Implementing a Reliable Furnace Monitoring System

by

V. Arunachalam
Sr. Project Engineer

Anand Chinnaswamy
Director & CTO

Ganesh Devaraj, Ph.D.
Managing Director

Soliton Automation Pvt. Ltd.

Category:
Manufacturing

Products Used:
RT Series PXI (PXI 1002 And PXI 8156B)
LabVIEW™ Real-Time
FieldPoint™

The Challenge: Implementing a reliable oven monitoring system that operates around the clock and unattended during the night, with supervisory control to shut down ovens that show signs of faulty operation.

The Solution: Developing a highly reliable, flexible monitoring and supervisory control system, accessible via the Web. Using National Instruments RT Series PXI, FieldPoint distributed I/O modules, and LabVIEW Real-Time graphical development environment to monitor and record the process parameters in 20 ovens and initiate safety shutdown when necessary.

Abstract
We developed a highly reliable and flexible monitoring and supervisory control system using RT Series PXI, FieldPoint distributed I/O modules, and a PC running a LabVIEW application. The system monitored and recorded the process variables in 20 ovens and also activated the shutdown procedures in the event of any emergency. The LabVIEW Real-Time application running on PXI provides the reliability needed for this system, which operates around the clock and unattended during the night. The system is also Web-enabled for remote viewing of the status and reports.

Introduction
The GE Medical Systems plant located in Bangalore, India, manufactures many critical components used to build sophisticated, high-value medical equipment. Some of these components are processed in ovens where both the temperature and vacuum are cycled according to predetermined recipes for up to 72 hr. Figure 1 shows the layout of the ovens in the plant. The oven manufacturer equipped each of the 20 ovens with a programmable logic controller (PLC) to control the numerous valves, vacuum pump, and sense operator inputs such as start and stop. A PID controller was incorporated for temperature control.

Figure 1: Layout of the Ovens in the Plant

Because the ovens were purchased at different times and they came equipped with PLCs of different manufacturers, the customer found it difficult to link them to a central computer to automatically record the process values. Therefore, this procedure was conducted manually by periodically reading the local displays showing the temperature and vacuum. When the number of ovens increased to 20, the customer decided to establish an automated monitoring system. They called upon Soliton Automation to provide a solution. GE wanted their investment in the monitoring system to ideally give them the following features:

- Automatically record the process parameters from each of the ovens (temperature and vacuum)
- Raise alarms and automatically shut down the oven in case of an emergency (over temperature for example)
- Provide the reliability to operate around the clock and also unattended during the nights
- Perform as a highly flexible system which can be reconfigured and reprogrammed easily for monitoring different cycle profiles and different alarm conditions
- Offer remote access to the entire monitoring system across the Web

The customer clearly wanted the flexibility, easy networking capabilities, and standardization provided by a Windows-based monitoring system. However, they also mentioned that reliability was a serious concern because the system had to run continuously around the clock. National Instruments innovations kept pace with the market requirements because NI released LabVIEW Real-Time for the PXI.

System Description

A schematic of the networked furnace monitoring system (FMS) is shown in figure 2. The brain of the system is the RT Series PXI, which continuously monitors the oven parameters, checks them against the limits, and initiates appropriate actions when necessary. Because the ovens are distributed around the plant floor, FieldPoint distributed I/O modules are used for the remote data acquisition and control. A PC running a LabVIEW application provides the user interface that allows the operator to view the status of all

the ovens and also set up the different cycle profiles and alarm conditions. The PC also runs a Web-server that allows the detailed status and trends to be viewed over the Internet.

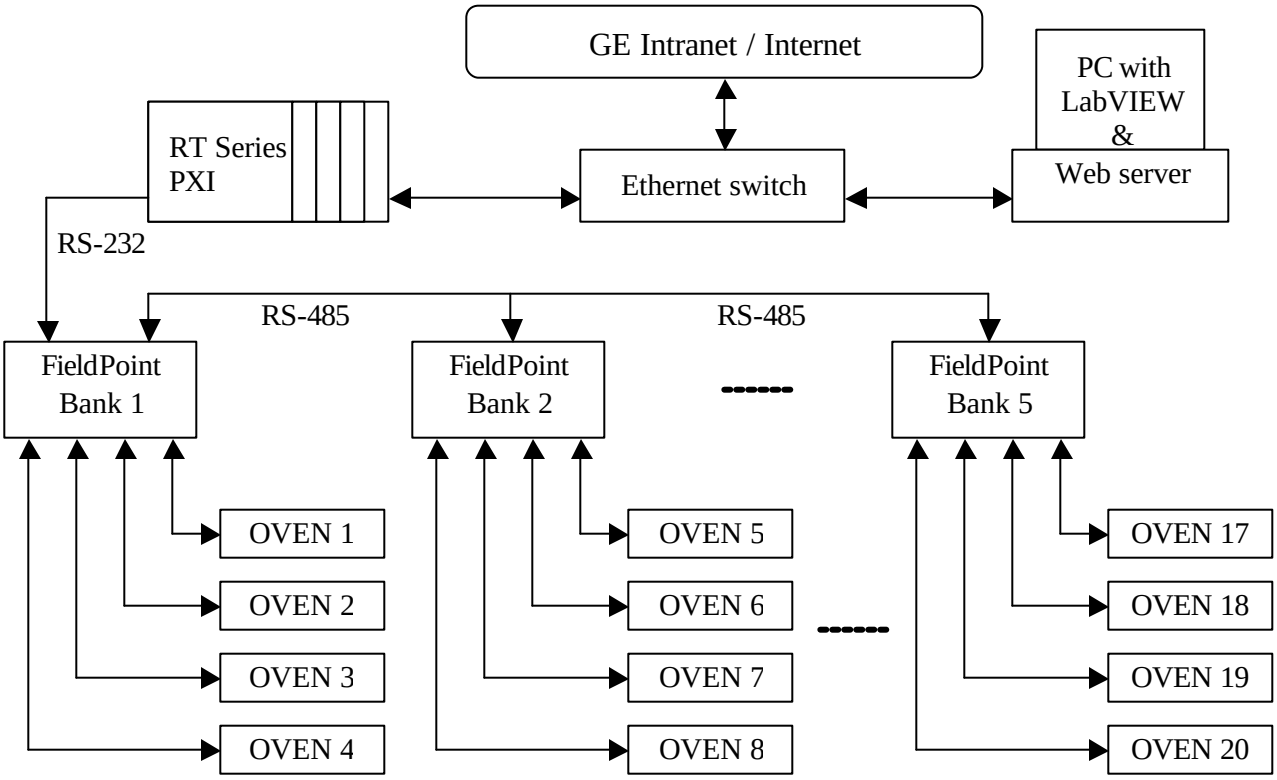

Figure 2: Schematic Representation of the Networked Furnace Monitoring System

The data acquisition from the ovens and the supervisory control is accomplished using distributed FieldPoint modules. Five banks of FieldPoint modules are used (depicted in figure 2) where each bank consists of a thermocouple module, an analog input module, a digital input module, and a relay module along with a RS-485 communications module. These modules are wired to the thermocouples, vacuum sensors, operator push buttons, audio alarms, and the main contactor feeding power to the ovens (for emergency shutdown).

The RT Series PXI system polls all the inputs from the 20 ovens every 250 ms, and then checks them against the expected profiles and tolerance limits. If a problem is detected, an audio alarm is raised, and the oven is shut down if necessary. The temperature and pressure values are periodically transferred to a database on the PC. TCP/IP is used to transfer the data from the RT Series PXI to the PC and the LabVIEW application running in the PC writes this data into an SQL database. An IIS Web-server running on the PC displays Web pages showing the current status of all the ovens, parameter trends, and the history of the alarms for each oven using the data from the database (Figure 3).

The PXI running LabVIEW Real-Time provides the necessary reliability for around the clock operation. If the PC or the Ethernet network connection fails, the RT Series PXI continues to perform monitoring and supervisory control and saves the measured data in the local 4 GB hard drive, while periodically rechecking the connection to the PC. After the connection is reestablished, the software applications running in the RT Series PXI and the PC work together to transfer the data to the database on the PC. Because the RT Series PXI has substantial hard drive capacity, no data is lost even if the PC is down for an extended time.

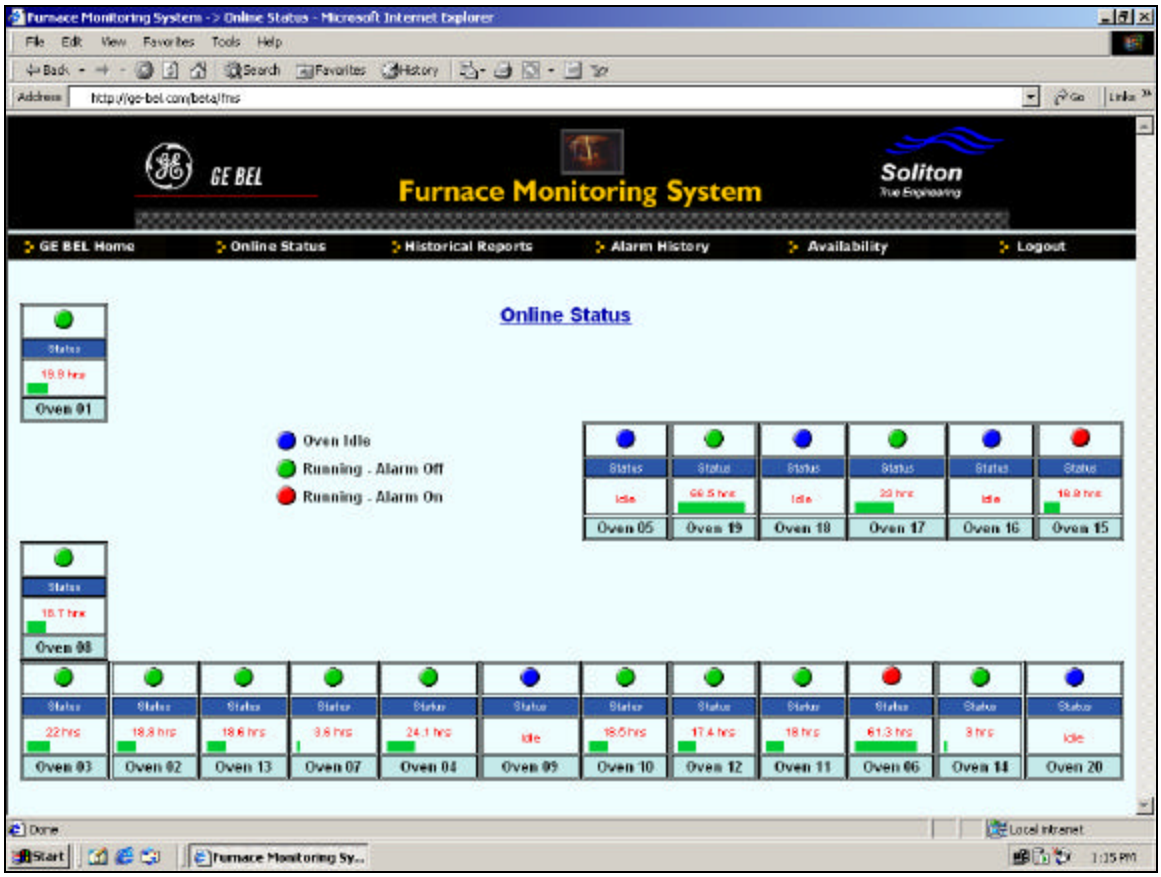

Figure 3: Oven Status across the Web

System Benefits

Comparison Parameter	Earlier Manual System	RT Series PXI-Based System
Productivity and Cost	People required around the clock to monitor and log parameters	Fully automated
Reliability and Safety	Cannot ensure integrity of manually collected data; no redundant safety mechanisms	Reliable data collection; supervisory control provides safe shutdown in case of malfunction
Access to Oven Status and Scheduling	Oven status updated only once every 30 min without convenient access for scheduling	Continuous real-time access to the status of all the ovens, alarms, and trends, from any location via the company intranet and Internet; scheduling becomes easy

Table 1: Comparison between the Earlier and New Systems

Conclusion

The customer wanted the reliability of a real-time operating system (RTOS), along with the benefits of the Windows operating system in terms of programming ease and networking standardization. The networked

furnace monitoring system built around RT Series PXI and FieldPoint has proven to be ideal for the application. Having never been exposed to an RTOS earlier, it would have been impossible for us to develop such a sophisticated system with all the features required by the customer and deploy it in 10 weeks without LabVIEW Real-Time. After the successful completion of this project, we confirmed that LabVIEW Real-Time provides both the reliability of an RTOS and the programming ease of LabVIEW.