOID VALVE

12V DC 1/2 inch Solenoid Water Air Valve Switch (Normally Closed) – controls the flow of fluid (liquid or air) and acts as a valve between high-pressure fluid! This liquid valve would make a great addition to your robotic gardening project. There are two ½” (Nominal NPT) outlets. Normally, the valve is closed. When a 12V DC supply is applied to the two terminals, the valve opens and water can push through.

The 12volt solenoid valves works with the solenoid coil which operates electronically with DC 12volt supply. As it is a normally closed assembly, it opens the flow of fluids as soon as it is powered ON and stops/blocks the flow when the supply voltage is removed.

Fig 6.3 12V DC Solenoid Valve

Features:

- Compact and convenient.
- Easily installed and serviced Precise and reliable.
- The installation direction can be arbitrary Angle
- Pressure-regulating valve (steady flow valve) function similar to the water flow switch Not only can it provide a steady flow, but it also prevents the dry burning.
- Suitable for fluids like water, oil, air

CHAPTER-7

PROGRAMMING

7.1 INTRODUCTION

Every controller must be programmed in a defined manner, in order to actuate the electrical and electronic components. The ESP32 microcontroller, the controller used in this project has been programmed in its Arduino IDE.

7.2 ESP32 PROGRAMMING

Programming the ESP32 involves writing code to control the ESP32 microcontroller, which is commonly done using the Arduino IDE or the ESP-IDF (Espress if IoT Development Framework). Here's an overview of the steps involved in programming the ESP32:

Setup Environment:

- The Arduino IDE from the official website or use other development platforms like PlatformIO.
- Install the ESP32 board package in the Arduino IDE by following the instructions provided by Espressif.

Writing Code:

- Open the Arduino IDE and create a new sketch.
- Start writing your code in the sketch. You can use functions provided by the ESP32 libraries to control GPIO pins, read analog inputs, manage Wi-Fi connections, etc.
- Make sure to include the necessary libraries using #include directives at the beginning of your sketch.

Uploading Code:

- Connect your ESP32 board to your computer using a USB cable. Select the appropriate board and port from the "Tools" menu in the Arduino IDE.

- Click on the "Upload" button to compile your code and upload it to the ESP32 board. Monitor the upload process in the Arduino IDE's console window for any errors or warnings.

Debugging and Testing:

- After uploading the code, open the serial monitor in the Arduino IDE to debug your program and monitor the output.
- Use print statements (Serial.print, Serial.println) to output debugging information to the serial monitor.
- Test your code thoroughly to ensure that it works as expected, making adjustments as needed.

Advanced Programming (Optional):

- For more advanced projects, you can use the ESP-IDF, which provides lower-level access to the ESP32's hardware and features.
- ESP-IDF programming involves writing C or C++ code using the ESP-IDF APIs and tools.
- This approach offers greater control and flexibility but requires a deeper understanding of the ESP32's hardware and software architecture.

Troubleshooting:

- If you encounter any issues during programming, refer to the official documentation, forums, or community resources for assistance.
- Common issues include incorrect board selection, driver problems, and syntax errors in the code.

7.3 PROGRAM

#define BLYNK_TEMPLATE_ID "TMPL3ZjbgCCEf"

#define BLYNK_TEMPLATE_NAME "Quickstart Template"

#define BLYNK_AUTH_TOKEN "_4xW9jHP5G6jbN1E2IuzDKtYJBEEqH96"

```
#define BLYNK_PRINT Serial
#include <WiFi.h>
#include <BlynkSimpleEsp32.h>
char auth[] = BLYNK_AUTH_TOKEN;
char ssid[] = "admin";           // wifi hotsopt username
char pass[] = "1234567890";      // wifi hotsopt password
#include <LiquidCrystal.h>
LiquidCrystal lcd(33,25,26,27,14,15);   // lcd pin connections
#define SENSOR1  19   //flow sensor 1
#define SENSOR2  21   //flow sensor 2
#define BUZZER   23
#define R1 5      //valve 1
#define R2 18     //valve 2
#define echoPin1 4  //ultrasonic sensor echo
#define trigPin1 2  //ultrasonic sensor trig
int x1,x2,sts;
int d,distance,duration;
long currentMillis1 = 0;
long previousMillis1 = 0;
```

```
int interval1 = 500;
float calibrationFactor1 = 4.5;
volatile byte pulseCount1;
byte pulse1Sec1 = 0;
float flowRate1;
unsigned int flowMilliLitres1;
unsigned long totalMilliLitres1;
long currentMillis2 = 0;
long previousMillis2 = 0;
int interval2 = 1000;
float calibrationFactor2 = 4.5;
volatile byte pulseCount2;
byte pulse1Sec2 = 0;
float flowRate2;
unsigned int flowMilliLitres2;
unsigned long totalMilliLitres2;
void IRAM_ATTR pulseCounter1()
{
  pulseCount1++;
}
void IRAM_ATTR pulseCounter2()
```

```
{
  pulseCount2++;
}

BLYNK_WRITE(V3)
{
x1 = param.asInt();
if(x1==1){Serial.println("valve-1 ON");digitalWrite(R1,HIGH);} // RIGHT
if(x1==0){Serial.println("valve-1 OFF");digitalWrite(R1,LOW);} // RIGHT
}
BLYNK_WRITE(V4)
{
x2 = param.asInt();
if(x2==1){Serial.println("valve-2 ON");digitalWrite(R2,HIGH);} // RIGHT
if(x2==0){Serial.println("valve-2 OFF");digitalWrite(R2,LOW);} // RIGHT
}

BLYNK_CONNECTED()
{
  Blynk.syncVirtual(V0);
  Blynk.syncVirtual(V1);
```

```
  Blynk.syncVirtual(V2);
  Blynk.syncVirtual(V3);
}
void setup()
{
  Serial.begin(9600);
  lcd.begin(16,2);
  Serial.println("Ready......");
  pinMode(SENSOR1, INPUT_PULLUP);
  pinMode(SENSOR2, INPUT_PULLUP);
  pinMode(BUZZER, OUTPUT);
  pinMode(R1, OUTPUT);
  pinMode(R2, OUTPUT);
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  digitalWrite(R1,LOW); digitalWrite(R2,LOW);
  pulseCount1 = 0;
  flowRate1 = 0.0;
  flowMilliLitres1 = 0;
  totalMilliLitres1 = 0;
  previousMillis1 = 0;
```

```
  pulseCount2 = 0;

  flowRate2 = 0.0;

  flowMilliLitres2 = 0;

  totalMilliLitres2 = 0;

  previousMillis2 = 0;


  attachInterrupt(digitalPinToInterrupt(SENSOR1),                pulseCounter1,
FALLING);

  attachInterrupt(digitalPinToInterrupt(SENSOR2),                pulseCounter2,
FALLING);

  lcd.setCursor(0,0);lcd.print(" WATER  LEAKAGE ");

  lcd.setCursor(0,1);lcd.print("     SYSTEM     ");

  delay(1500);

  lcd.clear();

  lcd.setCursor(0,0);lcd.print("CONNECTING  WIFI");

  Blynk.begin(auth, ssid, pass);

  digitalWrite(BUZZER,HIGH);

  lcd.setCursor(0,0);lcd.print("......DONE......");

  delay(1500);digitalWrite(BUZZER,LOW);

  lcd.clear();

lcd.clear();
```

```
}
void loop()
{
 Blynk.run();
  SonarSensor(trigPin1, echoPin1);
  d = distance;
  Serial.print("Distance:");Serial.println(d);
  currentMillis1 = millis();
  currentMillis2 = millis();
  if(currentMillis1 - previousMillis1 > interval1)
  {
  pulse1Sec1 = pulseCount1;
  pulseCount1 = 0;
  pulse1Sec2 = pulseCount2;
  pulseCount2 = 0;
  flowRate1=((1000.0/(millis()-previousMillis1))*pulse1Sec1)/calibrationFactor1;
  flowRate2=((1000.0/(millis()-previousMillis1))*pulse1Sec2)/calibrationFactor2;
  previousMillis1 = millis();
  lcd.setCursor(0,0);lcd.print("F1:");lcd.setCursor(3,0);lcd.print(flowRate1);
  lcd.setCursor(0,1);lcd.print("F2:");lcd.setCursor(3,1);lcd.print(flowRate2);
```

```
    }
    lcd.setCursor(9,0);lcd.print("LEV:");lcd.print(d);
    if(flowRate2>2){lcd.setCursor(9,1);lcd.print("LK:DET");}
    if(flowRate2<2){lcd.setCursor(9,1);lcd.print("LK:---");}
    Blynk.virtualWrite(V0, flowRate1);
    Blynk.virtualWrite(V1, flowRate2);
    Blynk.virtualWrite(V2, d);
    delay(500);
    lcd.clear();
}
void SonarSensor(int trigPin,int echoPin)
{
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
//distance = (duration/2) / 29.1;
distance = duration * 0.034;
}
```

CHAPTER-8

COST OF THE PROJECT

8.1 INTRODUCTION

This chapter lists the approximate cost of components used in the project.

8.2 COST TABLE

S.no	Component	Cost(rs)	Quantity	TOTAL COST
1	ESP 32 NODE MCU	460	1	460
2	Water Flow Sensor	750	2	1500
3	12V solenoid valve	280	2	560
4	AC pump	500	1	500
5	Ultrasonic sensor	60	1	60
6	LCD Display	160	1	160
7	Relay	35	2	70

8.3 CONCLUSION

The components were chosen after the research.The cost of the components were mentioned in this chapter.

CHAPTER-9

CONCLUSION

9.1 INTRODUCTION

This chapter talks about various positives of this project followed by shortcomings, advancements with future technology and its wide range of applications in the field of Smart Water Management System. This chapter helps us in determining the future scope and greater scalability in development of this project.

9.2 ADVANTAGES

- Real-Time Water Consumption Analysis: IoT water management systems use numerous sensors to collect real-time data on water usage. This data can be analyzed to understand consumption patterns and make necessary adjustments to ensure efficient use of water.

- Reduced Equipment Maintenance Expenses: IoT devices attached to various water management assets like storage tanks, pipes, pumps, and treatment plants enable constant monitoring and automation. This reduces the need for frequent manual checks and maintenance, leading to cost savings.

- Improved Efficiency: Smart water management systems enhance the efficiency of water supply systems by reducing costs and improving sustainability. They help in improving water quality, controlling leakage, scheduling appropriate maintenance in aqueducts, and reducing operative costs.

- Leak Detection: These systems can detect leaks early, preventing water wastage. They use strategically placed sensors that can identify changes in water pressure or listen for the sound of running water, indicating a potential leak.

- Water Quality Monitoring: Smart water management systems allow for continuous monitoring of water quality. They ensure a safe and clean water supply by analyzing various parameters like pH, turbidity, and temperature.

- Sustainability: These systems facilitate sustainability by providing valuable insights into water resources and associated equipment. They promote efficient water usage and sustainable practices.

- Resource Conservation: Smart water management systems help conserve water by ensuring its optimal use. They can identify areas of excessive water use and suggest measures to reduce wastage.

- Cost Savings: By reducing water wastage and optimizing water usage, smart water management systems can lead to significant cost savings in the long run. They also reduce maintenance expenses and improve the efficiency of water supply systems.

- Data Analysis: The data collected by these systems can be used for planning and decision-making. It can provide insights into consumption patterns, leakages, and the efficiency of various components of the water management system.

- Public Awareness: Smart water management systems can help create awareness about household water use. For instance, smart meters can provide real-time data on water consumption, helping households understand their water usage patterns and make necessary adjustments.

9.3 DISADVANTAGES

- Initial Cost: The initial installation cost of smart energy metering systems can be higher compared to traditional meters. This cost includes not only the hardware components but also the installation, setup, and integration with existing systems, which may deter some users from adopting the technology.
- Privacy and Security Concerns: Smart energy meters collect and transmit data about energy consumption, raising concerns about privacy and data security. Unauthorized access to this data could compromise user privacy or provide insights into occupants' behavior patterns. Ensuring robust encryption, authentication mechanisms, and data protection measures is crucial to mitigate these risks.
- Reliance on Internet Connectivity: Smart energy meters rely on internet connectivity to transmit data to monitoring systems or cloud platforms. Any disruptions in internet connectivity, such as outages or network congestion, may affect the real-time monitoring and management capabilities of the system.
- Compatibility and Interoperability Issues: Integrating smart energy metering systems with existing infrastructure and devices can be challenging due to compatibility and interoperability issues. Ensuring seamless integration with various communication protocols, standards, and legacy systems requires careful planning and coordination.
- Maintenance and Upkeep: Smart energy metering systems require regular maintenance to ensure proper functionality and accuracy. This includes firmware updates, calibration, and troubleshooting of hardware or software issues. Failure to maintain the system adequately may lead to inaccurate measurements or operational inefficiencies.
- Complexity and Technical Expertise: Implementing and managing smart energy metering systems may require specialized technical expertise, particularly in programming, networking, and data analysis. Users without the necessary skills or resources may find it challenging to set up and maintain the system effectively.
- Potential Health Concerns: Some individuals express concerns about the potential health effects of electromagnetic radiation emitted by wireless smart meters. While regulatory bodies and studies generally indicate that exposure levels are well below established safety limits, addressing public perceptions, and providing transparent information about safety measures is essential.

9.4 APPLICATIONS

Lack of Standardization: There are no globally accepted standards used by developers of IoT systems for water management. This leads to issues with the compatibility and integration of tools offered by different vendors. The lack of standardization among producers' water ICT equipment hinders proper monitoring and control systems, resulting in low efficiency in water distribution and consumption, system's maintenance and improvement, and failure identification.

Problems with Interoperability: This challenge is related to the lack of standardization1. Different manufacturers use different protocols to communicate with their smart water meters. This can make it difficult for engineers and building owners to collect data from all of the devices in their buildings or campuses, unless they are all of the same manufacturer. This can create a proprietary situation that further drives up the costs.

Limited Network Reach: Some smart water meters use mobile networks to transmit data. If your area has poor mobile signal reception, this data transfer may fail. When smart devices are installed in locations with a poor signal, such as basements, the system may not be able to ensure data exchange in real time.

High Installation Costs: The initial cost of installing these systems can be high3. This is a serious challenge in some regions, especially in developing countries where infrastructure development costs are disproportionately high. The meter installation itself, communication infrastructure, data management platforms, and training can all present increased costs for a utility's smart water management.

Limited Support: Smart water metering systems also have limited support5. Existing systems may depend on multiple pieces of hardware and software, much of which may not be compatible and allow for complete system integration. Facilities for communicating directly with AMR/AMI meters may be limited in both number and quality. So, it is not just a simple matter of installing meters and running them.

9.5 CONCLUSION

The completion of the smart water management system project marks a significant step towards sustainable and efficient water usage. It has successfully integrated technology to monitor, control, and optimize water resources, despite facing challenges such as high installation costs and interoperability issues. This project has paved the way for future advancements in water management, promising a more sustainable and water-efficient future.

REFERENCES

1. Lakshmanan, V.; Saele, H.; Degefa, M.Z. "Electric water heater flexibility potential and activation impact in system operator Perspective Norwegian" scenario case study. Energy 2021, 236, 121490.

2. Emrani-Rahaghi, P.; Hashemi-Dezaki, H. "Optimal Scenario-based Operation and Scheduling of Residential Energy Hubs Including Plug-in Hybrid Electric Vehicle and Heat Storage System Considering the Uncertainties of Electricity Price and Renewable Distributed Generations". J. Energy Storage 2020, 33, 102038.

3. Heidari, A.; Olsen, N.; Mermod, P.; Alahi, A.; Khovalyg, D. "Adaptive hot water production based on Supervised Learning". Sustain. Cities Soc. 2020, 66, 102625.

4. Melville-Shreeve, P.; Cotterill, S.; Butler, D. "Capturing high-resolution water demand data in commercial buildings". J. Hydroinformatics 2021, 23, 402–416.

5. Uddin, M.J.; Jeong, Y.K. "Urban river pollution in Bangladesh during last 40 years: Potential public health and ecological risk, present policy, and future prospects toward smart water management". Heliyon 2021, 7, e06107.

6. Oberascher, M.; Kinzel, C.; Kastlunger, U.; Kleidorfer, M.; Zingerle, C.; Rauch, W.; Sitzenfrei, R. "Integrated urban water management with micro storages developed as an IoT-based solution–the smart rain barrel". Environ. Model. Softw. 2021, 139,105028.

7. Fuentes, H.; Mauricio, D. “Smart water consumption measurement system for houses using IoT and cloud computing”. Environ. Monit. Assess. 2020, 192, 1–16.

8. Alshehri, M.; Bhardwaj, A.; Kumar, M.; Mishra, S.; Gyani, J. “Cloud and IoT based smart architecture for desalination water Treatment”. Environ. Res. 2021, 195, 110812.

9. Praba, M.B.; Rengaswamy, N.; Deepak, O. “IoT based smart water system. In Proceedings of the 2018 3rd International Conference on Communication and Electronics Systems (ICCES)”., Coimbatore, India, 15–16 October 2018; pp. 1041–1045.

10. Narendran, S.; Pradeep, P.; Ramesh, M.V. “An Internet of Things (IoT) based sustainable water management”. In Proceedings of the 2017 IEEE Global Humanitarian Technology Conference (GHTC), San Jose, CA, USA, 19–22 October 2017; pp. 1–6.

11. Gutai, M.; Kheybari, A.G. “Energy consumption of hybrid smart water-filled glass (SWFG) building envelope”. Energy Build. 2020, 230, 110508.

12. Santos, E.L.Q.; Bautista, J.C.D.; John, M.W.S.E.C.; Paloa, B.; Villaran, A.B.A. “Development of an IoT-based water and power monitoring system for residential building”. Indones. J. Electr. Eng. Comput. Sci. 2021, 22, 744–751.Processes 2022, 10, 2462 18 of 18.

13. Maltais, L.-G.; Gosselin, L. “Predictability analysis of domestic hot water consumption with neural networks”: From single units to large residential buildings. Energy 2021, 229, 120658.

14. Pomianowski, M.; Johra, H.; Marszal-Pomianowska, A.; Zhang, C. “Sustainable and energy-efficient domestic hot water systems”: A review. Renew. Sustain. Energy Rev. 2020, 128, 109900.

15. Chambers, N.; Coakley, D.; McCaffrey, M.; Curry, E.; Keane, M.; Costa, A.; Clifford, E. “Assessment and planning for the Application of Fault Detection and Diagnosis (FDD) to Building Water Networks”, A WATERNOMICS Approach. In Proceedings of the 36th

IAHR World Congress (IAHR 2015), The Hague, The Netherlands, 28 June–3 July 2015.

16. Mulligan, S.; Hannon, L.; Ryan, P.; Nair, S.; Clifford, E. "Development of a data driven FDD approach for building water networks": Water distribution system performance assessment rules. J. Build. Eng. 2020, 34, 101773.