Wireless Clustered SCADA System

Wireless Sensor Networks: Final Project

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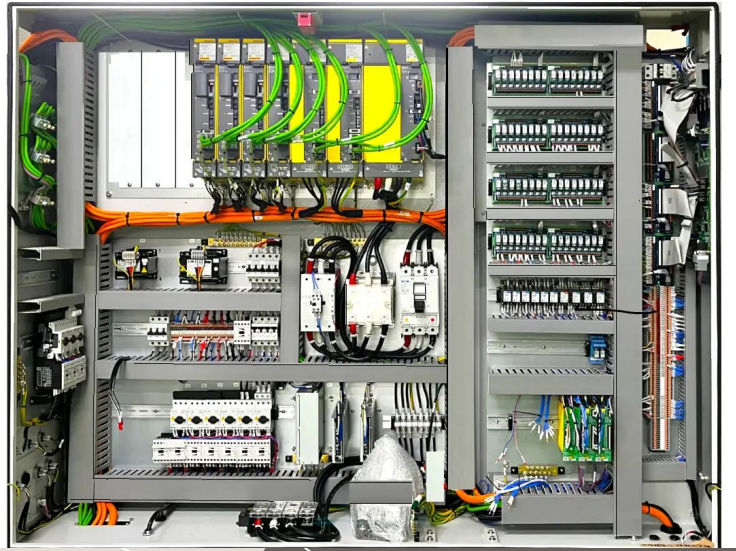
Problem Statement:

Large industrial plants rely on extensive wiring for process automation.

Physical cabling increases cost, complexity, and potential failure points.

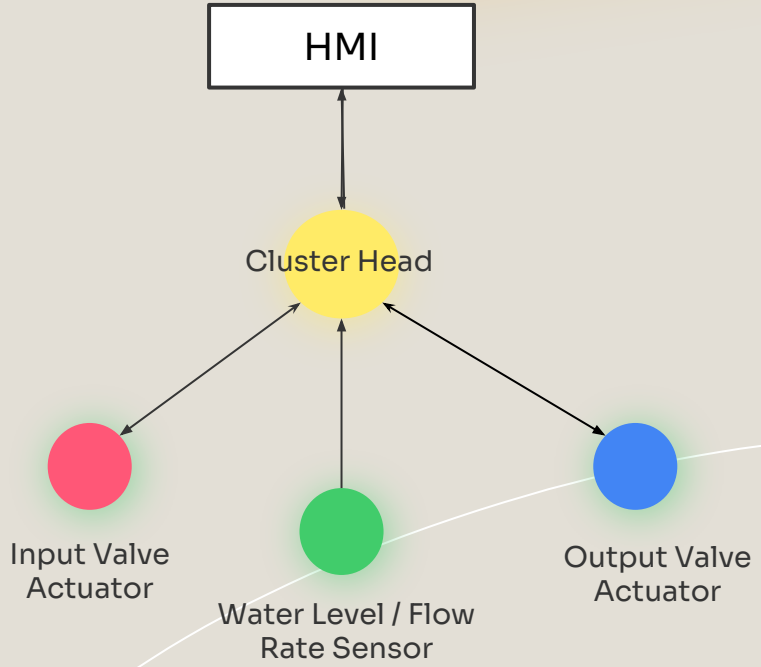
Goal: Create a scalable wireless **SCADA (Supervisory Control and Data Acquisition)** cluster that reduces field wiring by grouping devices through a Wireless Sensor Network.

Our prototype demonstrates automatic reservoir-level control as one cluster in a larger plant.

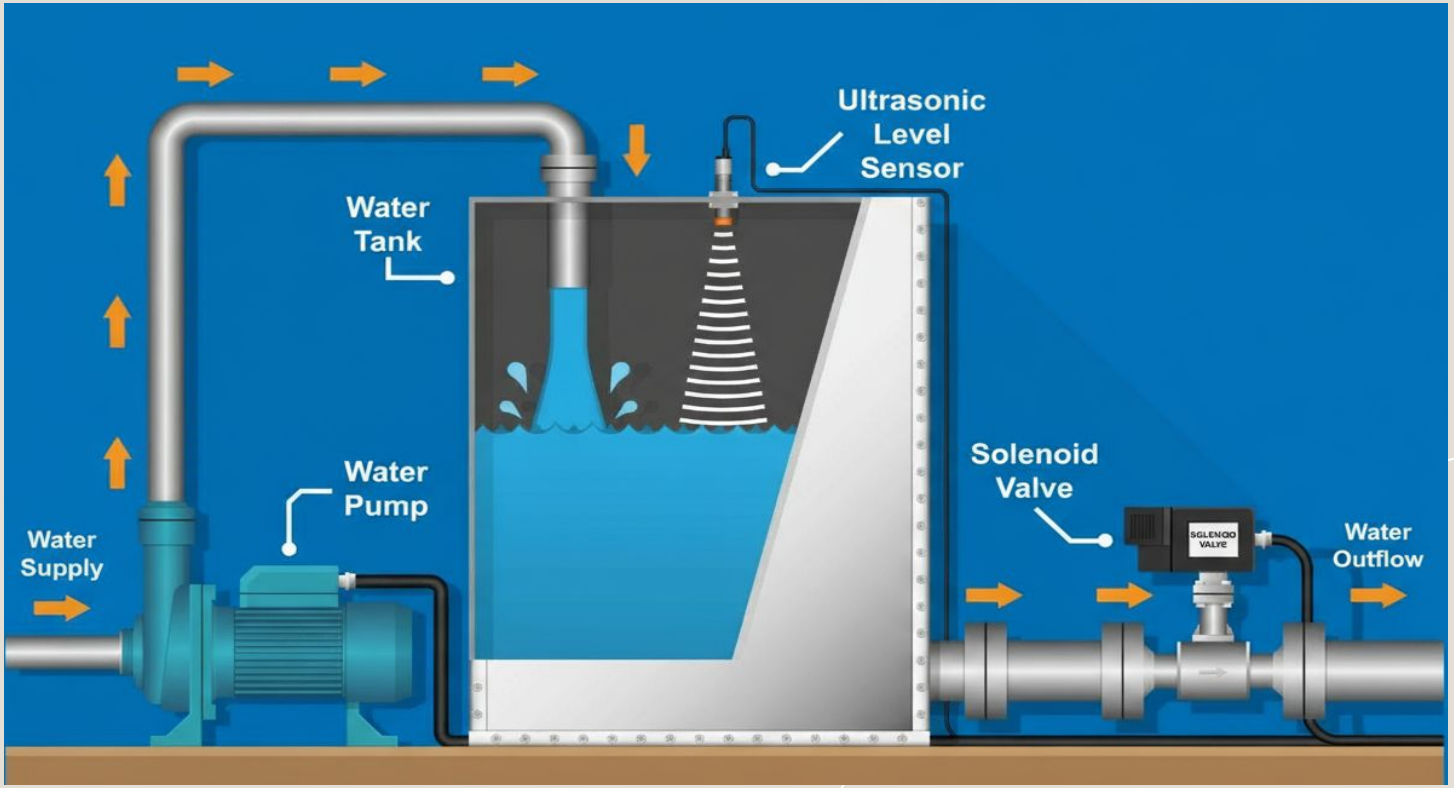


System Overview

Node	Functionality
Cluster Head	Central coordinator; processes sensor data, computes control action, sends actuator commands.
Sensor Nodes	Samples from flow rate & water level sensors; transmits data to cluster head.
Actuator Nodes	Drives a stepper motor to regulate inflow from pump and Drives another one for outflow control
Human-Machine Interface (HMI)	Connects to LCD allowing user to set setpoint and see system statistics.



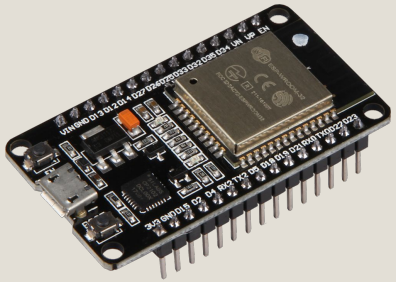
System Diagram



Hardware and Tools

Microcontrollers

- 4 ESP-32s



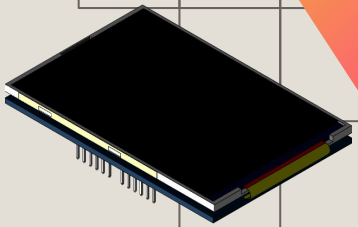
Programming Tools

- Arduino IDE
- ESP-NOW

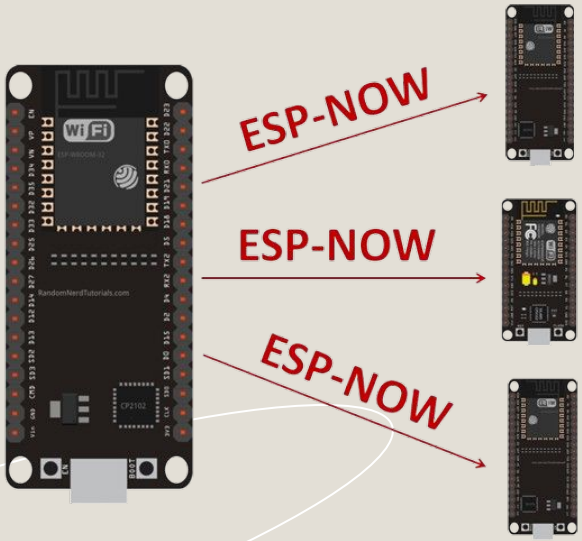
ARDUINO

Sensors and Actuators

- 2 Stepper Motors
- Flow Rate Sensor
- Ultrasonic Sensor
- LCD TFT Display
- Water Pump



Inputs, Outputs, Communication



Signal flow and data exchange within the wireless SCADA cluster

Inputs:

Flow Rate Sensor (Analog)

Ultrasonic Water level Sensor (Analog)

Desired Setpoint (From Human-Machine Interface)

Outputs:

Stepper-motor position (For Input/Output Valves)

System Status (via Serial Monitor or LCD)

Communication:

ESP-NOW (peer-to-peer 2.4GHz communication)

Data Processing and Control Logic

Cluster Head

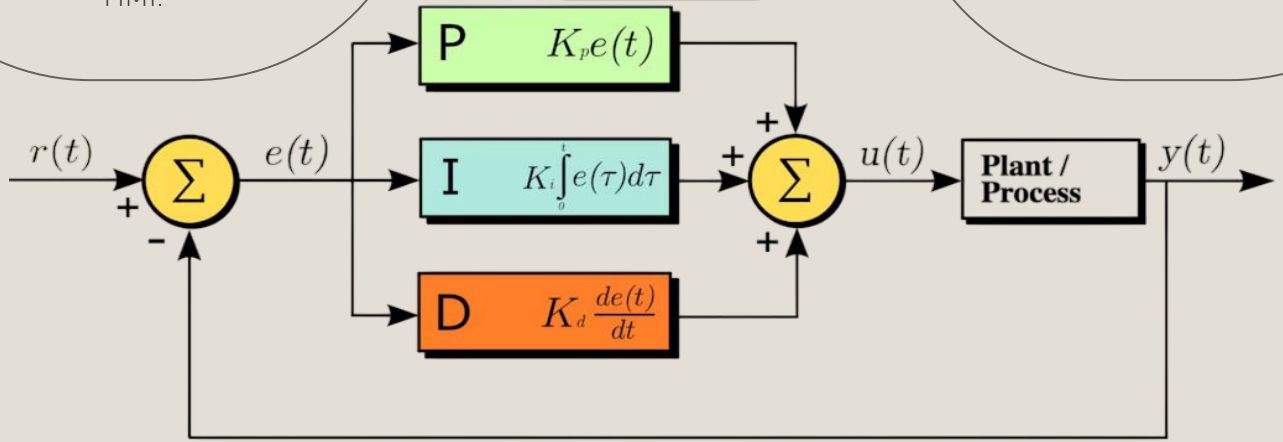
Communicates with cluster members and controls water depth depending on the sensor values via PID Control. Receives set point inputs and displays control values via the HMI.

Sensor Nodes

Flow rate and water depth are sensed and sent to the head using round-robin polling.

Actuator Nodes

A signal from the cluster head is sent to the valves and pump. The valves and pump respond back with acknowledgement.



Project Roadmap

Week 1 Goal

Software testing and complete wireless communication finalized.

Week 1 Deliverable

Verified wireless network with stable data transmission.

Week 2 Goal

Assemble the full reservoir setup, integrate feedback control, and calibrate sensors and actuators.

Week 2 Deliverable

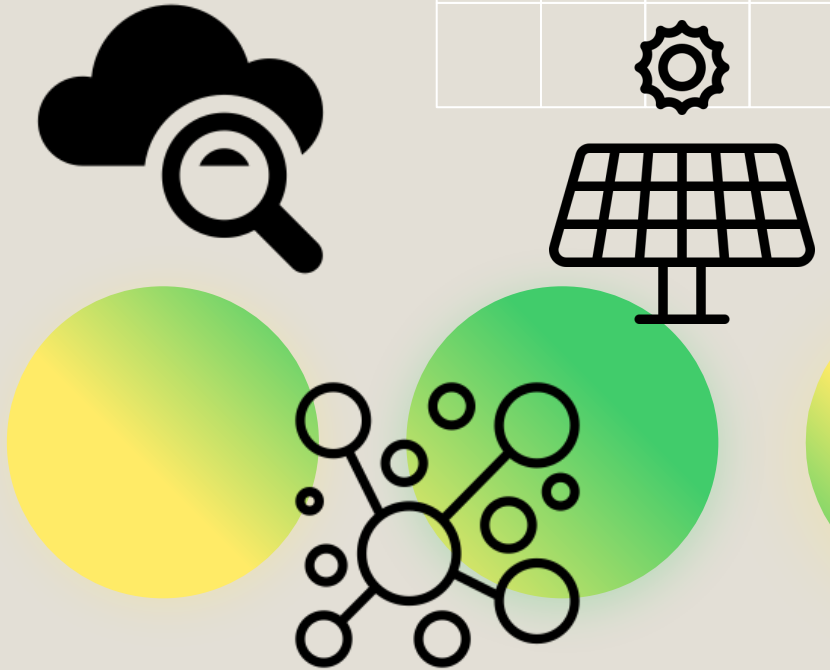
Working proof-of-concept demo of autonomous water-level control.

Expected Outcomes and Future Work

Demonstrate autonomous water-level regulation through a 4-node Wireless Sensor Network cluster.

Validate reduced wiring and modular scalability for larger SCADA systems.

Beyond This Prototype: multi-cluster coordination, cloud monitoring, or solar-powered sensor nodes.



Thank you.
Any questions?

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