IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 8 Issue 11, November 2021
ISSN (Online) 2348 – 7968 | Impact Factor (2020) – 6.72
www.ijiset.com

Design Network Topology of Air Handling Unit Control System Based-on Programming Logic Controller and Human Machine Interface

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Abstract

Workers require a healthy working environment in order to carry out their tasks. This can make employees more productive by making them feel more at ease at work. Air conditioning is used in office buildings to provide good air quality in each workspace. The Air Handling Unit (AHU) machine is used to centrally manage the air conditioner and then distribute it to each workspace's ventilation. The issue is that each workspace has different conditions. There are workspaces that are empty, workspaces that are fully occupied by workers, and workspaces that serve as a repository for important documents. Currently, the AHU engine's condition allows it to only massively distribute air to each room. Additional components are required to distribute according to the needs of the room. In this study, we will look at what components are required to control the AHU engine. Programming Language Controller and Human Machine Interface are components that will be used to control the AHU machine. This study generates a network topology design based on component interactions that can be used as a reference in the development of the AHU machine automatic control system.

Keywords: *Air Handling Unit, Programming Logic Controller, Human Machine Interface, Internet of Things.*

1. Introduction

One of the factors influencing worker health is air quality in the workplace. Sick Building Syndrome (SBS) or Tight Building Syndrome (TBS) can be caused by deteriorating indoor air quality conditions [1][2]. Furthermore, some diseases, such as asthma, have been linked to specific air contaminants or indoor environments, such as damp indoor environments [3][4][5]. The use of an air conditioner (AC) causes an increase or decrease in the quality of the indoor air. The air conditioner has a cold air delivery system as well as a pollutant filter [6][7]. The use of an effective air conditioner can reduce pollen levels, as well as the number of bacteria and spores in the room, and it making employees more comfortable while performing their tasks [8][9]. To produce cold air in every room, office buildings currently use a central air conditioning system. A central air conditioning system can evenly distribute cold air to each room. However, the problem with this central air conditioning system is that even if there is an empty room or if there aren't many people using it, the room still receives cold air. This will result in a waste of energy [9]. The Air Handling Unit (AHU) is a machine that centrally distributes cold air to rooms [10][11]. The AHU engine is currently configured in the distribution of cold air to the room using the traditional method, namely by turning the AHU motor and opening the valve on the duct pipe to the room ventilation [11]. If there are many AHU machines and many rooms in one building, there will be a waste of time in the AHU machine configuration. Based on the problems stated above, this research will look into what components and network topology design can be used to control the AHU machine. Programming Logic Controller (PLC) is a component that is used to control the motor on a machine [12][13]. Human Machine Interface (HMI) is a component used to access data to PLC [14][15][16]. Both of these component will be used in the network topology as components that function to control the AHU machine. The study's findings can be used to guide the development of the AHU engine control automation system.

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2. Research Methodology

The research method used is observing the condition of the AHU and the room in one building, then analyzing the component requirements and designing the network topology. The Universitas Trilogi lecture building is the site of the research. The following are the stages of research that have been completed.

2.1 Observation of Existing Condistions

In the first stage, it will monitor the condition of the AHU engine and rooms. This monitoring is performed to determine the number of rooms receiving cold air, the capacity of the AHU engine, and the length of the air distribution pipe connecting the AHU to the rooms. Furthermore, at this stage, information about the use of the room will be obtained, including the number of workers who use the room, the length of time the room is used, and when the room is empty or full. This information will be obtained based on the room's scheduled.

2.2 Analysis of Component Requirements

The second stage will determine which components are required to control the AHU machine. These components are determined by the state of the AHU engine. Pay attention to the number of sensors required from each room, what variables can affect the use of the AHU machine, and the ease with which mechanics can control cold air in each room. At this stage will also describe the specifications of the components that will be used.

2.3 Design of Network Topology

The network topology of the components used will be designed in the third stage. This design is carried out to ascertain the relationship between components and the data communication process employed. The network topology will be designed based on the existing conditions at the research site.

3. Result and Discussion

Monitoring of real conditions is carried out for 1 month by involving mechanical technicians at Universitas Trilogi. Some of the data that can be gathered includes the current status of two AHU machines, each of which distributes cold air to four rooms. The photo below was taken while inspecting the condition of the AHU engine.

Fig 1. AHU Engine Observation

Fig 2. Electrical Panel Observation

The AHU engine used is relatively old, and the motor owned cannot be fully rotated. This demonstrates that some motors have limitations. The following components are required based on the results of observations.

Table 1: Component List and Specifications

No	Component	Spesifications
1	Inverter	Output Power: 300 Watt, AC Output Voltage: 220V +/- 2% , DC Input Voltage: 12 Vdc Efficiency : > 85% , Output Frequency: 50 Hz +/- 0.5% Dimension (mm): 260 x 130 x 83
2	Programming Logic Control (PLC)	PLC Type PS4-201 MM1 Digital Inputs 8, Digital Outputs 6 Analog Inputs 4, Analog Outputs 1 Interfaces Through RS485 , Memory 32 Kb
3	KwH Meter Digital	Single Phase, 2 W / 50 Hz Direct connection 220 VAC , AC voltage 2 KV for 1 minute Impulse voltage 6 KV , Pulse output (open collector) Dimension 88 x 75 x 73 mm
4	Human Machine Interface (HMI)	Series 7 Inch, CPU Cortex A8 800 Mhz Memory 4GB Flash +512M DDR3 Resolution 800x480 , Dimension 200x146x37 mm Serial port/ U disk / SD card / Ethernet port/ Haiwell cloud
5	Box Panel	Panel Indoor, Dimension 35x25x15 cm Plat Thickness 0.9 mm
6	Thermostat	4 thermostat temperature sensor AC 220 Vac, DC 12 Vdc Interface Through RS485
7	Network Cable	UTP Cat-6 , Serial RS485
8	Microcontroller Gateway	Arduino UNO R3 , Ethernet Shield for Arduino UNO

The components listed above are used to construct a PLC and HMI-based AHU engine control system. The inverter specifications are determined by the state of the AHU motor. The PLC used has four analog inputs for data from the thermostat and four digital inputs for data from the KwH meter. The thermostat is used to measure the temperature of the room, while the KwH meter is used to measure the wattage of the AHU motor. The HMI will be used to assist technicians in operating the control system. Compile the network topology design of the AHU engine control system, as shown in the diagram below.

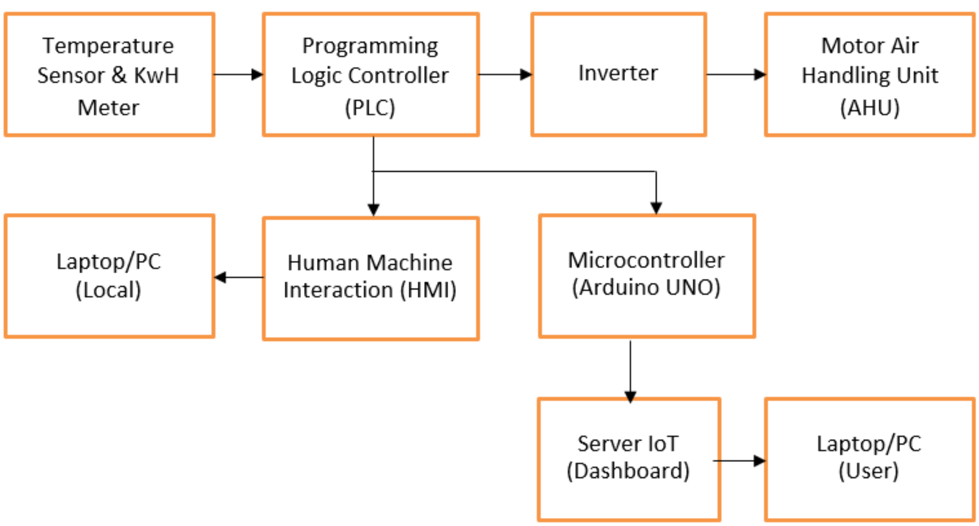

Fig 3. Diagram of the Network Topology of the AHU Machine Control System

The above-mentioned network topology describes the relationship between each component. The thermostat is used to read the room temperature, and the AHU motor's wattage is read. RS485 serial communication is used to send data from the thermostat and KwH Meter to the PLC. The AHU engine motor will be driven by the PLC connected to the inverter. The

PLC will then send data to the HMI. Mechanical technicians can use an HMI or laptop to monitor the condition of room temperature and AHU motors. The microcontroller acts as a gateway, forwarding data from the PLC to be saved on the IoT Server. The stored data can be accessed via an internet-connected web dashboard.

4. Conclusions

Based on the study's findings, it is possible to conclude that the network topology design can be implemented using a list of components. In addition, the components used have standardized specifications that are compatible with the AHU engine capacity. Because it only processes data from the PLC, the microcontroller is also used specifically as a gateway and has a relatively small load. Conducting connectivity trials to determine the configuration of each component, developing an IoT dashboard to test data reliability, and developing artificial intelligence-based data analysis functions are all suggestions for future research.

Acknowledgments

Thank you to the Directorate of Research and Community Service, Ministry of Technology Research National Innovation Research Agency which has provided funding through collaborative research schemes between universities. This research was conducted jointly between Universitas Trilogi and CV. Sangkakala Bersinar and PT. Canindo Daya Elektrika.

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