Simulator Human Machine Interface (HMI) using visual basic on the SCADA system

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Abstract. Recently, many industries are using Supervisory Control and Data Acquisition (SCADA), especially in the electrical industry. SCADA system is a computer based in control and monitoring system. This research is proposed to design a Human Machine Interface (HMI) on the SCADA system for power plant. However, due to the high cost of HMI as used in the industry, a simulator HMI was built. The objective of this study is to design HMI simulator by using Visual Basic to simulate controlling process as similar as in the real plant. The strategy to examine the performance of HMI simulator is manipulating data from analogue data contained in a three-phase plant simulator and converted into the real SCADA scale and displayed. Based on the experiment, the performance of HMI simulator is following what it should be, where the entered data from the RTU to the HMI is running well and can be displayed on a computer.

1. Introduction

SCADA has significant impact in control system. There is some important part of the SCADA system, Master Terminal Unit (MTU), Remote Terminal Unit (RTU) and Human Machine Interface (HMI) [1]. The SCADA system is an automation technology that is very important in the industrial. Almost all high-tech industries use the system. However, because of the high cost of SCADA, it is difficult to study this system in full both for learning media and development tools that can help work in real life. Therefore, the SCADA system was built using prototype development. There have been many studies in the field of SCADA with various applications and uses simulations. SCADA can be used in many fields such as factories, power generation, gas and oil and others [2-4]. Sahin et al. conducted a simulation study of the SCADA System using LabView software [5]. Making the proposed SCADA system aims as a learning tool. From the results carried out by Sahin et al., it has been proven that using this simulation can effectively help facilitate an understanding of the SCADA system even deeper. Wijayanto et al. conducted a study using Wonderware In Touch software [6]. This study was also conducted for the development of the laboratory. The simulator is different from the proposed research. A simulator that used by Wijayanto et al. is Automatic Main File (AMF). This research helps to create a virtual instrument for learning tools in educational institutions [6]. Das et al. conduct a simulation research about control and monitor tank level using SCADA system [7]. Sahin developed SCADA system using Modbus [8].
SCADA is not only for learning tools, but also it can be for the development of an existing system. Salihbegovic et al. using SCADA for refinery application [9]. Helmi et al. conducted an HMI study on prototype Filling Bottle and Capping Machines for Milk Packaging [10]. This research was conducted to increase the productivity of filling milk in bottles so that because the controller can make milk production more efficiently. In Nicola et al. researching the area of SCADA based on OLE (Object Linking and Embedding) - for Process Control (OPC) and Web Servers that can be used for communication. Software for monitoring using LABVIEW [11]. Database for this research using MySQL database server. The study of this journal will be one of the literature reviews for further research development that is web-based and the use of a more centralized database.

HMI is one of the interesting topics in the automation field [1]. Therefore, the proposed research focuses on HMI on the SCADA system. HMI is part of SCADA Telemetry to demonstrate data from RTU also display processes that happen throughout the entire system. HMI in the form of software that facilitates the supervision of the plant, so that it can facilitate dispatchers (operators) if there are problems at the plant. HMI converts data in the form of numerical figures, both in graphical form and into languages that can be understood by dispatchers. The simulation plant used is a three-phase Power Generation plant. Analogue HMI data obtained from the RTU at the plant are converted and displayed on a computer. The experiment method is proposed Before starting the design, conduct a literature study related to the research that will be proposed. Moreover, to determine the SCADA system specifications contained in the Power Plant.

2. Method
The proposed research using the three-phase system. Analogue data from the plant sent to the RTU. In RTU, measurements obtained from the plant are converted to quantities that are following system specifications. The processed data is sent to the PC through the Front-End Processor which will later be displayed by HMI on the computer.

![Block diagram system](Figure 1)

2.1. The experiment
The process carried out is to convert analogue data obtained from the plant, into data that has been converted as needed. The measurement parameters that are controlled by the SCADA system are Voltage, Current, Power, Temperature, Motor Speed, Frequency. From this data, the condition of the system can have controlled. HMI is designed using two forms. The first form is used as an initial display that is equipped with a data entry facility for the operator, in the form of a login name and password. The facility is used as a safeguard against unexpected system operations that might be carried out by irresponsible people. The second form contains several properties that represent the real appearance of the plant. The panel display shows the conditions or conditions at the plant in the field.

Because it uses a three-phase system, voltage and current have three in each configuration, V-R, V-S, V-T, A-R, A-S, A-T. Temperature measurement focuses on the temperature of the generator. Then there are Sr, Ss, St and total power from voltage and current measurements. There are two operating modes, local and master. In Local operation mode, the plant simulation plant works by Direct On-Line (DOL). When the push button for the primary contactor is pressed, the indicator for the primary contactor will light up. Likewise, with the others for secondary contactors. So, in Local operation mode, contactor operation is done manually by pressing the push button located on the plant's simulation plant. For light simulators, the load is controlled manually by a switch. Whereas in the master operating
mode, contactors on the primary and secondary sides of the plant simulation plant are controlled by MTU. When the MTU sends a command to the RTU to turn on the contactor on the primary side, the RTU immediately executes the command, as well as the others on the contactor on the secondary side. So, in the master operating mode, the RTU only acts as an intermediary between the MTU and the Plant of the simulation plant except the load that are still controlled manually using switch.

Figure 2. HMI process flowchart.

2.2. HMI design
From the proposed research, an HMI simulator was designed using Visual Basic (VB). Visual Basic is a software that provides a Graphic User Interface (GUI) based programming facilities. The login form is made so that those who can access the main form are only those who are interested. Figure 2 is the login form of the proposed research. Several tools are used as display measurements, such as CW Knob and CW Slider. In addition, there is a status form for each measurement and alarm. The alarm will work if a measurement deviation occurs.

3. Results
Before entering the main form, first a login form is created, where this form is a validation form for only certain people of the dispatcher who can access the main form as shown in figure 3.
After logging in, the dispatcher will enter the main form as shown in Fig. 4. Each frame has a function that analogizes the SCADA function as Telemetering represented by “Metering” and Tele signaling labels represented by Labels and Images under the "Status" label. Then visually the appearance of the plant is depicted in the "Plant" Frame, in which there are various graph properties.

![Figure 4. Main form.](image)

There are measurement readings that are displayed on the HMI in table 1. There are several measurement samples based on existing parameters and following the graph for each measurement.

**Table 1. Measurement displayed on HMI.**

| No. | Voltage (V)   | Current (A) | Power Total (VA) | Rpm | Temp. (°C) | Freq (HZ) |
|-----|--------------|-------------|------------------|-----|------------|-----------|
| 1   | 220          | 221         | 220              | 1.0 | 0.8        | 0.9       | 571.7 | 1502 | 31.5 | 50  |
| 2   | 218          | 219         | 220              | 0.9 | 0.8        | 0.9       | 569.4 | 1480 | 31.2 | 49  |
| 3   | 218          | 220         | 222              | 0.9 | 0.9        | 0.9       | 594.0 | 1506 | 31.0 | 50  |
| 4   | 221          | 219         | 224              | 0.8 | 0.8        | 0.9       | 552.7 | 1512 | 30.9 | 50  |
| 5   | 216          | 215         | 217              | 0.8 | 0.8        | 0.8       | 518.4 | 1444 | 30.2 | 48  |
| 6   | 217          | 218         | 219              | 0.9 | 0.9        | 0.8       | 588.6 | 1486 | 29.7 | 49  |
| 7   | 224          | 223         | 222              | 0.9 | 0.9        | 0.9       | 602.1 | 1520 | 32.3 | 51  |
| 8   | 224          | 225         | 223              | 0.9 | 1.0        | 0.9       | 627.3 | 1518 | 31.8 | 51  |
| 9   | 220          | 222         | 220              | 1.0 | 1.0        | 0.9       | 640.0 | 1500 | 31.0 | 50  |
| 10  | 222          | 221         | 220              | 0.9 | 0.9        | 0.8       | 574.7 | 1504 | 31.1 | 50  |

![Figure 5. Voltage (Volt).](image)

![Figure 6. Current (Ampere).](image)
4. Discussion
From the research above, there are some important things to be obtained. The instability of the incoming data is due to the data sent in accordance with that from the RTU, so that HMI displays unstable data as well. But this change in value is not significant and is still within the normal range. This can be caused by several factors, for example the components of the plant simulator.

5. Conclusion
This results of this study, HMI that has worked well. This HMI designed using Visual Basic and can displayed data sent by RTU. Some functions such as status and alarms can already respond when a problem occurs at the plant. Visual Basic can work well if you have an official license, because if you have an unofficial license there will be some tools that cannot be used. For further development, it will focus on real-time data database systems from HMI with Web-based using proper plant simulator.

Acknowledgment
Author deeply thankful to my supervisor, Dr. Yusuf Sofyan for the advice, and support to help finishing this research also supported by Politeknik Negeri Bandung.

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