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Boiler Temperature and Pressure Monitoring System for Thermal Power Plant through LabVIEW

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Abstract. In the ongoing processes of the thermal power plant, temperature and pressure regulation and control is important. The complete process involves two main sections, such as a temperature- and pressure sensor, which is regulated with a real-time control program and therefore employing a temperature- and pressure sensors. Within this research, a temperature sensor and pressure sensor centered on the MEMS is developed for the sensing and monitoring of temperature and pressure, along with the use of LabVIEW. This study is mainly used in the thermal plants where the high-frequency wave is being emitted. Since the wireless data transfer is being distracted by these frequencies noise this study with the help of CAN is been implemented for the information sharing and with the help of LabVIEW the process takes place in the industry can be controlled from a single monitoring room which reduces the manpower.

Keywords: Thermal power plant; temperature sensor; pressure sensor; boiler; LabVIEW

1. Introduction

This study demonstrates monitoring and controlling multiple parameters [1] of the industry using the CAN and ARM controller. The study aims at monitoring the important parameters of the boiler [2] in an industry. The parameters that are to be monitored are pressure and temperature. These parameters are taken and given to the microcontroller [3] after converting into the required formats. The microcontroller transmits the parameters to a PC. The study uses pressure and temperature sensors [4] for measuring them. Further, the parameters are taken converted into digital by a microcontroller with inbuilt ADC. The same can be received by the PC [5] and displayed in the PC for analyses. ARM controllers are selected because of their high speed [6] and complex operations. The ARM Cortex is a 32-bit processor core designed for high-performance applications in fields like automobiles, wireless networking, and industrial controls. It is based on the popular ARMv7-M processor [7] core and has been tailored for high speed and high-performance 32-bit microcontroller units. This study will use a microcontroller

from the Texas Instruments Stellaris series of microcontrollers based on the ARM Cortex. All these individual devices are connected using a network that employs CAN which is a long-distance serial protocol [8] and RS232 standards. The use of CAN gives the advantage that each system can be nearly 4000 feet apart but still communicate with accuracy.
Further, it provides greater immunity to the noise in an industrial environment. Further, all the obtained data and the control data are displayed on the PC which runs virtual instrumentation (VI) LabVIEW [9] which is an advanced measurement and automation software. The user-friendly control panel gives the operator to operate everything in mouse clicks whereas its robust architecture gives reliable security [10] and unmatched accuracy. VI has everything in digital so any change can be made with ease. Further, a lot of analyses such as histograms, graphs, etc. which are not possible in conventional software can be plotted on the screen. Further, the user interface has the option of user setting the threshold values thereby making the whole process entirely dynamic. So the whole system can be used for multiple machines and the parameters can be set depending upon the machine and the actual requirement. This prevents the breakdown of the machine [11] and in many cases prevents the whole industry from the shutdown. The response time is in milliseconds and so there is very little chance of error.
Ahmed Ghaly et al., [12] undertook an automated multi-sensor LabVIEW core test to incorporate a wide range of smart temperature monitoring device. This paper aims to use an auto-selected multi-sensor center in LabVIEW to incorporate a broad spectrum temperature measurement method. This multi-sensor center can be made up of a variety of different sensors and can measure multiple temperature ranges. Lazarević et al. [13] have developed a novel approach to designing the substation heating system in real-time with LabVIEW. The mathematical model of the heating substation is described in this study, which is a significant aspect of the district heating system. The key components in this paper of the heat exchanger and three-way valve from the automated control point of view are the district heating substation system. Ricman et al., [14] have done work on the development of solar collector online logging tools for vacuum control. The goal of this work is to create a program for pressurizing a solar thermoelectric hybrid device solar collector in the vacuum chamber. These experiments contributed a great deal to finalizing the aim of this work.

2. Methodology and Design

Figure 1 shows the field unit of the proposed work and Figure 2 shows the control unit design where it's connected to the pressure and temperature sensor monitoring [15] which has been controlled from a base station via LabVIEW. The CAN protocol is implemented for transmitting and receiving the signal in both the field unit and the control unit [16] in the thermal plant.

3. Interface Equipment's

The first ARM ® CortexTM-M3 based controller, ARM, is the Stellaris ® family of microcontrollers that introduces high-speed 32,000-bit computing to cost-sensitive embedded microcontroller applications. These revolutionary modules provide a 32-bit cost-efficiency equal to the legacy 8-bit and 16-bit systems in a compact footprint box. The MicroController LM3S811 is intended to work in industrial applications including monitoring and measuring equipment, plant automation, HVAC and building management, motion control, medical devices, fire and protection, and power/energy. The LM3S811 microcontroller [17] also provides the benefits of widely-accessible developer software for ARM, the IP-infrastructure application System-On-Chip (SoC), and a robust user base. Besides, the microcontroller uses the Thumb-2 compliant instruction from ARM to minimize and thus cost memory requirements. Finally, the microcontroller LM3S811 is programmed for all the members of Stellaris' large family and scalable to satisfy the exact specifications of our clients.

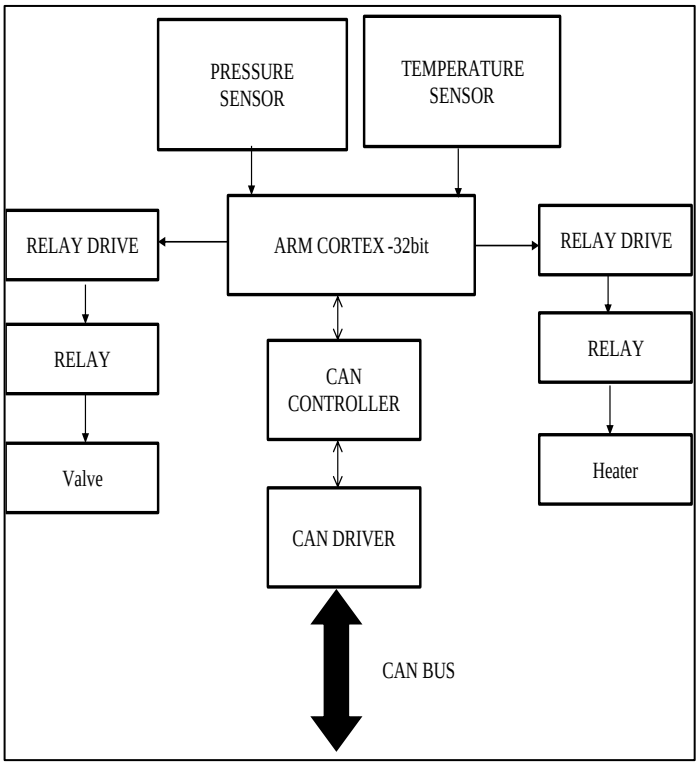

Figure 1. Field unit

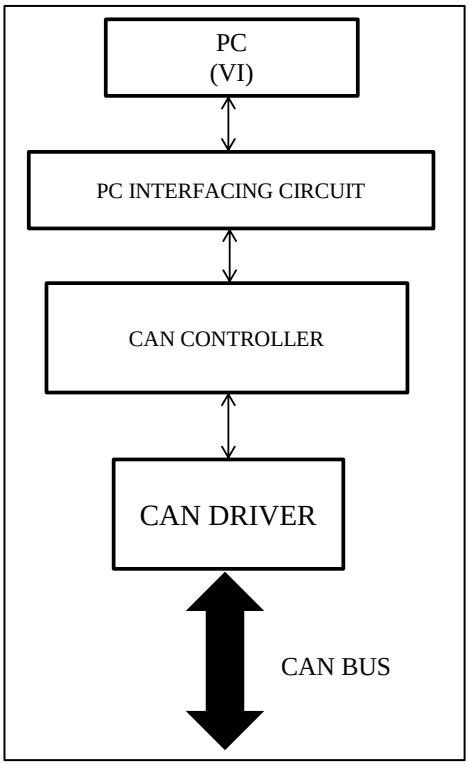

Figure 2. Control unit

The CAN is a typical vehicle bus system that enables the communication between microcontrollers and devices [18] in a vehicle without a host computer. It was originally developed for automobile applications but is now used in other fields as well. In this study, we are using MCP2551 [19] as a CAN transceiver. It is an 8Pin IC and It is capable of duplex CAN communication. The LM35 series are integrated precision circuit temperature sensors with a linear output valuation commensurate with the temperature of Celsius. The LM35 is incredibly easy to re-read or handle circuits with its low output impedance, a linear output, and accurate inherent adjustment. It can be used for single energy sources or more and less. Since it only pulls 60 μA from its source, its auto-heating is very low and even airs below 0.1°C. It is rated that the LM35 may work in a range of temperature from −55°C to +150°C, while the LM35C may work inside −40°C to +110°C [20] (−10°C with enhanced precision).
The Piezo Resistive Transducers series MPX5010 are state-of-the-art monolithic silicon pressure sensors designed for various applications, but particularly those with A / D inputs on a microcontroller or microprocessor. The present can be turned on or off. Relay location is double-throw switches and the present can be turned on or off. Relaxes allow for a second circuit to be entirely independent of the first circuit. For starters, a relay may be used to turn a 230V AC power circuit by a low voltage battery circuit. The interfaces are magnetic and mechanical. There are no electrical connections in the relay between the two circuits.

4. Results and Discussion

Figure 3, 4, 5, 6 shows how the LabVIEW interface is being used for monitoring the boiler. The relay circuit is used to cut the temperature source and to release the pressure when it's attained the saturation point. From Figure 3, one can see that the temperature and the pressure were maintained in the normal condition. The relay circuit and the RS232 series connections have been placed to monitor the conditions change in the vessel. The LabVIEW provides the virtual monitoring of the panel where the monitoring can be controlled through GUI. When the pressure and the temperature started to increase in the vessel,

the GUI started to show the indication of the rise in the temperature and also in pressure. In Figure 4, one can identify that the temperature and pressure exceed the maximum range the relay is being switched off as it might cause a problem inside the vessel.
Figure 5 and Figure 6 show the variations in the instability of the pressure and the temperature inside the vessel. The relay is used to monitor the changes and concerning the variations, the temperature and the pressure feed is turned on and off. The pressure and temperature were monitored through the base station have it has to be in controlled condition so these RS232 with LabVIEW helps in transmitting the information directly from the vessel to the base station. The reason behind using the wired connection is because the environmental disturbance can be neglected and the transfer rate will be high when compared to the wireless communication. This system makes the perfect monitor of the vessel and this will increase the accuracy level of the temperature and the pressure monitoring of the vessel.

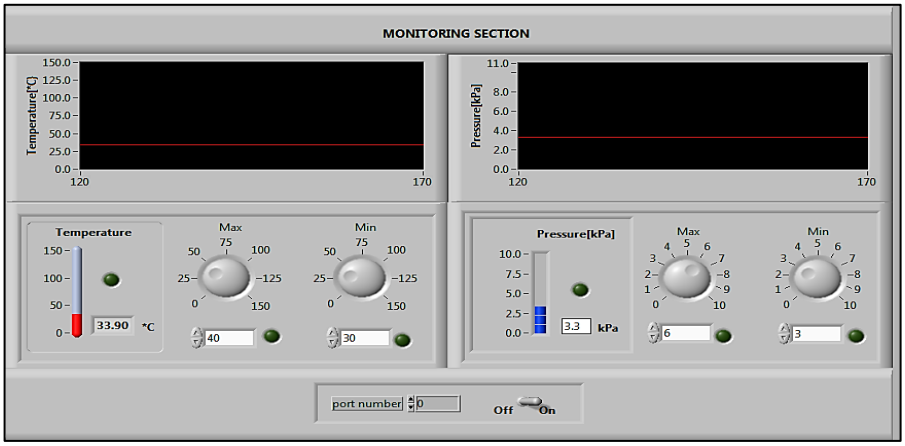

Figure 3. At the beginning stage when the temperature and pressure are normal in condition

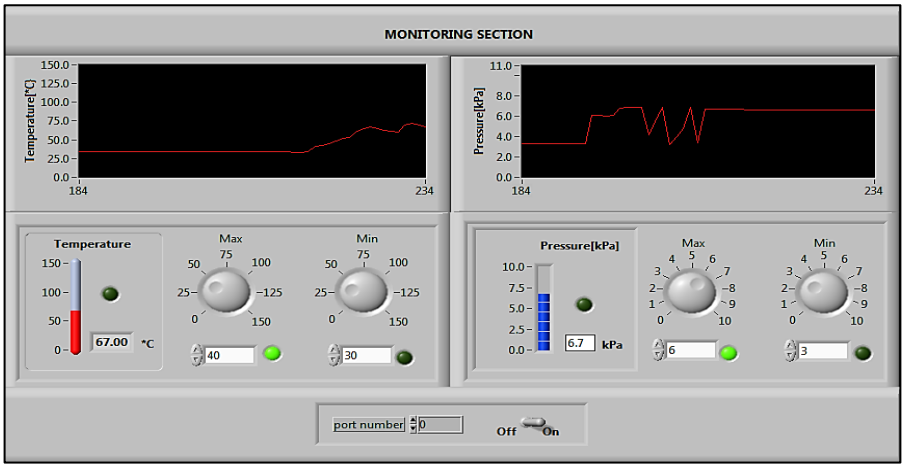

Figure 4. When the temperature and pressure exceeds the maximum range the relay is being switched off

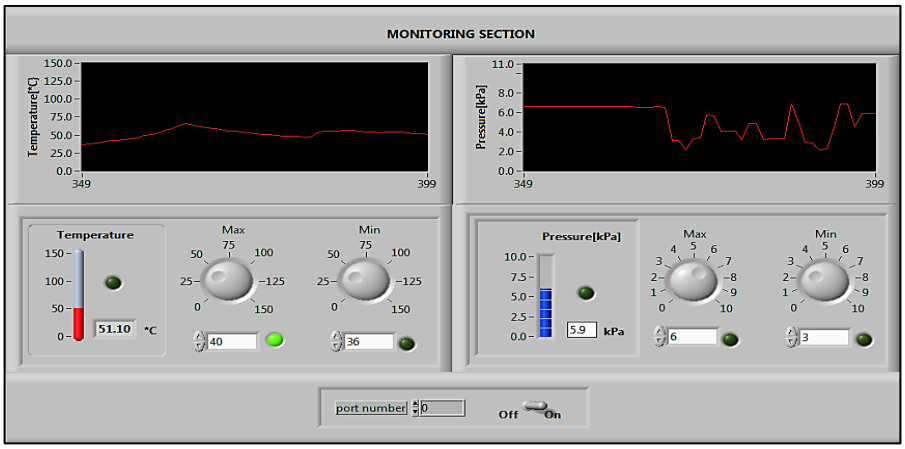

Figure 5. Variations are being shown in the monitoring screen

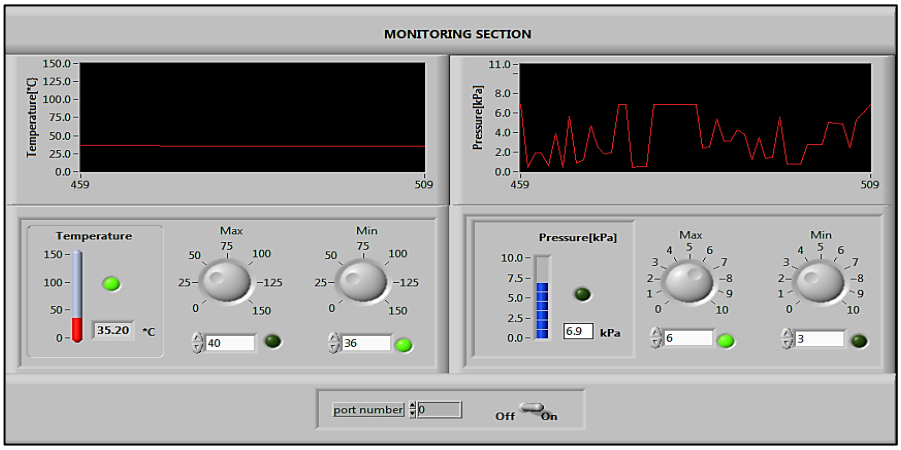

Figure 6. Relay is being switched on after it becomes to the normal condition

5. Conclusion

As this study is being concerned the thermal power plant boiler which is been spread to a large area can be monitored and controlled by a single personal computer (PC) in which the transmission of the data is been taken with the help of CAN. The pair of CAN wires are being used in the data transfer in which the replacement of the defected is been simple. This study is mainly used in the thermal plants where the high-frequency wave is being emitted. Since the wireless data transfer is being distracted by these frequencies noise this study with the help of CAN is been implemented for the information sharing and with the help of LabVIEW the process takes place in the industry can be controlled from a single monitoring room which reduces the manpower.

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