**SMART WATER MONITORING AND OPTIMIZATION SYSTEM IN HOUSEHOLDS BASED ON IOT AND AI**

**Name:** Lê Trường Duy  
**Email:** 42101294@student.tdtu.edu.vn

**1. Project Objectives**

* Develop an intelligent real-time water usage monitoring system for households.
* Apply Artificial Intelligence (AI) to predict water consumption demand and determine the optimal time for maintenance or filter replacement.
* Integrate an automated control system through the Home Assistant platform to optimize water usage, conserve resources, and ensure water safety.
* The system can be applied not only to household water purifiers but also to small-scale water filtration systems used in households or organizations. It can manage water intake from storage tanks, wells, or collection reservoirs before being processed and distributed.

**2. System Structure**

**a. Hardware Components**

* **ESP32** as the central unit for data collection and transmission.
* **Sensors:**
  + **Flow sensor:** Measures water consumption.
  + **Current sensor:** Measures power consumption to monitor the pump or purifier's energy usage, assess efficiency, and detect anomalies.
  + **Ultrasonic or infrared sensor:** Detects user presence to enable or disable water flow automatically.
* **Control Devices:**
  + **Solenoid valve:** Automatically opens/closes based on consumption thresholds.
  + **Water pump:** Controls water supply from storage tanks to the filtration system or household purifiers.
* **OLED Display:** Visually displays measured metrics such as water usage and filter maintenance information from input data.

**b. Software Platform**

* **Home Assistant:** The main platform for device management and automation.
* **Node-RED:** A tool for data flow processing and system logic programming.
* **InfluxDB + Grafana:** Stores time-series data and provides visual analytics.
* **Docker on Ubuntu Server:** Enables flexible and scalable system deployment.

**c. Communication Methods**

* **MQTT:** Ensures lightweight and stable communication between ESP32 and the server.
* **Wi-Fi (preferred),** with optional **LoRa** for areas with unstable network coverage.

**3. AI and Big Data Applications**

**Predictive Maintenance & Consumption Analysis**

* Forecasts the optimal time for filter replacement or tank cleaning.
* Analyzes water consumption trends on a daily, weekly, and monthly basis.

**System Optimization**

* Automatically adjusts the operation of the pump and solenoid valve to maintain water pressure, prevent leaks or overflows, and deactivate when not in use.

**4. System Benefits**

* **Water Conservation & Efficiency:** Smart control optimizes water usage.
* **Automation:** Streamlines water supply, maintenance, and filtration monitoring.
* **Health Protection:** Ensures timely water quality monitoring and alerts.

**Applicable to:**

* Households using storage tanks and simple filtration systems.
* Schools, rural health centers, dormitories, and small residential areas.
* ODA programs or climate adaptation projects for water resource management.