CONTROL SYSTEM DESIGN USING OPEN SOURCE SOFTWARE (SCILAB)

Mayur Jain, Sheetal Bhande, Aditya Chhatre, Amit Naik, [#]Vishal Pande, *Prafulla Patil

Instrumentation, Vidyavardhini's College of Engineering and Technology

[#]Assistant Professor, Instrumentation, Vidyavardhini's College of Engineering and Technology

Address

mayurjain0405@gmail.com

ABSTRACT

Most process control courses rely on MATLAB/ Simulink to fulfill, at least partially, their simulation needs.

Albeit this choice represents a standard and rather satisfactory solution, the availability of such commercial software in academia should not be taken for granted. This paper shows that with some adjustments and moderate additional effort, teaching material developed with MATLAB/Simulink can be successfully replaced by equivalent material developed with Scilab/Scicos, a free and open source computing environment .This contribution presents remote process control and monitoring.

The objective of this project is to access the control loop trainer kit remotely. The main motivation behind this project is the unavailability of such kits because of high cost in many institutions where it is extremely necessary.

For this purpose we are using Scilab which is a free and open source software(FOSS) having powerful benefits and simplicity in hardware interfacing, ease in implementation of various soft controllers, etc.

By using Scilab we can develop various controller algorithms like P,PI,PID etc. where end user can get real time process outputs.

With further improvements in the same, the system can be operated over the internet and will have a very wide scope.

KEYWORDS

Process control, Real time control, Scilab, Distance education, Web based control.

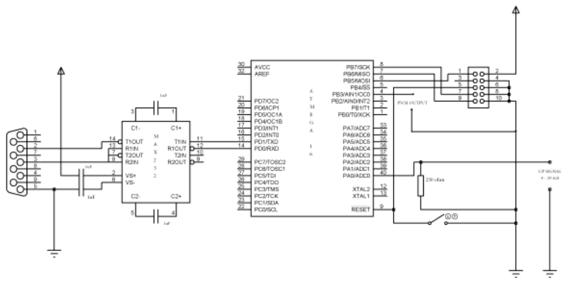
INTRODUCTION

The World Wide Web has provided an opportunity for design and analysis of control systems through the Internet. An increasing number of Web-based software packages have been developed to enhance the teaching and design of control systems. Today, the most popular applications in control systems are Web-based real time laboratories. One of the aims in control education, therefore, is to teach the techniques and possible difficulties of theoretically based design methods when applied in practice. The control system design process involving practical experiments and observing the dynamics of a real plant gives a valuable insight. Simulations may also be a suitable complement in achieving this aim, however, in many cases they cannot replace a real experiment.

The project includes a pressure control loop from the PID trainer kit of our laboratory. The loop consists of mainly one pressure transducer and one final control element to regulate and control the pressure through loop. To make the process real time work and remotely operable, signals from transducer and output to control valve is connected to computer via. Input Output module. On software part SCILAB is used for development of various control algorithms such as PID, PI, PD, model based, etc. Moreover we can experiment step change, ramp change response of the process.

To make the process remotely accessible, client server connectivity is used through SCILAB. In final stage of the project, we will try to develop a website which will help students to access the trainer kit for experiment and study purpose through internet with the given time slots.

DATA ACQUISITION CARD



DAQ card is mainly developed using ATmega16 microcontroller, Max 232 voltage translating chip and serial communication circuit. It is used to gather information from the process and also used to generate the control signal to the final control element according to the control algorithm.

PROCESS CONTROL LOOP

We have selected a pressure control loop from the trainer kit. It consist of sensor (diaphragm), Transmitter and final control element (control valve). For controlling the process remotely, we have to connect transducer and final Control element via computer based control system. DAQ card is used to convert signal from analog to digital and vise versa

BLOCK DIAGRAM

As shown in fig. 2, output from the pressure transmitter i.e. current flow rate (4 to 20 mA) is converted to voltage (1 to 5 V) i.e. V to I converting. This voltage is given to microcontroller (ATmega16) which is then send to computer i.e. to SCILAB via serial communication. From computer, control signal in voltage is send back to microcontroller which is converted to analog voltage via PWM. The voltage signal is converted to current signal (4 to 20 mA) and given to final control element i.e. control valve for regulation of the pressure.

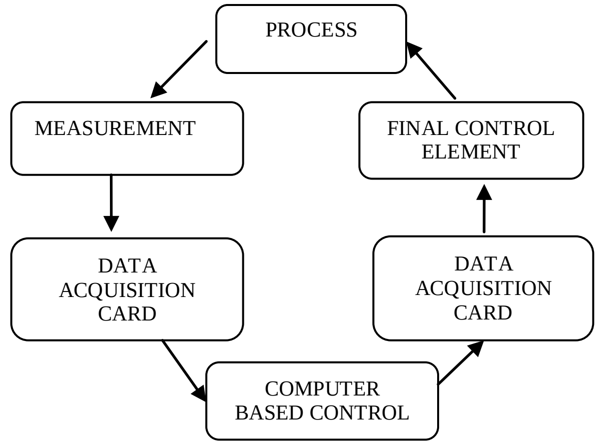


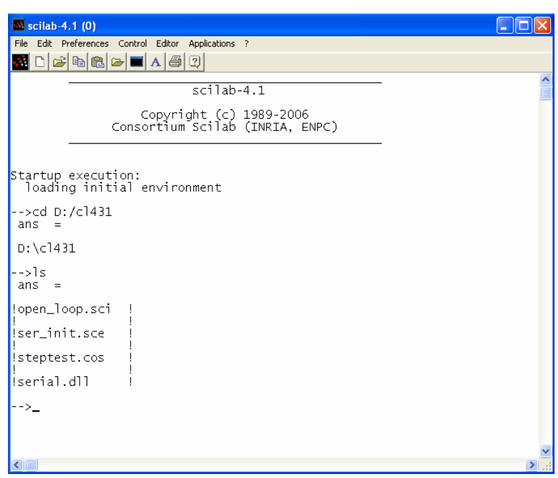
Fig loop2 Block diagram of process.

OPEN SOURCE SOFTWARE

Now a days using open source software is cutting cost to a very large extent. Many open source softwares are developed to replace those ones that costs a huge amount of money. Any person can modify the code of open source platform and put forth his newer version from the existing one.

SCILAB

Scilab is a freely distributed and open source scientific software package providing a powerful open computing environment for engineering and scientific applications. Developed since 1990 by researchers from INRIA and ENPC, distributed via the Internet since 1994, it is now maintained and developed by Scilab Consortium since its creation in May 2003. Scilab is increasingly being used in educational institutions, research centers and companies around the world.

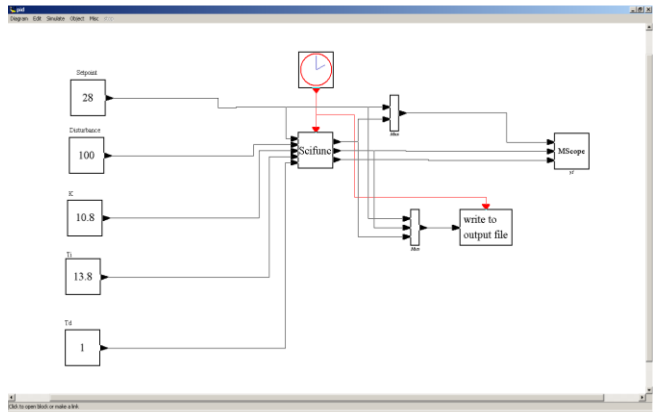


Scilab's main features are:
• a high-level programming language
• an interpreter
•integrated object-oriented 2-D and 3-D graphics with animation
• an XML-based help system
• a dedicated editor
• sophisticated and transparent data types including dense and sparse matrices, lists, polynomials, rational functions,linear systems ...
•hundreds of built-in primitive mathematical functions
•open system where the user can define new data types and operations on these data types by using overloading
•possibility to add interactively programs from various languages (C, Fortran...)
• various Scilab-coded toolboxes :
– linear algebra
– polynomial

– ODE solver and DAE solver
– differentiable and non-differentiable optimization
– signal processing
– statistics
– graphs and networks (Metanet)
– classic and robust control
– LMI
– parallel Scilab using PVM
– hybrid dynamic systems modeler and simulator (Scicos)
• interfaces with symbolic computing packages (Maple and MuPAD 3.0)
• an interface with Tcl/Tk
• a large number of contributions.

Scilab works on most Unix systems (including GNU/Linux) and Windows (9X/2000/XP). It comes with source code, on-line help and user manuals. Binary versions are available.
Scilab latest release (4.0, February 2006) provides, among other things, an improved Windows version, an extended graphical environment, a debugging tool, a better Matlab to Scilab converter, an interface with Excel. Thanks to the creation of Scilab Consortium, with better funding, a well structured development organization and a more reactive user support, Scilab promises to become a worldwide reference for academics and companies all around the world.

XCOS



Xcos (scilab Connected Object Simulator) is a dynamic
systems modeler and simulator, similar to Simulink in Matlab,with the following features:
• a GUI-based editor for modeling dynamical systems as
block diagrams
• hierarchical block diagram structure (Super blocks)
• a large number of standard blocks available in various
palettes (equivalent to Simulink block-sets)
• possibility to define a new blocks using C, Fortran (dynamic link) or Scilab language

• formalism for modeling hybrid systems
• diagram compilation and C code generation.

As a matter of fact, Scicos is in a somewhat less mature development stage than (the rest of) Scilab. It is certainly not as debugged, well-documented and user-friendly as Simulink.In spite of this, everything needed for technical education is there and works (reasonably) well.

SERVER – CLIENT CONNECTIVITY

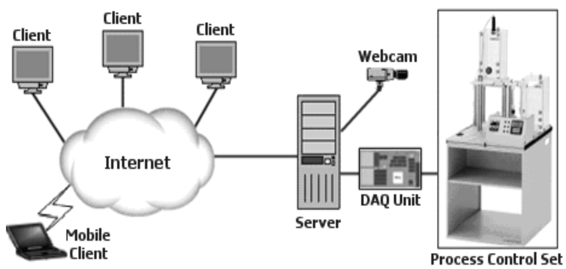
By using SCILAB and suitable server – client protocols remote process in real time is to be implemented. For the same, website is also be developed which will provide user interface for clients. Access of kit to clients is going to be schedule as per slot booking system so that at a time only
one client will be able to access the kit in real time and others can view the output.

CONCLUSION

Data Acquisition Card is developed using ATmega16 microcontroller from avr family and serial communication circuit and it is interfaced successfully with Scilab. Work of website and client server connectivity is in progress.

FUTURE SCOPE

We can design and develop web based laboratory experiments. New and attractive features, such as camera capturing the real-time video, can be useful to people performing experiments remotely as shown in figure below.



Our approach comes to propose the supervision and the control of a Web-based real laboratory. This remote process control idea can also be further implemented virtually using internet on a large scale. In the present context few of the control algorithms have been implemented in flow control loop. Using the same free, open source and powerful platform of SCILAB similar process trainer kits of educational institutes and engineering applications can be developed and access remotely in real time.

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