COMPUTERISED CONTROL OF 6 MV EN-TANDEM ACCELERATOR

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Abstract

The 6 MV EN-Tandem accelerator from High Voltage Engineering at the Schonland Research Centre for Nuclear Sciences is being computerised. This paper describes the conception, design and implementation of the control system at the level of the electronic interface. The system is considered suitable for small laboratories with minimal electronic and computational infrastructure. It therefore relies very strongly on commercially available and industry standardised tools, and on advanced software control engineering concepts. The hardware interface is modular, rugged, simple and components are easily replaced or upgraded. Only three type of interface modules are needed, as they are specialised to a given operation by programming an onboard processor. A network of computers distribute the function and intelligence of the system, in an object oriented approach which allows messaging, dynamically prioritised queuing and sub-class generation via database access. This allows the code to be easily maintained as new control objects are generated by modification of the control database. The design criteria of affordability, reliability, modularity, flexibility, efficiency, simplicity have been realised with a satisfactory communication cycle time with the accelerator devices.

1 INTRODUCTION

The accelerator is divided into six logical sections, where local control and monitoring operations are administered by a dedicated node computer. The node computer occupies an intermediate level in the network wide distributed control system. The node computer implements the local monitoring, control and some intelligence, as triggered by a tabular messaging system derived from other control computers on the system. The actual sections used in our system are the ion sources(s), low energy transport, the high voltage system, high energy transport and target beam-line control. Each apparatus in a given section interfaces to the node computer via one of three kinds of digital and/or analogue interface modules. This set of interface modules belong to a single node are connected together on a local RS-485 serial network. This serial network is then connected to the standard serial port of the appropriate local node computer via a RS-232 / RS-485 converter module.

The node computers are on a further local 10base2 ethertnet network, to which various other computers relevant to the control system are also connected. Some of these other computers are the SQL Database server which contains a hierarchical object oriented database of all control parameters, console computers which provide a GUI operator interface and a safety computer for filtering out and screening safety critical commands. Intelligent control algorithms can be deployed in separate control computers or on the node computers. A dynamically maintained flat table of all active control parameters, exists on all networked computers, using high priority NetBios messages. This inter-computer tabular messaging forms the heart of the communication between components of the control system and the triggering of instructions, monitoring and control events. The system is described in more detail in the companion paper to these proceedings [1]. Figure 1 below shows the concept outline of the system schematics.

The three types of electronic interface modules deployed are an analog input module, an analog output module and a Digital 8 bit I/O module. These modules are compact with an onboard processor, which allows diagnostics, unit conversion, addressing and ramp rate programming to be performed. The analog modules control and monitor the status of power supplies. The digital units are used for binary functions (on/off, in/out etc). In the case where 16 bit precision is required, the following procedure is implemented. A linear signal is obtained by using two Digital 8 bit I/O modules together to drive the inputs of a separate high performance digital to analog converter in a specialised module. This system is used for the dipole magnet power supplies. The realisation of the modules is that provided by Nudam [2].

1.1 THE NUDAM MODULE

The Nudam module uses the EIA RS485 communication protocol bi-directional, balanced transmission line. The RS485 standard supports half duplex communication. This means that two wires are needed to both transmit and receive data. The sample rate is 10 s/sec. A special circuit in the RS232 / RS485 converter senses the direction of the data flow and switches the transmission direction.

2 IMPLEMENTATION

2.1 ANALOGUE INPUT MODULE

The analogue input module use a 16-bit A/D converter to read sensor signals for e.g. Volts or Current. The digital data from the A/D is converted into engineering units, and transmitted when requested by the host computer over the RS485 network.

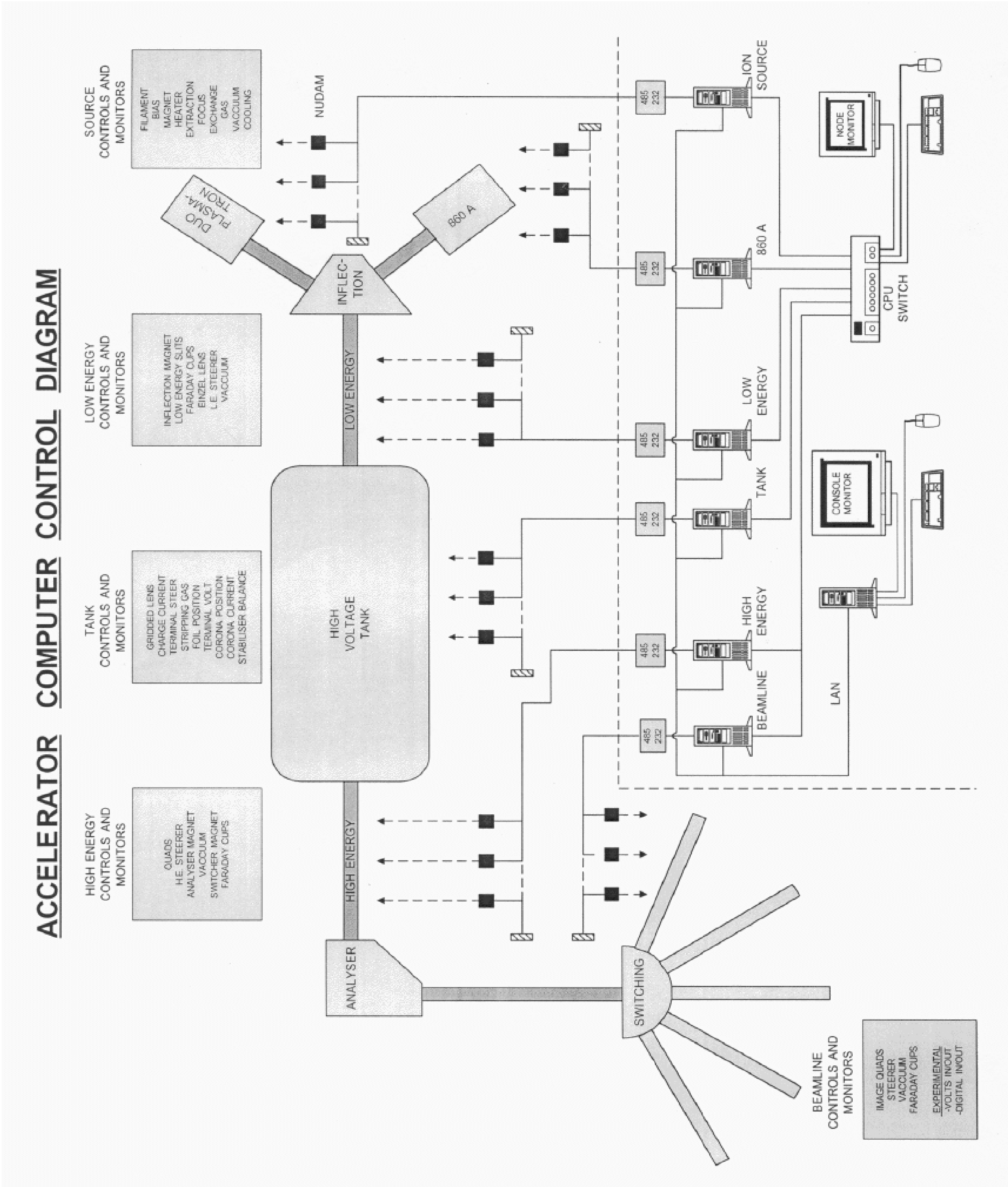

Figure 1: Schematic of Control System.

2.2 ANALOGUE OUTPUT MODULE

The analogue output module supplies an output voltage of 0 - 10 Volts with 12 bit precision. Change in voltage can be electrically programmed to give a slew rate between: 0,0625 to 64.0 V/sec. An independent ADC is incorporated which provides a true readback of the analogue output.

2.3 DIGITAL INPUT / OUTPUT MODULE

The module has 8 output and 7 input channels The output has open collector transistors switches, which enables to control solid state relays etc.

3 CONCLUSION

The control system has already been implemented and is in routine operation for the Duoplasmatron H/He Ion source as well as the Low Energy Transport beam line of the accelerator. Most of the envisaged types of control objects (dipoles, slits, lenses, vacuum handling, gas supplies, electrodes, solenoids, steerers etc) have been tested. The approach used has been found to perform as designed. A cycle time of less than 100 ms for digitialfeedback after issuing an instruction is obtained. Analogue feedback, for example via a reaction on the analog beam current monitor, is of course much faster, as the messaging is tuned to have the highest priority for instructions rather than digital feedback. The system has been operational for 6 months. The operational stability of the accelerator has improved appreciably. It is expected that by the end of the year, the computerisation of the accelerator will be completed.

4 REFERENCES

[1] R.D. Maclear, S.H. Connell, A.H. Andeweg, J.P.F. Sellschop, companion paper *Software design of the Schonland 6MV EN-Tandem Accelerator Control System*, these proceedings.

[2] NUDAM / ADLINK Technology Inc. Taiwan, R.O.C. http://www.adlink.com.tw (fax: 886-2-22493235)