Modbus Connected Multichannel channel Parameter Data Acquisition, Monitoring And User Management Web Application

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ABSTRACT- The Modbus connected Multichannel channel Parameter Data Acquisition, Monitoring, and User Management System is a comprehensive system designed for efficient and reliable data acquisition and monitoring of multiple channels simultaneously enabling accurate and efficient measurement of many parameters. The system operates on the Modbus protocol, enabling easy communication and connectivity with various devices. The user-friendly interface allows for intuitive system management and user access control. With its high accuracy and real-time monitoring capabilities, the system provides valuable insights into various parameters and enables effective decision-making for industrial and commercial applications. A Modbus RTU is frequently used in industrial control systems to send data over vast distances. It is a master-slave architectural protocol that uses a binary representation of the data to facilitate communication between devices. Data is transferred across a serial line in Modbus RTU, often utilising the RS-485 or RS-232 standards. The master device sends commands to the slave devices to seek data or carry out a specified function. Each device on the network has a distinct address. The requested data or an acknowledgment of the activity is returned by the slave devices. In larger companies, this device can measure eight channels for different characteristics like temperature, humidity, and pressure. They are making sure that the system's many features work properly as it is being developed. The Modbus-connected multichannel channel parameter is what we utilise to deal with the various industrial sensors.

Keywords: Modbus communication, Web Application, User Interface, MODBUS is connected to multichannel DAC, DAC

1. INTRODUCTION –

Modbus RTU (Remote Terminal Unit) is a serial communication protocol that was developed by Modicon (now Schneider Electric) in the 1970s for communication with PLCs (Programmable Logic Controllers) and other industrial devices. It is widely used in industrial automation applications for communication between devices such as sensors, actuators, and controllers.

The Modbus RTU protocol uses a master-slave architecture, where the master device initiates the communication and the slave devices respond to the requests. The protocol uses a binary representation for

data communication, where data is transmitted in the form of ones and zeros. The data is sent in packets or frames, which include the address of the device, the function code, the data to be transmitted, and a cyclic redundancy check (CRC) for error detection.

Modbus RTU uses serial communication, typically over RS-485 or RS-232, with a maximum distance of up to 1200 meters between devices. It operates at various baud rates, typically ranging from 1200 to 115200 bits per second.

Modbus RTU is a widely adopted protocol due to its simplicity, reliability, and ease of implementation. It has become an industry standard for communication in industrial automation and is supported by a wide range of devices from different manufacturers.

Modbus has several modes of operation, including Modbus ASCII, Modbus RTU, and Modbus TCP/IP. Modbus ASCII and RTU are used for serial communication, while Modbus TCP/IP uses Ethernet as its physical layer. Modbus TCP/IP is becoming increasingly popular because it can operate over standard Ethernet networks, providing more flexibility and scalability than serial communication.

In industrial processing, Modbus is used for a wide range of applications, such as data acquisition, remote monitoring and control, system configuration and troubleshooting, and device diagnostics. Modbus is commonly used in industries such as oil and gas, power generation, water treatment, and manufacturing, among others.

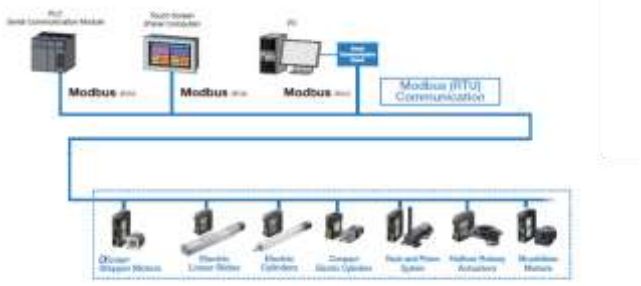

Figure 1. Block Diagram of Modbus rtu Communication

Overall, Modbus is a reliable and cost-effective communication protocol for industrial processing applications. Its popularity is due to its simplicity, openness, and compatibility with a wide range of devices, making it an ideal solution for real-time control and monitoring.

The Modbus RTU connected multichannel channel parameter data acquisition, monitoring, and user management system is a web application that allows users to monitor and manage data from multiple channels in real-time. The system is based on the Modbus RTU protocol, The system architecture consists of a data acquisition module that collects data from multiple channels, a processing module that performs data analysis and visualization, a storage module that stores the data, a communication module that enables communication between different components of the system, and a user interface module that allows users to interact with the system.

The web application allows users to access the system from anywhere using a web browser. Users can view real-time data from multiple channels, set alarm thresholds, and receive notifications when the threshold is exceeded. The system also provides historical data analysis and visualization tools that enable users to identify trends and patterns in the data.

User management is an essential part of the system, which ensures that only authorized users have access to the data. The system includes features for user authentication and authorization, which allows administrators to control user access to the system.

For optimum performance and productivity in industrial environments, data collecting is essential. The use of sensors, which can track numerous factors including temperature, pressure, flow rate, and more, is one method of gathering data.

A central control system or database can receive data from up to eight linked sensors

using the Modbus communication protocol. Data is delivered accurately and in real-time through Modbus protocol, which makes device communication efficient and dependable.

A database can be used to store the sensor data. once it has been gathered so that it can be processed and further analysed. This makes it possible to spot patterns and identify trends, which can be used to enhance overall efficiency and optimise business operations. Overall, the Modbus RTU connected multichannel channel parameter data acquisition, monitoring, and user management system web application provides an efficient and convenient way to monitor and manage data from multiple channels in real-time, enabling users to make informed decisions based on the data.

2. LITERATURE SURVEY

A complete solution for gathering and monitoring data from various channels is the Modbus connected multichannel parameter data acquisition, monitoring, and user administration system. In order to investigate current research and products linked to this system, we will conduct a literature review in this part.

By Jianbo Zhang, Hongzhou Luo, and Yong Liu (2016): describes the design and implementation of a data acquisition and transmission system based on Modbus RTU protocol. The system consists of a data acquisition module, a processing module, a storage module, a communication module, and a user interface module. The authors demonstrate the effectiveness of their system through experiments[1].

By Hongzhi Xu and Ping Liu (2018): This paper describes the design of a multi-channel data acquisition and transmission system based on Modbus RTU protocol. The system consists of a data acquisition module, a processing module, a storage module, a communication module, and a user interface module. The authors demonstrate the effectiveness of their system through experiments[2].

By Jianbo Zhang, Hongzhou Luo, and Yong Liu (2018): design and implementation of a multi-channel data acquisition and transmission system based on Modbus-RTU protocol. The system consists of a data acquisition module, a processing module, a storage module, a communication module, and a user interface module. The authors also conducted experiments to validate the performance of their system[3].

By Jing Wang and Yanfen Liu (2020): the design and implementation of a Modbus-RTU based multi-channel data acquisition system. The system consists of a data acquisition module, a processing module, a storage module, a communication module, and a user interface module. The authors demonstrate the effectiveness of their system through experiments[4].

By Chunrong Xie and Jianguo Zhou (2021): design and implementation of a Modbus-RTU based multi-channel data acquisition system. The system consists of a data acquisition module, a processing module, a storage module, a communication module, and a user interface module. The authors also conducted experiments to validate the performance of their system[5].

By S. K. Pandey et al. This paper describes the development of a Modbus-based energy monitoring and management system for residential buildings. The system collects data from various energy meters and transmits the data to a remote server using the Modbus protocol. The authors demonstrated the system's ability to monitor the energy consumption of residential buildings in real-time[6].

By Liu and Wang provides a comprehensive overview of data acquisition and control systems based on the Modbus protocol.

They also highlights the potential of IoT in data acquisition and control systems. However, further research is needed to evaluate the performance of the proposed system and to compare it with other data acquisition and control systems[7].

By Ahmed and Iqbal provides a comprehensive overview of data acquisition systems for condition monitoring based on the Modbus protocol. They also highlights the potential of machine learning and IoT in condition monitoring systems a data acquisition system that uses the Modbus protocol to acquire data from various sensors and transmit it to a central monitoring station[8].

By Hafidh and Shihab provides a comprehensive overview of industrial monitoring and control systems based on the Modbus protocol. The paper also highlights the potential of HMI and IoT in such systems. focuses on industrial monitoring and control systems, which are widely used in various industrial applications such as manufacturing, power plants, and chemical processing. uses various sensors and actuators to monitor and control the industrial processes[9].

By Ibrahim et al. presents the design and implementation of a distributed control system based on the Modbus protocol for a small-scale robot. They also highlights the potential of IoT in robotics applications. The paper uses the Modbus protocol for communication between the distributed controllers and the robot. uses various sensors and actuators to control and monitor the robot.[10]

By Kabir et al. presents the development of a data acquisition system for temperature monitoring of a solar cell based on the Modbus protocol. [11] uses the Modbus protocol for communication between the data acquisition system and the solar cell presents the design and implementation of a data acquisition system for temperature monitoring of a solar cell based on the Modbus protocol. They also highlights the importance of renewable energy sources and their monitoring for efficient and sustainable energy production [15-18]

3. METHODOLOGY

The methodology for developing a Modbus connected multichannel channel parameter data acquisition, monitoring, and user management web application can be broken down into the following steps:

Define the requirements: The first step in developing any application is to define the requirements. In this case, the requirements would include the number of Modbus connected channels, the data parameters to be acquired and monitored, the user management system, and the type of web application to be developed.

Determine how many channels there are: Establish the numberof communication channels to be used as well as the type of communication interface needed (e.g., RS-232, RS-485, Ethernet, etc.).

Choose the appropriate technology stack: Based on the defined requirements, choose the appropriate technology stack for developing the web application. This may include selecting a programming language, web framework, database management system, and any other necessary tools.

Develop the backend: The backend of the web application will be responsible for handling the Modbus communication and data acquisition. This can be achieved by using libraries and APIs that support Modbus communication. The backend will also handle the user management system, including user authentication and authorization.

Develop the frontend: The frontend of the

web application will be responsible for displaying the acquired data in a user-friendly format. This can be achieved by using web development technologies such as HTML, CSS, and JSP

Select the communication equipment: Choose hardware that can accommodate the necessary number of channels and communication interface. Devices like Modbus gateways, protocol converters, or Modbus-capable controllers may be included in this.

Set up the hardware: Set up the hardware according to the demands of the particular applications, such as baud rate, parity, data bits, stop bits, and network configurations.
Implement monitoring and alerts: The web application should have a monitoring system that alerts the users in case of any abnormal data values. This can be achieved by setting up thresholds for each parameter and triggering an alert if the threshold is breached.

Create a communication protocol: Create a protocol that outlines the data flow between the numerous channels and Modbus-enabled devices. Determining the data structure, addressing method, error handling, and synchronisation needs may fall under this category.

Test the application: The web application should be thoroughly tested to ensure that it meets the defined requirements and performs as expected. This may include unit testing, integration testing, and user acceptance testing.
Deploy the application: Once the web application has been tested and is ready for deployment, it can be deployed to a web server or a cloud platform.

Provide support and maintenance: After the deployment of the web application, it is essential to provide support and maintenance to ensure that it continues to function correctly and meet the changing needs of the users.
Overall, the development of a Modbus connected multichannel channel parameter data acquisition, monitoring, and user management web application requires a combination of technical skills, domain knowledge, and project management skills.

3.1 Block Diagram

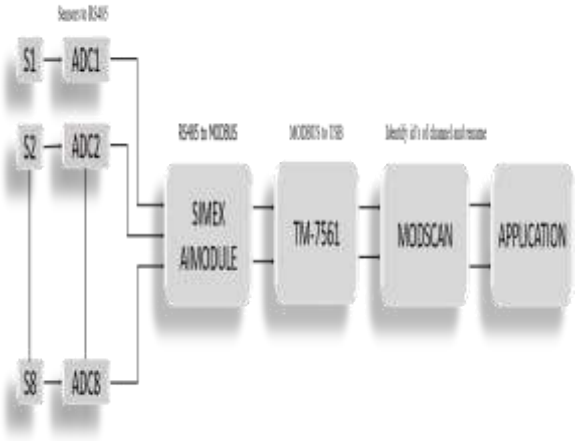

Figure 2 Block Diagram of System.

Sensor: A sensor block is a component in an electronic system that is responsible for sensing a physical quantity or phenomenon and converting it into an electrical signal that can be measured and processed. The block typically consists of two main components the sensing element and the signal conditioning circuit.
The sensing element is the part of the sensor block that directly interacts with the physical phenomenon being measured.
The signal conditioning circuit is the part of the sensor block that amplifies, filters, and otherwise prepares the electrical signal produced by the sensing element for further processing by other components in the electronic system.

(ADC) Analog-to-digital converter: An Analog-to-Digital Converter (ADC) block is

a component in an electronic system that is responsible for converting an analog voltage or current signal into a digital signal that can be processed by a digital system. The ADC block typically consists of three main components the sample-and-hold circuit, the analog-to-digital conversion circuit, and the digital output interface.

The analogue signal from the sensor is converted into a digital signal via an analog-to-digital converter (ADC). Analogue signals are periodically sampled by the ADC, which converts the samples into a series of digital values that may be processed by a microcontroller or other digital circuit

The digital signal is then converted to a format that the RS485 communication protocol can recognise. The RS485 industrial automation and control system standard enables several devices to interact with one another over a single pair of wires. The RS485 interface is then used to transmit the data to further attached devices through the communication network. The given data can be further processed and analysed to understand more about the physical environment being detected by the sensor.

Overall, the use of a sensor, an ADC, and an RS485 interface makes it possible to send data from the physical world to electronic devices in a reliable and efficient manner.

SIMEX AIMODULE: The SIMEX AIMODULE is a block that is designed to provide artificial intelligence (AI) capabilities to electronic systems. It typically consists of four main components: the AI processor, the memory subsystem, the input/output (I/O) interface, and the software stack

The SIMEX AIMODULE is a device that converts data from the RS485 communication protocol to the Modbus communication protocol. The module is frequently used in industrial automation and control systems to allow connection between multiple devices that use different communication protocols.

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The AIMODULE responds to commands from a Modbus master device as a Modbus slave device. The module converts the data into registers for Modbus so that the Modbus master device can access the data obtained from RS485 devices.

MODBUS TO USB Converter: The TM-7561 is a device that converts data from the Modbus communication protocol to the USB communication standard. The device is frequently used in industrial automation and control systems to provide communication between multiple devices that use different communication protocols. Data is sent to the TM-7561 by devices using the Modbus communication protocol.

The information, which is typically kept in Modbus registers, can be accessed by a Modbus master device. The device then processes the data and transforms it into a format that is suitable with the USB connection protocol. The USB protocol is a widely used standard for exchanging data between computers and other electrical devices. The TM-7561 is connected to a computer or other electrical device using a USB cable so that it can operate as a USB device. The modified data is then sent to the computer via the device so that software applications can process and analyse it.

MODSCAN:

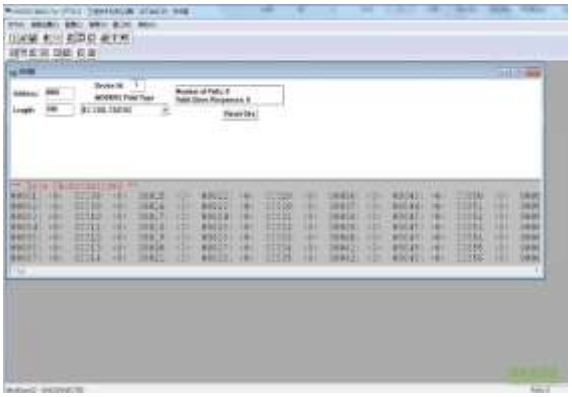

Figure 3 Modscan interface.

The MODSCAN block is a component in an electronic system that is designed to communicate with industrial devices that use the Modbus communication protocol. The Modbus protocol is a widely used standard for communication between industrial control systems and field devices such as sensors, actuators, and other equipment. The MODSCAN block typically consists of three main components: the Modbus communication interface, the data processing unit, and the I/O interface.

To make channels easier to identify and organise, programme users can rename them and alter their channel IDs. The Modbus network can be scanned using MODSCAN to get each channel's ID. The programme also shows each channel's ID in addition to information about the device type and the data being transferred. Users can then rename each channel's ID for easier identification and organising.

Application: A web application is a software program that is accessed through a web browser over the internet, and typically runs on a web server. The web application block typically consists of several main components, including the front-end interface, the back-end server, and the database.

This functionality may be extremely useful in large industrial automation and control systems where several Modbus devices and channels need to be monitored and managed. For this application, we are collecting various types of data from the sensors attached to industrial projects. We collect the sensor data via MODBUS, send it to the database, and then deliver that data to the user interface of the web application.

3.2 ALGORITHM

Here's an algorithm for a Modbus connected multichannel parameter data acquisition, monitoring, and user management system using a web application:

1.Sensor: The ADC, which converts the physical parameter into the right electrical signal, is connected to the sensor. The sensor data is then converted to RS485 by attaching the appropriate electrical signal to the ADC.

2. Establish connection: Identify the Modbus connected multichannel device and obtain its IP address or network name.

Install a Modbus TCP/IP driver or library on the server where the web application will run.

Develop the web application using a suitable programming language and framework, such as Java. The application should include functionality to connect to the Modbus device using the Modbus driver or library, and retrieve data from its channels.

Deploy the web application on a web server, either on-premises or in the cloud, and configure it to communicate with the Modbus device using its IP address or network name.

Test the connection and functionality of the web application by accessing it through a web browser, and verifying that it can retrieve and display data from the Modbus device, and that user management features are working correctly.

By following these steps, you can establish a connection of Modbus connected multichannel channel parameter data acquisition, monitoring, and user management web application, and provide users with a secure and convenient way to access and monitor data from the Modbus device.

3. Multichannel data acquisition: Data from many channels is read, monitored in real-time, and then stored in a database using SQL.

Obtain that data from the server and show it on the web application.

5.Authentication: An authentication is a security mechanism used to verify the identity of a user or system before granting access to a resource or service. It is often implemented as part of a larger security protocol, such as in an authentication system for a web application.

The authentication block typically requires the user to provide some form of credentials, such as a username and password which are then compared against a stored database of authorized users. If the provided credentials match those in the database, the user is granted access to the requested resource. If

the credentials do not match, access is denied.

6.User roles and permissions: Assign user roles to individual users based on their job responsibilities or privileges. This can be done manually by the administrator, or automatically based on predefined rules or user attributes.

authentication mechanisms to ensure that only authorized users can access the system.

Assign different user roles and permissions to ensure that only authorized users can access the system and provide a secure and efficient user experience.

7. Alerts and notifications: Alerts and notifications are critical features for a Modbus connected multichannel channel parameter data acquisition, monitoring, and user management web application. They allow users to receive real-time updates and alerts on the status of their devices and channels, ensuring that any issues are promptly addressed.

8. Data analysis: Analyzing the data acquired from multiple channels is a critical feature for a Modbus connected multichannel channel parameter data acquisition, monitoring, and user management web application. It allows users to gain insights into their device performance, detect issues, and optimize their operations.

Provide data visualization tools, such as charts, graphs, and tables, to help users quickly and easily understand their data. This can include real-time dashboards that display the status of their devices and channels, as well as historical trends and performance metrics.

9.Remote access: Remote access is an important feature as it allows users to access their devices and channels from anywhere, at any time.

Ensure that your web application is accessible via the internet. This may involve setting up a secure and reliable hosting environment, such as a cloud-based platform or a dedicated server.

Implement authentication and authorization mechanisms to ensure that only authorized users can access the system remotely. This can include user accounts, passwords, two-factor authentication, and IP restrictions.[19-24]

3.3.WEB APPLICATION

Figure 4 SuperUser login Interface

Figure 4.1 PlantHead login Interface

Figure 4.2 Manager login Interface

Figure 4.3 User login Interface

In this mobile application, four sections are created.

1.Supper User Login: A Super User Login block is a login form designed for users with administrative or higher level access privileges in a web application. A super user is a user who has complete control over the system, including the ability to manage other users, assign roles and permissions, configure settings, and perform other administrative tasks. The Super User Login block typically includes a username and password field

The Super User Login block is an important feature in web applications, as it ensures that only authorized users have access to the administrative features and controls of the system. This helps to prevent unauthorized access, data breaches, and other security risks, and allows administrators to maintain the integrity and security of the system.

The super user has the ability to add, remove, and update the information related to a manager, plant head, and user, and he can also view the data related to this.

2.Plant Head: A Plant Head block is a user interface element designed for the role of the plant head in a web application. The plant head is responsible for managing the overall operations and performance of the factory, and the Plant Head block provides them with access to key information and tools to help them achieve their goals.

The plant head has the ability to add, remove, and update the information related to a manager and user, and he can also view the data related to this.

3.Manager Login: A Manager Login block is a user interface element designed for the role of a manager in a web application. A manager is typically responsible for overseeing a team of employees or a specific department within an organization, and the Manager Login block provides them with access to key information and tools to help them manage their team or department effectively.

The Manager Login block typically includes a login form that requires the manager to enter their username and password in order to access the system. Once logged in, the manager may be presented with a dashboard that displays key performance indicators (KPIs) related to their team or department. And manger has the ability to add, remove, and update the information related to a user, and he can also view the data related to this.

4.User: A User block is a user interface element designed for the role of a regular user in a web application. A regular user is typically an employee or a customer who uses the system to perform specific tasks or access specific features.

The User block typically includes a login form that requires the user to enter their username and password in order to access the system. Once logged in, the user may be presented with a dashboard or main menu that allows them to only analyse the data. The user cannot make any changes. He also does not have the authority to make changes to the system or web application.

3.4 DATABASE

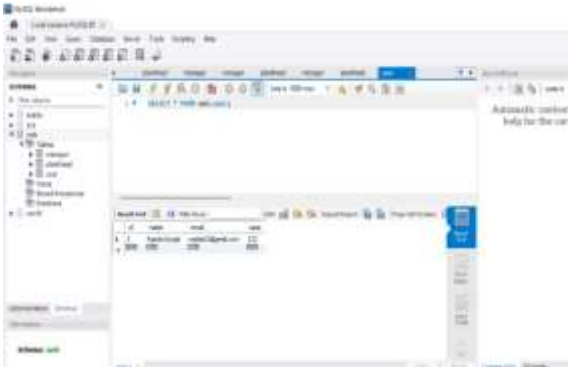

Figure 5 User Database.

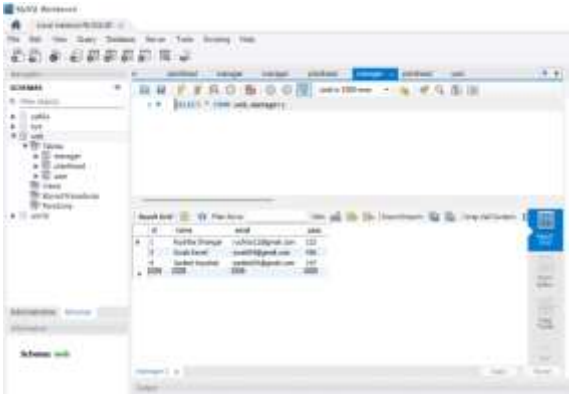

Figure 5.1 Manager Database.

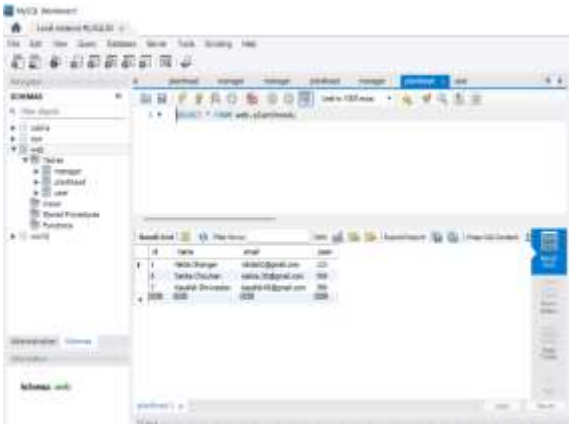

Figure 5.2 PlantHead Database.

SQL (Structured Query Language) is a programming language designed for managing and querying relational databases. A relational database is a type of database that organizes data into tables or "relations" that are related to each other based on certain attributes or keys.

In this system, we use a MySQL database for storage purposes. Popular SQL databases include MySQL, PostgreSQL, Microsoft SQL Server, Oracle, and SQLite.

MySQL stores data in tables, which can be organized into databases. Each table contains columns that define the types of data that can be stored, as well as rows that represent individual records. SQL commands can be used to create, modify, and retrieve data from these tables.

4. EXPERIMENT

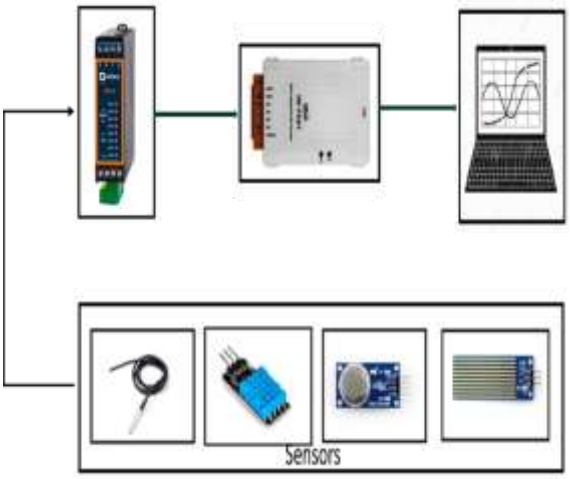

Figure 6 Figure of experiment (Boiler)

A boiler is a device that heats liquids to produce steam or hot water for use in a variety of industrial and commercial applications. In this illustration, the boiler is linked to a number of additional equipment using the Modbus communication protocol.

A pressure metre is an instrument that gauges the fluid pressure inside the boiler. The boiler can be managed to maintain ideal pressure levels and avert damage or safety risks by monitoring the pressure.

A water level valve controls the amount of water in the boiler. By ensuring that the water level is kept within a safe range, it stops the boiler from overflowing or going dry. The level of the water in the boiler is determined using a level sensor. To guarantee that the water level is maintained at the desired level, this information is used to operate the water level valve.

A gadget called an energy metre is used to gauge the boiler's energy usage. The efficiency of the boiler can be increased and potential energy waste can be discovered and reduced by keeping an eye on the energy consumption.

The boiler is connected to all of these components through the Modbus communication standard. In industrial automation systems, the Modbus

communication protocol is frequently utilised. The boiler can operate more effectively and efficiently as a result of the devices' ability to exchange data and control signals with it.

5. CONCLUSION

In conclusion, the Modbus Connected Multichannel Parameter Data Acquisition, Monitoring and User Management Web Application is a powerful tool for industrial process control and automation. It allows users to remotely monitor and control multiple devices, collect and analyze real-time data, and manage user access and permissions.

By leveraging the Modbus protocol, the application is compatible with a wide range of industrial devices, making it highly flexible and versatile. The web-based interface provides an intuitive and user-friendly experience, allowing users to easily configure and customize the application to suit their specific needs.

Additionally, the user management system offers a high degree of security, making sure that only individuals with permission can access the data. In circumstances where data security is of the utmost significance, this is crucial.

This system's capability to deliver remote access to real-time data is one of its main advantages since it enables users to monitor crucial operations and make educated decisions from any location in the world. This is made possible by the web application, which offers users a very flexible and practical way to access and analyse data. Users can examine data on their web browser using the web application.

Overall, the Modbus Connected Multichannel Parameter Data Acquisition, Monitoring and User Management Web Application is an essential tool for any organization looking to improve their industrial process control and automation capabilities. Its robust features and ease of use make it a valuable asset for optimizing productivity and efficiency in industrial settings.

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