Design and Implementation of SCADA Training Module: Human Machine Interface (HMI) Based on Open Software

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RESEARCH ARTICLE

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Design and Implementation of SCADA Training Module: Human Machine Interface (HMI) Based on Open Software

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HMI is a part of Supervisory Control and Data Acquisition (SCADA). The provision of HMI requires a relatively high cost as most HMI products on the market are intended for industrial purpose. This makes it difficult for educational institutions, such as vocational schools, colleges, courses, and training institutions. This paper suggests an alternative HMI which is built by using open-software concept approach for developing software parts and optimizing hardware requirements so the total cost required will be much lower. It utilizes open source software Microsoft Visual Studio Community version as the main platform and combined with AdvancedHMI as a source of visual components. The hardware core is built using fanless Single Board Computer (SBC) which has low power profile, no need for maintenance, small and compact.

Keywords: SCADA, Human Machine Interface, Open Source, SBC.

1. INTRODUCTION

SCADA is built from several parts of supervision, control, data acquisition and interface system/HMI which provides interaction between human and system.[1,4] Human-machine interaction with industrial plants and other dynamic technical systems has nowadays been recognized as essential for process safety, quality, and efficiency. It comprises all aspects of interaction and communication between human users and their machines via human machine interfaces.[2] Supervisory control is the set of activities and techniques developed over a set of controllers (programmable logic controllers and process controllers) which ensures the fulfilling of control goals. One of the main goals is to prevent possible plant malfunctions that can lead to economical lose and/or result in damage.[6] There is a human machine interface (computer display, industrial panel) provides the connection between the human operator action and the input to algorithm control inside the controller (control based PC, control based PLC).[5]

In the past, the user interfaces in the Visual Display Unit (VDU-based) control rooms were character-based (CUI: character-based user interface) where the users mainly input data to the system with keyboard-like input devices.[3] Development of computer technology today has a major role in the development process of interaction in computer-based applications.[11] Nowadays, the CUIs have been replaced with graphic user interfaces (GUIs) which is computer-based.

HMI is used by educational institutions for SCADA training purposes. Students practice their ability to perform control and monitor simulated industrial process through HMI screen. There are many products of HMI developed by various brand in market. The average price varies from 750 to 850 Dollars for 10 inches screen size of 800 × 480 pixels resolution. Educational institutions will have difficulty to afford that cost for they will need 1 unit/person to have a good training program. It is needed to develop an alternative HMI which is more economic and still has major features of existing industrial HMI. This paper proposes the solution through open-software concept approach for developing software parts and optimizing hardware requirements so the total cost required will be much lower. It utilizes an open source software Microsoft Visual Studio Community version as the main platform for screen design of HMI and combined with AdvancedHMI as a visual components. Microsoft Visual Studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web apps, web services and mobile apps. Built-in languages include C[7], C++, VB.NET, C#, F# (as of Visual Studio 2010[8]). Support for other languages such as Python,[9] Ruby, Node.js, and M among others is available via language services installed separately. It also supports XML/XSLT, HTML/XHTML, JavaScript and CSS. Java (and J#) were supported in the past. The Visual Studio Community edition was announced on 12 November 2014, as a new free version similar in functionality to Visual Studio Professional. Visual Studio

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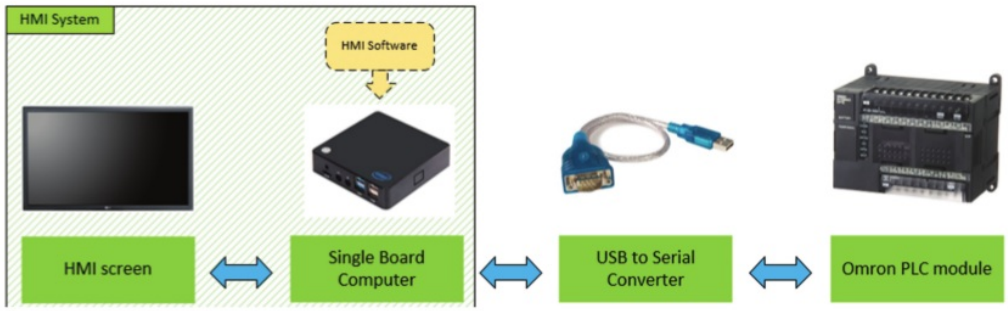

Fig. 1. Hardware interconnection between HMI and PLC.

Community is oriented towards individual developers and small teams.[10] AdvancedHMI is software based on .NET framework and uses Microsoft Visual Studio as development environment. It has several basic visual components and functions for building HMI and built-in PLC communication driver such as Omron, Modbus, and Allen Bradley.

The hardware core is built using Single-Board Computer (SBC). The testing of HMI will be done by connecting to Programmable Logic Controller (PLC) module as an unit control and data aquisition. The results of the research are expected to be widely applied in educational institutions, training institutions and home industries.

2. EXPERIMENTAL DETAILS

There are hardware and software part of building blocks of HMI. Hardware part is built using fanless single board computer (SBC) and general purpose touchscreen monitor. HMI is connected to Omron PLC module using USB to serial converter as seen on Figure 1. It uses VGA for graphic signal and USB for touch signal. Touch driver is provided by Microsoft Windows 10 operating system. Software part includes basic functions such as discreet and analog inputs, discrete and analog indicators, and ability to record data. All functions are presented as visual components provided by AdvancedHMI. Discrete and analog inputs will give access to human operator to control process parameters and acknowledge any alarm or failure condition. Discrete and analog indicators will give information to human operator about process status and conditions. Critical process value parameter will be recorded periodicaly and stored in internal memory then human operator can collect it easily with common USB drive.

3. RESULTS AND DISCUSSION

Figure 2 shows the Omron PLC module used for HMI tests. It has special input and output peripherals associated with visual components on HMI screen. Discrete inputs is tested by touching the push button on HMI screen as seen on Figure 3. Analog input is tested by entering input voltage value on HMI screen. The input voltage value from HMI screen is compared with voltmeter reading on PLC analog output voltage terminal as seen on Figure 4. Discrete indicators is tested by comparing the PLC output status with output indicator associated on HMI screen as seen on Figure 5. Analog indicator is tested by changing the analog input voltage potentiometer on PLC module. The voltage value display on HMI screen is compared with voltmeter reading on PLC analog input voltage terminal as seen on Figure 6. Datalogger function and alarm is tested as seen in Figure 7. Log file contains the time and input voltage value from PLC module.

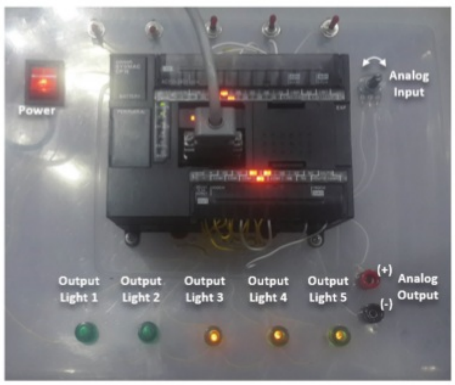

Fig. 2. Omron PLC module for testing purpose.

Fig. 3. Discrete inputs testing.

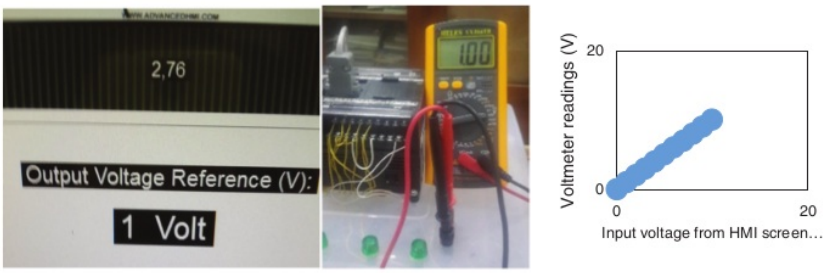

Fig. 4. Analog input testing.

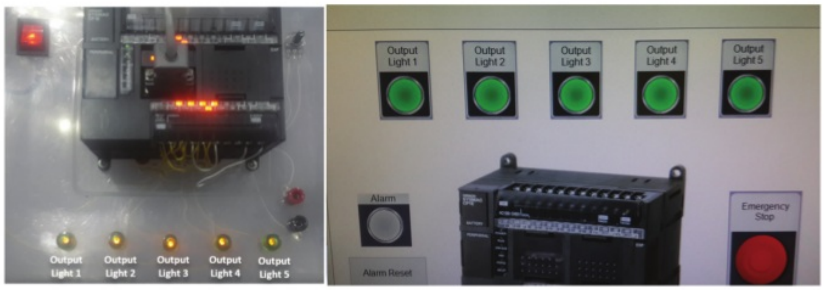

Fig. 5. Discrete indicators testing.

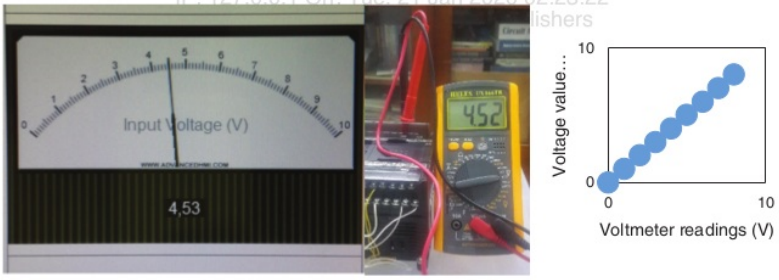

Fig. 6. Analog indicator testing.

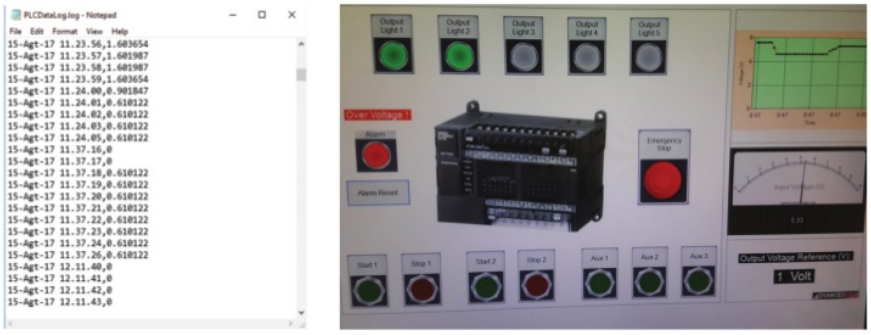

Fig. 7. Datalogger and alarm function testing.

4. CONCLUSION

An alternative HMI proposed in this paper has worked perfectly. The HMI software part and HMI screen design process is easy to build by utilizing the benefit of free open-software, Microsoft Visual Studio Community version and AdvancedHMI. The hardware part is also easy to obtain from the market and relatively has cheap price for small screen size. The HMI screen is very scalable because it can utilizes any touchscreen monitor with USB touch signal interface. Computation load is also light so it can run smoothly with low power based processor with minimum 2 GB of RAM. By utilizing free open-software for HMI software development, low profile hardware specifications, and easy to replace feature (hardware is easy to obtain from market), an alternative low cost HMI can be achieved.

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