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REAL-TIME MOTOR CONTROL SYSTEM FOR BEAMLINES

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INTRODUCTION

Closed-loop control is a vital part of a control system. The parameters of closed-loop control and the advantage and disadvantage of an analog input/output system will lay influence on the control system results. This text is designed to discuss about the applications for Closed-loop control and analog input/output system, in order to enhance the stability and accuracy of beamline motor control system. Consequently, we adopt analog input/output system, FPGA and closed-loop control for design.

Because the stepper motor equipped with a reducer can analyze mobile platform to 10 nanometers per stepper, with FPGA accompanied to simultaneously trigger the activation of an analog input/output system, the addition of a closed-loop control mode firmware into this hardware structure can enhance the stability of the beamline motor system, and the convenience of real-time adjustment against stability. Thus, the beamline control system will be about stability, accuracy and convenience.

SYSTEM ARCHITECTURE

The control system structure in this text is designed by way of R-T closed-loop control, with the analog in-put/output module acting as the reading and processing center, and FPGA module and firmware controllers acting as the hardware. The computer end serves to give location orders and besides, the stepper motor serves as the hardware of actual motion and the reading sensor serves to return its actual moving distance for the Encoder.

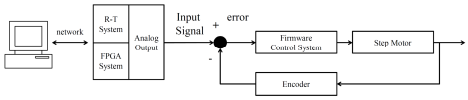

Figure 1: Close-loop Control architecture of Motor control system

Control system description

The hardware related to the control system in the text is composed of three portions: the first is, the computer-controlled center, including the PXI-8108 multicore processor equipped with R-T module, the analog in-put/output module, FPGA module; the second is the firmware, the stepper motor control system, responsible for converting the analog output of the analog in-put/output module into digital forms, and use this data as motion signal; the third is Encoder, which will act according to the moving distance of motion signal after receiving that signal. The information on distance changes can be accessed the value of Encoder Count.

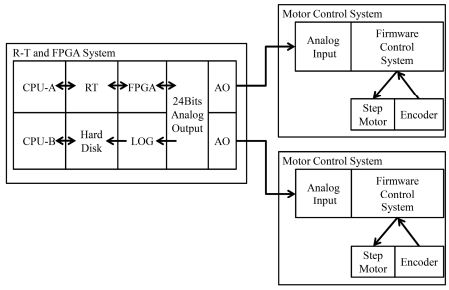

Figure 2: System architecture of R-T control system

PROGRAM INTERFACE

Program interface applies National Instruments LabVIEW as the layout. One can acquire system information from the graph, including Encoder, analog output waveform and set point information; moreover, the content of the program is composed of high resolution analog output module reading program, data storage, dual core control and synchronize motion control program.

Figure 3: The visual Control interface

FIRMWAVE CONTROL

To enhance stability and instantaneity, the integration of firmware's closed loop controls and motor controllers is used to maintain the accuracy of required locations through reduced time of communication with computers. In the following procedure of firmware's closed loop control, the required location is identified through analog output on the computer. While the location information required by controllers through analog input is digitized by way of the firmware program, the closed loop controlled module of the firmware system will initiate location modification. Since there's the farthest distance be-tween the starting point and the targeted one, the enhanced motion distance will be the likewise farthest. The shorter motion distance is then used to make modifications. While the location is reached within the range of tolerable errors, the closed loop control will run into a status of placidity and the entire system will run stably. In this state of stability, if any displacement takes place, the system will move its structure to a correct position in order to lock in the location.

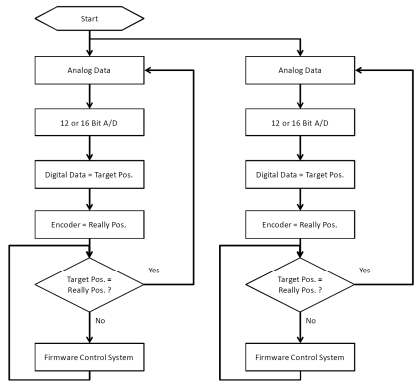

Figure 4: Flow chart of Firmware control system

CONCLUSION

The FPGA hardware module can trigger signals activation and integrate with high-resolution analog input/output module to accompany R-T System, while the software applies the closed loop control module, which can enhance the stability of stepper motor control to a 10-nanometer level. Consequently, the system can effectively enhance the stability and convenience of beamline controlling, and the R-T and FPGA system can reduce signal error caused by deferred time and thus improve the real-time efficiency of signal process.

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