THE DESIGN OF A REMOTE-CONTROLLED AUTOMATION SYSTEM USING MOBILE DEVICES

by

151220192022 YAHYA ARSLAN

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A Graduation Project Report

Electrical Electronics Engineering Department

JUNE 2024

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A Report Presented in Partial Fulfilment of the Requirements for the Degree Bachelor of Science in Electrical Electronics Engineering

ESKISEHIR OSMANGAZI UNIVERSITY

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ABSTRACT

This project addresses the design and implementation of a contemporary automation system in the agricultural sector, which can be remotely controlled via mobile devices. The focal point of the system is to precisely monitor and control environmental factors - such as temperature, humidity, light, and irrigation - in greenhouse environments to optimize plant growth.

Among the core components used in the project are industrial control devices like the Siemens S7-1200 series PLC. This PLC collects, processes, and provides necessary commands to control various actuators, while sensors such as temperature and humidity sensors are also employed, along with actuators like fans, lights, and irrigation pumps.

In addition to electrical and electronic components, the mobile application interface is an integral part of the project. This application allows users to access and monitor the system from anywhere, anytime, enabling them to observe and regulate environmental conditions. Furthermore, cloud-based database systems like Firebase Realtime Database and programming tools like Node-RED are utilized for communication and data management.

The project offers an approach aimed at increasing efficiency and supporting sustainability in the agricultural industry by leveraging the advantages provided by technology. This contributes valuable insights for those seeking modernization and innovative solutions in the agricultural sector.

Keywords: *automation, mobile application, greenhouse, sensors, actuators, communication*

ÖZET

Bu proje, tarım sektöründe çağdaş bir otomasyon sistemi olan ve mobil cihazlar aracılığıyla uzaktan kontrol edilebilen bir tasarım ve uygulama sürecini ele almaktadır. Sistemin odak noktası, sera ortamlarında bitki büyümesini optimize etmek için çevresel faktörlerin- sıcaklık, nem, ışık ve sulama gibi- hassas bir şekilde izlenmesi ve kontrol edilmesidir. Bu, bitki yetiştiriciliğinde geleneksel yöntemlere kıyasla daha tutarlı ve verimli bir yaklaşım sunar.

Projede kullanılan temel bileşenler arasında, Siemens S7-1200 serisi PLC gibi endüstriyel kontrol cihazları yer almaktadır. Bu PLC, sensörlerden gelen verileri toplar, işler ve çeşitli aktüatörleri kontrol etmek için gerekli komutları sağlar. Sensörler arasında sıcaklık ve nem sensörleri bulunurken, aktüatörler arasında fanlar, ışıklar ve sulama pompaları gibi öğeler yer alır.

Elektrik ve elektronik bileşenlerin yanı sıra, mobil uygulama arayüzü de projenin ayrılmaz bir parçasıdır. Bu uygulama, kullanıcılara sisteme her zaman ve her yerden erişme ve çevresel koşulları izleme ve kontrol etme imkânı sunar. Ayrıca, haberleşme ve veri yönetimi için Firebase Realtime Database gibi bulut tabanlı veritabanı sistemleri ve Node-RED gibi programlama araçları kullanılmaktadır.

Proje, tarım endüstrisinde teknolojinin sağladığı avantajlardan faydalanarak verimliliği artırmayı ve sürdürülebilirliği desteklemeyi amaçlayan bir yaklaşım sunmaktadır. Bu, tarım sektöründe modernleşme ve yenilikçi çözümler arayanlar için değerli bir katkı sağlar.

Anahtar Kelimeler: *otomasyon, mobil uygulama, sera, sensörler, aktüatörler, haberleşme*

ACKNOWLEDGEMENT

We are grateful to Prof. Dr. Semih Ergin for his continuous support and guidance throughout the project, from its inception. Additionally, we would like to thank Ender Kelleci, our industry advisor, for his support within the scope of the TÜBİTAK 2209-B University Students Sector-Focused Research Projects Support Program.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol	**Explanation**
cm:	Centimeter
GHz:	Gigahertz
GB:	Gigabyte
V:	Volts
mA:	Milliampere
V_{cc}:	Positive supply voltage
GND:	Ground
°C:	degrees Celsius
W:	Watt

Abbreviation	**Explanation**
PLC:	Programmable Logic Controller
SCADA:	Supervisory Control and Data Acquisition
RAM:	Random Access Memory
CPU:	Central Process Unit
TIA Portal:	Totally Integrated Automation Portal
HMI:	Human Machine Interface
LED:	Light Emitting Diode
DC:	Direct Current
AC:	Alternating Current
RLY:	Relay
3D:	Three-Dimensional
Node-RED:	Node-Representation of Events in Dom

1. INTRODUCTION

The rapid advancement of technology has facilitated the widespread adoption of automation systems in the agricultural sector. These systems are used to read, evaluate, and execute necessary operations based on data from sensors in the environment, allowing critical agricultural activities to be carried out with greater precision. This aims to minimize costs and enhance efficiency and sustainability in agricultural production.

Digitalization refers to the use of information and communication technologies across all areas and the transition of business processes to digital platforms. With digitalization, significant advantages are achieved in terms of efficiency, speed, and accessibility. The aim of this study is to optimize plant growth by precisely monitoring and controlling environmental factors such as temperature, humidity, light, and irrigation in a greenhouse using a mobile application.

Our project addresses complex technical requirements in the field of electrical and electronic engineering through a multifaceted approach. Integration of various electrical and electronic components is necessary to ensure the integrity of the system. This includes technical aspects such as accurate collection of sensor data, electronic circuit designs, reliability of control systems, and data communication.

When comparing our project with existing methods, similarities such as remote monitoring, data collection, and user interface are observed. However, mobile applications offer greater flexibility compared to SCADA systems due to their accessibility and portability via smart devices. Thus, mobile applications enable users to access and manage data anytime, anywhere, enhancing operational efficiency.

2. REQUIREMENTS SPECIFICATION

- **Physical Requirements**

1. The system will be manufactured in an area about 3200 cm^2.
2. The environment must be safe and suitable for electrical connections.
3. The materials chosen for the cabin should be durable, lightweight, and insulated.

- **Performance and Functionality Requirements**

1. Accurate and sensitive sensors should be used for humidity and temperature control.
2. The PLC should accurately read sensor data and provide control according to desired conditions.
3. The mobile application and the PLC should work synchronously.
4. An appropriate LED lighting system is required to provide plants with the necessary light for photosynthesis.

- **System Requirements**

1. Processor type should be Pentium M, 1.6 GHz or similar.
2. RAM should be at least 1 GB.
3. There should be at least 2 GB of free space on the system drive C:.
4. The operating system must be at least Windows 7.

- **Economic Requirements**

1. The overall cost of the system should be optimized to ensure affordability and cost-effectiveness.
2. Durable and long-lasting components should be selected to minimize maintenance and repair costs.

- **Environmental Requirements**

1. The system should minimize energy consumption and waste generation to reduce environmental impact.

- **Health and Safety Requirements**

1. High temperatures should be avoided to prevent the cabin from melting.
2. The electrical components must be properly isolated.
3. Sensors must be provided with voltage within their operating range.
4. Actuators must be securely mounted to prevent displacement.

- **Manufacturability and Maintainability Requirements**

1. Spare parts should be readily available when needed.

3. STANDARDS

- **IEC 61508** (*Functional safety standard of electrical/electronic/programmable electronic safety-related systems of the International Electrotechnical Commissio*n): Compliance with safety standards is ensured in our project to reduce the risks related to electrical systems and ensure the safety of users and operators.

- **ISO 9001** (*International Organization for Standardization's standard for quality management systems*): Testing procedures should align with ISO 9001 to ensure the reliability and consistency of our system's performance.

- **IEC 61131** (*International Electrotechnical Commission's standard for PLC programming languages*): Adhering to programming language standards like IEC 61131 ensures consistency and compatibility in the development of control software for PLCs.

4. PATENTS

- Automated Greenhouse, Patent No: US20160212948A1
- Intelligent fertilization control system for greenhouse, Patent No: CN210352379U

5. THEORETICAL BACKGROUND

Automation integrates industrial equipment by using electronic devices that monitor every step of the process, ensuring control until the outputs are obtained through processing inputs. This enables a range of benefits such as accelerated processes, error-free operation, increased workforce productivity, cost reduction, and enhanced competitiveness.

5.1 System Prototype

In the first stage of our project, a cabin was designed to be used as a greenhouse, and a 3D model was created in the Sketchup application before implementing this design. Thanks to 3D modelling, the placement of all necessary components such as a resistor, cooling fan, humidity sensor and temperature sensor inside the cabinet was planned efficiently. In addition, the locations of the LEDs to be used for lighting were determined, and the overall system layout was created. The 3D drawing of the system prototype is given in Figure 1.

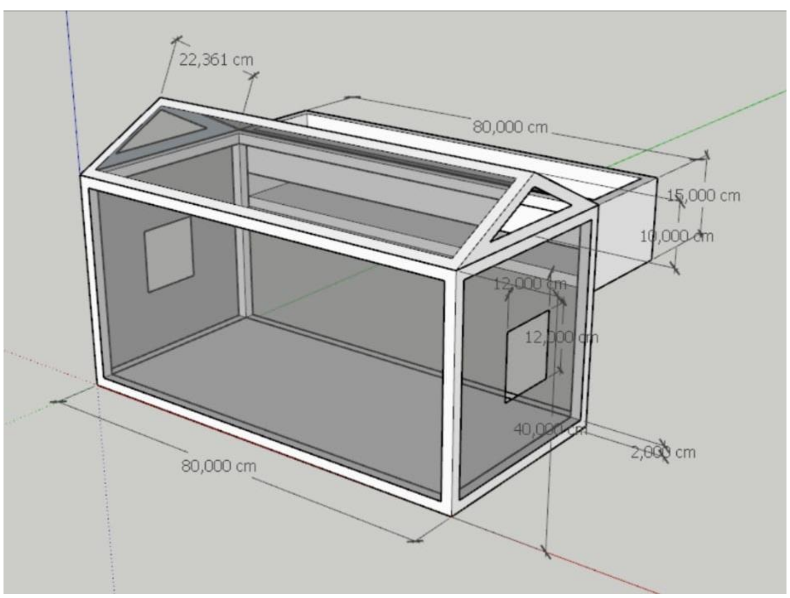

Figure 1. *System Prototype*

5.2 PLC (Siemens S7-1200)

The S7-1200 controller provides the flexibility and power to control a wide variety of devices in support of your automation needs. The CPU combines a microprocessor, an integrated power supply, input, and output circuits, high-speed motion control I/O, and on-board analog inputs in a compact housing to create a powerful controller.[1] The structure of the controller is given in Figure 2 below.

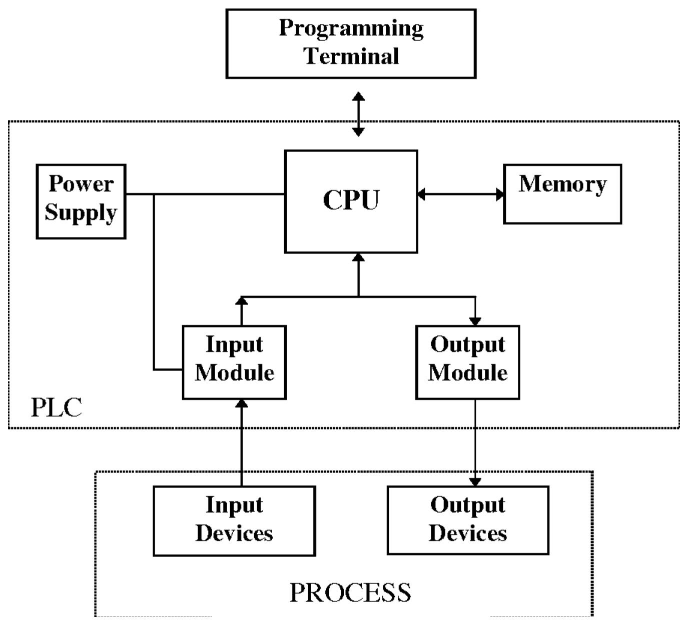

Figure 2. *Structure of Siemens S7-1200*

5.2.1 TIA Portal

TIA Portal enables the design, configuration, programming, and monitoring of automation applications such as PLC programming, HMI design, drive configuration, and integration of SCADA systems in a single environment. The portal view and the project interface in the TIA Portal are given in Figure 3 and Figure 4, respectively.

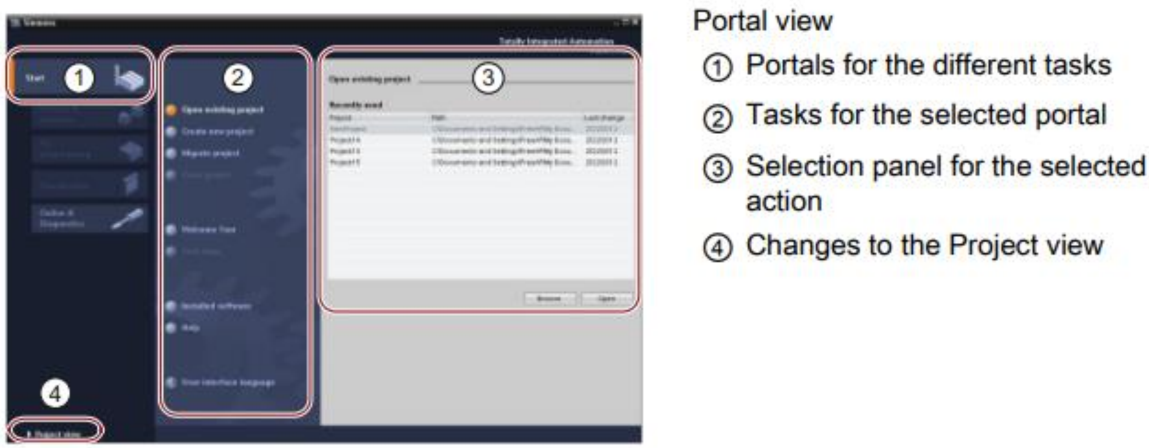

Figure 3. *Portal View*

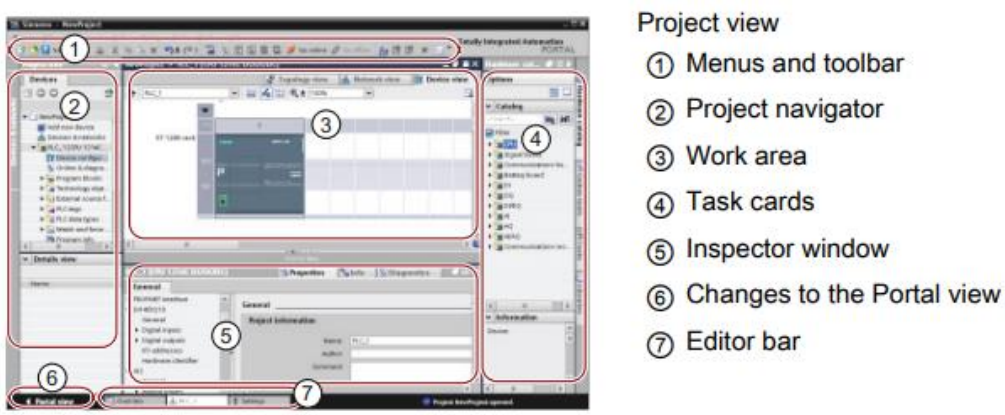

Figure 4. *Project View*

5.3 Sensors

Sensors are devices that detect various physical quantities and convert this information into electrical signals. Sensors receive an input based on the physical quantity they measure and detect environmental conditions based on this input. These detected physical changes are then converted into electrical signals through special components or circuits inside the sensor. This conversion process occurs depending on the physical quantity detected by the sensor.

Typically, voltage or current signals are found at the output of sensors. This output signal varies depending on the value of the physical quantity measured by the sensor. Sensors that produce voltage signals typically generate signals in the range of 0 to 5 volts, while sensors that produce current signals usually generate signals in the range of 4 to 20 mA. The operating principle of sensors are given in Figure 5 below.

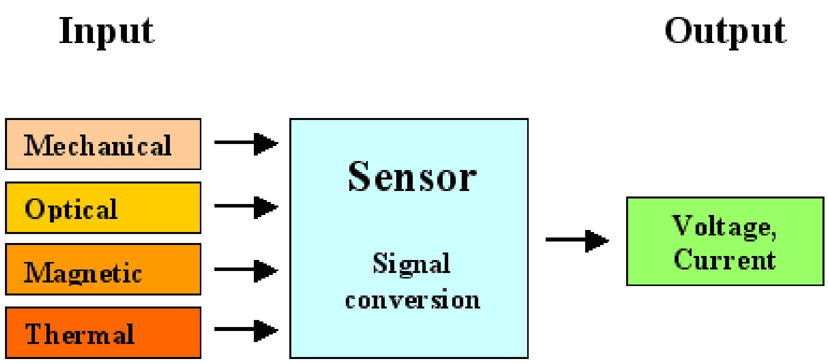

Figure 5. *Operating Principle of Sensors*

Sensors generally have three main connections: V_{cc}, GND, and data. The V_{cc} connection provides the positive supply voltage required for the sensor to operate. This voltage value may vary among different sensors. The GND connection is the negative connection point used to complete the sensor's electrical circuit. The data connection provides an output signal corresponding to a physical quantity measured by the sensor. This output signal can be both analog and digital. The functions of the cables in the sensors are given in Figure 6 below.

Figure 6. *Sensor Connections*

5.3.1 Analog Sensors

Analog sensors are devices that detect the physical quantity they measure and convert this information into analog electrical signals. These types of sensors typically produce analog signals such as voltage or current. These sensors vary according to the measured quantity and reflect these changes in the output signal. The output signal of analog sensors usually changes over a continuous range, allowing for more precise monitoring of environmental variations.

5.3.2 Digital Sensors

Digital sensors are devices that detect the physical quantity they measure and convert this information into digital signals. These sensors are typically used to indicate situations where a certain threshold value is exceeded or not met. Since digital sensors produce digital signals, the data is generally more stable and less susceptible to noise. This makes digital sensors more reliable than analog sensors for data transmission and processing.

The general specifications of the sensors used in this project are provided in Table 1.

Table 1. *General Specifications of Sensors*

Sensor Type	Operating Voltage	Output Range	Accuracy	Interface
DS18B20	3.0V – 5V	-10 °C - +125 °C	±0.5%	Analog
Waterproof Capacitive Soil Moisture Sensor	3.3V – 5V	0 – 100	±5%	Analog

5.4 Actuators

An actuator is a part of a device or machine that helps it to achieve physical movements by converting energy, often electrical, air, or hydraulic, into mechanical force. The quantity and the nature of input depend on the kind of energy to be converted and the function of the actuator.[2]

The general specifications of the actuators used in this project are provided in Table 2.

Table 2. *General Specifications of Actuators*

Actuator Type	Operating Voltage	Power Consumption	Interface
Fan	12V DC	3W	Digital
LED	12V DC	14.4W	Digital
Resistance	220V AC	1000W	Digital
Water Pump	5V DC	1.5W	Digital

5.5 Firebase Realtime Database

Firebase Realtime Database is a cloud-based database system that provides real-time data synchronization. Data is synchronized among all connected clients within milliseconds, allowing for instant updates and seamless data sharing.[3]

5.6 Node-RED

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and interesting ways. It provides a browser-based editor that makes it easy to wire together flows using the wide range of nodes in the palette that can be deployed to its runtime in a single click.[4]

6. METHODOLOGY

In this project, a cabin has been designed for use as a greenhouse. It includes a resistor for heating, two fans for cooling, a water pump for irrigation, LEDs for lighting, a humidity sensor for measuring humidity, and a temperature sensor for measuring temperature. Our project utilizes the S7-1200 series PLC to collect sensor data and create an automation system with a control system. Additionally, the system can be controlled via a mobile application. The hierarchy of the system is given in Figure 7 below.

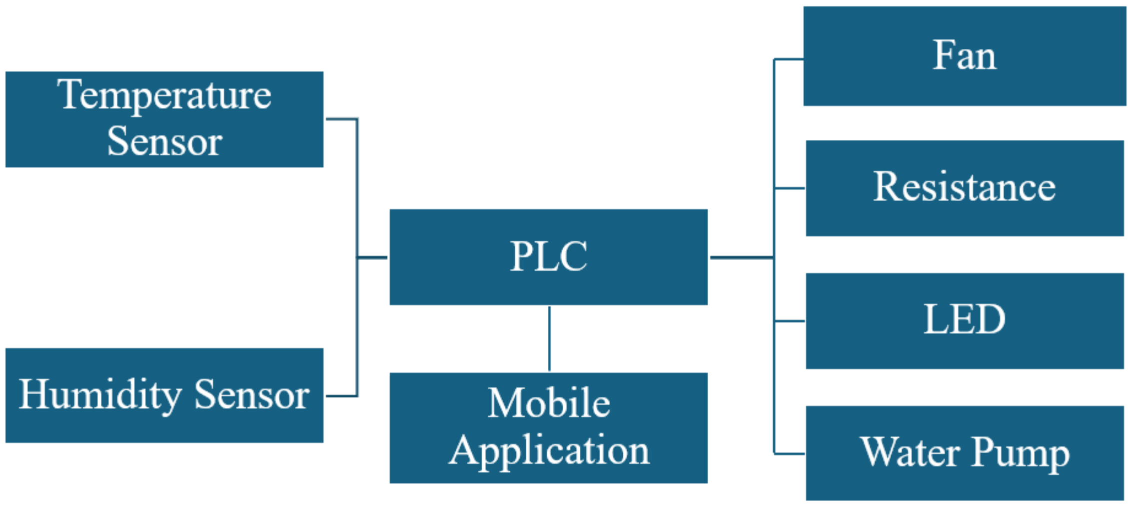

Figure 7. *System Hierarchy*

6.1 System Hardware

The hardware of the system plays a critical role in ensuring the proper functioning of processes. At the same time, it facilitates the accurate reading and transfer of data while maintaining the performance of devices. Hardware components form the backbone of the system by providing the necessary infrastructure for smooth and uninterrupted operation. The workflow of the hardware system in the cabin is given in Figure 8 below.

Figure 8. *Workflow of Hardware*

6.1.1 Siemens S7-1200

The wiring diagram of the PLC used in our project is given in Figure 9 above.

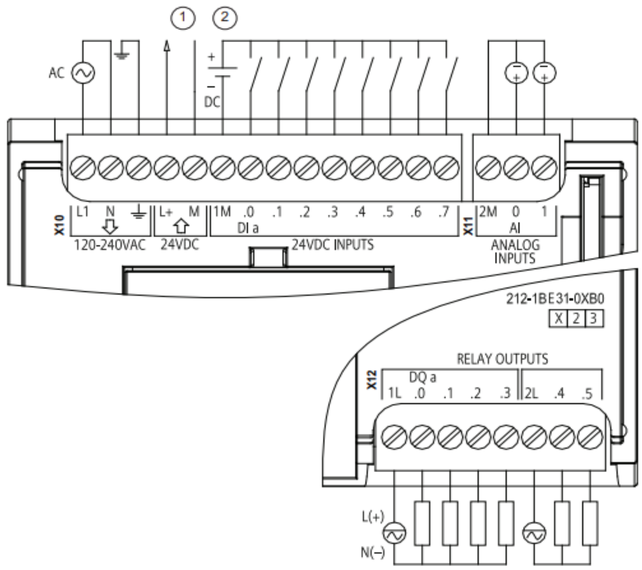

Figure 9. *Wiring Diagram of CPU 1212C AC/DC/RLY*

6.1.2 Sensors

In our project, sensors will continuously check and collect data on the environmental conditions inside the cabin, providing a constant flow of information to our control system. This will ensure that the optimal climate conditions for the plants are maintained within the cabin.

6.1.2.1 Temperature Sensor

The DS18B20 temperature sensor used in our project has a wide temperature range. The sensor can measure temperatures from -55°C to +125°C with an accuracy of ±0.5°C. The sensor generates a voltage value based on the ambient temperature and sends this value to the PLC. The PLC detects this voltage value and calculates the ambient temperature using specific commands. Thus, the temperature information in the environment becomes monitorable.[5] The temperature sensor used in our project is given in Figure 10.

Figure 10. *Temperature Sensor (DS18B20)*

6.1.2.2 Humidity Sensor

The Waterproof Capacitive Soil Moisture Sensor used in our project has the capacity to measure a wide range of moisture levels. This sensor measures the soil moisture percentage and sends this value to the PLC. The sensor operates on the capacitive measurement principle, producing a capacitance value based on the amount of water in the soil and converting this value to a voltage. The PLC detects this voltage value and calculates the soil moisture percentage using specific commands. Thus, the moisture information in the environment becomes monitorable. [6] The humidity sensor used in our project is given in Figure 11.

Figure 11. *Humidity Sensor*

6.1.3 Actuators

Actuators are critical components that assist in achieving the desired environmental conditions within a system. The actuators used in this project are designed to manage various environmental conditions within the system. Various actuators such as resistors for heating, fans for cooling, LEDs for lighting, and water pumps for irrigation are utilized to optimize factors such as temperature, humidity, light, and irrigation within the greenhouse cabin. These actuators play a crucial role in providing the desired conditions within the system and optimizing the process of plant cultivation.

6.1.3.1 Resistance

The resistors used in our project are controlled by the control system. When heating of the environment is required, they are activated by the PLC. The PLC continuously monitors the ambient temperature and activates the resistors when it falls below a certain temperature threshold. This ensures that the ambient temperature is maintained at the desired level and prevents issues arising from freezing or cold temperatures. The resistance used in our project is given in Figure 12.

Figure 12. *Resistance*

6.1.3.2 Fan

The cooling fans used in our project operate based on information received from the control system. The PLC continuously monitors the ambient temperature and activates the fans when it exceeds a certain temperature threshold. This ensures that the environment's temperature is maintained at the desired level and prevents overheating. The fan used in our project is given in Figure 13.

Figure 13. *Fan*

6.1.3.3 LED

The PLC controls the LEDs used in our project. When illumination of the environment is desired, the PLC keeps the LEDs on for a certain period to illuminate the area. The illumination duration can be easily adjusted thanks to the programmable nature of the PLC. This allows for the illumination of the environment according to the need. The LED used in our project is given in Figure 14.

Figure 14. *LED*

6.1.3.4 Water Pump

The water pump used in our project enables the irrigation system in the cabin to be activated as desired. Upon transmission of the irrigation duration information to the PLC, the irrigation system is automatically activated, and irrigation is carried out for the specified duration. The water pump used in our project is given in Figure 15.

Figure 15. *Water Pump*

6.1.3.5 Relay

To protect the PLC from high voltage and current hazards, we placed 24V relays between the actuators and the PLC. These relays close their contacts when a signal is received from the PLC, allowing energy to pass through. This way, the PLC can easily control the operation of the actuators. The relay used in our project is shown in Figure 16 below.

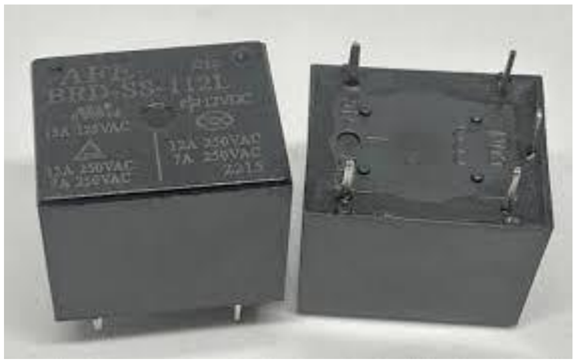

Figure 16. *Relay*

6.2 Software

The software in our project has been specially coded to ensure process control. Through this software, users can easily adjust and optimize environmental factors. The precise monitoring and control of parameters such as temperature, humidity, and lighting allow for the creating of ideal growth conditions for plants. Additionally, the system's user-friendly interface provides both local and remote access, enabling users to control the system from anywhere.

6.2.1 Ladder Logic

Our project utilizes the Ladder Logic programming language to construct the software of our control system. Through this software, data from sensors is processed and the operation of the system is controlled. Additionally, effective communication and coordination among various components of our control system are facilitated thanks to the Ladder Logic programming language. This enhances the reliability of our system while also simplifying maintenance and debugging processes. The flowchart of the PLC code is given in Figure 16 below.

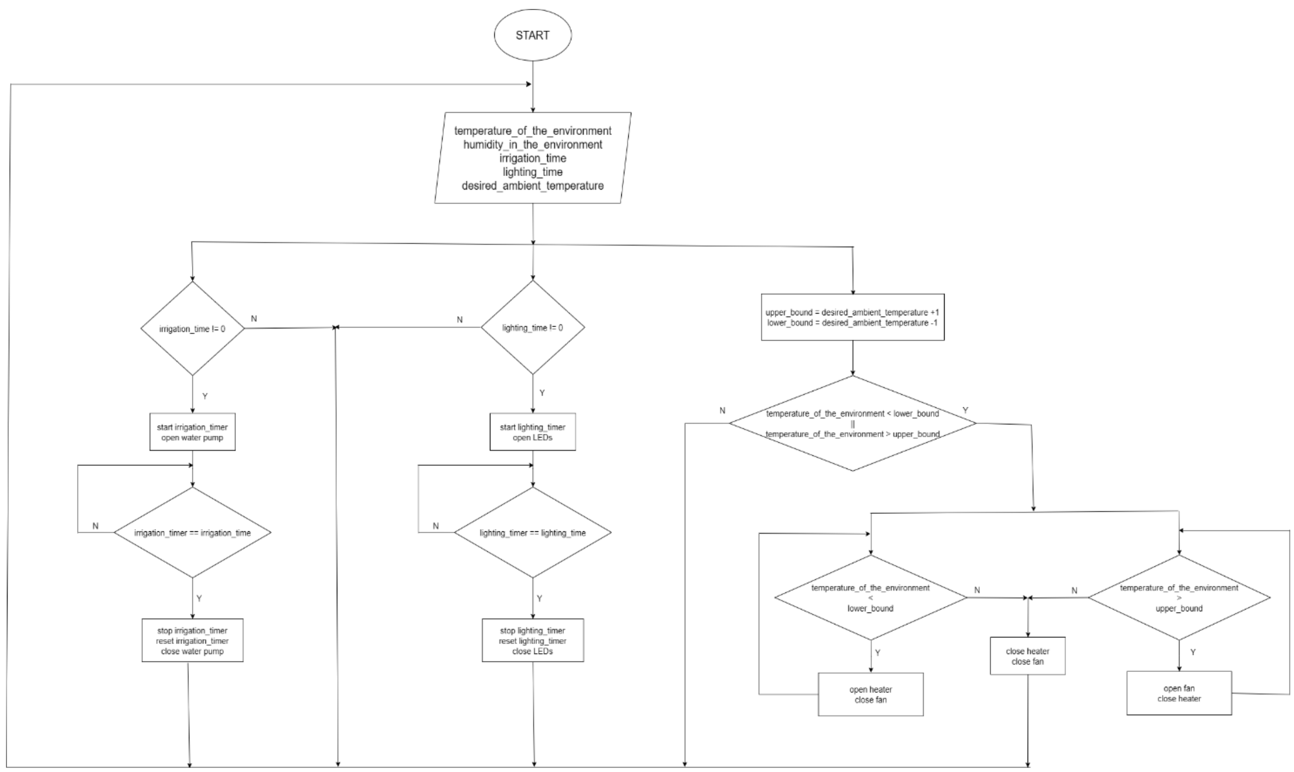

Figure 17. *Flowchart of TIA Portal Software*

6.2.1.1. Temperature Control System Software

The temperature control system operates by converting the voltage value from the temperature sensor to appropriate temperature units using function blocks. This conversion ensures precise monitoring of the ambient temperature. The system activates suitable devices such as fans or resistors to achieve the desired temperature level in the environment. These devices continue to operate until the ambient temperature is maintained within the specified range. Consequently, a constant ambient temperature within the designated range is maintained, creating an environment that meets the desired conditions.

6.2.1.2. Irrigation System Software

The irrigation system software processes the duration information received via the mobile application for irrigation time. This information determines how long the irrigation system will operate. Using a "Timer" function block, the software ensures that the irrigation system remains active for this duration. When the active period ends, the irrigation process is automatically stopped.

6.2.1.3. Lighting System Software

The LED control system software processes the duration information received via the mobile application for lighting time. This information determines how long the environment will be illuminated. Using a "Timer" function block, the software ensures that the LEDs used in the lighting system remain active for this duration. When the active period ends, the lighting process is automatically stopped.

6.3 Communication

6.3.1 Firebase Realtime Database

This program is used in our project to store user input data and send it to the main communication channel. Initially, the variable values are set to default, and they are updated as the user enters new data. The entries to which we assign the initial value in Firebase are given in Figure 17 below.

Figure 18. *Firebase Realtime Database Configuration*

6.3.2 Node-RED

In this project, Node-RED is utilized to establish a bridge between the PLC and the database, enabling the transfer of user-inputted data to the PLC. Node-RED is chosen for its visual programming interface and extensive libraries, facilitating flexible and straightforward data processing and communication.

6.4 Tools

- SketchUp
- TIA Portal
- draw.io
- Firebase
- Node-RED

7. EXPERIMENTS

7.1 Testing of Materials

7.1.1 Sensors

The sensors provide voltage values ranging from 0 to 5V at their outputs. To interpret these values correctly, the sensors were tested with the help of a multimeter. The measured voltage values were analyzed together with the environmental conditions. This analysis enabled the evaluation of how the sensor readings correspond to the voltage values. During the humidity sensor test phase, the images are given in Figure 18.

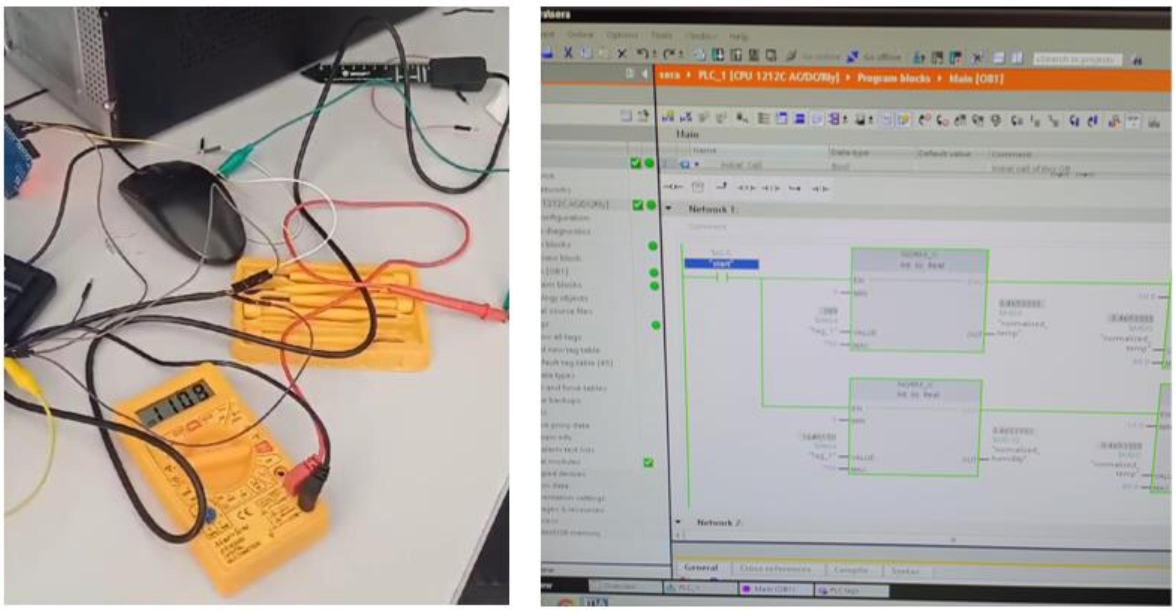

Figure 19. *Testing of Humidity Sensor*

Additionally, some sensors were replaced due to their failure to provide any output voltage values.

Among the challenges encountered during the testing phase of the sensors, the inadequacy of the cables used to transmit the expected values held significant importance. Particularly, the jumper cables shown in Figure 12 have hindered the acquisition of accurate measurements. This situation has adversely affected the reliability of the tests and diminished the trustworthiness of the results. To identify and resolve the issue, the cables were replaced.

7.1.2 Actuators

The actuators used in the system were thoroughly tested to ensure their proper functionality and performance. Each actuator was connected to the control unit, and their responses to various input signals were observed and measured. At this stage, no deviations from the expected performance were recorded. The actuators were connected to the PLC using relays. An image from the test phase of Resistance is given in Figure 19 below.

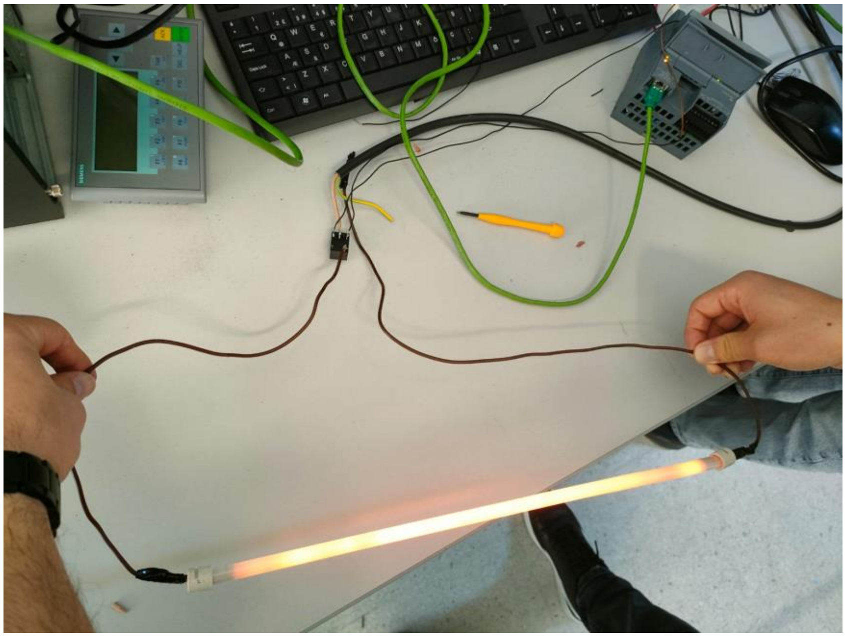

Figure 20. *Testing of the Resistance*

7.2 System Tests

During the system testing phase, the simultaneous operation of all actuators was tested. The purpose of this test was to determine whether all components of the system were working in harmony with each other and to identify any performance or compatibility issues during integration. The image of all the elements in the system working together is given in Figure 20 below.

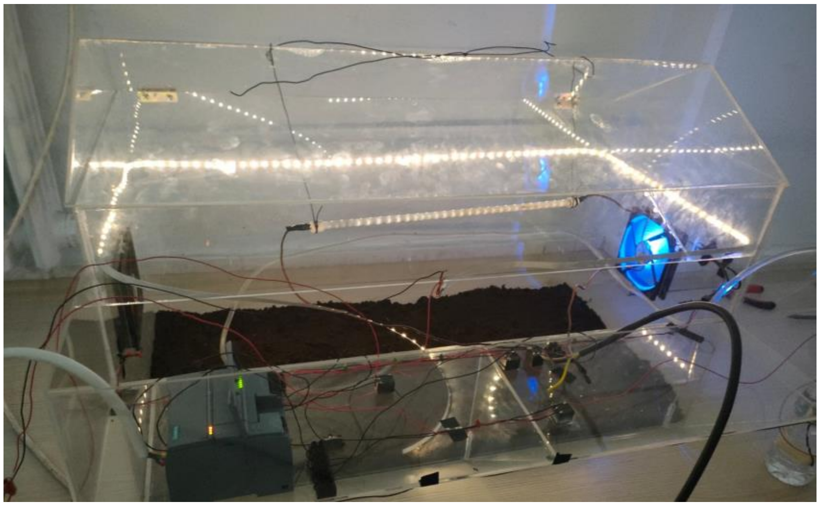

Figure 21. *Testing of the System*

8.PROJECT PLAN

- **Work Package 1 – Scope:** It involves determining the scope of the project and the prototype and making a 3-dimensional drawing in a virtual environment.
- **Work Package 2 – Material Analysis:** It involves the procurement and testing of materials to be used.
- **Work Package 3 – Coding**: It involves the TIA Portal and HTML software, which constitute the project's control system.
- **Work Package 4- Design:** It involves designing all the materials used inside the cabin.
- **Work Package 5- Testing:** It involves testing all the parts of the system.

Table 3: Resource assignments for work packages

Work Package	Resource	Duration (weeks)
1	Abdulkadir, Ali, Sedat, Yahya	3
2	Abdulkadir, Ali, Sedat, Yahya	6
3	Abdulkadir, Ali, Sedat, Yahya	4
4	Abdulkadir, Ali, Sedat, Yahya	3
5	Abdulkadir, Ali, Sedat, Yahya	2
PROJECT COMPLETITION TIME		18

Resource assignments for work packages of the project are given in Table 3 above. Finally, the Gantt diagram of the project is given in Figure 21 below.

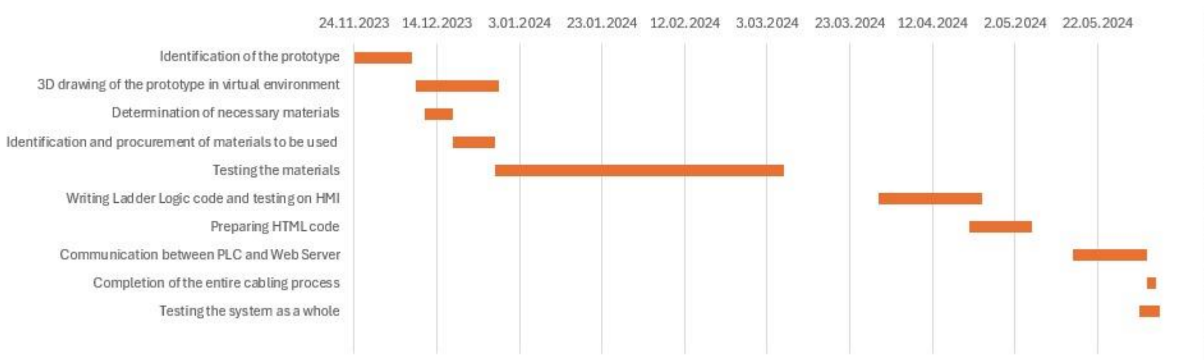

Figure 22: *Gantt Diagram of the Project.*

9. CONCLUSION

This study focuses on the design and implementation of an automation system in the agricultural sector that is remotely controlled via mobile devices. Sensors and actuators were used to monitor and control environmental factors within the project. However, the inability of some sensors to provide the desired data or their malfunctioning indicates that accurate decisions could not be made during the material analysis phase, leading to increased project costs.

On the other hand, the actuators performed as expected, indicating successful hardware selection and installation. This demonstrates that the physical components of the system functioned correctly and responded as required.

The designed cabin is ideally sized for use in greenhouse environments and optimized to ensure the orderly placement of all components. The assembly process was carried out with careful planning and precise applications, resulting in a structure that fully meets the desired standards.

Unfortunately, no results were obtained from the communication aspect, which is one of the most critical elements of the project. Although the necessary interfaces, databases, and platforms like Node-RED were prepared, they could not be integrated to work with the PLC. This highlights the challenges faced in communication modulation and integration processes.

In conclusion, this study emphasizes the potential and significance of automation in the agricultural sector. However, further work is needed to ensure that sensors operate correctly and to strengthen communication systems. Overcoming such challenges can enhance productivity and support sustainability in agricultural production.

REFERENCES

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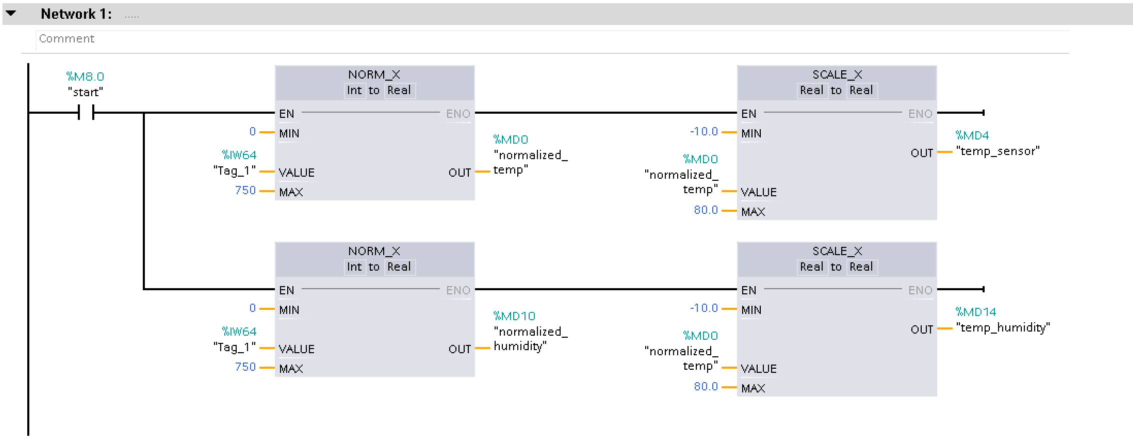
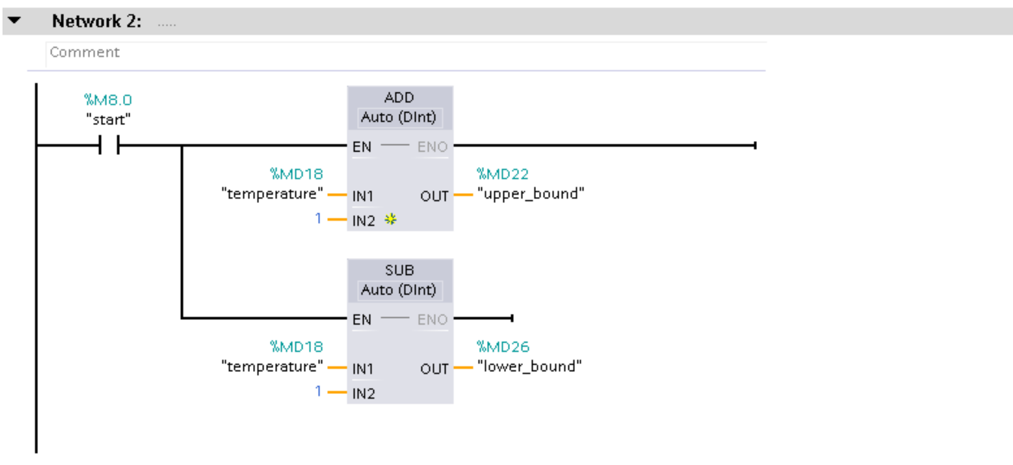
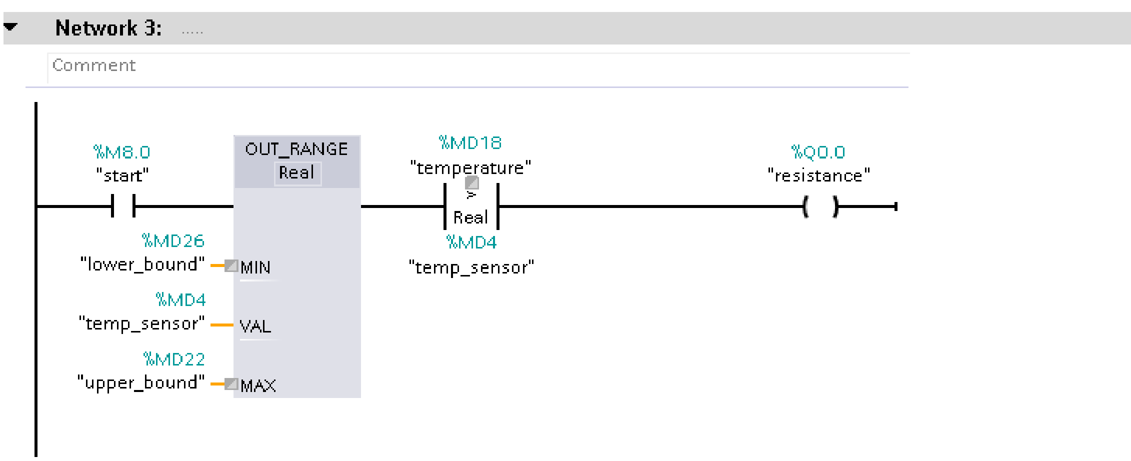
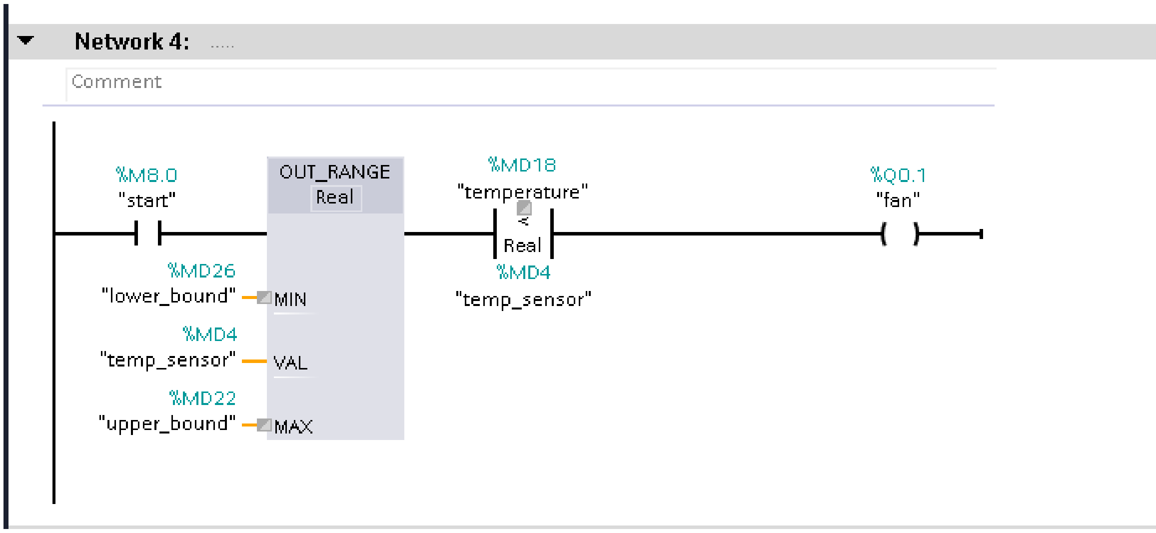
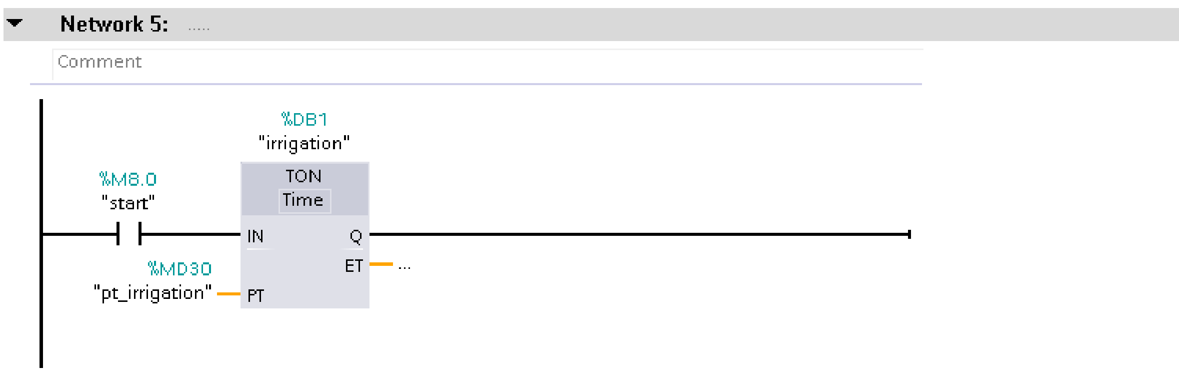
APPENDIX

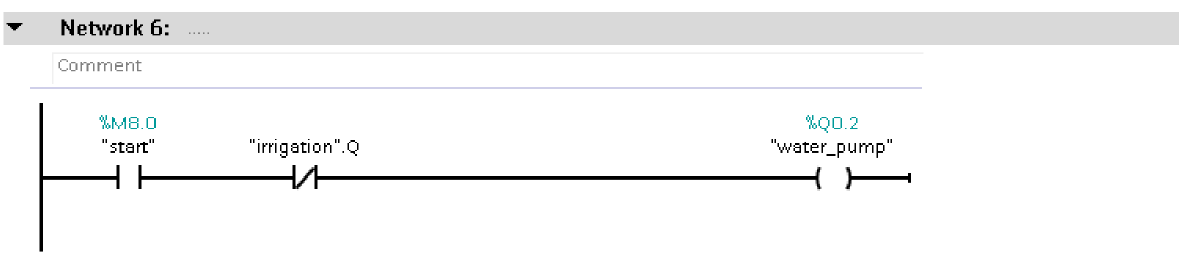

Network 1:
Comment
%M8.0
"start"
NORM_X
Int to Real
EN
ENO
0
MIN
%IW64
"Tag_1"
VALUE
OUT
750
MAX
%MD0
"normalized_
temp"
SCALE_X
Real to Real
-10.0
%MD0
"normalized_
temp"
80.0
%MD4
"temp_sensor"
%MD10
"normalized_
humidity"
%MD14
"temp_humidity"

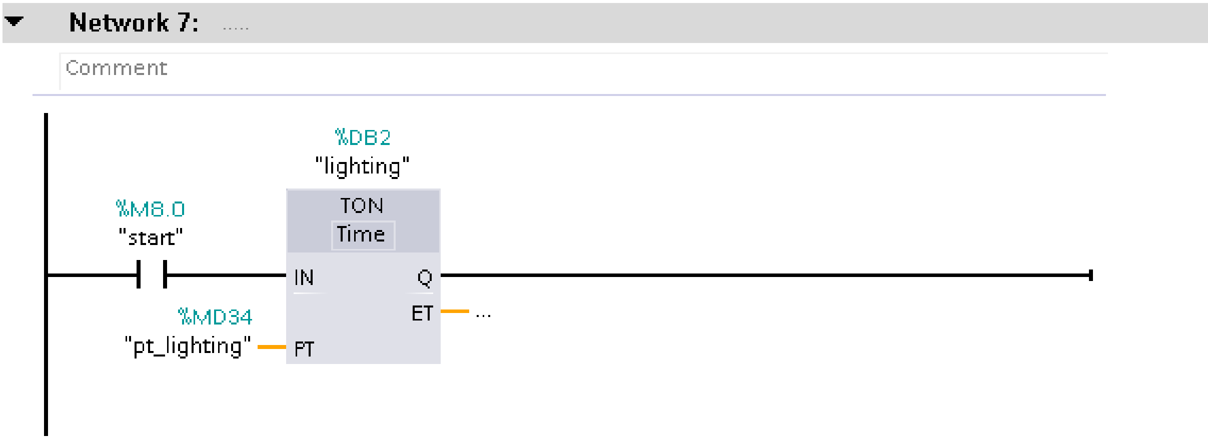

Network 2:
Comment
%M8.0
"start"
ADD
Auto (DInt)
EN
ENO
%MD18
"temperature"
IN1
OUT
1
IN2
%MD22
"upper_bound"
SUB
Auto (DInt)
%MD26
"lower_bound"

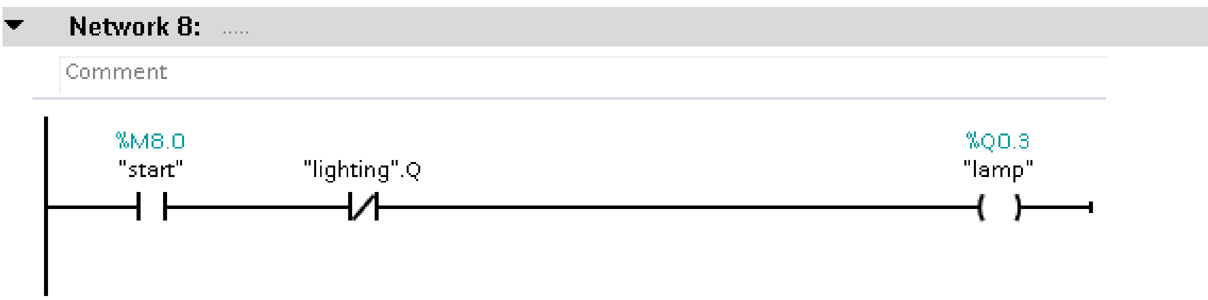

Network 3:
Comment
%M8.0
"start"
OUT_RANGE
Real
%MD26
"lower_bound"
MIN
%MD4
"temp_sensor"
VAL
%MD22
"upper_bound"
MAX
%MD18
"temperature"
>
Real
%MD4
"temp_sensor"
%Q0.0
"resistance"


Network 4:
Comment
%M8.0
"start"
OUT_RANGE
Real
%MD26
"lower_bound"
MIN
%MD4
"temp_sensor"
VAL
%MD22
"upper_bound"
MAX
%MD18
"temperature"
<
Real
%MD4
"temp_sensor"
%Q0.1
"fan"


Network 5:
Comment
%DB1
"irrigation"
TON
Time
%M8.0
"start"
IN
Q
ET
...
%MD30
"pt_irrigation"
PT


Network 6:
Comment
%M8.0
"start"
"irrigation".Q
%Q0.2
"water_pump"


Network 7:
.....
Comment
%DB2
"lighting"
TON
Time
%M8.0
"start"
IN
Q
ET
...
%MD34
"pt_lighting"
PT


Network 8:
.....
Comment
%M8.0
"start"
"lighting".Q
%Q0.3
"lamp"