**SMART WATER SYSTEM - USING IOT**

* This IOT project is aimed to promote sustainable water consumption and conservation strategies in public parks.
* **Overall design plan:**
* **Sensor and components:**
  + - Velocity/pressure sensors shall be placed in the pipeline network housing the tap-water system and irrigation system of park flora to measure the water flow rate.
    - Ultrasound sensors shall be positioned on water tanks to check water levels during different times of the day.
    - Other data such as weather information and soil moisture etc. are collected as per needs.
* **Data analysis:**
  + - Water flow rate can be used to determine the volume of water utilised for drinking, washroom purposes and irrigation.
    - By checking the water levels of tanks, the number of refills over a period of time can be determined.
    - Microprocessors such as ESP-32 and Raspberry-Pi as to be used.
* **Data interfacing and display:**
  + - By implementing Machine Learning Algorithms , analysed data can be effectively interfaced for the user’s benefit to view a detailed depiction of water consumption in parks.
    - Mobile App:
    - To create a user-friendly mobile app for park managers, maintenance staff, and the general public.
    - Users can access real-time water consumption data, receive alerts, and report issues like leaks or water quality concerns.
    - Dashboard:
    - To develop a web-based dashboard for park management to monitor water usage, system health, and predictive analytics.
    - It provides insights into water conservation efforts and cost savings.
* **Machine Learning Algorithm deployment:**
* **Purpose in IOT system:** 
  + - Predictive Analytics:
    - To utilize machine learning algorithms to predict water demand based on historical data, weather forecasts, and park foot traffic patterns.
    - These predictions can help optimize water supply in advance, preventing wastage.
    - Anomaly Detection:
    - To implement anomaly detection algorithms to identify water leaks, pipe bursts, or abnormal water usage patterns in real-time.
    - If an anomaly is detected, the system can trigger alerts for immediate action.
    - Irrigation Optimization:
    - To employ machine learning to optimize park irrigation schedules based on soil moisture levels, weather forecasts, and plant types.
    - The system can automatically adjust irrigation frequency and duration to conserve water while maintaining healthy green spaces.
    - Public Toilet Usage Prediction:
    - To analyze historical data to predict peak hours of public toilet usage.
    - This allows for efficient maintenance and cleaning schedules, reducing water consumption while ensuring restroom hygiene.
* **Some ML Techniques to be used:**
  + - Random Forest Algorithm:
    - Random Forest is an ensemble learning technique in machine learning.
    - It combines multiple decision trees, each trained on a random subset of the data and a random subset of features.
    - This randomness reduces overfitting, improves model accuracy, and provides feature importance scores for better understanding of factors influencing predictions.
    - It is widely used for classification and regression tasks and excels at handling diverse data types.
    - Decision Trees and Random Forests can classify factors influencing water usage in public parks and toilets by identifying key features, such as weather conditions, visitor density, and time of day, that impact water consumption.
    - This model helps create decision rules to analyze and categorize these factors, aiding in understanding and optimizing water management strategies.
    - ARIMA Algorithm:
    - ARIMA, or AutoRegressive Integrated Moving Average, is a time series analysis and forecasting method that models and predicts how a variable changes over time.
    - It consists of three components: AutoRegressive (AR) for past values, Integrated (I) for differencing to achieve stationarity, and Moving Average (MA) for random fluctuations.
    - The model is expressed as ARIMA(p, d, q), where "p" represents past values, "d" is the number of differencing steps, and "q" is the order of moving averages.
    - ARIMA is used to preprocess data, identify the model's parameters, fit the model, make predictions, and assess forecast accuracy.
    - It is well-suited for data with temporal patterns, making it applicable to water consumption analysis where historical usage patterns change over time.
    - ARIMA can capture seasonality and trends in water consumption, making it useful for short to medium-term predictions.
    - Its parameters (p, d, q) are tuned to optimize model performance, and it is often used for univariate time series data.
* **Water Conservation strategies :**

This project aims to develop conservation strategies as follows:

* **Smart Valve Control:** 
  + - To install smart valves and actuators that can be remotely controlled and programmed based on the recommendations from the machine learning algorithms.
    - Valves can be shut off during rainy periods or when anomalies are detected.
* **Water Quality Control:** 
  + - To integrate water quality sensors in public toilets to monitor water cleanliness.
    - If the water quality degrades, the system can automatically shut off the supply, preventing contamination.
* **Remote Maintenance:** 
  + - To Enable remote diagnostics and maintenance of the entire system to reduce downtime and ensure optimal performance.
    - Also, to alert and notify to replace older and less water-efficient fixtures with low-flow toilets, faucets, and showerheads in park restrooms and facilities.
* **Leak Detection and Repair:**
  + - To detect leaks in the park's water infrastructure promptly and repair any leaks as soon as they are identified to prevent water wastage.
* **Irrigation Optimization:**
  + - To adjust the park's irrigation schedule based on real-time data from the monitoring system.
    - To implement smart irrigation systems that can adjust water flow based on weather conditions and soil moisture levels.
* **Scheduled Watering:**
  + - To set specific hours for watering the park's landscaping to reduce evaporation losses.
* **Xeriscaping Practices:**
  + - To incorporate xeriscaping principles in park design, focusing on minimal water use and sustainable landscaping practices.
* **Community Involvement:**
  + - To engage the local community in park conservation efforts by providing real-time data.
    - To promote awareness on minimal water usage and sustainable water conservation by highlighting factual data.
* **Benefits:**
* Efficient water usage leading to significant water conservation.
* Reduced water costs for park management.
* Improved green space health due to optimized irrigation.
* Enhanced restroom hygiene in public toilets.
* Quick detection and mitigation of water leaks and anomalies.
* Data-driven decision-making for park management.
* Public engagement in water conservation efforts.

Implementing such an innovative smart water management system not only contributes to environmental sustainability but also enhances the overall experience of park visitors and reduces operational costs for park management.