Online Ship Control System using Supervisory Control and Data Acquisition (SCADA)

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Abstract

This paper is practical design and implementation of open architecture ship control, alarm and monitoring system using Supervisory Control and Data Acquisition (SCADA) .Modern ships have an automatic system control which includes control, alarm and monitoring system that have access to all process control station and can monitor them. All the screens for different sensors in our design are

Communication, fire doors control station, each type is dictated to specific task. The alarm system is connected to sensors everywhere in the ship and continuously monitors them, if any sensor reading is outside the preset limits we get an alarm. The monitoring system can record any alarm status and save it in hard disk or printer with time stamp. The alarm system depends mainly on data coming from different sensors connected to corresponding measuring points, also an inhibit control can be applied to certain alarm group for disable at certain conditions for the system

Keywords: IMO, SOLAS, Ship control, Signal Processing, Sensors

Introduction

SCADA is Supervisory Control and Data Acquisition. SCADA systems that use to considered as the HMI (Human Machine Interface) of the SCADA system monitoring a group of sensors, which can help the operator in the control room to make online control on ship. WinCC Flexible is used to create screens. The control system control several types of self-running process as voyage data recorder, GPS, hull opening, hull stress, Radar, ship speed, tank fuel level, fuel and machinery temperature, wind speed and direction.

monitor and control a plant or equipment in industries such as water and waste water control , energy , oil, telecommunications and gas refining and transportation. Within the environment of a marine plant there are many parameters which need to be controlled or monitored including: temperatures, pressure, level, viscosity, flow control, speed, torque control, voltage, current, machinery status (on/ off), and equipment status (open/ closed).In olden times it was the role of the watch keeping engineers to monitor and control the machinery plant. This was achieved by periodically taking rounds around the engine room and manually inspecting the condition of the running machinery. Often the engineer was totally dependent on his natural senses, frequently supported by only the minimum of widely distributed simple monitoring devices. [1] This is an example

design of an open architecture system. The intention here is to Supervisory Control and Data Acquisition (SCADA). To be able to use different number of screens and with different types of man machine interface such that it can display and control different sensor or system status. As an example of these sensors voyage data recorder, GPS, hull opening, hull stress, Radar, ship speed, tank fuel level, fuel and machinery temperature, wind speed and direction. Communication, fire doors control station.

Typical SCADA system and its benefits

A typical SCADA system consists of one more field data interface devices usually RTUs or PLCs which interface to field sensing devices, local control switch boxes and valve actuators. A communication system used to transfer data between field data interface devices, control units and the computers in the SCADA central host which is a central host computer server or servers. A collection of standard and/or custom software, sometimes called Human Machine Interface HMI software , used to provide the SCADA central host and operator terminal application , support the communications system, monitor and control remotely located field data interface devices .Devices such as level meters, water flow meters, valve position transmitters, temperature transmitters, power consumption meters , and pressure meters all provide information that can tell an experienced operator how well a system is performing .Benefits SCADA Systems provide: Reduces operational costs, Provides immediate knowledge of system performance, Improves system efficiency

and performance, Increases equipment life, Reduces costly repairs, Reduces number of man-hours (labor costs) required for troubleshooting or service, Frees up personnel for other important tasks, Facilitates compliance with regulatory agencies through automated report generating
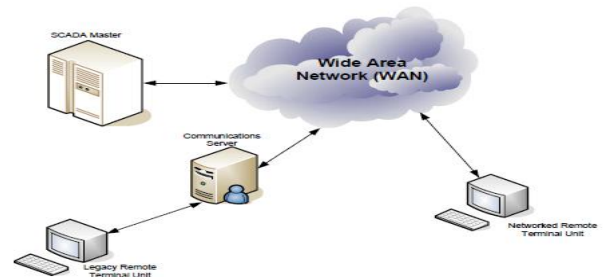

Fig. 1 A networked SCADA system

SCADA software

a. Central Host Computer Operating System It is the software used to control the central host computer hardware.

b. Operator Terminal Operating System the software uses to control the RTU computer hardware. It is usually the same as the central host computer operating system, and usually contributes to the networking of the central host and the operator terminals.

c. Central Host Computer Application the software that handles the transmition and reception of data between the RTU and the central host computer. The software also provides the graphical user interface, which offers site mimic screens, alarm pages, trend pages, and control functions**. d. Operator Terminal Application** it is the application that enables users to access information available on the central host computer application.

e. Communication Protocol Drivers the software that is usually based within the central host and the RTUs, and is required to control the translation and interpretation of the data between ends of the communications links of the system.

Automation Protocols

a. **Standard Protocol VS Vendors Protocols** SCADA protocols have been designed for being extremely compact and a major portion is also designed for sending information to master station only when the RTU is polled by master station. Typically, the legacy of SCADA protocols consists of Conitel, Profibus, Modbus RTU and RP-570. These protocols of communication are specifically SCADA-vendor but they are popularly used and adopted. Standard protocols mainly are IEC 61850, DNP3 and IEC 60870-5-101 or 104. These protocols of communication are recognized and standardized by all big SCADA vendors. Several of these protocols contain extensions for operating over the TCP/IP. It is considered good practice of security engineering for avoiding the SCADA systems from connecting to Internet for reducing attack surface

b. **Compilation of automation protocols** Due to this creation of multitude of control protocols by the developers and its management. In order to 'lock in' their own customer base amongst the many vendors an incentive was there to create own protocols. Compilation of automation protocols is given here. For the better intercommunication between the different software and hardware PLE for Process Control (OPC) is a widely accepted solution, which then even allows communication between the devices which were originally

not even intended to be part of the industrial network

WinCC Flexible

1. Automation Levels are a. Controllers b. Machine HMI c. Process visualization

2. WinCC Flexible Stages The first stage is configuring the HMI devices for operating and monitoring at machine level using the WinCC flexible engineering system, so it replaces the complete functionality of protocol, The second stage is permitting configuration of WinCC functionality, i.e. it will also take over as successor to WinCC" Uniform Engineering " will then exist for the complete visualization sector from a small panel in the lower performance range of operation at machine level up to powerful and redundant client/server structure in the upper performance range of process visualization

3. Components of WinCC Flexible

3.1Engineering System (ES) the Engineering System is the software with which you can carry out all configuration tasks required to create a GUI for operation and monitoring of machines and plants

3.2 Runtime (RT) WinCC flexible Runtime is the software for process visualization on the HMI device to execute the project in process mode

3,3 Options The options depend on the target system used . An HMI device which does not support a particular functionality cannot use the corresponding option either.

The Screens

These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units RTUs and /or Programmable Logic Controllers PLCs, as well as the central host and the operator terminals. A SCADA system gathers information, transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, and displaying the information in a logical and organized fashion. WinCC Flexible is used to create screens, to help the operator in monitoring the following sensors: Communications, Echo Sounder, Fire Doors, GPS, Hull Openings, Hull Stress, Radar, ship speed, level of tank Fuel, Temperature, Wind Speed, and the basic window VDR. Figure 2 shows the VDR window.

Fig.2 Voyage Data Recorder

Moving among screens takes place through the main screen. Choose what sensor you need.

Figure 3 shows the communication screen, which can detect the voice call between the ship crew.
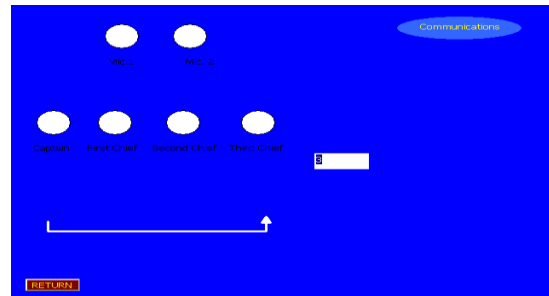

Fig.3 Communication Window

Figure .4 shows fire alarm status. The screen contains three sections; each one has three indication levels. The first level ranges from 1 to 40, which is considered to be safe. The second level ranges from 41 to 70, which indicates the smoking level. The third level ranges from 71 to 100, which indicates the danger level.

Fig.4 Fire Door Windows

Figure 5 shows the Echo Sounder screen. It will be the depth under the keel of ship using acoustic technology .

Fig.5 Echo Souder Window

Figure .6 shows the GPS screen, which indicates the current location of the ship based on the longitude and latitude.
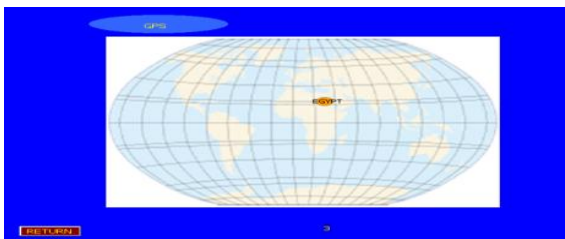

Fig.6 GPS Window

Figure 6 shows the Hull Opening screen, which indicates the current water level on the sides of the ship, that inform user the stability status

Fig. 7 Hull Openings Window

Figure 8 shows the Hull Stress screen, which indicates the current ship weight and the extra weight
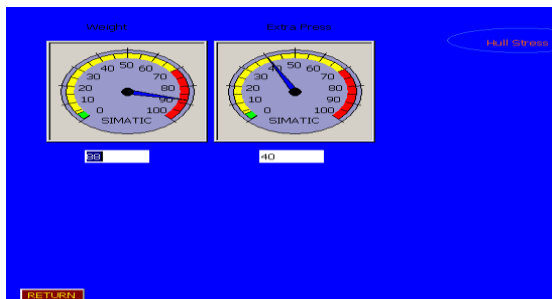

Fig.8 Hull Stress Window

Figure.9 shows the Radar screen, which will detect the moving and fixed targets nearby the ship.
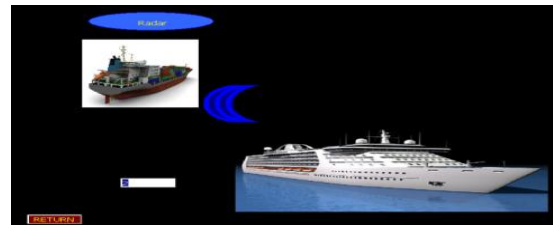

Fig.9 Radar Window

Figure 10 shows the ship Speed screen. That used to displays the current speed of the ship and the direction of movement.
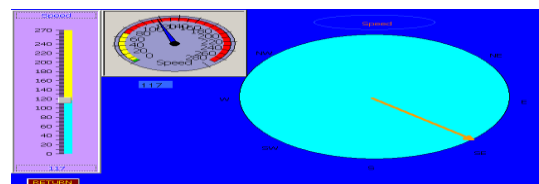

Fig.10 ship Speed Window

Figure .11 shows the Tank Fuel screen, which detect the fuel level in the fuel tank
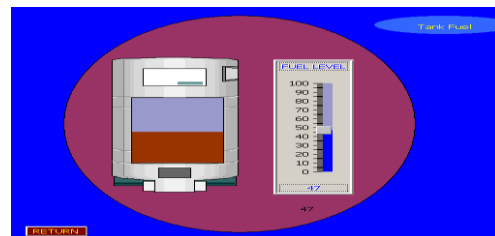

Fig.11 Tank Fuel Window

Figure.12 shows the Temperature screen, which displays the internal and external temperature of the ship.
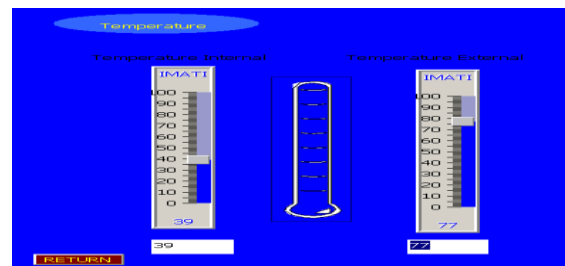

Fig.12 Temperature Window

Figure 13 shows the Wind Speed screen, which indicates the speed of the wind and its direction.
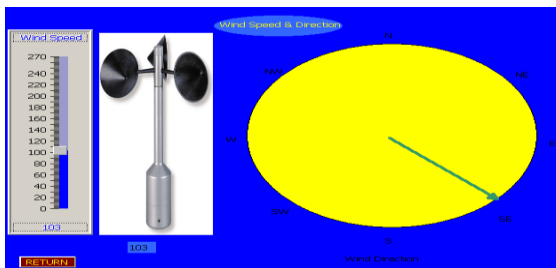

Fig.13 Wind Speed and direction Window

All the previous screens are considered as the HMI (Human Machine Interface) of the SCADA system monitoring a group of sensors, which can help the operator in the control room to make online control on ship control system.

Summary

The offered designed SCADA is Supervisory Control and Data Acquisition. SCADA systems that use to monitor and control a ship in our case or equipment in industries such as water and waste water control , energy , oil, telecommunications and gas refining and transportation. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units RTUs and /or Programmable Logic Controllers PLCs, as well as the central host and the operator terminals. A SCADA system gathers information, transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, and displaying the information in a logical and organized fashion. These systems can be relatively simple, such as one that monitors environmental conditions of a small ship, or very complex, such as a system that monitors all the activity in large ship system. Traditionally, SCADA systems have made use of the Public Switched Network (PSN) for monitoring purposes.

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