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DEVELOPMENT OF BABY-EBM INTERFACE SYSTEM

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Abstract

This paper explains the works being done to develop an interface system for Baby-Electron Beam Machine (Baby-EBM). The function of the system is for the safety, controlling and monitoring the Baby-EBM operation. The integration for the system is using data acquisition (DAQ) hardware and LabVIEW to develop the software.

Abstrak

Kertas kerja ini menerangkan kerja-kerja yang dilakukan untuk membangunkan system pengantarmukakawalan untuk Baby-EBM. Sistem ini berfungsi untuk keselamatan, kawalan dan pemantauan terhadap operasi Baby-EBM. Integrasi untuk system ini dilakukan dengan menggunakan perkakasan pemerolehan data, manakala perisian komputer dibangunkan dengan menggunakan perisian LabVIEW.

Keywords/Kata Kunci: Electron beam machine (EBM), interface system, data acquisition (DAQ) hardware and LabVIEW.

INTRODUCTION

Baby Electron Beam Machine (Baby-EBM) is small scale laboratory project to produce an electron. The project is designed by Accelerator Development Centre's team by using the available resources such as an old unused Philips x-ray machine of model MG-160. This is because the main purpose of the project is to localize the technology and to gain the knowledge.

Recently, the Baby-EBM doesn't have an integrated control system to operate the machine. Each of the subsystem such as a high voltage supply, vacuum pump, and interlock system have their own controller and user need to use a manual button to operate each controller separately. The idea to combine all of these subsystem controllers into one integrated system is to highlight the safety of operation and to increase the efficiency of the machine.

In this paper, a design methodology to develop the integrated control system of the Baby-EBM based on software PC-windows will be described further.

INTERFACE SYSTEM DESIGN

Hardware Configuration

The hardware systems that used in this project consist of a PC or laptop that interfaced to the vacuum controller (Edwards TIC Instrument Controller) and Arduino board via the USB hub as shown in Figure 1. Then, the vacuum controller are connected to the Edwards Backing Pump and Edwards Turbo Pump while all the interlock point (accept for vacuum) as shown in Table 1 will be connected to analogue/digital input pin on the Arduino board.

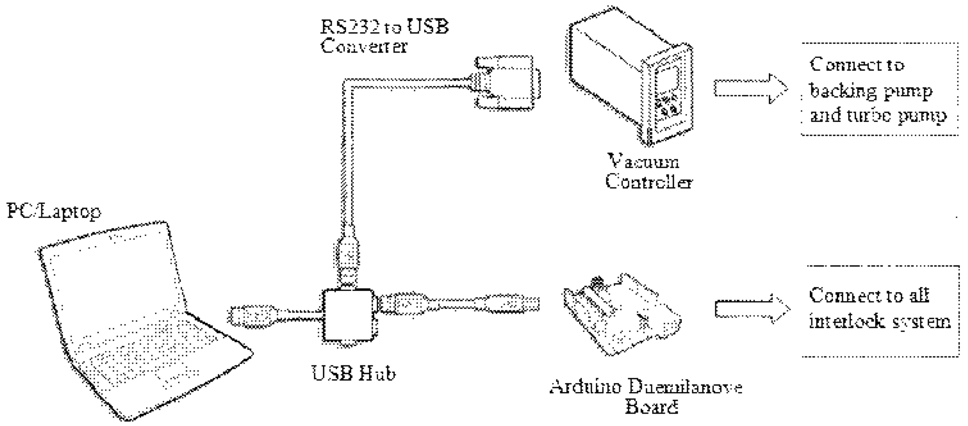


Figure 1. The overall interface system for Baby-EBM

No.	Interlock points	Arduino Duemilanove pin	Descriptions
1	Door 1, 2 and 3	DI 8, 12, 13	Boolean logic either door open (TRUE) or closed (FALSE)
2	Blower	AI 0	Boolean logic either blower on (TRUE) or off (FALSE)
3	Vacuum	Not use	Use RS232 tu USB converter to sense pressure. In the range .... Pa to .....Pa, interlock indicate 'TRUE' else 'FALSE'
4	X and Y coil	AI 1, 2	Boolean logic either X and Y on (TRUE) or off (FALSE)
5	Column current	AI 3	Boolean logic either column ok (TRUE) or not ok (FALSE)

Table 1. List of interlock points connected to Arduino board

The Arduino Duemilanove (Arduino board) as shown in Figure 2 is an open source electronics prototyping board. "Duemilanove" means 2009 in Italian and is named after the year of its release. The Arduino Duemilanove ("2009") is a microcontroller board based on the ATmega168 or ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analogue inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. This Arduino board is a cheap, flexible and easy-to-use hardware. It can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators.

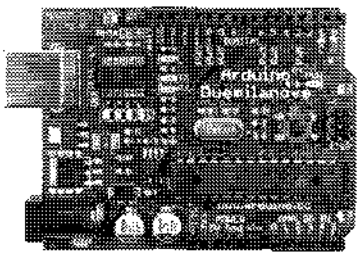


Figure 2. Arduino Duemilanove board (dimension 7cm x 5.5cm

Communications Protocol

Virtual Instrument Software Architecture, commonly known as VISA is the main communication protocol used in this project. It is a widely used I/O API in the Test & Measurement industry for communicating with instruments from a PC.VISA is an industry standard implemented by several T&M (Test & Measurement) companies, such as Rohde & Schwarz, Agilent Technologies, National Instruments and Tektronix.

The communication between PC (LabVIEW) and the vacuum controller is via RS232 to USB converter. The VISA protocol is starting up by set up the same baud rate for the controller and the software. The standard configuration for the vacuum controller (set up by the factory) is 9600 baud rate, 8 data bit, and none parity. After the communication is established, a command string according to manual either to query or control the vacuum is send by software to the vacuum controller. Lastly, the instrument will give the feedback that indicates the current status of the vacuum.

The Arduino board can also communicate with LabVIEW via VISA protocol. The baud rate needs to be set in the microcontroller by using Arduino programming language (C++) when to start the communication. The figure 3 showed the command that had been uploading to the microcontroller. In the void setup ( ) loop the baud rate had been set for 9600, however one of these rates also can be use: 300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, or 115200. The projects using this Arduino board can be stand-alone or they can communicate with software that running on a computer (e.g. Flash, Processing, MaxMSP, LabVIEW) but it is depend to the programs in the microcontroller on the board.

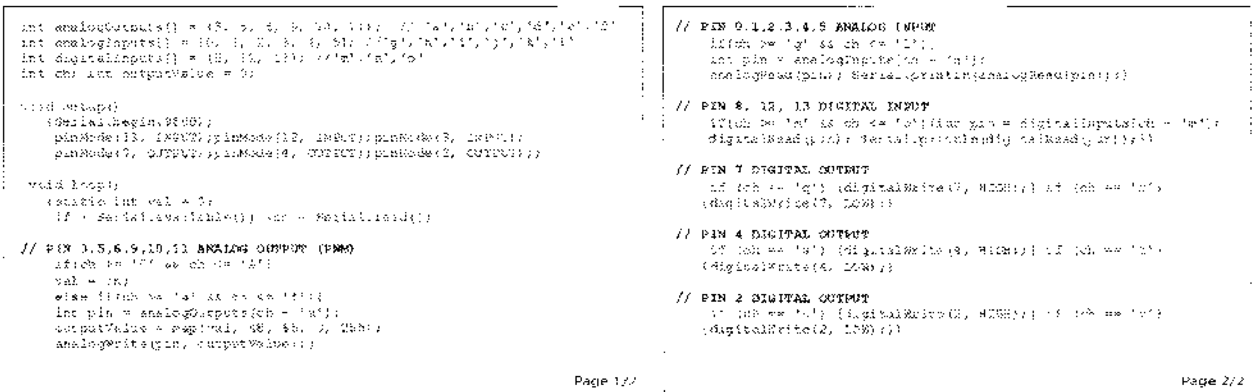


Figure 3. Arduino programming language (C++)

Software Development

LabVIEW programming software is used to develop software for Baby-EBM interface system. LabVIEW is a graphical programming environment with drag-and-drop, graphical function blocks instead of writing lines of text.

The figure 4 shown LabVIEW block diagram or a source code for the Baby-EBM interface system. It is starting by establish a connection with the hardware and execute the while loop until the programming is stopped by a user. All the indicator and the control icon in the block diagram is connected to the LabVIEW front panel (Figure 5), the front panel is visible to user while the block diagram is disable from user.

Front panel for Baby-EBM interface consist a front page for selecting communication port, main control panel for all sub system, and data logger panel.

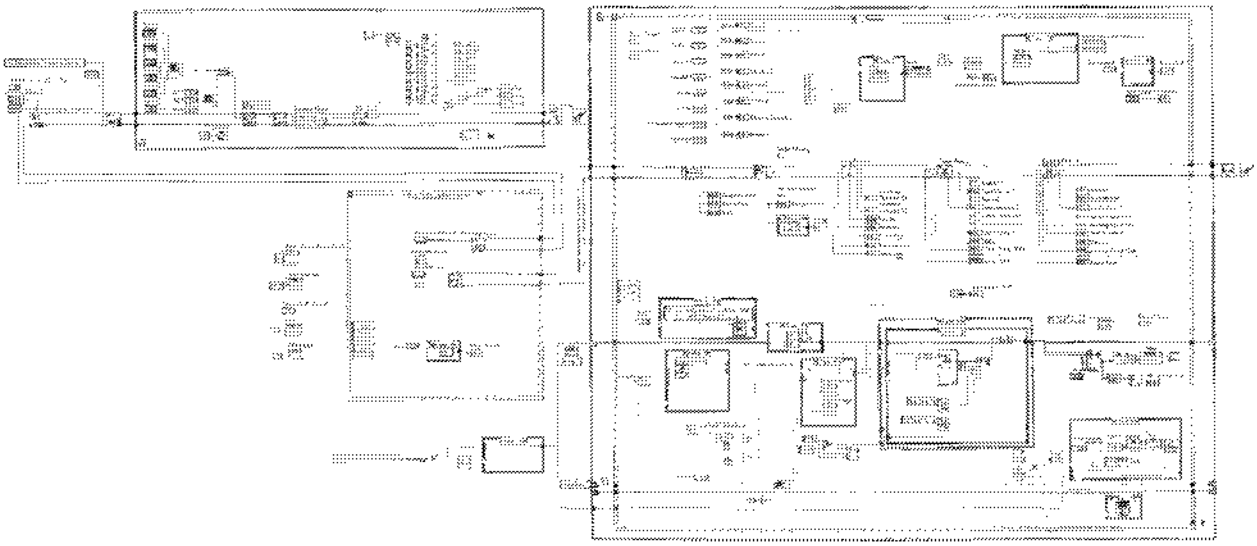
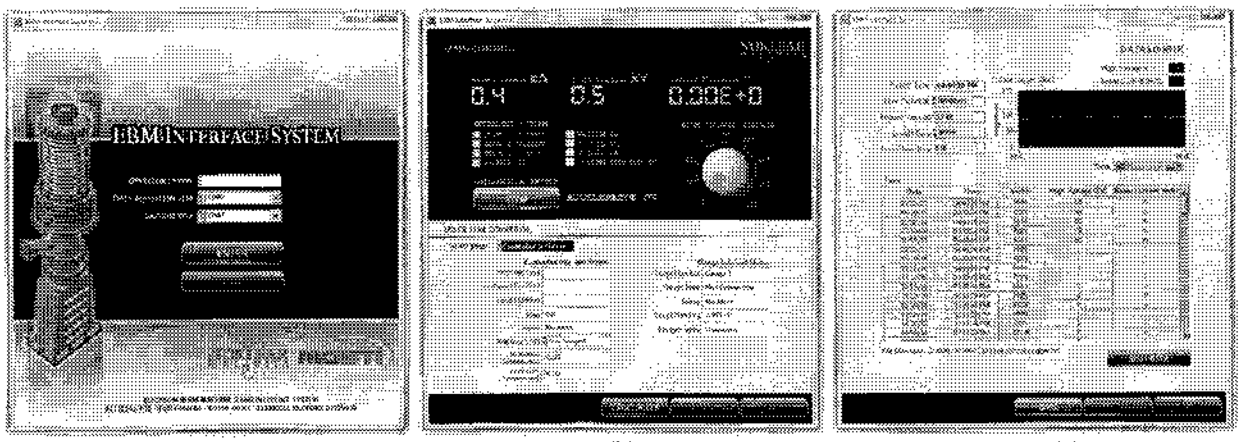


Figure 4. LabVIEW block diagram (source code for the programming)



(a) (b) (c)

Figure 5. LabVIEW custom front panel; (a) front page for selecting communication port, (b) main control panel for all sub system, and (c) data logger panel.

DISCUSSION

The overall design is using the USB as a platform to interface. Even though it is easy to use, there is a length limitation. The hardware use USB 2.0 which is limited data transfer up to 5 meter. As for right now it still relevant to use the USB platform to operate the Baby-EBM because the accelerator is design for a low energy and there are shields protection for human operator from radiation. Furthermore, the interface system can be upgrade to LAN platform for a wide range and remote interface system.

The design of the software not only can be used for this project, it is also can be modified and save as a template to be used in the future project.

CONCLUSION

Even the overall system not fully tested, but several subsystems such as interlock system and vacuum system are tested and it was successfully functioned. Currently, the subsystems are simplified the control and monitoring task because the entire vacuum and interlock status can be control and viewed in one control panel.

ACKNOWLEDGMENT

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