Qt BASED CONTROL SYSTEM SOFTWARE FOR LOW ENERGY ACCELERATOR FACILITY

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Abstract

Qt based control system software for Low Energy Accelerating Facility (LEAF) is operational at Bhabha Atomic Research Centre (BARC), Trombay, Mumbai. LEAF is a 50 keV negative ion electrostatic accelerator based on SNICS ion source. Control system uses Nokia Trolltech's QT 4.x API for control system software. Ni 6008 USB based multifunction cards has been used for control and read back field equipments such as power supplies, pumps, valves etc. Control system architecture is designed to be client server. Qt is chosen for its excellent GUI capability and platform independent nature. Control system follows client server architecture. Following paper will describe the control system.

INTRODUCTION

Low Energy Accelerating Facility (Figure 1) is a 50 keV DC electrostatic accelerator operational at Van de Graaff building in Bhabha Atomic Research Centre, Trombay, Mumbai [1]. LEAF can accelerate various beams across periodic table. A sputtered negative ion source generates negative ions which are accelerated using high voltage. For this purpose entire ion source floats at negative high voltage (typically −50 kV). Extracted ion beams are bent by a 90 degree magnet which acts as mass analyzer and selects desired mass to deliver at target. Ion currents delivered at target is micro amperes of particle current for prolific beams such as C^- or H^- and for difficult beams such as Li^-, delivered current at target is few hundred nano amperes. This accelerator has already delivered negative ion beams of Hydrogen, Lithium, Carbon, Sulphur, Tellurium, Gold, and Silver etc. This accelerator is used for various experiments in material science and atomic physics studies using ion clusters [1].

Though LEAF is a small accelerator but smooth and efficient running of this accelerator requires robust control system. To deliver the various energies and masses of the ion beams at the target it is required to tune the beam by changing various power supply voltages and currents. Control System receives operator command and set the values on field devices. Data acquired from the field devices are displayed on the GUI and used for the interlocking system. LEAF control system consists of a data acquisition and operator command execution module and Graphic User Interface (GUI) based analog and digital control interface.

One of the aims of the LEAF control system was to make it automatic, so that a good set of parameter values can be automatically loaded by the control system in a gradual and safe way without the intervention of operator.

DESCRIPTION

Analog and digital field data is acquired from the field via National Instrument's micro-controller based (NI 6008) system. It is a low cost, USB powered multifunction DAQ. It has 8 analog input channels which gives 12 bit resolution for differential connection and 11 bit resolution for single ended connection. It has a sampling rate of 10kS/s which is sufficient for the control requirement of LEAF. NI 6008 has 12 digital channels which can be configured either digital in or digital out. Digital channels, in digital out mode are used to turn on and off devices. Digital input modes reads the actual on off status of the device. Single ended analog input channels are used to read the analog field signals [2].

LEAF control and instrumentation is physically divided into two parts because Ion source of LEAF and all power supplies are floating at negative 50 kV. Non ion Source parameters are at ground potential.

LEAF control software has the client server architecture (Figure 2).To Ensure proper galvanic isolation, a dedicated server is written for the ion source side. Another server deals all the other parameters at ground potential.

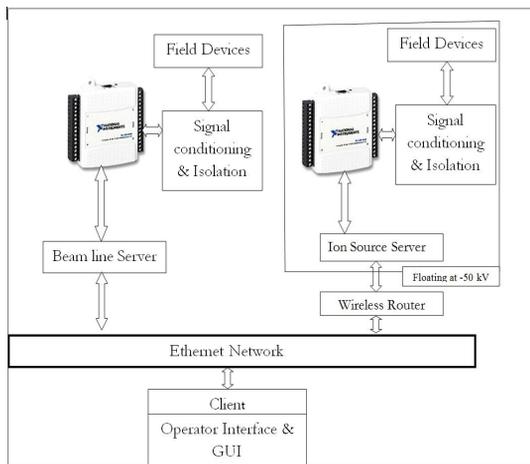Figure 1: Low Energy Accelerator Facility.

Figure 2: Control System Architecture.

Each server is having its own scan cycle. In a typical scan cycle, server first acquires analog and digital field data, code them and send it to client via LAN using connection oriented TCP/IP protocol. Next server reads the client command, if any, and decoding the command apply analog or digital signal in the USB-6008 microcontroller. In LEAF control system each server's scan cycle period is 250 milli second.
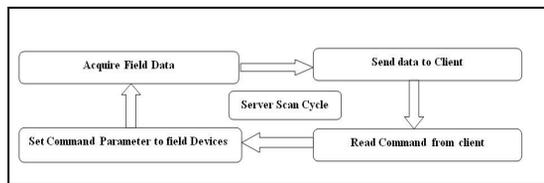

Figure 3: Server Scan Cycle.

Operator interface of the control system also acts as client. Client receives the field data from both the servers, decode them and display the field parameters on GUI. Operator can change different analog and digital values as per operational requirements and change is communicated to the server as the client command. Client side also has an interlock module. In the client cycle various interlock conditions are evaluated and either alarm is raised for operator or appropriate action according to defined rule is executed automatically.
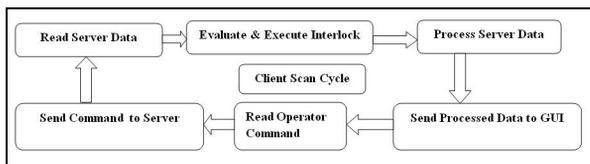

Figure 4: Client Scan Cycle.

Software Description

Entire software is written in Qt 4.0 [3]. Server side is a timer driven console program. Qt's network module is used to communicate using connection oriented TCP/IP protocol. National Instrument's USB-6008 interaction library is imported to interact with it. Effort is taken to use only those calls, which can also be used in LINUX operating system. Presently server side program runs in Windows 7 Home version in the ion Source server and under windows XP professional in beam line server. Servers are operating satisfactorily under both operating systems.

Client cum operator interface used extensively Qt's excellent graphical capabilities. A screenshot of the GUI is present in Figure 5.

Figure 5: Operator Interface GUI.

All relevant details of the analog and digital channels and description of all field devices are kept in the configuration files. Servers and client read relevant configuration files and sets up control program by taking data from configuration files. After initial configuration, repetitive server and client cycles described in the Figure 3 and Figure 4, keep on running till the programs are alive.

In every scan cycle collected data is logged in the file, which helps to understand the dynamics of machine and to troubleshoot.

PERFORMANCE

The control system is operational for more than six months and working as per specification and design. Automatic loading of the parameters, automatic shut down of the machine is working satisfactorily.

FUTURE SCOPE

The LEAF control system is designed to scale up as and when required. Presently operator and user feedbacks are being collected and most of them will be incorporated in the future.

ACKNOWLEDGEMENT

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