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**Smart Water Management Project Documentation**

**Project Title:**

**Smart Water Management for Preserving The Water Quality Monitoring Using Sensors.**

**Project Objectives:**

* **Improve water resource utilization and efficiency.**
* **Enhance water quality monitoring and management.**
* **Reduce water wastage through leakage detection and control.**
* **Ensure the sustainable and reliable supply of clean water.**

**Project Scope:**

* **Installation of sensors to continuously monitor parameters such as pH levels, turbidity, and temperature.**
* **Implementation of an alert system for water quality deviations.**

**Project Components:**

**Water Quality Monitoring:**

* **pH levels, turbidity, and temperature.**
* **Data collection, analysis, and reporting.**

**Leakage Detection and Control:**

* **Deployment of smart leak detection sensors in the water distribution network.**
* **Integration with a centralized control system to isolate and repair leaks.**
* **Reduced water loss and maintenance cost.**

**Water Metering and Billing:**

* **Replacement of traditional water meters with smart meters.**
* **Real-time consumption monitoring and automated billing systems.**
* **Improved accuracy in billing and revenue collection.**

**Data Management and Analytics:**

* **Centralized data storage and analysis platform.**
* **Integration of historical and real-time data for informed decision-making.**
* **Visualization of data for stakeholders.**

**Automation and Control:**

* **Integration of remote control systems to manage water distribution and treatment processes.**
* **Automation of pumps, valves, and treatment processes for efficiency.**

**Public Awareness and Engagement:**

* **Public education campaigns on water conservation and efficient use.**
* **Communication channels for reporting water-related issues**

**Project Benefits:**

* **Improved water quality and safety.**
* **Reduced water wastage and operational costs.**
* **Enhanced customer service through accurate billing.**
* **Increased sustainability and resilience of the water supply system.**

**Using IoT technology to monitor water quality**

**Finally, field technicians resorted to Smart Water Quality Monitoring, which allowed them to monitor the water quality in real-time from anywhere across the globe using a combination of digital computing devices, internet services, communication media, and portable sensors.**

**Smart Water Quality Monitoring systems have become extremely useful in domestic applications, agriculture, aquaculture, and municipal waste recycling. In addition, these systems monitor water quality in lakes, rivers, and other water bodies.**

**The IoT networks are incredibly safe, and the communication speed is also high. The technology comfortably resolves all the issues that the previous techniques had.**

**Attention to Water Management Top Challenges:**

**The biggest challenge in water management is, perhaps, monitoring the level of water, flow through different channels, and of course, the quality. IoT can identify and calculate the amount of residue or toxicity levels in the water.**

1. **It is no surprise we are dealing with more severe weather worldwide — be it hurricanes, floods, or extreme heat. Research shows that the critical situations are around the cornerIng, Things will worsen as the years pass due to the high population and limited water resources. On the other hand, the scarcity will increase the water bills of those using it because of the fight for scarce water utilities.**
2. **The population in urban areas continues to increase, putting a lot of pressure on water supply systems to function smoothly. If they are not inspected in real-time, they can result in massive repairs, in the long run, not to forget, higher overhead expenses.**
3. **The waters in many supply systems have to be allocated based on past availability or existing consumer demand. The practice does not necessarily mean the allocation is proper. In fact, some supply systems can get overly crowded and suppose their waters’ quality is not monitored frequently. In that case, it can lead to severe implications such as leakages or pipe damage and unnoticed toxicity levels — thus hampering the supply and causing harm to those consuming that water.**
4. **There are no specific management plans or sanctions on water extractions in many areas, such as pumping groundwater or rivers. These have caused less water to be soluble and even led to the mining of that resource in some respects. This hampers the water levels and increases the risk of contaminated water.**

**Source Code**

**//include libraries**

**#include <SoftwareSerial.h>**

**#include <LiquidCrystal.h>**

**//for bluetooth – create an object called BTserial, with RX pin at 3 and TX pin at 2**

**SoftwareSerial BTserial(3,2); // RX | TX**

**//decraration of all our variables**

**Float reads;**

**Int pin = A0;**

**Float vOut = 0 ;//voltage drop across 2 points**

**Float vIn = 5;**

**Float R1 = 1000;**

**Float R2 = 0;**

**Float buffer = 0;**

**Float TDS;**

**Float R = 0;//resistance between the 2 wires**

**Float r = 0;//resistivity**

**Float L = 0.06;//distance between the wires in m**

**Double A = 0.000154;//area of cross section of wire in m^2**

**Float C = 0;//conductivity in S/m**

**Float Cm = 0;//conductivity in mS/cm**

**Int rPin = 9;**

**Int bPin = 5;**

**Int gPin = 6;**

**Int rVal = 255;**

**Int bVal = 255;**

**Int gVal = 255;**

**//we will use this formula to get the resistivity after using ohm’s law -> R = r L/A => r = R A/L**

**//creating lcd object from Liquid Crystal library**

**LiquidCrystal lcd(7,8,10,11,12,13);**

**Void setup() {**

**//initialise BT serial and serial monitor**

**Serial.begin(9600);**

**BTserial.begin(9600);**

**//initialise lcd**

**Lcd.begin(16, 2);**

**//set rgb led pins (all to be pwm pins on Arduino) as output**

**pinMode(rPin,OUTPUT);**

**pinMode(bPin,OUTPUT);**

**pinMode(gPin,OUTPUT);**

**pinMode(pin,INPUT);**

**//Print stagnant message to LCD**

**Lcd.print(“Conductivity: “);**

**}**

**Void loop() {**

**Reads = analogRead(A0);**

**vOut = reads\*5/1023;**

**Serial.println(reads);**

**// Serial.println(vOut);**

**Buffer = (vIn/vOut)-1;**

**R2 = R1\*buffer;**

**Serial.println(R2);**

**Delay(500);**

**//convert voltage to resistance**

**//Apply formula mentioned above**

**R = R2\*A/L;//R=rL/A**

**//convert resistivity to condictivity**

**C = 1/r;**

**Cm = C\*10;**

**//convert conductivity in mS/cm to TDS**

**TDS = Cm \*700;**

**//Set cursor of LCD to next row**

**Lcd.setCursor(0,1);**

**Lcd.println©;**

**//display corresponding colours on rgb led according to the analog read**

**If( reads < 600 )**

**{**

**If (reads <= 300){**

**setColor( 255, 0, 255 ) ;**

**}**

**If (reads > 200){**

**setColor( 200, 0, 255 ) ;**

**}**

**}**

**Else{**

**If( reads <= 900 )**

**{**

**setColor( 0, 0, 255 ) ;**

**}**

**If( reads > 700 )**

**{**

**setColor( 0, 255, 255 ) ;**

**}**

**//send data to Ardutooth app on mobile phone through bluetooth**

**BTserial.print©;**

**BTserial.print(“,”);**

**BTserial.print(TDS);**

**BTserial.print(“;”);**

**Delay(500);**

**}**

**Void setColor(int red, int green, int blue)**

**{**

**analogWrite( rPin, 255 – red ) ;**

**analogWrite( gPin, 255 – green ) ;**

**analogWrite( bPin, 255 – blue ) ;**

**}**

**Innovative Idea Implementation:**

**Innovations in IoT (Internet of Things) technology have led to significant advancements in monitoring and improving water quality using sensors. These innovations have a wide range of applications, from ensuring safe drinking water to protecting natural ecosystems. Here are some key aspects of IoT-based water quality monitoring:**

1. **Sensor Types:**
   * **Physical Sensors: These measure physical properties like temperature, pH, turbidity, conductivity, and dissolved oxygen levels.**
   * **Chemical Sensors: These detect specific chemicals or compounds in water, such as heavy metals, nutrients, and pollutants.**
   * **Biological Sensors: These focus on biological indicators like bacteria, algae, and other microorganisms.**
2. **Remote Monitoring:**
   * **IoT allows for real-time monitoring of water quality. Data collected by sensors can be transmitted wirelessly to a central server or cloud platform for analysis and storage.**
3. **Data Analytics and Visualization:**
   * **Advanced analytics can process the data generated by sensors to identify trends, anomalies, and potential issues. Visualization tools provide easy-to-understand representations of water quality parameters.**
4. **Alerts and Notifications:**
   * **IoT systems can be programmed to send alerts or notifications in case of abnormal readings or when predefined thresholds are crossed. This enables quick response to potential water quality issues.**
5. **Integration with GIS (Geographic Information Systems):**
   * **Combining IoT with GIS technology allows for spatial analysis of water quality data, helping to identify specific areas of concern and track trends over time.**
6. **Predictive Analytics:**
   * **Machine learning algorithms can be applied to historical data to make predictions about future water quality conditions. This can be valuable for proactive decision-making and resource allocation.**
7. **Integration with Water Treatment Systems:**
   * **IoT sensors can be integrated with water treatment plants to optimize treatment processes in real time based on actual water quality conditions.**
8. **Autonomous Sensors and Drones:**
   * **Autonomous sensors and drones equipped with water quality sensors can be deployed in remote or hard-to-reach areas, providing a comprehensive view of water quality in diverse environments.**
9. **IoT in Smart Cities:**
   * **In smart city initiatives, IoT-based water quality monitoring can be integrated into broader urban planning and management systems to ensure sustainable and resilient water infrastructure.**
10. **Citizen Science and Public Engagement:**
    * **IoT technology can enable citizen science projects where individuals or communities actively participate in monitoring and reporting on water quality, fostering a sense of ownership and responsibility.**
11. **Regulatory Compliance:**
    * **IoT-based water quality monitoring systems can assist regulatory bodies in ensuring compliance with water quality standards and regulations.**
12. **Cost Efficiency and Scalability:**
    * **Advances in sensor technology and IoT infrastructure have made these solutions more cost-effective and scalable, allowing for widespread adoption.**

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**Selecting Sensors:**

**1.pH Sensor:**

**Choose a reliable and accurate pH sensor to measure the acidity or alkalinity of water. These sensors typically consist of a pH electrode that generates a voltage proportional to the pH level.**

**2.Turbidity Sensor:**

**Select a turbidity sensor that can measure the cloudiness or haziness of water caused by the presence of suspended particles. Turbidity sensors use light scattering or absorption principles to determine turbidity.**

**3.Data Logger and Telemetry:**

**Connect the sensors to a data logger or microcontroller, such as Arduino or Raspberry Pi. These devices can collect and store data.**

**If necessary, set up a telemetry system to transmit data to a central monitoring station. This can be done using various communication methods, including Wi-Fi, cellular, or satellite connections.**

**4.Calibration:**

**Regularly calibrate the sensors to ensure accuracy. Calibration should be done using standard solutions or reference materials to establish a baseline for measurements.**

**5.Sensor Placement:**

**Install the sensors in the water bodies or systems you want to monitor. Ensure that they are properly submerged and positioned to obtain representative measurements.**

**6.Power Supply:**

**Ensure a stable power supply for the sensors and data logger. This may involve using batteries, solar panels, or a reliable electrical source, depending on the monitoring location.**

**7.Data Collection and Analysis:**

**Collect data continuously or at predefined intervals. Store the data for further analysis.**

**Set up data analysis tools to monitor and visualize the collected data. This may involve using software or cloud-based platforms.**

**8.Alert System:**

**Implement an alert system to notify relevant personnel or authorities if certain water quality parameters fall outside acceptable limits. This can help respond to water quality issues promptly.**

**9.Maintenance:**

**. Regularly maintain and clean the sensors to prevent fouling or drift in measurements.**

**Replace or recalibrate sensors as needed to ensure accurate and reliable data.**

**10.Regulatory Compliance:**

**Ensure that your water quality monitoring system complies with local and national regulations. Some regions may have specific requirements for water quality monitoring.**

**11.Data Reporting:**

**Share the collected data with relevant stakeholders, such as water treatment authorities, environmental agencies, or the public, depending on the context.**

**12.Data Interpretation:**

**. Interpret the data to identify trends, anomalies, and potential water quality issues. Use this information to make informed decisions and take appropriate actions.**

**Conclusion:**

**Continuous monitoring of water quality parameters is crucial for early detection of pollution, ensuring the safety of drinking water, and protecting aquatic ecosystems. It helps in proactive management and addressing water quality challenges in a timely manner.**