Hafiz check

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CHAPTER 1

Introduction

1.1 Background Information

Data capture and industrial remote monitoring have significantly changed the way that production is done. Manufacturing has gone digital in this modern era. Industry 4.0 refers to this transformation, which is the fourth manufacturing revolution to have taken place. [1] Mechanisation using conventional water or steam power was the first industrial revolution. The age of mass manufacturing and innovative production employing assembly lines and electricity characterised the second industrial revolution. [2] Controlling and production automation based on programming was the third industrial revolution. The introduction of computers and automation, together with its improvement with smart and autonomous systems that are data and machine learning driven in their analysis and creativity, marks the beginning of the fourth industrial revolution. [3]

This initiative is built on the widespread application of cutting-edge IIOT technologies in Pakistan's rapidly expanding industrial sector. [4] We therefore concentrate on the industrial IOT-based secure, quick, and reliable data collecting and monitoring system that has been developed for remote monitoring of industry parameters. The goal of this project is to develop Industry 4.0 by integrating an IOT gateway with several PLCs. [5]

We were given a project in which we would develop three various systems, including conveyor system, motor speed control system, and temperature control system, keeping in mind the boom of industry 4.0. PLCs (Programmable Logic Controllers) are used to automate all three of these systems, and we will link all of the PLCs with the IOT gateway. Additionally, remote monitoring provided the management with a state of the production and an understanding of its flaws. Data collection made it possible to trace the evolution of system characteristics and use new analytical methods to boost operational effectiveness in the future. NodeRed was used to create a remote, cutting-edge UI Dashboard that included the needs of the industrial revolution.

1.2 Significance and Motivation

Students majoring in engineering at the undergraduate level are frequently required to do projects to show that they comprehend the subject matter. These undergraduate projects provide teachers the chance to assess their students' comprehension of the subject matter and give them the chance to apply what they have learned to actual scenarios. Participating in pertinent initiatives helps students become ready for entering the industry workforce. To get the most out of their undergraduate project work, undergraduates must do this.

It has frequently been observed that engineering students work on making up challenges as part of their assignment. This strategy could help create new technology remedies for the problem at hand, but seldom is the research that goes along with such initiatives really put into practise. The initiatives that address actual technical issues, on the other hand, are valuable because of what they do to improve technology in their particular disciplines.

1.3 Problems and Challenges

Both small- and large-scale enterprises depend on human input to carry out their manufacturing processes. Furthermore, the key barriers preventing Pakistan from innovating in the industrial sector are remote monitoring, interactive UI design, and a lack of data collecting. Eventually, the cyber world will require quick and safe data collecting. Since industries make up the majority of the economy in Pakistan, there are a number of issues that impact how quickly and efficiently things are produced, including a lack of modern equipment and a shortage of skilled engineers. Another problem is the inability to reliably monitor the plant in real time from a distant location. [6]

1.4 Problem Statement

The problems have targeted are:

1. Demand of Real-Time Monitoring system of Industrial Process in remotel locations.
2. Problem of Fast & Secure Data Transmission & Acquisition of Industrial Parameters.

The fundamental worry for companies is remote real-time monitoring of a system. If a minor production-line error is not fixed quickly, it may pose a risk to the workers. While machine operators report a defect to upper management, the condition may persist and worsen, resulting in damage to the plant and harm to workers. Subsequentially, remote monitoring and controlling is important to the happenings. Additionally, it can improve system efficiency since managers and engineers are constantly informed about the plant's control system, its parameters, and any malfunctions. Additionally, they were able to make quick fixes for any problems. [7]

The historical data collection of plant characteristics is a second prerequisite for an enterprise. In the modern world, data is the most valuable resource. When it comes to equipment and industries, this is precisely the situation. Using data, we might examine the results and patterns of the products and develop fresh approaches to deal with these issues. Higher productivity eventually results in the prosperity of the industry. Thus we have to evolve the problem of fast and secure data transmission and acquisition through reliable mediums and communication protocols. [8]

1.5 Possible Solution

Regarding the problem statement we could have multiple choices in terms of hardware selection, data acquisition platforms, and protocols to be used. Though the possible solution are as follows.

1.5.1 Selection of Hardware

For the real-time monitoring of industrial plant parameters, we can utilize theintegration of the following Hardware with PLC

- Arduino / Ethernet Shield
- Raspberry-Pi
- IOT Gateway

With a few lists of settings, Arduino / Ethernet Shield is mostly used to export data to the cloud. In contrast, the Raspberry-Pi is more dependable than the Arduino, but it is likely only used to transmit data to Node-Red using a single PLC and the MQTT protocol, and it overheats more while operating in a demanding environment. [9]

Iot Gateway is a durable IIOT device that is primarily made for industrial use. It contains far more specialised capabilities in terms of platforms, memory, and protocols.

1.5.2 Data Acquisition Platforms

The remote acquisition of plant parameters can be achieved on the following platforms

- Cloud
- Database
- IOT Gateway Storage

The most common option for the data collecting platform is the Cloud. Additionally to having various data storage options, it is simple to use and allows for straightforward data visualisation. It is the contemporary database substitute. Database storage is the second most often utilised data collecting platform. It might hold a much more data in a small, organised space, but utilising the SQL programming language to store data requires far more complicated operations. The third platform makes use of the device's internal storage or connects an external hard drive to IoT Gateway or Raspberry-Pi devices.

1.5.3 Selection of Communication Protocol

Secure data transmission can be accomplished using the following communication protocols

- OPC UA
- MQTT
- S7 protocol

The worldwide communication standard used by devices in autonomous systems is called OPCUA. OPCUA communicates between devices using a server and client model. Additionally popular, MQTT employs the publish-and-subscribe model for device communication. Only Siemens products are intended for use with the S7 protocol.

1.6 Proposed Solution

Acknowledging these challenges along with other the industry requirements, the following solution was proposed:

Remote Monitoring by the integration of IOT Gateways with PLCs:

Unlike other microcontrollers and microprocessors like the Raspberry Pi and Arduino, which are only used for DIY projects or home automation, the IOT gateway is particularly made to work in challenging industrial situations under high temperatures.

Because it can interface with several devices, the IoT gateway Cmt-g04 was chosen. In addition, it supports a variety of Industrial Protocols and Standards, including OPCUA and MQTT. Additionally, it supports up to 300 motor drives and PLCs from various brands. It is often built with large memory storage capacity and fast processing speeds to run constantly throughout the production year.

Data Acquisition platforms that are used:

- Amazon Web Service (AWS) Cloud

We sent data and remotely monitored it using a few data gathering tools. To begin with, secure data collection and remote monitoring are done using an AWS Cloud. The chapters that follow provide further information on this procedure. In the end, it would always be possible to keep an eye on the parameters, even when the internet was down.

Communication Protocol selected to communicate between devices is OPCUA:

The open source and widely used industrial communication protocol used for automation is called the OPCUA protocol. It guarantees dependable and secure data transfer and is platform agnostic. It mostly focuses on industrial device communication. In this project, OPCUA is utilised for both IoT Gateway to NodeRed and PLC to IoT Gateway communication.

Along with this proposed solution, we also had the following Industrial requirements.

- Designing a Dashboard for the controlling of induction motor, temperature control and conveyor system control.

1.7 Objectives

Following are the objectives that will be achieve during the project:

1. IIOT-based real-time data visualization in an industrial setting.
2. The IOT Gateway's integration with the current industrial process.
3. Establish a network of communication between PLC Network and IIOT Device
4. over Ethernet (TCP/IP) with the (CMT-G04).
5. Create a wireless industrial monitoring system (using the CMT and RED mobile apps for monitoring).
6. Remote monitoring of industrial parameters across a variety of platforms, including the cloud, device storage, node-red, and cmt-viewer.

1.8 Organization of the Project

The literature review for the project is covered in Chapter 2 of the book. The project's methodology and the specifics of the plant are explained in Chapter 3. Results and discussions related to the project and its advantages are described in Chapter 4. The project's conclusion and recommendations for the future are included in Chapter 5.

CHAPTER 2

Literature Review

2.1 Introduction

This chapter includes the literature review of the following research paper regarding the project. These research papers assisted us to evolve and think out of the box to develop a sustainable and up-to-date project.

2.2 Industry 4.0, Digitization, and Opportunities for Sustainability

Due to smaller markets, industrialists choose a simple configuration over the complex and time-consuming design of standard automated product systems. Although there are several myths about how to streamline the engineering process by using a device's capabilities or general skills, run-time control is still accomplished through personal communication protocols and instructions. The usage of abilities shown in this research is not limited to the engineering phase but also appropriately for the direct and widespread management of field-bias. Because of its built-in services, information model, and seller independence, OPC UA was used to carry out the crime. The implementation uses customer/ server based OPC UA and the cantina / sub pattern to fit for a deterministic real- time control, which is needed by industrial automation. OPC UA is the standard communication protocol of Industry4.0. [10]

2.3 Skill-based Engineering and Control on Field Device Level with OPC UA

The fourth industrial revolution, sometimes known as Industry4.0, and the supporting digital transformation are both expanding rapidly. The way that physical entities live and work is changing significantly as a result of the digital revolution, and humanity continues to be in awe of the potential sustainability opportunities that Industry 4.0 may bring up.

By fully integrating the sustainability functions of Industry4.0, the study presented makes a significant contribution to the literature on sustainability. The research initially analyses some basic Industry4.0 design fundamentals and technological developments before introducing the architectural strategy. According to research, sustainable business practises are similar to Product effectiveness and the creation of new business models are typically Industry 4.0's further immediate byproducts, which pave the way for the growth of its more distant socio-environmental sustainability functions, such as energy sustainability, harmful emission reduction, and social welfare enhancement. Industry4.0 performs the desired sustainability functions as efficiently, equitably, and successfully as is possible.[11]

2.4 Remote Monitoring and Control of Microgrid using Smart Sensor Network and Internet of Thing

Modern power systems are moving away from centralised, regulated power systems and towards a growing, deregulated electric power system. A contemporary power system experiences significant changes in energy demand, as well as the inclusion of more dispersed renewable energy sources and nonlinear loads. To ensure efficient and reliable operation, this endeavour needs improved monitoring, control, and energy operation. Additionally, it will enable users to use energy more wisely and include distributed renewable energy sources.

DCS that is computer-based was used to manage an active lot MG operation. A smart sensor network with online monitoring capacity may be used to monitor and safeguard the company's crucial assets, such as generators, PV inverters, and loads. IoT and detector network deployment make MG automation more feasible and control decisions for energy conservation more precise. IoT and online condition monitoring facilitate simpler preventative maintenance of MG's vital assets. [12]

2.5 An Overview on Industrial Control Networks

The paper includes the overview of an industrial control network and its architecture.

In general, the sector may be broken down into the process and manufacturing sectors. While manufacturing assiduity is focused on the production of distinct things, the process sector works with processes involving very big material flows in both nonstop and spastic manners and frequently has challenging safety requirements. Typically, maximizing production output is a real objective a crucial component in artificial industries generally. Practically, it has been necessary for industrial systems to evolve in order to improve production monitoring and quality control while also keeping operating costs as low as feasible. Additionally, this offers required monitoring, which the mills and production facilities both set up for improved supervision and quality control. The artificial networks, which are based on technological operations, are made up of three main control components, including HMI and Programmable Logic Controllers. PLCs are merely digital computers that can operate in abrasive industrial environments. Similar controller systems receive input from sensors and other data generating devices, communicate with the entire production unit, and output to HMI.[13]

2.5.1 Architecture of Industrial Control Networks

Device communication is necessary for networks to do their assigned responsibilities. Industrial monitoring and control networks have benefited greatly from the use of conventional wired communication technology. As a result, this communication was carried out using wired point-to-point systems. These systems, however, required a significant quantity of wiring, which in turn produced numerous physical failure points, such as connections and wire harnesses, leading to a system that was incredibly unreliable. Due to these shortcomings, point-to-point methods were replaced by modern industrial communication technologies.

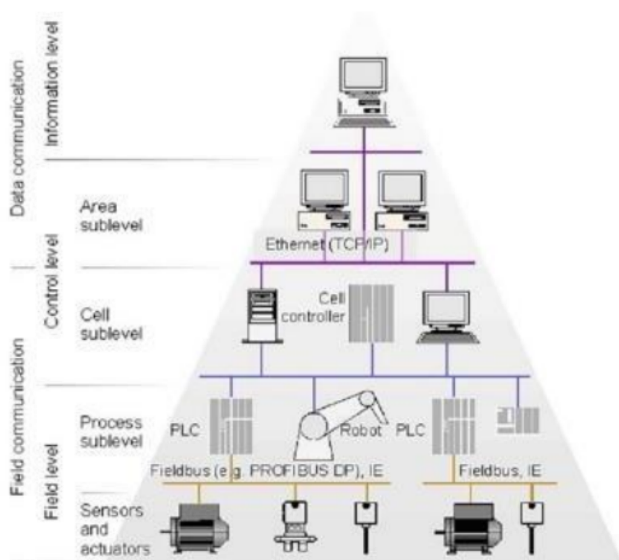


Figure 2-1 Architecture of Industrial Control Network

Industrial processes are changing swiftly and continually as a result of technology. It may be challenging for firms to integrate new technologies into an established system. To operate a newly launched system, you need to have training and professional competence. Businesses must swiftly adapt and make use of the power automation systems, nevertheless, given the rising demand for technology and high-quality goods.

2.6 A Cloud-Based Monitoring System for Performance Assessment of Industrial Plants

the creation of a control-loop performance monitoring system that runs as a single entity in the cloud for the worldwide control of data flowing from many industrial units spread across various locations. This is the go-to option for many businesses since it is affordable (in terms of systems, people, and their upkeep and updating), feasible, and supported by Industry 4.0 technology. Cloud computing is easily available, repeatable, distributable, and adaptive, which are all significant traits. The development of appealing process-related applications, such as data storage and management, analytical tools, alarm management, asset management, performance management and its analysis, training simulators, and remote diagnostics, is attributed to cloud computing. The system took use of current Industry 4.0 technology and could be constructed with very few expenditures to finish the necessary automation and instrumentation, most of which was already pre-existing/old equipment in the facility. The higher expenses of the cloud will be offset by savings and benefits in the requirement for a special monitoring system, resulting in a decrease in the skills that must be acquired and maintained on each individual plant. The same cloud-based architecture will eventually be expanded to include additional functionalities, such as condition monitoring for other plant machinery, such as pumps, compressors, and motor devices, with the primary goal of performing preventive and predictive maintenance by analyzing the managed data. [14]

2.7 Intelligent remote monitoring and manufacturing system of production line based on industrial Internet of Things

The growth of Internet of Things technology and the incorporation of intelligent manufacturing to speed the modernization of conventional industrial production lines are both products of the development of Internet communication technology. An Internet of Things miscellaneous data emulsion method based on intelligent optimisation algorithm is proposed to improve the Internet of Things miscellaneous data fusion effect as a result of the slow speed, low emulsion accuracy, and other issues that have been observed on the conventional Internet of Things data emulsion system. First, data on the monitoring object state are gathered from a number of nodes. Enterprises will be much more competitive if a network is built to support the integration of the value chain and serve as the foundation for network development. Network installation may assist businesses in enhancing information flow in design, process, and other areas, ultimately achieving the aim of cooperative design and manufacturing. Additionally, the network may accomplish unified deals and conservation, decrease the cost of deals and maintenance in a unified way, and increase the logistics and procurement connections of customization to speed up production. This study integrates the being experimental environment and applicable circumstances, which is based on the understanding the growth of the intelligent manufacturing industry and the development of industrial Internet of Things covering technology. The goal of the entire product line of material processing, access, and deformity diagnosis alarm function is to build the network-based Internet of Things technology. This work develops an Internet of Things miscellaneous data fusion approach based on intelligent optimization algorithm to address various deficiencies in the present process of Internet of Things miscellaneous data fusion. [17]

2.8 IIoT device solution design according to the concept of Industry 4.0

With the help of the Open Platform Communications Unified Architecture (OPC UA), IIOT devices capture process data. It makes data collecting and process monitoring in any cloud or database possible. Numerous industrial organisations are investing in Industry 4.0 to collect production data, but there is still a disconnect between the data's acquisition and its use. Any manufacturing process problems may be found with big data. [19]

2.9 State of the Art: Energy-Efficient Protocols for Self-Powered Wireless Sensor Networks in IIoT tosupport Industry 4.0

Industry 4.0 is focused on the adoption of cutting-edge manufacturing methods that gather real-time process data and employ machine learning algorithms, enabling system interconnection and making the entire system self-determining. 4.0. The observed trade-off between various protocols is between algorithm complexity and energy efficiency. Energy efficiency gains can be made at the expense of complicated protocol design methods. A potential wireless sensor network's design prioritises the correct use of the energy acquired in addition to energy efficiency. Operations that are energy neutral will reduce energy consumption by the amount of energy produced.20]

2.10 Comprehensive overview of Industry 4.0, IIoT and areas of implementation

Businesses desire a mechanism to go from physical to digital operations. New software and sensors are needed as we progress towards a cloud-based system. The problem of security and connectivity has started to surface as more and more systems transition to being digital. By making their equipment remote and cloud-based, the oil and gas, food, pharmaceutical, steel sectors, and many others get a lot of advantages. Businesses increase efficiency, precision, dependability, and overall efficiency by optimising their machinery. To mimic very distant data processing and administration, the SAP Cloud IoT platform solution described in one of the research papers was able to experimentally connect a virtual PLC device modelled using

CODESYS in Australia and an actual PLC device in Brazil to a cloud hosted in Germany. It was discovered that data signals transmitted from Australian devices took five seconds to reach a German cloud server, but data signals from Brazilian devices took fifteen seconds. The amount of data transmitted inside the system was noticed to be relatively low compared to what is seen in industry, and the authors did not take into account the integration of maintenance or supply chain systems, despite the fact that they did not define the size of the data conveyed. information. This transit time may need to be shortened in the future to make high-speed real-time operations feasible. IIoT and Industry 4.0 are anticipated to keep expanding in a variety of ways. In order to provide real-time functioning at greater distant distances and the integration of several various 3.0 machine operating systems into the same cloud 4.0 ecosystem, two of these seem to be intended to shorten the implementation time between a remote operating system or cloud. [21]

2.10.1 IIOT application

The following IIOT applications are being described in this research paper

Oil and gas

To efficiently monitor and manage the status of oil and gas wells within the petroleum sector, an intelligent Internet of Things-based monitoring system has been developed. In order to measure system characteristics like pressure and temperature, smart devices were put on wellheads. These devices transfer this data to the control centre via gateways for additional system analysis. The control centre oversaw the management of the smart object apps that sent off fire alarms or handled occurrences like device failure and theft.

Food processing and production

Predictive maintenance, which use artificial neural networks (ANNs) to foretell when maintenance may be required, is a key advantage of IIoT integration. The monitoring of processing floor moisture levels and other machine sensor data using predictive maintenance algorithms has been demonstrated to have applications in the pasta business. Longer lead times and the capacity to prevent workflow disruptions were made possible by a complete built-in ANN system's ability to offer early notice of required maintenance. The capacity to discover certain resources or commodities and follow their history forward or backward along the supply chain is referred to as traceability. It has been seen to assist with logistics management, supply chain process optimization, and product storage management. Each approach to traceability has been implemented using QR code scanning to effectively deliver a large amount ofproduct information.

2.11 An approach to the implementation of the Industry 4.0 framework in the steel industry

Real-time decision-making in the steel sector demands a fully integrated production and business system. The gap between corporate systems like Enterprise Resource Planning (ERP) and shop floor systems like Manufacturing Execution System (MES) is a significant issue in the steel industry. For example, Steel Industries' manufacturing process needs insight into operations, planning and scheduling, lead times, quality control, machine condition, and maintenance planning. It can be difficult to manage and comprehend data in the steel sector. The data algorithms used by devices that transmit or store data are either specialised, have a small number of data sets, or are not standardized. With little justification or factual support, the industry utilizes past data to fit present patterns. Determining the integration between corporate systems and manufacturing systems is defined by the Industry 4.0 framework as being clear and decisive. By controlling the product lifecycle and assuring data flow and visibility from suppliers, operations, and customers, Industry 4.0 further enhances organisations. Technologies like the Internet of Things (IoT), Cyber-Physical Systems (CPS), and Big Data are used in Industry 4.0. [22]

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter covers information on our three plants, project workflow and hardware wiring diagrams, project design process, and specifics about the hardware and software that were utilized to complete the project. The programming of the Node Red is covered last.

3.2 Plant Details

Our project consists of three plants which are:

1. Conveyor system
2. Temperature Control using RTD pt100
3. Induction motor speed control using VFD

Conveyor System

We built a logic into this system so that anytime a metal object passes in front of a sensor, it instructs the pusher motor to remove the object off the conveyor and then returns to its starting position. For this operation, we employed a Siemens S7-1200, which has three digital outputs and four digital inputs.

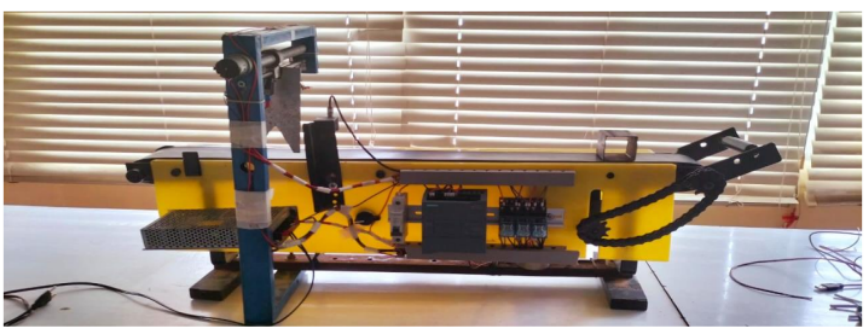


Figure 3-1 Conveyor System

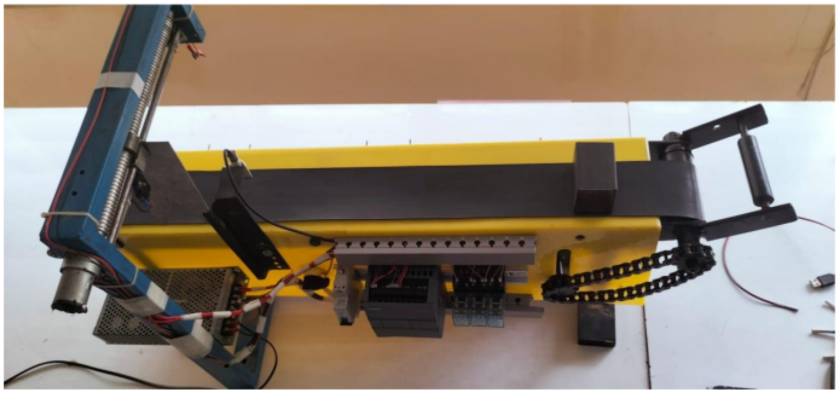


Figure 3-1a Conveyor System

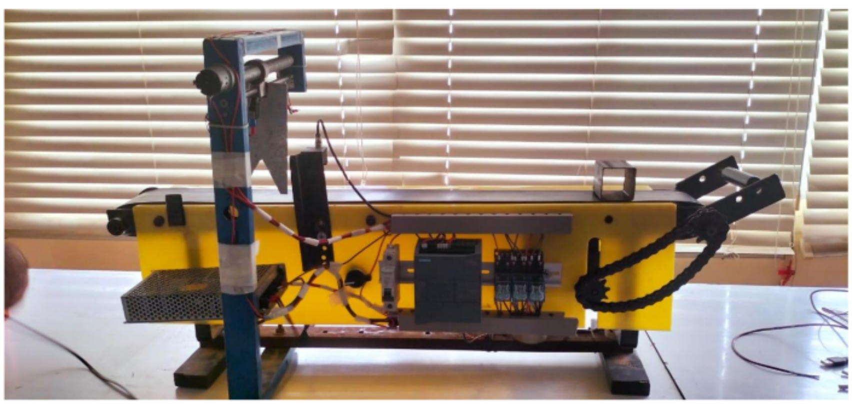


Figure 3-1b Conveyor System

Temperature Control using RTD pt100

The term "RTD" refers to a sensor known as a "Resistance Temperature Detector" that is used to monitor temperature. The resistance of an RTD sensor varies as its temperature changes. As the temperature rises, the RTD's resistance rises linearly. Wire wound is a common name for RTDs. By attaching any RTD (PT100) a=0.000385 sensor, temperature may be adjusted. Power to the device and output power are both controlled via a switch on the front panel. A fused power cable and fused output receptacle are included as standard features.

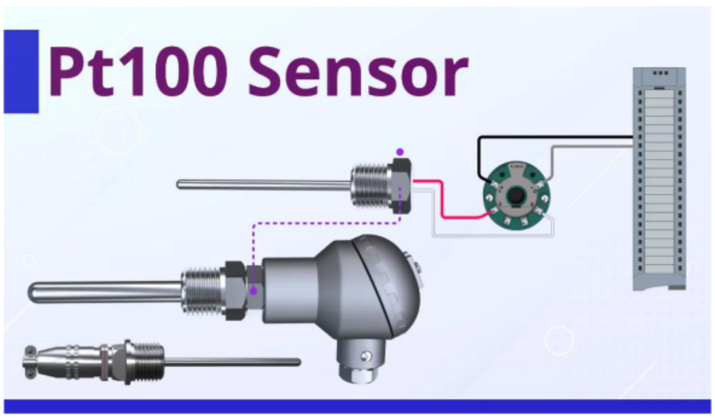


Figure 3.2 Pt100 Diagram

Induction motor speed control using VFD

A motor controller known as a variable frequency drive (VFD) controls an electric motor by adjusting the power supply's frequency and voltage. The VFD may also regulate the motor's ramp-up and ramp-down during start and stop, respectively.

This is the voltage to frequency ratio.

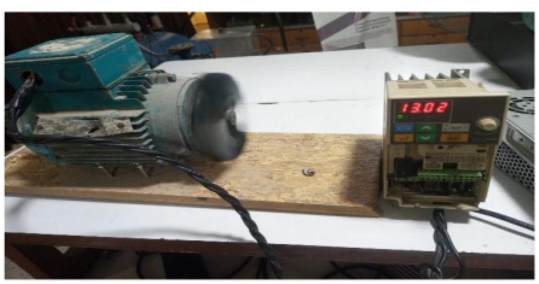


Figure 3-3 Induction motor with vfd Diagram

Omron VFD 3G3MV

The phrase "3G3MV VFD" most likely refers to a particular variation or style of Variable Frequency Drive (VFD) made by Omron. VFDs are electronic devices that regulate the speed and torque of electric motors. They are sometimes referred to as AC drives or inverters. They are frequently used to control how motors operate in machinery including pumps, fans, conveyor systems, and more in industrial and commercial settings.

VFDs are among the industrial automation and control devices that Omron, a well-known firm, produces. The term's "3G3MV" portion most likely refers to a specific series or model of VFD made by Omron. Electric motor speed and performance may be precisely controlled by varying the frequency and voltage supplied to the motor using VFDs like the 3G3MV. In applications where variable speed and energy efficiency are necessary, these devices are crucial.

Since my knowledge is based on information available up until September 2021, I may not have details on specific products released after that date. To get the most up-to-date information about the 3G3MV VFD, including its features, specifications, and usage, you would need to consult Omron's product documentation or contact their customer support.

Figure 3-4 Omron VFD 3MV3_Diagram

3.3 Project Design

The following section describes the solutions selected and methodologies adopted to implement those solutions to meet the objectives of the project.

3.3.1 System Model

The system model for the suggested system is shown below. The three PLCs are connected to the IOT Gateway using an Ethernet switch. The IOT Gateway is the component that connects the conventional S7-300 and S7-400 series to the OPC UA communication protocol. We could allow the server-client device setup, in which PLCs function as the server and Node-Red serves as the client, by enabling the OPC UA protocol. Unlike this Weintek CMT-G04 gadget. In order to watch and operate an HMI in real time, we could develop one using the Easy Builder Pro Software and link it to any display using an HDMI connector.

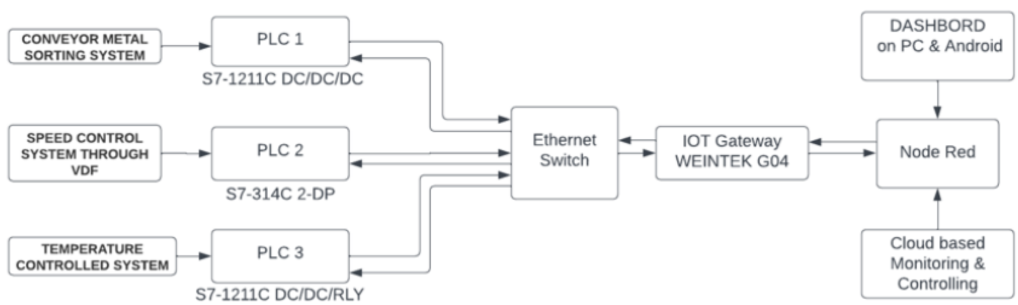


Figure 3-5 System Model

The gadget might serve as a data collecting tool and save certain parameters in its inbuilt 4-GB memory. By using the interactive UI Dashboard of Node-Red, we can monitor things remotely. Additionally, we might send data to the cloud using this Node-Red for dependable, secure, and distant data collection.

3.3.2 Wiring Diagram of Weintek CMT-G04

A built-in Ethernet switch allows the CMT-G04 to function as an Ethernet bridge. Users must connect the current controller to the SW2 port of the CMT- G04 and the existing HMI to the SW1 port of the CMT- G04 in order to bridge the device. This design can guarantee that the controller's and HMI's communication is unaffected. The CMT-G04's LAN port is utilised to join a business or manufacturing network.

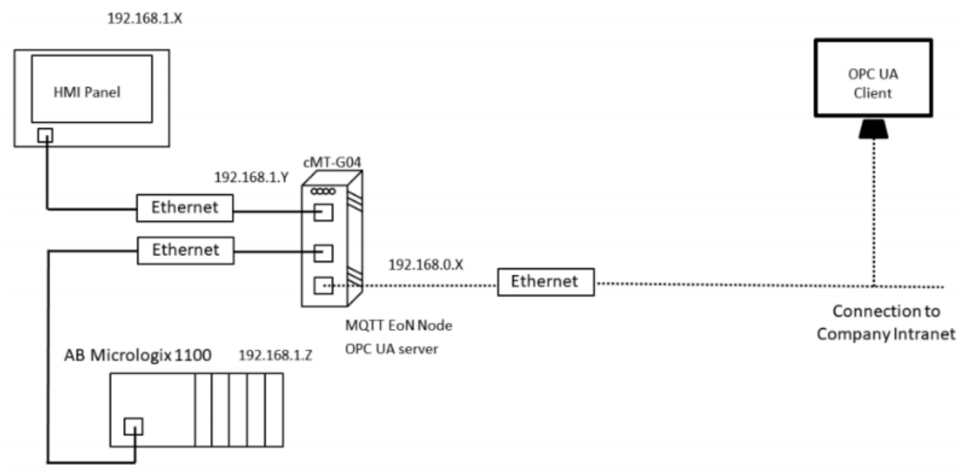


Figure 3-6 Wiring Diagram of Iot Gateway

3.3.3 Hardware Configuration

The following figures demonstrate the physical wiring diagram of the Device CMT-G04. The LAN1 is connected to the router meanwhile the LAN2 is connected to S7-1200.

Figure 3-7 IOT Gateway with s7-1200

The device CMT-G04 is connected to a 24V power supply along with a circuit breaker for further protection.

Figure 3-8 IOT Gateway with temp control system.

Figure 3-9 Final Configuration of Device

3.3.4 PLC to OpcUA Integration

Requirement

The conveyor system and conveyor belts are monitored and controlled by a S7-1200 CPU during manufacturing. Regularly, the S7-1200 CPU compares the conveyor belt's actual speed, "ActualSpeed," to a predetermined number, "setPointSpeed."

The speed "ActualSpeed" is decreased to the value "SetPointSpeed" if the real speed exceeds the specified value.

The speed "actualSpeed" is increased to the value "SetPointSpeed" if the actual speed is less than the predetermined value.

These values ("ActualSpeed," "SetPointSpeed"), together with the conveyor belt's "isActive" status, are questioned by the OPC UA Client "UaExpert." The SIMATIC S7-1200 OPC UA Server relays this information from the S7-1200 CPU. The OPC UA Client presents the data.

An overview of the automation task may be seen in the following figure.

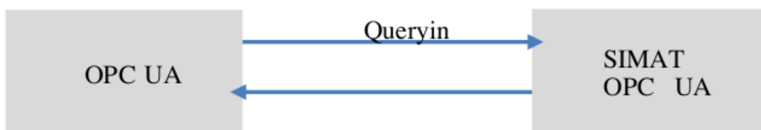


Figure 3-10 Plc to Opcua Server

Principle of Operation

Direct communication occurs between the OPC UA Client "UaExpert" and the SIMATIC S7-1200 OPC UA Server. Through an Ethernet connection, OPC UA is used to communicate between the client and server.

- The SIMATIC S7-1200 OPC UA Server and the OPC UA Client "UaExpert" communicate directly.
- OPC UA is used to communicate between the client and server over an Ethernet link.

The following Figure shows the most important components of the solution:

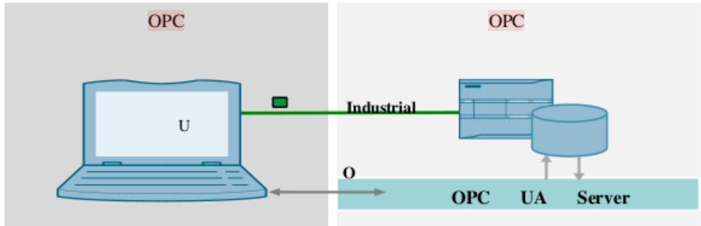


Figure 3-11 Operation of Integration

Configuration and Project Engineering

Note: The SIMATIC S7-1200 OPC UA Server setup and project engineering for the S7 station have been fully realised.

The creation of a project using a SIMATIC S7-1200 CPU is demonstrated in this section.

Configuring the S7 Station

- Create a new STEP 7 project.
- Configure the S7 station:
- CPU 1211C DC/DC/DC or RLY
- Create a new global data block with the tags to which the OPC UA client is to have read and write access.
    - *You must choose the "Accessible from OPC UA" checkbox in order to allow read access for a tag through OPC UA.*
    - *You must choose the "writeable from OPC UA" checkbox in order to allow write access for a tag through OPC UA.*
    - *The "Visible in HMI Engineering" check box must be selected in order to define a tag for OPC UA.*

Activating the SIMATIC S7-1200 OPC UA Server

Security concerns prevent the S7-1200 CPU's OPC UA Server from being activated by default; OPC UA Clients cannot read or write data to the S7-1200 CPU.

- Follow these steps to enable the S7-1200 CPU's OPC UA Server:
- Navigate to the S7 station's "Devices & Networks" section.

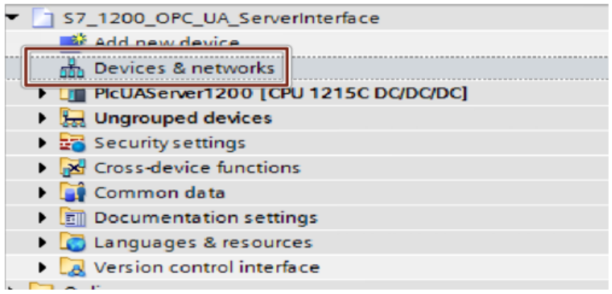


Figure 3-12 Configuration of S7 Station

Select the S7-1200 CPU. Click the CPU icon in the Network View

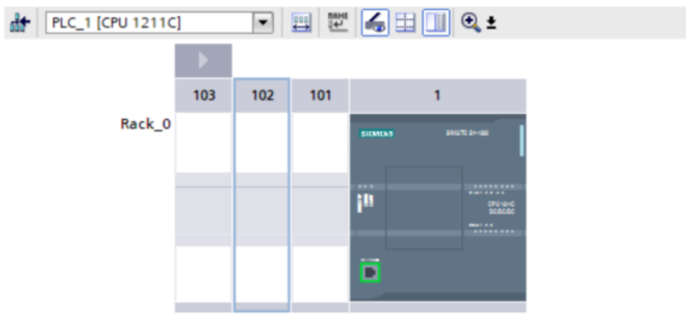


Figure 3-13 Adding the CPU

Click "OPC UA > Server" in the properties of the CPU.

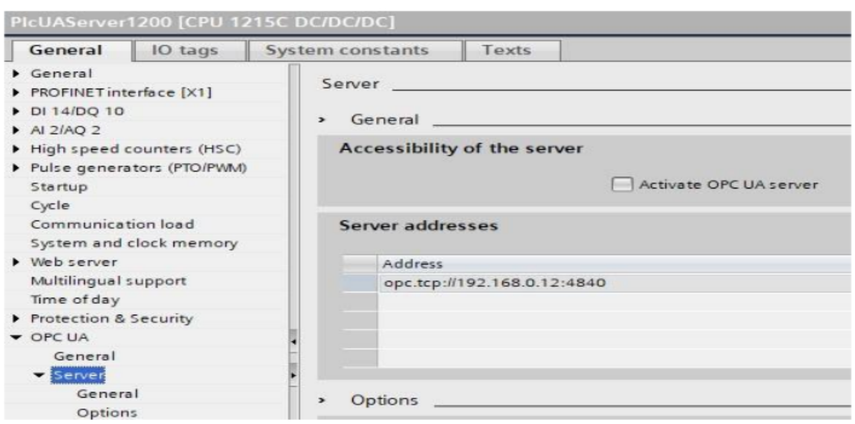


Figure 3-14 Selecting Properties

Activate the OPC UA Server of the CPU

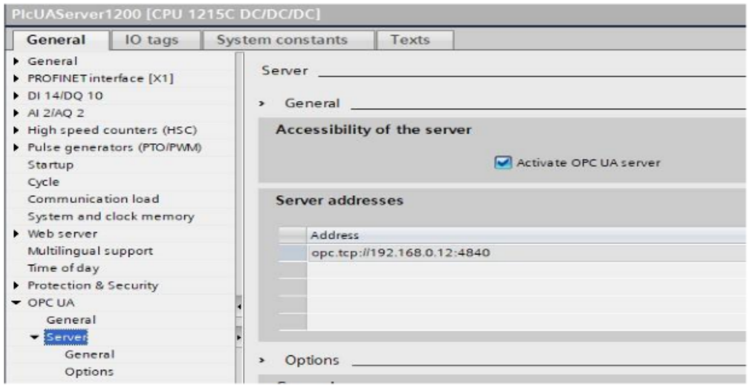


Figure 3-15 Activating the Opcua Server

Compile the S7 station's hardware and software. To achieve this, choose "Compile > Hardware and software (only changes)" from the menu that appears when you right-click the device in the project navigation.

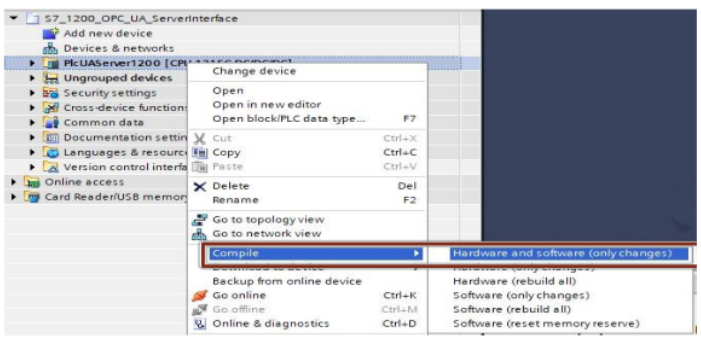


Figure 3-16 Compiling the software and hardware to the s7 station

Installation and Commissioning Hardware Setup

The following graphic shows the hardware setup of the application.

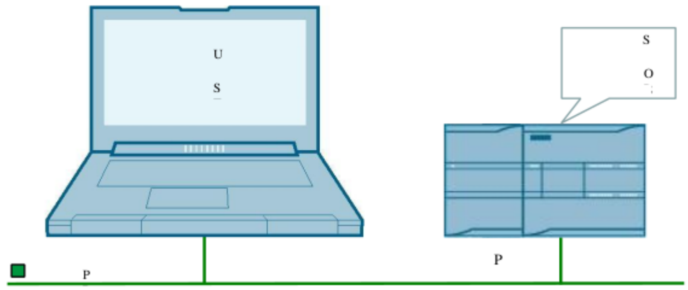


Figure 3-17 hardware setup of the application

The following table provides an overview of all IP addresses used in this example. Assignment of static IP addresses is assumed.

Components	*IP address*	*Description*
CPU 1211C DC/DC/DC	*192.168.100.120*	*S7-1200 CPU with OPC UA Server*
Programming computer	*192.168.100.10*	*UaExpert* *STEP 7 V16*

The subnet mask in all network components is 255.255.255.0.

Downloading the S7-1200 Configuration

- To load the S7-1200 configuration, proceed as follows:
- Launch the TIA Portal V16.
- Launch the "S7_1200_OPC_UA_ServerInterface" project.

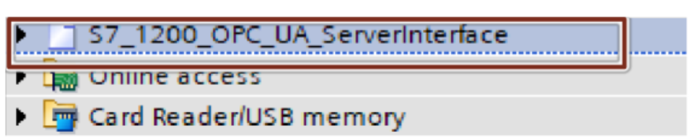


Figure 3-18 Downloading the S7-1200 Configuration

Connect the S7-1200 CPU's Ethernet port and the Ethernet jack of the programming computer.

Download the "PlcUAServer1200" configuration. To achieve this, just choose "Download to device > Hardware and software (only changes)" from the menu that appears when you right-click the device in the project navigation.

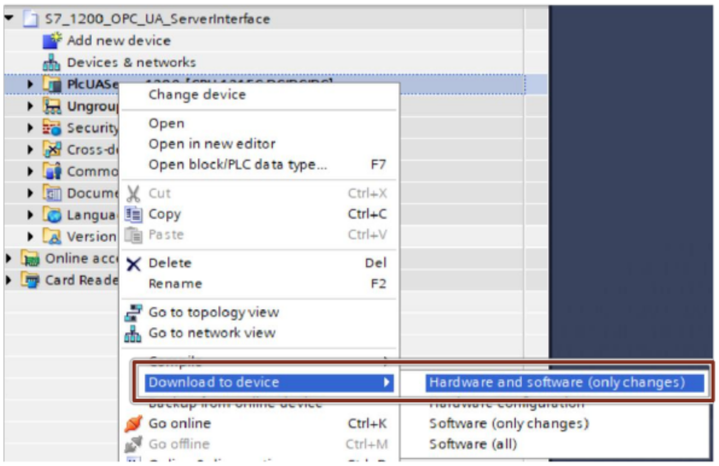


Figure 3-19 Download the configuration

Operation

Introduction

You will be shown how to use the features of the application sample in this section.

Data reading using the OPC UA Client "UaExpert"

The OPC UA Client "UaExpert" requires the following in order to function:

- "UaExpert" is set up on your computer.
- "PlcUAServer1200" has OPC UA Server active.
- The controller has been loaded with the STEP 7 project.

Follow these steps to read the data using the OPC UA Client "UaExpert":

- Launch "UaExpert" and select "Add Server".

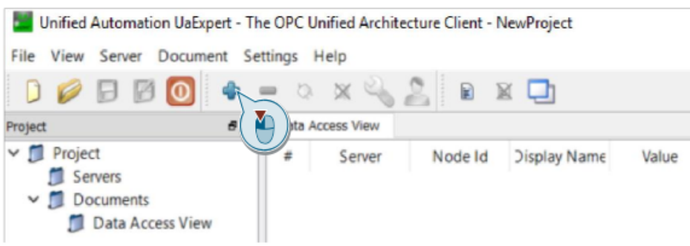


Figure 3-20 Reading data via opcua client 'Uaexpert'

Double-click " Double click to Add Server... >" located in the "Custom Discovery" list part of the dialogue.

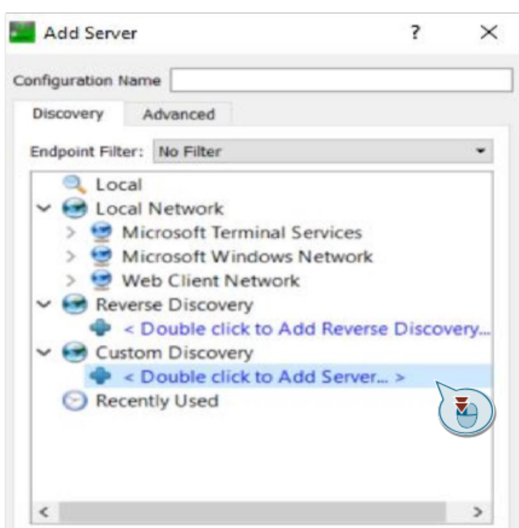


Figure 3-21 Adding a Server

Enter the URL and port of the S7-1200 CPU's OPC UA Server in the next dialogue box (for example, opc.tcp://192.168.0.12:4840), and then click "OK".

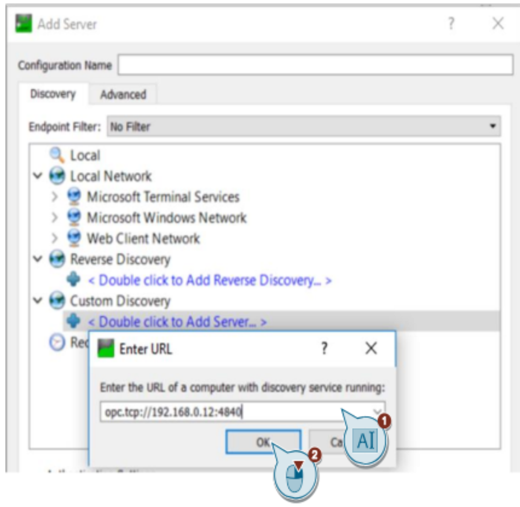


Figure 3-22 Entering URL and Port

Choose an OPC UA Server endpoint (such as SIMATIC.S7-1200.OPC-UA.Application:PlcUAServer1200- None -None) to which you wish to create a connection.

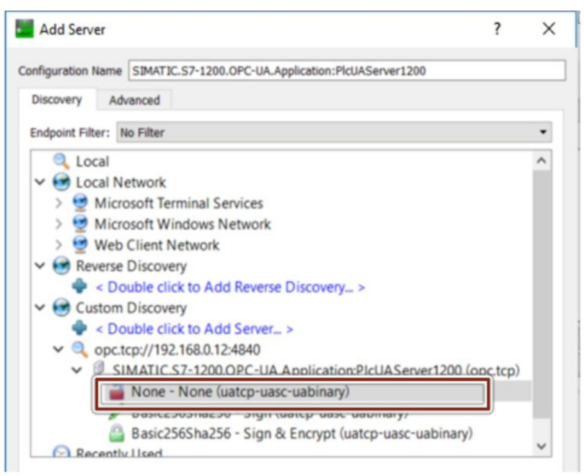


Figure 3-23 End point of Opcua Server

Note:

Since no users are stored in this application example, the "Anonymous" field is activated under "Authentication Settings".

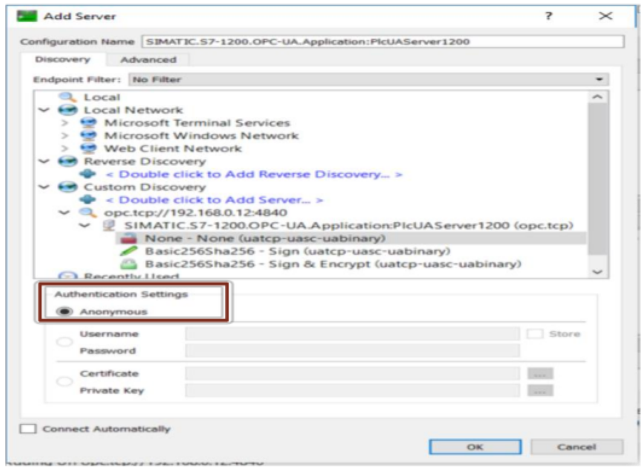


Figure 3-24 Authentication settings

Set the "Connect Automatically" checkbox and then confirm with "OK".

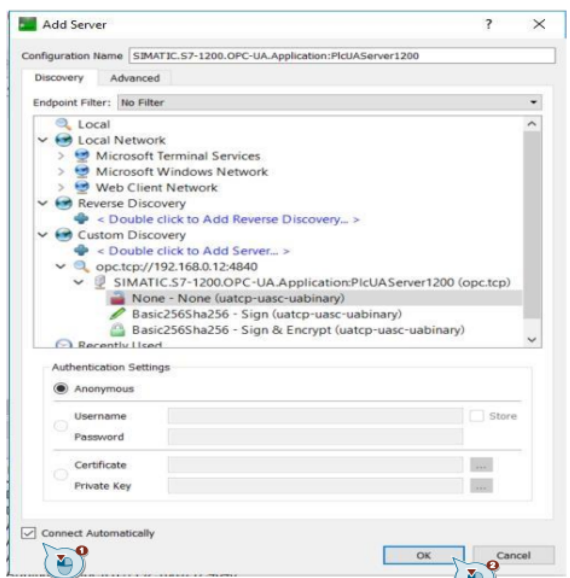


Figure 3-25 Checkbox to connect automatically.

In the following dialog, accept the server certificate by setting the checkbox "Accept the server certificate temporarily for this session".

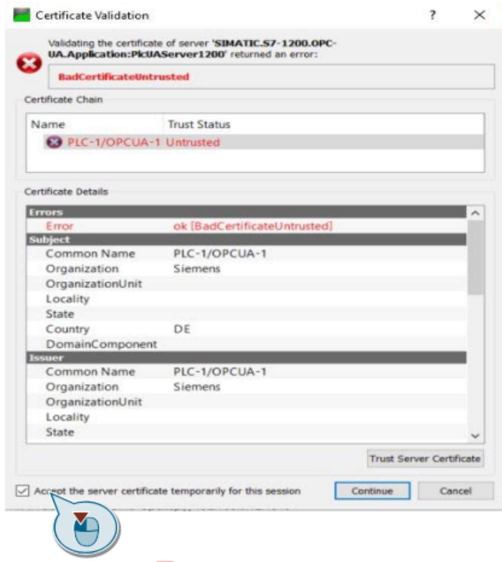


Figure 3-26 Accepting the server certificate temporarily for this session

The certificate is not kept in the "UAExpert" trusted list.

Note: You must choose "Trust Server Certificate" in order to permanently add the certificate to the "UaExpert" trusted list.

Click "Continue" next.

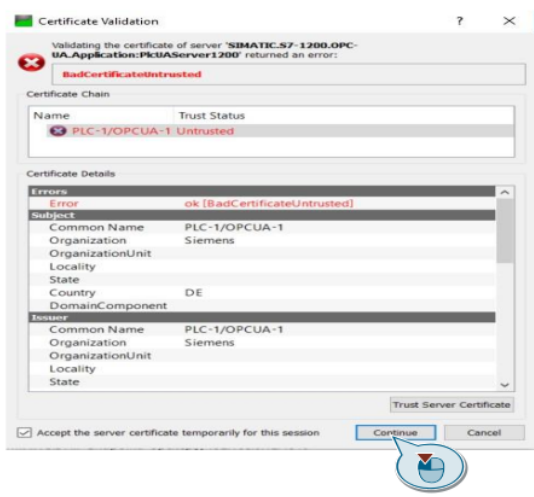


Figure 3-27 Trust Server Certificate.

Your connection to the "PlcUAServer1200"'s OPC UA Server has been established.

Drag and drop the tags "actualSpeed", "isActive", and "setPointSpeed" into the "Data Access View" section by going to "Root > Objects > ServerInterfaces > ConveryorUnit > drive1" in the server's "Address Space".

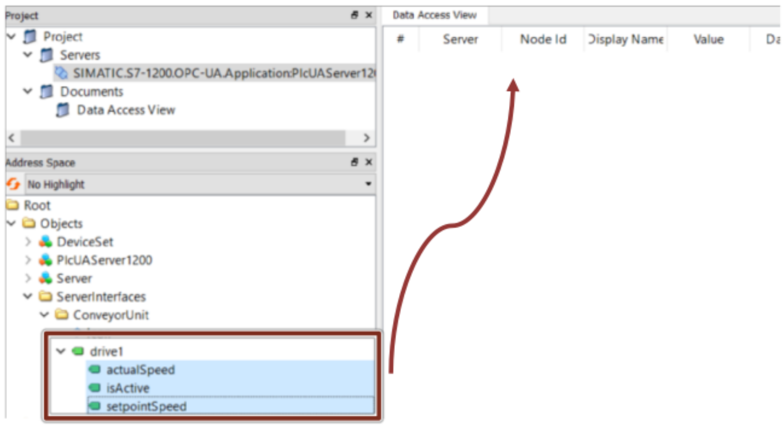


Figure 3-28 Setting the tags

Turn the online view on in your project's OB1 by opening it.

Use the "setPointSpeed" field to provide the required value, such as "10". The "actualSpeed" output gives you the current speed.

The "Value" column in the "Data Access View" section is where you may see the data.

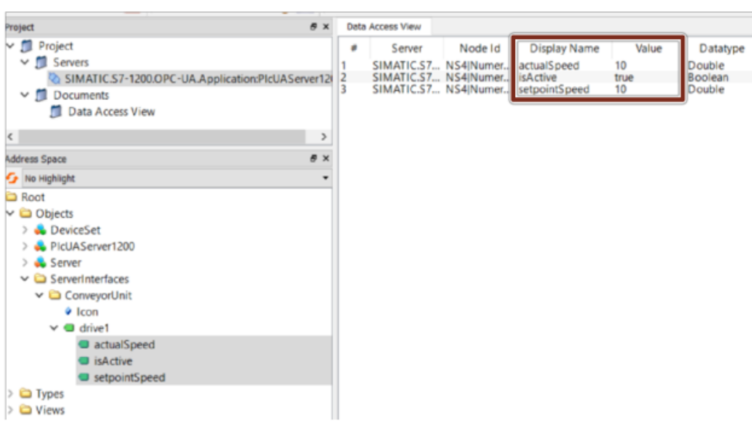


Figure 3-29 Data Access View

3.4 Hardware Details

The project consists of the following hardware that are described below.

3.4.1 IOT Gateway CMT-G04

With two switches (SW) and one Ethernet port (LAN/WAN) installed, the cMT-G04 may serve as an Ethernet switch. The cMT-G04 bridges the upper layer-to-device connection while being entirely invisible to the system and ensures that current operation is unaffected by simply connecting the upper layer device (HMI/SCADA) and the existing device (PLC) with the SW ports. Without the need of an additional industrial Ethernet switch, this is accomplished.

Figure 3-30 CMT-G04 2

Specifications:

Because SW1 and SW2 have an Ethernet switch built into them, they may connect to the machine network without the need of purchasing an additional Ethernet switch. The LAN port connects to the industrial or business network.

Wide input voltage range: 10.5–28VDC; Supports OPC UA and MQTT; Supports MODBUS TCP/IP Gateway; Compact Design and DIN-rail Mountable; Fan-less Cooling System; Built-in 256 MB Flash Memory; Built-in Power Isolator;

3.4.2 Power Supply

In many electrical and electronic applications, a power supply rated for 24 volts at 6.5 amps (24V 6.5A) is often used. It can generate a maximum current of 6.5 amps and a consistent output voltage of 24 volts, respectively, to power connected components or devices. Here are a few typical applications for a power supply meeting this criteria.

- Industrial Equipment: To power sensors, actuators, and other components, 24V 6.5A power supplies are often used in industrial automation, equipment, and control systems.
- LED Lighting: In order to function effectively, many high-power LED lighting systems, particularly those used in commercial and outdoor applications, need 24V power sources.

Figure 3-31 Power SupplY

Specifications:

Attribute	Value
Output Voltage	24V dc
Output Current	6.5A
Power Rating	156W
Number of Outputs	2
Input Voltage	220v AC
Mounting Type	Chassis Mount
Package Type	Enclosed
Length	199mm
Width	98mm
Depth	38mm
Efficiency	86%
Weight	700g
Minimum Temperature	-25°C
Maximum Temperature	+70°C

3.4.3 Programmable Logic Controllers (PLC's)

PLCs are specialized industrial control systems that are used in manufacturing, industry, and commercial settings to automate and manage numerous processes and gear. PLCs may carry out a variety of functions, including monitoring sensors, making choices, and regulating outputs depending on programd logic. They are made to be programmable.

Figure 3-32 Programmable Logic Controllers (PLC's)

PLC’s:

We have used three PLC’s in our project. Here are the details of all the PLC’s,

1. **SIEMENS S7-1200 1211 DC/DC/RLY**

A specific model of the Siemens Simatic S7-1200 series programmable logic controller (PLC) is the Siemens S7-1200 1211 DC/DC/RLY. The industrial automation and control applications for this PLC are numerous. Let's examine the main characteristics and parts of the Siemens S7-1200 1211 DC/DC/RLY:

Model Information:

Siemens S7-1200 1211 DC/DC/RLY is the model.

The "DC/DC/RLY" in the model name denotes that this particular model has the ability to output relays (RLY) and digital input/output (DC).

Hardware Features:

a. Central processing unit (CPU): The S7-1200 1211 has a CPU that runs the control program.

b. I/O, or input/output: Sensors, switches, and other devices that produce digital signals are connected via digital inputs.

c. Relay Outputs: Devices like motors, solenoids, or lights can be controlled via relay outputs.

d. Power source: The "DC/DC" in the model name denotes the use of a DC power source for operation.

e. Programming: The Siemens TIA (Totally Integrated Automation) Portal software is generally used to program Siemens S7-1200 PLCs. This software supports a number of programming languages, including ladder logic, structured text, and function block diagrams.

f. Communication: The S7-1200 series PLCs are capable of exchanging data with other industrial network devices thanks to the support for communication protocols including PROFINET, Modbus, and others.

g. Memory: PLCs contain both program memory and data memory, which are used to store the variables and data that are needed in the control program.

h. Integration with Human-Machine Interfaces (HMIs): The S7-1200 series may be integrated with HMIs to give operators a user-friendly interface for monitoring and controlling processes.

i. Applications: The S7-1200 series is employed in a variety of settings, such as building automation, process control, and machine automation.

j. Scalability: To meet the needs of varied applications, Siemens provides a range of models and extension possibilities within the S7-1200 series.

k. Monitoring and Diagnostics: PLCs like the S7-1200 include capabilities and diagnostic tools for keeping tabs on the functionality and overall health of the control system.

In industrial automation, Siemens S7-1200 PLCs are renowned for their dependability and adaptability. The S7-1200 1211 DC/DC/RLY type you specifically specified, which runs on a DC power source, is appropriate for situations where digital inputs/outputs and relay outputs are required. The programming and setup of this PLC must be done using Siemens' TIA Portal software.

Figure 3-33 SIEMEND S7-1200 1211C DC/DC/RLY

2. SIEMENS S7-1200 1211 DC/DC/DC

A specific model of the Siemens Simatic S7-1200 series programmable logic controller (PLC) is the Siemens S7-1200 1211 DC/DC/DC. Various industrial automation and control applications are supported by this PLC. Let's examine the main characteristics and parts of the Siemens S7-1200 1211 DC/DC/DC in more detail:

Model Specifications:

Siemens S7-1200 1211 DC/DC/DC model

The "DC/DC/DC" in the model name denotes that this particular model is capable of digital input/output (DC) and uses a DC power source.

Hardware Features:

- CPU: The S7-1200 1211 is equipped with a central processing unit (CPU) that executes the control program.
- **Input/output (I/O):**
- Digital Inputs: These allow connections to be made between sensors, switches, and other electronic devices that produce digital signals.
- Digital Outputs: Devices or indicators that require digital signals can be controlled by digital outputs.
- Power Source: A DC power source is used to power this model.
- Programming: The Siemens TIA (Totally Integrated Automation) Portal software is generally used to program Siemens S7-1200 PLCs. This software supports a number of programming languages, including ladder logic, structured text, and function block diagrams.
- Communication: The S7-1200 series PLCs are capable of exchanging data with other industrial network devices thanks to the support for communication protocols including PROFINET, Modbus, and others.
- Memory: PLCs contain both program memory and data memory, which are used to store the variables and data that are needed in the control program.
- Integration with Human-Machine Interfaces (HMIs): The S7-1200 series may be integrated with HMIs to give operators a user-friendly interface for monitoring and controlling processes.

- Applications: The S7-1200 series is employed in a variety of settings, such as building automation, process control, and machine automation.
- Scalability: To meet the needs of varied applications, Siemens provides a range of models and extension possibilities within the S7-1200 series.
- Monitoring and Diagnostics: PLCs like the S7-1200 include capabilities and diagnostic tools for keeping tabs on the functionality and overall health of the control system.

The Siemens S7-1200 1211 DC/DC/DC, which runs on a DC power source, is appropriate for applications requiring digital inputs/outputs. You must program, configure, and monitor the controller using Siemens' TIA Portal software to interact with this PLC. This PLC, which is a member of the well-liked Siemens S7 series, is renowned for both its performance and dependability in industrial automation.

Figure 3.34 SIEMENS S7-1200 1211C DC/DC/DC

3. SIEMENS S7-300 314C 2DP

A specific model of the Siemens Simatic S7-300 series programmable logic controller (PLC) is the Siemens S7-300 314C 2DP. Applications for industrial automation and control frequently employ the S7-300 series. Let's examine the main characteristics and elements of the Siemens S7-300 314C 2DP:

Model Information:

- Siemens S7-300 314C 2DP is the model.
- The model number "314C 2DP" specifies detailed information about the characteristics and abilities of this PLC.
- Hardware characteristics Central Processing Unit (CPU): The PLC's 314C CPU, which runs the control program, is its brain.
- Digital Inputs/Outputs (DI/DO): To interact with sensors, switches, and other devices, this architecture provides a mix of digital inputs and outputs.
- Communication: This model features two communication interfaces for establishing connections with other devices or networks, as indicated by the "2DP" designation. A popular industrial communication protocol used in many applications is called Profibus DP.
- Power Supply: This PLC normally has an external power source that will deliver the necessary voltage for optimal functioning.
- Applications: The S7-300 series is appropriate for a variety of tasks, including manufacturing, process automation, machine control, and more.
- Scalability: To satisfy the needs of various applications, the S7-300 series provides a variety of CPU types with variable capabilities and extension possibilities.
- Diagnostics and Monitoring: To assist in keeping track of the condition and well-being of the control system, these PLCs have diagnostic tools.
- Human-Machine Interface (HMI) Integration: Siemens provides Human-Machine Interface (HMI) solutions that can be combined with S7-300 PLCs to give operators a user-friendly interface for monitoring and controlling operations.

The Siemens S7-300 314C 2DP is a component of the company's venerable S7-300 series, which has long been utilised extensively in industrial automation. In industrial settings, it is renowned for its dependability and toughness. To regulate and automate procedures and equipment, this PLC is utilised in a number of industries and applications. Siemens' Step 7 software, which provides a complete set of tools for PLC development, is commonly used for programming and setup.

Figure 3.35 SIEMENS S7-300 314C 2DP

3.5 Software Details

In the evaluation of the project, the following software were used.

3.5.1 Easy-builder Pro

Weintek's Easy Builder Pro is the newest HMI software. It is quick, seamless, and really simple to use. Easy Builder Pro makes it simple and quick to create stunning and comprehensive HMI solutions. It looks like Windows, with toolbars, for instance. Dialog boxes, menus and "drag and drop" objects.

Graphics, buttons, histories, alarms, and other multi-purpose items with dynamic use are supported by Easy Builder Pro. Large library containing a variety of built-in animations and graphics, as well as compatibility for BMP, JPG, GIF, and PNG image formats. Additionally, it offers a debug mode that is clear and straightforward, as well as data logging for the whole track on previous trend data.

Figure 3-36 Easy Builder Pro

More than 350 distinct drivers for all popular PLCs and other controllers are included in Easy Builder Pro. With user levels, passwords, and remote control and monitoring through VNC or Easy access, advanced security is supported. Macro for advanced recipe, programming, or log features.

3.5.2 Node-Red

Node-RED is a visual programming development tool for the Internet of Things that was created by IBM to link hardware components, APIs, and web services. [23]

An online flow editor powered by Node-RED is available for developing JavaScript functions. The application's components can be shared or stored for later use. The Node.js runtime is used. Node-RED flow creations are stored in JSON format. MQTT nodes may create correctly configured TLS connections as of version 0.14. [24]

The OpenJS Foundation received IBM's Node-RED as an open-source project in 2016. [25]

Node-RED is a flow-based development tool created originally for visual programming.

IBM for connecting hardware, APIs, and online services as part of the Internet of Things, and it is utilized for improved parameter visualization across all screens.

Figure 3-37 NodeRed

3.5.3 Expert - OPCUA Client

The UaExpert is an OPC UA client with all the features, showcasing the power of our C++ OPC UA Client SDK/Toolkit. The OPC UA capabilities including Data Access, Alarms & Conditions, Historical Access, and invocation of UA Methods are supported by the UaExpert, an all-purpose test client. A cross-platform OPC UA test client called. The UaExpert was created in C++.

Figure 3-38 UaExpert

3.5.4 Amazon Web Service (AWS)

AWS, or Amazon Web Services, is a feature-rich and very scalable cloud computing platform offered by Amazon.com. Since its launch in 2006, AWS has grown to rank among the most well-liked and commonly used cloud service companies. It provides a wide range of cloud computing services, making it simple and effective for companies, people, and organizations to create and administer complex applications.

Key Features and Offerings:

Compute Services: AWS offers a range of computer services, such as server less computing with AWS Lambda and scalable virtual servers with Amazon EC2 (Elastic Compute Cloud).

Storage Alternatives: Amazon Web Services (AWS) provides a variety of storage services, including Amazon S3 (Simple Storage Service) for scalable object storage, Amazon EBS (Elastic Block Store) for block storage, and Amazon Glacier for long-term archive storage.

- **Databases:** AWS offers managed database services including Amazon Redshift for data warehousing, Amazon DynamoDB for NoSQL databases, and Amazon RDS (Relational Database Service) for relational databases.
- Dedicated network connections are available through AWS Direct Connect, while domain name system (DNS) web services are provided by Amazon Route 53 and Virtual Private Cloud (VPC) respectively.
- **Identity and security**: AWS Key Management Service (KMS) offers encryption key management, while AWS Identity and Access Management (IAM) gives secure control over user access.
- **Artificial intelligence and machine learning**: AWS provides AI and ML services, including Recognition for image and video analysis and Amazon SageMaker for creating, honing, and deploying machine learning models.
- IoT (Internet of Things): AWS IoT Core enables IoT applications at scale by facilitating secure connectivity between internet-connected devices and the cloud.
- **DevOps and Management Tools:** AWS offers tools for infrastructure as code, configuration management, and continuous integration and delivery, including AWS Code Pipeline and AWS Cloud Formation.

- **Global Infrastructure:** AWS runs data centers across several continents, allowing users to deploy applications in geographically specific locations for reduced latency and enhanced performance.

- **Benefits of AWS:**

  With AWS's flexibility to scale resources up or down in response to demand, customers may achieve peak performance without over-provisioning.

- **Cost-Effectiveness:** Users only pay for the services they really use, which makes it economical, particularly for new and small organizations.

- **Flexibility:** AWS provides the freedom to select the best solutions for different applications from among a large range of services and tools.

- **Security:** To ensure data safety and regulatory compliance, AWS offers strong security features and compliance certifications.

  New services and features are often released by AWS, allowing users to exploit cutting-edge technologies in their projects.

- **Dependability:** AWS provides excellent availability and dependability for hosted applications and data thanks to redundant and geographically dispersed server centres.
- **AWS** has revolutionized the way businesses approach IT infrastructure and application development, empowering them with the tools and resources needed to innovate, scale, and succeed in the digital age.

Figure 3-39 Amazon Web Service

3.6 NodeRed Designing

In order to link NodeRed Dashboard with the Cloud database, NodeRed Dashboard is developed utilizing the flows and sub-flows of the nodes connected.

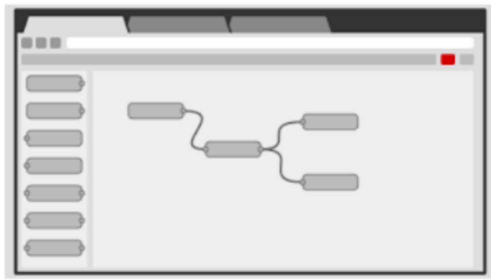


Figure 3-40 Node red Designing

3.6.1 Node-Red Flow

For building the dashboard on NodeRed, we used nodes-based programming, and we used flows and sub-flows to organise the work structure and group of nodes. The primary flow diagrams are shown in the following picture.

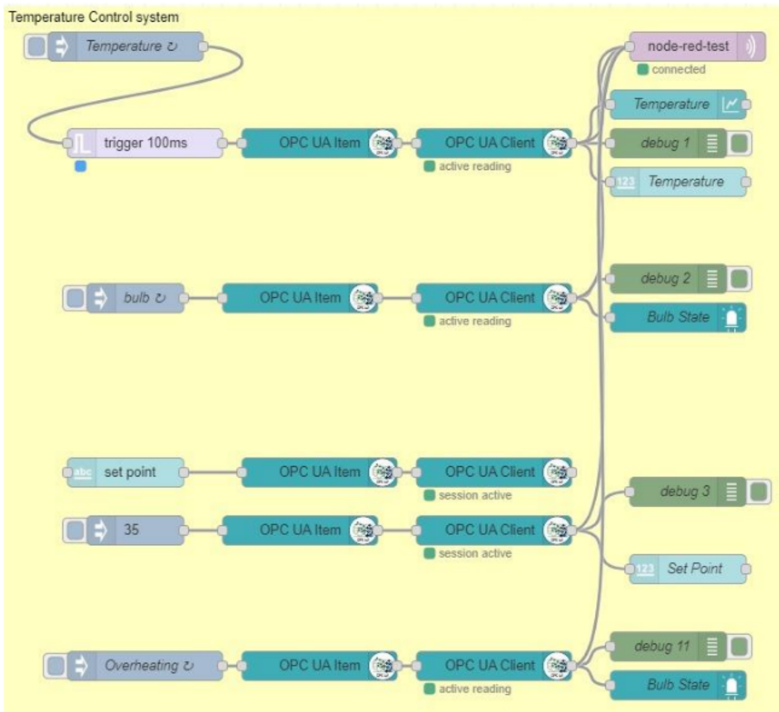


Figure 3-41 Node red designing for temperature system,

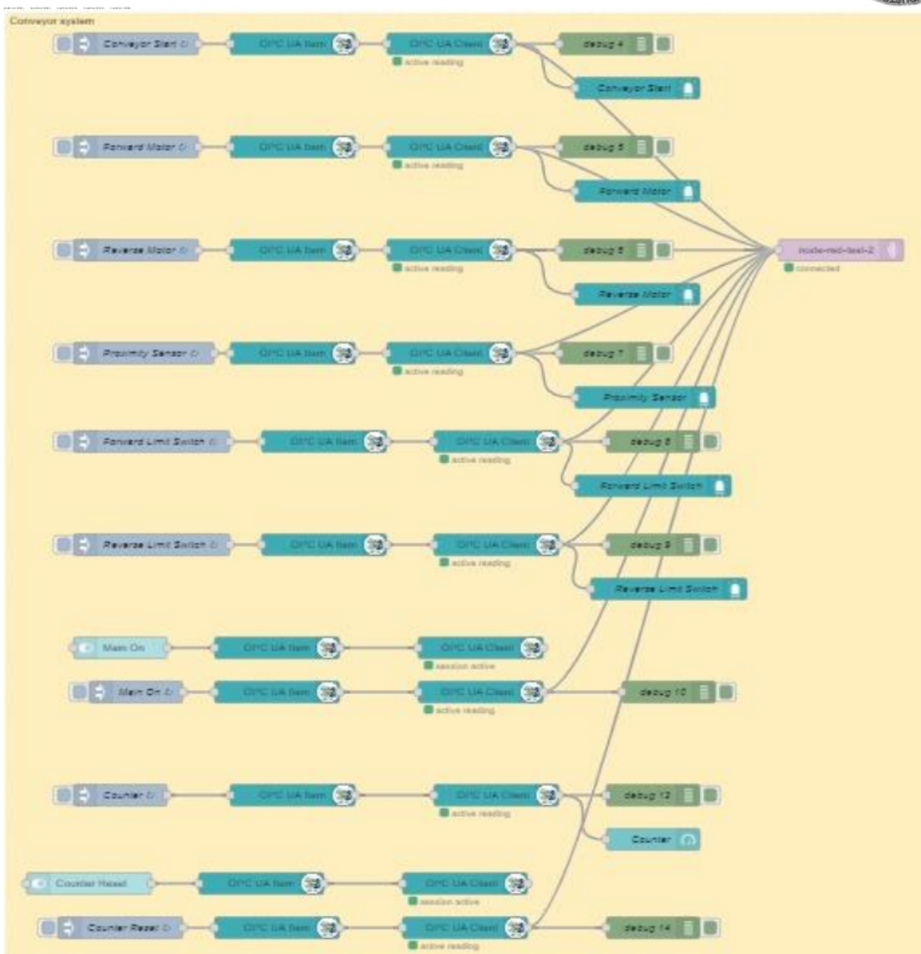


Figure 3-42 Conveyor flow Node red Designing

3.6.2 NodeRed Flow on Cloud

A common IOT platform for sending data to cloud storage is the node. In a similar vein, we've utilized NodeRed to send various plant accessories to the AWS cloud storage. The programming of the NodeRed to create a cloud-based visual representation of the plant's peripherals is shown in the below sub-flow diagram.

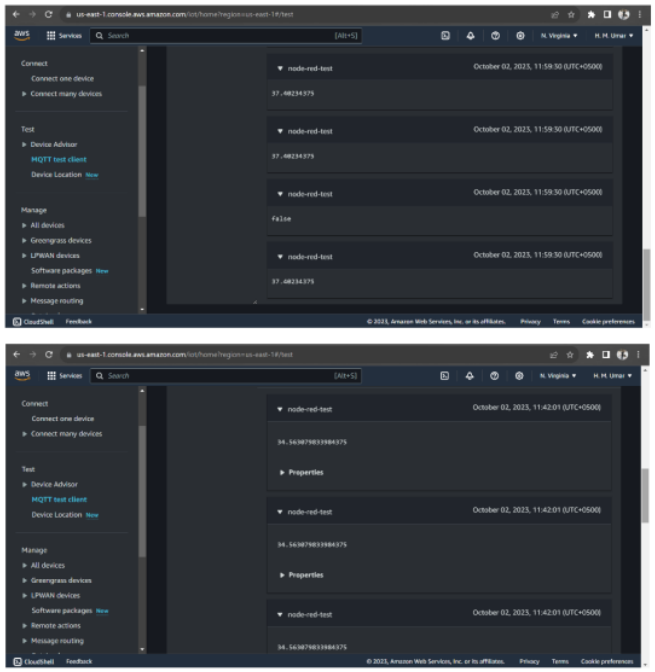


Figure 3-43 NodeRed Flows for Cloud

CHAPTER 4

Results and Discussion

4.1 Introduction

This chapter discusses the outcomes of designing and developing the software, as well as integrating the hardware. The results enable the control system to be upgraded to industry 4.0. Along with the project's advantages, further evaluation of the project is also presented. [27]

4.2 Panel

We created the control panel for the temperature and induction motor speed systems. The IoT gateway and S7-1200 are mounted on the panel. [28]

4.2.1 Simulation Results

The following are the simulation pages of different areas of the plants,

Temperature control system by PID:

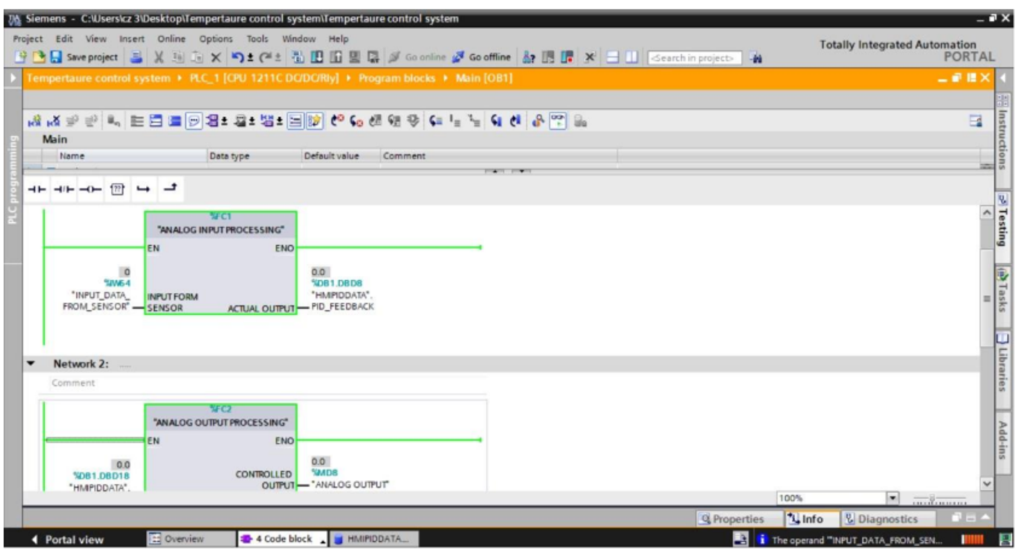


Figure 4-1 Temperature Control System Simulation-1

Totally Integrated Automation Portal		

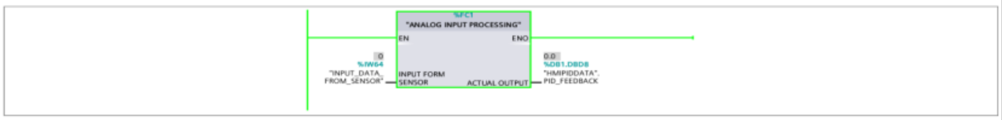
Tempertaure control system / PLC_1 [CPU 1211C DC/DC/Rly] / Program blocks

Main [OB1]

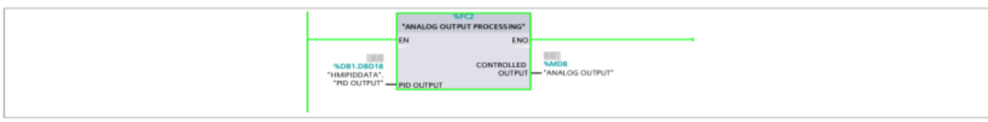
Main Properties							
General							
Name	Main	**Number**	1	**Type**	OB	**Language**	LAD
Numbering	Automatic						
Information							
Title	"Main Program Sweep (Cy- cle)"	**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Main			
Name	**Data type**	**Default value**	**Comment**
▼ Input			
Initial_Call	Bool		Initial call of this OB
Remanence	Bool		=True, if remanent data are available
Temp			
Constant			

Network 1:



Network 2:



Network 3:

Figure 4.2 Temperature control logic

Totally Integrated Automation Portal		

Tempertaure control system / PLC_1 [CPU 1211C DC/DC/Rly] / Program blocks

Cyclic interrupt PID [OB30]

Cyclic interrupt PID Properties							
General							
Name	Cyclic interrupt PID	**Number**	30	**Type**	OB	**Language**	LAD
Numbering	Automatic						
Information							
Title		**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Cyclic interrupt PID			
Name	**Data type**	**Default value**	**Comment**
▼ Input			
Initial_Call	Bool		Initial call of this OB
Event_Count	Int		Events discarded
Temp			
Constant			

Network 1:

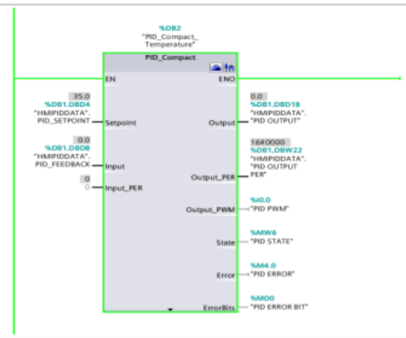


Figure 4.3 Temperature control logic-2

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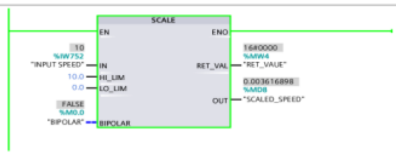
SPEED CONTROL MOTOR / PLC_1 [CPU 314C-2 DP] / Program blocks

Main [OB1]

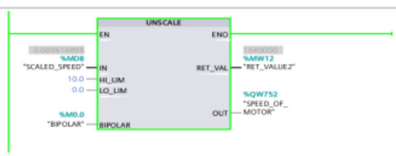
Main Properties							
General							
Name	Main	**Number**	1	**Type**	OB	**Language**	LAD
Numbering	Manual						
Information							
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**		**Family**	
Version	0.1	**User-defined ID**					

Main				
Name	**Data type**	**Offset**	**Default value**	**Comment**
▼ Temp				
OB1_EV_CLASS	Byte	0.0		Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
OB1_SCAN_1	Byte	1.0		1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
OB1_PRIORITY	Byte	2.0		Priority of OB Execution
OB1_OB_NUMBR	Byte	3.0		1 (Organization block 1, OB1)
OB1_RESERVED_1	Byte	4.0		Reserved for system
OB1_RESERVED_2	Byte	5.0		Reserved for system
OB1_PREV_CYCLE	Int	6.0		Cycle time of previous OB1 scan (milliseconds)
OB1_MIN_CYCLE	Int	8.0		Minimum cycle time of OB1 (milliseconds)
OB1_MAX_CYCLE	Int	10.0		Maximum cycle time of OB1 (milliseconds)
OB1_DATE_TIME	Date_And_Time	12.0		Date and time OB1 started
Constant				

Network 1:



Network 2:



Network 3:

Network 4:

Figure 4.3 Motor Speed control

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conveyor main program / PLC_1 [CPU 1211C DC/DC/DC] / Program blocks

Main [OB1]

Main Properties					
General					
Name	Main	**Number**	1	**Type**	OB
Language	LAD	**Numbering**	Automatic		
Information					
Title	"Main Program Sweep (Cycle)"	**Author**		**Comment**	
Family		**Version**	0.1	**User-defined ID**	

Main			
Name	**Data type**	**Default value**	**Comment**
Temp			
Constant			

Network 1:

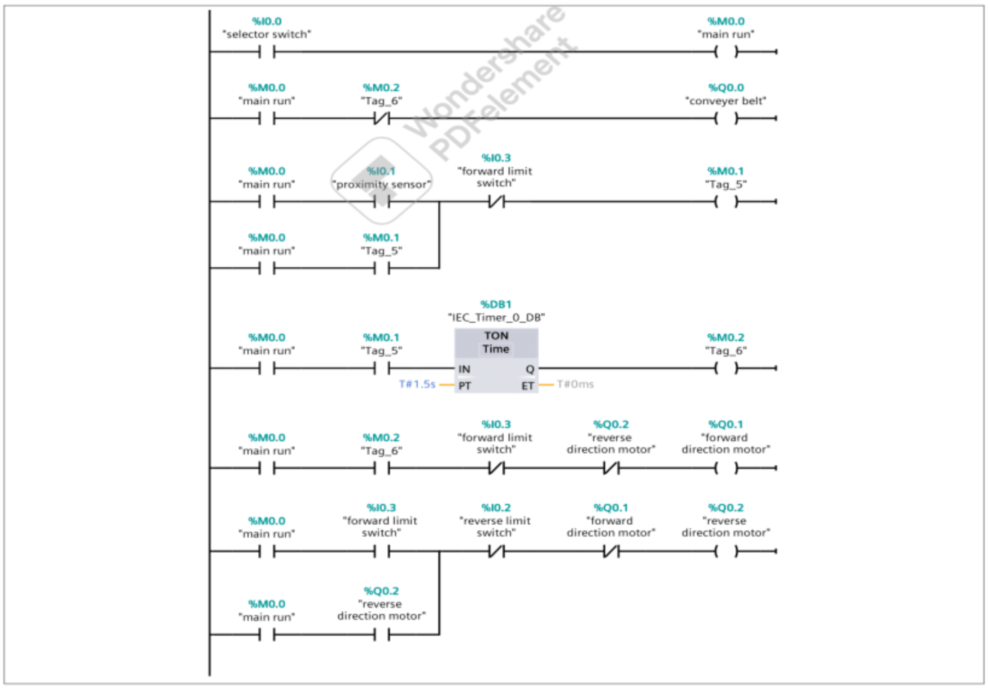

Figure 4.5 Conveyor System Main Program

4.2.2 Real Time Monitoring

The integration of the CMT-G04 device with the router, router, and PLCs allowed for the real-time monitoring of the plant.

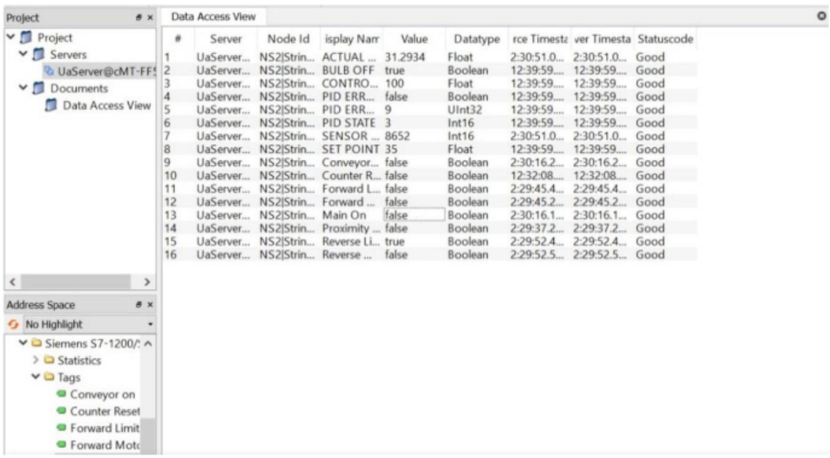

Figure 4.5 Real time monitoring with IOT Gateway CMT-G04

4.3 NodeRed Dashboard

The NodeRed dashboard was created to support the adoption of newer, better technologies for remote plant parameter access via an interactive dashboard user interface. The chapter before this one included a flowchart that showed how the dashboard was designed.

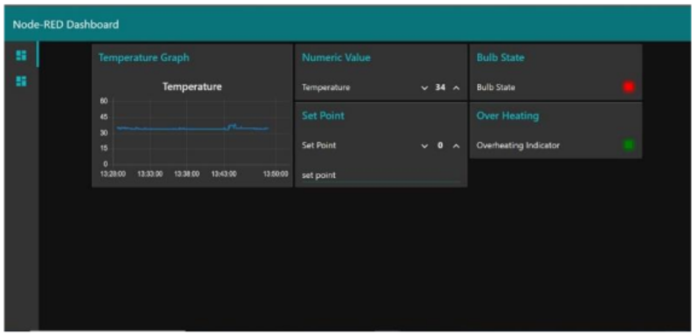

Figure 4.6(a) Node Red Dashboard

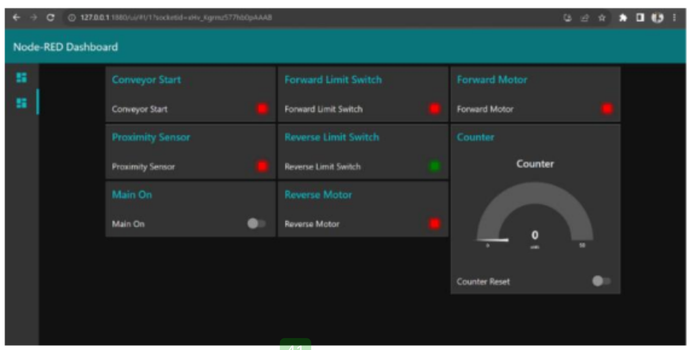

Figure 4.6(b) Node Red Dashboard

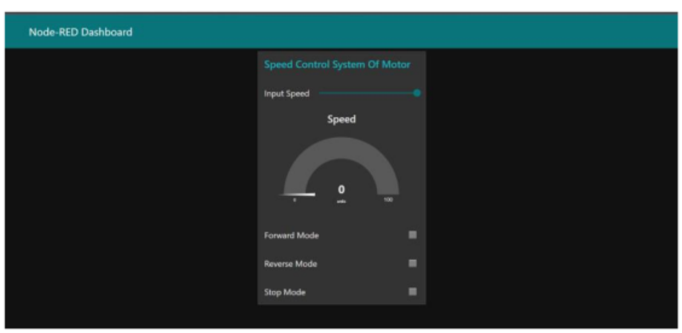

Figure 4.6(c) Node Red Dashboard

4.4 NodeRed Mobile App

On an Android phone, the functioning status of the plant is available via the NodeRed mobile application. This gives us more alternatives for accessing the facility remotely. The Dashboard may be seen by connecting the plant's IP with a certain password.

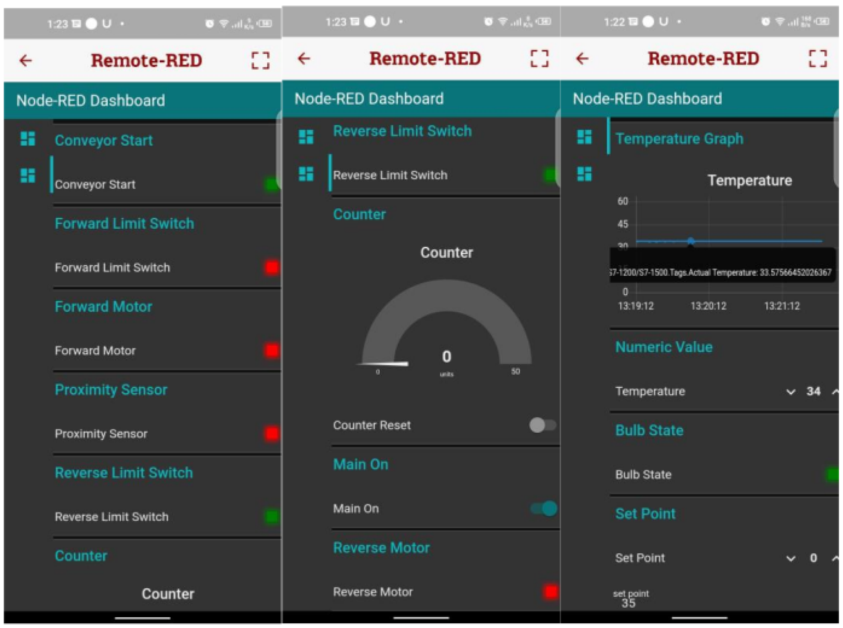

Figure 4-7 NodeRed Dashboard on Android Application

4.5 AWS IoT Cloud

Cloud connection of Plant enables remote data acquisition and monitoring. The preceding chapter gave an example of a sub-flow diagram of nodes interacting to create a visual representation on the cloud. The project makes use of AWS as its cloud. Because AWS offers free access to its services for a small amount of data storage, it was chosen. IIOT Gateway is used as the hardware and AWS as the software to enable remote data on the Cloud. [30]

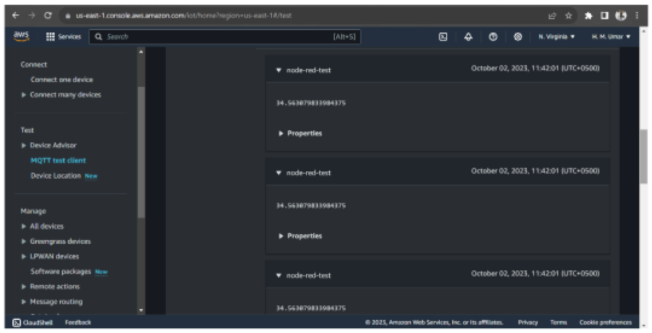

Figure 4-8 Plant Parameters on Cloud

4.5.1 Remote Monitoring

The most important component of managing a system and responding to flaws in any kind of dangerous circumstance is remote monitoring. Therefore, we created a mechanism to use CMT Viewer in remote locations to continually watch the dashboard. In order to track plant characteristics, we also created an interactive user interface for the Node-Red Dashboard. Similar to this, distant locations throughout the world might likewise monitor the Node-Red Dashboard. A remote monitoring system is eventually created to manage the plant appropriately. [31]

4.5.2 Data Acquisition

Arguably the most important component of industry 4.0 is data acquisition. It aids in gathering data on the plant's characteristics and operations. The information is then refreshed using this data, and patterns, interpretations, and findings related to plant health monitoring are made. Data analysis is used to produce these results. The efficiency of the plant and its operation is increased by putting these conclusions into practice.

In this project, we're using a few different platforms to collect data. First, the IoT Gateway's internal storage is prioritized as the main source of data collecting. Second, we are utilizing AWS to store data and the operation of a few specific plant characteristics in the cloud. This makes remote data collection possible.

CHAPTER 5

Conclusions

5.1 Summary

In order to be ready for the emergence of the next digital industrial revolution, leading companies have been deploying cutting-edge digital technologies like IIOT, cloud computing, and AI. The present study attempted to provide an interpretive model of Industry 4.0's sustainability function explaining the processes through which the industrial digitalization and the underlying technology trends and design principles can contribute to the achievement of economic, environmental, and social sustainability development goals. Industrialists believe that Industry 4.0 may have a positive impact on sustainability. [32]

Despite the fact that a control system has been developed for this project, it primarily provides a few crucial aspects of the fourth industrial revolution. Finally, a unique user interface for the supervisory panel and a Node-Red Dashboard are created for further analysis of the plant data. In the meantime, this project is continuing to design the Cloud Data Acquisition. As a result, remote access to Node-Red Dashboard and Data Acquisition was possible.

The local data capture of plant characteristics in the CMT-G04 device, which is connected to Node-Red Dashboard, is one of this project's additional features. The supervisory Panel and the Node-Red Dashboard may also be viewed via a mobile application, to round out the access options.

5.2 Recommendations for Future Work

Further Enhancement of this project could be made possible by vitalizing the following recommendations:

5.2.1 Easy Access 2.0

If an Internet connection is available, Easy Access 2.0 offers a new method to access a Maple Systems HMI from anywhere in the globe. This is the fee-based software used to access Weintek HMI from anywhere in the world. [3] This capability allows for remote HMI monitoring and management, and eventually factory management. This aids in the early detection of problems that may arise and protects the plant from any dangerous circumstances.

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