SMART WATER MANAGEMENT SYSTEMS

PHASE 5: PROJECT DOCUMENTATION AND SUBMISSION

Introduction:

Smart Water Management is the activity of planning, developing, distributing and managing the use of water resources using an array of IOT Technologies which are designed to increase transparency and make more reasonable and sustainable usage of those water resources. With the increase in water consumption due to an increase in the human population, there are growing concerns of water scarcity .Besides the general concerns of freshwater scarcity for drinking purpose, there are rising concerns for scarcity of water for agricultural purposes. In order to tackle the challenges of water scarcity, an effective water management system is vital. The water management system can help detect water leaks in a smart home by analyzing water levels during different hours of the day. One of the main reasons for the low adoption of smart water management system is its high cost. In recent years, with the advent of the Internet of Things (IoT) for smart cities, the cost has come down significantly. Internet of Things is a system of connected devices with the ability to transmit data. Devices in an IoT ecosystem can transfer data without human interaction thereby making them ideally suitable for real-time water level monitoring. Use of IoT platforms provides easy access for remote monitoring and control.

Objectives:

The main objectives of the project are:

- Minimize usage of water usually utilized in higher amounts for manufacturing, agriculture, and power production.
- Establish public policies with the help of real-time data gathered by IoT devices.
- Detect leakage and spillage, and where exactly they are occurring.

The objective of this project is to create a basic monitoring system for aquarelated parameters, such as temperature, pH, and NH_3 levels. By interfacing with an I2C LCD and simulating sensor data, the project aims to demonstrate how to visualize and display these parameters on the LCD screen. The project serves as a starting point for those interested in building more advanced aquatic monitoring systems, where the real objective would be to collect and display accurate and meaningful data from physical sensors in order to monitor and maintain optimal conditions in an aquatic environment, such as water quality control system.

WOKWI: Wokwi is a versatile online platform that allows you to design, simulate, and test electronic circuits in a virtual environment

Related work:

The water management system can be broadly classified into two main categories namely water level monitoring systems and water quality monitoring systems. Water level monitoring system are those systems that attempy to measure in real-time the water level of a water reservoir using sensors .The water quality monitoring system attempts to measure various water quality parameters like pH, conductivity, TDS, etc. value in the water by using different sensors.

Proposed IoT based smart water management system:

In this section, we propose an architecture for a smart water management system keeping in mind the key analysis of various techniques discussed earlier. The proposed system is an IoT based real-time smart water management system that will record water level as well as water quality parameters. The proposed system consisting of programs written in popular programming languages like python will be running in the controller e.g. Raspberry Pi.

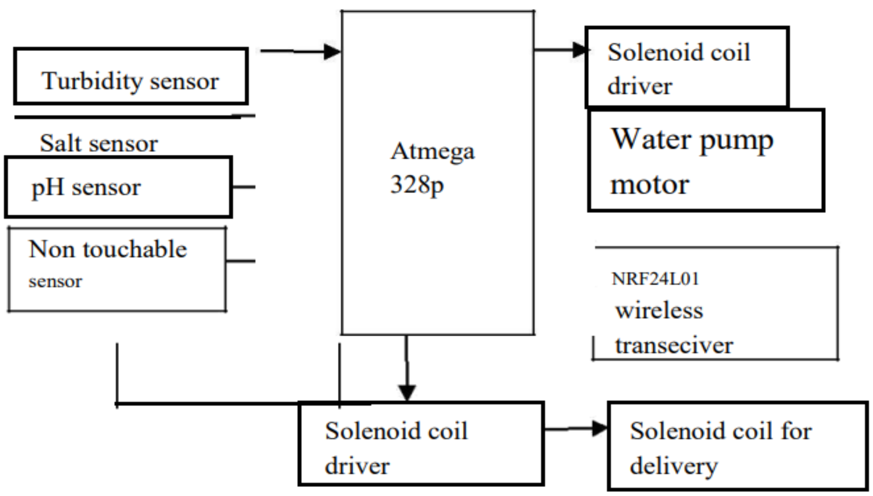
Project Definition:

In order to monitor water levels and proper maintenance of water via a public platform. The project entails placing IOT sensors in the public.The goal is to maintain the tank without bacteria and microbes and then they are integrated using Python and IOT technology.

IoT sensor Network design:

The sensors placed at the different places reads the data which are manipulated through the microcontroller and the values of the sensors are displayed. The values obtained repeatedly are send to database and through the web API, warning message is sent into the phone.

The single chip microcontroller named ATMEGA 328p was used. It is used to collect the data from the sensor and post to main unit through wireless transceiver. It has 14 digital I/O pins, of which 6 can be used as PWM outputs and 6 analog input pins. These I/O pins account for 20 of the pins. 2 of the pins are for the crystal oscillator. This is to provide a clock pulse for the ATMEGA chip. A clock pulse is needed for synchronization so that communication can occur in synchrony between the ATMEGA chip and a device that it is connected to. The chip needs power so 2 of the pins, VCC and GND, provide it power so that it can operate. The Atmega328 is a low-power chip, so it only needs between 1.8-5.5V of power to operate. The Atmega328 chip has an analog-to-digital converter (ADC) inside of it. This must be or else the Atmega328 wouldn't be capable of interpreting analog signals. Because there is an ADC, the chip can interpret analog input, which is why the chip has



Basic block diagram

Hardware Description:

ATMEGA 328p:

Micro Controller- The Atmega328 is one of the very popular microcontroller chip produced by Atmel It is an 8 - bit microcontroller that has 32K of flash memory, 1K of EEPROM, and 2K of S RAM. The Atmega328 is one of the microcontroller chips that are used with the popular Arduino boards. This microcontroller has analog pin and digital pin for easy interface of the = Microcontroller Operating Voltage: – 1.8 - 5.5V23 Programmable I/O Lines Two 8-bit Timer/Counters Real Time Counter with Separate Oscillator Six PWM Channels6- channel 10-bit ADC .

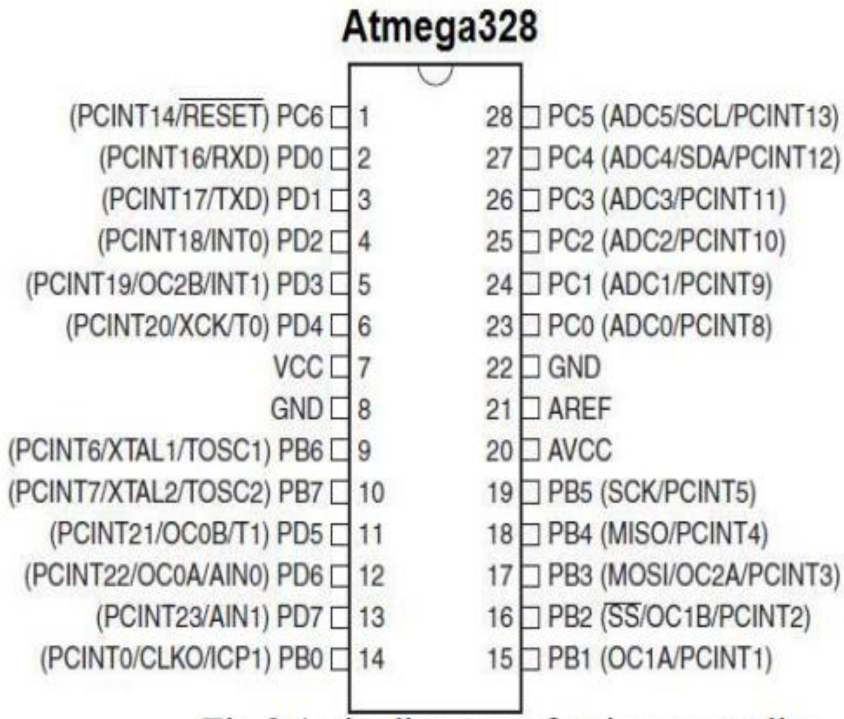


Fig 2.1 pin diagram of microcontroller

ESP 8266:

Wi-Fi Direct (P2P), soft-AP Integrated TCP/IP protocol stack+19.5dBm output power in802.11b mode Supports antenna diversity Power down leakage current of < 2msStandby power consumption Operating Voltage. The esp8266 module it is a 8 pin . VCC is a power supply and it is operated by the voltage is 3.3v .This exceed and it is burn the ESP module. GND is connected to the ground terminal. Rx pin is the receiver pin UART serial communication The Tx pin is a transmitter. GPIO general purpose input and output. Reset pin reset the module apply in 3.3v. the CH-PD pin configure channel.

Fig 2.2 esp 8266

NRF 2401L:

The NRF wireless trans-receiver is 8 pin of the operation. GND pin it is also used to for the ground terminal. VCC is a power supply operated by the voltage range is 1.9v to the 3.6v and it is mostly apply the 3V. The CE pin is a select the mode of operation either is operated by transmit data or receive a data. CSN it is used to for the enable the SPI chip. SPI pro vise is high the clock is enable and low the clock is dis-able. MOSI transmit a data from user module to the external circuit. It has following pin name Serial Peripheral Interface, or SPI is a very common communication protocol used for two-way communication between two devices. A standard SPI bus consists of 4 signals: Master Out Slave In (MOSI), Master In Slave Out (MISO), the clock (SCK), and Slave Select (SS). An SPI bus has one master and one or more slaves .The master can talk to any slave on the bus, but each slave can only talk to the master. Each slave on the bus must have it's own unique slave select signal. The master uses the slave select signals to select which h slave it will be talking to.

Fig 2.3 nrf 2401L

Salt Sensor:

It is used to monitoring the salt content of the sewage water and communicate with microcontroller for posting this information to internet. It has consists of two rods one is reference rod and measuring rod. The voltage is given to the reference rod and the conducting current passes to measuring rod. The voltage present in the measuring rod is proportional to the salt content of the water.

pH Sensor:

pH sensor used to determine the pH value content in the water. The pH value range from the acidity – Neutral – Alkaline. It has two rod to measure the value of the pH value in the water. The pH meter is used for the quality check if water is safe for drinking. A balanced pH level is very important for human health; it should be approximately equal to 7. It gives Full range pH reading from 1 to 5 voltage scale range and given.

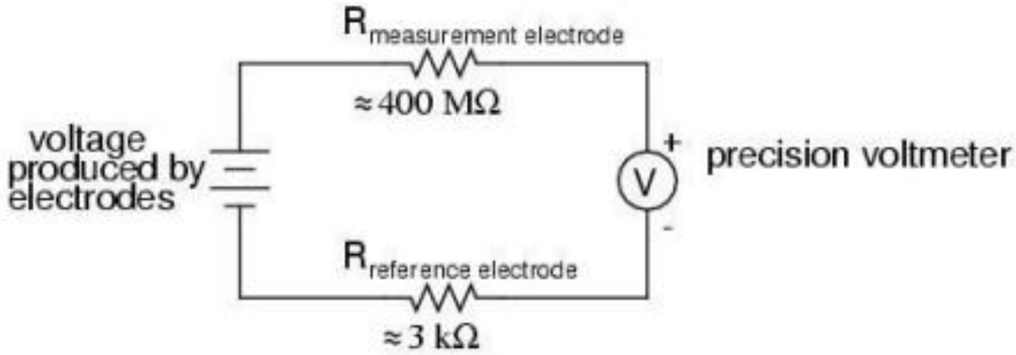


Fig:3.1 Circuit design for pH sensor

Turbidity Sensor:

The turbidity sensor SKU: SEN0189 is used to detect water quality by measuring level of turbidity. The turbidity sensor enables the detection of suspended particles in water by measuring the light transmittance and analogue and digital signal output modes, either of the mode can be selected according to the microcontroller unit (MCU). The threshold is adjustable by adjusting the potentiometer in digital signal mode. The operating voltage of the turbidity sensor is 5V DC and the operating current is 40mA (max) respectively.

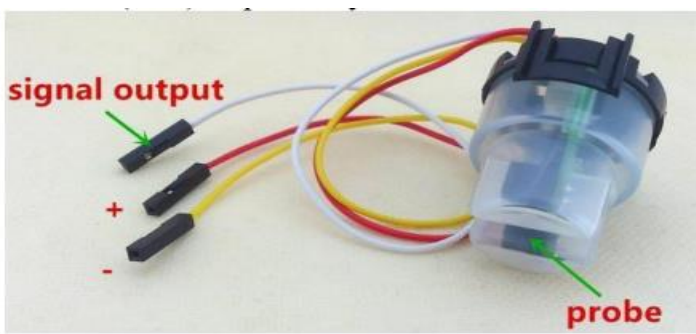


Fig:3.2 Structure of turbidity sensor

Ultrasonic Sensor:

This is used to measure the level of the water in the Tank in term of distance from top to surface of water. The distance value shown in centi-meter in display unit. From this sensor we find the level of the water level. This ultrasonic sensor is operated by emitting high-frequency sonic wave at regular time interval starting from the front of the transducer. The sonic waves are reflected by an object and received back in the transducer. The time interval between emitting and receiving sound waves is proportional to the distance between the transducer and the object can be calculated. As the ultrasonic sensor is using sound wave instead of light wave, it is more suitable for sensing uneven surface such as water surface. According to its datasheet, the ultrasonic sensor detects objects from 0-inches to 254-inches (6.45- meters) and provides sonar range information from 6-inches out to 254-inches with 1-inch resolution.

Fig:3.3 Circuit diagram for ultrasonic sensor

Solenoid value of water:

A solenoid is a simple device that converts electrical energy into linear mechanical motion, but it has a very short stroke (length of movement), which limits its applications. The solenoid consists of a coil of wire with an iron plunger that is allowed to move through the center of the coil. Above figure shows the solenoid in the unenergized state. NRF24L01 wireless trans-receiver ATMEGA 328p IOT A solenoid valve is the combination of a basic solenoid and mechanical valve. So a solenoid valve has two parts namely- Electrical solenoid, mechanical valve. Solenoid converts electrical energy to mechanical energy and this energy is used to operate a mechanical valve that is to open, close or to adjust in a position.

Water pump motor:

This is a mini submersible type water pump that works on 12V DC. It is extremely simple and easy to use. Just immerse the pump in water, connect a suitable pipe and power the motor to start pumping water. Great for building science projects, fire-extinguishers, fire fighting robots, fountains, waterfalls, plant watering systems etc. This motor is small, compact and light. It is manufactured to be used in automobiles for spraying wiper water, hence it is quite durable. It can be controlled from a micro controller/Arduino using our DC Motor Drivers or one of our Relay Boards

Fig 5.4 Water pump motor

Integration and Approach:

An internet-based approach to measuring water quality and delivery systems on a real-time basis. The results of the various parameters of water quality are verified that the system achieved the reliability and feasibility of using it for the actual monitoring purposes. The WSN network will be developed in the future comprising of more number of nodes to extend the coverage range. In our proposed system, water level can be monitored continuously from anywhere using web browser. Motor can be controlled automatically full smart automation is achieved. It is a robust system & small in size. This Project uses ultrasonic sensors which provide more accurate and calibrated information for water level in tank. An electromagnetic box is used to drop the chlorine power in the tank by automated system and show the various parameter of water in a web browser that can be viewed any whereby user.

IOT SENSOR DEPLOYMENT:

WOKWI:

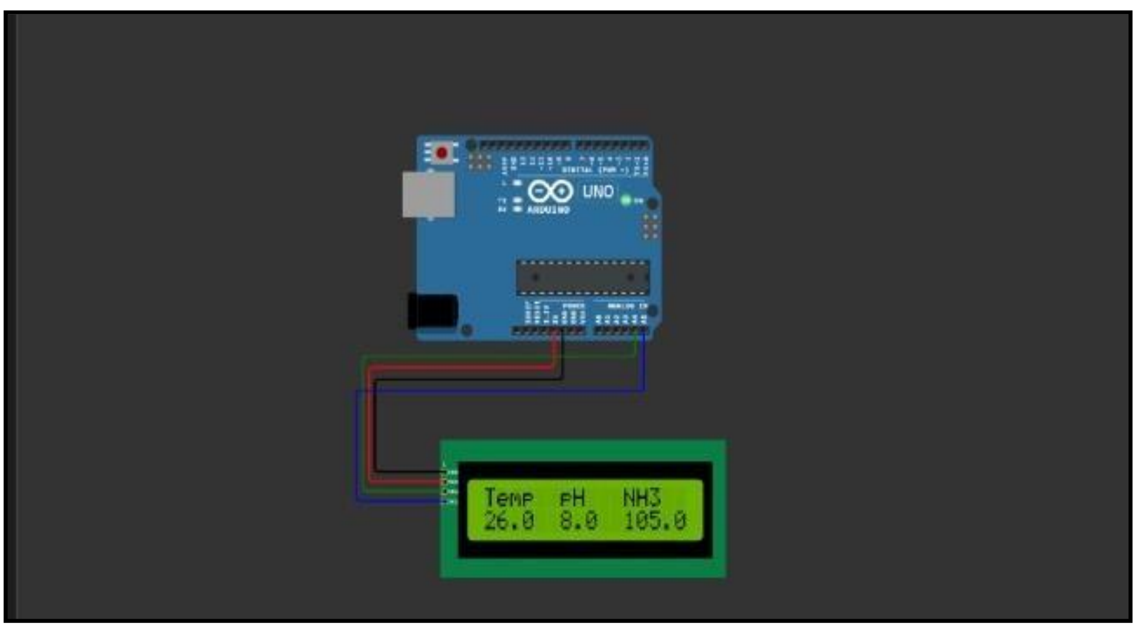
COMPONENTS REQUIRED:

- Arduino Board
- I2C LCD Display
- LiquidCrystal_I2C Library

WIRING INSTRUCTIONS:

1. **Arduino Board Connections:**

   - **VCC (5V):** Connect the 5V output of the Arduino to the VCC (Power) pin on the I2C LCD.
   - **GND (Ground):** Connect the GND (Ground) pin of the Arduino to the GND (Ground) pin on the I2C LCD.
   - **SDA (Serial Data):** Connect the SDA (Serial Data) pin of the Arduino to the SDA (Data) pin on the I2C LCD.



   - **SCL (Serial Clock):** Connect the SCL (Serial Clock) pin of the Arduino to the SCL (Clock) pin on the I2C LCD.

These connections establish the communication between the Arduino board and the I2C LCD, allowing the Arduino to send data and instructions to the display for visualization.

CODE DESCRIPTION:

```
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,20,4);float

t;

float pH;

float nh3;

long readT()

{

long t = random(1700, 2900)*0.01;

return t;

}

long readNh3()

{

long nh3 = random(9000, 14000)*0.01;

return nh3;

}

long readPh()
```

```
{
long pH = random(500, 900)*0.01;
return pH;

}
void setup()
{
  Serial.begin(9600);
  lcd.init();
  lcd.backlight();

  lcd.print("Aqua Sensor");
delay(3000);

lcd.clear();
}
void loop()
{
Serial.println("GET data from SENSORS");t =
readT();

pH =readPh();

 nh3 = readNh3();

Serial.print("Temp:");
Serial.println(t,1);
```

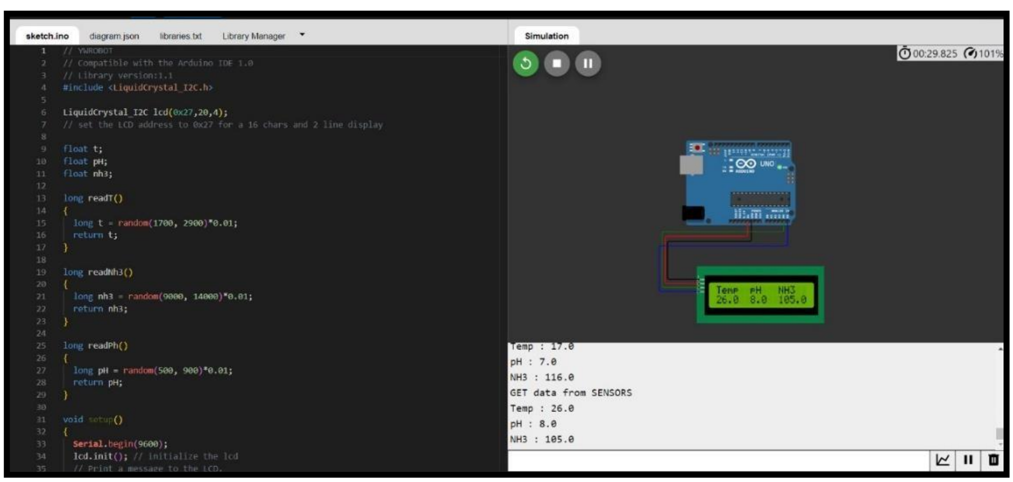
```
Serial.print("pH:");
Serial.println(pH,1);
Serial.print("NH3:");
Serial.println(nh3, 1);
lcd.setCursor(0,0);
lcd.print("Temp");
lcd.setCursor(0,1);
lcd.print(t, 1);
lcd.setCursor(6,0);
lcd.print("pH");
lcd.setCursor(6,1);
lcd.print(pH,1);
lcd.setCursor(11,0);
lcd.print("NH3");
lcd.setCursor(11,1);
lcd.print(nh3,1);
delay(2000);
lcd.clear();

}
```

This code employs the LiquidCrystal_I2C library to interface with a 20x4 I2C-based LCD, demonstrating the visualization of simulated sensor data. Three float variables, representing temperature, pH, and NH3 levels, are declared, and functions generate random data within predefined ranges to mimic sensor readings. In the setup phase, serial communication is initiated, the LCD is initialized, and a brief "Aqua Sensor" message is displayed before clearing the screen. The main loop iteratively generates simulated sensor data, displaying it on both the LCD and the Serial Monitor with corresponding labels, followed by a 2-second delay and screen clearing for the next data set. To apply this code practically, replace the simulated data with actual sensor readings from physical sensors connected to the Arduino.

RESULT ANALYSIS:

The Smart Water Management System project successfully displayed simulated sensor data, including temperature, pH, and NH3 levels, on a 20x4 I2C-based LCD. Upon startup, the LCD showed an "Aqua Sensor" message for 3 seconds, followed by clear presentation of the sensor data with labels, separated by 2-second intervals. While the project achieved its goal of showcasing data visualization, it's important to note that the data generated was simulated rather than obtained from actual sensors.



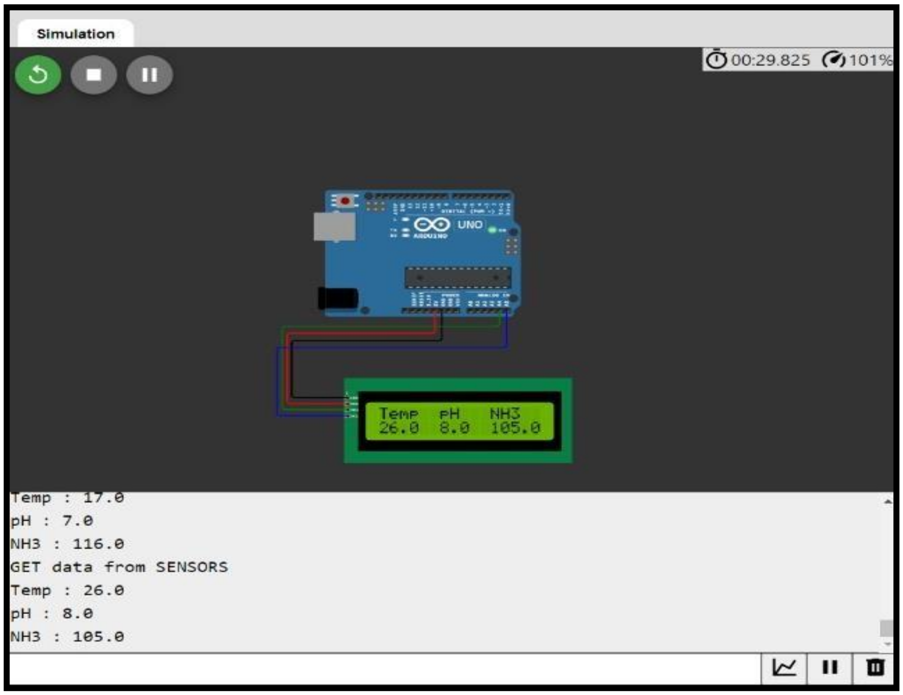


Fig: Smart Water Management System

PROGRAM:

```
  Private boolean isOn;
  Private int waterLevel;
 Public SmartWaterManagement()
{
  isOn = false; waterLevel = 0;
  }
Public void turnOn()
{
      isOn = true;
      System.out.println("Water is now on.");
   }
 Public void turnOff()
{
   isOn = false;
   System.out.println("Water is now off.");
   }
Public void fillWater(int amount)
{
 If (isOn)
```

```
    waterLevel += amount;
     System.out.println("Water level increased by " + amount+liters.");

         }

Else
{

   System.out.println("Cannot fill water when the water is off.");

         }

    }
 Public void dispenseWater(int amount)
{

        If (isOn)
 {

       If (waterLevel >= amount)

 {
      waterLevel -= amount;
       System.out.println("Dispensing " + amount + " liters of
water.");

             }

 Else
```

```
System.out.println("Insufficient water for dispensing.");
            }

        }
 Else

  {

   System.out.println("Cannot dispense water when themanaging water is off.");

        }

  Else
   Public int getWaterLevel()

 {
     Return waterLevel;
     }
   Public boolean isOn()

  {

        Return isOn;
     }

  Public static void main(String[] args)
  {

    SmartWater Management = new SmartWater Management ();
 management.turnOn();
```

```
    Management.fillWater(20);
     Management.dispenseWater(10);

     System.out.println("Current water level: " +
management.getWaterLevel());

    Management.turnOff();
     }

}
```

OUTPUT:

Water level is now on.

Water level increased by 20 litersDispensing 10 liters of water

Current water level: 10Water is now off.

CONCLUSION:

A water management system is the need of the hour for smart cities and campuses. The use of IoT devices for the water management system is becoming increasingly prominent. The availability of low-cost sensors connected to IoT devices has fixed the challenges of measuring water quality. In this paper, various components of IoT based water management systems were presented along with the in-depth survey of all existing smart water management systems. The Smart Water Management System successfully demonstrated the visualization of simulated sensor data on the I2C LCD display. This project serves as a foundational example for those interested in creating water monitoring systems.To make this project practical for real-world applications, the next steps would involve connecting actual sensors to the Arduino and adapting the code to read and display real data.