A

PROJECT REPORT ON

Availing Telepresence for the expeditious retrieval of datum

In the fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

INSTRUMENTATION AND CONTROL ENGINEERING

Submitted by,

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CANDIDATE'S DECLARATION

We hereby declare that the work which is being presented in the Project Report titled "**Availing Telepresence for the expeditious retrieval of datum**" in partial fulfillment of the requirements for the award of the Degree of Bachelor of Technology in Instrumentation & Control Engineering, submitted to the Department of Instrumentation and Control Engineering, Faculty of Technology, Dharmsinh Desai University, Nadiad, Gujarat, India, is an authentic record of our own work carried out during a period from December, 2022 to March, 2023 under the supervision of **PROF. (Dr.) Vipul A. Shah**, Associate Professor, Department of Instrumentation and Control Engineering, Faculty of Technology, Dharmsinh Desai University, Nadiad, Gujarat, India. The matter presented in this Project Report has not been submitted by us for the award of any other degree of this Institute or any other Institute.

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ABSTRACT

The project work involves the study and conceptual layout of Industry 4.0. By adding remote monitoring features to existing industries, we can get various parameters of field sensors in the industries using Augmented Reality. This work majorly involves the field instruments and software for programming PLC, communicating with the cloud, and inculcating augmented reality as a part of industry 4.0.

The development work involves acquiring the process variables from the sensors like Pt 100 (temperature sensor) with final control elements as a heater, and a motor that will provide temperature data to PLC. Allen Bradley MicroLogix will send this data to the cloud platform via raspberry pi 4. It is a single-board computer that is being used to communicate with the cloud platform.

Since Industry 4. O is popular nowadays and everyone understands its significance, So, in an effort to showcase one of the augmented reality applications, we have created a prototype. Data from the IoT platform is fetched into an application using C# scripting. This way the personnel can analyze live data of instrument parameters by just scanning the instruments.

1. INTRODUCTION

1.1 COMPANY PROFILE

Fig.1.1 Servilink Systems Ltd

Servilink was founded in 1981 at Baroda – Gujarat, with a prominent presence in Electrical Industry. The company expanded the business horizon and entered SERVILINK SYSTEMS LIMITED in an Automation Field, in 1995 at Vadodara. They are given solutions – provider for Industrial Automation, Manufacturing IT, and Turnkey Projects by the world's leading plants owners, process suppliers to increase their productivity & efficiency.

Today, SSL is having wide experience in Industrial Automation Sector to Supply and Execute Control Systems in areas of the process. The industries served are Chemicals, Oil & Gas, Fertilizers, Power, Metal, Pharmaceuticals, Food & Beverages, Dairy, Agro Chemicals, Automobile, Cement, Textile, Glass and Utilities. Our business area covers Consultancy, Design, Engineering, Manufacturing, and Commissioning and Installation.

They are ISO 9001:2015 Certified Company. They are one of the Indian companies to earn "Recognized System Integrator" from Rockwell Automation, the world's biggest company dedicated to Industrial Automation & information.

SSL has four major divisions:
i. i. Industrial Automation
ii. IOT Solution
iii. Fluke Process Instrument
iv. FLIR Thermal Solution
v. Industrial Training

Servilink Systems Limited has established manufacturing activities at GIDC POR, Vadodara to deliver quality product. Ignore to strive for excellence, quality measures have been implemented at various stages and are subjected to testes as per relevant applications for Customers.

Team of experienced engineers and skilled force, who have rich and varied experience infield of industrial automation and industries, only supports all our above activities.

Our mission is to provide solution to the users in industrial Automation using right Controls and Software to achieve a competitive edge in a rapidly changing world.

1.2 PROBLEM STATEMENT

Automation, (manufacturing) process improvement, and productivity/production optimization are the most common initial objectives of Industry 4.0. Even in industries today, the personnel visiting the plant must connect to the control room to get information about any equipment involved in the process. Such tasks can take a lot of time and can be erroneous. This can be resolved by using augmented reality, a key component of industry 4.0, to gain direct access to all the real-time plant parameters.

1.3 PREPARATION OF PROJECT

The main task is to seek a platform that can handle our requirements and can interact with our paradigm. Generally, the cost of such a platform is way ahead of our imagination. Thus, the main concern of our team is how to deal with the price.

The preparations for the project are as follows:

1.3.1 Literature Survey
Study of PLC

Automation is the use of various control systems for operating equipment, such as boilers, machinery, heat treating ovens and processes in factories, switching in telephone networks, stabilization of ships and steering, aircraft, and other applications with minimum involvement of humans. The advantage of automation is that it saves labor, however, it is also used to save energy, and materials and to improve quality, precision, and accuracy. The term automation, inspired by an automaton, was not commonly used before 1947. In the 1930s, the industry introduced feedback controllers, which were adopted very fast. Automation has been achieved by various means including, mechanical, pneumatic, hydraulic, electrical, electronics, and computers, mostly in combination. Combined techniques are usually used in complicated systems, such as ships, modern factories, and airplanes. Engineers can now have numerical control over automated devices. Information technology, together with industrial machinery and processes, can lend a hand in the design, implementation, and monitoring of control systems. PLC is a good example of an industrial control system. PLCs are specialized computers that are often used to synchronize the flow of inputs from sensors and events with the flow of outputs to actuators and events.

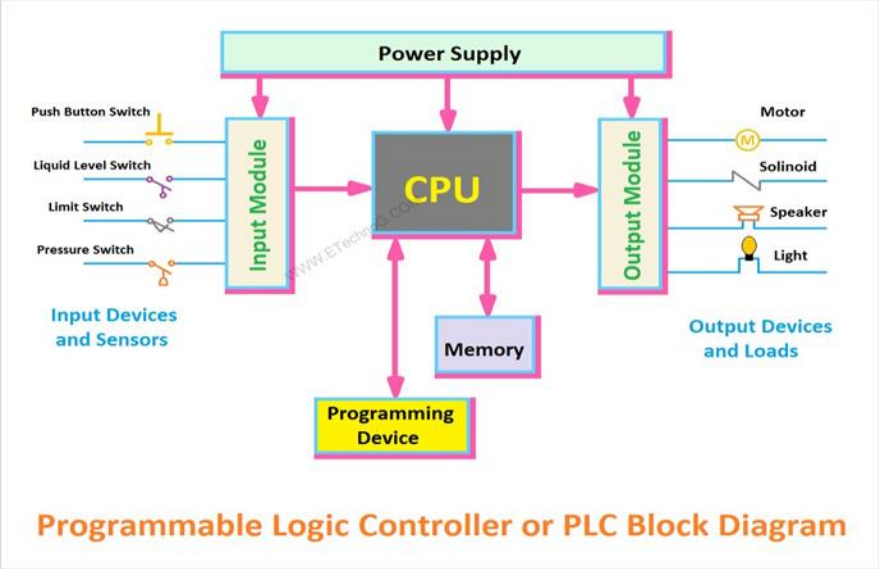


Fig.1.2 PLC Block Diagram

Study of SCADA

SCADA, referred to as Supervisory Control And Data Acquisition System is widely used in industries. The system consists of mainly two things:

i. A controller

ii. A Data Acquisition System

At the industrial level, there are so many process units to look after, SCADA provides the facility to the operator to visualize all the necessary process parameters e.g. the condition of the valve (% open or closed), pressure, and temperature in a tank, level of a tank, flow in a pipeline, etc. He also has the facility to give new set points to different process parameters. The operator is also given the facility of manual control in case of a controller failure or emergency situation.SCADA systems are used to perform data acquisition and control at the supervisory level, HMI's are typically depicted as local user interfaces that permit process engineers to manipulate the process locally and perform SCADA programming work to customize the system.

Data Acquisition begins at the RTU or PLC level which involves parameter readings by sensors that are transmitted to the SCADA supervisory system The data is then compiled and formatted in such a way that a control room operator using an interface terminal (HMI) can make appropriate supervisory decisions that may be required to adjust or override normal PLC controls SCADA systems also allow operators to change the settings as appropriate at the level of the RTU or the central station. Alarming conditions like high temperatures can then be recorded and displayed.

A programmable Automation Controller (PAC) is a compact controller that combines the features and capabilities of a PC-based control system with that of a typical PLC. PACs can be deployed in SCADA systems to replace the RTU or PLC functionality.

SCADA System benefits

A well-designed SCADA system saves time and money by eliminating the need for service engineers to visit each site for inspection and data collection/logging Further SCADA system benefits are as follows

i. Increases productivity and profitability.

ii. Wear and tear on equipment can be reduced by continuously monitoring levels

iii. The number of man-hours for troubleshooting and/or maintenance can be drastically reduced.

iv. Operating costs can be reduced and greater ROI (return on investment) can be achieved by using a PAC-based SCADA system compared to a proprietary system

v. Expensive service calls by repair engineers' technicians can be eliminated.

vi. The number of customer complaints inquiries can be drastically reduced, for example, incoming calls concerning low pressure or poor water quality in water systems.

Study of process automation

PLC and the SCADA systems are widely used in most industrial processes e.g. chemical industries, steel manufacturing, power generation, etc. Automated level control systems using PLC, SCADA, and HMI are used ubiquitously in industrial applications. To prevent industrial accidents by overfilling any open container, to avoid overfilling any closed container thereby creating overpressure conditions. Therefore, process control industrial applications require effective supervise level control in multiple tanks.

1.3.2 Idea of project

The field instruments like Pt 100 and float switches to Allen Bradley MicroLogix PLC will control the final control elements as a heater and motor. The real-time data of sensors from the plc is transferred to the cloud platform via raspberry pi 4 using node-red software. Raspberry Pi is a small single-board computer. It connects the plc to the internet so that the data can be uploaded to the cloud platform.

The cloud platform used for this project is IOTflows. The graphical dashboard is created on Iotflows for supervisory purposes where the person can monitor the process parameters.

Using C# scripting, this data from the cloud platform is fetched to the unity application. Unity software is used as an AR camera for android devices.

1.4 AUGMENTED REALITY FOR INDUSTRY 4.0

Augmented Reality (AR) is a technology that superimposes computer-generated images or information onto a real-world environment, thereby enhancing the user's perception of reality. AR is becoming increasingly popular in Industry 4.0, which is the fourth industrial revolution

characterized by the integration of advanced technologies, such as the Internet of Things (IoT), artificial intelligence, and robotics, into manufacturing and production processes.

Here are some examples of how AR is being used in Industry 4.0:

1. Maintenance and Repair: AR can help technicians and engineers visualize the inner workings of machines and equipment. By superimposing digital information onto the physical equipment, AR can guide technicians through repair procedures, identify faulty components, and provide real-time feedback on the status of the equipment.
2. Training: AR can be used to train workers on complex processes, such as assembling components or operating machinery. By overlaying digital information onto the physical environment, AR can provide interactive and immersive training experiences that improve learning outcomes.
3. Quality Control: AR can be used to identify defects in products during the manufacturing process. By overlaying digital images onto physical products, AR can highlight defects or deviations from specifications, enabling workers to quickly identify and correct quality issues.
4. Product Design: AR can help designers visualize and test product designs in a virtual environment before creating physical prototypes. By superimposing digital images onto physical spaces, AR can provide designers with a realistic sense of scale, function, and aesthetics.

Overall, AR has the potential to revolutionize the way manufacturing and production processes are carried out in Industry 4.0. By improving efficiency, productivity, and quality, AR can help businesses stay competitive in a rapidly changing global marketplace.

CONCLUSION

The project is focused on using augmented reality to collect real-time data in the field. Field tools and programmable logic controllers both have unique QR Codes. The instruments can be scanned by a maintenance engineer using a single mobile app, and real-time data can be viewed. Using this has the advantage of saving the maintenance engineer the pilgrimage to the control center.

2. HARDWARE

Hardware is an important section of a project which consists of the tools and machinery used in model making. In this project, we are making use of these tools or types of machinery to design a prototype for the section of the manufacturing plant.
Different types of instruments have been used for different purposes in the project for example

2.1 MINI IMMERSION HEATING ROD

Fig. 2.1 Mini Immersion Rod

An immersion heater is a fast, economical, and efficient method for heating liquids in tanks, they have heating elements that can be directly inserted into a container of water, oil, or other material in order to heat the entire contents. By using the direct heat transfer of an immersion heater, liquids quickly reach the desired temperature. Made of bundles of tubing, immersion heaters can be mounted on the side of a container or submerged in the contents. Their heating coils transfer heat to the contents, which spreads throughout the container.

Immersion heaters have an electrical resistance heating element encased in a sheath. When the heating element is activated, it heats its enclosing jacket which heats the sheath, which heats the liquid. Its effectiveness depends on the conductivity of the jacket and sheath.

An immersion heater is inserted directly into the liquid at the top or in a fitting on the side. Its heating element comes in contact with the fluid to be heated. Once positioned, it is turned on and electricity runs through the heating element into the liquid.

2.1.1 Specifications:

- Voltage: 230 Volts
- Power(watts): 250-500 W
- Heater Material: Copper
- Plating: Nickel Plating
- Weight: 200 gm

2.2 FLOAT TYPE LEVEL SWITCH

Fig. 2.2 float switch

It is a type of contact liquid level sensor which uses a float to operate a switch within a tank. This switch is also known as a level sensor. These switches play a key role in controlling other devices like pumps & alarms when a level of liquid increases or drops to a particular point.

2.2.1 Specifications:

- Maximum Load: 50 W
- Max Switching Voltage: 100V DC
- Minimum Voltage: 250V DC
- Maximum Switching Current: 0.5 A
- Max Load Current: 1.0 A

2.2.2 Working:

The working of a float switch is based on the principle of buoyancy i.e. when there is no liquid in contact with the float, it floats on top of the liquid surface and triggers an alarm signal, when

there is a sufficient amount of liquid in contact with float, it submerges itself into liquid and stops alarming.

The mechanical float switch is the most common type of water level switch and is used to detect the presence of water in a tank or vessel.

The device consists of a float that rises and falls with the liquid level. This type of Float switch consists of an arm or lever which moves up and down with the level of the liquid in which it is installed. A rod goes through the center of this arm and has one end fixed on top while another end is attached to a lever which will work as an actuator. When there is more liquid present in the container, then more weight is added on top and this causes movement of the lever which turns on the power supply to the appliance connected with it. When there is less liquid present in the tank or pool, less weight is added on top and therefore the arm does not move downwards according to gravitational force but remains static at its position because of an equal amount of weight from both sides.

2.2.3 Float switch materials:

A wide range of liquids, from potable water to highly corrosive chemicals, uses float switches. Hence, it is necessary to ensure the switching material remains compliant with the media.

The plastic float switch

Plastic materials like PVC (Polyvinyl chloride) or PP (Polypropylene) are ideal for generic applications involving acidic and basic conditions. However, plastic is unsuitable for high-temperature applications.

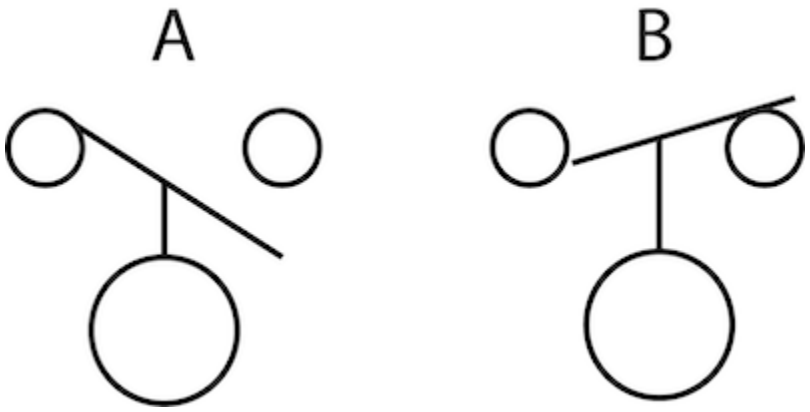
Stainless steel float switch

Stainless steel is highly durable, and the material is suitable for liquids involving high-temperature applications. The material is compatible with highly corrosive chemicals and various sanitary and washdown conditions, making it an ideal choice for medical and food processing industries.

2.2.4 Float switch wiring

Normally open (NO) float switch: The electrical circuit within the switch remains open when the switch is at the bottom and closed in the ‘up’ position. So, the switch is open with gravity pulling it down and closes as the liquid level rises to the pre-set level.

Normally closed (NC) float switch: The electrical circuit within the switch remains closed when the switch is at the bottom and open in the ‘up’ position. So, the switch is closed with gravity pulling it down and opens as the liquid level rises to the pre-set level.



2.3 DC MOTOR

Fig. 2.3 DC motor

This is a high-speed, high-power, high Torque DC motor that can also work as an electric generator. Rated for 6 Volts DC, but it operates safely with 4.5V up to 9V. It has two electrical contacts in the back that may be used to plug a connector or simply attach a wire with or without soldering. A normal DC motor would have only two terminals. Since these terminals are connected together only through a coil they have no polarity. Revering the connection will only reverse the direction of the motor

2.3.1 Specifications:

- Operating range: 4.5 - 9.0 Volts
- Nominal Voltage: 6
- No Load Speed: 14000 rpm
- No Load Current: 0.28 A
- Max. Efficiency Speed: 11910 rpm
- Max. Efficiency Current: 1.6 A
- Max. Efficiency Torque: 45.5 g.cm
- Stall Torque: 305 g.cm
- Stall Current: 9.1 A
- Body Diameter: 23.8 mm
- Body Length: 32 mm
- Shaft Diameter: 2 mm
- Shaft Length: 10.5 mm
- Weight: 42 grams
- Contacts: 2.9mm x 5mm

2.4 MINI SUBMERSIBLE PUMP

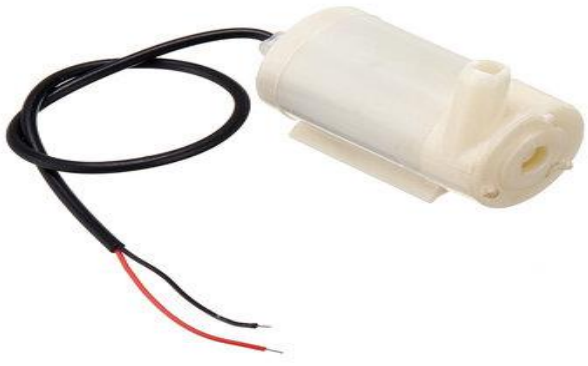


Fig. 2.4 Mini submersible pump

A mini submersible pump is a smaller version of the submersible water pumps which is lightweight, small size, low consumption, and makes little noise.

A mini submersible water pump is a centrifugal water pump, which means that it uses a motor to power an impeller that is designed to rotate and push water outwards. The motor is located in a waterproof seal and closely connected to the body of the water pump which it powers. At the center of the motor, there is a rotor with coils around it. Around those coils are the magnets, which create a lasting magnetic field that flows through the rotor. The rotor then acts on the magnetic force, allowing the rotor itself to spin around 180 degrees.

As the rotor spins, the direction of the electricity in the coils flips, pushing the rotor again so that it spins the rest of the way around. Through several pushes, the rotor continues to spin and drive the impeller to power the pump.

During the water pumping, the impeller spins very fast. The curved blades channel water into the eye, or the center of the impeller, and the water flows along the outer part of the blades. Due to the fast movement of the impeller, the centrifugal force compresses the water against the outer part of the blade. The pressure then causes the water to jet forward in a high-speed manner out of the impeller. This resulting speed generates pressure on the outlet side of the pump, pushing the water through the pipe.

2.4.1 Specifications

- Input Voltage: DC 3V-5V
- Flow Rate: 1.2-1.6 L/min
- Operation Temperature: 80 Deg. C
- Operating Current: 0.1-0.2A
- Suction Distance: 0.8 meter (Max)
- Outside diameter of water outlet: 7.5mm
- Inside diameter of water outlet: 5.0 mm
- Diameter of water Inlet: 5.0 mm
- Wire Length: 200 mm
- Rubber tube length: 1 meter
- Size: 45 x 30 x 25 mm
- Weight: 30g

2.5 PT-100

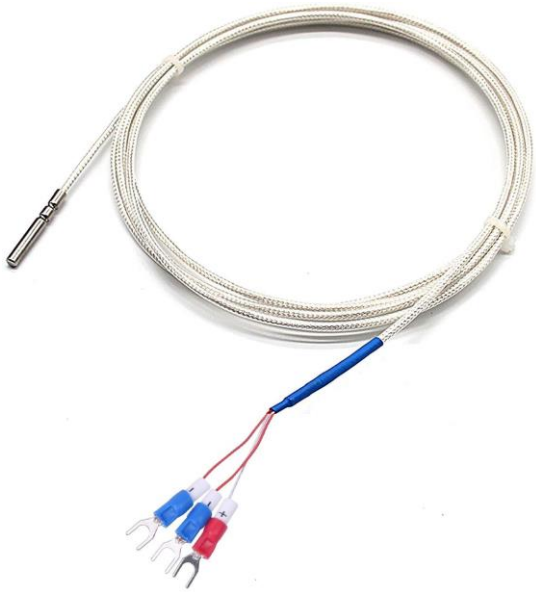


Fig. 2.5 Pt100

PT100 is a type of temperature sensor that is commonly used in industrial and scientific applications. It is a platinum resistance thermometer that uses the resistance of platinum to measure temperature.

The PT100 sensor works by measuring changes in the resistance of a thin platinum wire as the temperature changes. The resistance of the wire increases with temperature, and this change in resistance can be measured and used to calculate the temperature.

A PT100 is the most common type of Resistance Temperature Detector (RTD). The PT100 has a resistance of 100 Ohms at 0°C and 138.5 Ohms at 100°C.

The PT100 sensor has a high level of accuracy and stability over a wide temperature range and is commonly used in applications where precise temperature measurements are required.

PT100 sensors are available in different types, such as 2-wire, 3-wire, and 4-wire configurations, each with its own advantages and disadvantages.

2-wire sensors are the simplest and most cost-effective but can suffer from measurement errors due to the resistance of the connecting wires.

3-wire sensors reduce these errors by compensating for the resistance of the connecting wires, while 4-wire sensors provide the most accurate and stable temperature measurements.

Overall, the PT100 sensor is a reliable and precise temperature sensor that is widely used in various industrial and scientific applications, including HVAC systems, food processing, automotive, aerospace, and pharmaceutical industries.

2.5.1 Specifications:

- Temperature Range: -200 to +600 degrees Celsius
- Resistance: 100 ohms at 0 degrees Celsius
- Accuracy: +/- 0.3 degrees Celsius
- Response Time: 0.2 to 5 seconds
- Material: Platinum
- Wire Type: 2-wire, 3-wire, or 4-wire configuration
- Wire Gauge: 24 AWG to 20 AWG
- Probe Material: Stainless steel, brass, or other materials
- Connection Type: Screw terminals, spade terminals, or other options

2.5.2 Advantages

- Stable
- Accurate
- Area temperature sensing
- Most repeatable temperature measurement

Disadvantages

- Current source required
- Self-heating
- Slower response time
- Low sensitivity to small temperature change

2.6 TEMPERATURE TRANSMITTER

Fig. 2.6 temperature transmitter

A temperature transmitter is a device that is used to measure temperature and convert the signal into a standardized output signal that can be transmitted to other devices, such as a temperature controller or a process control system.

The transmitter typically consists of a temperature sensor, which can be a thermocouple, a resistance temperature detector (RTD), or a thermistor, and a signal conditioner, which amplifies and linearizes the output signal from the sensor. The transmitter may also include a transmitter power supply and a communication interface.

The output signal from the temperature transmitter is typically a standardized signal, such as a 4-20 mA signal or a digital signal, that can be easily interpreted by other devices in the system. This standardized signal can be used for temperature control, monitoring, and logging, and can be displayed on a local indicator or sent to a remote system for analysis and control.

2.6.1 Specifications:

- Input Range: -200 to +600 degrees Celsius
- Output Range: 4-20 mA (linear)
- Accuracy: +/- 0.2% of span
- Response Time: < 100ms
- Temperature Coefficient: < 0.01% per degree Celsius
- Power Supply: 12-36 VDC
- Power Consumption: < 50mW
- Isolation: 1 kVAC (input to output)
- Material: ABS or Aluminum (housing)
- Connection Type: Screw terminals or DIN rail mount

2.7 MICROLOGIX 1400 SERIES B PLC

Fig. 2.7 Micrologix 1400

2.7.1 Hardware Features:

The MicroLogix 1400 programmable controller contains a power supply, input and output circuits, a processor, an isolated combination RS-232/RS-485 communication port, an Ethernet port, and a non-isolated RS-232 communication port. Each controller supports 32 discrete I/O points (20 digital inputs, 12 discrete outputs) and 6 analog I/O points (4 analog inputs and 2 analog outputs: 1766-L32BWAA, 1766-L32AWAA, and 1766-L32BXBA only).

2.7.2 Component Descriptions: MicroLogix 1400 Memory Module and Built-in Real-Time Clock

The controller has a built-in real-time clock to provide a reference for applications that need time-based control.

The program and data in your MicroLogix 1400 are non-volatile and are stored when the power is lost to the controller.

The memory module provides additional backup that can be stored separately. The memory module does not increase the available memory of the controller.

2.7.3 Communication Cables:

The following communication cables are used with the MicroLogix 1400 controllers. These cables are required for Class I Div. 2 applications.

- 1761-CBL-AM00 Series C or later
- 1761-CBL-AP00 Series C or later
- 1761-CBL-PM02 Series C or later
- 1761-CBL-HM02 Series C or later

2.7.4 Programming:

Programming the MicroLogix 1400 controller is done using RSLogix 500/ RSLogix Micro software, version 8.10.00 or later for Series A controllers and version 8.30.00 or later for Series B and Series C controllers.

2.7.5 Communication Options:

The MicroLogix 1400 controllers provide three communications ports, an isolated combination RS-232/485 communication port (Channel 0), an Ethernet port (Channel 1) and a non-isolated RS-232 communication port (Channel 2).

2.7.6 Key Features and Benefits:

- Built-in 10/100 Mbps Ethernet/IP port for peer-to-peer messaging – offers users high-speed connectivity between controllers, with the ability to access, monitor, and program from anywhere an Ethernet connection is available.

- Online editing functionality – modifications can be made to a program while it is running, making fine-tuning of an operating control system possible, including PID loops. Not only does this reduce development time, but it aids in troubleshooting.

- Embedded Web server – allows a user to custom configure data from the controller to be displayed as a web page.

- Isolated RS-232/RS-485 combo port – provides a host of different point-to-point and network protocols.

- Embedded LCD screen – allows the user to monitor data within the controller, optionally modify that data, and interact with the control program. Displays the status of embedded digital I/O and controller functions, and acts as a pair of digital trim pots to allow a user to tweak and tune a program.

2.8 SMPS (SWITCHED MODE POWER SUPPLY)

Fig. 2.8 SMPS

A switched-mode power supply (SMPS) is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

Switching power supplies have high efficiency and are widely used in a variety of electronic equipment, including computers and other sensitive equipment requiring stable and efficient power supply.

A switched-mode power supply is also known as a switch-mode power supply or switching-mode power supply.A basic isolated AC to DC switched-mode power supply consists of:

- Input rectifier and filter
- Inverter consisting of switching devices such as MOSFETs.
- Transformer
- Output rectifier and filter
- Feedback and control circuit

2.8.1 Specifications:

- Input Voltage Range: 3 x 320...3 x 575 V AC / 2 x 360...2 x 575 V AC
- Usage/Application: Industrial Automation
- Brand: Weidmuller
- Output Voltage: 24 V DC +- 1 %
- Input Voltage: 400V
- Design: SMPS
- Dimensions: 120 mm*125mm*160mm
- Output Power: 240W

2.8.2 Working:

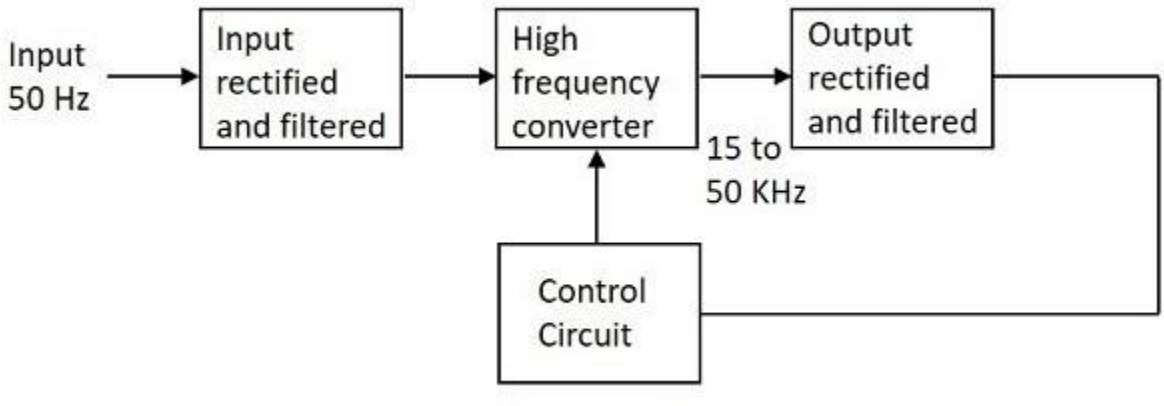


Fig. 2.9 Block diagram

Input Stage

The AC input supply signal 50 Hz is given directly to the rectifier and filter circuit combination without using any transformer. This output will have many variations and the capacitance value of the capacitor should be higher to handle the input fluctuations. This unregulated dc is given to the central switching section of SMPS.

Switching Section

A fast switching device such as a Power transistor or a MOSFET is employed in this section, which switches ON and OFF according to the variations and this output is given to the primary of the transformer present in this section. The transformers used here are much smaller and lighter ones unlike the ones used for 60 Hz supply. These are much more efficient and hence the power conversion ratio is higher.

Output Stage

The output signal from the switching section is again rectified and filtered, to get the required DC voltage. This is a regulated output voltage which is then given to the control circuit, which is a feedback circuit. The final output is obtained after considering the feedback signal.

Control Unit

The output from the rectifier is again fed to the high-frequency device for feedback error control logic. This is done to ensure that we get a constant DC output voltage every time. The deviations are monitored and nullified again by the whole circuit once again.

2.8.3 Advantages

- The efficiency is as high as 80 to 90%
- Less heat generation; less power wastage.
- Reduced harmonic feedback into the supply mains.
- The device is compact and small in size.
- The manufacturing cost is reduced.
- Provision for providing the required number of voltages.

Disadvantages

- The noise is present due to high-frequency switching.
- The circuit is complex.
- It produces electromagnetic interference.

2.9 MCB (MINIATURE CIRCUIT BREAKER)

A miniature circuit breaker (MCB) is an Electrical Switch that automatically switches off the electrical circuit during an abnormal condition of the network means an overload condition as well as a faulty condition.

MCBs are compact cased devices and they have two different tripping mechanisms, the delayed thermal tripping mechanism for overload protection and the magnetic tripping mechanism for short circuit protection.

Thermal effect takes place whenever the condition of overload occurs in the electrical circuit. This bimetallic strip arrangement is used in situations where a constant overload condition prevails over a long time in the connected circuit thus resulting in the heating of the bimetallic strip. Overheating of the bi-metallic strip results in the deformation of the strip i.e. the bimetallic strip bends further than the predefined level due to which the latch mechanism is released and contacts get open.

Electromagnetic effect A short circuit event is associated with a sudden surge of a heavy short circuit current that tends to flow through the circuit. When this sudden surge of short circuit current flows through a very sensitive magnetic trip coil inside MCB i.e through the solenoids, a sudden change in magnetic flux occurs and it activates the trip coil unit. Due to this, the plunger inside the coil deflects and attracts upwards which in turn releases the latch mechanism.

2.9.1 Schneider Multi 9/6A :

Fig. 2.10 Miniature Circuit Breaker

This Multi9 C60SP is a low-voltage miniature circuit breaker (MCB).
It is a 2P circuit breaker with 2 protected poles, 6A rated current and a C tripping curve.
It has been designed to offer enhanced protection by preventing and protecting equipment from electrical threats.

- Ensures no accidental contact with live part – Finger-proof IP-20 terminals
- Avoids false insertion of cables and loose termination with Pull up terminals
- Total Flexibility: Line-Load reversibility
- Low cost with higher performance: Cascading.
- Reduce Downtime: Discrimination.
- Easy Installation: Bi–connect terminals
- Increased service life: Fast Closing mechanism

2.10 RASPBERRY PI 4 (MODEL B)

Fig. 2.11 Raspberry Pi 4

The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.

The Raspberry Pi 4 is the latest product in the Raspberry Pi range, boasting an updated 64-bit quad core processor running at 1.4GHz with built-in metal heatsink, USB 3 ports, dual-band 2.4GHz and 5GHz wireless LAN, faster (300 mbps) Ethernet, and PoE capability via a separate PoE HAT.

2.10.1 Specifications Of Raspberry Pi 4 Model B with 2 GB RAM:

- Model-Raspberry Pi 4 Model-B
- Processor- Broadcom BCM2711, quad-core Cortex-A72 (ARM v8) 64-bit SoC @ 1.5GHz
- RAM Memory - 2 GB LPDDR4 SDRAM
- Connectivity:-
- 2 × USB 2.0 Ports
- 2 × USB 3.0 Ports
- 2.4 GHz and 5.0 GHz IEEE 802.11b/g/n/ac wireless LAN, BLE Gigabit Ethernet Bluetooth 5.0
- Operating Power:-
- 5 Volt 3 Ampere DC via GPIO Header
- 5 Volt 3 Ampere DC via USB Type-C Connector
- Power Over Ethernet (PoE)–Enabled (requires separate PoE HAT)
- GPIO- (Fully backward compatible with previous boards)
- Multimedia:-
- H.264 (1080p60 decode, 1080p30 encode);
- H.265 (4Kp60 decode);
- OpenGL ES, 3.0 Graphics
- Video and Sound:-
- 2 × micro HDMI ports (up to 4Kp60 supported)
- 2-Lane MIPI CSI Camera Port
- 2-Lane MIPI DSI Display Port
- 4-Pole Stereo Audio and Composite Video Port
- Clock Speed- 1.5 GHz
- Micro-SD Card Slot- Yes (FAT32 format), support maximum 32G Micro SD Card Memory Features
- Operating Temperature Range- 0ºC to 50ºC

2.11 TERMINAL BLOCK

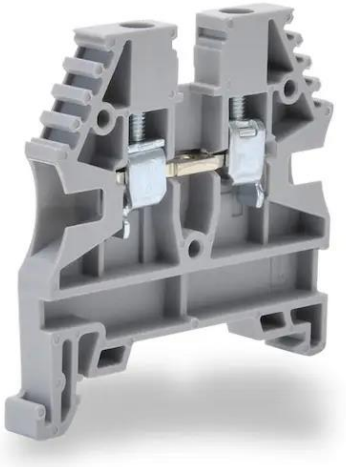


Fig. 2.12 Terminal Block

A terminal block (also called a connection terminal or terminal connector) is a modular block with an insulated frame that secures two or more wires together. It consists of a clamping component and a conducting strip.
The insulating body of a terminal block houses a current carrying element (a metal strip or terminal bar). It also provides a base for clamping elements. The body has a mounting arrangement so that the block can be easily mounted on or unmounted from a PCB or a mounting rail.

2.12 MINIATURE POWER RELAYS:

A **power relay** is a device that uses an electromagnet to open or close a circuit when the input (coil) is correctly excited. They provide a high level of isolation between the control signal (coil) and the output (contacts)

The basic design of a power relay utilizes an electromagnet (coil and iron core), an armature, a spring and one or more pairs of contacts.

With normally open (NO) contacts a small current flows through the input circuit, activating the electromagnet. The resulting magnetic field attracts the armature which moves the contacts together, completing the second circuit, allowing a large current to flow. When the source of power is removed, the armature is no longer attracted, a spring returns it to the rest position

allowing the contacts to separate, stopping the flow of electricity in the second circuit and turning off the device.

In the case of a normally closed (NC) relay, it is reversed. The return spring keeps the contacts closed. When the input circuit is activated, the electromagnet attracts the armature, this overcomes the force of the return spring and the normally closed contacts separate, stopping current flow in the second circuit. As such, NC relays keep the larger circuit in the on position by default.

2.12.1 Omron MY4N-GS

Fig. 2.13 Multi Channel Relay

Reduces wiring work by 60% when combined with the PYF-PU Push-In Plus Socket
Relays with AC and DC coils have different colors of operating indicators (LEDs).

2.12.2 Specifications:

- Coil ratings: 24 VDC 36.3 mA
- Operating indicator: LED
- Contact form: 4PDT
- Contact method: Single
- Contact material: Au clad + Ag alloy
- Contact rated load: 220 VAC 3 A (Resistive load)
  220 VAC 0.8 A (Inductive load (cosφ = 0.4))
  4 VDC 3 A (Resistive load)
  24 VDC 1.5 A (Inductive load (L/R = 7 ms))
- Terminal structure: Plug-in terminal

2.12.3 PYF14A-N

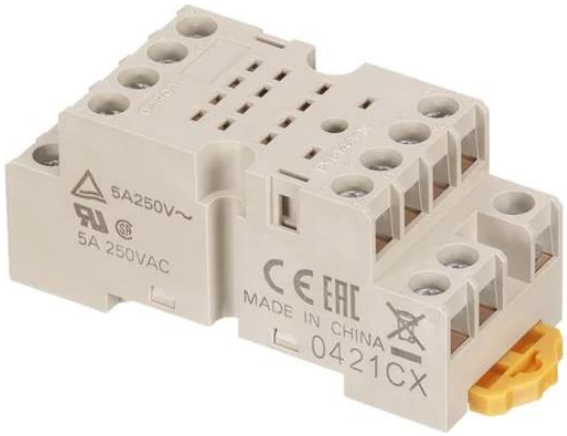


Fig. 2.14 Track Mounted Socket

The PYF14A-N is a 4-pole 14-pin Track Mounted Socket, DIN rail/screw mounting, easy labeling, and quick connection with 3 coil terminals. Front connecting socket with standard, bifurcated contacts operation indicator, built-in diode, CR circuit, used with MY series general purpose relays.

- Finger protection

2.13 RELAY SWITCH

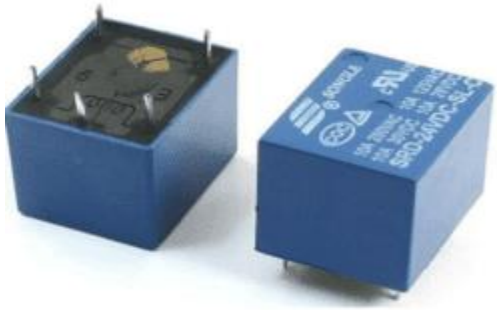


Fig. 2.15 Relay Switch

2.13.1 Specifications

- Product name: Power Relay
- Mounting Form: PCB
- Voltage: DC 24V
- Voltage: 250VAC (10A), 30VDC (10A)
- Current: 10A
- Pin Number: 5
- Contact: SPDT
- Size (Approx.): 19x15x15mm
- Main Color: Blue
- Main Material: Plastic, Metal
- Weight: 9g

This relay can be used to switch High power (whether AC or DC) to a load by driving the relay coil with a far much lower voltage and current.
When Current flows through the relay coil, It makes or breaks its contacts through electromagnetic induction.
A relay contact comprises the Normally-Open (NO) and Normally Closed (NC) contacts.
When driving a relay coil from a digital output or transistor, always connect a diode in reverse bias across the coil of the relay in order to avoid the resulting back-emf that appears across the coil of the relay when it is turned off from damaging the digital device or transistor.

3. SOFTWARE

3.1 RSLINX

RSLinx acts like a communication link between the Allen Bradley programming softwares like RSLogix and the hardware like PC. RSLinx adds the required drivers between hardware and software.

Rockwell RSLinx Classic Lite is the most commonly used edition of Rockwell Automation's brand of PLC communication software.

RSLinx Classic is the communication driver that Rockwell has been using for many years. It provides connections to devices on networks such as EtherNet/IP, Devicenet, ControlNet, and older serial networks like DF-1, DH-485, and DH+.

1 RSLinx Classic Lite: This is an unlicensed version of RSLinx Classic that installs with Rockwell PLC programming software. It provides communication for this software to talk to PLC's for use in flashing firmware, troubleshooting, and programming. Since it does not require a license, it is free to download from the Rockwell Program Compatibility and Download Center (PCDC).

2. RSlinx Classic Single Node: In addition to the connection capabilities of Lite, Single Node also provides an OPC DA connection to a single Rockwell PLC. The software that is connecting to the PLC must be installed on the same PC as Single Node.

3. RSLinx Classic OEM: OEM allows third party software to connect to multiple Rockwell PLC's. Like Single Node, OEM must be installed on the same PC as the third-party software.

4. RSLinx Classic Gateway: Gateway provides distributed OPC data access to multiple PLC's for third-party software that can be installed locally or remotely.

3.1.1 Installation Steps

Step 1: Double Click on the setup file after that you will see the below screen. Then Select the file path or keep it default.

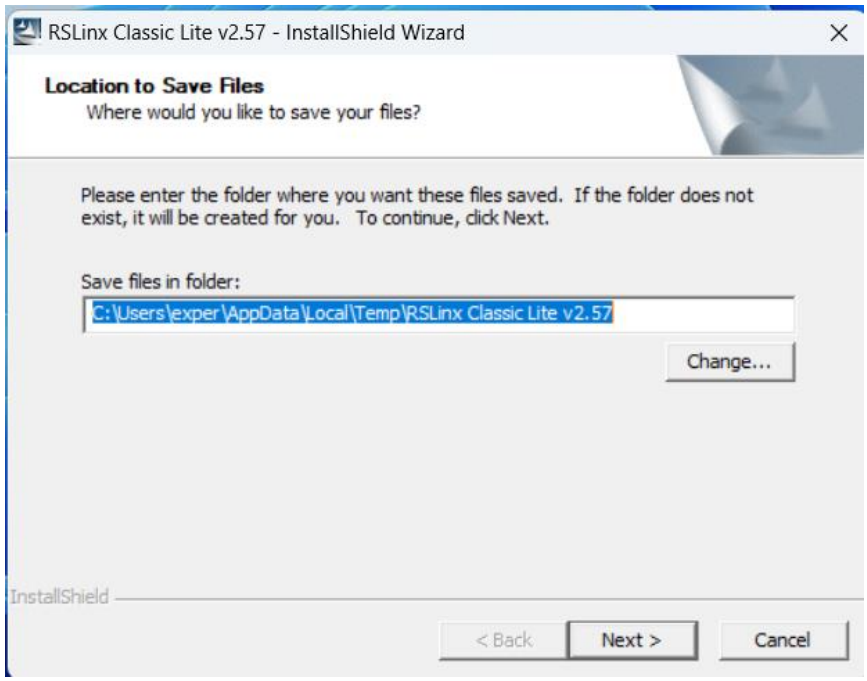


Fig. 3.1 RS Linx part 1

Step 2: Click on Next.

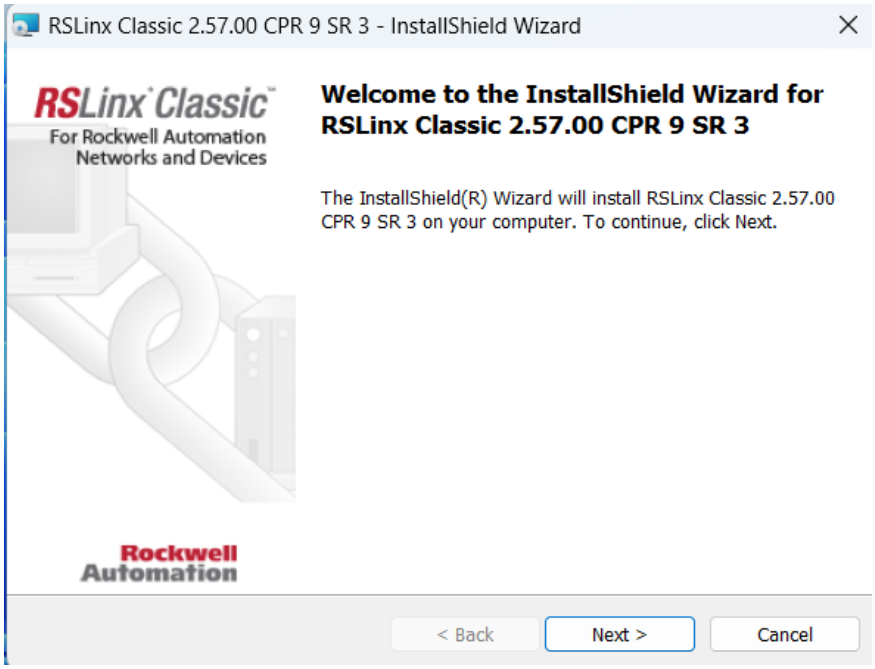


Fig. 3.2 RS Linx part 2

Step 3: Accept the license terms and click next.

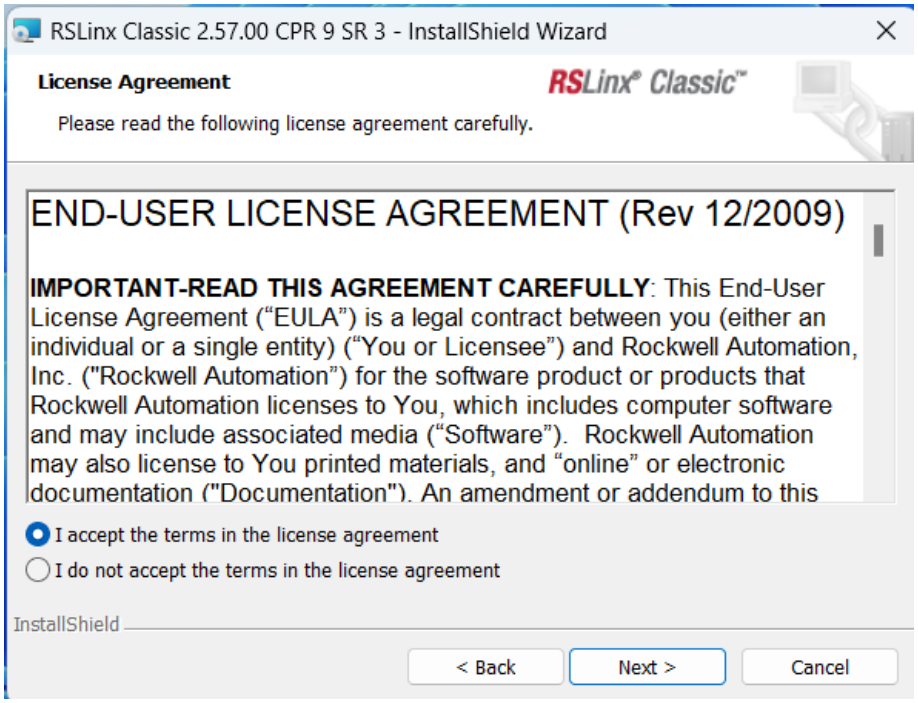


Fig. 3.3 RS Linx part 3

Step 4: Enter the User name, Organization as per your choice, and then click on Next.

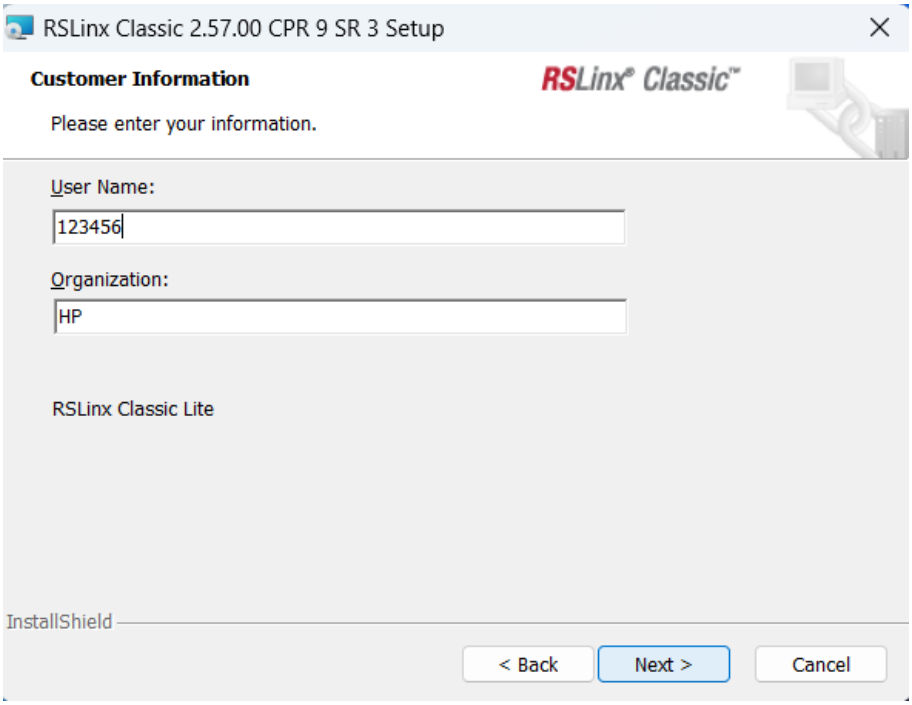


Fig. 3.4 RS Linx part 4

Step 5: Click on Electronic Data Sheet and then click on Next.

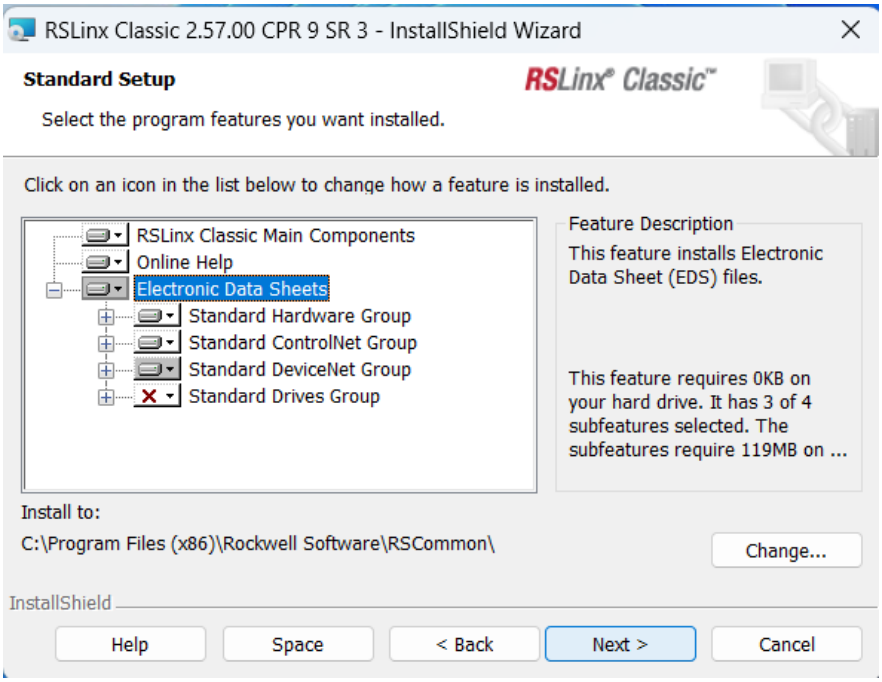


Fig. 3.5 RS Linx part 5

Step 6: Click on Install-to-install RSLINX Classic and then Click on Next. And wait until the process completes.

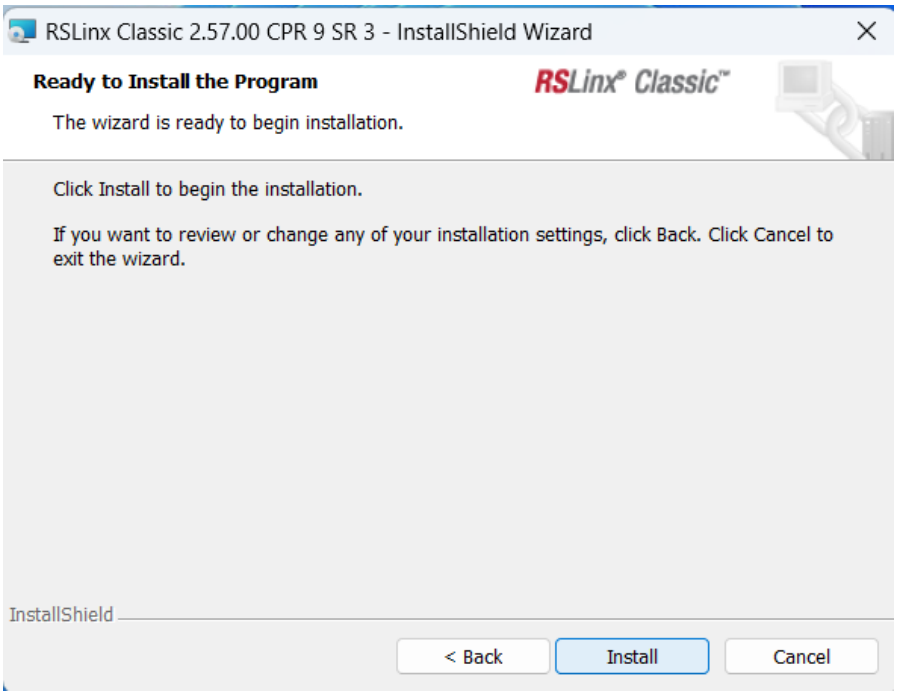


Fig. 3.6 RS Linx part 6

Step 7: Click on Finish as Installation is done.

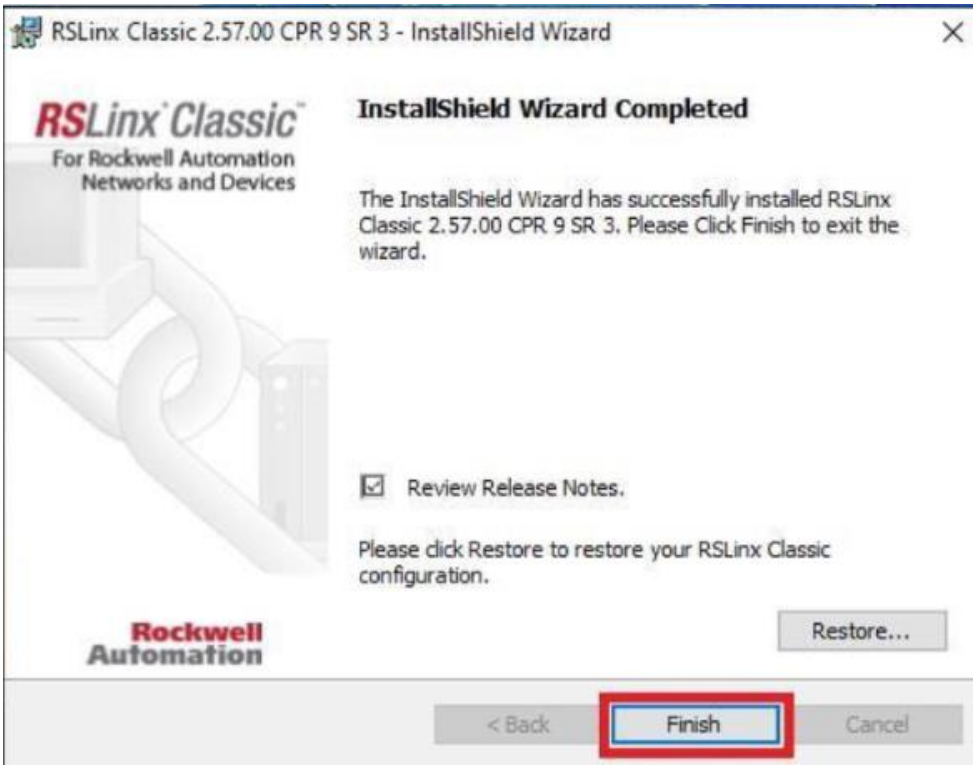


Fig. 3.7 RS Linx part 7

3.2 RS LOGIX 500

RSLogix 500 is a ladder logic programming package for the SLC 500 and MicroLogix processors. RSLogix 500 is compatible with SLC 500 and MicroLogix programs created with any Rockwell Automation programming packages. RSLogix Micro is also a ladder logic programming package for MicroLogix processors.

RSLogix 500 and RSLogix Micro software include:

- A free-form ladder editor.
- A project verifier to build a list of errors that you can navigate to make corrections.
- Drag-and-drop editing to move data table elements from one data file to another, rungs from one subroutine or project to another, or instructions from rung to rung within a project.
- Search and replace to change occurrences of a particular address or symbol.
- A point-and-click interface to access all of the project's folders and files.
- A custom data monitor to view separate data elements together and observe interactions.
- Trending and histogram reports for monitoring and displaying process data.

3.2.1 Installation steps

Step 1: Double Click on the setup file after that you will see the below screen. Then select Required Steps.

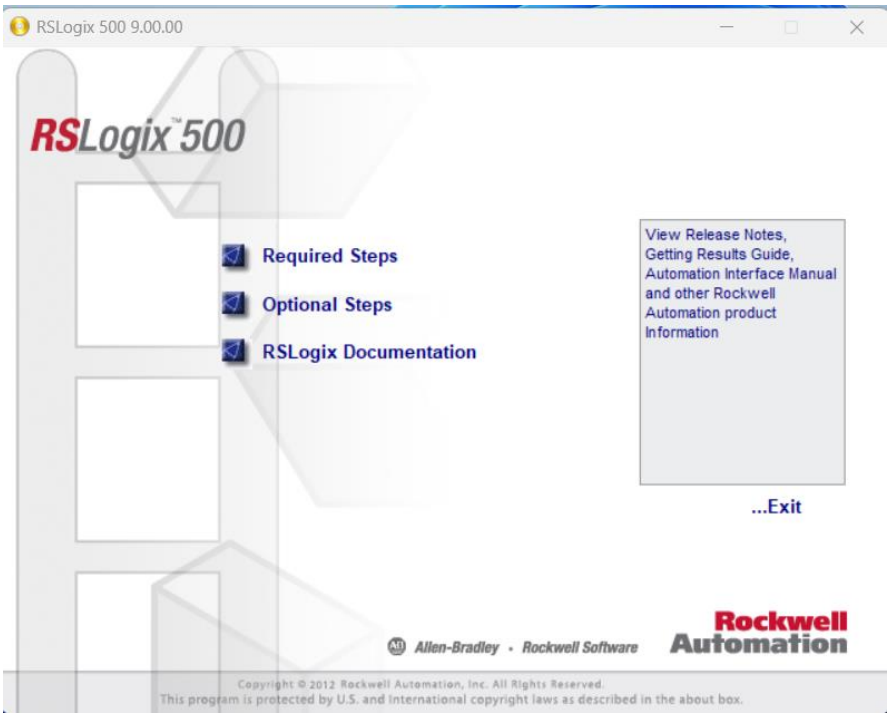


Fig. 3.8 RS Logix part 1

Step 2: Click on Install RSLogix 500 9.00.00.

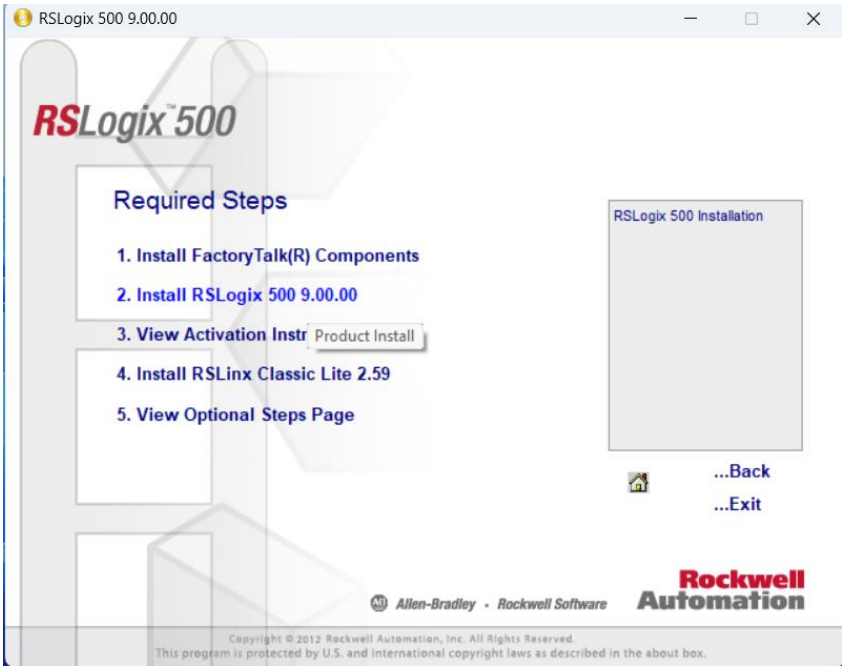


Fig. 3.9 RS Logix part 2

Step 3: Click on Next.

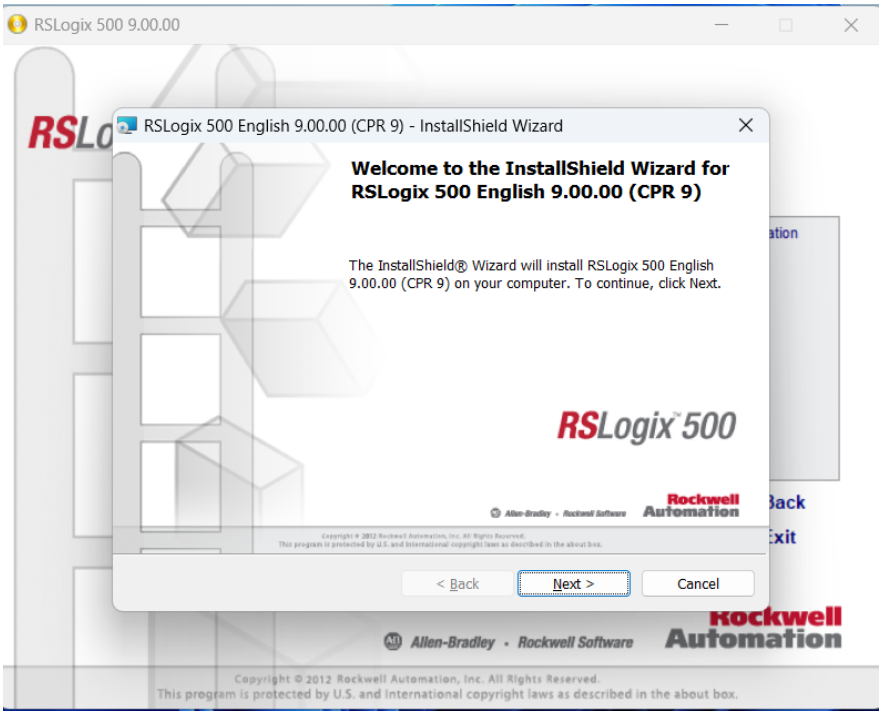


Fig. 3.10 RS Logix part 3

Step 4: Accept the license terms and click next.

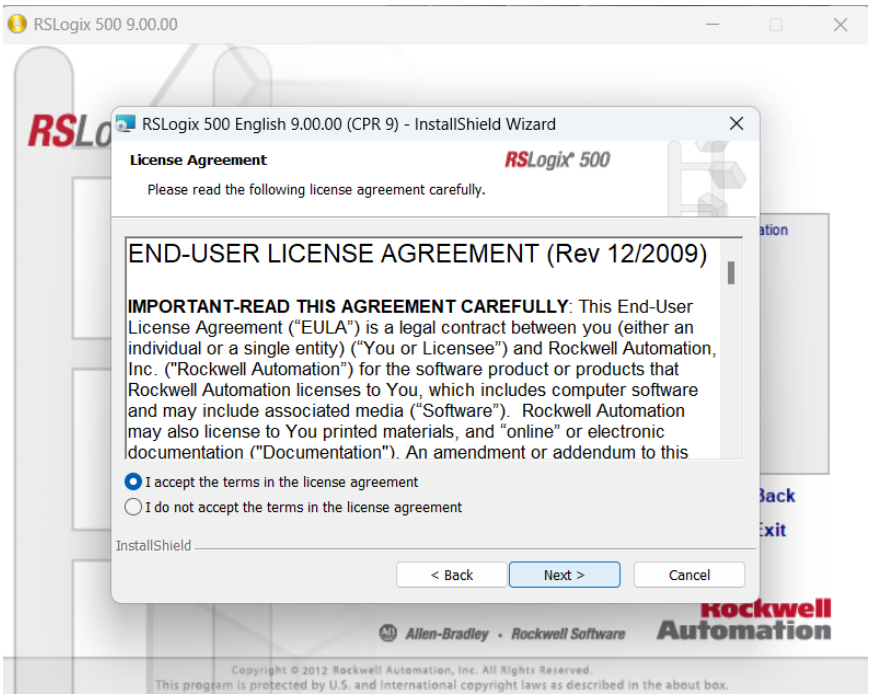


Fig. 3.11 RS Logix part 4

Step 5: Enter the User name, Organization as per your choice, and then enter a 10 digit Key. Then Next.

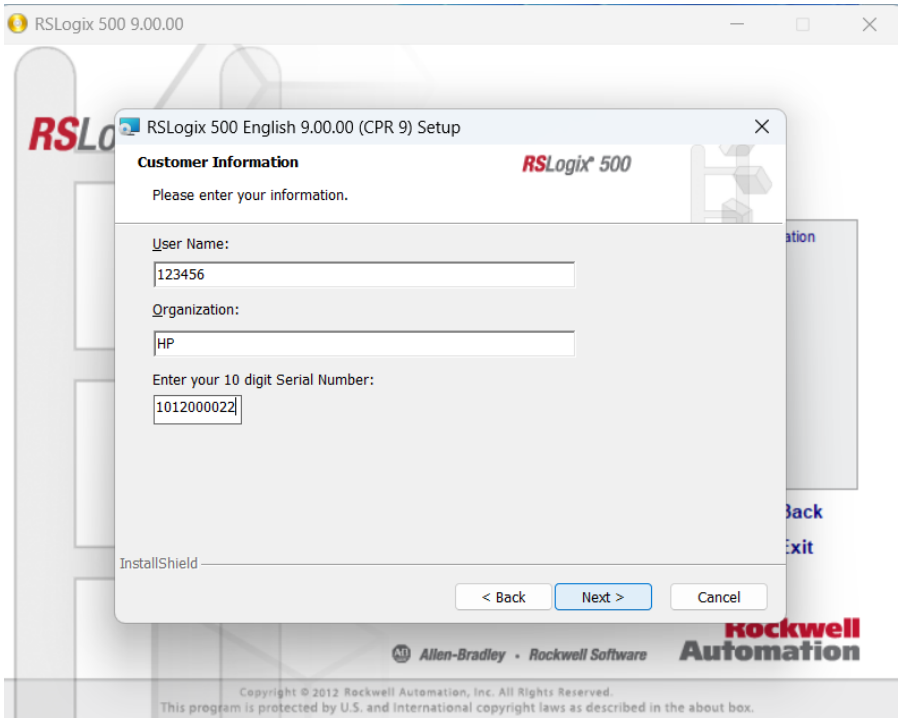


Fig. 3.12 RS Logix part 5

Step 6:Click on Install.

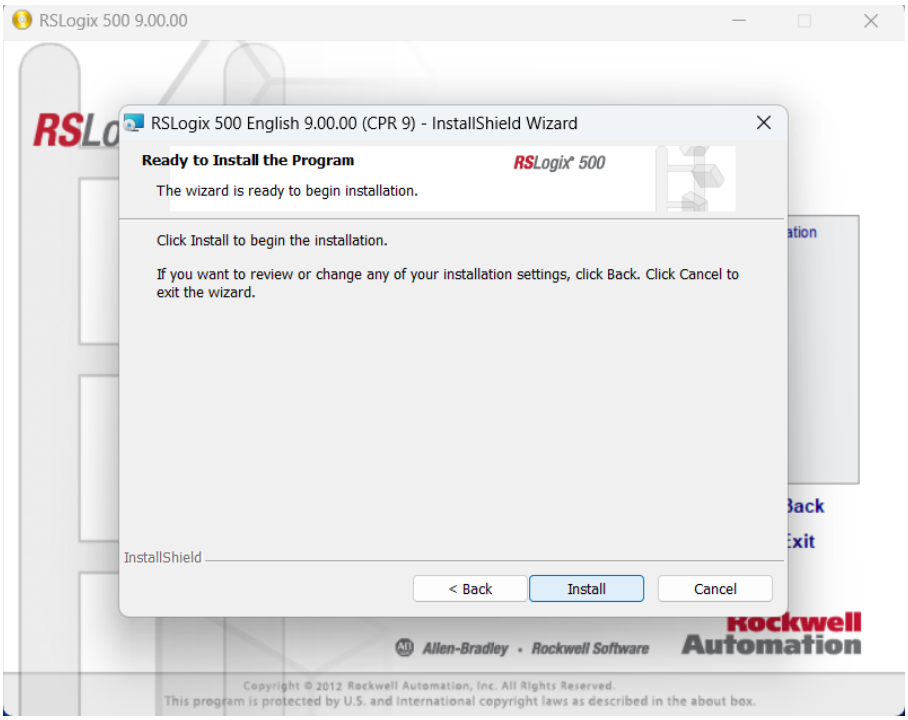


Fig. 3.13 RS Logix part 6

Step 7: Click on Finish. Installation is done.

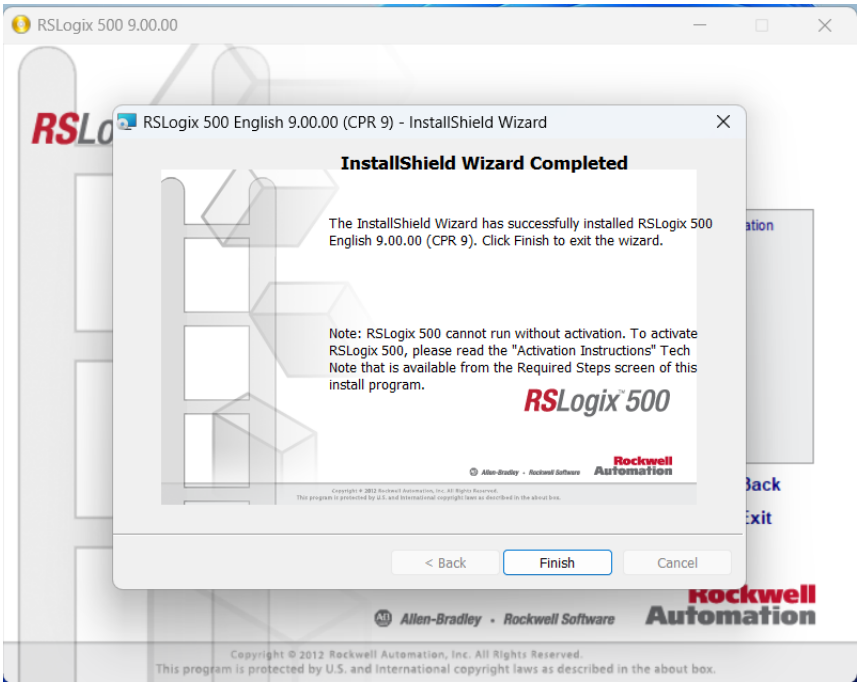


Fig. 3.14 RS Logix 7

3.3 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.

3.3.1 Key features of Node-RED:

- Supports browser-based flow editing making it user friendly, accessible and visual
- It is built on Node.js, which is an non-blocking, lightweight I/O model, making it lightweight and efficient
- Flows created in Node-RED are stored using JSON, and can imported and exported and shared with ease
- Node-RED can be run locally
- Ability to run in cloud environments like Bluemix, MS-Azure, FRED etc
- Node library is continuously growing
- Simple user interface creation

3.3.2 Installation Steps

Step 1: Open browser window and search https://nodered.org

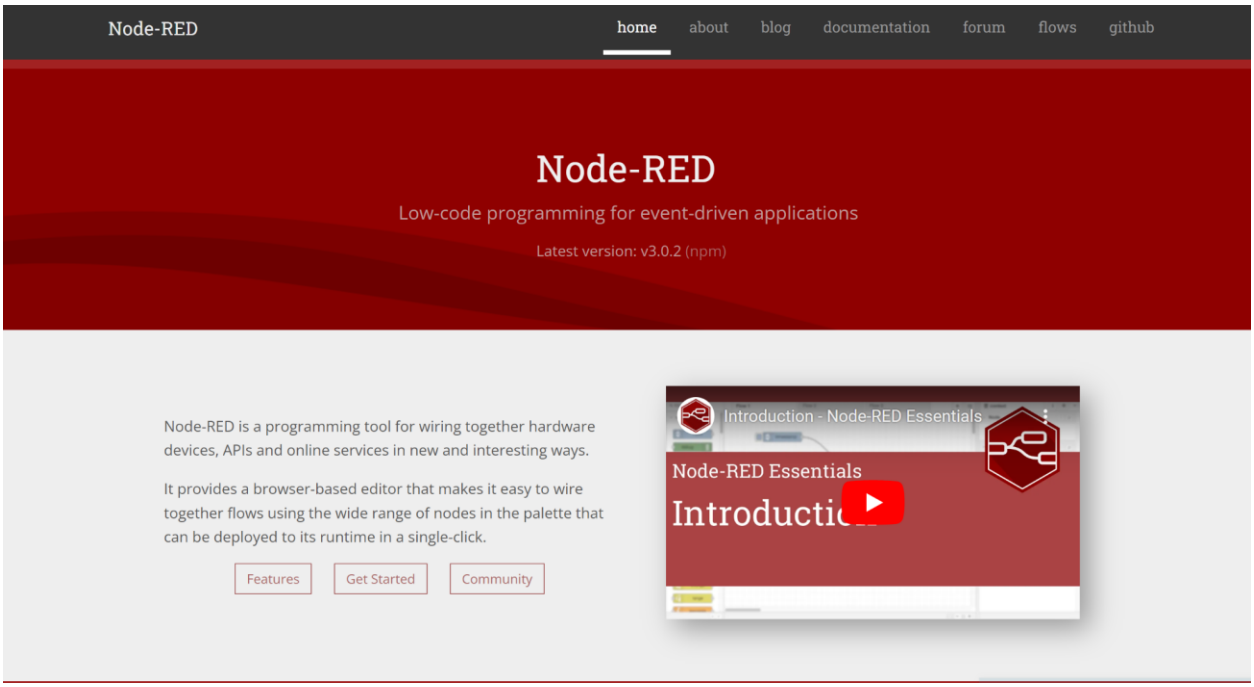


Fig. 3.15 Node-Red part 1

Step 2: Click on “Getting started”.

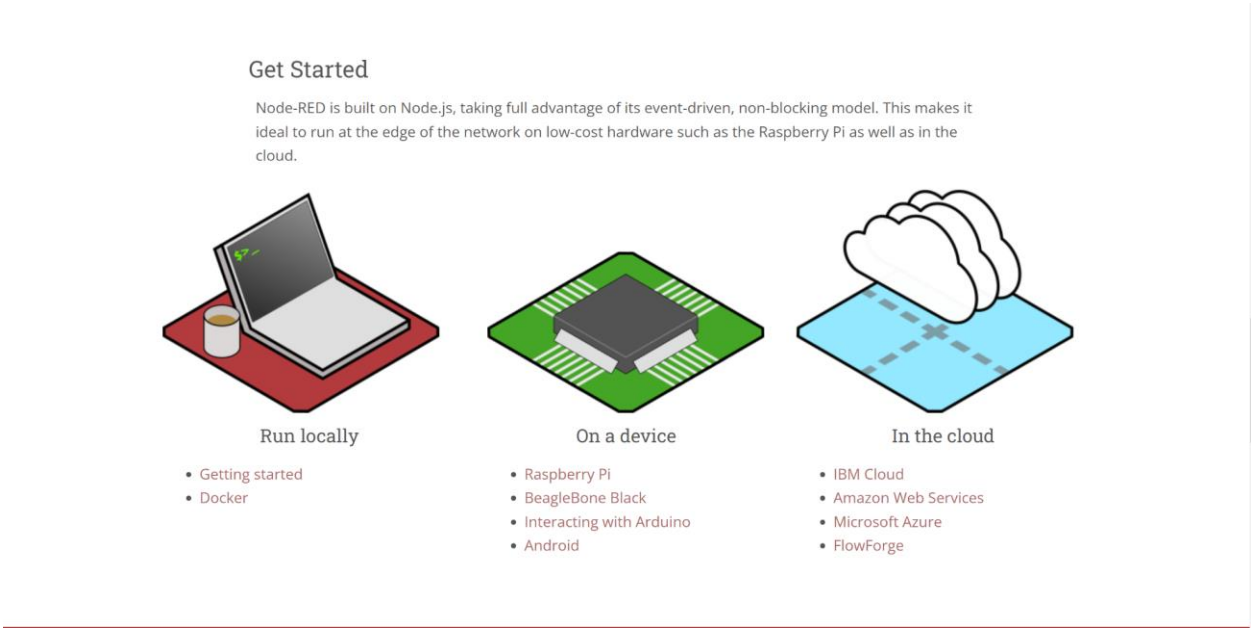


Fig. 3.16 Node-Red part 2

Step 3: Click on “Running locally”.

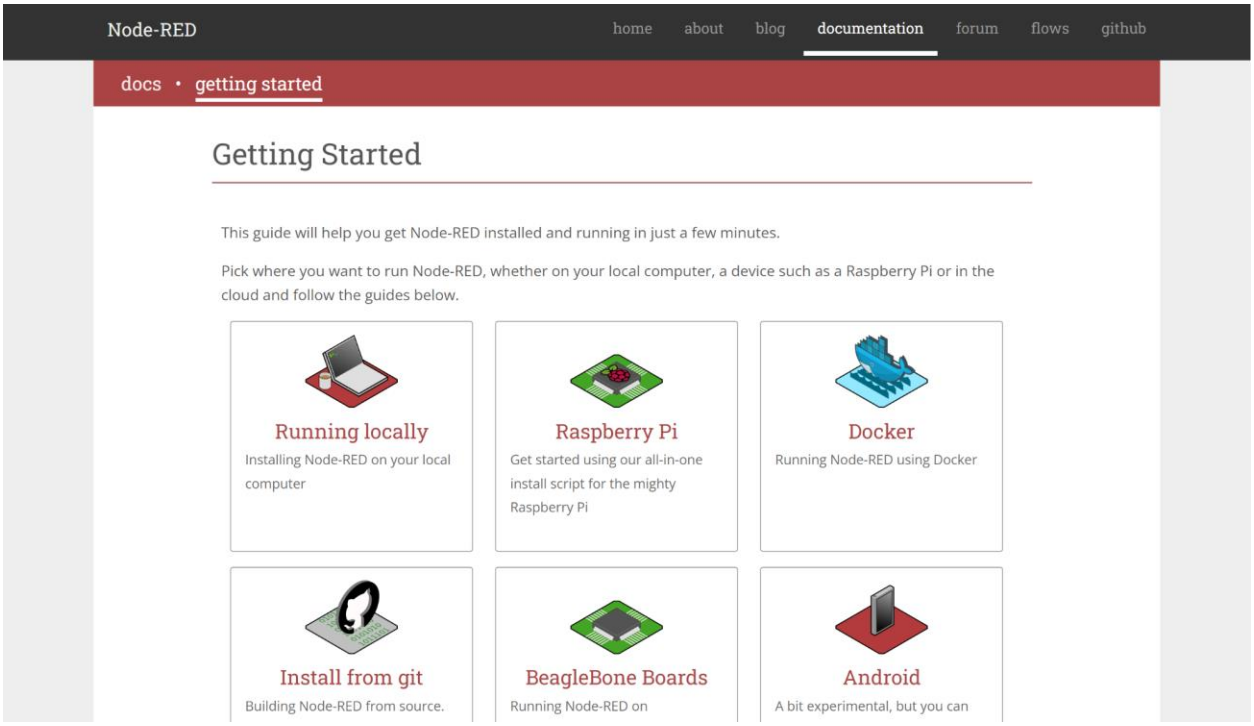


Fig. 3.17 Node-Red part 3

Step 4: Click on “here” for installation of Node-Red in windows.

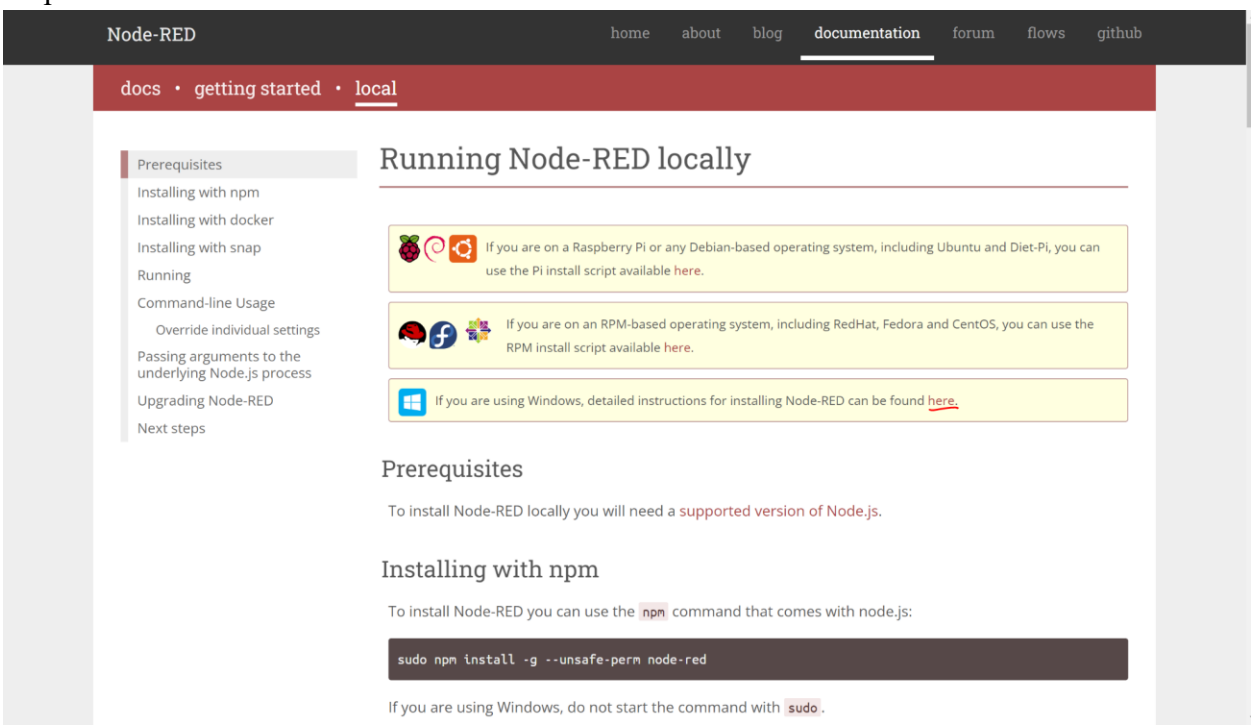


Fig. 3.18 Node-Red part 4

Step 5: Click on the Node.js home page.

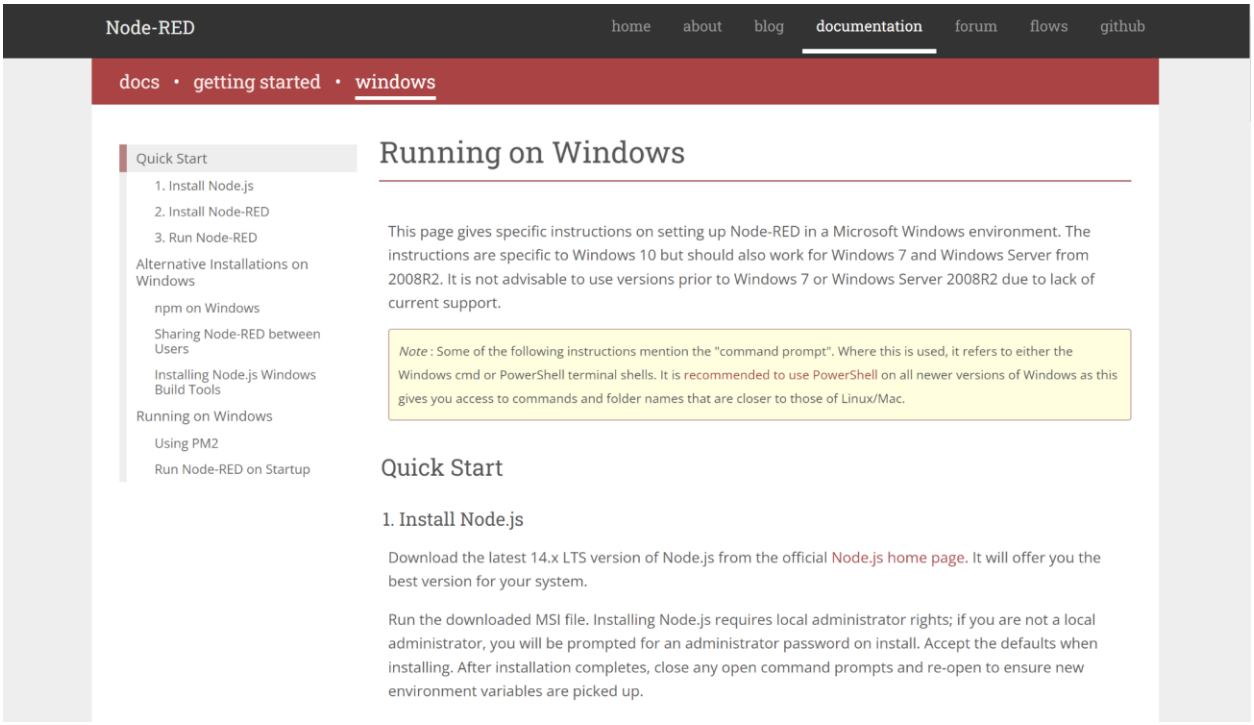


Fig. 3.19 Node-Red part 5

Step 6: Click on “downloads”.

Fig. 3.20 Node-Red part 6

Step 7: Choose software as per your system.

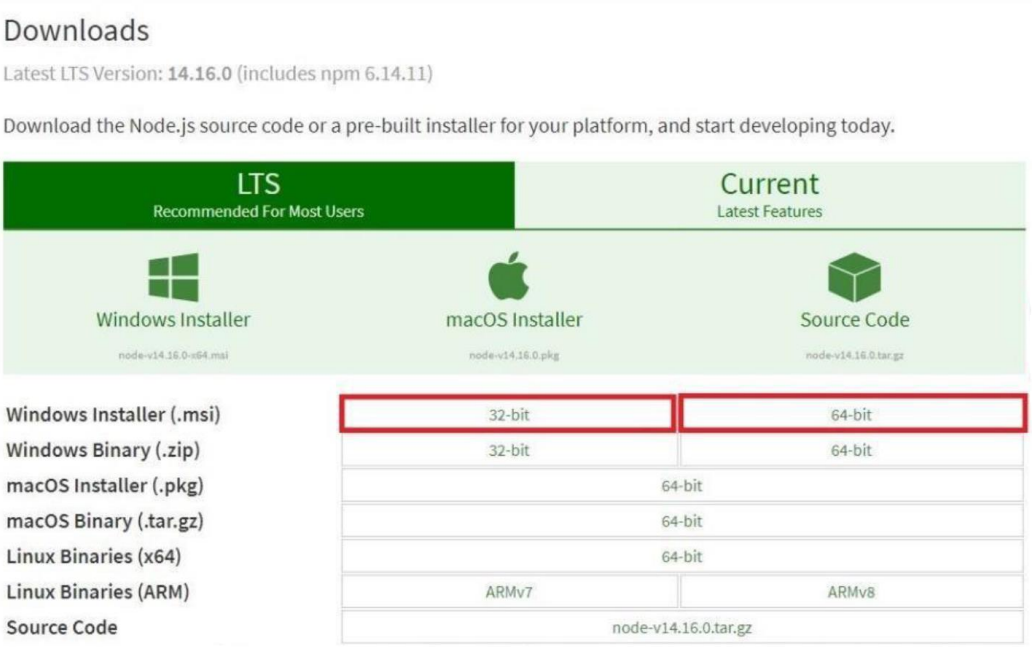


Fig. 3.21 Node-Red part 7

Step 8: Setup wizard will open and then click on the “Next” button.

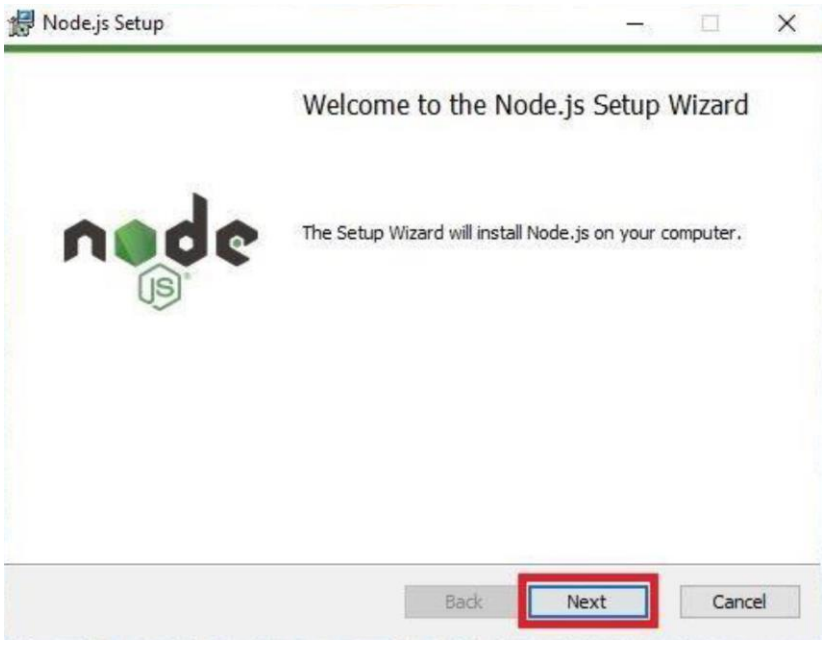


Fig. 3.22 Node-Red part 8

Step 9: Set the installation path or choose default and click on the “Next” button.

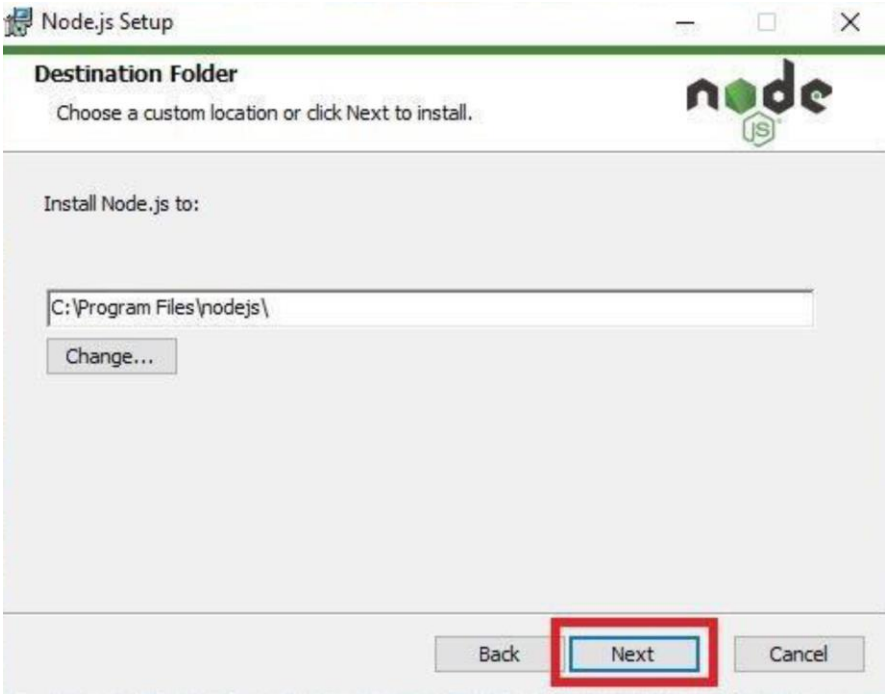


Fig. 3.23 Node-Red part 9

Step 10: Click on the “Next” button.

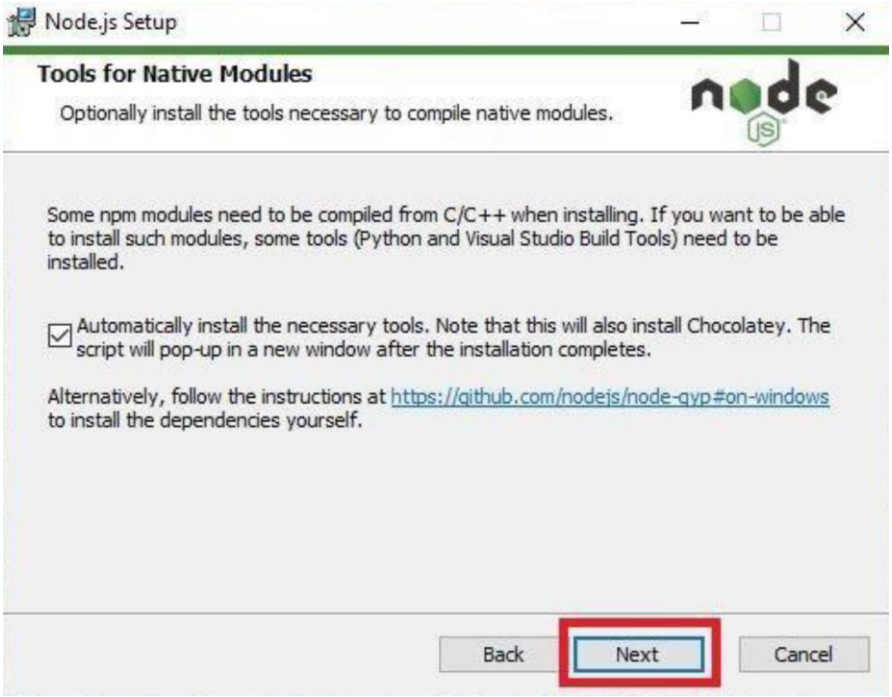


Fig. 3.24 Node-Red part 10

Step 11: Click on the “Install” button.

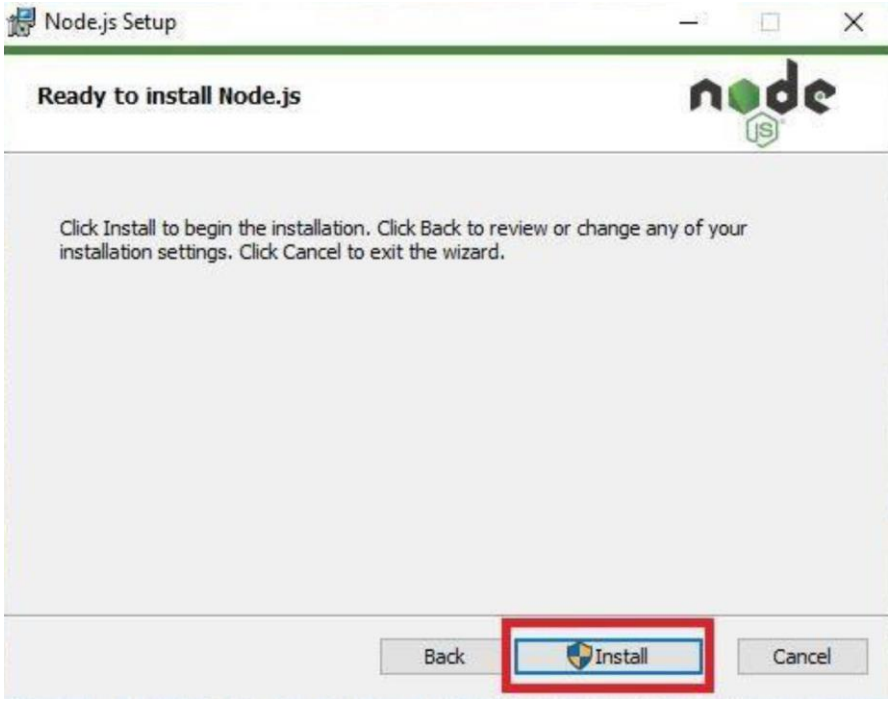


Fig. 3.25 Node-Red part 11

Step 12: Press any key to continue and then click on the “Finish” button.

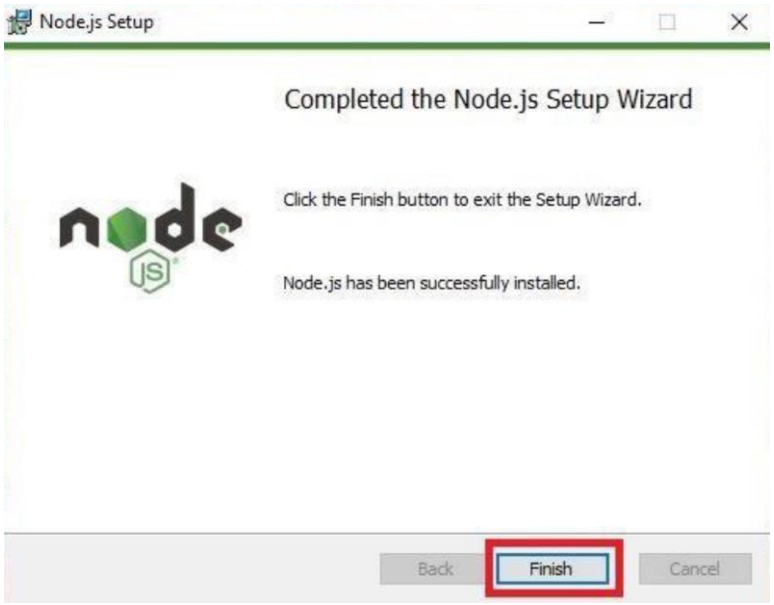


Fig. 3.26 Node-Red part 12

Step 13: To install Node-Red write down “npm install -g --unsafe-perm node-red” in the command prompt.

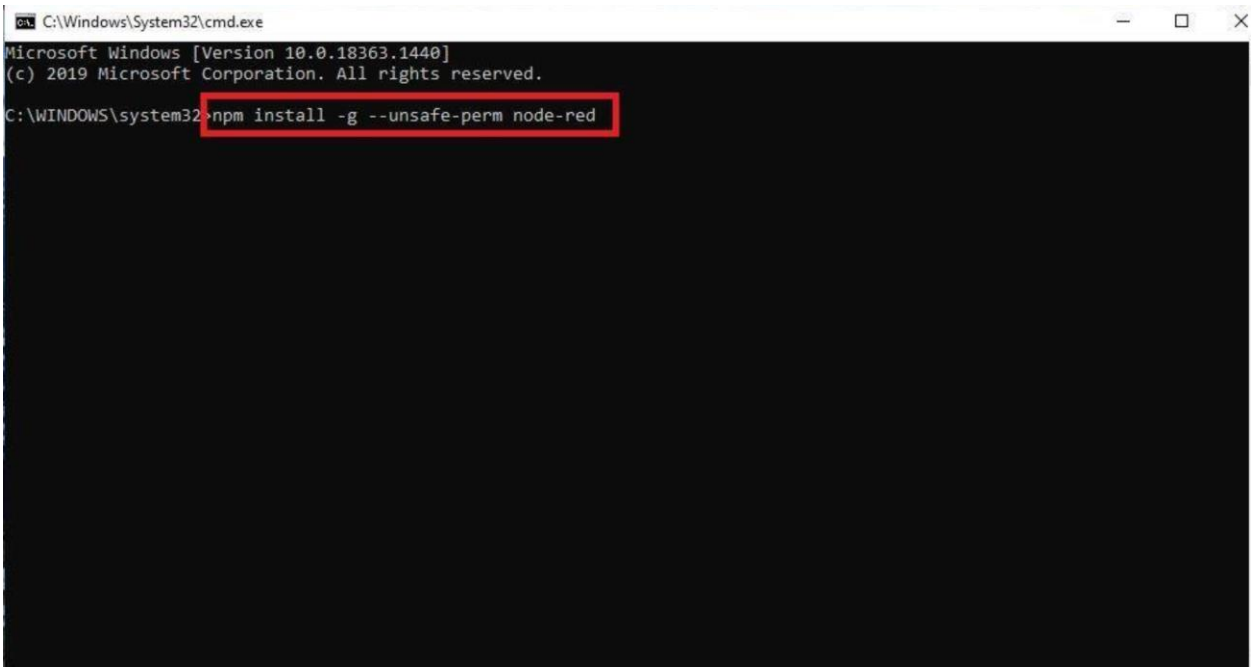


Fig. 3.27 Node-Red part 13

Step 14: After successful installation write “node-red start” on the command prompt.

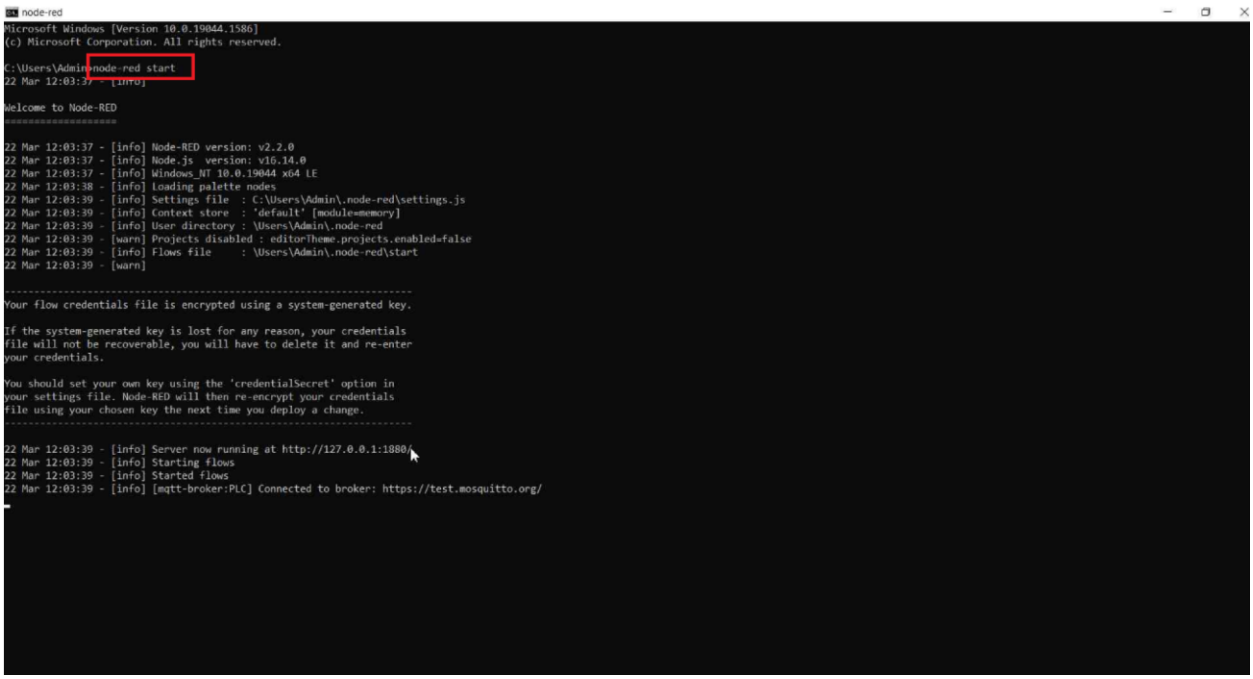


Fig. 3.28 Node-Red part 14

Step 15: Open the browser window in chrome or Mozilla firefox and search http://127.0.0.1:1880/ where the Node-Red server is running (it is recommended to use the latest version of a browser).

Fig. 3.29 Node-Red part 15

Step 16: Node-Red screen will look like below.

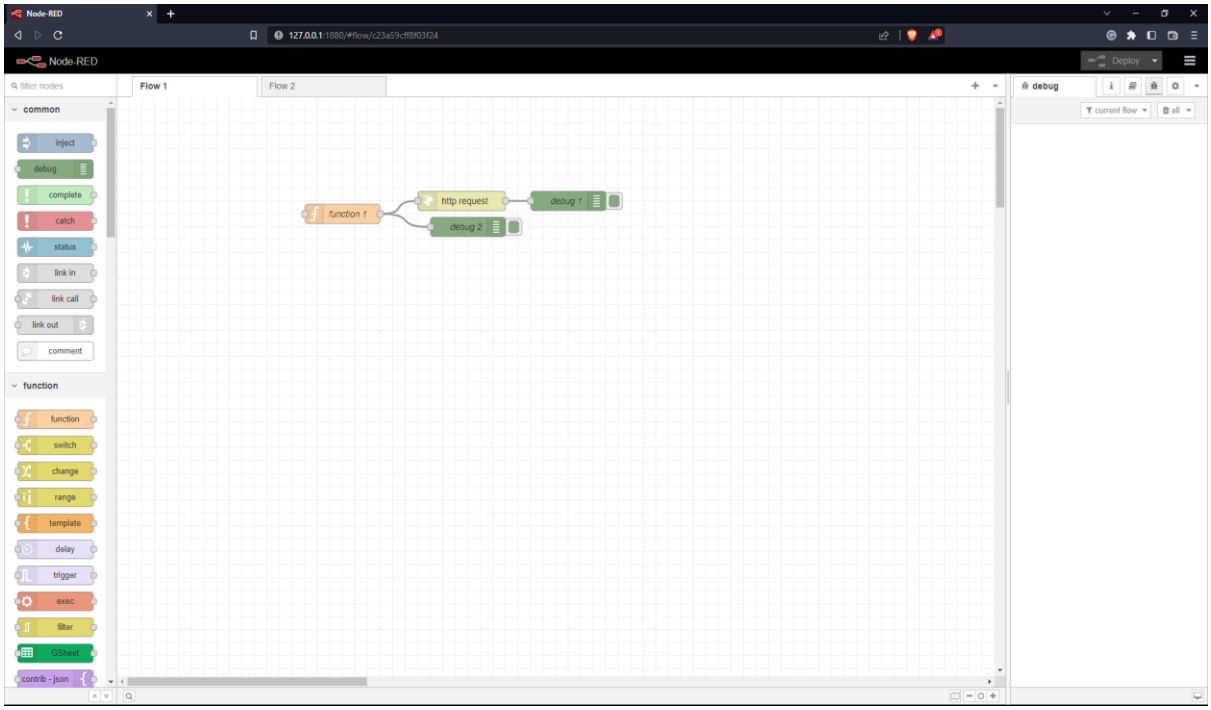


Fig. 3.30 Node-Red part 16

3.3.3 Understanding of Node-RED:

Node:

A Node is the basic building block of a flow.

Nodes are triggered by either receiving a message from the previous node in a flow or by waiting for some external event, such as an incoming HTTP request, a timer, or GPIO hardware change. The process that message, or event, and then may send a message to the next nodes in the flow.

A node can have at most one input port and as many output ports as it requires.
i. Working with Nodes
ii. The Core Nodes
iii. Creating Nodes

Configuration node:

A Configuration (config) Node is a special type of node that holds reusable configuration that can be shared by regular nodes in a flow.

For example, the MQTT In and Out nodes use an MQTT Broker config node to represent a shared connection to an MQTT broker.

Config nodes do not appear in the main workspace but can be seen by opening the Configuration nodes sidebar.

i. Working with Configuration nodes
ii. Configuration node sidebar

Flow:

A Flow is represented as a tab within the editor workspace and is the main way to organize nodes.

The term “flow” is also used to informally describe a single set of connected nodes. So a flow (tab) can contain multiple flows (sets of connected nodes).

i. Working With Flows

Context:

Context is a way to store information that can be shared between nodes without using the messages that pass through a flow.

There are three types of context;
i. Node - only visible to the node that set the value
ii. Flow - visible to all nodes on the same flow (or tab in the editor)
iii. Global - visible to all nodes

By default, Node-RED uses an in-memory Context store so values do not get saved across restarts. It can be configured to use a file-system-based store to make the values persistent. It is also possible to plug in alternative storage plugins.

i. Working with context
ii. Context Store API

Message:

Messages are what passes between the nodes in a flow. They are plain JavaScript objects that can have any set of properties. They are often referred to as msg within the editor. By convention, they have a payload property containing the most useful information.

i. Working with messages

Subflow:

A Subflow is a collection of nodes that are collapsed into a single node in the workspace.

They can be used to reduce some visual complexity of a flow or to package up a group of nodes as a reusable component used in multiple places.

i. Working with Subflows

Wire:

Wires connect the nodes and represent how messages pass through the flow.

i. Working with Wires

Palette:

The Palette is on the left of the editor and lists the nodes that are available to use inflows.

Extra nodes can be installed into the palette using either the command-line or the Palette Manager.

- Working with the Palette
- Adding nodes to the palette
- The Palette Manager

Workspace:

The Workspace is the main area where flows are developed by dragging nodes from the palette and wiring them together.

The workspace has a row of tabs along the top; one for each flow and any subflows that have been opened.

- Working with the Workspace

Sidebar:

The sidebar contains panels that provide several useful tools within the editor.
These include panels to view more information and help about a node, to view debug messages, and to view the flow's configuration nodes.

- Working with the Sidebar

3.4 FACTORY TALK VIEW

FactoryTalk View Site Edition (SE) meets the demands of each of these groups, providing robust and reliable functionality in a single software package that scales from a stand-alone HMI system to a distributed visualization solution.
With FactoryTalk View SE, HMI challenges in process, batch and discrete applications are managed in a single software solution that enables critical visibility in real time when and where you need it.

3.4.1 Features and Benefits:

- No need to create and maintain a separate HMI tag database – define tags once in the Logix controller, then access them throughout your system.
- Referencing Logix controller tags directly from HMI displays provides optimized communications and display of data.
- Take advantage of rich, reusable graphics and animation capabilities with Symbol Factory graphic library, Global Objects, and Rockwell Automation Process Object Library faceplates.
- View and interact with alarm conditions throughout the architecture with easy-to-use graphical alarm objects.
- Mobile HMI provides continuous system visibility anytime, anywhere.
- Extend your applications to your favorite iOS or Android mobile device for improved real-time decision making.

3.4.2 Installation Steps

Step 1: Double Click on the Setup file and then select Studio enterprise from the list.

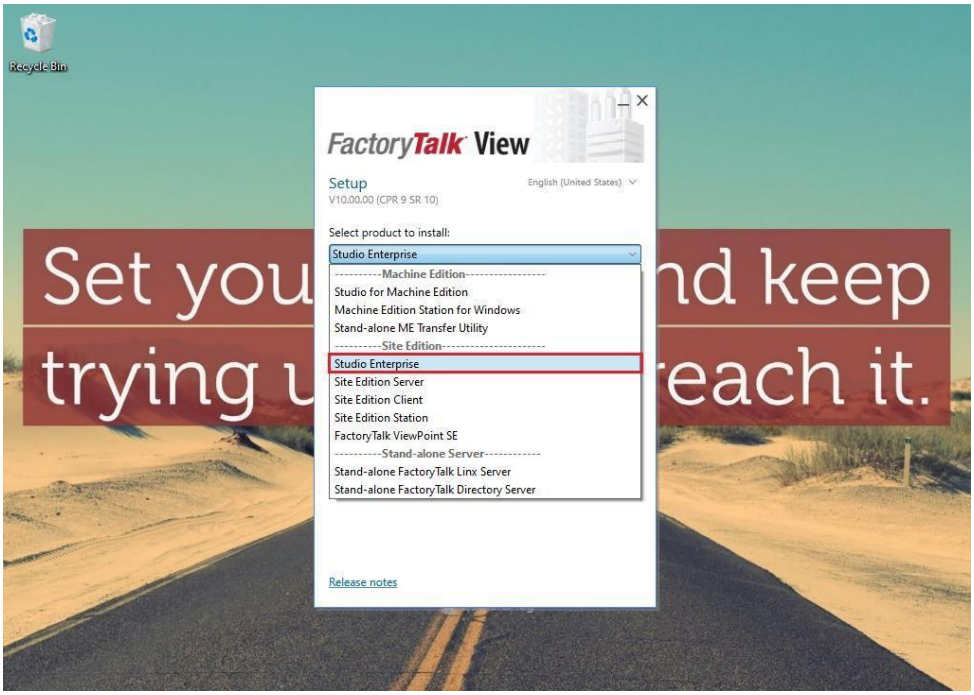


Fig. 3.31 Factory Talk part 1

Step 2: Select Skip activation then Click Next. Then it's a complete installation.

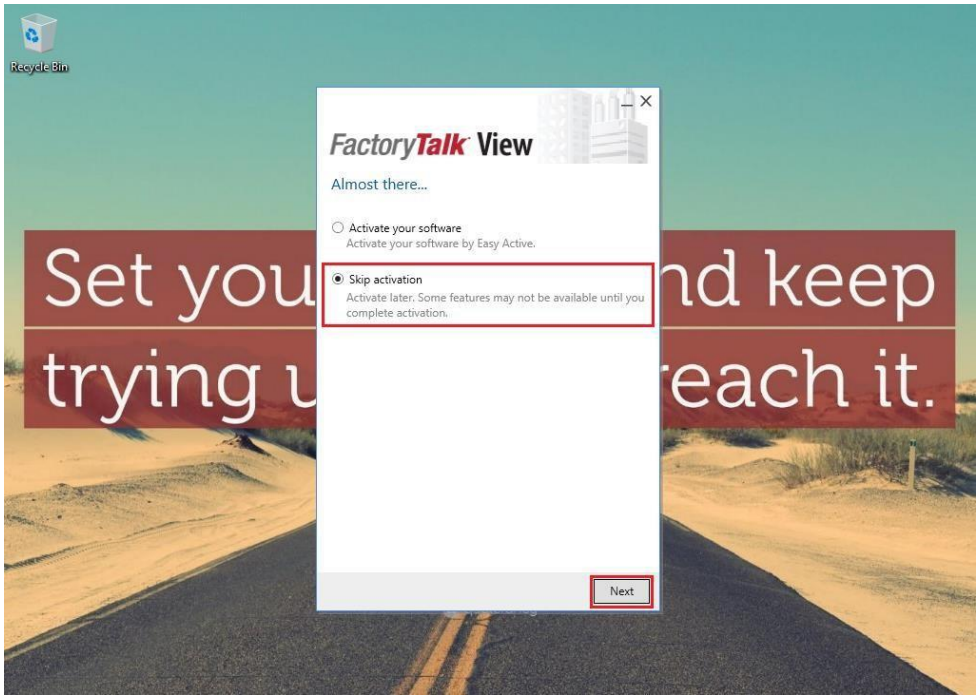


Fig. 3.32 Factory Talk part 2

Step 3: After installation open the software and you can see the screen below.

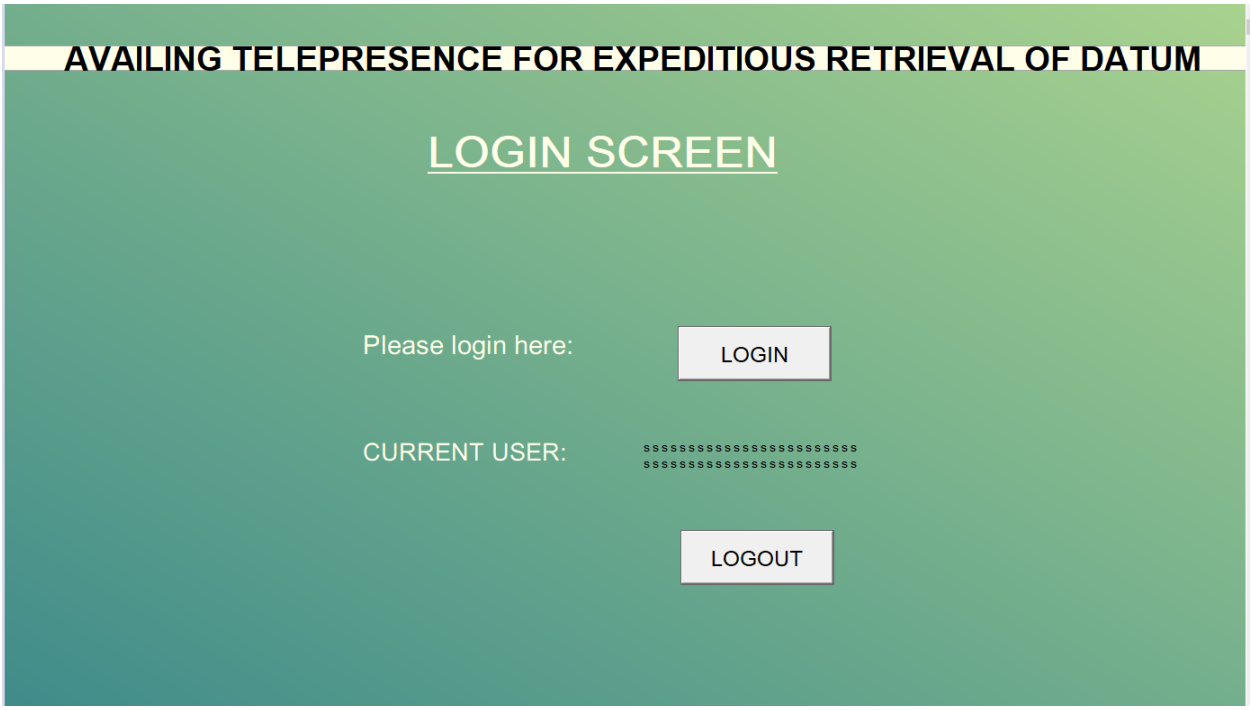


Fig. 3.33 Factory Talk part 3

3.5 UNITY

Unity is a cross-platform game engine developed by Unity Technologies, which is primarily used to develop video games and simulations for computers, consoles and mobile devices.
Unity is an all-purpose game engine that supports 2D and 3D graphics, drag and drop functionality and scripting through C#.

3.5.1 Key Features:

3D and 2D Graphics Support

Unity provides support for both 3D and 2D graphics. Each graphic type comes with its own specialized set tools (such as sprite sheet cutting for 2D graphics) and even has its own script APIs to call upon for different physics options that are suited for each style. 3D graphics also offer an extremely robust set of tools as well with the ability to create custom materials.

Easy-to-Understand Architecture

Unity offers a very transparent method for composing your game architecture. Unity also offers the ability to have a parent-child relationship between objects in the Hierarchy, making it very easy to add multiple objects (like an outfit, gun, or collider for collision detection) to one parent player character object.

Unity Scripting API

Rather than going in blind, Unity comes with a powerful scripting API that offers you quick access to the most commonly needed features. This includes both general game features, as well as specific API calls that allows us to access specific features and nuances for the engine.

Cross-platform Build Support

Unity games support building to an immense number of platforms. As long as the developer downloads the appropriate kit, we can export games for Android, iOS, Windows, MacOS, Linux, PS4, Xbox One, and more.

Virtual Reality & Augmented Reality Capabilities

When it comes to VR and AR, which are newer technologies, Unity is one of the key supporters for developing with them. For VR, there are numerous packages available that support almost all

VR headsets available, and they are constantly updated and kept flexible with this changing technology.

Large Asset Store

Unity has an immensely large asset store that comes with a variety of paid and free assets you can use for any game project. Unity makes it very easy to add assets to our collection and install them into our project with the package manager, meaning no fussing with files manually.

Unity Developed Packages

Unity itself offers a ton of in-house developed packages and assets for free that extend the functionality of the engine in useful ways.

3.5.2 Installation Steps

Step 1: Click on Download for Windows from https://unity.com/download

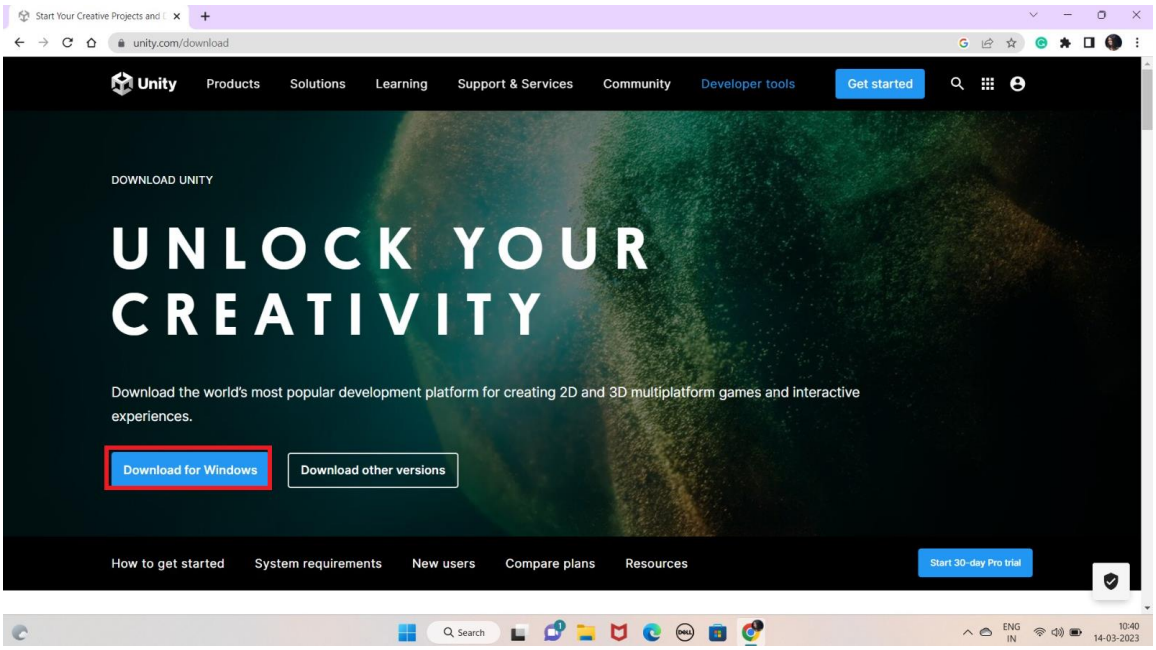


Fig. 3.34 Unity part 1

Step 2: Click on Unity Hub Setup and click on I Agree.

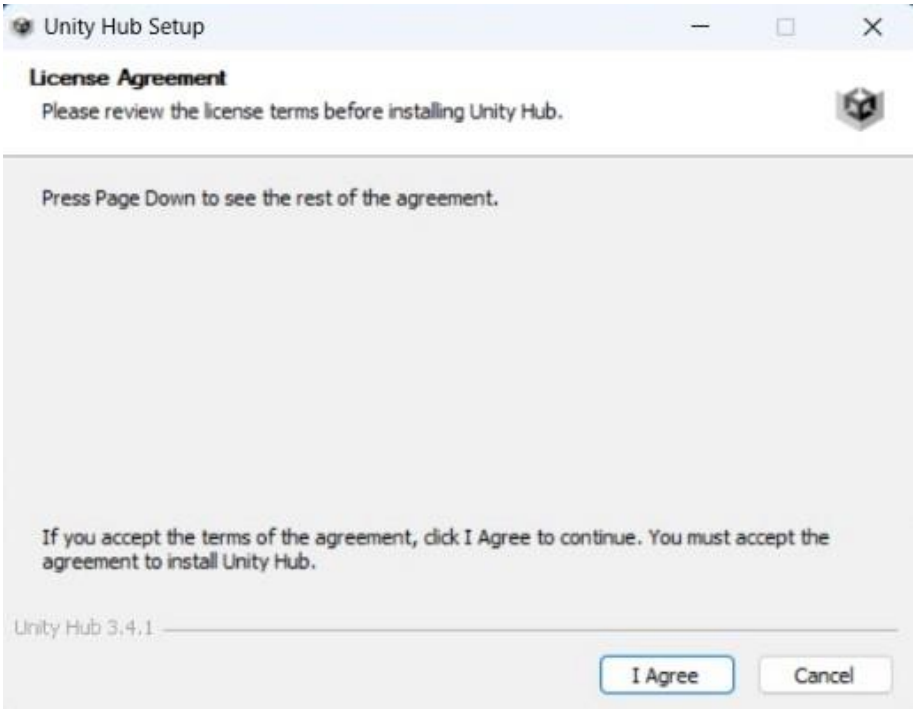


Fig. 3.35 Unity part 2

Step 3: Choose the install location and click on Install.

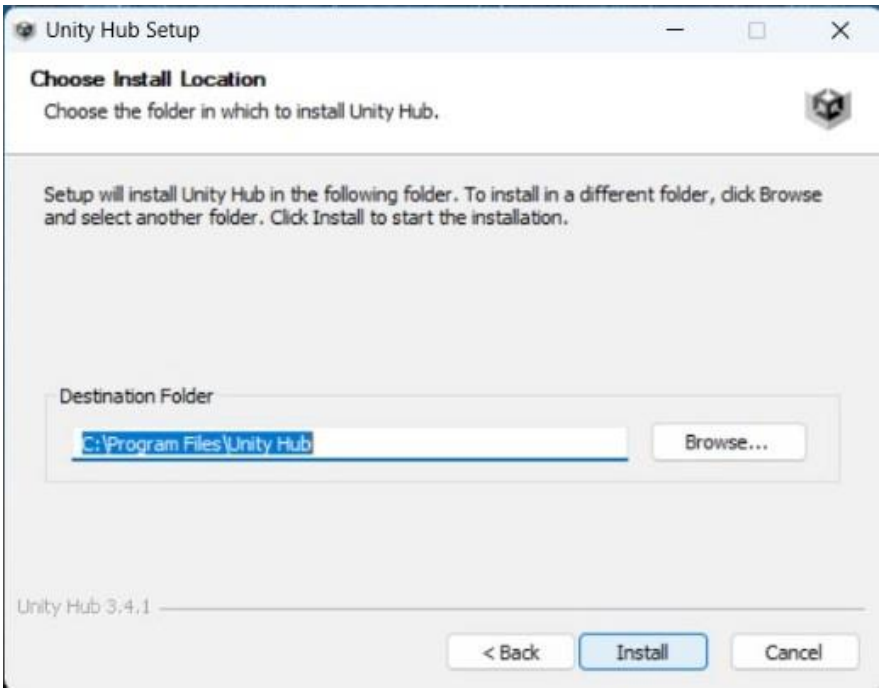


Fig. 3.36 Unity part 3

Step 4: Click on finish.

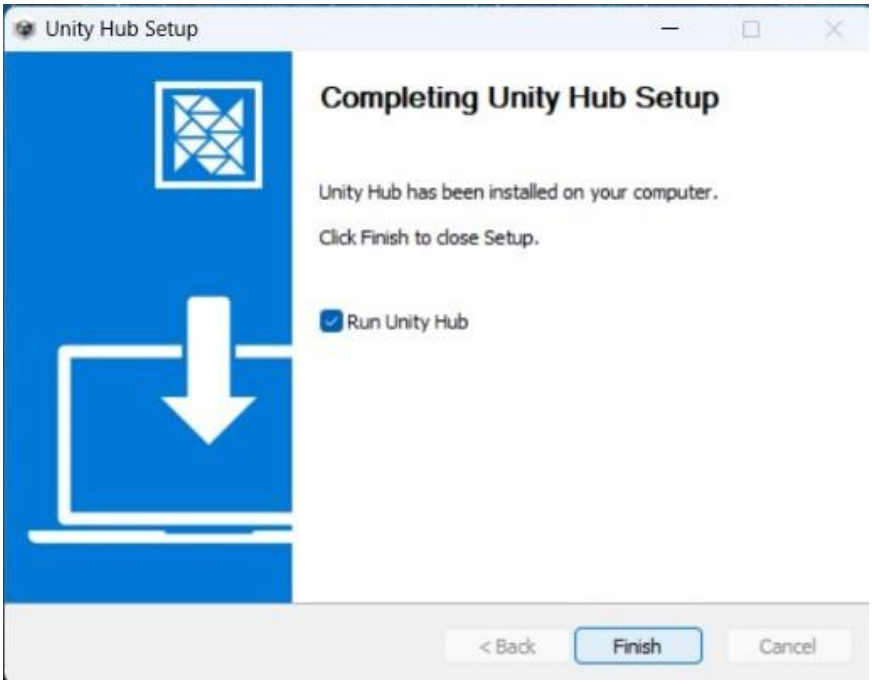


Fig. 3.37 Unity part 4

Step 5: Sign in to the unity hub or create an account if new to unity.

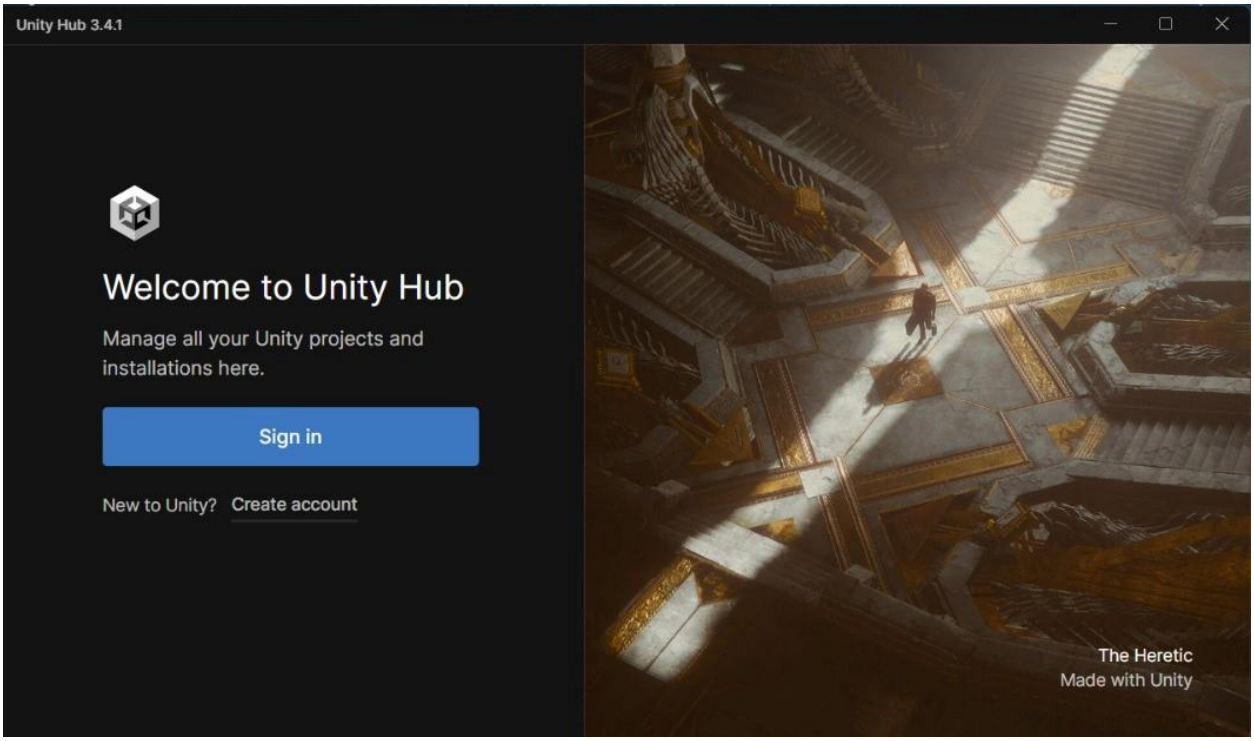


Fig. 3.38 Unity part 5

Step 6: Click on installs and then click on install editor.

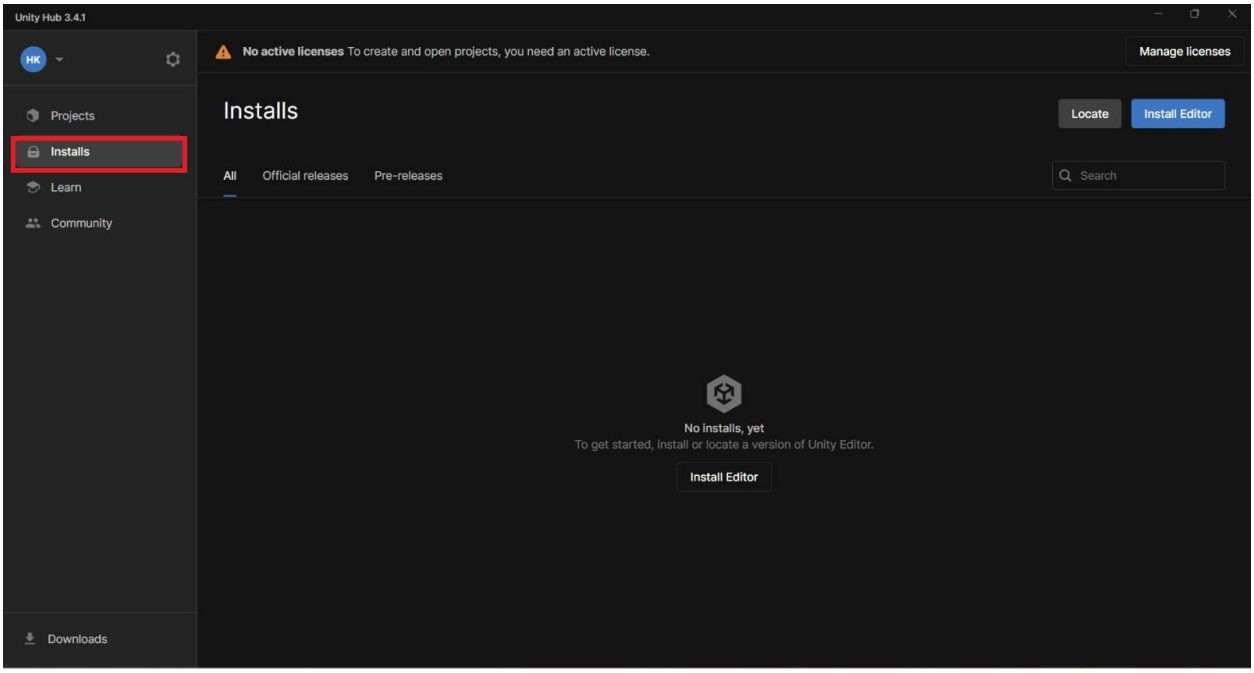


Fig. 3.39 Unity part 6

Step 7: Install 2020.3.46f1 version under official releases.

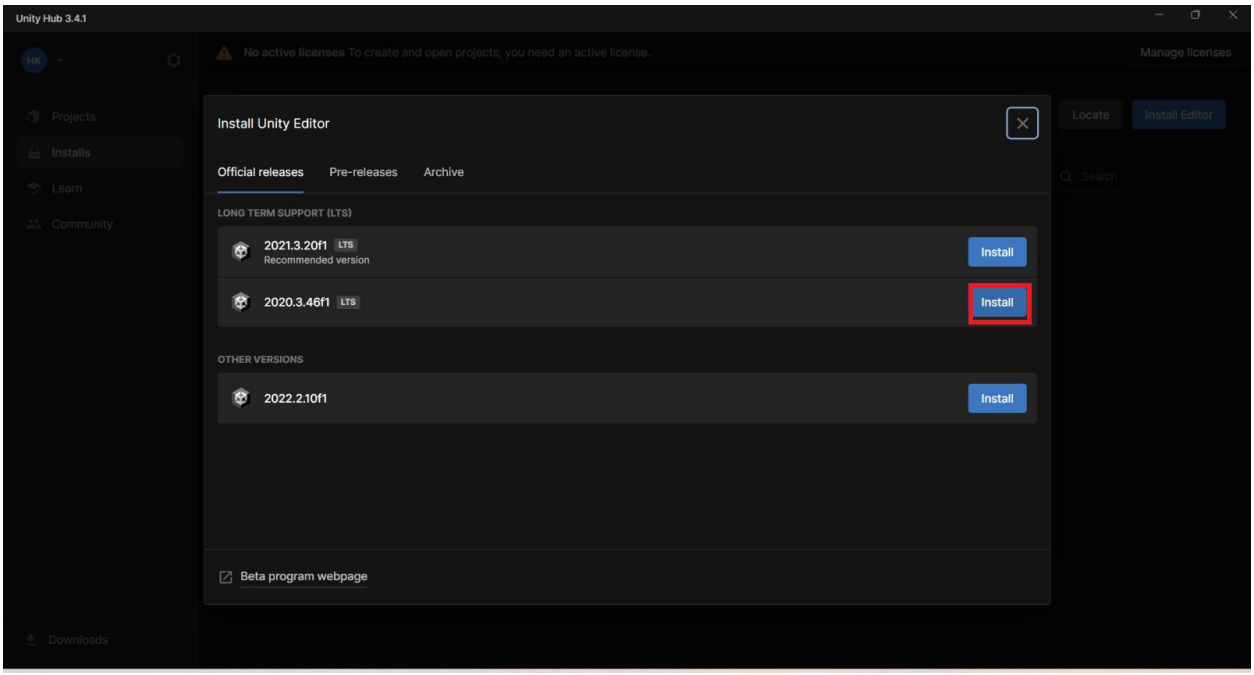


Fig. 3.40 Unity part 7

Step 8: Click on Projects and then New Project.

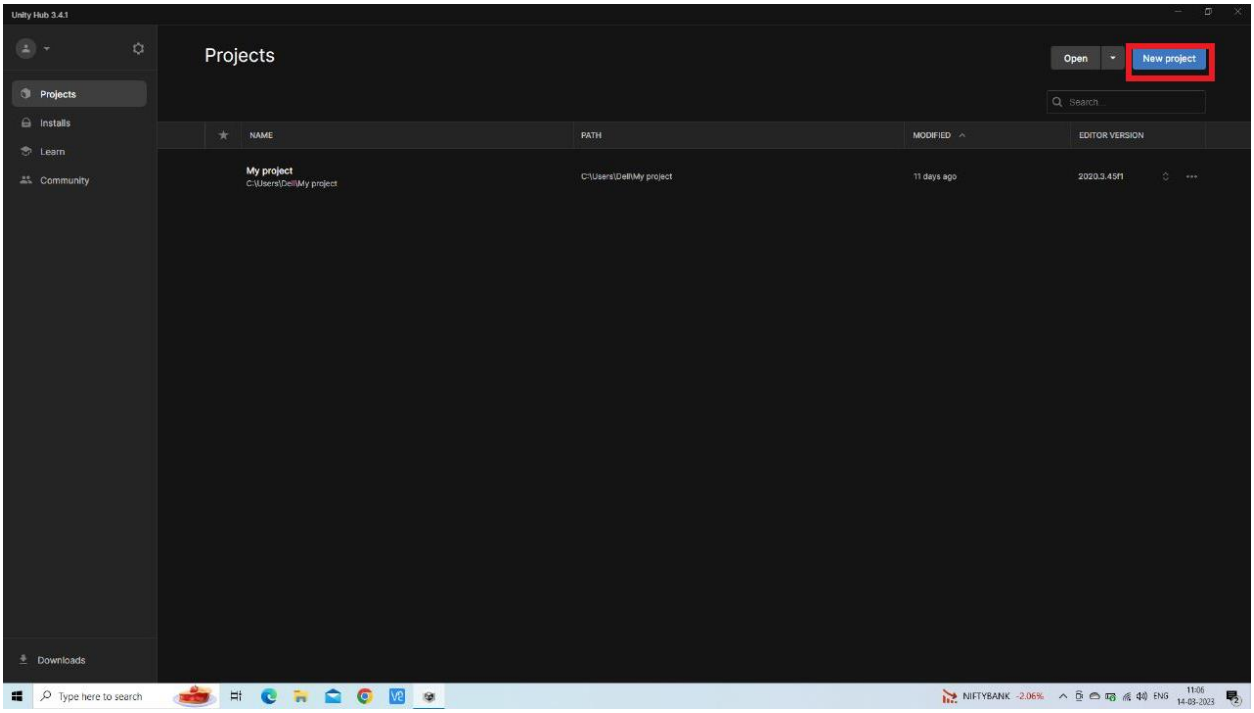


Fig. 3.41 Unity part 8

Step 9: Click on Create project and then 3D.

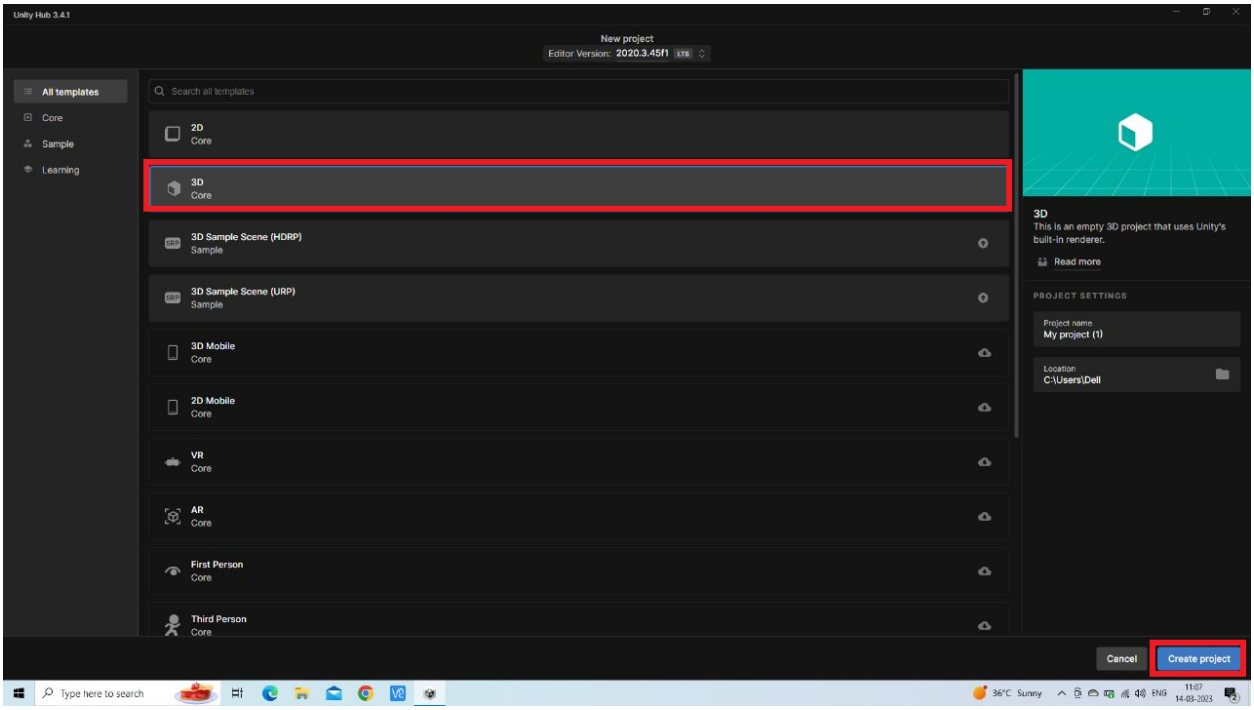


Fig. 3.42 Unity part 9

Step 10: A sample scene in Unity software will open up.

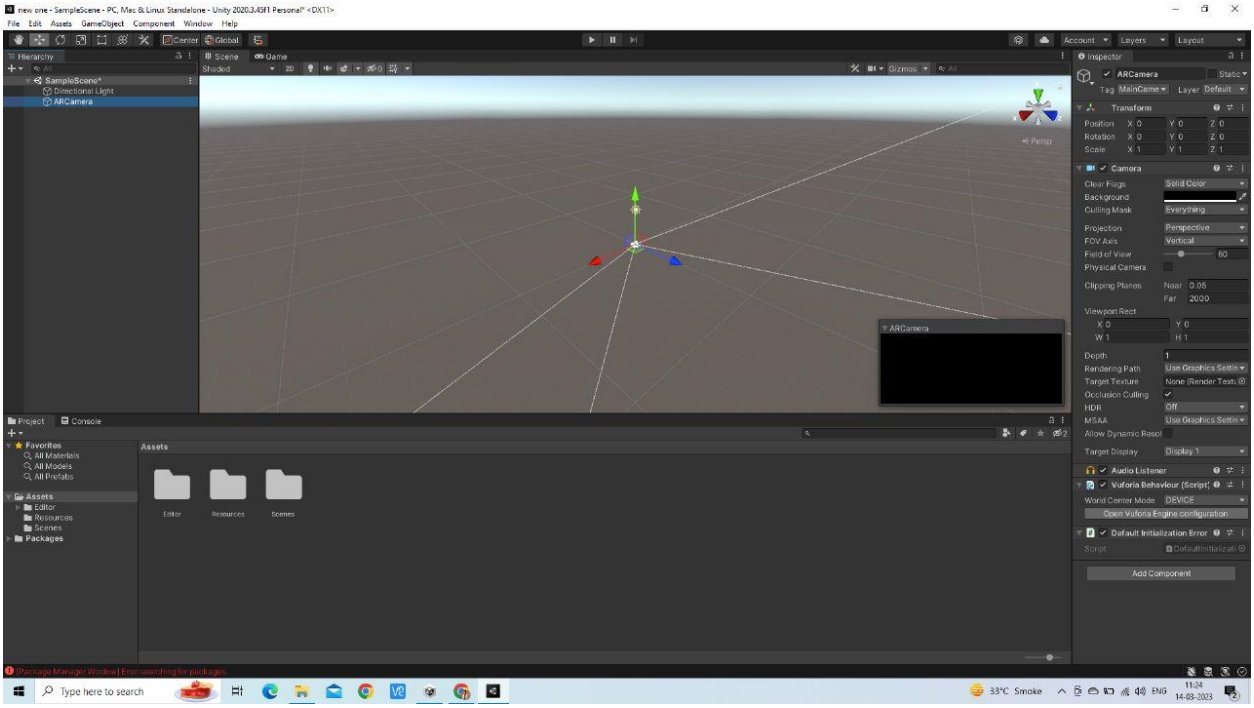


Fig. 3.43 Unity part 10

Step11: Download Vuforia Engine to Unity Project from
https://developer.vuforia.com/downloads/SDK

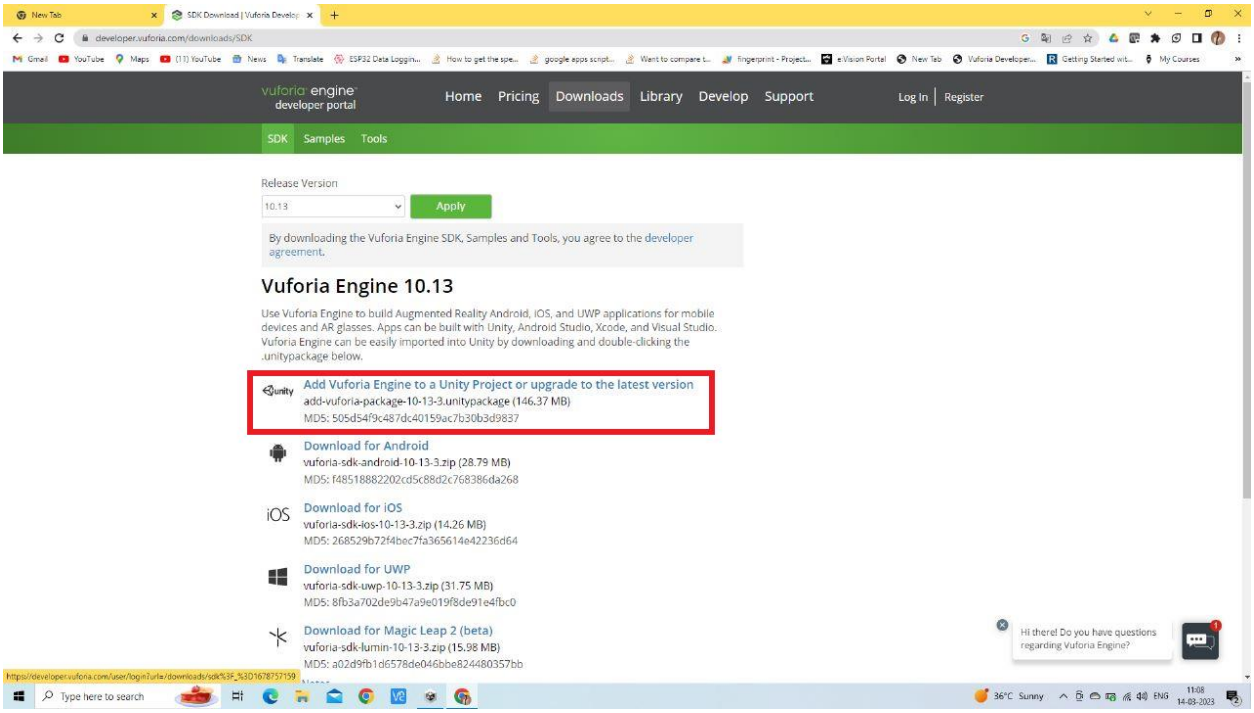


Fig. 3.44 Unity part 11

Step 12: Login to the Vuforia Engine developer portal or register as a new user.

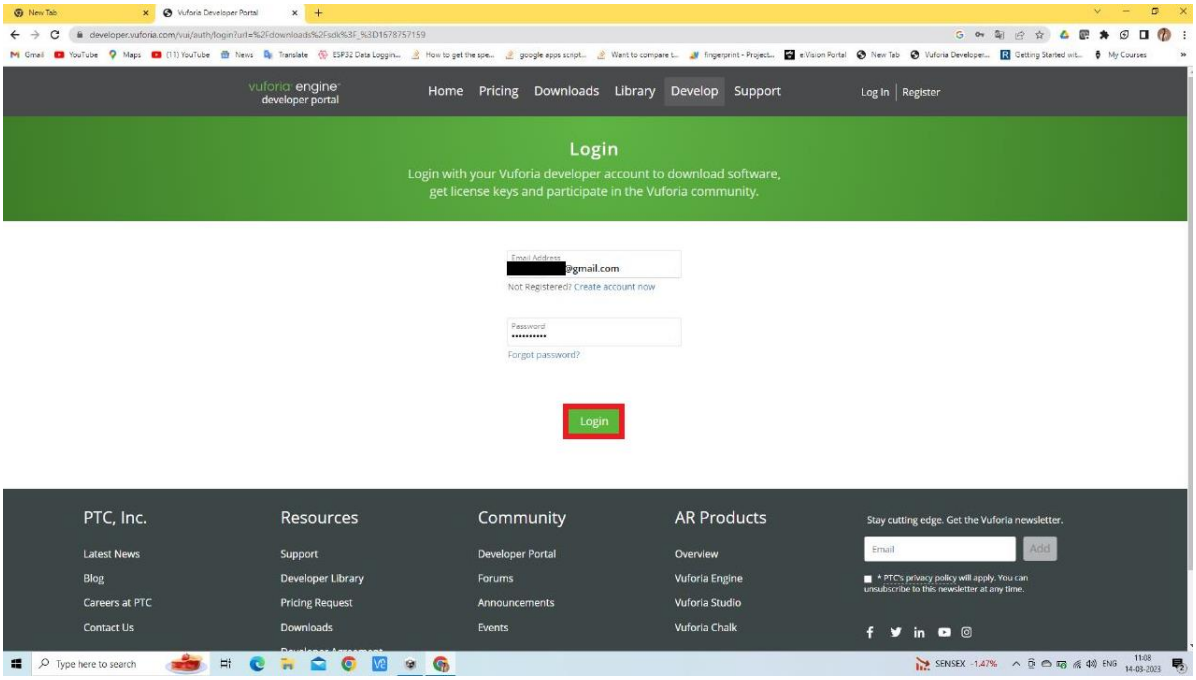


Fig. 3.45 Unity part 12

Step 13: Click on Develop and License Manager.

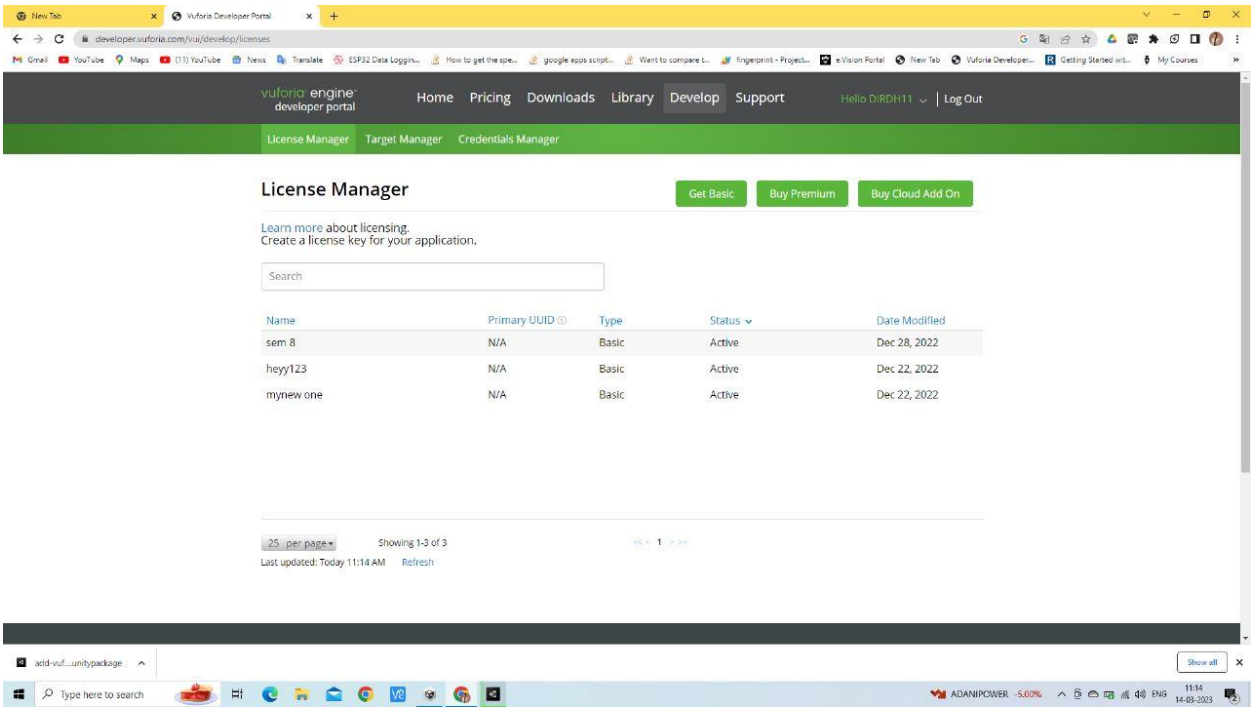


Fig. 3.46 Unity part 13

Step 14: Click on Target Manager and Add Database.

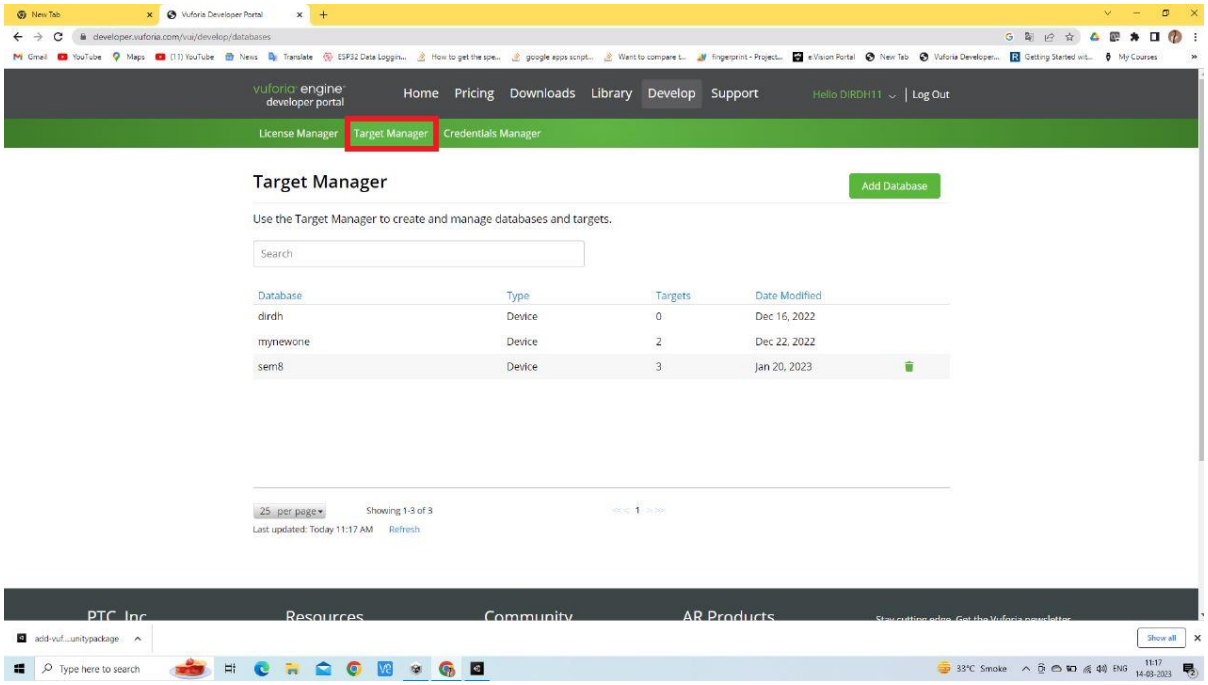


Fig. 3.47 Unity part 14

Step 15: Click the respective database and add target images to the database.

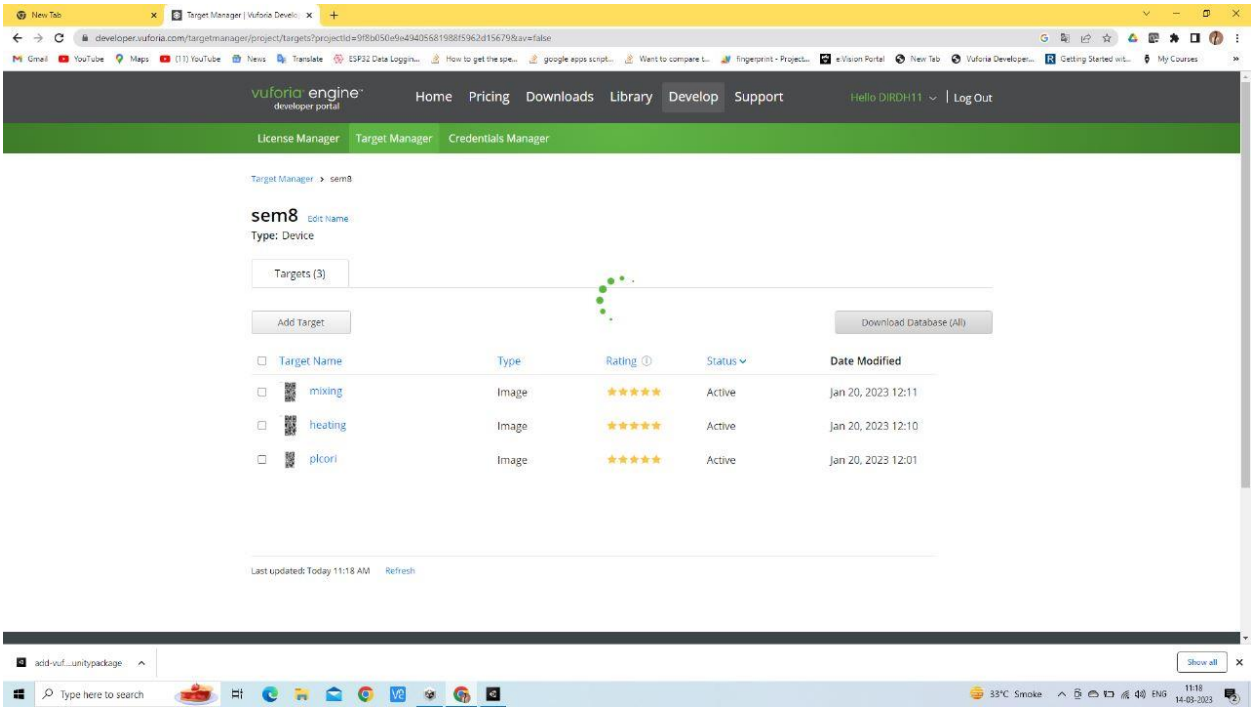


Fig. 3.48 Unity part 15

Step 16: Click on download Database and select the development platform as Unity Editor.

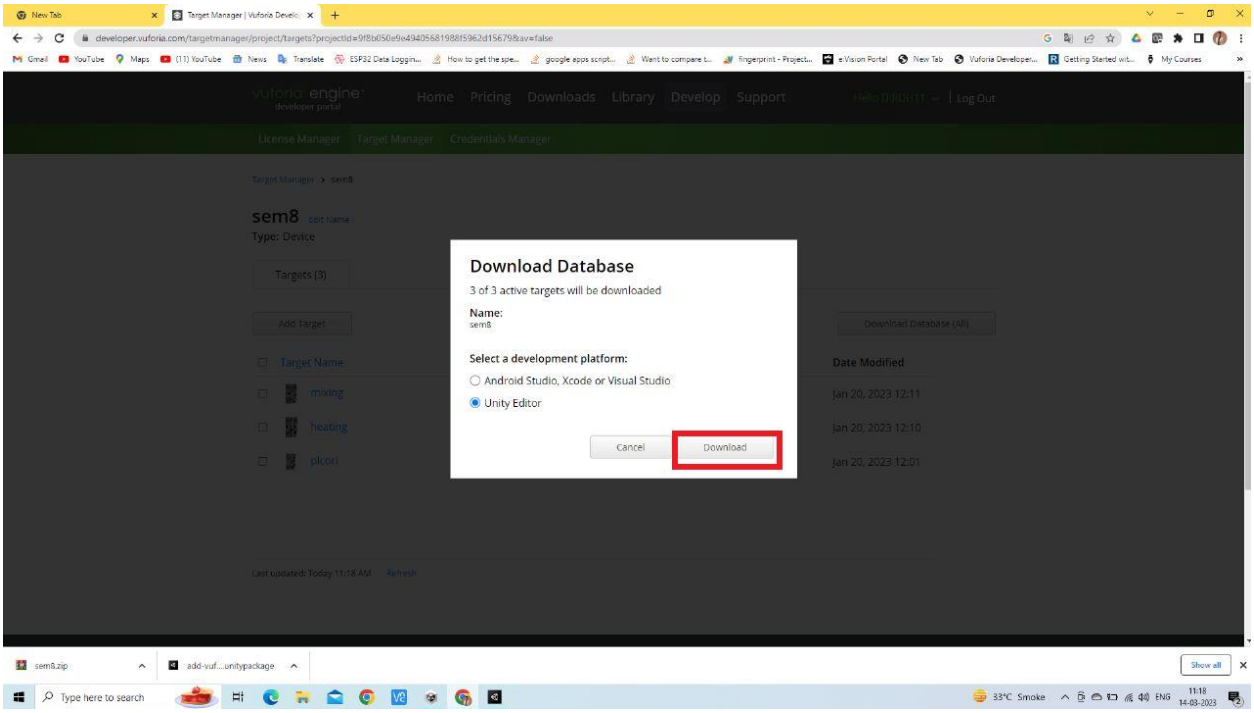


Fig. 3.49 Unity part 16

Step 17: Click Import Package in Unity sample scene.

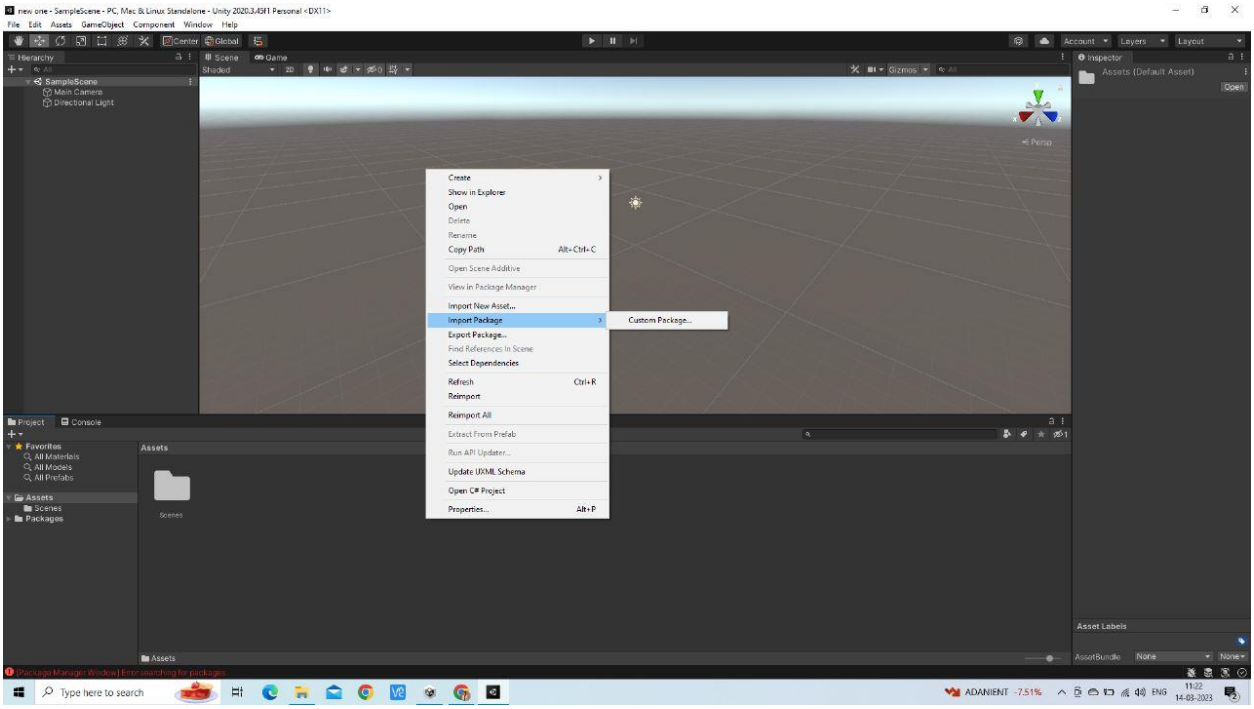


Fig. 3.50 Unity part 17

Step 18: Add the downloaded Vuforia engine package.

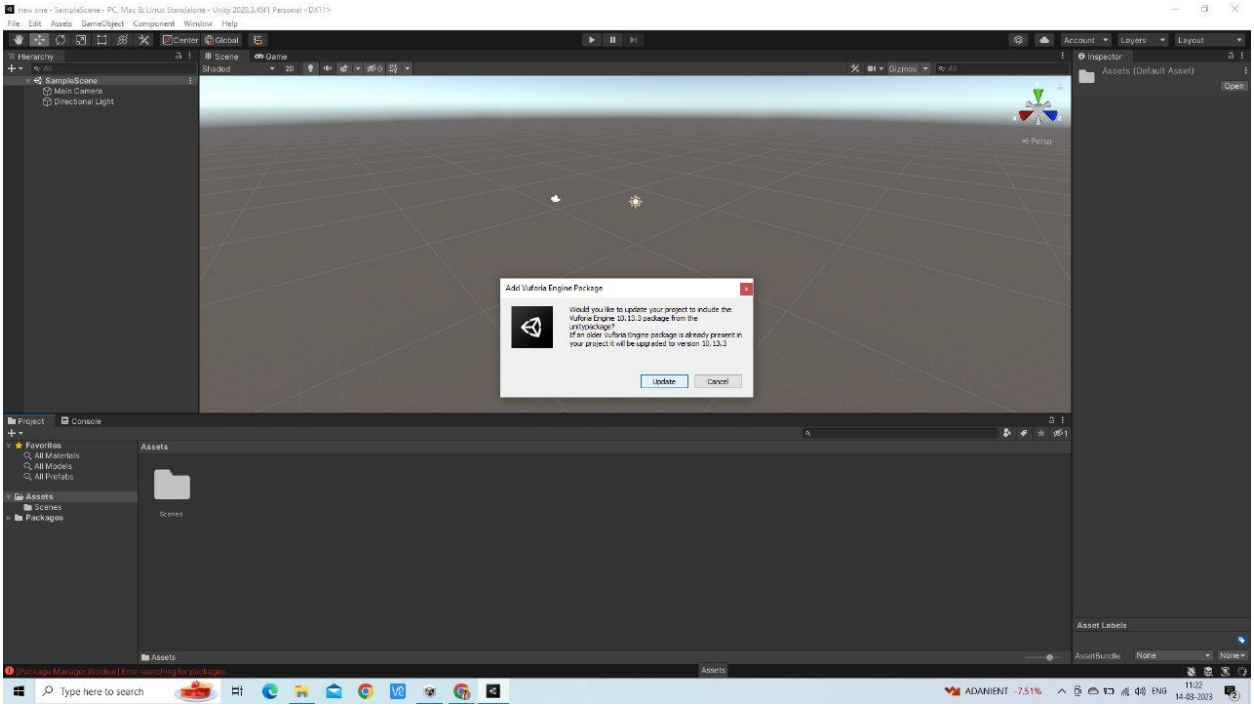


Fig. 3.51 Unity part 18

Step 19: Add AR Camera from Vuforia Engine.

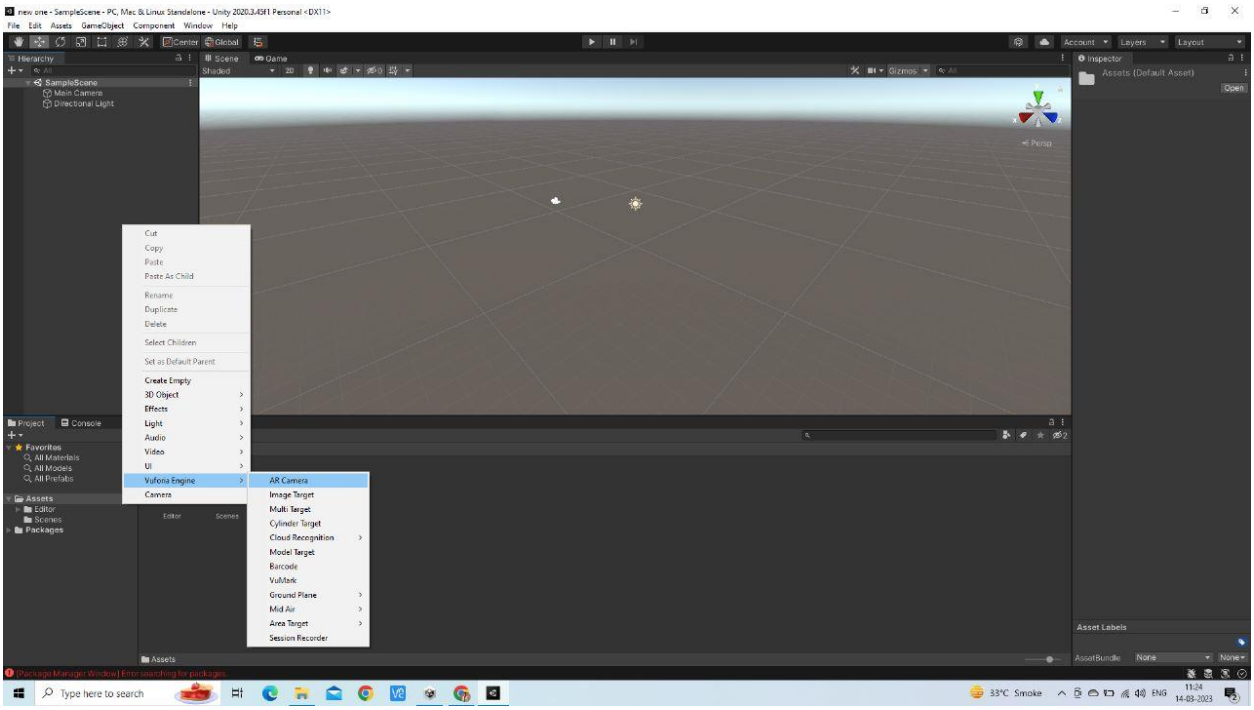


Fig. 3.52 Unity part 19

Step 20: Copy the license key below from Vuforia Developer Portal.

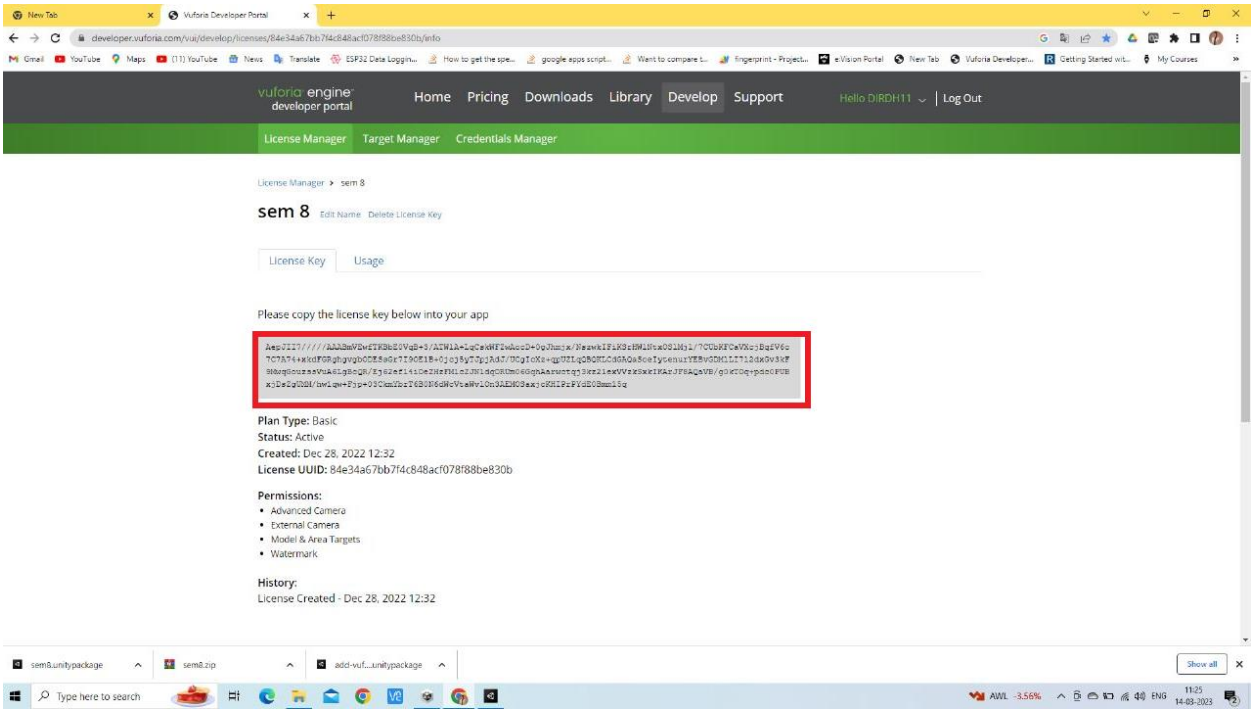


Fig. 3.53 Unity part 20

Step 21: Paste the copied app license key in Unity software under Inspector Panel.

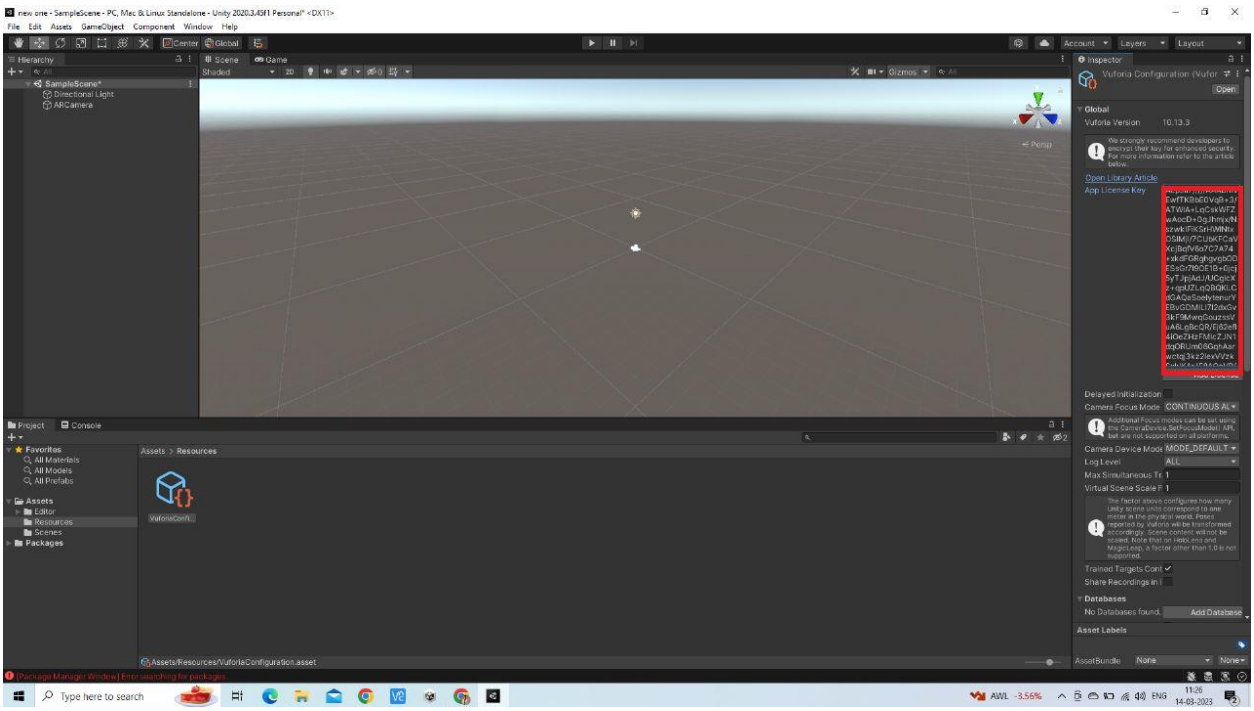


Fig. 3.54 Unity part 21

4. DESIGN AND IMPLEMENTATION

4.1 ASSEMBLY DESIGN AND CONSTRAINTS

While working on the project, we discovered a few limitations and dangers that were present. The following paragraphs go into more depth about it.
In our case pumps were not getting enough current, we solved this issue using an adapter.
Heater which we have used can be burnt if we use it without water. Thus, we need to take care of its operation.
As PLC is expensive, we need to take care of wiring because if any of the connection get shorted it can damage the whole PLC.
SMPS failure can directly destroy PLC.

4.2 SYSTEM ARCHITECTURE

As per the Architecture of the project shown below, the sensor and final control elements connected to the PLC store the data in Data Files in RSLogix 500 software. All the variables have different types of data types like Integer, Float, Binary, etc. Further, bidirectional transportation of multiple tags can be achieved by using the pccc in and pccc out blocks in Node-Red. After getting the data into the Node-Red, we are classifying and parse the data by considering the variable name and data type of that particular dot, to do so we are made the specific code by using the knowledge of java scripting in the function block of Node-Red.
Further, the extraction of data is required before transferring it to the cloud because of the message type. While transferring the data with any server by using any protocols like PCCC, HTTP, and MQTT, we get the message packets in which we get multiple data related to its authentication, timestamp, value, device name, and variable name, etc., this kind of data is publish to Mosquito MQTT broker.

At a later stage, to transmit the data from the local server to the cloud server, NodeRed uses the MQTT protocol, which is the most suitable for the Internet of Things (IoT) solution nowadays. The transmitted data is stored in the generated Devices, in our case, its name is “PLC”. Through that gateway, we can access the variables while adding the widgets to the dashboard.

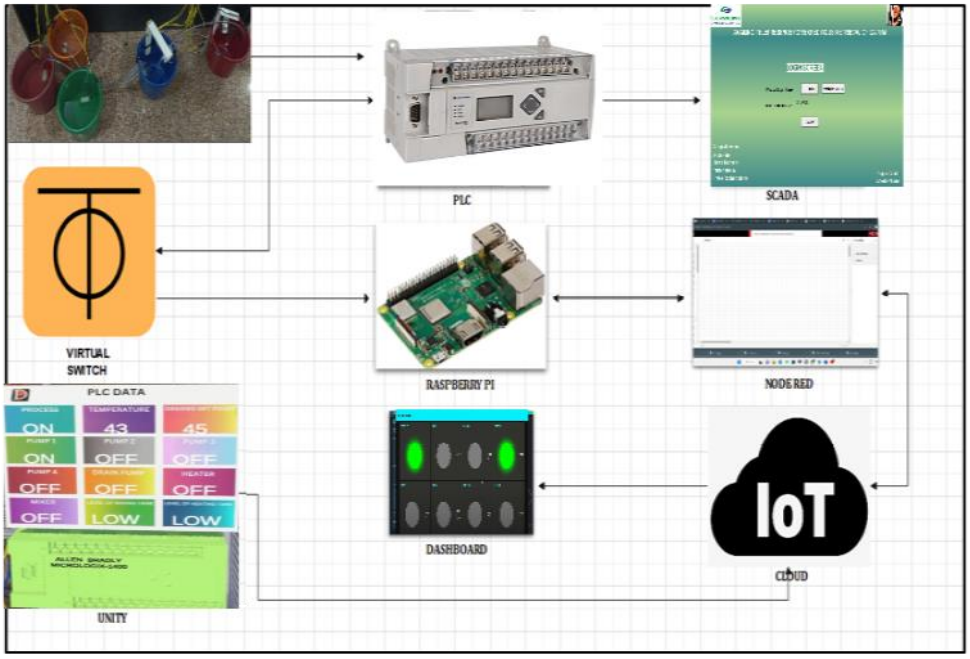


Fig. 4.1 System architecture

4.3 P&ID

The below P&ID illustrates the physical layout of piping, equipment, instrumentation, and controls for a process system.

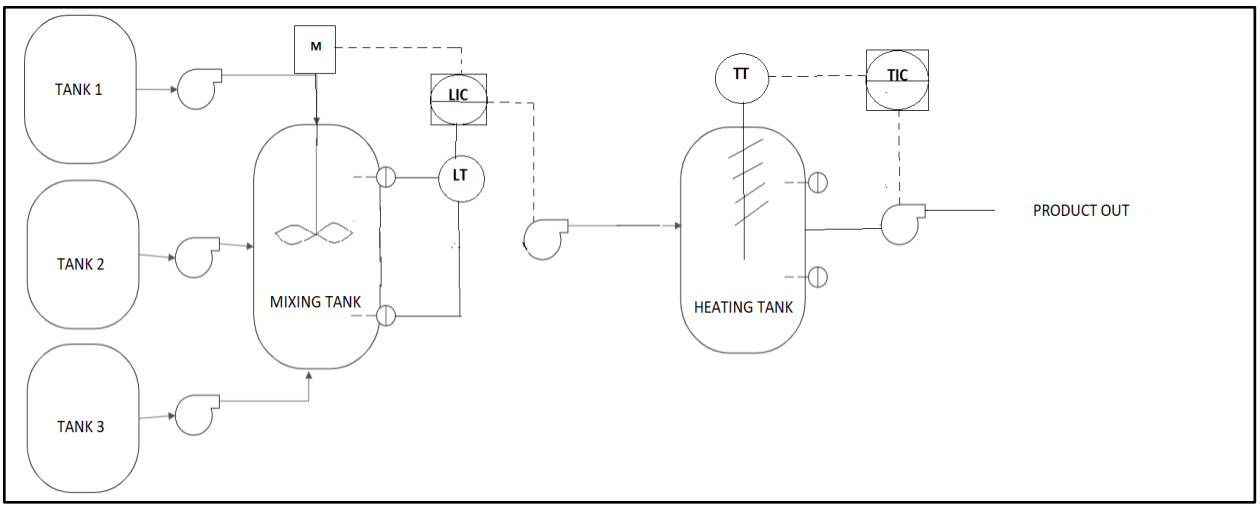


Fig.4.2 P&ID

4.4 BLOCK DIAGRAM

The below block diagram is a graphical representation of the major components or stages of a process, along with their inputs, outputs, and interconnections.

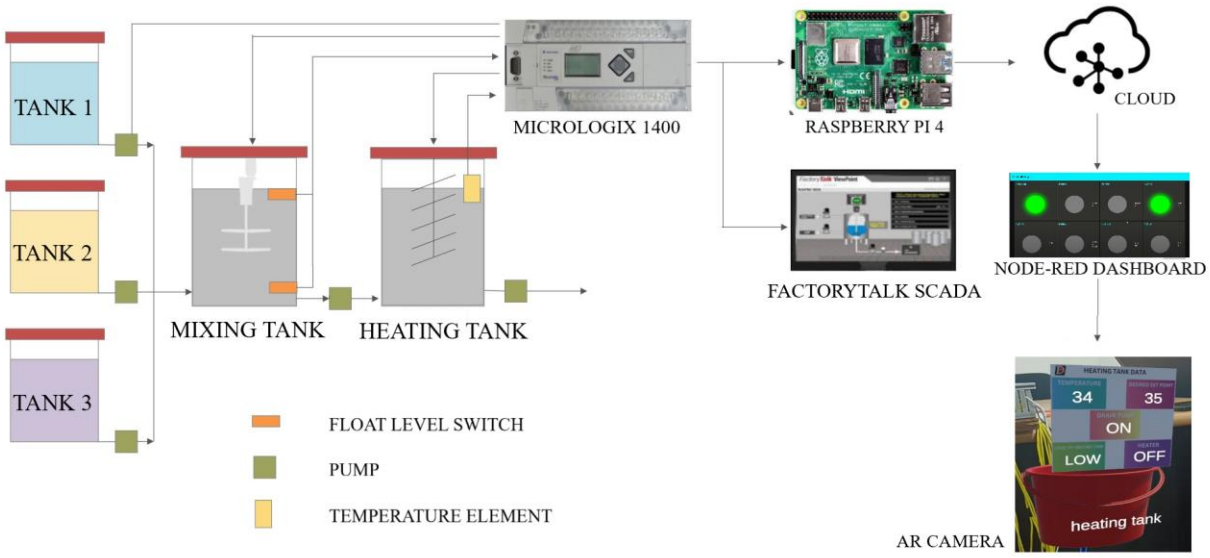


Fig.4.3 Block diagram

4.5 WIRING DIAGRAM

The below wiring diagram shows the connections between various components in an electrical system.

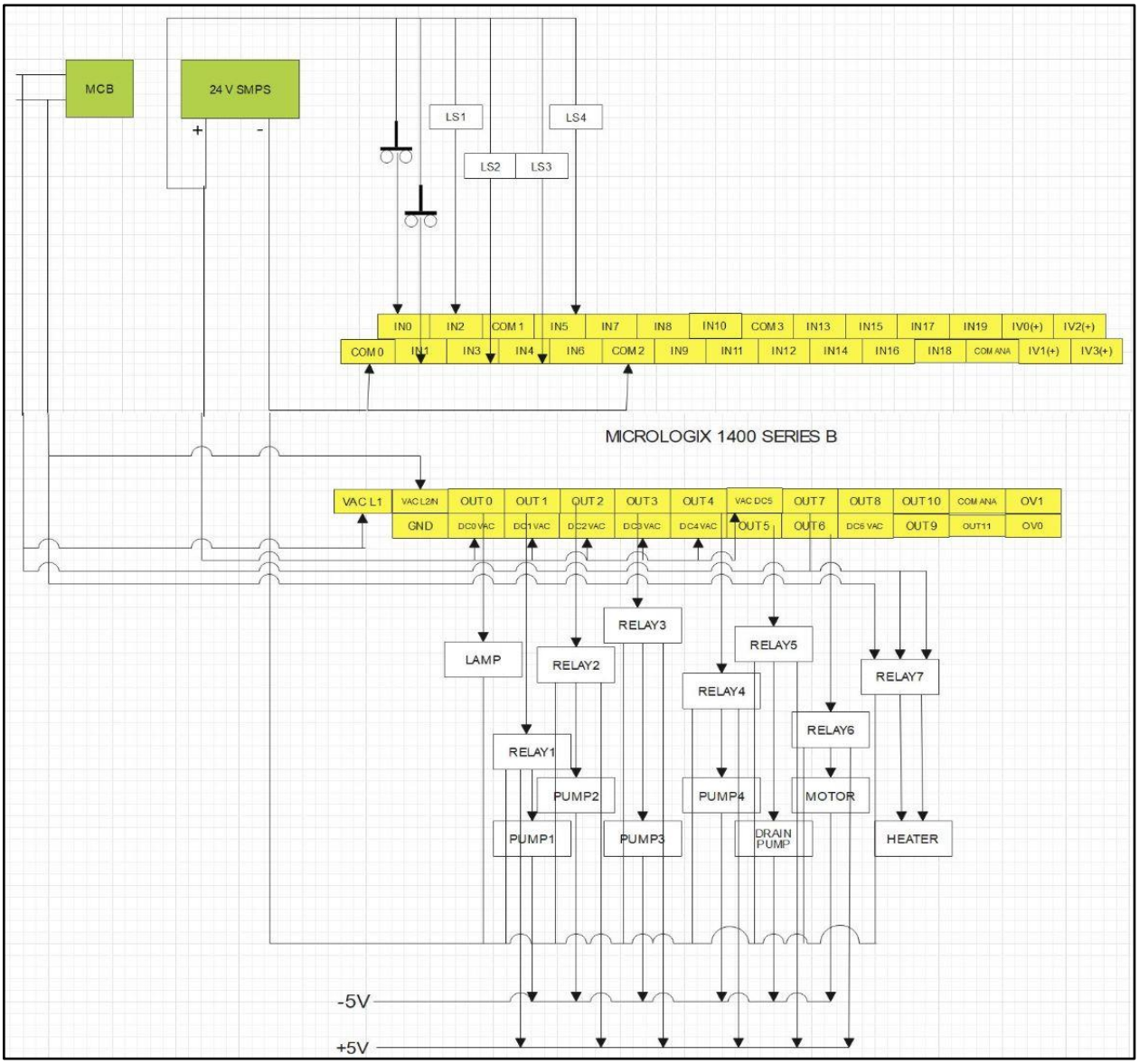


Fig.4.4 Wiring diagram

4.6 HARDWARE IMPLEMENTATION

The below shown figures 4.5 and 4.6 are the implementation of the hardware of the process which is automated by programmable logic controller with other components.

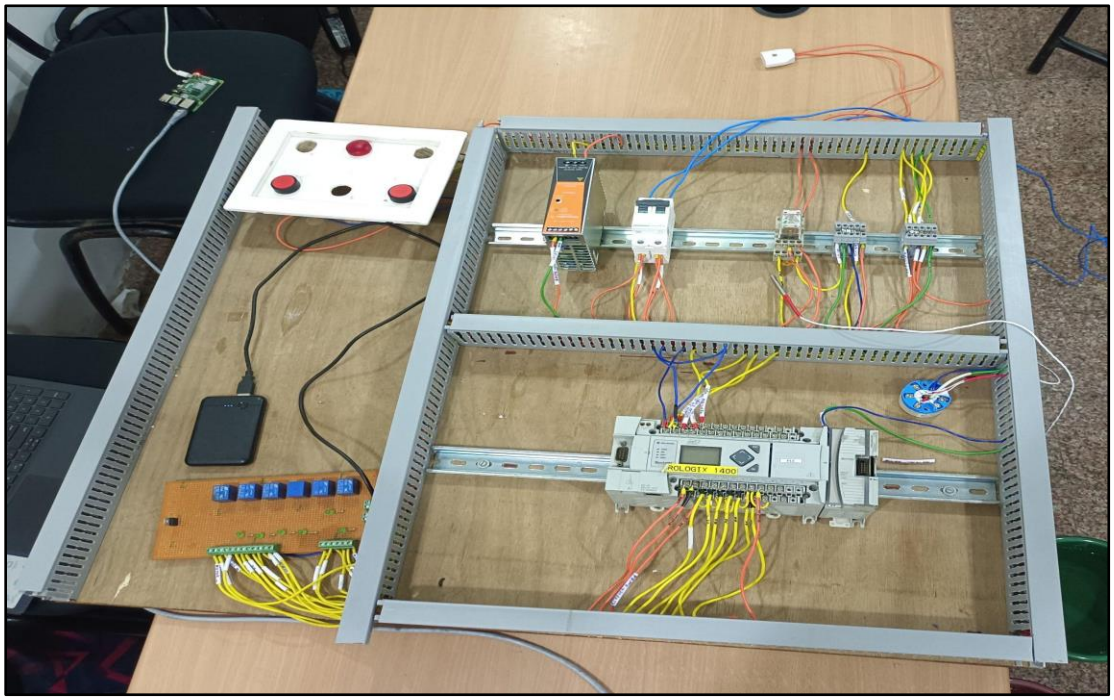


Fig. 4.5 Hardware 1

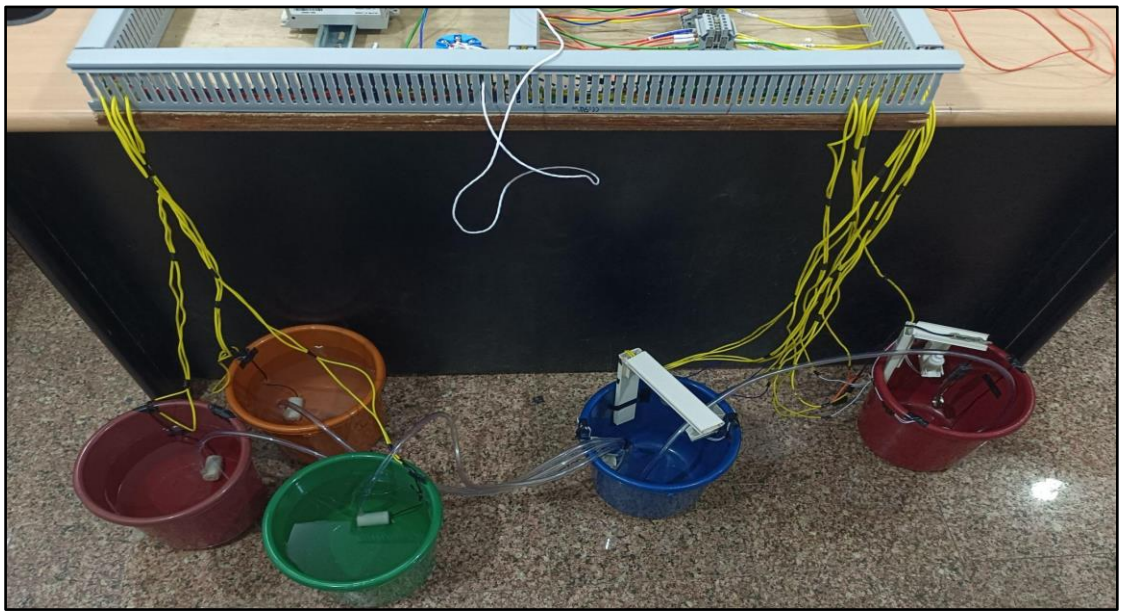


fig.4 .6 Hardware 2

As shown in fig., we have used rack to implement our electronic devices like Programmable Logic Controller, MCB, SMPS, relay circuit board, raspberry PI. We used the plastic bucket to replicate the phenomenon of the industrial tank due to its ease of availability and its cheap price. Along with that, it is durable enough to handle our attachments, which are mounted on it. The process tank is used as a housing medium of fluid as well as various components. While working with the fluids and tanks level is most important to take care off. We have used adhesive and taps to mount pumps and level switches in the buckets. For agitation purpose DC motors is used. Heater and DC motors are mounted on one structure prepared by us using trunk cases. Heater used is cheaper so it is required to turn on the heater with fluid. Operating Heater without fluid can damage it.

4.7 RELAY CIRCUIT BOARD IMPLEMENTATION

This relay circuit is used to provide 2 main functions of the project:

1. It is used to provide 5 Volts supply to pumps and motor.
2. It provides isolation to the 24V which is required to actuate the relays and 5V to pumps.

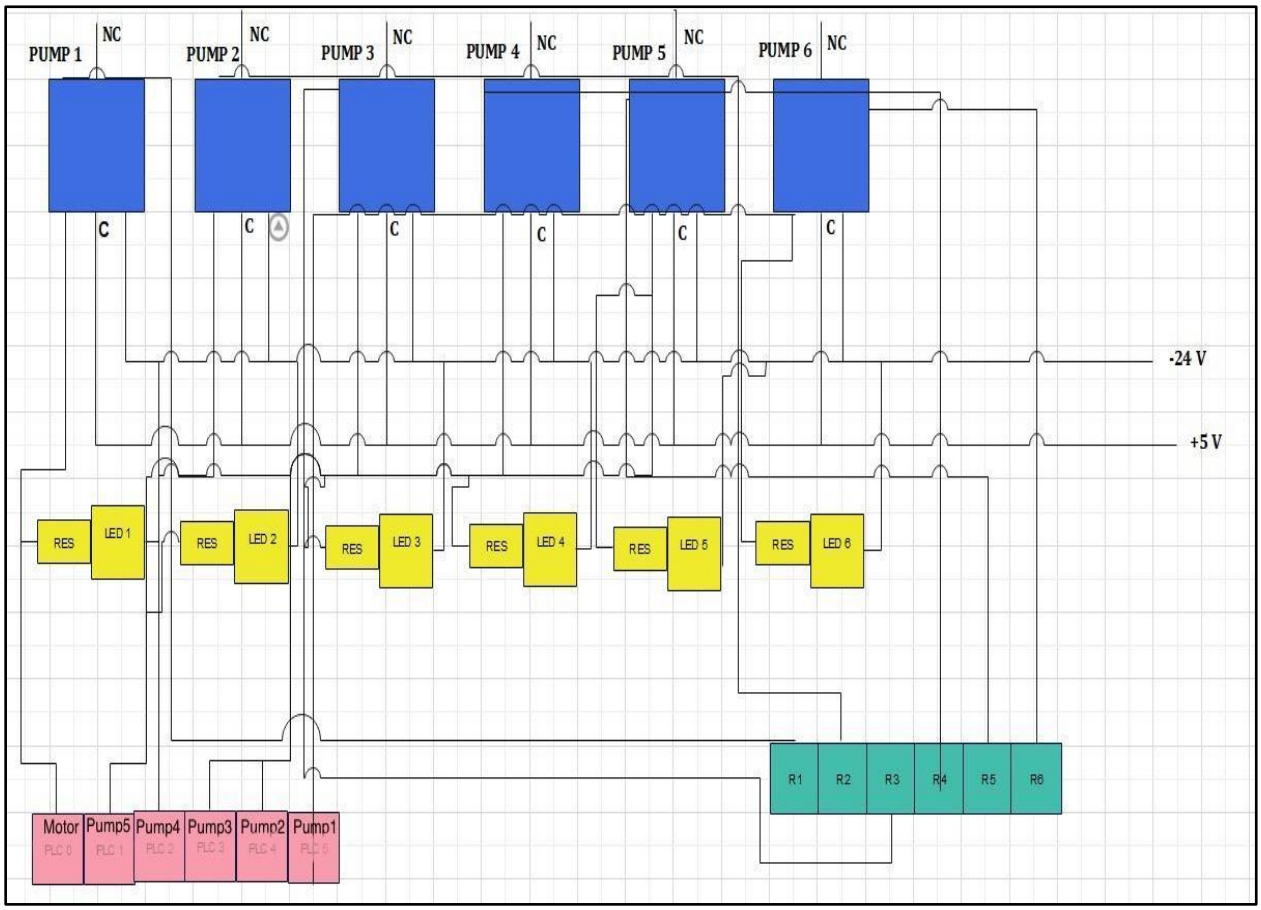


Fig.4.7 Relay circuit board implementation

4.8 I/O LIST

SR. NO.	ADDRESS	SYMBOL	DATA TYPE
PLC			
1.	I:0/0	START PUSH BUTTON	DI
2.	I:0/1	STOP PUSH BUTTON	DI
3.	I:0/2	LOW-LEVEL MIXING	DI
4.	I:0/3	HIGH-LEVEL MIXING	DI
5.	I:0/4	LOW-LEVEL HEATING	DI
6.	I:0/5	HIGH-LEVEL HEATING	DI
7.	I:0/6	RTD	AI
8.	O:0/0	LAMP	DO
9.	O:0/1	PUMP 1 (RESIN TANK)	DO
10.	O:0/2	PUMP 2 (PIGMENT TANK)	DO
11.	O:0/3	PUMP 3 (WATER TANK)	DO
12.	O:0/4	PUMP 4 (MIXING TANK)	DO
13.	O:0/5	DRAIN PUMP	DO
14.	O:0/6	MOTOR	DO
15.	O:0/7	HEATER	DO
NODE-RED			
15.	B9:0/1	Process ON	Binary bit
16.	B9:0/2	Process OFF	Binary bit
17.	B9:0/3	LL of Mixing	Binary bit
18.	B9:0/4	HL of Mixing	Binary bit

19.	B9:0/5	LL of Heating	Binary bit
20.	B9:0/6	HL of Heating	Binary bit
21.	B14:0/0	Level for Unity Mixing	Binary bit
22.	B14:0/1	Level for Unity Heating	Binary bit
SCADA			
23.	B12:0/0	START PUSH BUTTON	Binary bit
24.	B12:0/1	STOP PUSH BUTTON	Binary bit
25.	I:0/2	LL Mixing	DI
26.	I:0/3	HL Mixing	DI
27.	I:0/4	LL Heating	DI
28.	I:0/5	HL Heating	DI
29.	O:0/0	Lamp	DO
30.	O:0/1	Pump 1 (Resin Tank)	DO
31.	O:0/2	Pump 2 (Pigment Tank)	DO
32.	O:0/3	Pump 3 (Water Tank)	DO
33.	O:0/4	Pump 4 (Mixing Tank)	DO
34.	O:0/5	Drain Pump	DO
35.	O:0/6	Motor	DO
36.	O:0/7	Heater	DO

4.9 PLC LOGIC FLOW CHART

The below shown flow chart represents the steps involved in the process mentioned in the project and their sequence.

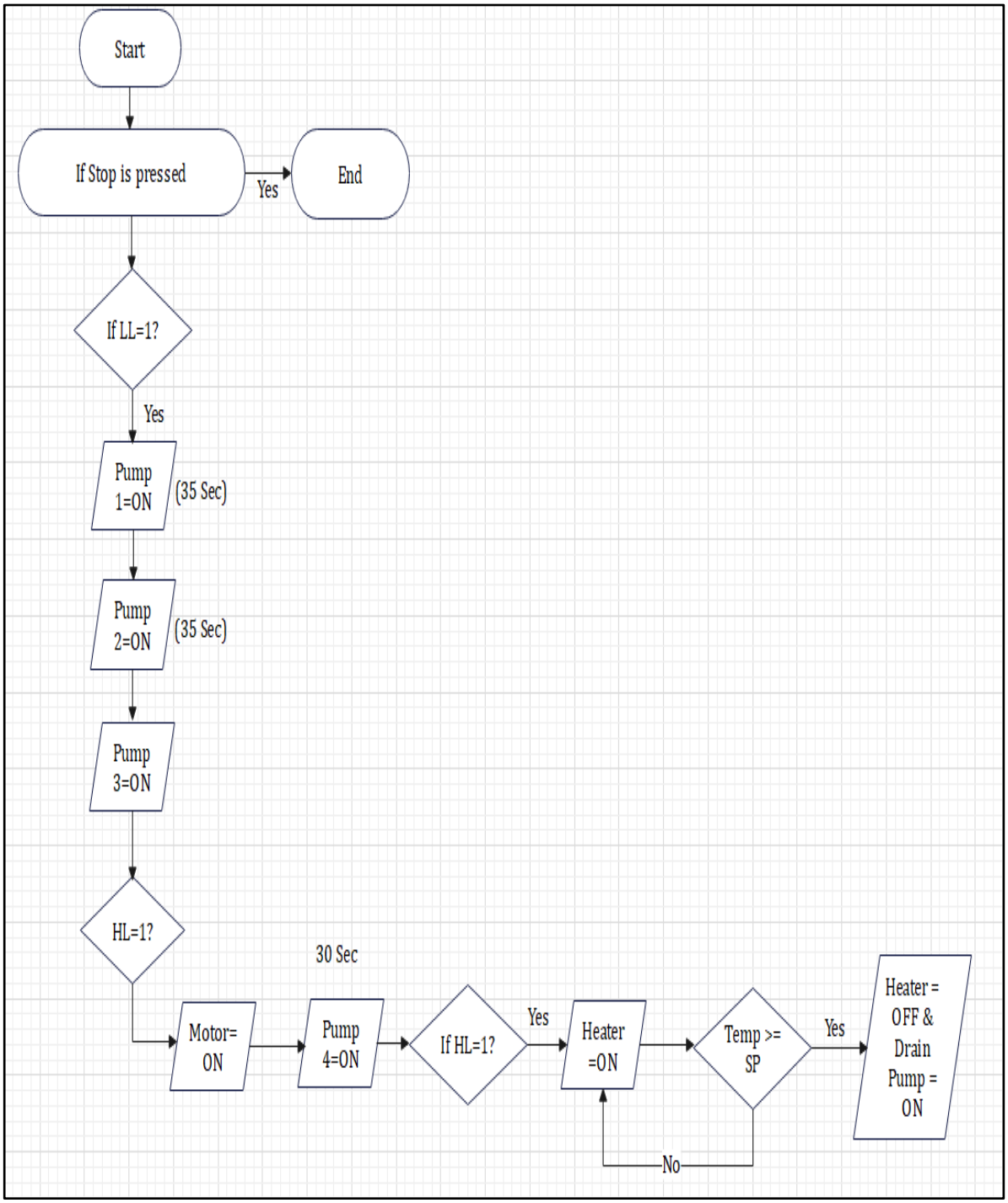


Fig. 4.8 PLC logic flow chart

4.10 LOGIC AND EXPLANATION

Logic:

1. I:0/0 is start push button when it is pressed process will start and lamp turns on which portrays that process is ON.
2. When the process starts, LL switch of Mixing tank is sensed and if it shows 1; pump 1 of Resin Tank starts and it supplies flow to Mixing tank for 35 Sec using TON instruction.
3. After 35 sec pump 2 of Pigment tank starts and supplies flow to Mixing tank for another 35 sec.
4. After a total of 70 sec pump 3 of water tank starts and supplies flow to Mixing tank till HL Switch changes its status.
5. After that the motor starts running on the timer basis for 30 Sec.
6. After timer turns off and done bit sets and low-level switch of heating tank is on pump 4 of mixing tank turns on and supplies flow to Heating tank.
7. When HL switch of heating tank changes its status; heater turns ON.
8. Temperature is continuously compared to set point if temperature is reaches set point heater turns off.
9. If temperature is low heater continuously heats fluid.
10. After providing some delay, drain pump of heating tank is turned ON.

Explanation:

The process begins by pressing the start button. When the process begins, the lamp illuminates and stays illuminated until the stop pushbutton is pressed. When the start push button is pushed, if the mixing tank initially has a low level, then pumps 1, 2, and 3 of the resin tank, pigment tank, and water tank all work on a timer basis.

The mixing procedure will now begin. When the amount is high, the mixer begins to stir the fluid. The mixer also works on a timer basis. After mixing, low level status of the heating tank is checked and if heating tank is on low level pump 4 of the mixing tank activates and provides fluid to the heating tank to heat the fluid.

The heating process in the heating tank will now begin. The heater starts heating the fluid. Temperature is continuously measured, and if it is less than the set point value, the heater continues to heat the fluid. When the fluid is heated to the desired temperature, the heater turns off, and the timer starts to add some delay. When the fluid reaches a sufficient temperature and is ready to drain, the drain pump operates and transfers the final product.

4.11 LADDER DIAGRAM

Fig. 4.9 Main screen of ladder diagram

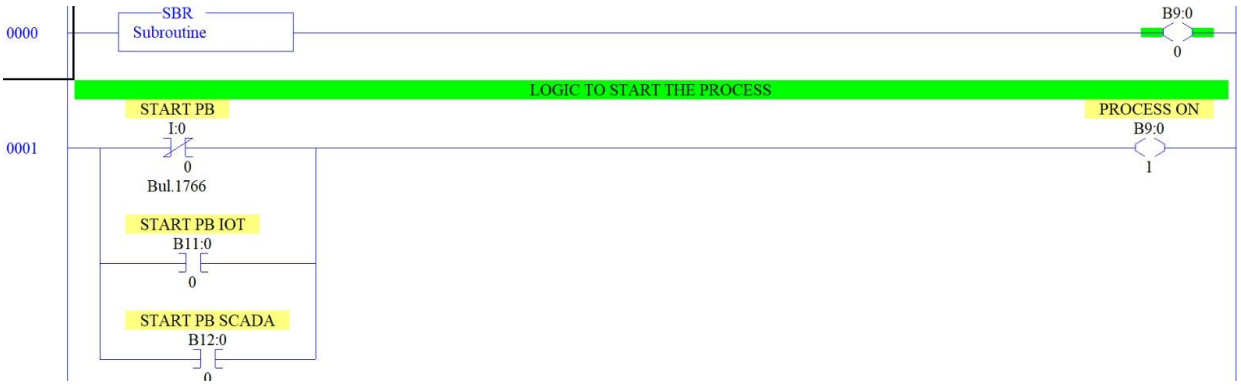


Fig. 4.10 DI Mapping part 1

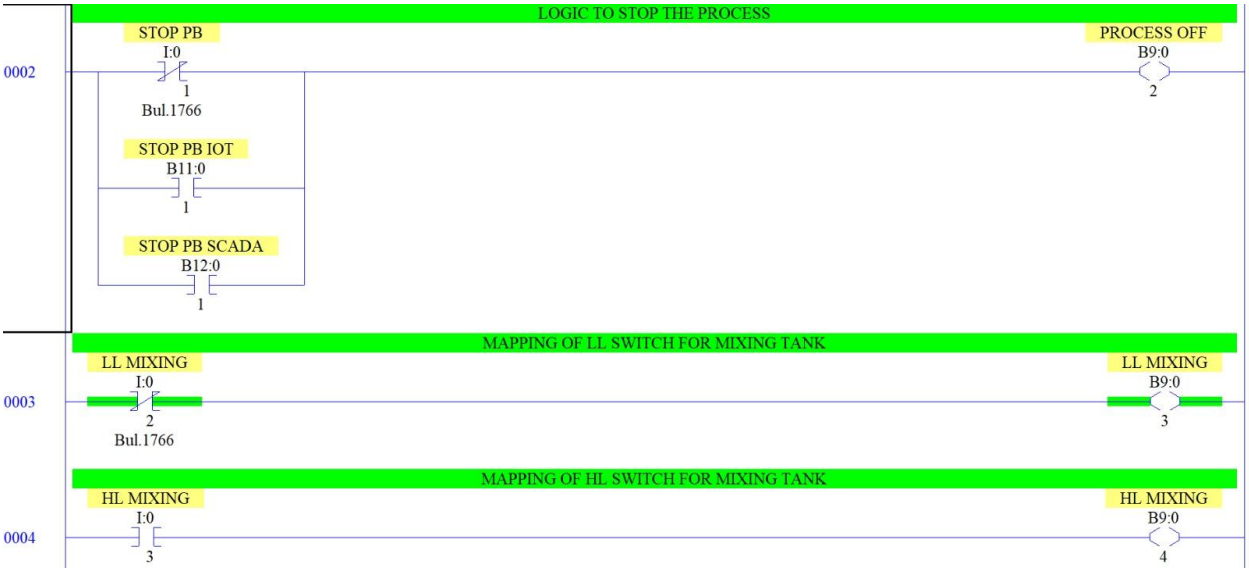


Fig. 4.11 DI Mapping part 2

Fig. 4.12 DI Mapping part 3

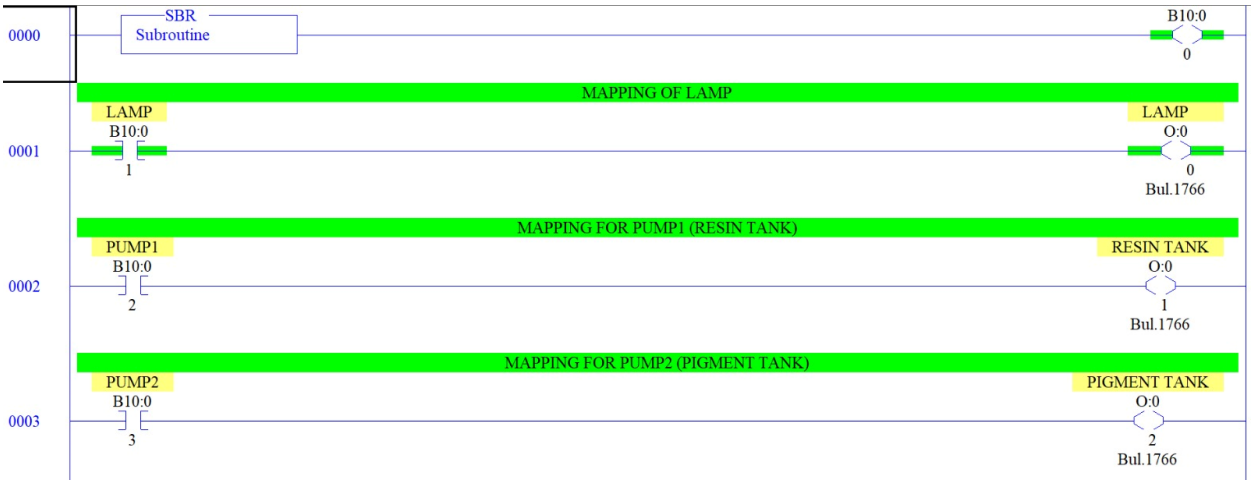


Fig. 4.13 DO Mapping part 1

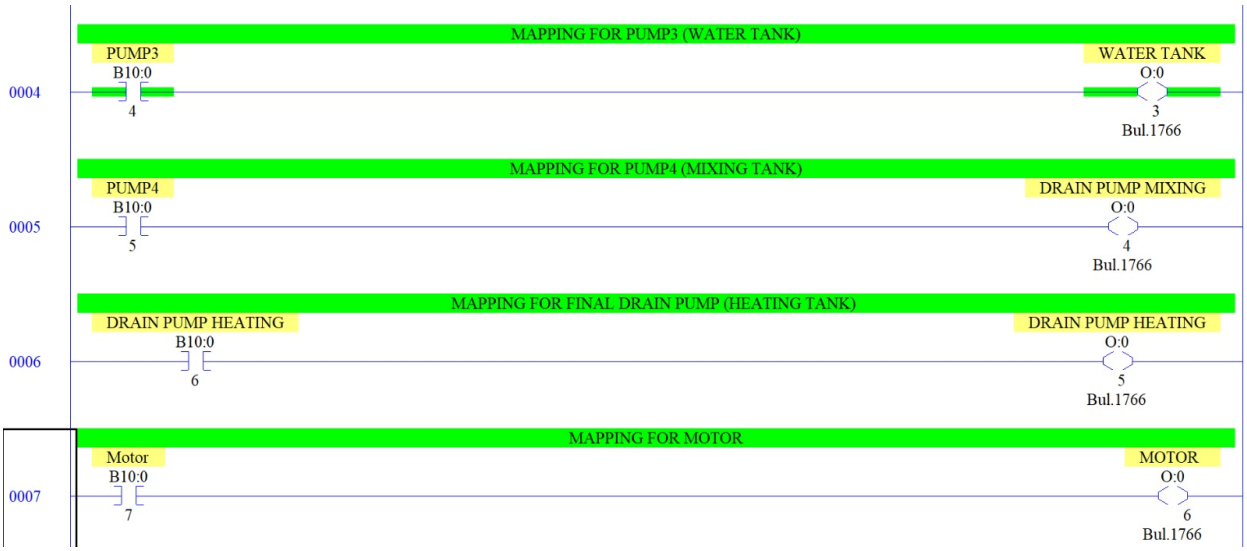


Fig. 4.14 DO Mapping part 2

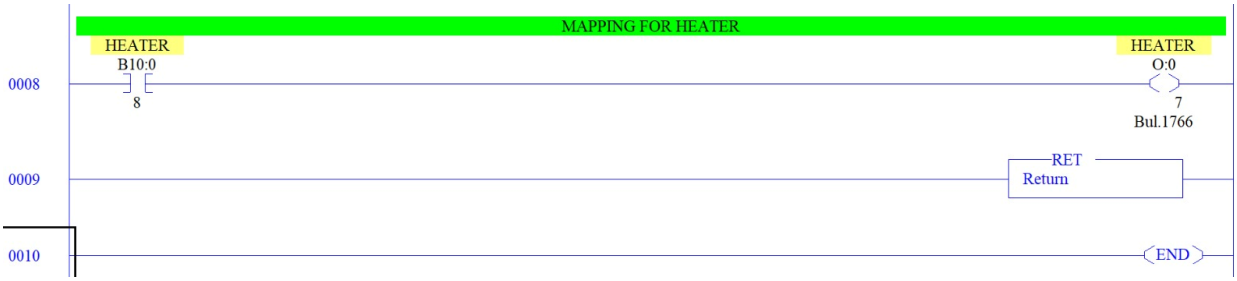


Fig. 4.15 DO Mapping part 3

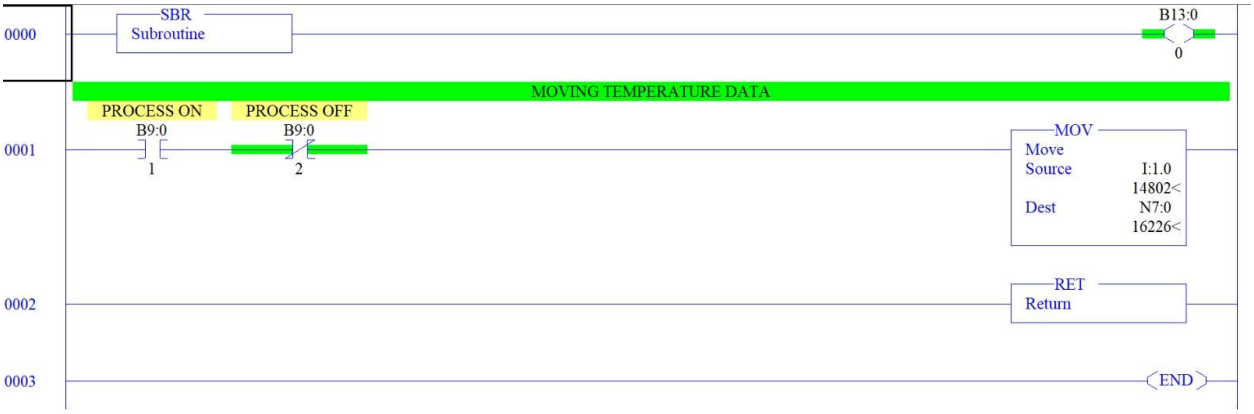


Fig. 4.16 AI Mapping

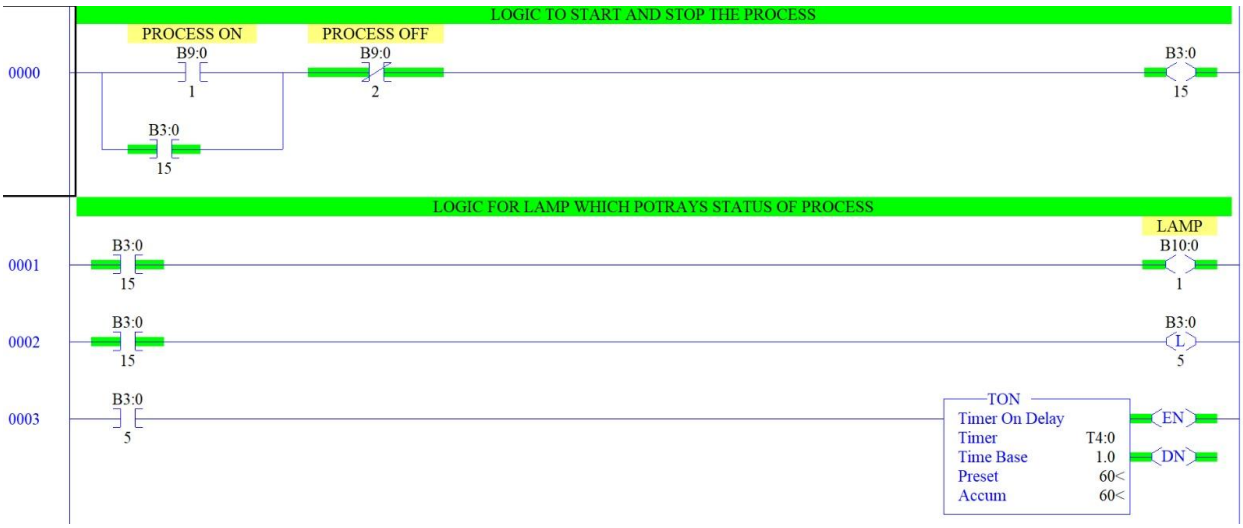


Fig. 4.17 Process part 1

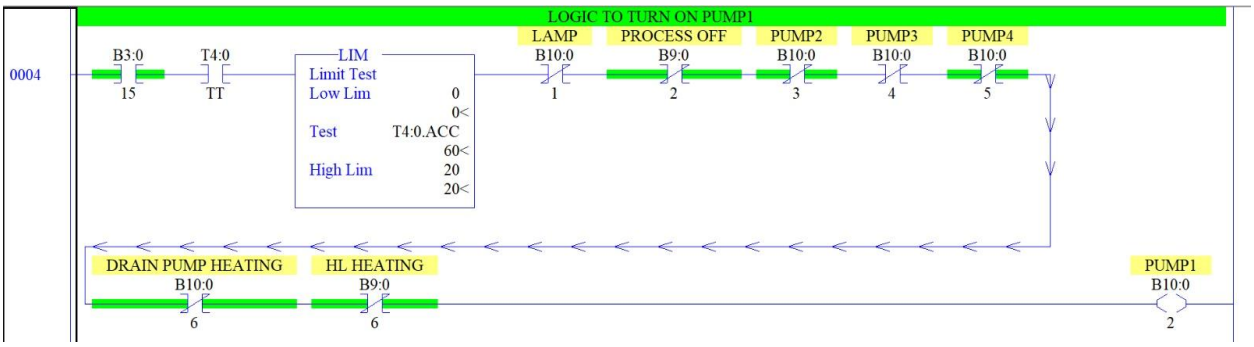


Fig. 4.18 Process part 2

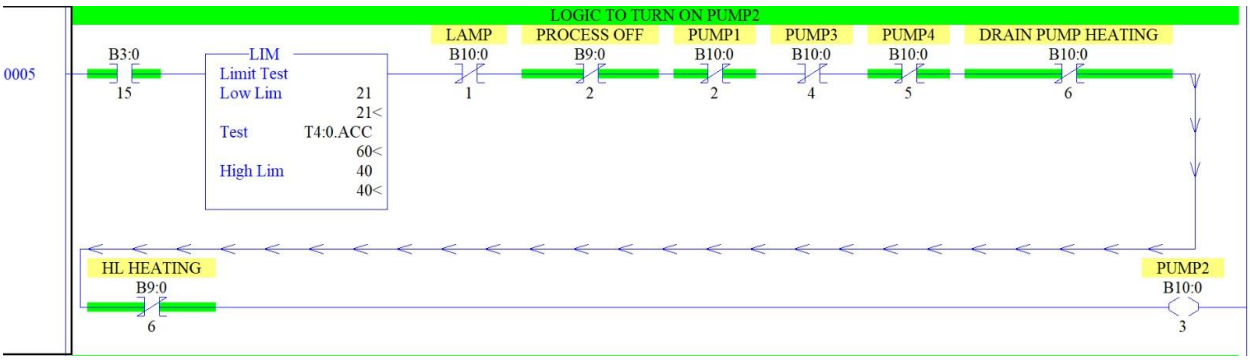


Fig. 4.19 Process part 3

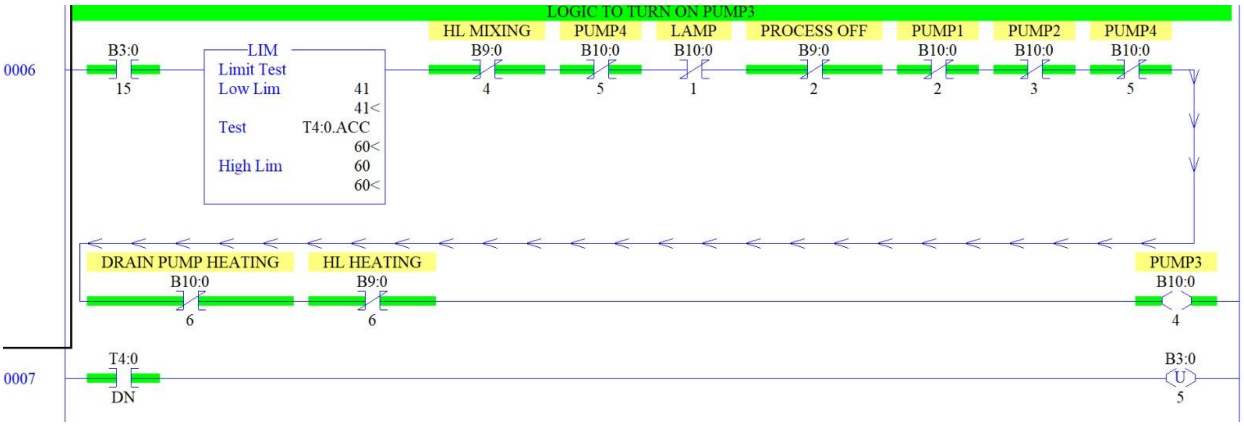


Fig. 4.20 Process part 4

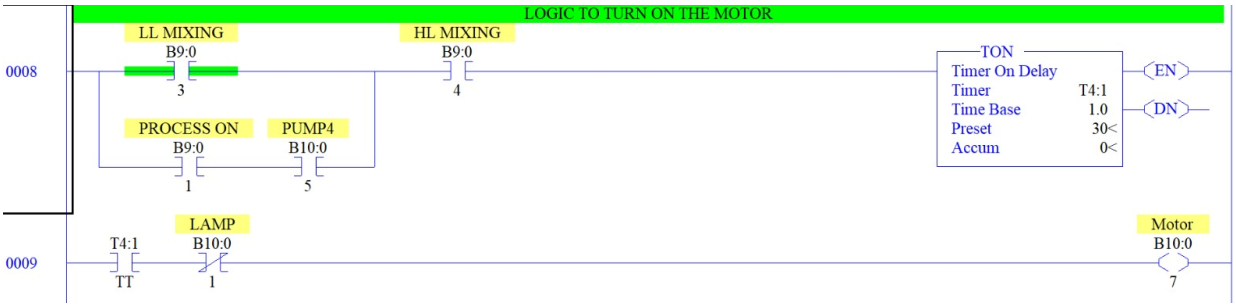


Fig. 4.21 Process part 5

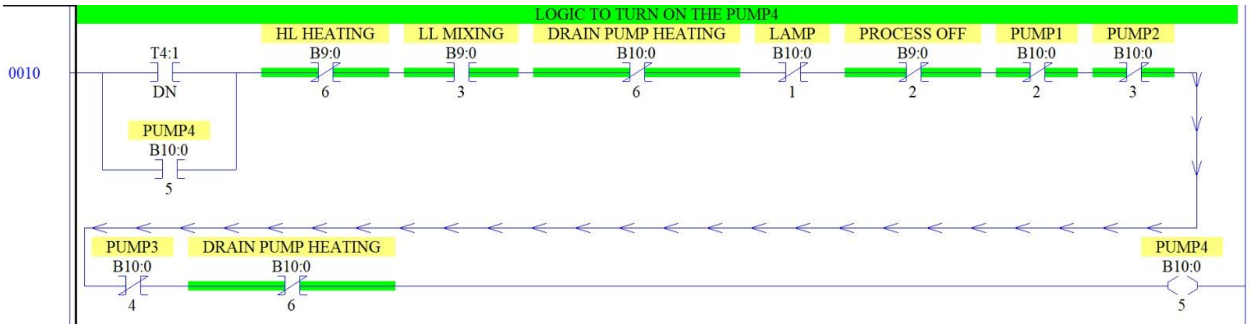


Fig. 4.22 Process part 6

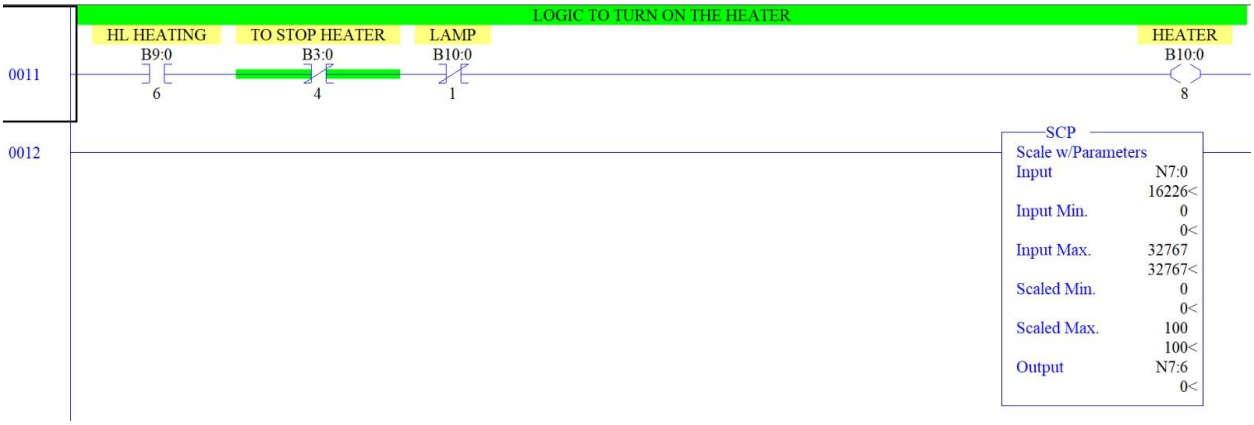


Fig. 4.23 Process part 7

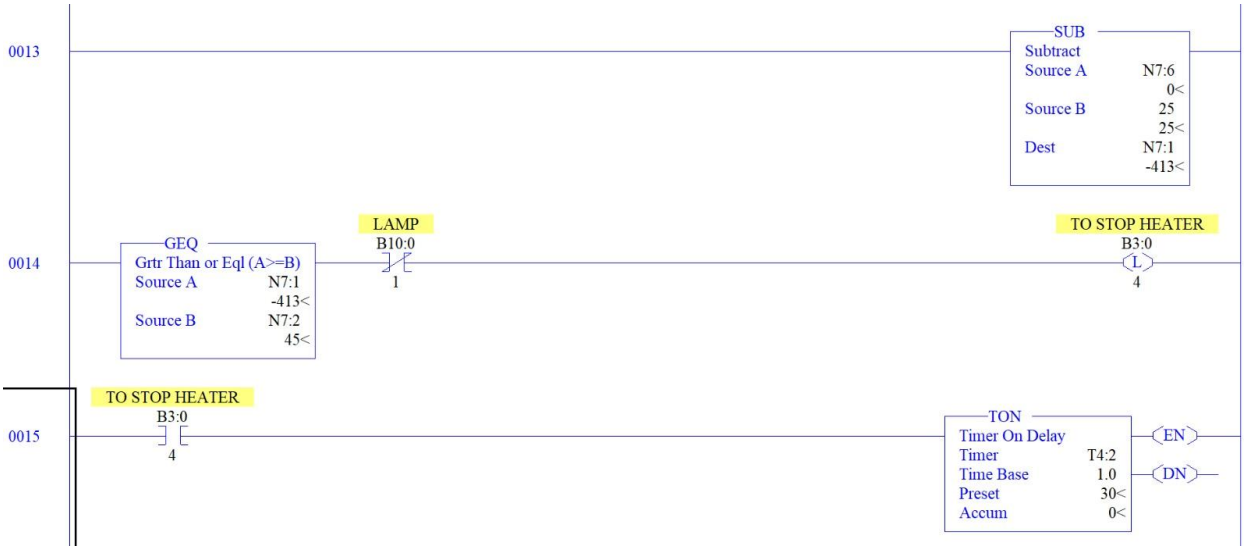


Fig. 4.24 Process part 8

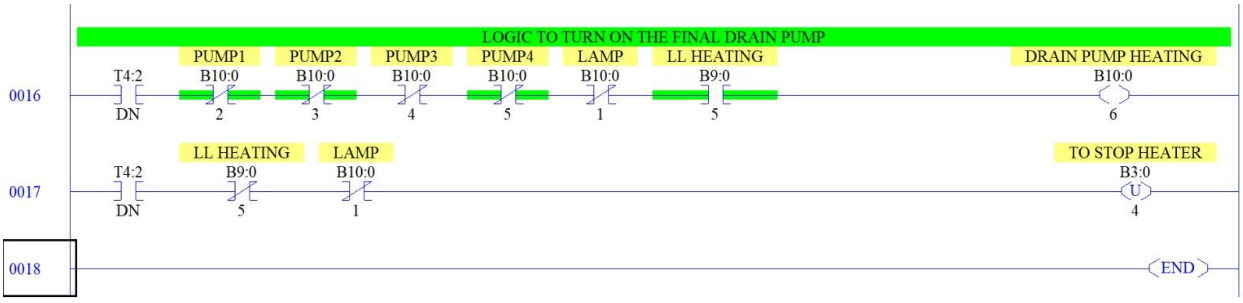


Fig. 4.25 Process part 9

4.12 NODE-RED INSTALLATION IN RASPBERRY PI

Step 1: Install VNC viewer in Device.

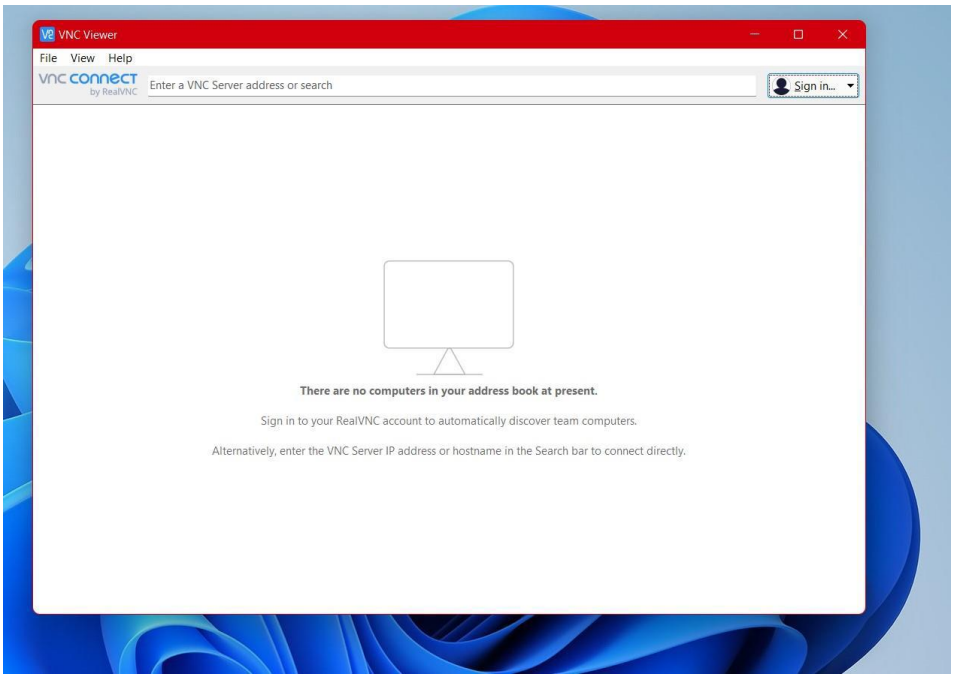


Fig.4.26 Node-Red in Raspberry Pi part 1

Step 2: Sign-In in VNC viewer.

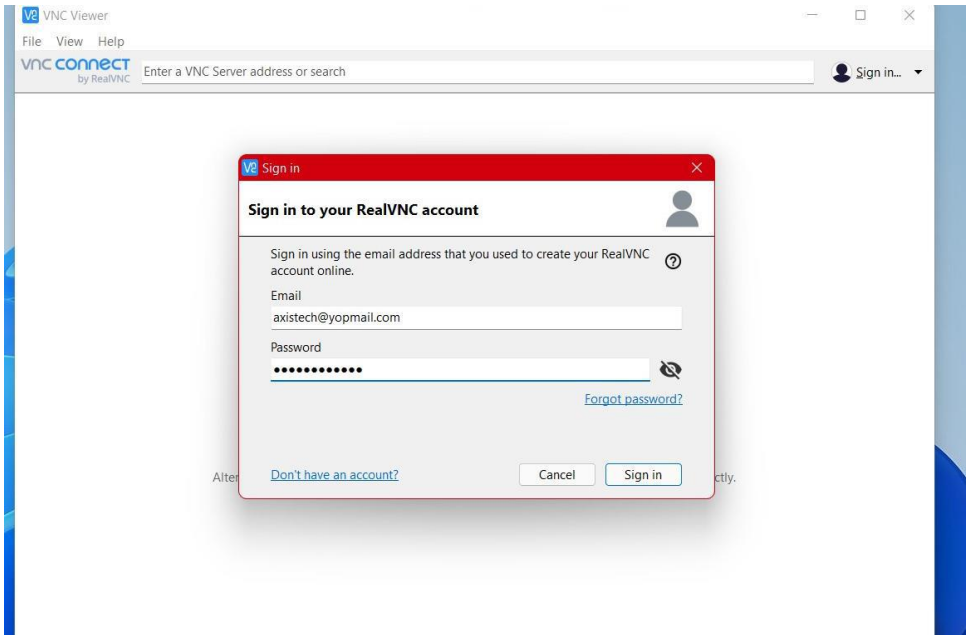


Fig.4.27 Node-Red in Raspberry Pi part 2

Step 3: Open Raspberry Pi in VNC viewer. For authentication use username as “ pi ” And password as “ raspberry ”.

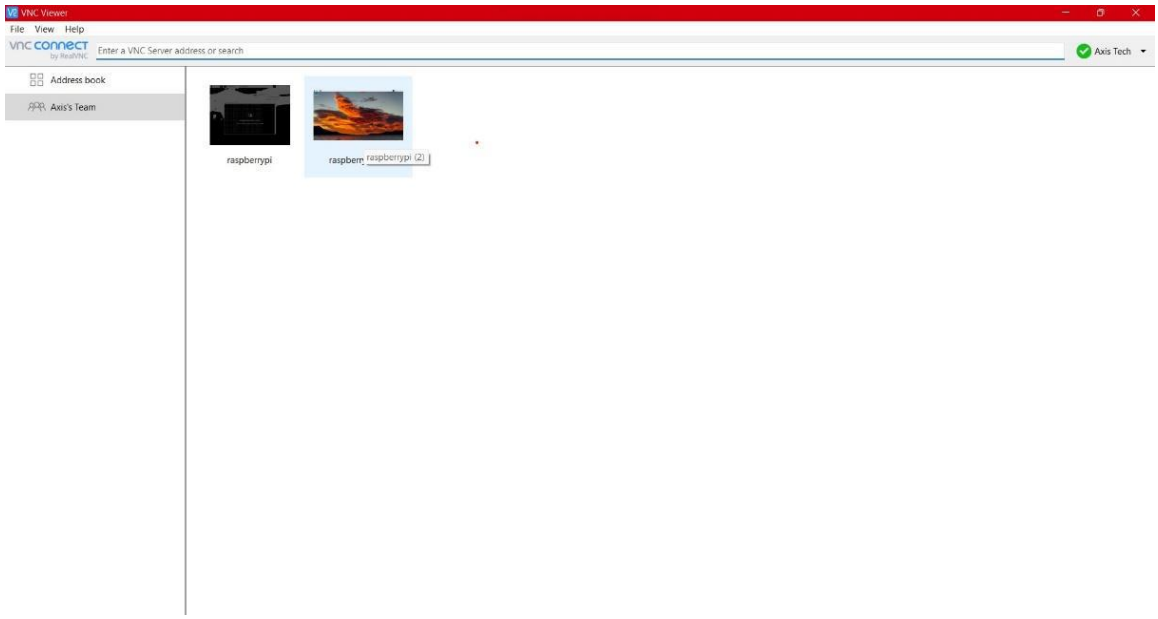


Fig.4.28 Node-Red in Raspberry Pi part 3

Step 4: Open Node-Red in Pi via programming.

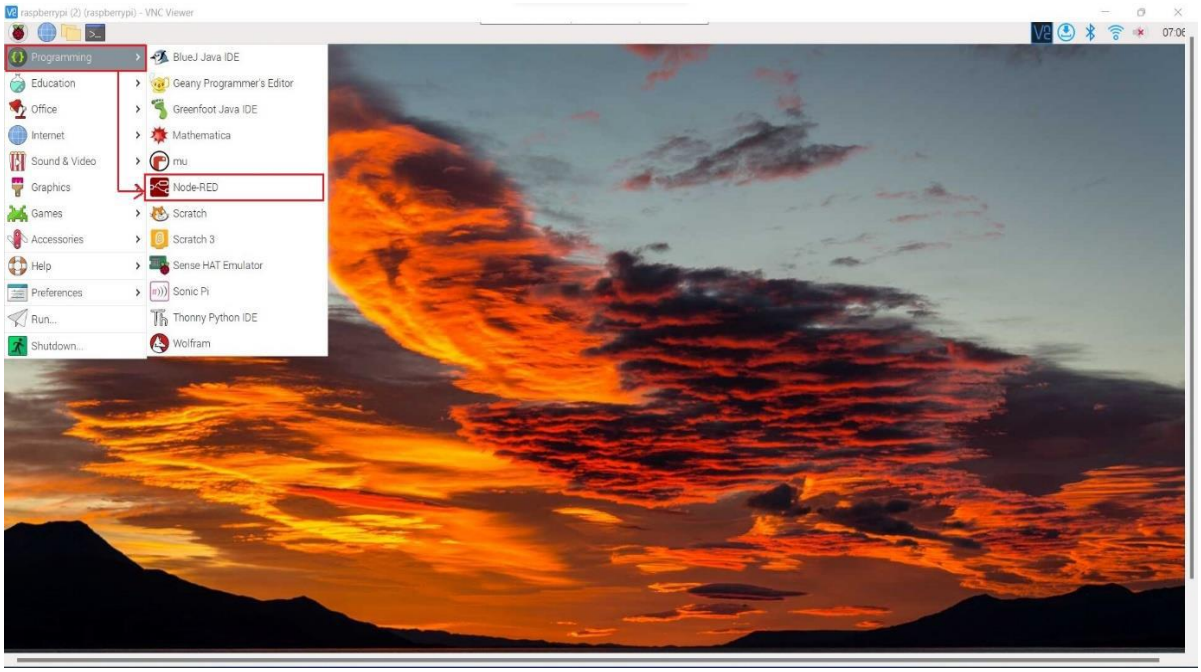


Fig.4.29 Node-Red in Raspberry Pi part 4

4.13 NODE RED AND PLC COMMUNICATION

In this section, we are going to explain the required steps to follow for establishing the network between the Node-Red and PLC (MicroLogix 1400 B). After implementing the PCCC protocol successfully we can fetch or deliver the data to the particular data file.
The steps for the same are listed below:

Step 1:
Open the Node-Red platform on a Computer as explained in previous installation steps. Then go to the Manage Palette wizard to download the “node-red-contribpccc” library.

Step 2:
As we drag and drop the pccc in a block in the workspace, one has to configure the node by just double-clicking on the node itself.

Step 3:
However, when we explore the screen we can identify what kind of setup is the most suitable option. In our project, we selected All variables, which means that the message packet contains the data of every possible update which is ongoing in RSLogix 500’s Data Files.

Step 4:
Click on the pen symbol to write the remaining information which is used for further proceedings.

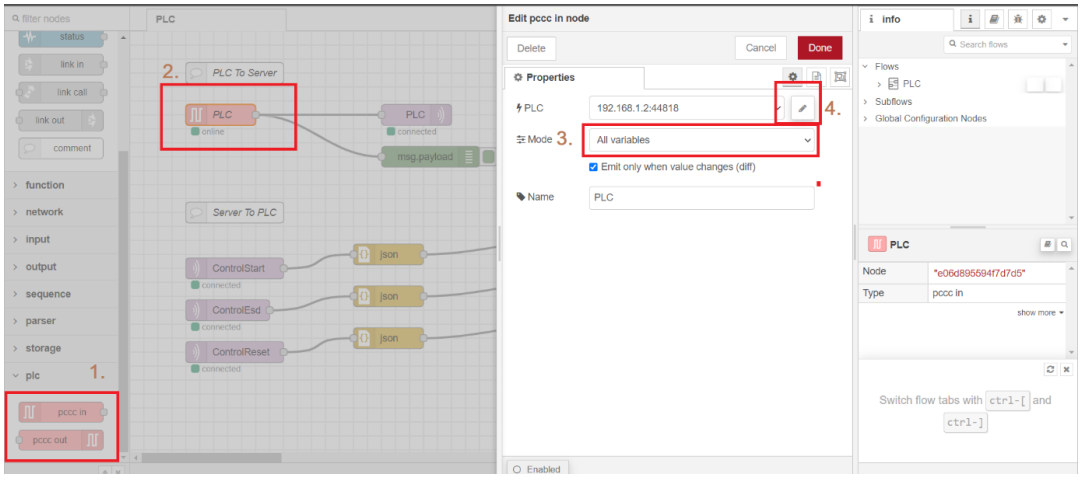


Fig.4.30 Node-Red with PLC part 1

Step 5:
Write your PLC’s IP Address in the given block.

Step 6:
First, find out the port value to initiate communication via the PCCC protocol.

Step 7:
Click on the Variables.

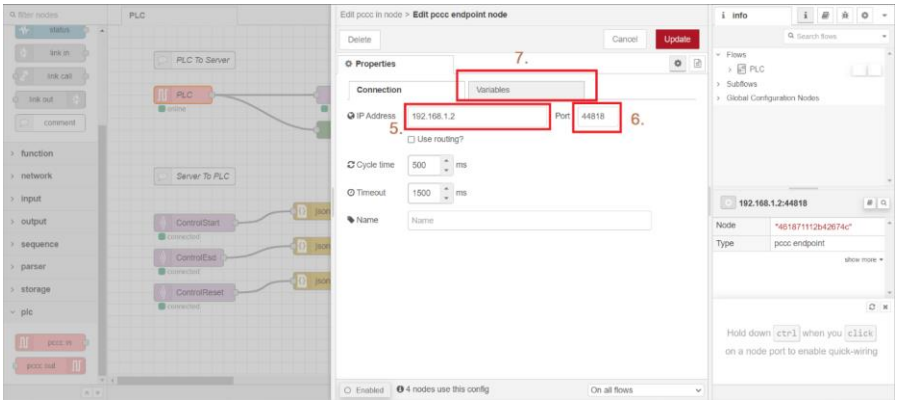


Fig.4.31 Node-Red with PLC part 2

Step 8:
Click on the "New" button to generate a new variable that is used in further stages.

Step 9
List out all variables which are used in your PLC code and make sure you maintain the list for the same and write appropriately in this given section. Anyone can refer to the below image to get a rough idea of its working.

Step 10
Click on the Update button as shown in the upper-right corner.

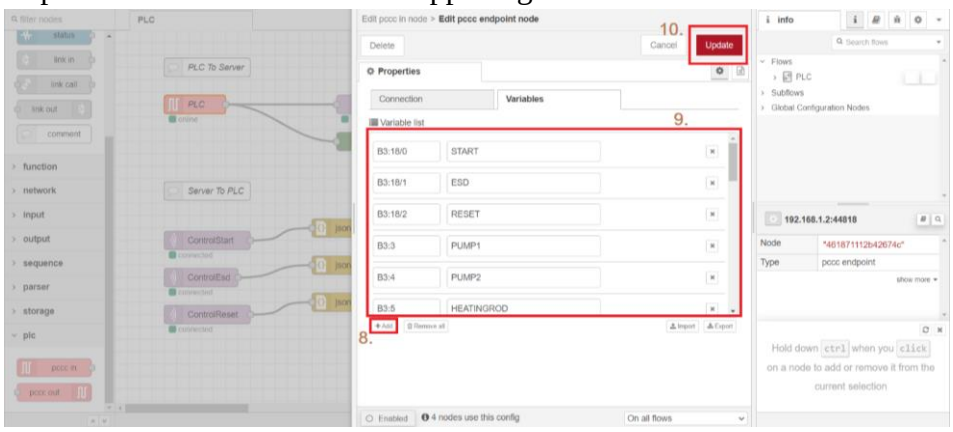


Fig.4.32 Node-Red with PLC part 3

4.13.1 Node-Red Code for communication between PLC and IOT Cloud

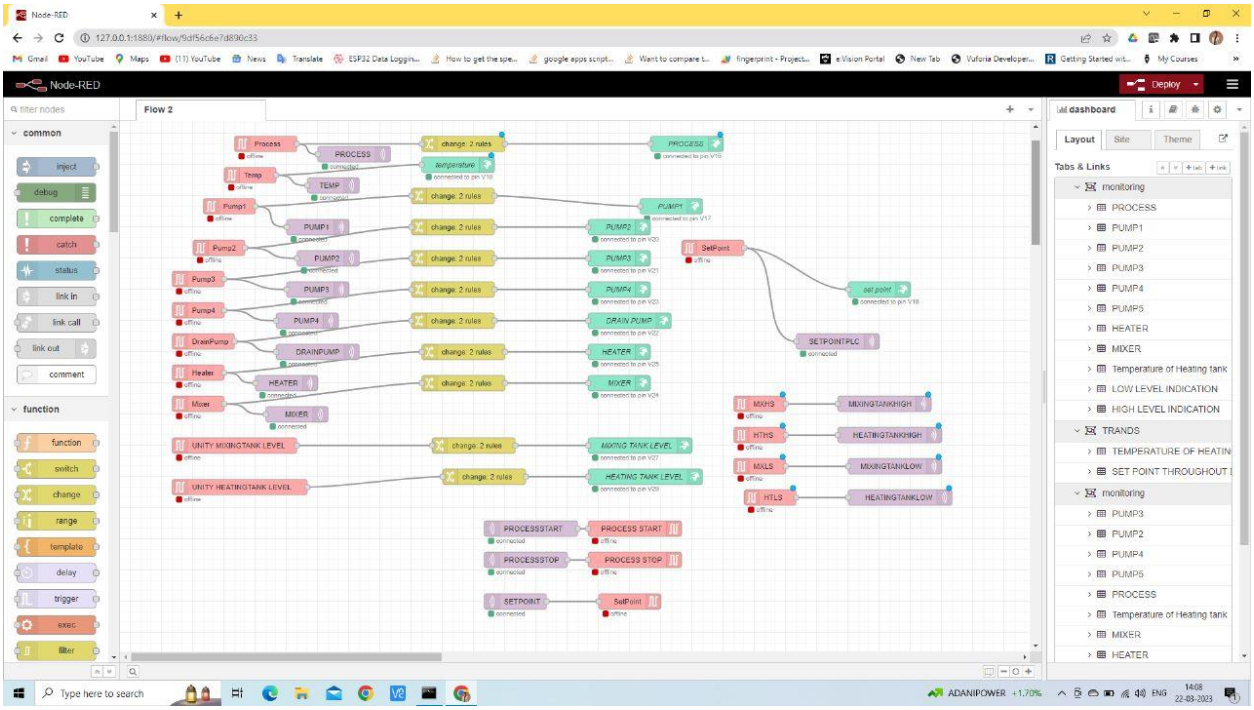


Fig.4.33 Node-Red with PLC part 4

The given diagram is our final code for our intermediate platform which is known as Node-Red. The code delineates the list of features.

i. The foremost application of this code is to establish the connection between the PLC and Node-Red, to transfer the data to the local server.

ii. The data from PLC is acquired via PCCC in node and then it is sent via two paths, first to the IOT cloud using Mqtt in node, second to the change node where the data is converted into binary (True=1 and False=0) and then it is sent to blynk using web socket node.

The main focus of our code are PCCC in, PCCC out, Mqtt in and Mqtt out block. Each of the blocks have been briefly described below:

1. PCCC in

   The "PCCC In" node is used to read data from an Allen Bradley PLC that uses the PCCC protocol. To use this node, you need to configure the following properties:

   Protocol: Set to "PCCC".
   Target Address: The IP address of the PLC you want to read data from.
   Port: The port number to use for the communication.
   Request: The PCCC request message to send to the PLC. This can be entered as a hex string or as an array of bytes.

Fig.4.34 PCCC in

2. PCCC out

   The "PCCC Out" node is used to write data to an Allen Bradley PLC that uses the PCCC protocol. To use this node, you need to configure the following properties:

   Protocol: Set to "PCCC".
   Target Address: The IP address of the PLC you want to write data to.
   Port: The port number to use for the communication.
   Request: The PCCC request message to send to the PLC. This can be entered as a hex string or as an array of bytes.
   Data: The data to write to the PLC. This can be entered as a hex string or as an array of bytes.

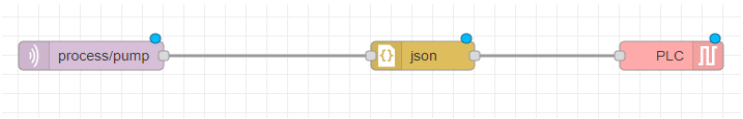


Fig.4.35 PCCC out

3. Mqtt in

   The MQTT In node is used to receive incoming MQTT messages from a broker. When a message is received, it can be processed in Node-RED and used to trigger an action, update a dashboard, or send a message to another device. The MQTT In node can be configured with the address of the MQTT broker, the topic to subscribe to, and the message format.

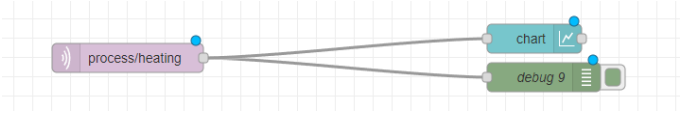


Fig.4.36 Mqtt in

4. Mqtt out

   The MQTT Out node is used to send MQTT messages to a broker. When a message is sent, it can be used to control a device, update a database, or trigger an event on another device. The MQTT Out node can be configured with the address of the MQTT broker, the topic to publish to, and the message format.

Fig.4.37 Mqtt out

4.13.2 Node-Red Code for dashboard

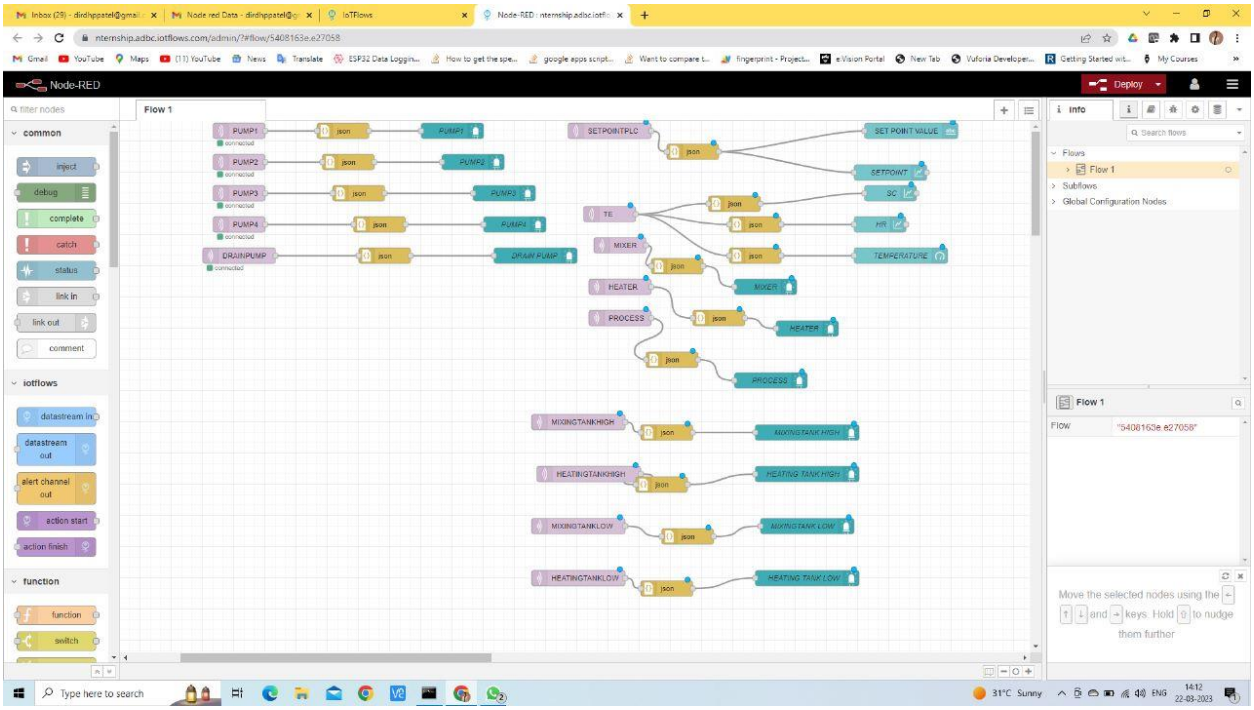


Fig.4.38 Node-Red with dashboard

In the above code, the data from the broker is acquired by Mqtt out node and is sent to json node, which converts the string into object and then to led node, chart node and gauge node as per requirement.

A JSON node is a built-in node that allows you to manipulate JSON data. It can be used to create, modify, or extract data from a JSON object.

When you add a JSON node to your flow, you will see a configuration panel that allows you to specify the behavior of the node. The most important fields are:

Name: A user-defined name for the node.

Property: The name of the property in the incoming message that contains the JSON data. If this field is left blank, the entire incoming message will be treated as JSON.

Rules: A set of rules that determine how the JSON data should be manipulated. This can include adding, deleting, or modifying properties, as well as filtering or transforming the data.

Output: The format of the output data. This can be set to "Object" to output a JSON object, or "String" to output a JSON string.

5. RESULTS AND DISCUSSIONS

5.1 RESULTS OF HARDWARE TESTING

In this section, we have the outcomes of our efforts which we had done in the 10-week duration. The hardware as shown in figure 6.1 below is made out of scrap material provided by the company itself and rest of the hardware material is bought from the store. The main objective of this prototype was to provide data like pressure, temperature, level etc of any instrument in the field via AR camera on our mobile phones.

Before the installation of different components of hardware like DC motor, Pt-100, Float level sensor, Pump, Heater, Start-Stop Push buttons and Lamp were individually tested. This testing covered a couple of days. After connecting all the components of the control panel, we tested connectivity between the devices. While connecting the PCB board to the hardware we found a connection error in the third relay from the PCB board . After solving that error in connection with the third relay, we again tested the connectivity between the devices. As a result, we can get some specific data of PLC, heating tank, mixing tank by scanning the QR code and getting the data on AR camera application.

The pictures of hardware are given below in fig 5.1 and 5.2.

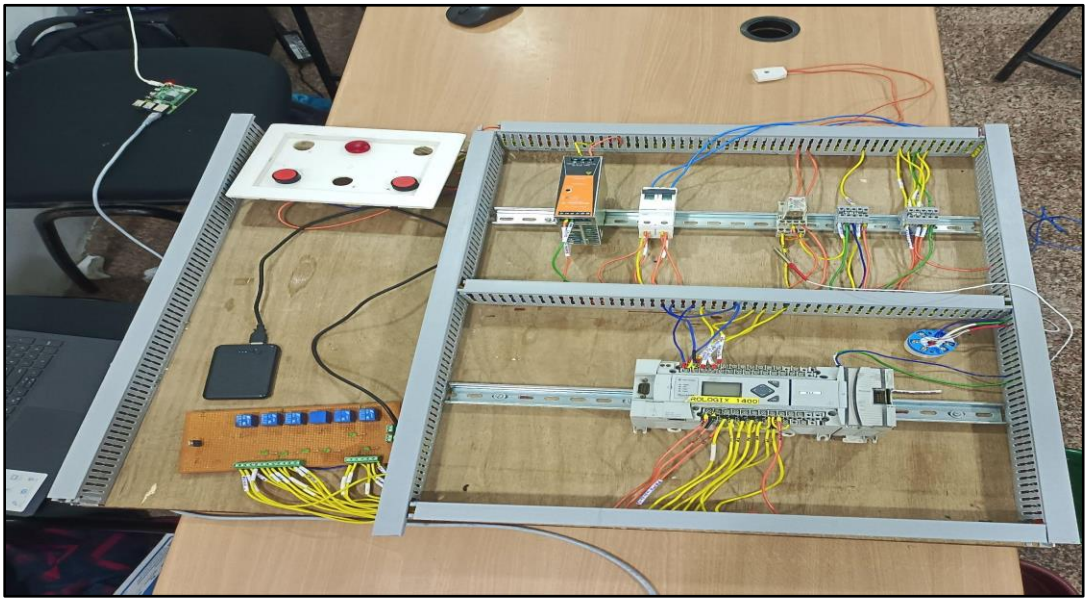


Fig.5.1 Hardware 1

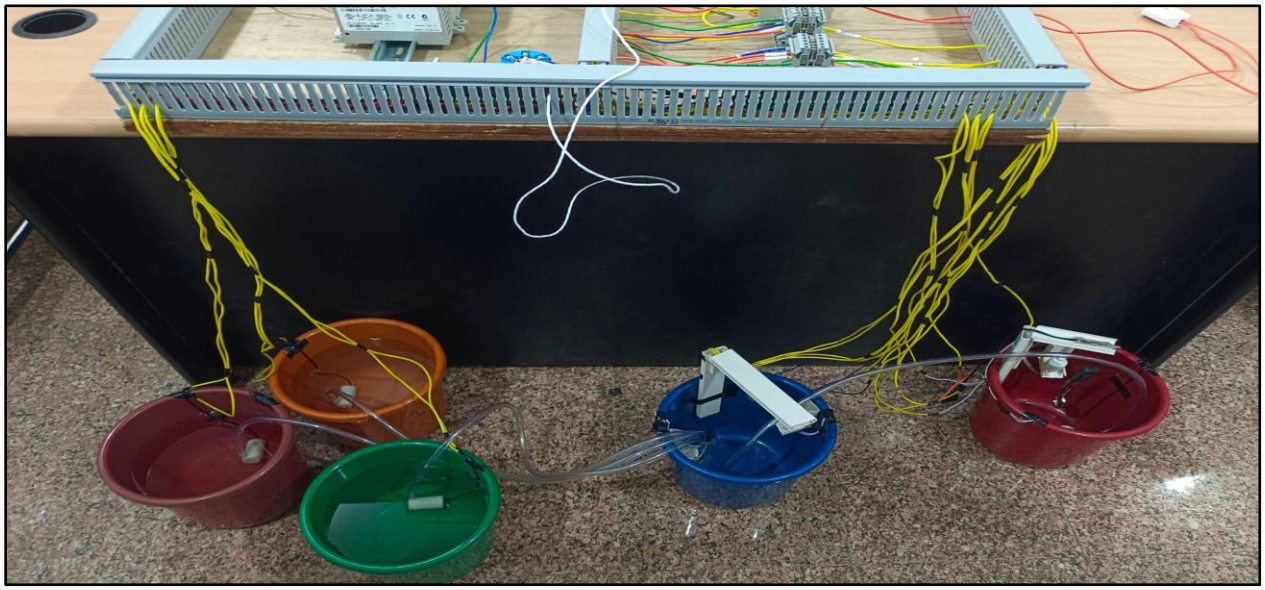


Fig. 5.2 Hardware 2

5.2 VALIDATION OF RESULTS USING AUGMENTED REALITY (AR) MOBILE APPLICATION

Augmented reality is a future technology in industry 4.0 which provides one step ahead in the path towards Industry 4.O. The proof of that one step advancement is shown in Fig. 5.3, 5.4 and 5.5.

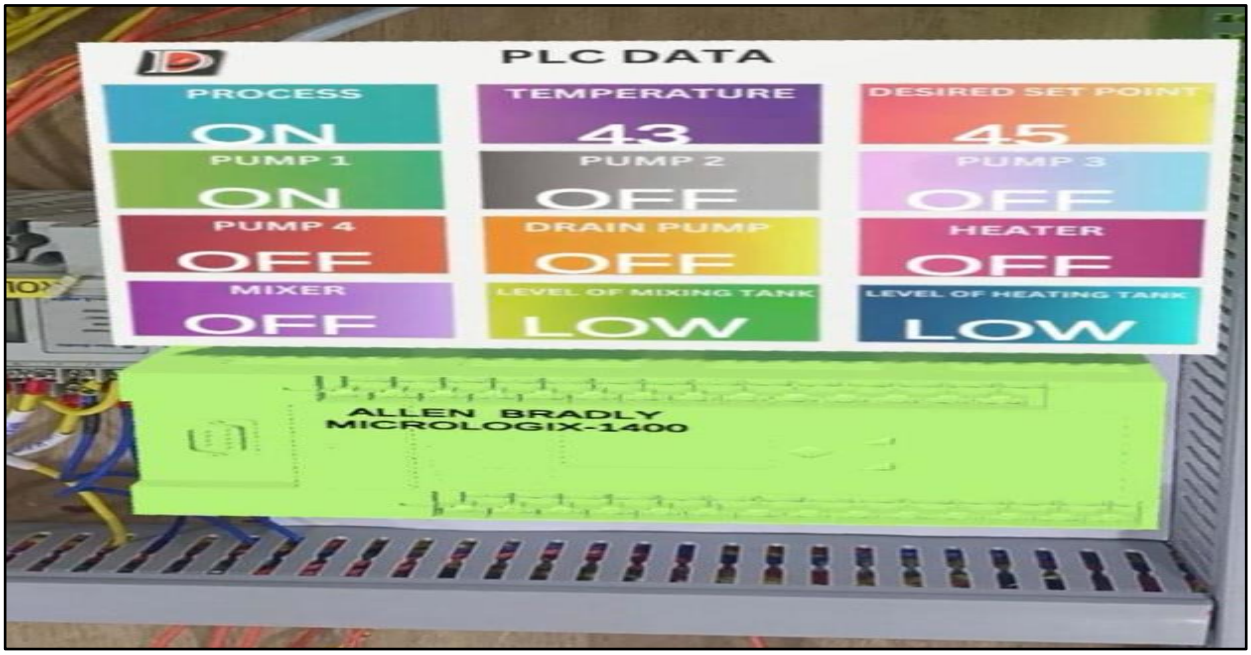


Fig.5.3 Result of scan on PLC

Fig.5.4 Real time mixing tank parameter using AR

Fig.5.5 Real time heating tank parameter using AR

5.3 VALIDATION OF RESULTS USING IOT PLATFORM

Once all the necessary steps are taken, we can have the key to unlock the IoT features, which provides one step ahead in the path towards Industry 4.O. The proof of that one step advancement is shown in Fig. 5.6, 5.7 and 5.8.

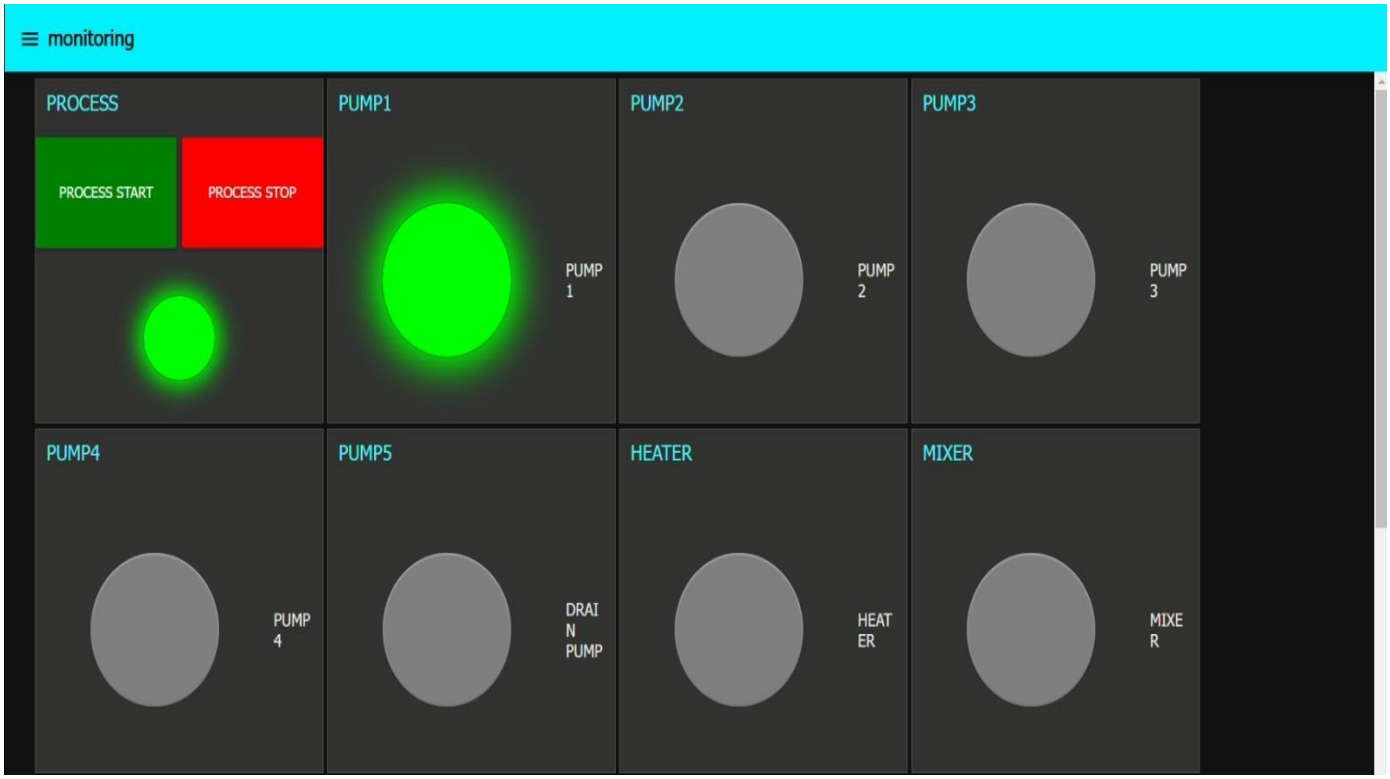


Fig 5.6 Dashboard of IOT on cloud

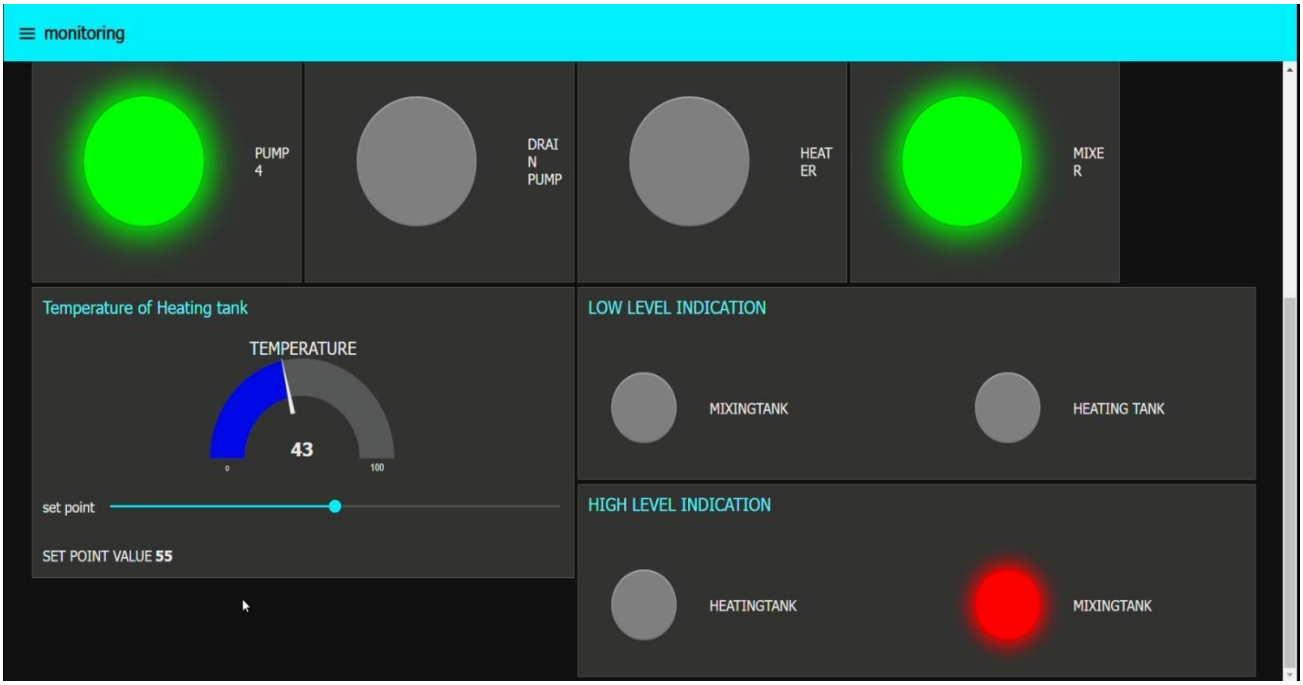


Fig 5.7 Dashboard of IOT on cloud

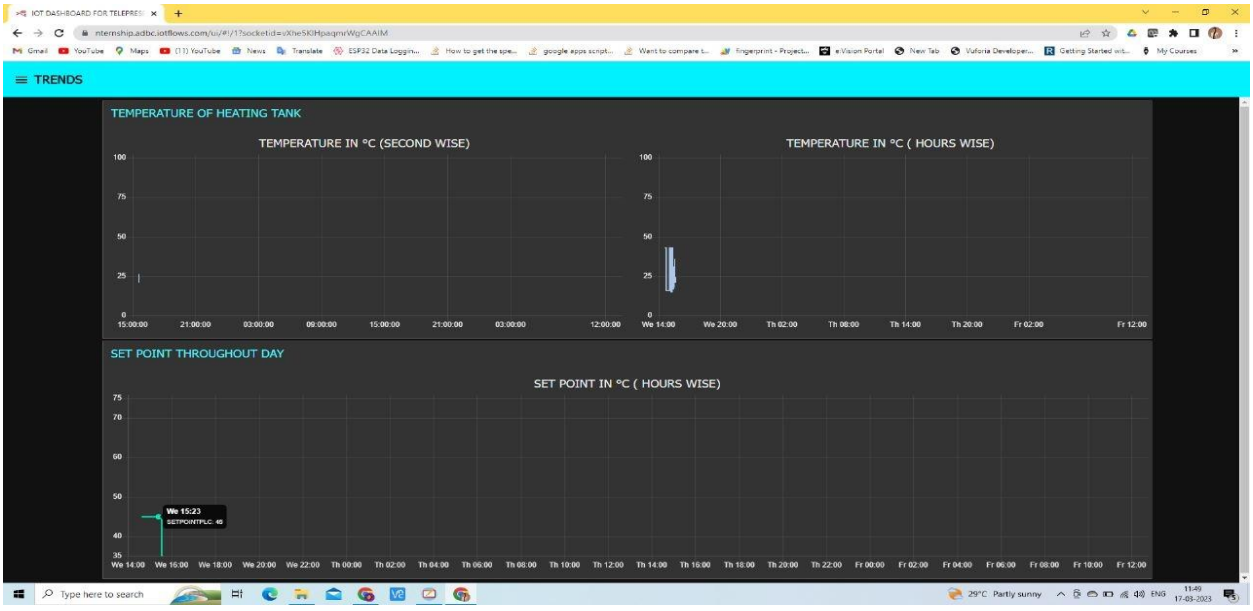


Fig. 5.8 Trends on dashboard

5.4 VALIDATION OF RESULTS USING FACTORY TALK SCADA

Despite having a virtual dashboard, we also developed the conventional SCADA screen to explore the current industrial scenario. The proof of that is also shown in below figures.

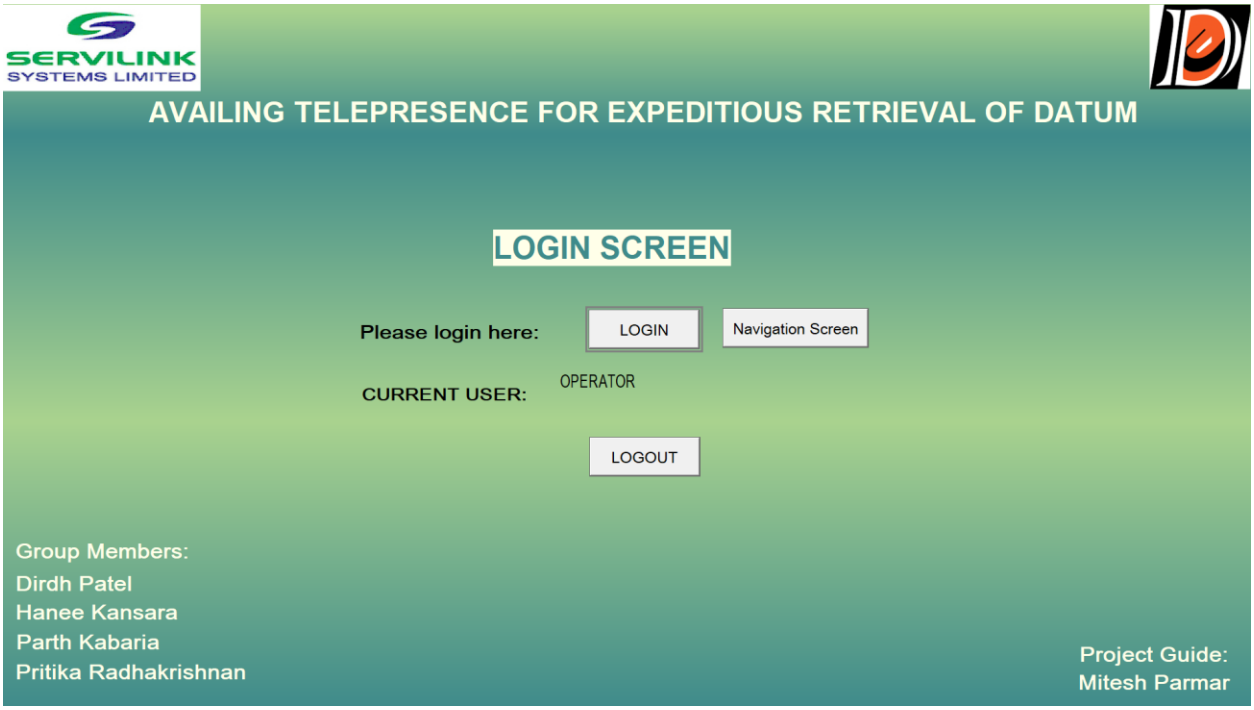


Fig.5.9 Login screen of SCADA

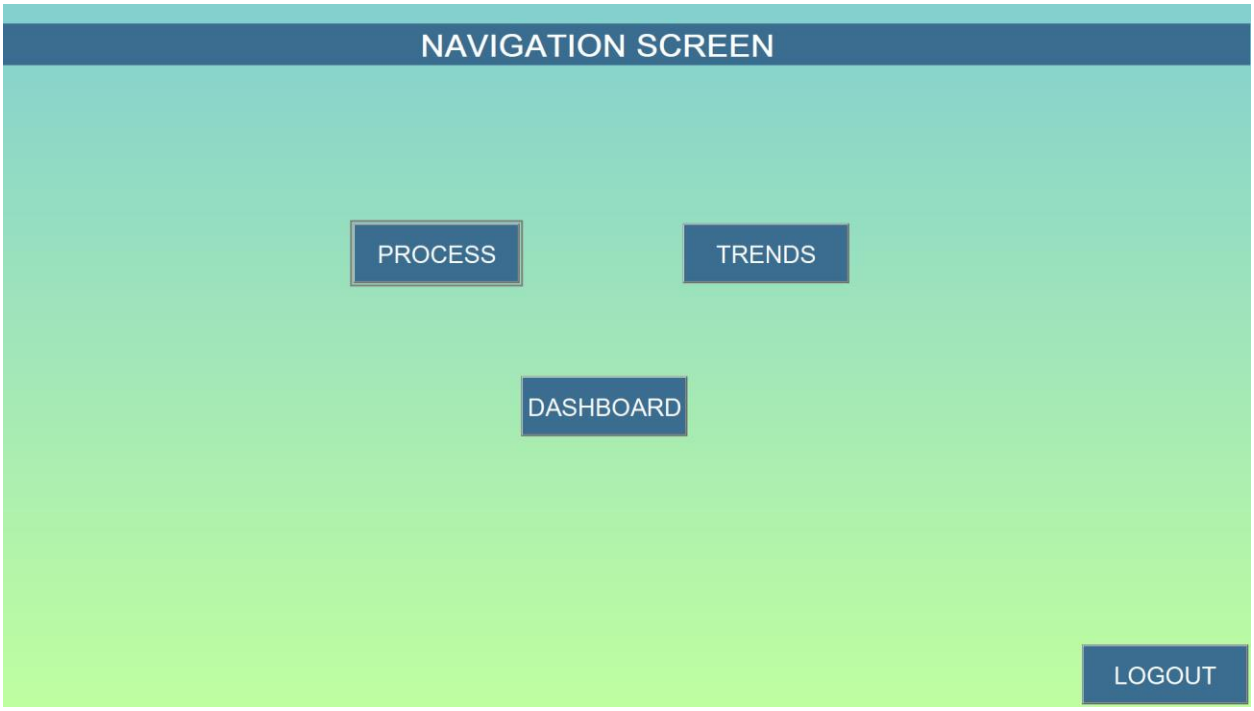


Fig. 5.10 Navigation screen of SCADA

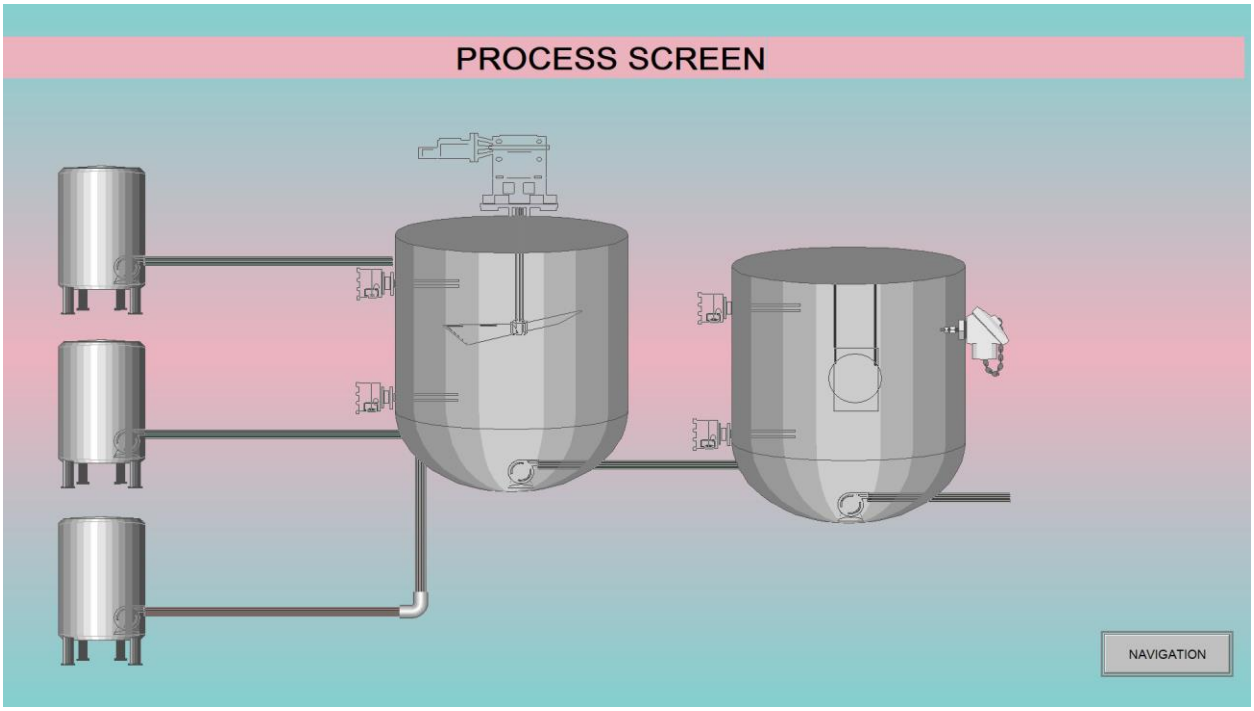


Fig.5.11 Process screen of SCADA

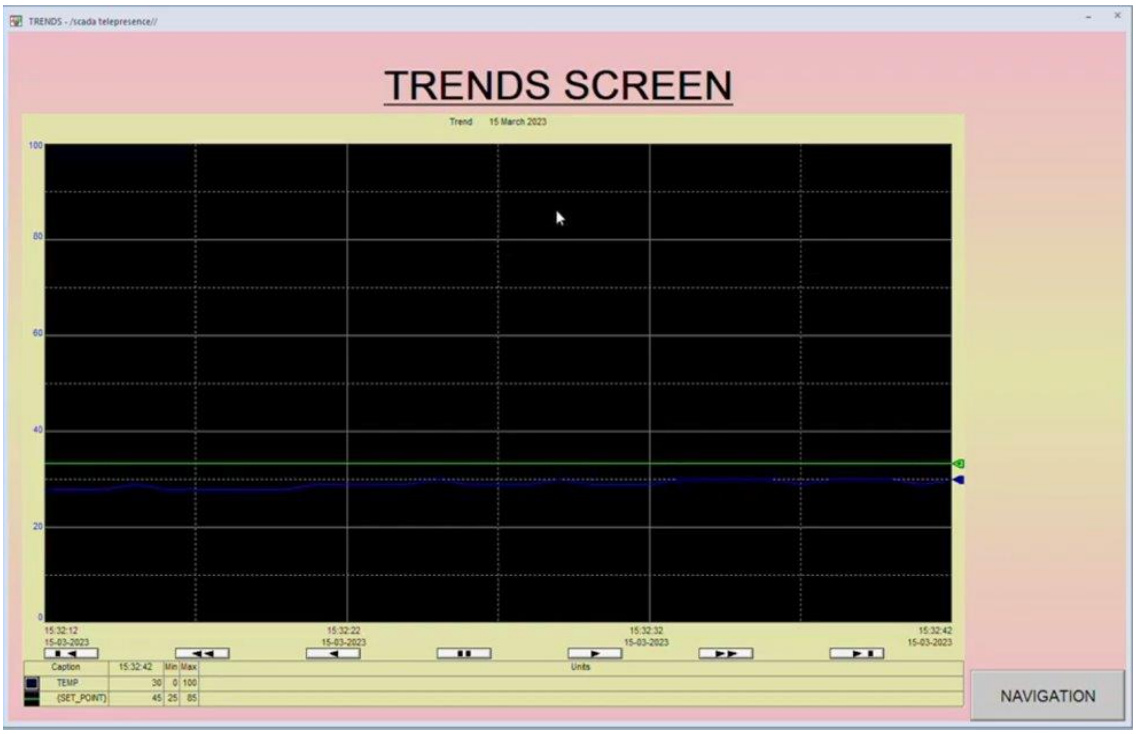


Fig.5.12 Trends screen of SCADA

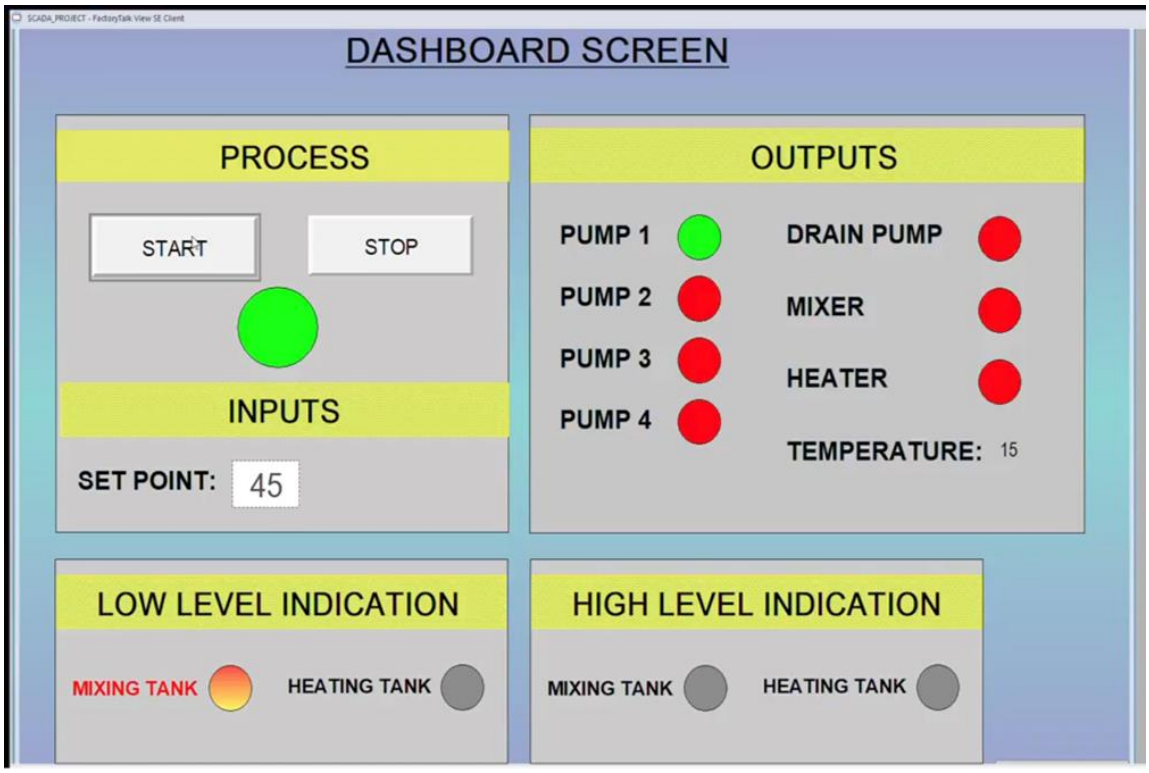


Fig.5.13 Dashboard screen of SCADA

6. CONCLUSION AND FUTURE SCOPE

6.1 CONCLUSION

The conventional method for a maintenance engineer to acquire and analyze real-time parameter data of instruments is to contact the control room personnel and obtain the data. It is a time-consuming task, and it may lead to miscommunication and incorrect data.

We used Augmented Reality technology to solve this issue and provide direct data access to a maintenance engineer on the field with just one scan.

By simply scanning instruments using an AR app installed in their smartphone or tablet, users can extract real time data of live parameters involved in the process in industries.

Although it is just a prototype, this project has the potential to be greatly expanded with advanced technologies and skills at a larger scale.

It can bring a revolutionary change in the industrial sector, resulting in more productive, rapid, and accurate data acquisition.

6.2 FUTURE SCOPE

Augmented reality (AR) has already been making waves in the manufacturing and industrial sectors, and its potential for future growth is significant. In Industry 4.0, AR has the potential to revolutionize manufacturing processes by improving productivity, safety, and quality.

Here are some potential future applications of AR in Industry 4.0:

Remote assistance: AR can be used to provide remote assistance to workers in the field, allowing experts to guide technicians through complex procedures, reducing downtime, and minimizing the need for on-site support.

Training and simulation: AR can be used to provide realistic training simulations, allowing workers to practice and perfect their skills in a safe and controlled environment. This can be particularly useful for training in high-risk or hazardous situations.

Quality control: AR can be used to help inspectors identify defects and inconsistencies in products or processes. This can improve quality control and reduce waste.

Maintenance and repair: AR can be used to provide technicians with detailed information on how to perform maintenance and repair tasks. This can help reduce downtime and extend the life of equipment.

Design and prototyping: AR can be used to create virtual prototypes and models, allowing designers to test and refine their products before committing to physical prototypes.

Logistics and supply chain management: AR can be used to optimize logistics and supply chain management by providing real-time information on inventory, shipment status, and delivery routes.

Overall, the future of AR in Industry 4.0 looks bright, as businesses continue to explore the many ways in which this technology can improve their operations and increase efficiency.

In India Augmented Reality is booming because of the growing industry adoption of head-mounted displays (HMDs), technological advancements, increasing digitization, and penetration of HMDs in the gaming and entertainment sectors following COVID-19, and high investments in the AR market.

The wide range of applications of Augmented Reality has grabbed the attention of tech giants to develop more innovative products. For example, Microsoft developed Hololens headset to solve real-world problems using intelligent apps. Even Google and Apple started investing in this technology.

ANNEXURE-I

DATASHEETS

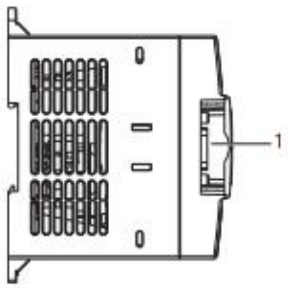
1. Micrologix 1400 Series B

Hardware Overview

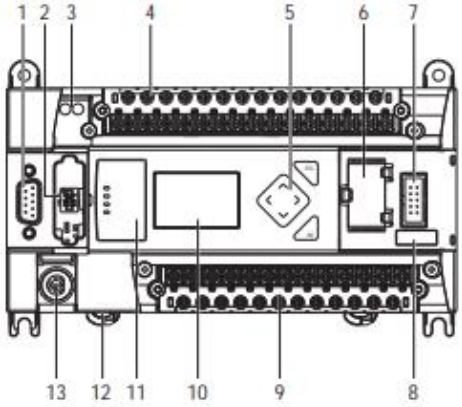
Hardware Features

The MicroLogix 1400 programmable controller contains a power supply, input and output circuits, a processor, an isolated combination RS-232/RS-485 communication port, an Ethernet port, and a non-isolated RS-232 communication port. Each controller supports 32 discrete I/O points (20 digital inputs, 12 discrete outputs) and 6 analog I/O points (4 analog inputs and 2 analog outputs: 1766-L32BWAA, 1766-L32AWAA, and 1766-L32BXBA only).

The hardware features of the controller are shown below.



Left side view



Top view

Controller Description

	Description		Description
1	Comm port 2 – 9-pin D-Shell RS-232C connector	8	Battery connector
2	Memory module[1]	9	Output terminal block
3	User 24V (for 1766-BWA and 1766-BWAA only)	10	LCD Display
4	Input terminal block	11	Indicator LED panel
5	LCD Display Keypad (ESC, OK, Up, Down, Left, Right)	12	Comm port 1 – RJ45 connector
6	Battery compartment	13	Comm port 0 – 8-pin mini DIN RS-232C/RS-485 connector
7	1762 expansion bus connector		

Controller Input and Output Description

Catalog Number	Description				
	Input Power	User Power	Embedded Discrete I/O	Embedded Analog I/O	Comm. Ports
1766-L32BWA	100/240V AC	24V DC	12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 12 Relay Outputs	None	1 RS-232/RS-485[1] 1 Ethernet 1 RS-232[2]
1766-L32AWA		None	20 120V AC Inputs 12 Relay Outputs		
1766-L32BXB	24V DC		12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 6 Relay Outputs 3 Fast DC Outputs 3 Normal DC Outputs		
1766-L32BWAA	100/240V AC	24V DC	12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 12 Relay Outputs	4 Voltage Inputs 2 Voltage Outputs	
1766-L32AWAA		None	20 120V AC Inputs 12 Relay Outputs		
1766-L32BXBA	24V DC		12 Fast 24V DC Inputs 8 Normal 24V DC Inputs 6 Relay Outputs 3 Fast DC Outputs 3 Normal DC Outputs		

(1) Isolated RS-232/RS-485 combo port.
(2) Non-isolated RS-232. Standard D-sub connector

Component Descriptions

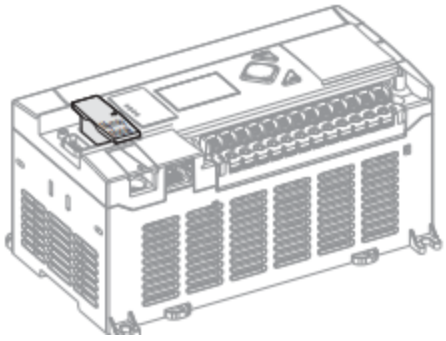
MicroLogix 1400 Memory Module and Built-in Real-Time Clock

The controller has a built-in real-time clock to provide a reference for applications that need time-based control.

The controller is shipped with a memory module port cover in place. You can order a memory module, 1766-MM1, as an accessory. The memory module provides optional backup of your user program and data, and is a means to transport your programs between controllers.

The program and data in your MicroLogix 1400 is non-volatile and is stored when the power is lost to the controller. The memory module provides additional backup that can be stored separately. The memory module does not increase the available memory of the controller.

Figure 1 - 1766-MM1 Memory Module



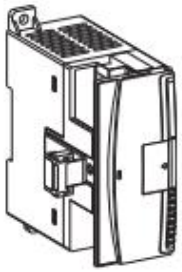
1762 Expansion I/O

1762 expansion I/O can be connected to the MicroLogix 1400 controller, as shown below.

A maximum of seven I/O modules, in any combination, can be connected to a controller. See Appendix H to determine how much heat a certain combination generates.

Figure 2 - 1762 Expansion I/O

1762 Expansion I/O



1762 Expansion I/O Connected to MicroLogix 1400 Controller

Expansion I/O

Catalog Number	Description
Digital	
1762-IA8	8-Point 120V AC Input Module
1762-IQ8	8-Point Sink/Source 24V DC Input Module
1762-IQ16	16-Point Sink/Source 24V DC Input Module
1762-IQ32T	32-Point Sink/Source 24V DC Input Module
1762-OA8	8-Point 120/240V AC Triac Output Module
1762-OB8	8-Point Sourcing 24V DC Output Module
1762-OB16	16-Point Sourcing 24V DC Output Module
1762-OB32T	32-Point Sourcing 24V DC Output Module
1762-OV32T	32-Point Sinking 24V DC Output Module
1762-OW8	8-Point AC/DC Relay Output Module
1762-OW16	16-Point AC/DC Relay Output Module
1762-OX6I	6-Point Isolated AC/DC Relay Output Module
1762-IQ8OW6	8-Point Sink/Source 24V DC Input and 6-Point AC/DC Relay Output Module
Analog	
1762-IF4	4-Channel Voltage/Current Analog Input Module
1762-OF4	4-Channel Voltage/Current Analog Output Module
1762-IF2OF2	Combination 2-Channel Input 2-Channel Output Voltage/Current Analog Module
Temperature	
1762-IR4	4-Channel RTD/Resistance Input Module
1762-IT4	4-Channel Thermocouple/mV Input Module

Communication Cables

Use only the following communication cables with the MicroLogix 1400 controllers. These cables are required for Class I Div. 2 applications.

- 1761-CBL-AM00 Series C or later
- 1761-CBL-AP00 Series C or later
- 1761-CBL-PM02 Series C or later
- 1761-CBL-HM02 Series C or later

- 1763-NC01 Series A or later
- 1747-CP3 Series A or later

ATTENTION: UNSUPPORTED CONNECTION
Do not connect a MicroLogix 1400 controller to another MicroLogix family controller such as MicroLogix 1000, MicroLogix 1200, MicroLogix 1500, or the network port of a 1747-DPS1 Port Splitter using a 1761-CBL-AM00 (8-pin mini-DIN to 8-pin mini-DIN) cable or equivalent.
This type of connection will cause damage to the RS-232/RS-485 communication port (Channel 0) of the MicroLogix 1400 and/or the controller itself. The communication pins used for RS-485 communications on the MicroLogix 1400 are alternately used for 24V power on the other MicroLogix controllers and the network port of the 1747-DPS1 Port Splitter.

Programming

Programming the MicroLogix 1400 controller is done using RSLogix 500/ RSLogix Micro software, version 8.10.00 or later for Series A controllers and version 8.30.00 or later for Series B and Series C controllers. Communication cables for programming are available separately from the controller and software.

Firmware Revision History

Features are added to the controllers through firmware upgrades. Use the listing in Table 1 to be sure that your controller's firmware is at the level you need. Firmware upgrades are not required, except to allow you access to the new features.

Table 1 - MicroLogix 1400

Catalog Number	OS[1] Series Letter	OS Revision Letter	OS Firmware Release No.	Release Date	Enhancement
1766-L32AWA 1766-L32BWA 1766-L32BBB	A	A	FRN1	August 2005	Initial product release.
	A	B	FRN2	October 2005	According to the SRAM component, MicroLogix 1400 may cause Hard-fault at the start of the Operating System in the very high temperature environment. Corrected.
	A	C	FRN3	February 2006	Added Data file write feature through web server.
1766-L32AWA 1766-L32BWA 1766-L32BBB	B	A	FRN4	February 2007	• Direct connection to RS-485 Network for DF1 half-duplex Master driver. • Direct connection to RS-485 Network for DF1 half-duplex Slave driver. • Direct connection to RS-485 Network for ASCII driver. • Selectable Stop/Data Bits for Modbus Master RTU driver. • Selectable Stop/Data Bits for Modbus Slave RTU driver. • Selectable Stop/Data Bits for ASCII driver. • Settable Inactivity Timeout feature for Ethernet driver. • Unsolicited Ethernet messaging to RSLinx® OPC topic. • CIP™ Generic messaging through the Ethernet port. • Unconnected EtherNet/IP protocol for Ethernet driver. • IP conflict detection mechanism. • E-mail feature. • Ethernet MSG break bit. • DNS functionality when E-mail feature is used. • Change IP Address using Ethernet MSG instruction. • ST file type for all PCCC commands. • HSC (High-Speed Counter) up to 40 K Hz. • PTO/PWM up to 40 K Hz. • 2-channel Analog Input Filter. • Web View Disable for Data Files.
1766-L32AWA 1766-L32BWA 1766-L32BBB	B	B	FRN5	May 2007	• Fixed defect for CIP Messaging Error when CIP service code is 4Bh or 4Ch. • Fixed defect for the EtherNet/IP List Identity reply. • Fixed defect for window size error in TCP/IP stack. • Improved system interrupt delay time.

Table 1 - MicroLogix 1400 (Continued)

Catalog Number	OS[1] Series Letter	OS Revision Letter	OS Firmware Release No.	Release Date	Enhancement
1766-L32DWD	B	B	FRN5	May 2007	• Initial Product release. Supports all the features listed above for the 1766-L32AWA, 1766-L32BWA, and 1766-L32BBB controllers.

(1) OS = Operating System.

Communication Options

The MicroLogix 1400 controllers provide three communications ports, an isolated combination RS-232/485 communication port (Channel 0), an Ethernet port (Channel 1) and a non-isolated RS-232 communication port (Channel 2).

The Channel 0 and Channel 2 ports on the MicroLogix 1400 can be connected to the following:

- operator interfaces, personal computers, and so on, using DF1 Full Duplex point-to-point
- a DH-485 network
- a DF1 Radio Modem network
- a DF1 half-duplex network as an RTU Master or RTU Slave
- a Modbus network as an RTU Master or RTU Slave
- an ASCII network
- an Ethernet network using the Ethernet Interface module (catalog number 1761-NET-ENI, or 1761-NET-ENIW)
- a DNP3 network as a Slave

2. Raspberry Pi 4 Model B

Hardware

- Quad core 64-bit ARM-Cortex A72 running at 1.5GHz
- 1, 2 and 4 Gigabyte LPDDR4 RAM options
- H.265 (HEVC) hardware decode (up to 4Kp60)
- H.264 hardware decode (up to 1080p60)
- VideoCore VI 3D Graphics
- Supports dual HDMI display output up to 4Kp60

Interfaces

- 802.11 b/g/n/ac Wireless LAN
- Bluetooth 5.0 with BLE
- 1x SD Card
- 2x micro-HDMI ports supporting dual displays up to 4Kp60 resolution
- 2x USB2 ports
- 2x USB3 ports
- 1x Gigabit Ethernet port (supports PoE with add-on PoE HAT)
- 1x Raspberry Pi camera port (2-lane MIPI CSI)
- 1x Raspberry Pi display port (2-lane MIPI DSI)
- 28x user GPIO supporting various interface options:
  - Up to 6x UART
  - Up to 6x I2C
  - Up to 5x SPI
  - 1x SDIO interface
  - 1x DPI (Parallel RGB Display)
  - 1x PCM
  - Up to 2x PWM channels
  - Up to 3x GPCLK outputs

Software

- ARMv8 Instruction Set
- Mature Linux software stack
- Actively developed and maintained
  - Recent Linux kernel support
  - Many drivers upstreamed
  - Stable and well supported userland
  - Availability of GPU functions using standard APIs

Mechanical Specification

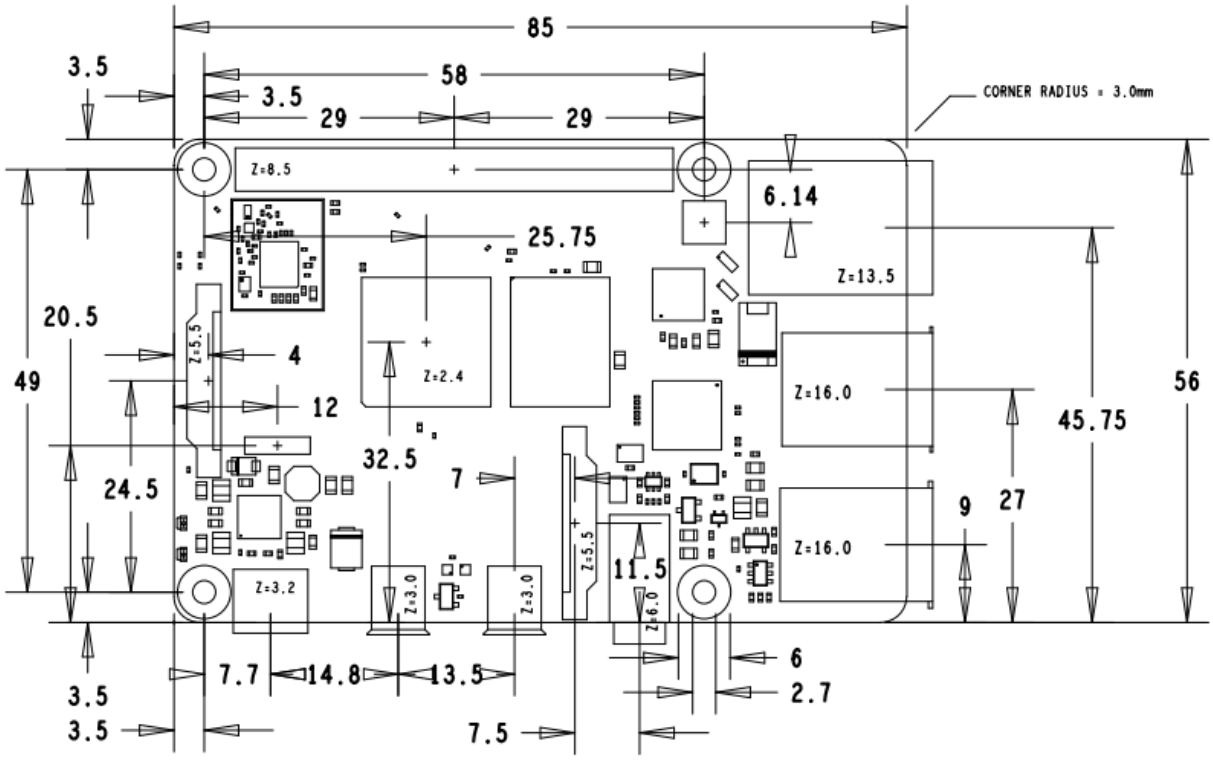


Figure 1: Mechanical Dimensions

Symbol	Parameter	Minimum	Maximum	Unit
VIN	5V Input Voltage	-0.5	6.0	V

Table 2: Absolute Maximum Ratings

Please note that VDD_IO is the GPIO bank voltage which is tied to the on-board 3.3V supply rail.

Symbol	Parameter	Conditions	Minimum	Typical	Maximum	Unit
V_{IL}	Input low voltage[a]	VDD_IO = 3.3V	-	-	TBD	V
V_{IH}	Input high voltage[a]	VDD_IO = 3.3V	TBD	-	-	V
I_{IL}	Input leakage current	TA = +85°C	-	-	TBD	μA
C_{IN}	Input capacitance	-	-	TBD	-	pF
V_{OL}	Output low voltage[b]	VDD_IO = 3.3V, IOL = -2mA	-	-	TBD	V
V_{OH}	Output high voltage[b]	VDD_IO = 3.3V, IOH = 2mA	TBD	-	-	V
I_{OL}	Output low current[c]	VDD_IO = 3.3V, VO = 0.4V	TBD	-	-	mA
I_{OH}	Output high current[c]	VDD_IO = 3.3V, VO = 2.3V	TBD	-	-	mA
R_{PU}	Pullup resistor	-	TBD	-	TBD	kΩ
R_{PD}	Pulldown resistor	-	TBD	-	TBD	kΩ

[a] Hysteresis enabled
[b] Default drive strength (8mA)
[c] Maximum drive strength (16mA)

Table 3: DC Characteristics

Pin Name	Symbol	Parameter	Minimum	Typical	Maximum	Unit
Digital outputs	t_{rise}	10-90% rise time[a]	-	TBD	-	ns
Digital outputs	t_{fall}	90-10% fall time[a]	-	TBD	-	ns

[a] Default drive strength, CL = 5pF, VDD_IO = 3.3V

Table 4: Digital I/O Pin AC Characteristics

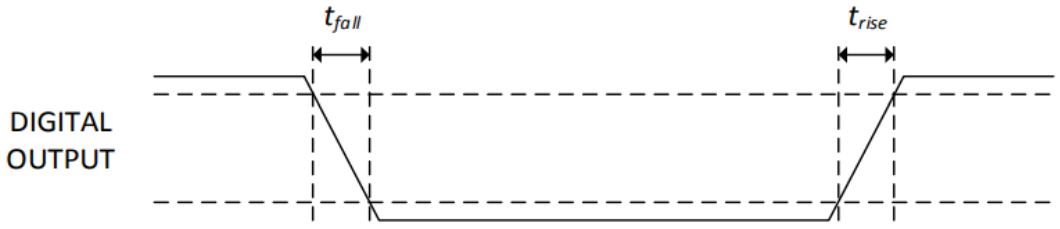


Figure 2: Digital IO Characteristics

ANNEXURE-II

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