

Design and Implementation of Machine-electron Subsystem Emulator Controlling Software

ZhixianZhang^{1, a}, ShaoyiLi^{2, b} and NanJiang^{3, c}

¹ Shenyang Aerospace University, Shenyang 110136, China;

² Shenyang Aerospace University, Shenyang 110136, China.

³ Avic Shenyang Aircraft corporation, Shenyang 110136, China.

^az zx_syiae@tom.com, ^b307128304@qq.com

Keywords: LabVIEW; simulation stimulus; RS422; storage and playback

Abstract. Virtual instrument technology is a connection of general computer and functional hardware module. It is defined completely according to the needs of the user to achieve and extend the functions of the traditional instrument. This paper describes an emulator of machine-electron subsystem based on LabVIEW. The emulator simulates real button control relay to give simulation stimulus, outputs analog values set on the front panel, displays the acquired discrete data on the front panel, simulates the communication status between different modules via RS422 bus. It can also realize the data storage, display and playback.

1 Introduction

With the rapid development of aircraft design and manufacturing techniques, the aircraft and its subsystems become more complex in recent decades. Simulation test plays an increasingly important position in the process of aircraft design and production. In order to ensure the airplane flying safety and reliable performance, reduce the risk of design and manufacture, not only the structure and the part of the aircraft need to go through a variety of test, but also main system of the aircraft need to establish their own simulation test system, and a large number of simulation experiment will be carried out. With the constant improvement of the advanced fighter aircraft development demand, airborne electromechanical system design/verification model is undergoing a new technology revolution. In order to reduce the risk and improve the quality, it has become necessary to carry out simulation experiment in the process of system development with the application of the semi physical simulation technology.

LabVIEW is a virtual instrument software development tool based on Graphics Language. It has the functions of data acquisition, data analysis, and signal occurrence, signal processing, and input/output control etc. It is recognized standard software of data acquisition and instrument control. The program is called VI which is programmed by LabVIEW development platform [1]. LabVIEW provides a variety of image lifelike controls similar to the real instruments, such as switch, knob, dashboard, voltmeter, ammeter, oscilloscope and so on. User can make controls according to their requirements, create the user interface easily. LabVIEW also provides abundant function library and subroutine library. It integrates all functions of hardware and data acquisition card communication that satisfying the GPIB, VXI, PXI serial port protocol. It has library functions that convenience for application of TCP/IP, ActiveX software standard. We can design the user interface easily using LabVIEW, find the corresponding controls in the control-bar and put them into the front panel without writing any programming code.

2 System function Introduction

Electromechanical management system test requires that accomplish the function verification of electromechanical management system before installing each subsystem of electromechanical system, test and assess the intermediate equipment that taking responsibility for subsystem interface cross-linking at the same time, verify the reliability of intermediate equipment. So emulator of electromechanical subsystem should simulate the function of each subsystem of comprehensive

electromechanical system.

The emulator of electromechanical system based on LabVIEW is developed completely according to the needs of the test task. The whole system consists of anti_icing, fire_prevention, environmental_control,brake,retarder,takeoff_landing,hydraulic and fuel subsystem emulator function modules. The front panel of the emulator is shown in Figure1. The emulator gives analog and digital signals output to the host computer as a simulation stimulus. It can also acquire the discrete signals from the host and display them on the front panel.



Figure1. The front panel of the emulator

3 Module function introduction

Through the requirement analysis of electromechanical management system simulation experiment, the emulator should have functions of discrete quantity output and acquisition, analog quantity output, communication, data recording and data playback. In order to achieve the above functions, we set up a virtual instrument system choosing NI PXI industrial computer with the necessary DAQ data acquisition cards. A DAQ card is one of the major parts of a Data Acquisition process. Basically, it is a hardware part which helps in interfacing the signal of the outside world with the PC. The most basic is to convert an analog signal into digitalize form. So computer can sense it. An analog signal can be voltage, current, temperature, etc. which is used in diagram form [2]. This system uses kinds of DAQ data acquisition cards such as relay output card PXI-2569, discrete quantity acquisition card PXI-6511, analog quantity output card PXI-6704.

4 Analog quantity output module

The emulator can output the fire alarm signal voltage, signal current value and ftmp fuel temperature, etc. Once given the analog value on the front panel, the emulator would give the analog output through the NI PXI-6704. NI PXI-6704 card is a 16-bit static update analog output module, it can provide 16-way voltage outputs and 16-way current outputs at the same time independently, as well as eight digital I/O lines, the first 16 channel output voltage, after 16 channels output current. After configured the DAQmx create channel, the DAQmx start task function output the analog voltage. After inputting the current value in the numerical input control, click on the OK button, the current value would output. After inputting values in the corresponding pressure parameters in the front panel, click on the OK button, the pressure parameters would output. The program block diagram is shown in Figure2.

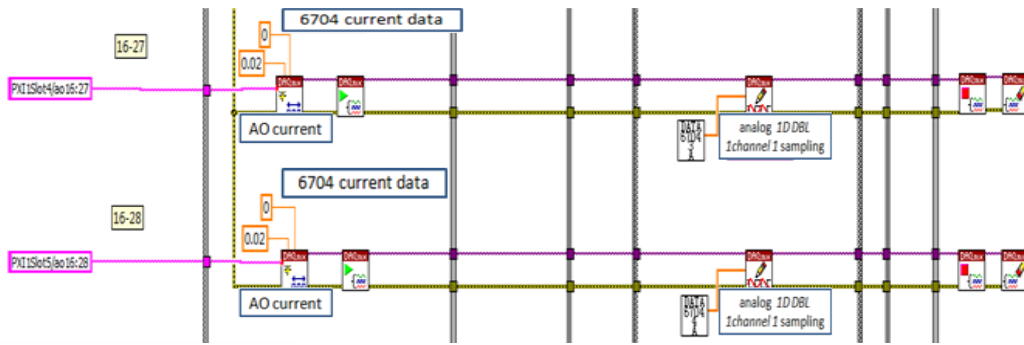


Figure2. The program block diagram of analog output module

5 Digital quantity input module

The NI PXI-6511 module is a 64-channel isolated digital input interface for PXI systems. Through the NI-DAQmx simple configuration, it can be very convenient to reach the data acquisition task. After configured signal channel, read the digital signal from the host by DAQmx reading function in the form of an array, display each signal status in the front panel through the array index. The emulator collects discrete signal from the computer through discrete quantity acquisition board PXI-6511. The data is collected by data acquisition card, and is stored in the system database after being analyzed and processed. At the same time, the system has the function of the classified inquiries, the output and printing report and the user management [3]. When a discrete signal is collected, the corresponding indicator light will be lighted to verify the interaction of electromechanical management system with the emulator. We can explain the connection mode of digital input card by taking an example of a channel. The block diagram is shown in Figure3.

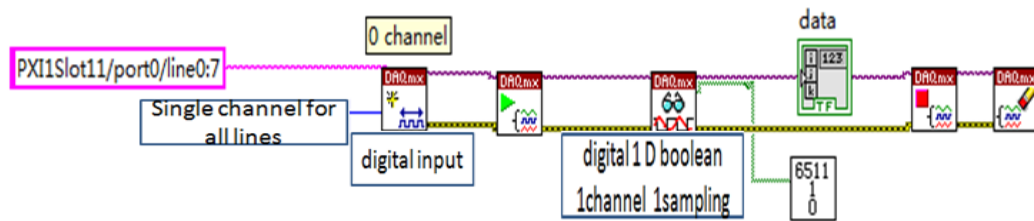


Figure3. The program block diagram of analog output module

Each port has eight channels, selecting the style of single channel for all lines when creating the virtual channel. After choosing the I/O port, start to collect data. DAQmx read function read the discrete signal array on the channel, read mode is digital 1d Boolean 1channel 1 sampling, reading a single boolean sampling in the task of containing a single digital input channels. The system sends the collected data to the sub VI, the indicator light will change corresponding. The 6511_1_0.VI is a sub VI, its front panel is shown in Figure4. Its block diagram is shown in Figure5.

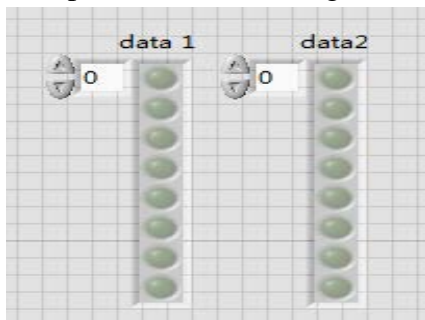


Figure4. The front panel of sub VI

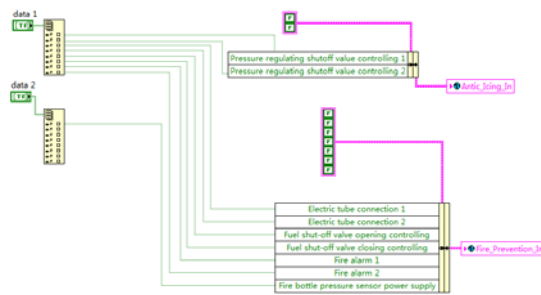


Figure5. The block diagram of sub VI

6 Digital quantity output module

The switch in the front panel simulates real button to control relay module NI PXI-2569, which outputs effective signal simulation to the host by opening or closing the button. Discrete signal encapsulated into an array, sampling in the form of digital multi-channel one sample through DAQmx write functions, then DAQmx start task function start to measure to make the task is in operation. The figure6 shows four switch signals simulation output process.

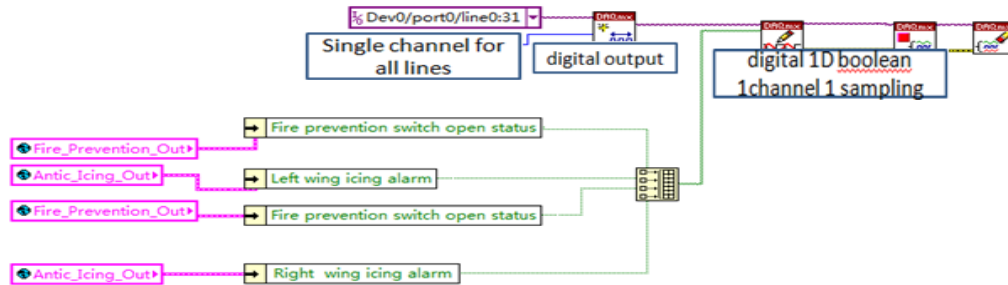


Figure6. Switch signals simulation block diagram

7 Data record and playback

In order to observe the trigger time and duration of each switch facility, electrical and mechanical subsystem emulator has record storage function, stores the action state of each signal, which can data playback and view when needed. The system has a lot of switch buttons, they are sorted storing according to the function. TDMS file channel attributes can accomplish the storage function well. After such classification, the data can be read by group easily when data playback, the shortage is avoided that it can't show all the switch state in the same interface at the same time. It is not necessary that record the switch state when the system starts, storage only when needed to record, so it must be able to start or stop recording data at any time.

It is needed to store these digital data when system starts, the first thing needed to do is select a file storage path, then click start button into storage recording module, click stop button to stop recording data file. Before making no selection to store path, start recording button will be in a disabled state. After choosing data file storage path, click start recording button, the state of the switch will be written in TDMS file by group. Discrete digital data is written through TDMS write function by the group name and channel name, so we can reads the data waveform through TDMS reads function by the corresponding group name and channel names, the results are displayed on the digital waveform figure. In order to more convenient to observe the action time of switch, the system also provides the function of scaling, dragging and the cursor. The simulation result is shown in Figure7.

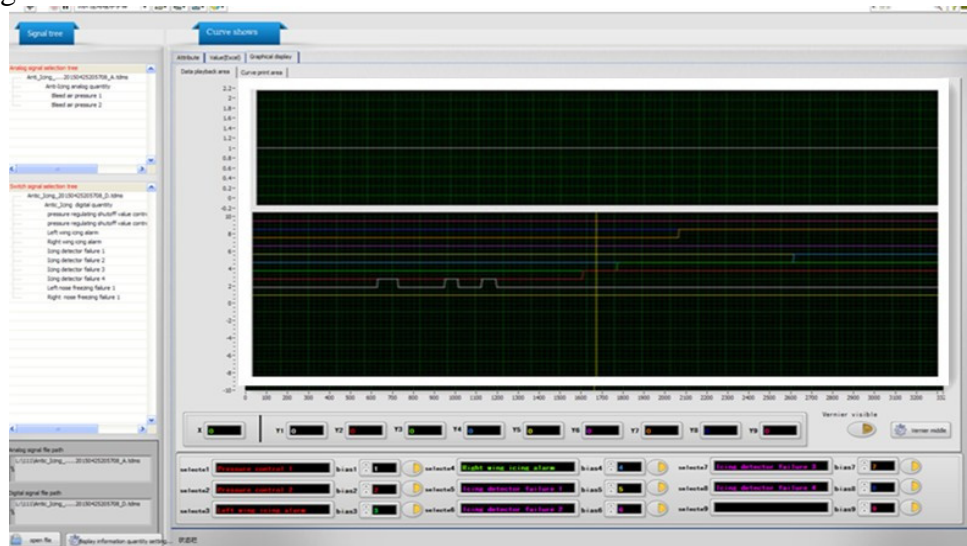


Figure 7.The front panel of simulation result

8 RS422 communication module

RS422 communication module simulates the communication between the panel and the host, sends information to the host and receives the information from the host. The input value in the temperature, oil, fuel input control will be transmitted to the host according to the predetermined data packet format through RS422bus, display the received information on the front panel according to the unpack protocol. RS422 communication is reached by its driver VISA. The Virtual Instrument Software Architecture (VISA) is standard for configuring, programming and troubleshooting instrumentation systems comprising GPIB, VXI, PXI, Serial, Ethernet, and/or USB interfaces[4].After port configuration through the VISA port configuration function, VISA read, VISA write to receive or send strings. The front panel is shown in Figure8.

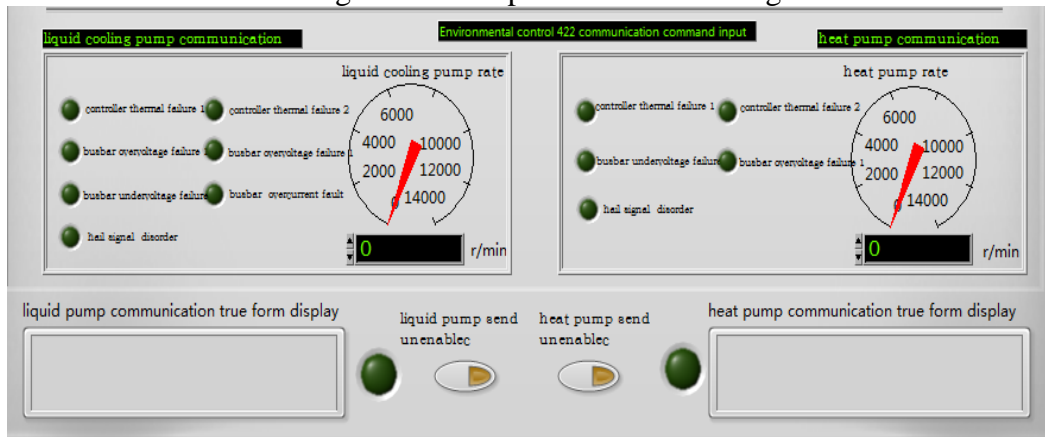


Figure8.The front panel of RS422 module

9 Acknowledgment

The paper combines with simulation task demand, completes the research of electromechanical subsystem emulator using the virtual instrument technology. The emulator completely replaces the actual hardware of the mechanical and electrical subsystems to provide simulation incentive to the electromechanical management system, validate the function of the electromechanical management system monitoring and control each subsystem of electromechanical subsystems. This emulator has completed the measurement task of electromechanical system well and achieves the expected requirements of users.

References

- [1] ZhaoHua. Application of LabVIEW in the design of dataacquisition and signal processing system of mechanical vibration, Jilin, August 19-22, 2011
- [2]Y,Yadav, Real time simulation of solar photovoltaic module using labview data acquisition card,Nagercoil 10-12 April,2013
- [3] WeiXuejie, The management system for data acquisition based on LabVIEW and LabSQL,Yangzhou, March 23-25,2013
- [4]QianXuwu,CaiTijng, Design and im implementation of data acquisitionsystem based on Agilent 3458A,Harbin,August,16-19,2013
- [5] <http://sine.ni.com/nips/cds/view/p/lang/en/nid/10707>.