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Development of Data Monitoring Based on Virtual Instrument

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Abstract

The objective of this work is the design and development of the Data Acquisition based on Virtual Instrument and Storage parts of a data monitoring that will be used for a certain control and guide equipment for electronic equipment. The data captured and stored in a database will be an application that will diagnose failure of control and guide equipment. Data acquisition and data Store were developed using finite-state machine model and Virtual Instrument. This paper focuses in the description of the Data Acquisition. The data monitoring is currently installed and applied on a certain control and guide equipment.

***Keywords**: Virtual Instrument, Data Monitor, Data Acquisition*

1. Introduction

Currently there is an increasing interest in developing and applying monitoring system for electrical equipment like transformers, generators and Fire Control system [1].The monitoring system has the potential to diagnose failure and verify the design.

During the development stages of Monitoring system, an ancient control and guide equipment was used. Although it is out of commission, some function can be custom made. In this experimental scenario the action models were designed and valideted. They were fed with the need of all data.

This paper focuses in hardware and software description of the Data Acquisition based on Virtual Instrument, developed. Although, a brief description of the complete is architecture for data monitoring system is also done. It is responsible for acquisition, processing and storing of measurement. The System is being monitored for a certain control and guide equipment with satisfactory results.

2. System Architecture

The architecture of the monitoring system is formed by two independent and interrelated subsystems: Programmable Virtual Instrument (PVI)and Data Store(DS).The two subsystems run in the same industrial computer, but been designed so that they are the most independent possible and their communication interfaces have been clearly defined.

In the way the previously commented subsystem can be executed in a distributed environment and changes in one of them do not affect to the others. The PVI subsystem will be introduced emphatically as follows.

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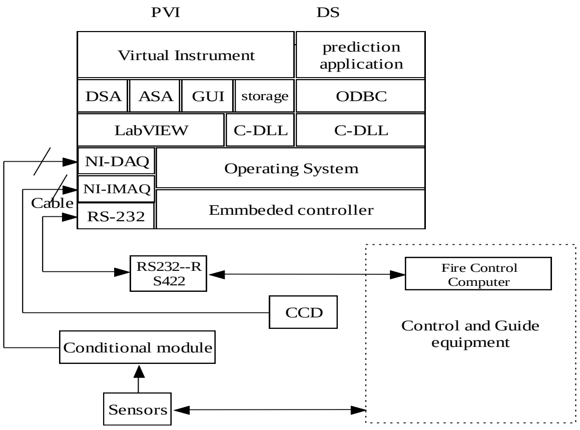


Figure 1. Architecture of the Monitoring System

A requirement that the system must fulfill that it should operate properly inside a cabinet attached on the control and guide equipment .For this reason and due to the mechanical, temperature and vibration, the chosen architecture was an industrial computer based on the 3U PXI(PCI eXtensions for Instrumentation) standard. The PXI architecture present, among others, the advantages with respect to other architectures(PCI,VXI):small, compact and rugged industrial Eurocard packaging, high performance IEC connectors, specific cooling and extended environmental requirements, low cost, multiple vendors, *etc* .As already was commented the two subsystems run in the same computer ,and as a result they share the hardware and software elements commented next.

Monitoring system designed with interchangeable virtual instrument (IVI) drivers allow the same software are code to be used with different instrument platforms. In other words, where IVI drivers are used in the monitoring system, instrument can be exchanged (evev between different manufacturers) with no expensive software updates required .This feature is particularly be benifical when a data acquisition card requires replacement due to obsolescence [2].With test sets supporting defence systems which are deployed are supported for 15 years or longer, hardware replacement or upgrades are the norm.

3. Hardware of Virtual Iustrument

The PXI subsystem developed uses the hardware described previously and it is responsible for making the acquisition, processing and storage of measured data. It consists of the following.

3.1. Host Computer and Operating System

The hardware core is based on a PXI-1031DC chassis inside which the PXI-8106 embeded controller is housed(both from National Instruments). The PXI-8106 embedded controllers include the dual-core Intel Core 2 Duo-processor T7400, with 1GB RAM, standard I/O and 80GB of hard disk storage. The standard I/O on each module includes DVI-I (Digital Video Interface

Integrated Analog/Digital) video, one RS-232 serial port, a parallel port, four Hi-Speed USB ports, Gigabit Ethernet, a reset button, and a PXI trigger[3].The operating system used is Microsoft’s XP .

3.2. The PXI Buses

The CompactPCI bus combines PCI(Peripheral component Interface) electrical specifications with Eurocard mechanics and high-performance connectors to define a core architecture that can be used to build various types of industrial systems[4]. Besides the

PXI (PCI eXtension for Instrumentation) extends CompactPCI for measurements and automation while it maintains interoperability with ComapctPCI [5]. The PXI specifications are of three kinds: electrical, mechanical and software. The first defines timing and triggering extensions that bring high-performance instrumentation capabilities to CompactPCI systems. The second adds requirements for environmental testing, electromagnetic compliance, and safety testing. Active cooling with fans is also required and controller locations are more rigidly defined to improve interoperability. The latter defines minimum software driver requirements that PXI modules must meet for operation in system using Microsoft Windows.

3.3. The I/O Boards

The PXI hardware platform fully supports any PXI board. Therefore, a great number of I/O boards are available on the market suitable for any kind of data acquisition application. We consider two particular boards that allow us to cover our specifications: two PXI-4204 for 16 channels DAQ and the PXI-1409 for IMAQ from National Instruments.

The first is a full-featured data acquisition module with a ±100 V input range, 16-bit accuracy, and software-selectable filter and gain settings per channel. Programmable filter and gain settings ensure that the PXI-4204 achieves maximum accuracy over the entire ±100 V input range. In addition, the PXI-4204 is designed to work with LabVIEW 7 Express or later and NI-DAQmx. The DAQ Assistant in LabVIEW 8 can configure the PXI-4204 and acquire data through a menu-based window, eliminating the need to manually program the device [6].

The second one is a high-accuracy, monochrome image acquisition (IMAQ) devices for PXI, PCI, or CompactPCI chassis that support RS-170, CCIR, NTSC, and PAL video standards, as well as some nonstandard cameras from any of four input sources, and is featured a 10-bit analog-to-digital converter (ADC) that converts video signals to digital formats. It acquires images in real time and stores them in onboard frame memory or transfers them directly to system memory. With NI-IMAQ, you can quickly and easily start your applications without having to program the device at the register level. As a standalone device, the IMAQ 1409 device supports four general-purpose control lines that are configurable to generate precise timing signals for controlling camera acquisition. It also supports four video sources and four external I/O lines to use as triggers or digital I/O lines [7] .

3.4. Conditional Module

The objective of this module is to zoom and insulate analog signal to make it filled with the testing desire, guarantee security with the monitoring instruments, and to provide the synchronization signal to another instrument. It is self-supplying on circuit principle. Any channel will be to insulate each other.

Figure 2. Operation Implement of the PXI Chassis

4. Software of Virtual Iustrument

The software of PVI subsystem has been developed using LabVIEW 8.5 graphical application development environment from National Instruments. It is a multithreaded application where five processes are being executed concurrently, and a finite-state machine model used where six state are divided independently. It is introduced with the following.

4.1 Multi-Thread

One is the Graphical User Interface(GUI) that allows configuring all the parameters related to the data acquisition(voltages and currents) ,data storages(database and image)and also displays the different measured signals.

System initialization procedure is on the following. It includes part of the system configuration and related properties of initialization. This initialization is not restored to the state at the beginning of design. But to save the system configuration and user content such as information from the database calls out for assignment system module. Realization of reasoning machine configuration in LabVIEW is introduced in front. It is including the DMM (universal meter), the SCOPE, Indicate (visual words), Picture (image), and other diagnostic mode configuration. Every kind of way configuration is not the same. In the implementation process needs a test steps to choose a way configuration.

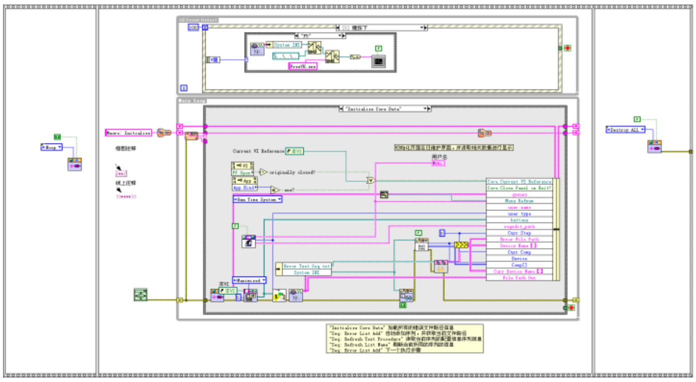


Figure 3. Initialize

Another process is responsible for the acquisition of the analog signals. The core of data acquisition is using NI-DAQmx function [8]. For all the analog sensors 1K samples are acquired with a sampling rate of 1KS/s, except the speed of turnplate sensor 5K samples is acquired with a sampling rate of 5KS/s. The interval between acquisitions can be configured by the user by means of GUI and currently is present to 20 seconds. These measures were divided int two groups: fast and slow. For the fast ones, (power and the speed of turnplate)it is necessary to refresh waveform graph. For the slow sensors RMS values are calculated. All these operations are carried out using LabVIEW’s mathematical Vitural Instruments(VI).

A third process is responsible for data traffic with Fire Control Computer(FCC) by the RS422 serial protocol .Yet PXI-8106 only have RS-232 interfere, so need the conversion from RS-232 to RS-422. Because some signal is from FCC that carry out the acquisition of digital sensors. This protocol prescribed 22 Bytes, at 9600BPS, *etc*.Firstly monitoring system transfer command with 8 Bytes. When FCC received it, will transfer data acquired with 22 Bytes continuted 20 seconds interval.

A fouth process is responsible for the acquisition of the missile video. It mainly implement by IMAQ function [9]. In order to guarantee acquisition image real-time and exactly, it is present to 5 seconds in while loop. It will go on 15 minutes.

The last process is the responsible for storing all the measurements carried out in a database and image. The database is visited storage, deleted and lookup By special package --LabVIEW SQL Toolkit [10]. A temporary storage queue is used so that the PVI subsystem and DS subsystem are asynchronous.

4.2. Finite-State Machine Model

In order to program, the complex system was simplified hypothesis by using finite-state machine. Essential of finite-state machine is state, event and action which are supplement each other .State machine is one of designing model in common use in LabVIEW. It is very simple to realize state machine. Main While loop and a Case structure make up the constructure parts of it, using shift register to implement the jump .While loop assure consecutive running, the embranchment of Case structure accord to the state of system, to ensure program readability. The name of the embranchment of Case structure accord to the name of state. Function of code correspond to the action of state. The condition variable corresponding for event of systems, arose transference of state and decides the direction of state. Convenient for the programming, the best method of all to realize enumerating all states is making use of Typedef. In this way to change enumerating variable only need to change Typedef.

The PVI subsystem is partitioned to 6 main states. It is Test oneself, Reset, Data Acquisition, Serial Port, Browsing information and Exit.

Due to the relation of complex state, when designing the program structure of state machine model, We follow the principle of that all function is achieved by enough state and the number of state is the least. To realize the logic functions in administrative levels, we make every state to a VI module.

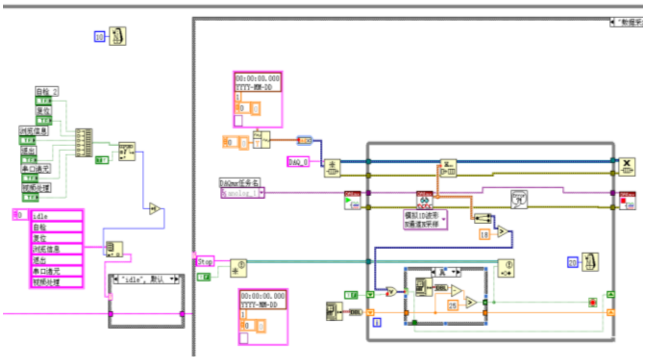
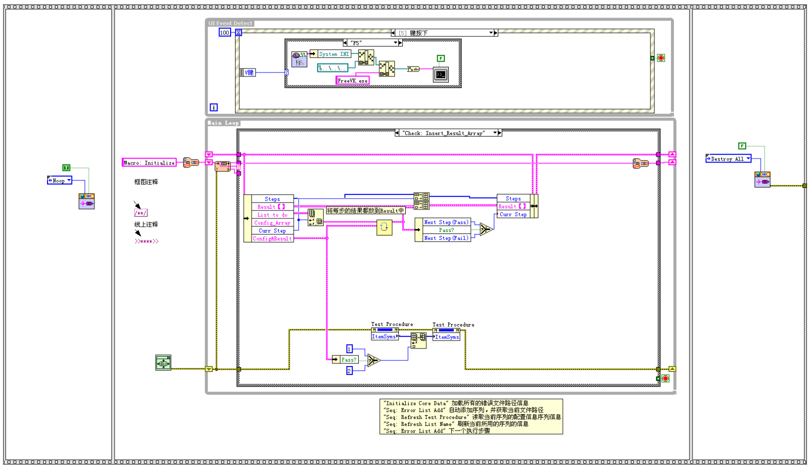


Figure 4. Implement Architecture of the Monitoring State.

4.3. Data Monitoring Model

This system the human-computer interaction interface design in the LabVIEW software platform, is based on the virtual instrument technology application software panel. For diagnostic system is to fault diagnosis process. It can be seen that in human-computer interaction, the work for the system configuration of reasoning and reasoning machine separate management, which is based on the user access layer management purposes. After the system configuration is initialized, read automatically the last save configuration results. Operating group users can steps, methods and strategies of reasoning to reconfigure, update the reasoning method of reasoning machine, added new fault tree knowledge reasoning configuration. Face on the fault diagnosis system initialization and configuration, diagnosis, read, *etc* are introduced, for achieving open fault diagnosis inference machine, it is on the one hand, the contents of the fault diagnosis module. Is the content of the fault diagnosis on the other hand, high efficient and accurate for fault detection. In the fault tree is a tree structure, in view of the fault tree each subtree, based on the qualitative and quantitative analysis in fault tree analysis in front of the search optimization strategy, each fault tree traversal in order to get the test results. In each test step, the step and the next step is according to the test of signs and make a decision to choose. Figure 5 for the implementation of fault diagnosis test program in LabVIEW. Fault record and fault diagnosis is now, in the application of fault diagnosis, can see there are to save test results to the design of the Result, whether for failure results in binary fault record implementation program. In fault diagnosis after the test, how to test the result of the preserved in the form of a spreadsheet, for from the printing way to or from the network for transmission, is an important content of fault diagnosis system. In equipment support, the statistical analysis of equipment failure for optimization design of equipment, equipment maintenance plan, the fault diagnosis system based on data monitoring, *etc* all have important significance.



"Initialize Core Data" 加载所有的错误文件路径信息
"Seq: Error List Add" 自动添加序列，并获取当前文件路径
"Seq: Refresh Test Procedure" 读取当前序列的配置信息序列信息
"Seq: Refresh List Name" 刷新当前所用的序列的信息
"Seq: Error List Add" 下一个执行步骤

Figure 5. The Process of Fault Diagnosis

In the process of fault diagnosis, friendly human-computer interaction, is not only the people who want to provide effective information supply system machines make effective decisions, at the same time machine will definitely ask questions to the customer, and tell the user the way to solve the problem, so can't let users understand the machine language effectively, certainly will cause communication barriers, which influence the fault diagnosis. Diagnosis and system interface design to be rational layout, distinct, users, can be clear at a glance know oneself to solve problems what need to use the system module.

In the design of this system, the main menu interface for user permissions, fault record and query, fault diagnosis, fault report output, configuration management module . In fault diagnosis, for the choice of the fault tree top events, according to the structure of the radar equipment level, using stratified points list to choose the display mode; In fault diagnosis process, adopts the way of question and answer, and gives effective answer also set, the user is based on the system after adopting effective measures according to make a simple choice, get the signs of man-machine communication simple and clear. Through the above measures, better solve the process of fault diagnosis system of easy comprehension and simplicity.

Finally the reliability of the whole system is increased by using the watchdog timer included in the PXI industrial computer. If there is a software failure, the system will be restart.

5. Conclusion

A new automated Monitoring system was developed using PXI hardware and the LabVIEW 8.5 framework. It makes use of a modular hybrid design architecture which allows maximum flexibility for hardware or hardware replacement .The Monitoring software makes use of IVI drivers which also facilitates hardware without expensive software upgrades, And makes use of a multithreaded application concurrently and a finite-state machine model. All the hardware and software are commerical-off-the-shelf products used to replace more expensive systems. Moreover, G system was able to cut cost system development time, from design to implementation, nearly in half. It is open, modular and easily expand abled and working properly in the certain equipment.

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