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Virtual Instruments in the Open Source World – A Review

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Abstract: ***Virtual instrument is the keyword for 21st century instrumentation engineering. More and more emphasis nowadays has been placed on the designing techniques, tools used and platform dependencies of virtual instruments. This research paper focuses on reviewing the open source alternative for virtual instruments nowadays. There are several open source alternatives available to research scholars as compared to the previous decades. The virtual instruments offered by todays professional companies tend to be too costly to be used by individual research scholars. Thus a need for open source alternative to virtual instrument is strongly desired. Keeping this as the main focus, the paper describes virtual instruments philosophy and its connection to the open source world.***

Keywords: data acquisition, open source, SCADA, Scilab, virtual instruments

1. Introduction

The rapid adoption of the PC in the last 20 years catalyzed a revolution in instrumentation for test, measurement, and automation. One major development resulting from the ubiquity of the PC is the concept of virtual instrumentation, which offers several benefits to engineers and scientists who require increased productivity, accuracy, and performance.

In the last decade a marathon increase in the open source alternatives has been developed, but the field of virtual instrument has not been benefited from that development. This paper discusses the alternatives offered by the open source community in the design and development of virtual instrument.

The organization of the paper is as follows, section two discusses the basics component of a virtual instrument, section three describes the various open source alternatives for the designing of a basicvirtualinstrument,and sectionfour describes the various open source systems already built by the research community.

2. Virtual Instruments

A virtual instrument [1] basically consists of an industry-standard computer or workstation equipped with powerful application software, a cost-effective hardware such as several plug-in boards, and some driver software, which nominally perform the functions of traditional instruments. Virtual instruments today represent a very fundamental shift from traditional hardware based instrumentation systems to software based systems that uses the computing power, enhanced productivity, efficient display, and several connectivity capabilities of popular desktop computers. Although the PC and IC technology have experienced significant advances in the last two- three decades, it is the software that truly provides the benefit to build on this powerful hardware platform to create virtual instruments, providing efficient ways to innovate and very significantly reduce cost. With virtual instruments, engineers and scientists can build measurement and automation systems that suit their needs.

Virtual instrumentation is the use of user defined software and user defined measurement hardware to create user-flexible measurement systems, called virtual instruments.

Traditional hardware instrumentation systems are usually made up of pre-defined hardware components, such as digital multimeters and oscilloscopes that are completely specific to their stimulus, analysis, or measurement function[2]. Because of their hardware specific function, these systems are more limited in their approach and usability than virtual instrumentation systems. The primary difference between hardware instrumentation and virtual instrumentation is that user defined software is used to replace a very large amount of hardware. The software enables complex , fast and expensive hardware to be replaced by already purchased computer hardware; e. g. analog-to-digital converter can act as a hardware complement of a virtual oscilloscope, a potentiostat enables frequency[3] response acquisition and analysis in electrochemical impedance spectroscopy with virtual instrumentation.

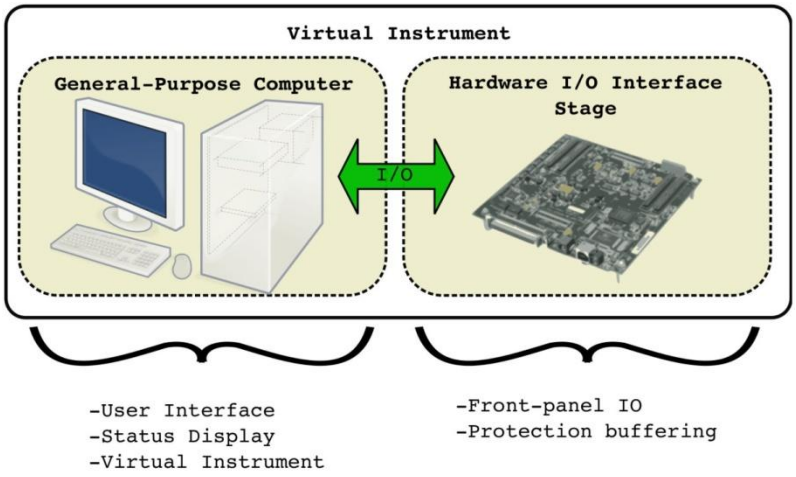

Figure 1: Basic Virtual instrumentation Setup

3. Open Source Hardware

As already discussed above that a virtual instrument requires a computing platform in which the software plays a very important role, but still an interface needs to be created between the computer and the data that is to be measured. In real world situation the form of data that a computer need to process can very vary from simple analog signal to more complex protocol oriented digital data such as I2C[5]data, RS 445 data[6] and CAN[7] data for example. Thus we usually require a small computing platform which could preprocess this data and then send it to the computer for further processing. Below we will discuss several open source alternatives for such hardware oriented devices.

3.1 Arduino

Arduino[8] is the one the latest buzzword in the open source computing world which offers fast prototyping and ready to use integrated development environment. Arduino board offers a wide range of development platform based on 8 bit and 32 bit microcontrollers which could be used for a wide range of application from simple input output processing to complex task involving multi-tasking applications.

Figure 2: Arduino 8 bit development platform

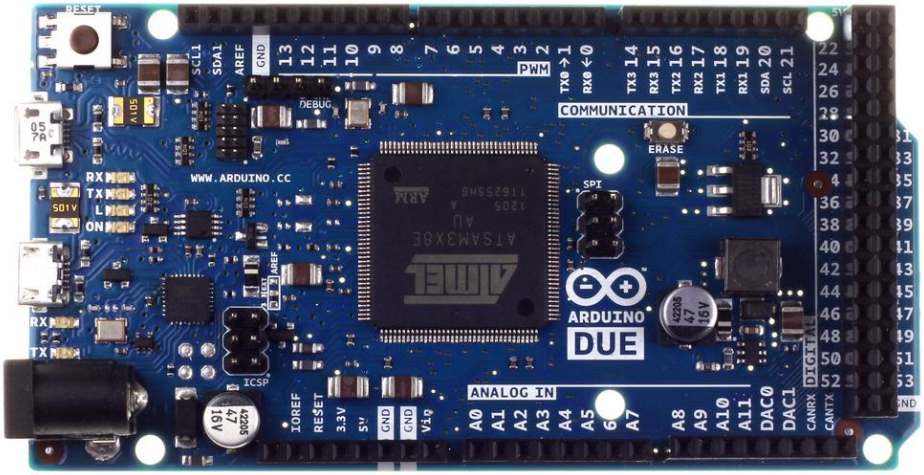

Figure 3: Arduino 32 bit development platform

3.2 Raspberry pi

Raspberry pi[9] foundation is a small sized computer in itself. It is by far the most advanced and up to date computing platform available to open source enthusiasts. The raspberry pi latest model i.e. B+ features an 800 MHz processor along with a graphical processing unit which is capable of interfacing a video display system. This small sized board is comparable to the performance of old age general purpose computer. The raspberry pi works solely on python programming language along with an integrated development environment and a host of new features regularly update on the web.

Figure 4: Raspberry pi model B+

3.3 Beagle board

Beagle board[10] is yet another open source computing platform offering high end performance and a plethora of features support such as integrated development environment and a host of user support libraries. The beagle board latest edition is called as beagle board black and is a very promising upcoming competitor in the open source computing environment. The beagle board is a truly robust system which works on Linux distributions and gets the user started within 10 seconds. The only downside of using beagle board black is that it is more expensive alternative as compared to all the above boards that we have discussed.

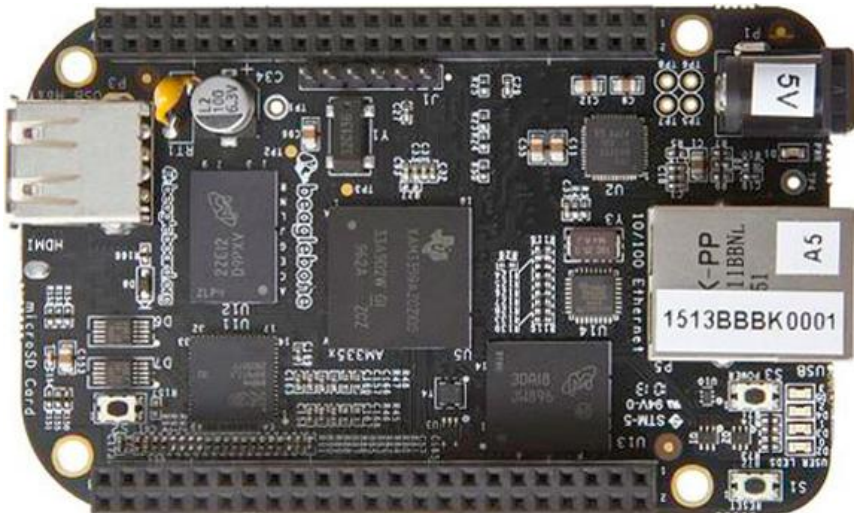

Figure 5: Beagle board black computing platform

4. Open Source Software

Here open source software means software's that can act as data acquisition terminals. The software must have the capabilities to access the hardware ports of the computer and they must also have the capabilities for data manipulation, graphics processing and data analyzing functionalities. The inclusion of a graphical user interfaces a must for today's graphical programming environment.

4.1 Pylab-works[11]

This unique development environment includes the best of two most popular scientific computing platform i.e. lab view and Matlab. It has a visual driven programming just like Lab view and is easier to customize. It also has a Matlab type command environment for better data visualization and manipulation. The Pylab-work is written entirely using Python and is nowadays extremely popular in open source computing platform.

4.2 Scilab[12]

Scilab is an open source computing platform almost similar to Matlab in terms of graphical user interface development, signal; processing capabilities and also in terms of toolbox availability. It would be worth saying that Scilab is the bestopen source alternative to Matlab. In fact the initial IDE of Scilab is almost similar to Matlab and hence a user migrating form Matlab would have no difficulty in learning Scilab.

4.3 GNU-Octave[13]

GNU-Octave is written entirely in C++ and is highly useful for solving linear and nonlinear equations and doing statistical and scientificcomputation. But because of the lack of a proper graphical user interface GNU-Octavecan't be used for virtual instrument as compared to Scilab and Pylab-work.

5. Conclusion

After analyzing all the above alternatives that we have seen for open source hardware and software available to the research community one must say that the selection of hardware depends upon the complexity of the data acquisition process. If the data acquisition process is complex then one can go for Raspberry pi or Beagle board hardware platform else for almost all the other works Arduino board will suffice. Now for the open source software part one must say that the research community is left with very little option and with the languages available one can go for Scilab or the Pylab-works as they provide a decent looking graphical user interface.

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