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8.5.2025

JES

Project final report

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1. Project description

Our plants suffer from inconsistent watering. Some receive too much water, while others don't get enough. To address this, we are developing an automatic watering system for plants. It will measure the soil moisture and if it's below 30% it will water the plant. We also want to gather data to our database and visualize it in Grafana. In addition to soil moisture, we gather data from air temperature and air humidity.

2. Project results

The project successfully delivered a functional and secure automatic plant watering system with real-time monitoring capabilities. It is built around an Arduino Uno R4 Wifi - microcontroller that measures soil moisture, air temperature, and humidity, and activates a water pump when necessary. Data is transmitted via MQTT and processed through a pipeline hosted on a virtual machine (VM) in CSC's cPouta cloud infrastructure. Grafana accessible through a custom HTTPS domain for secure remote monitoring and control.

- Virtual Machine & Infrastructure:
  - Hosted on CSC's cPouta IaaS -cloud environment.
  - VM Specifications:
    - Flavor: standard.large
      - VCPUs: 4
      - RAM: 7.8GB
      - Size: 80GB
    - Image: Ubuntu-24.04
  - Runs all essential services as part of the MTIG stack in Docker (Mosquitto, Telegraf, InfluxDB, Grafana).
  - Also runs Nginx as a reverse proxy for secure HTTPS access to Grafana.
  - Security:
    - Configured with a firewall to control incoming and outgoing traffic, ensuring only authorized connections are allowed.
    - TLS certificates (managed via Let's Encrypt) are used for encrypting communication to the Grafana dashboard.
- Microcontroller & Sensor Data Collection:
  - Built using an Arduino UNO R4 WiFi board.

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    - Accurate measurement of soil moisture (analog sensor), temperature, and humidity (DHT11).
    - Sensor data collected every 2 minutes for real-time monitoring.
  - Automated Watering Logic:
    - Pump activates only when soil moisture is below 30%.
    - Double-pump cycle improves water absorption into the soil.
  - MQTT
    - ESP32 publishes sensor data to a Mosquitto MQTT broker.
  - Telegraf:
    - Subscribes to MQTT topics and consumes sensor data.
    - Parses JSON-formatted messages and forwards them to InfluxDB.
  - InfluxDB:
    - Time-series database used to store sensor values and pump events.
- Grafana:
  - Visualizes real-time and historical data via interactive dashboard.
    - Gauges: Three real-time gauges display humidity, air temperature, and soil moisture.
    - Individual Graphs: Separate graphs for each data point.
    - Combined Graph: A graph showing all three sensor readings together for comparison.
    - Pump activation time: Displays pump activation times from latest to oldest.
  - The data is aggregated over 10-minute intervals using the mean function, which averages the last 5 data points sent every 2 minutes, helping to smooth out error readings and provide more stable values.
  - Accessible securely at https://jeid.live via HTTPS and reverse proxy.

3. Project success

Enter a short summary of the progress of the project. Analyze the task planned for the project in relation to the actual one. Describe the achievement of project results in relation to what was planned.

First we started with the physical building and Virtual Machine setup. Here we made some changes - instead of using Raspberry Pi we used Arduino UNO R4 WiFi. We also switched our virtual machine from AWS to cPouta. After our virtual machine was ready we jumped to connect arduino and virtual machine. For this connection we used MQTT Mosquitto. When

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the connection was ready we wanted to gather the data from Arduino to InfluxDB which is a database. For data visualization we decided to use Grafana. Grafana retrieves data from our database and visualizes it. For Grafana to get the data we configured Telegraf which transfers the data from InfluxDB to Grafana.

This was our first time doing anything like this and we all learned a lot of new things. Overall our project was completed as planned and we are really happy with the results.

4. Performance of the project team

Describe the role and tasks of the project team members in the project and report the working hours spent on the project.

Name	Tasks and responsibilities in the project	Project hours
Jade Malin	Project Manager, Virtual Machine setup, MTIG stack.	175
Emilia Hauskaviita	Physical configurations and physical building.	172
Selma El Uharani	Grafana and documentation.	151

5. Experiences

- Troubleshooting skills
- Project management
- Virtual Machine setup
- Docker configuration
- C++
- Grafana
- Documentation

6. Links to project materials

https://github.com/redbulls77/plantproject

JES - Monitoring - Grafana -snapshot