



Design and Implementation of Smart SCADA in Sugar Mill using LabVIEW

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ABSTRACT

The objective of this paper is to describe the method for implementing smart features in sugar mill SCADA (Supervisory Control and Data Acquisition) system. Indian sugar industry is the second largest agriculture based processing industry after the cotton textiles industry in India. There are more than 500 sugar factories in India. Over the years, the Indian Sugar Industry has been relying on 'analog automation systems' for various controls in Mill Section. Since last decade, the whole world of process industry is transforming from analog to digital, and even Sugar Industry cannot stay lagging the world. But in India, digital automation in sugar industry is very limited. Fully automated sugar mills are very few. The presented method aims towards providing smart automation system in sugar mill. The graphical programming software LabVIEW has been utilized to develop SCADA software. Virtual instrumentation is the latest form of modern technology and it is highly customizable. By using smart SCADA system, the performance and reliability of the sugar mill can be improved.

Key words: SCADA, G programming, LabVIEW

INTRODUCTION

SCADA is not a specific technology, but a type of application. SCADA stands for Supervisory Control and Data Acquisition - any application that gets data about a system in order to control that system is a SCADA application. In order to automate a plant and minimize human intervention, there is a need to develop a SCADA system that monitors the plant and helps reduce the errors caused by humans [1]. Supervisory Control and Data Acquisition systems are computers, controllers, instruments; actuators, networks, and interfaces that manage the control of automated industrial processes and allow analysis of those systems through data collection. They are used in all types of industries, from electrical distribution systems, to food processing, to facility security alarms.

Automation in Sugar Mill

India is the second largest country to produce sugar worldwide. About 45 million farmers are engaged in sugarcane cultivation in India. India produces around 250 lakh tonne of sugar per year. Most of the sugar mills of India have been relying on analog automation system. No doubt, these systems have definitely served the industry up to the mark, but with a very basic purpose. Key benefits of automation in the sugar industry are:

- Improved recovery by 0.5 to 1% (absolute units)
- Reduction in manpower (30% to 40%)
- Savings in steam (and water) consumption by 5% to 10%.
- Savings in electrical power consumption by 5% to 10%.
- Increased percentage extraction
- Improved reliability in plant operation
- Reduction in sugar ICUMSA (International Commission for Uniform Methods of Sugar Analysis) by 10 to 20 units
- Uniform grain size of sugar
- Control on sulphur content
- Elimination of operational human errors

PLC (Programmable Logic Controller) based SCADA system are being used in sugar mill to implement automation system. PLC is being used to perform control action and transferring field data to master station. An operator can monitor or alter the values of plant variables through HMI (Human Machine Interface) at master station. This paper presents the implementation of smart features i.e. real time view of the mill section, message boards, and LUX control in mill operating areas through SCADA software, instant alerts of critical alarm situation through SMS (Short Message Service) and mill equipments maintenance schedule reminder in the existing SCADA system.

DESIGN AND IMPLEMENTATION OF SMART SCADA

A smart SCADA system for sugar mill has been developed with combined implementation of hardware and software. Hardware has been developed for implementing smart features like real time view, LUX control, SMS alert and message board displays while software development provide HMI to control plant operations.

Hardware Framework

Fig. 1 shows the basic hardware framework used for implementing the smart features of SCADA system. The hardware for implementing smart features of SCADA system has been interfaced using USB (Universal Serial Bus) ports. For real time view of the sugar mill, cameras have been interfaced directly to USB ports while other modules have been controlled through microcontrollers and interfaced through USB to serial converter.

Software Framework

Fig. 2 shows the software framework used for SCADA design. The mimic diagrams of sugar mill have been designed in software. The mimic diagrams of sugar mill have been divided into different sub-diagrams. Graphical User Interface (GUI) and block diagram has been designed using G programming in LabVIEW.

Real Time View Module

The real time view has been implemented by using vision development module of LabVIEW software. It has been used to grab real time view from cameras installed in the mill. IMAQdx open camera function has been used to load the camera configuration file and creating a unique reference to the camera. IMAQdx configure grab function has been used to perform acquisition that loops continually on a ring of buffers. IMAQdx close camera function has been used to stop the current acquisition and releases the resources. The webcams has been connected through USB ports of PC (Personal Computer) to acquire real time images of the mill. Fig. 3 shows the simulation of Real Time View module. Each attached camera has been identified with a unique number such as cam0, cam1, cam2 and so on in camera name box. Multiple cameras can be attached to SCADA software for real time viewing.

Message Board

The message boards have been used for displaying instructions to field operators controlled by SCADA operator. The message boards have been used for mirroring the process variable values of SCADA software to field operators. The LCD (Liquid Crystal Display) has been used as a message board. Menu controls of LabVIEW software have been used to select the mode of display. String controls have been used to write the messages. Boolean push buttons have been used to send the messages to microcontroller. The mode of display can be selected through software. It can operate in message mode or indicator mode. If indicator mode has been selected then the message board will display the current levels of chute on message board 1 and the display will automatically update at regular interval. Otherwise it will display the message written by operator in the display box. Fig. 4 shows the simulation of message board.



Fig.1 Hardware Framework for SCADA System

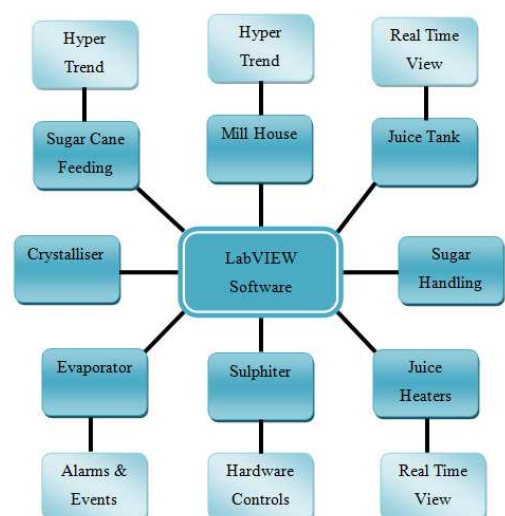


Fig. 2 Software Framework for SCADA System



Fig. 3 Simulation of Real Time View



Fig. 4 Simulation of Message Board

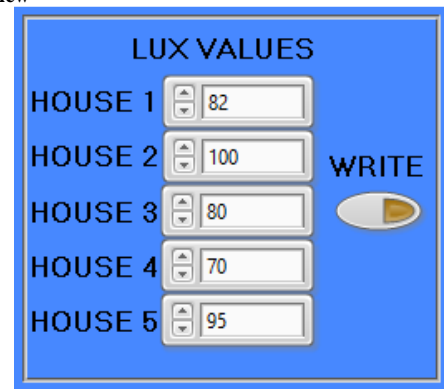


Fig. 5 Lux Control Module Interface

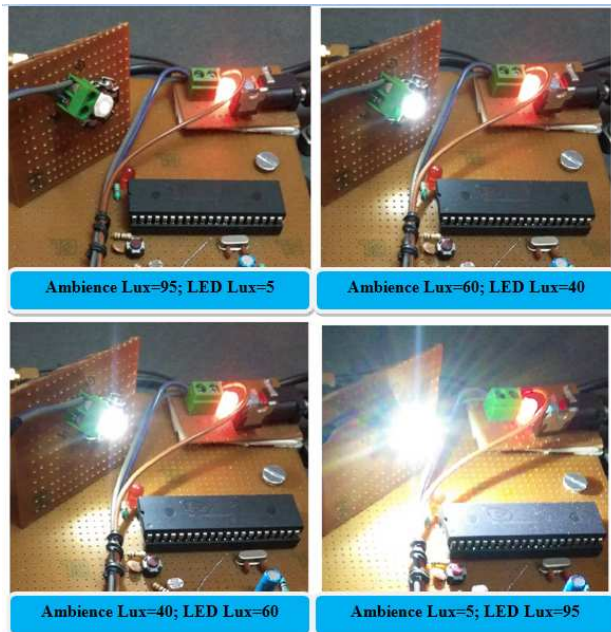


Fig. 6 Variations in Intensity of LED Lamp

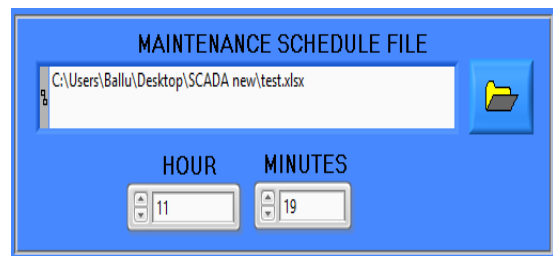


Fig. 7 Simulation of Maintenance Schedule Reminder

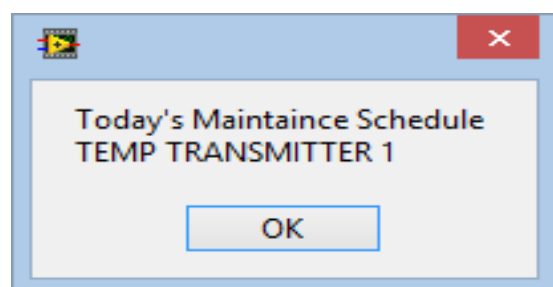


Fig. 8 Pop Up Message Window



Fig. 9 GSM Module

Lux Control Module

Lux control module has been designed to maintain recommended lux levels in different working areas of the mill. Lux control module senses the current lux levels of the area and compares it to desired lux levels. If current levels are not equal to desired levels than it varies the LED (Light Emitting Diode) lamp intensity to match with desired levels. A LDR (Light Dependent Resistor) has been used to sense the lux levels of a particular area. The intensity of a power LED has been varied to maintain lux levels of that particular area. Lux levels have been transferred to microcontroller with a push of write button. The string of lux levels and set of identification characters has been concatenated with concatenate string function to make a single string of characters. The levels of lux have been set through software for various houses. Fig. 5 shows the software interface of lux control module. The software sends the desired lux levels of different houses to lux control hardware through serial communication.

Fig. 6 shows the actual variations in LED intensity to maintain a desired lux level of 100 LUX under different ambience light variations.

Maintenance Schedule Reminder Module

The maintenance schedule reminder reads the maintenance schedule excel file everyday at a specified time. Excel worksheet library has been used to read the maintenance schedule file. Current date and time of the system has been compared with the file. If the time and date matches than a pop appears on computer screen to notify about the today maintenance schedule. The path of excel file has been entered in maintenance schedule file box and the time has been set for reminder. Fig. 7 shows the simulation of maintenance schedule reminder. A pop up message window has been appeared to remind the maintenance schedule. Fig. 8 shows the pop up message window.

GSM Alert Module

GSM (Global System for Mobile Communications) module has been used to send critical alert messages of mill processes to mobile phones. The critical alarms raised in SCADA software has been sent to mobile phones by GSM module. The GSM module used is SIM300. Fig. 9 shows the SIM300 GSM module. The string of mobile number, alert message and set of identification characters has been concatenated with concatenate string function. The sequence of mobile alert message has been initiated with occurrence of critical alert.

RESULTS AND DISCUSSION

The advantages of smart SCADA over traditional SCADA are as follows:

Realistic Graphics

The developed smart SCADA has more realistic mimic of the industry. It has eye catcher graphics with animation effect.

Standard Based

The smart SCADA has been developed in open or standard based environment as compared to proprietary traditional SCADA software.

User Friendly GUI

The developed graphical user interface is user friendly and easily operates able with tab controls.

Wide Communication Protocol Support

The developed smart SCADA software supports a number of industrial communication protocols to communicate with hardware such as CANopen, DeviceNet, DNP, EtherCAT, EtherNet/IP, Foundation Fieldbus, Modbus serial and TCP, Profibus, OPC DA, OPC UA.

Camera Interface

Cameras have been interfaced with the developed smart SCADA software for real time view of the industry. It supports various standards of cameras interfacing such as IEEE 1394, Gigabit Ethernet, USB or IP (Internet Protocol) camera.

Message Board Interfacing

Message boards have been interfaced with the software. The boards can be used as process local indicators or message display, selectable through GUI.

Lux Control

The developed SCADA software has the feature of controlling lux of various working areas through master station.

Instant Alarm Notification

The smart SCADA software has the capability of sending SMS alert of critical alarm situation to the higher authorities.

Maintenance Schedule Reminder

The developed software automatically reminds the operator about the service schedule of instruments.

Future Customization

The developed software is based on the virtual instrumentation; it is easily customizable for future advancement.

CONCLUSION

The features of the smart SCADA system developed by author are as mentioned below:

- A user friendly human machine interface has been developed using LabVIEW.
- Low cost high performance microcontrollers have been used to implement smart SCADA.
- The developed lux control module reduces the energy consumption of mill lightning system.
- The developed real time viewing system enables the SCADA operator to monitor and survey mill processes.
- The developed message board module mirrors the SCADA values of process variables to field operators.
- The developed GSM module floats the SMS about event of high alert in the mill to higher authorities.
- The developed algorithm for maintenance schedule reminder automatically reminds the operator about the service of instruments.
- As the developed SCADA software is based on the most modern technology i.e. virtual instrumentation, it is highly configurable.
- It has ability to save data on computer hard disk, which can be used for further analysis.

The developed smart SCADA system can easily outrun the traditional SCADA.

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