Smart solutions for increasing the quality of plant life

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OBJECTIVES

- ▶ Making an automatic irrigation system based on weather conditions and environmental data

- ▶ Control over the irrigation process

- ▶ Remote irrigation monitoring

- ▶ Efficiency of water and energy consumption

WORK ENVIRONMENT

▶ The garden in Apoldu de Jos, Sibiu County

▶ The test area is marked with red border

▶ Tube system installed now
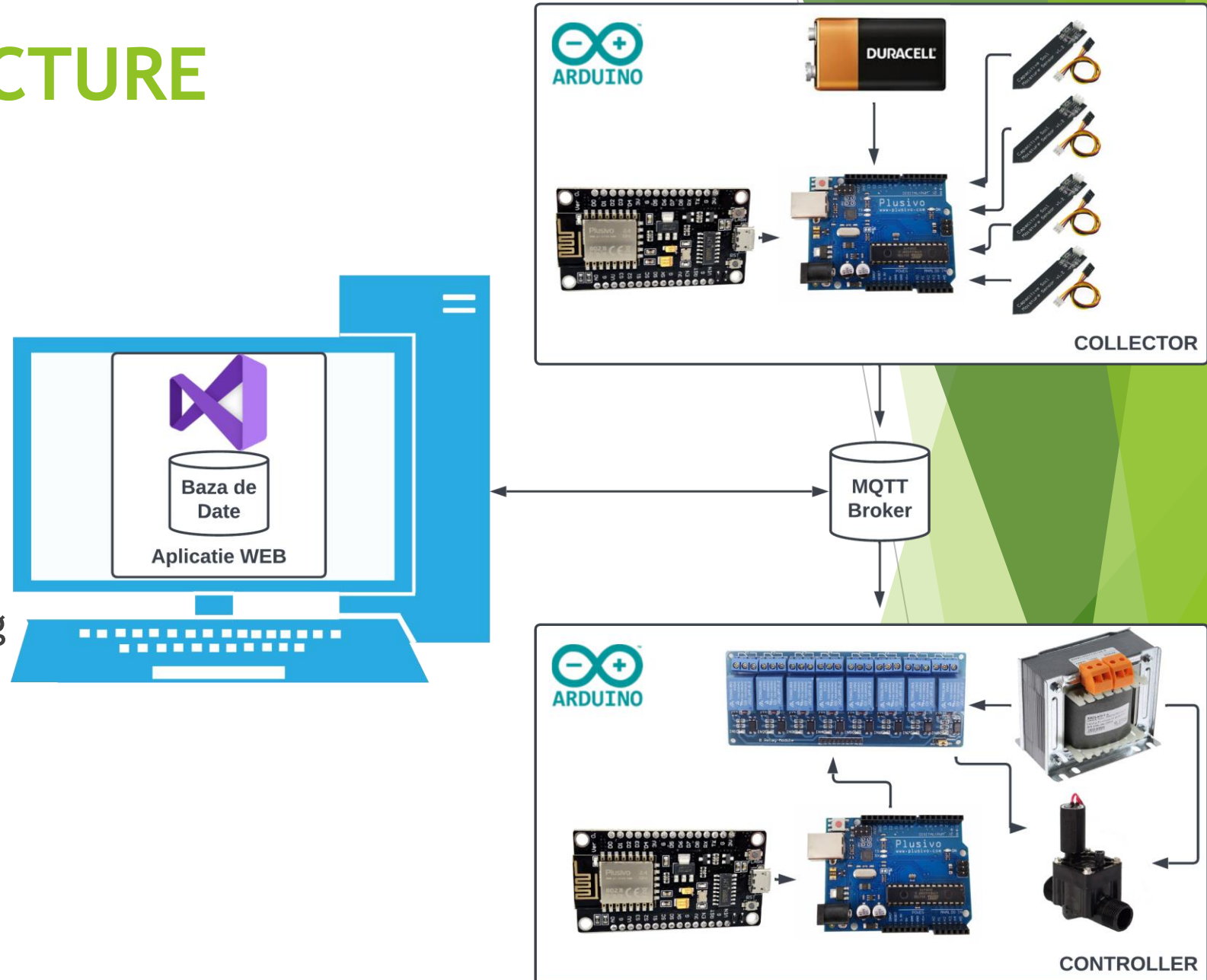
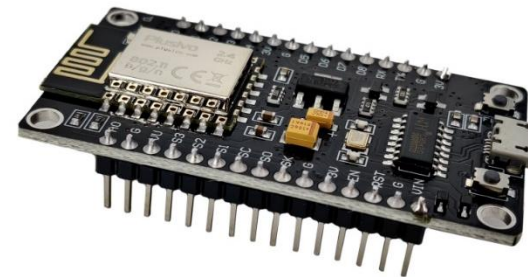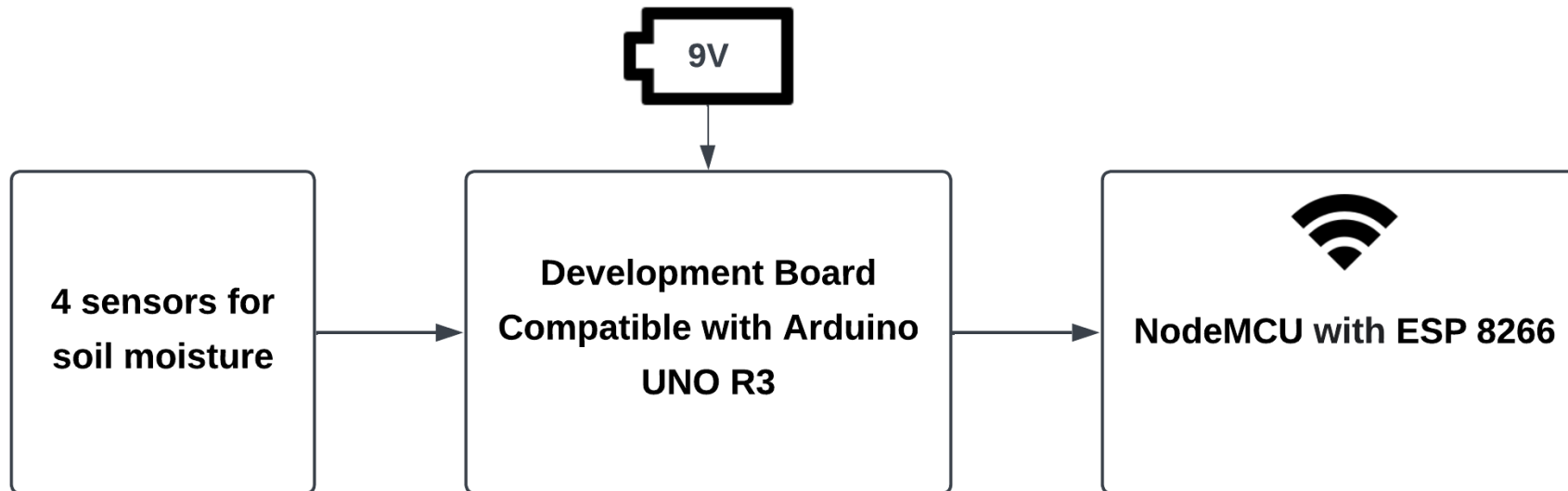▶ Drip irrigation directly to the plant root

SYSTEM ARCHITECTURE

▶ **SOFTWARE**

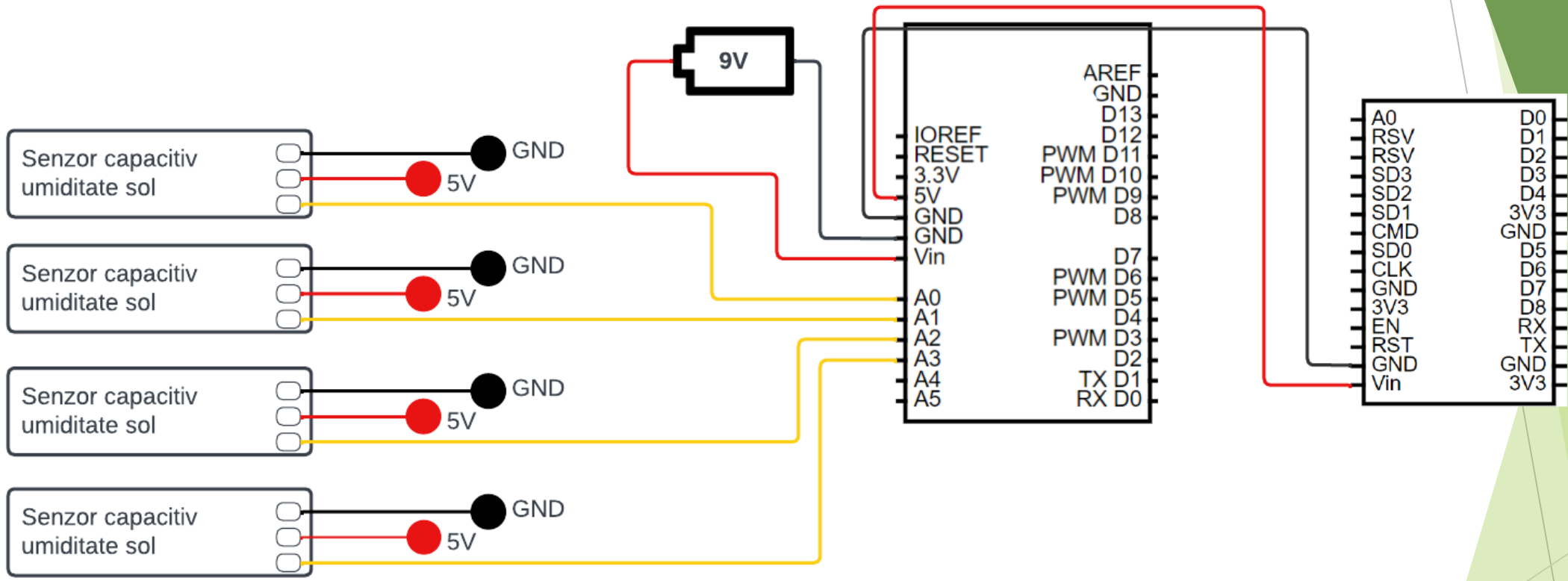▶ Web application to monitor environmental conditions and control irrigation

▶ **HARDWARE**

▶ Embedded device for collecting data from the living environment of plants

▶ Embedded irrigation process control device

Baza de Date

Aplicatie WEB

COLLECTOR

MQTT Broker

CONTROLLER

COLLECTOR

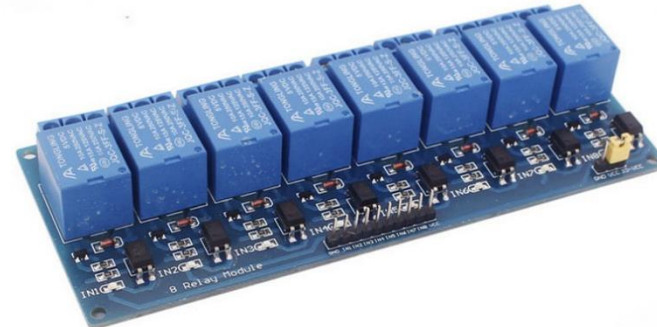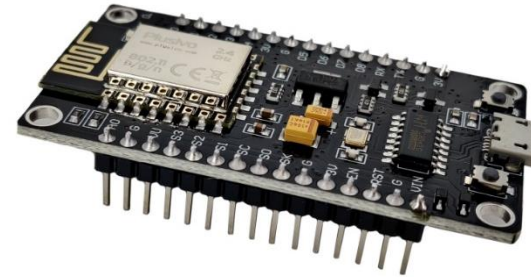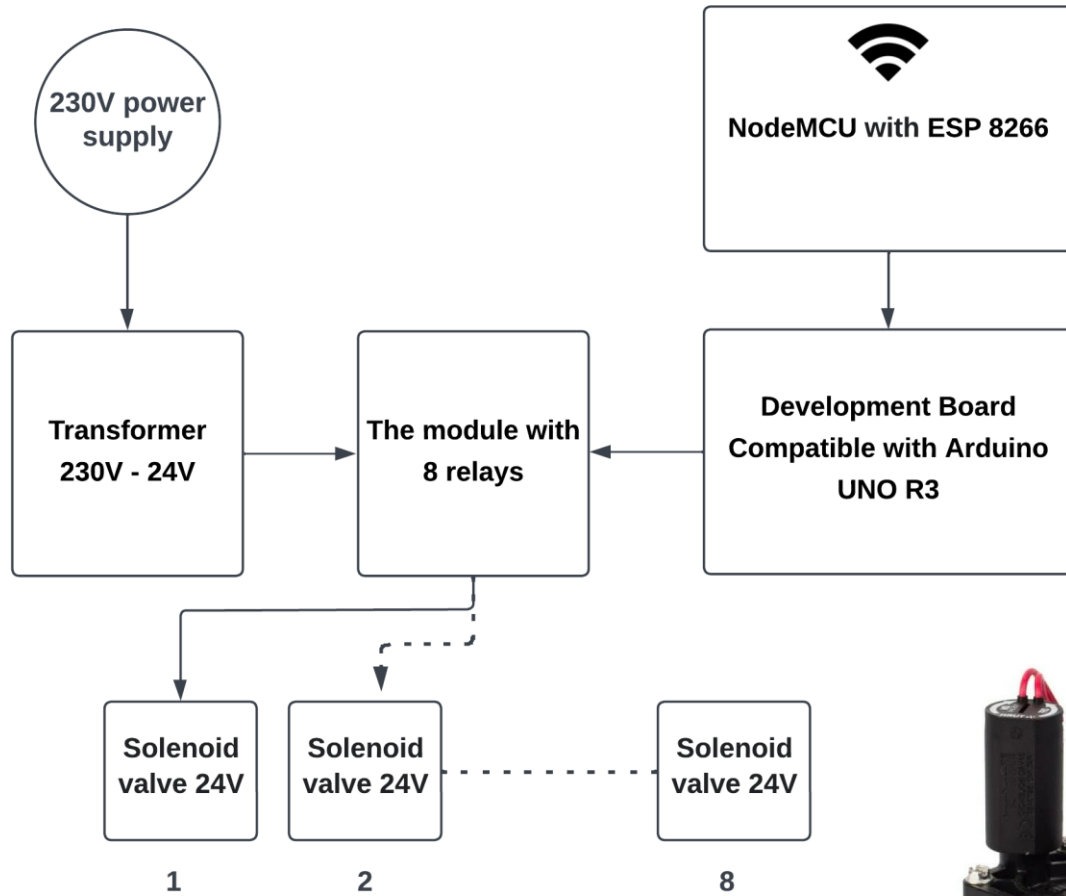4 sensors for soil moisture → Development Board Compatible with Arduino UNO R3 → NodeMCU with ESP 8266

9V

COLLECTOR
Wiring diagram

COLLECTOR

CONTROLLER

230V power supply → Transformer 230V - 24V → The module with 8 relays

NodeMCU with ESP 8266 → Development Board Compatible with Arduino UNO R3 → The module with 8 relays

The module with 8 relays → Solenoid valve 24V (1), Solenoid valve 24V (2), Solenoid valve 24V (8)
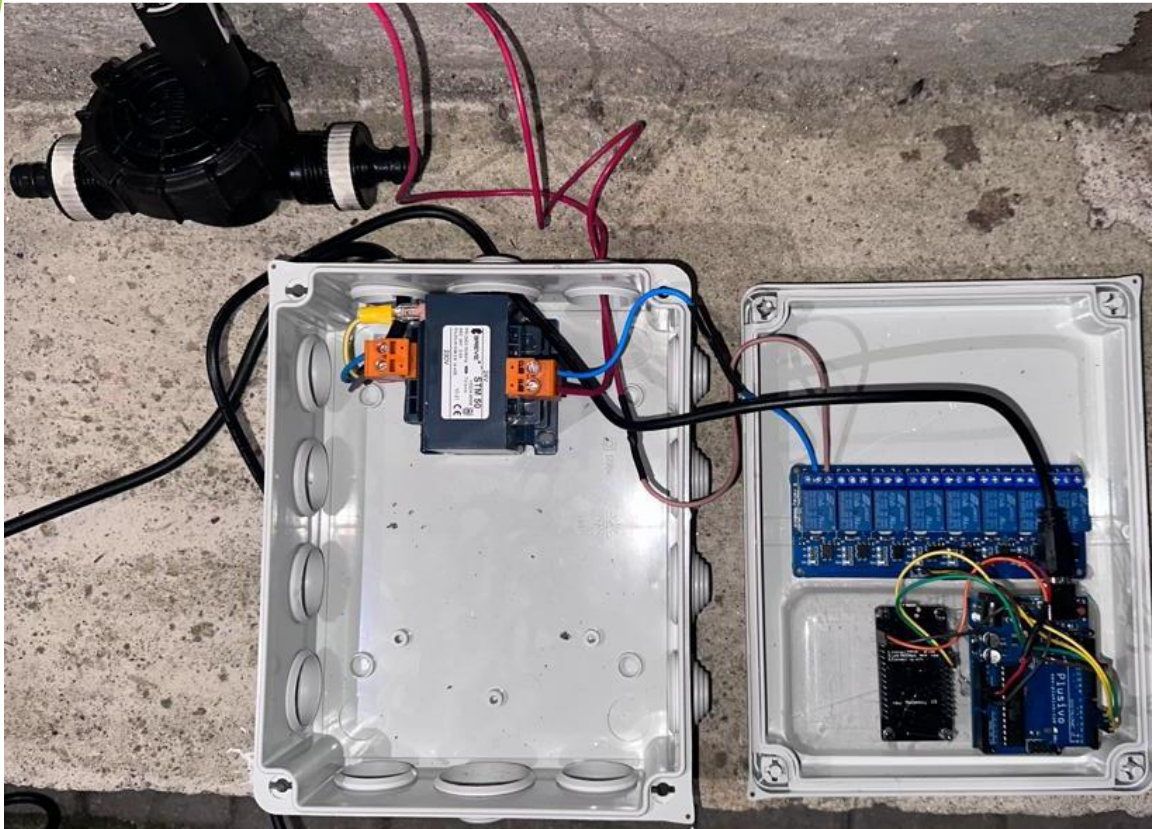
Internal
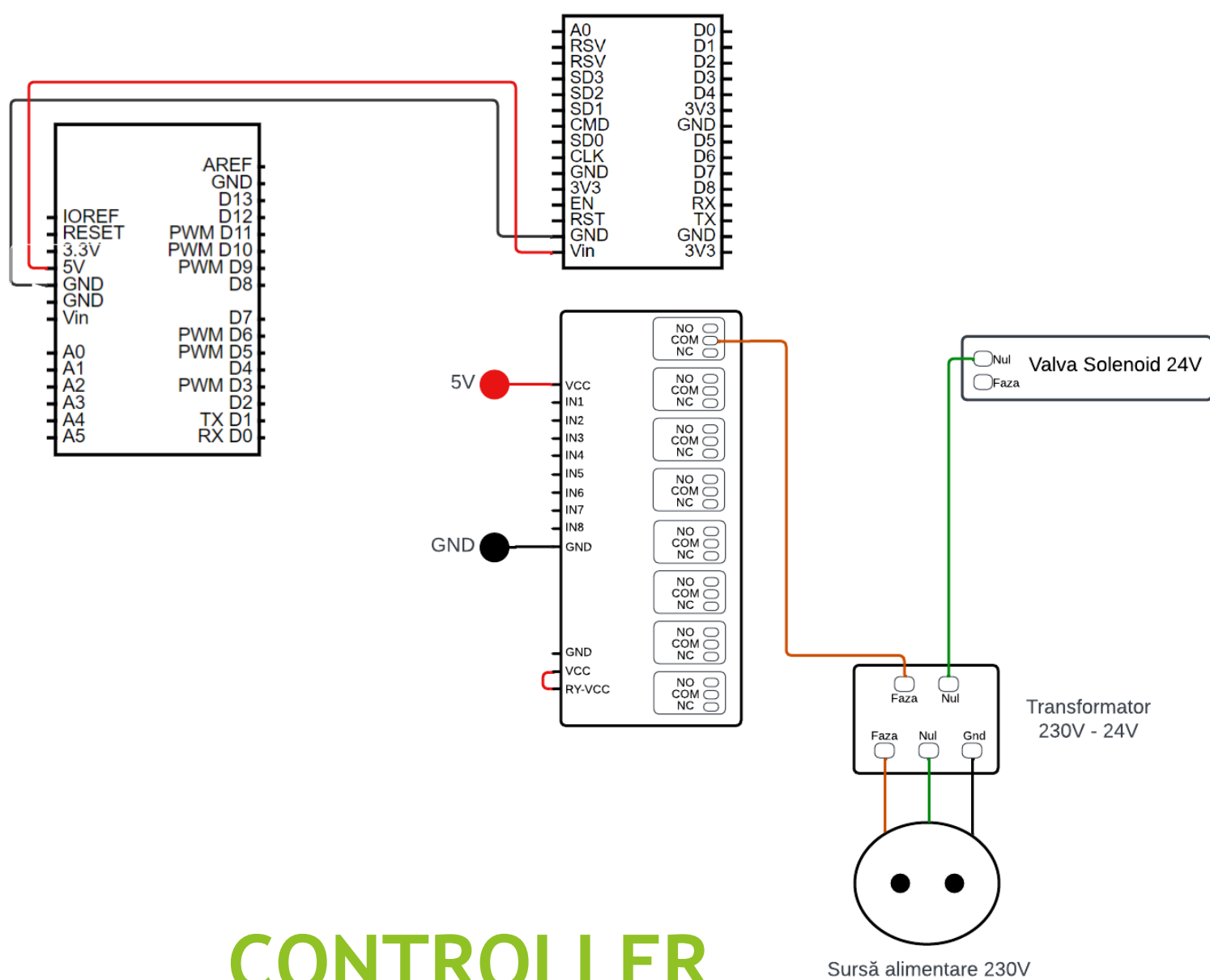
CONTROLLER
Wiring diagram

CONTROLLER

COMMUNICATION

Baza de Date

Operatii CRUD
(Create,Read,Update,Delete)

Aplicatie WEB

/valve/status

/collector/data

Collector — /collector/data → MQTT Broker — /valve/status → Controler
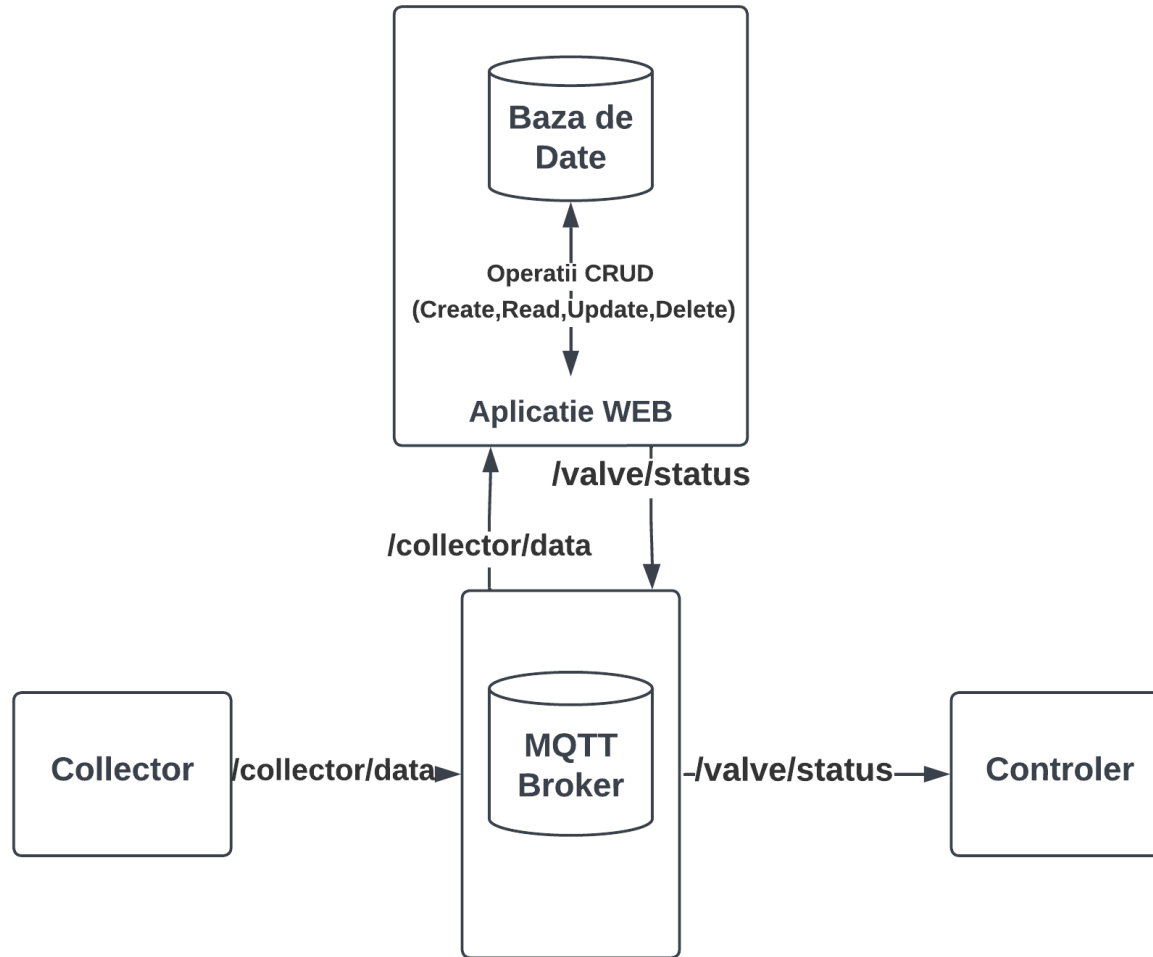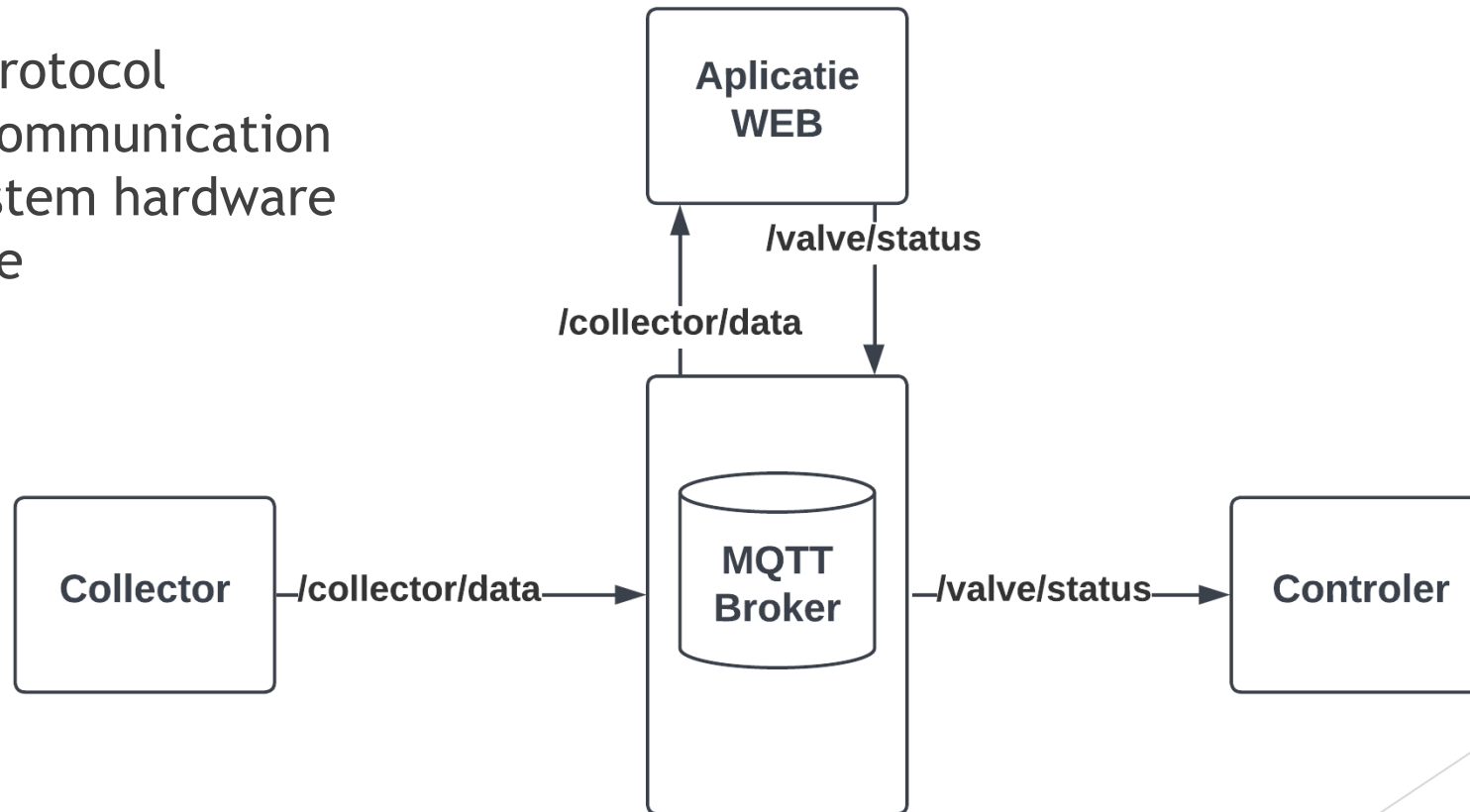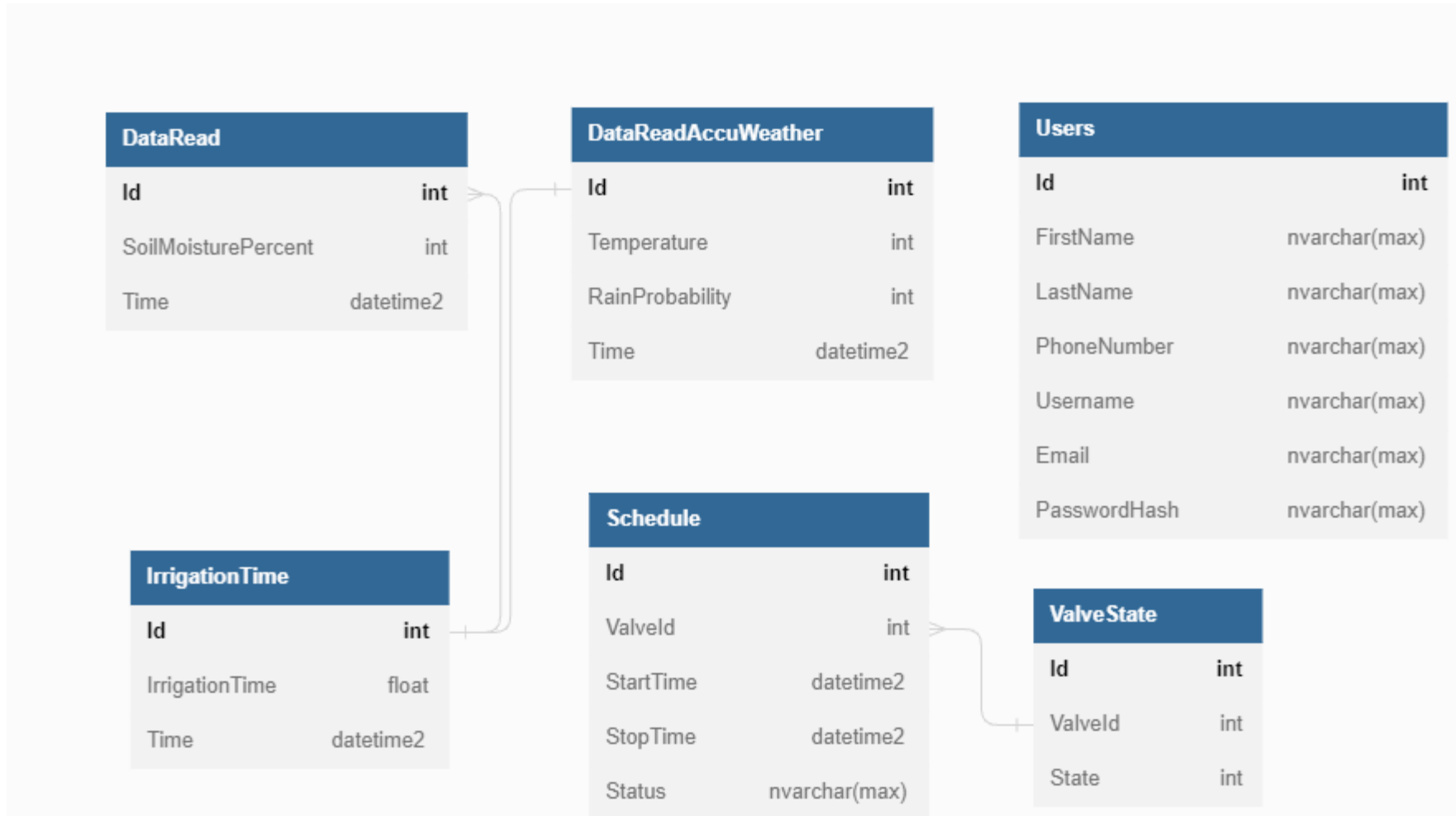
MQTT

The MQTT protocol facilitates communication between system hardware and software

DATA BASE

COLLECTOR

▶ Applications developed in the Arduino IDE, in the C++ programming language

▶ It uses serial communication and the MQTT protocol

▶ Read data from sensors

▶ Send the data to the web application

CONTROLLER

▶ Applications developed in the Arduino IDE, in the C++ programming language

▶ It uses serial communication and the MQTT protocol

▶ It handles valve control

▶ Receives data from the web application about the status of the valve

WEB APPLICATION

▶ Web application developed in ASP.NET Core Model-View-Controller(MVC), using the Visual Studio development environment

▶ Database built using Visual Studio's development tools

▶ Communication with embedded devices through the MQTT protocol

▶ CRUD operations on database data

▶ It allows controlling the irrigation process in 3 ways:

   ▶ Manual

   ▶ Scheduled

   ▶ Automatic
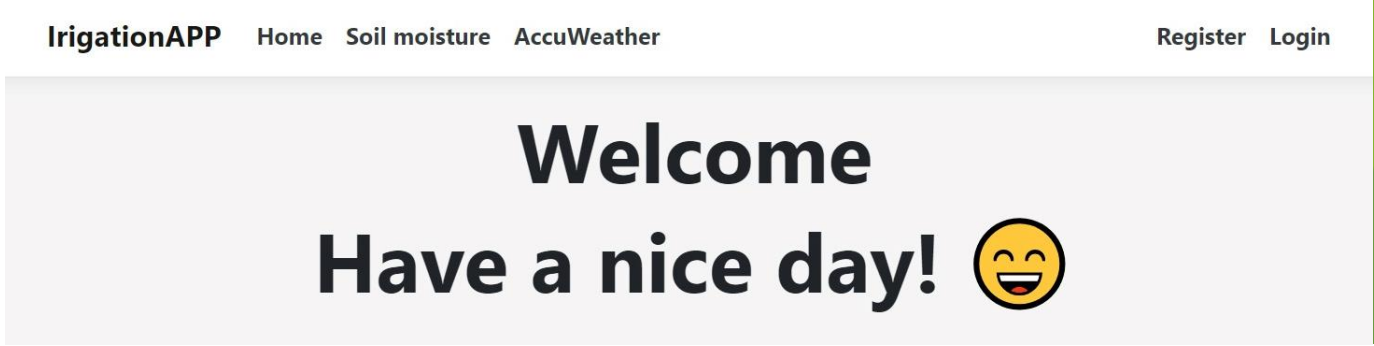
▶ Contains the calculation logic for automatic mode
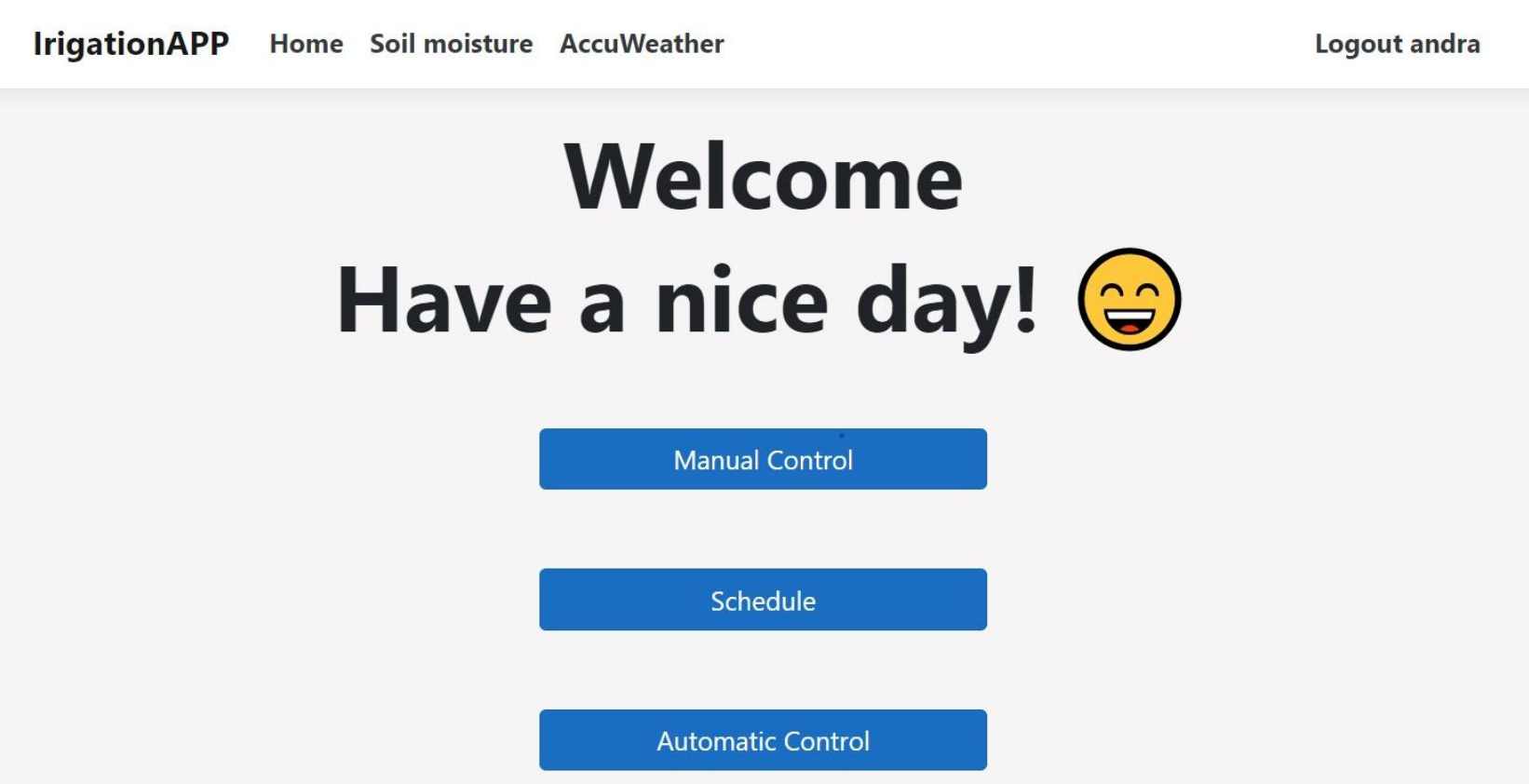
WEB APPLICATION
AUTOMATIC IRRIGATION PROCESS

▶ Based on data from Collector and AccuWeather API (AccuWeatherService), irrigation time is calculated

▶ Decisions are made based on fuzzy rules

▶ Fuzzy system variables:

  ▶ Soil Moisture {DRY, MODERATE, WET}

  ▶ Air Temperature{COLD, MODERATE, HOT}

  ▶ Rain Probability{NO, YES}

  ▶ Irrigatin Time{NONE, SHORT, MEDIUM, LONG, VERY_LONG}

▶ The total number of possible rules will be 3 (for humidity) * 2 (for rain) * 3 (for temperature) = 18 rules

▶ Examples of rules:

IF (soil_moisture IS dry) AND (rain_probability IS no) AND (air_temperature IS cold) THEN (irrigation_time IS long).

IF (soil_moisture IS moderate) AND (rain_probability IS no) AND (air_temperature IS cold) THEN (irrigation_time IS short).

WEB APPLICATION
HOME

▶ Logged out

▶ Logged in

▶ Simple and intuitive interface

▶ It allows users to interact with the system simply and easily

IrigationAPP   Home Soil moisture AccuWeather   Register Login

Welcome
Have a nice day! 😄

IrigationAPP   Home Soil moisture AccuWeather   Logout andra

Welcome
Have a nice day! 😄

Manual Control

Schedule

Automatic Control

Internal

WEB APPLICATION

▶ Manual control

Manual Control

Valve Id	State	Time	
1	OFF	6/30/2023 5:18:33 PM	Turn On / Turn Off

Schedule

Create New

ValveId	Start Time	Stop Time	Status	
1	6/30/2023 4:55:00 PM	6/30/2023 5:00:00 PM	In Progress	Delete
1	6/30/2023 7:57:00 PM	6/30/2023 8:06:00 PM	Waiting	Delete
1	6/22/2023 11:03:00 PM	6/22/2023 11:04:00 PM	Finished	Delete
1	6/22/2023 9:09:00 PM	6/22/2023 9:10:00 PM	Finished	Delete
1	6/21/2023 12:47:00 PM	6/21/2023 12:49:00 PM	Finished	Delete
1	6/21/2023 12:31:00 PM	6/21/2023 12:32:00 PM	Finished	Delete
1	6/21/2023 12:28:00 PM	6/21/2023 12:29:00 PM	Finished	Delete

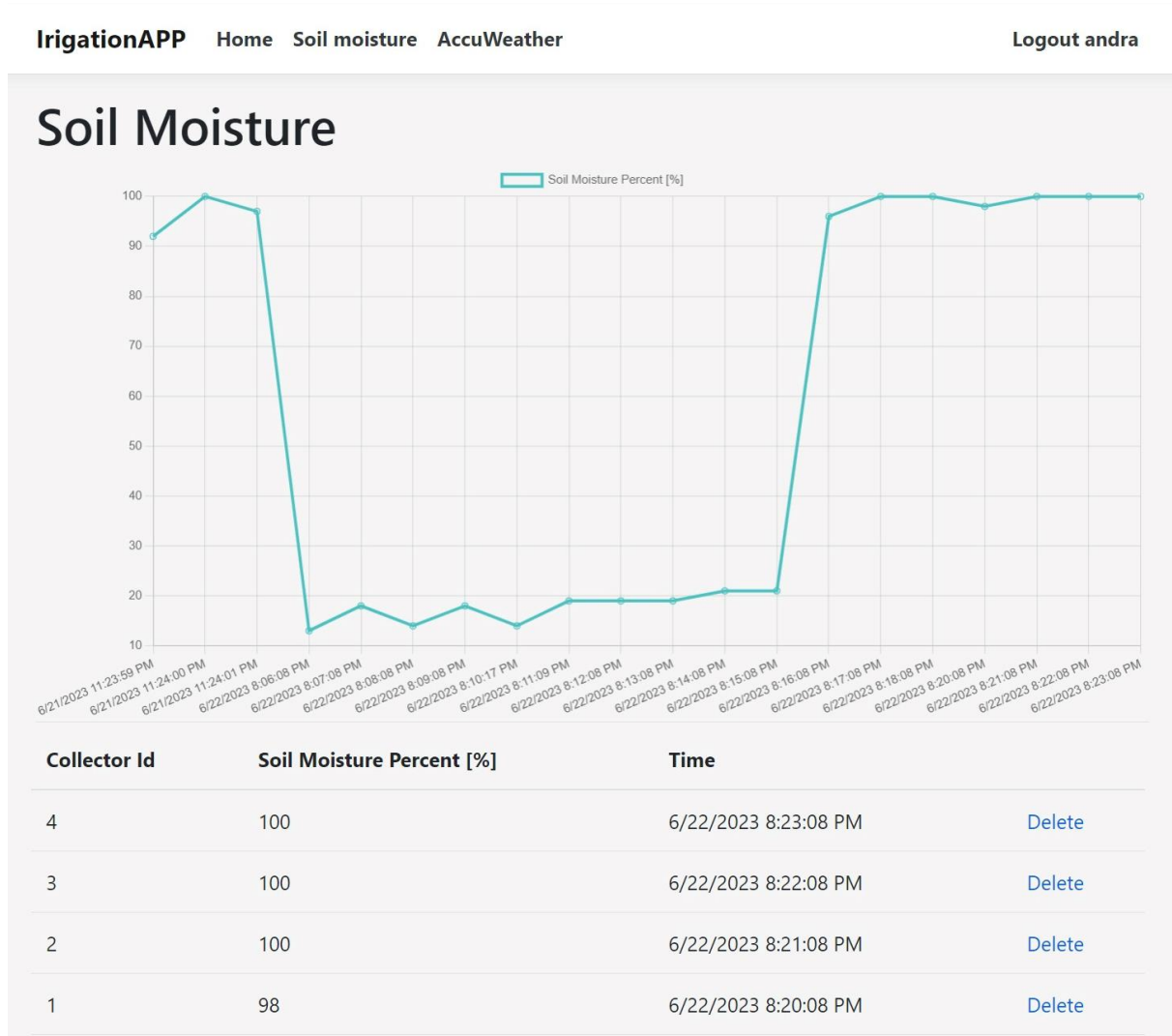▶ Programming irrigation plans

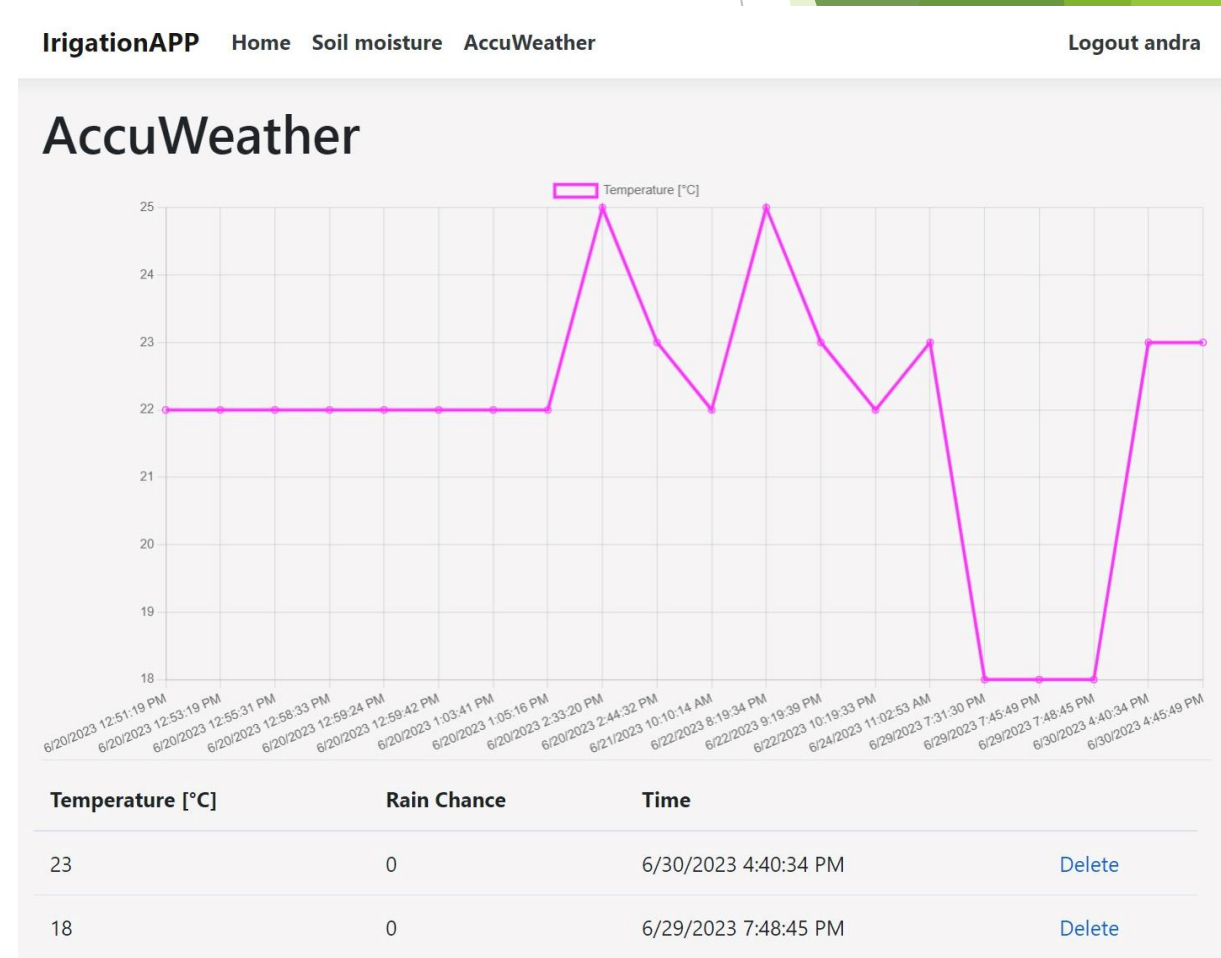# WEB APPLICATION

▶ Auto control statistics in graph and table

WEB APPLICATION

View data from AccuWeather in real time in tables and graphs

View data from the Collector in real time in tables and graphs

LIMITATIONS

- Good Wi-Fi signal to facilitate communication between components

- The collector is powered by the battery, which requires constant checking and periodic replacement

- The need to recalibrate soil moisture sensors

CONCLUSIONS

▶ The proposed system makes the irrigation process more efficient

▶ It provides the opportunity to monitor plants

▶ Provides control over the irrigation process, allowing it to be adjusted and customized according to the specific needs of the garden

▶ It offers the advantage of remote control, giving users the ability to manage the system from anywhere through an easy-to-use web application

▶ It contributes to the efficient use of irrigation water, minimizing wastage and maximizing plant productivity

FURTHER DEVELOPMENTS

▶ Extending the system over the entire garden to cover the remaining areas

▶ Improving and adapting the automatic calculation method to the type of plants and their moisture needs

▶ Adding a backup plan in case the server is unavailable or there is no data from the AccuWeather collector or API

▶ Improving system security

Internal

Thank you!