Integrating the Emona FOTEx Interface into the Batched iLabs Client

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Abstract – The use of Internet Laboratories (iLabs) at Makerere University has gained momentum, enabling students to conduct remote experiments on physical equipment. iLabs are based on the Massachusetts Institute of Technology (MIT) iLabs Shared Architecture (ISA) which consists of three tiers: labserver onto which the hardware is connected; the client which is an interface that a user interacts with; and the service broker which provides communication between lab server and client. The majority of the iLabs used are based on the Batched Architecture. The current batched client is a java applet that presents a block diagram of a basic circuit at the labserver and dialog boxes for a user to configure hardware components. This usually leaves the user uninformed of the physical connections made on the physical equipment. Presented in this paper is the work undertaken to introduce augmented reality into the communications batched iLab client, thus improving user experience. The lab, which addresses the fundamentals of fiber optic communications, is based on the EMONA Fiber Optics Telecommunications Experimenter (FOTEx) add-on Board for the National Instruments Educational Laboratory Virtual Instrumentation Suite (NI ELVIS II) Platform. A soft interface of the add-on board was incorporated into the lab to enable users to wire the experiment setups virtually before the lab is run, as would be done on the physical board. The processes involved in development of the interface as well as test runs are here-after presented.

Key Words: Batched Client, FOTEx, iLab, Virtual Reality

I. INTRODUCTION

Laboratory experience gives students knowledge and expertise in what goes on in nature beyond the mere theory studied in the classroom. Various educational institutions across the globe have integrated the use of remote laboratories into their course curriculum thereby technically empowering students in the face of large student numbers with inadequate equipment [1,2].

Makerere University has adopted iLabs (internet Laboratories) as a supplement to the existing traditional labs in the Department of Electrical and Computer Engineering [3,4,5]. Although the students are given a brief introduction to the equipment used, once the lab has been deployed, their access to the physical wiring is limited. They can only configure the instruments being used through dialogue boxes, Fig. 1, and then run the experiment. This creates a significant gap between the client interface, Fig. 2, at the client side and the real circuit set up, Fig.3, at the labserver end.

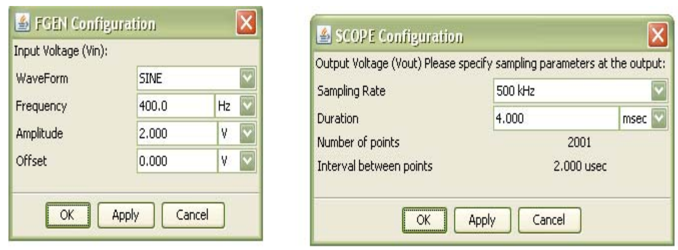


Figure 1: Functional Generator and Oscilloscope Configuration Windows

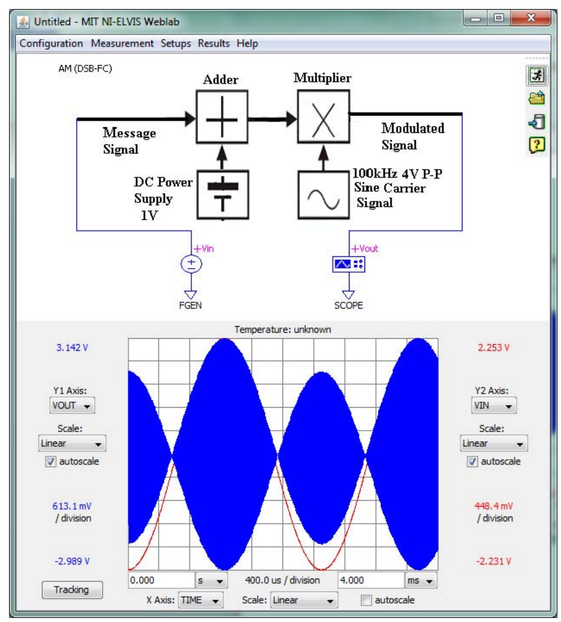


Figure 2: Current Java-Enabled Client

Figure 3: Experiment Setup on Lab Server Side

Clearly, justice has to be done to bridge the large separation between the circuit at the labserver end and what is portrayed at the client side. The student ought to be presented an opportunity to visualize the set up of the hardware. Virtual reality has been applied in medical field such as surgical simulation [6], also in remote engineering experimentation on the EMONA DATEx (Digital Analog Telecommunications Experimenter) board [7], however for the EMONA FOTEx (Fiber Optics Telecommunications Experimenter) board; no work has yet been done to include virtual reality to experimentation on this board.

The EMONA FOTEx Board is an add-in module integrated on the NI ELVIS II (National Instruments Educational Laboratory Virtual Instrumentation suite) and fully compatible with LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) programming environment [8]. It is a collection of blocks/modules that can be patched together to emulate and implement a dozen fiber optic communications scenarios. It supports incorporation of optical fiber cable in the circuitry. The full kit consists of optical patch cables and connection wires. The modules include; the Master signals module that generates AC signals, speech module that generates speech signals, the amplifier, transmitter and receiver modules. It is also used as an interface between devices and circuits that cannot normally be connected, filters that discriminate signals by their frequency, transmitters that convert the electrical signal to optical signal for transmission over the optical link and receivers to do the reverse process [9]. This paper therefore presents the integration of an interface for the EMONA FOTEx board with all the different modules so as to add virtual reality to the batched client and allow a user to make wiring configurations like those at the labserver.

II. RATIONALE

Integration of the Emona FOTEx interface into the communications batched iLabs client was driven by the results of a survey carried out on the efficiency of the existing Lab Client interface within the student body in the Department of Electrical and Computer Engineering at the College of Engineering, Design, Art and Technology in Makerere University, Uganda. Questionnaires were handed out and the student responses were summarized and graphically represented in Fig 4.

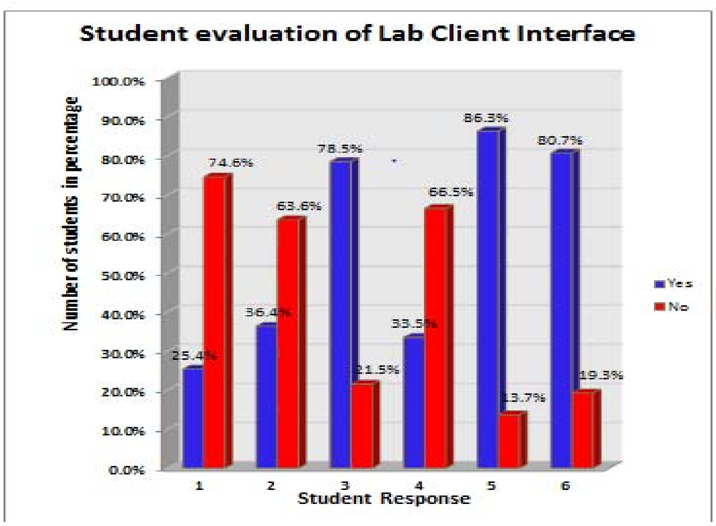
III. SYSTEM DEVELOPMENT

A. HARDWARE INTERFACES

The main pieces of equipment used towards the realization of this interface were the NI ELVIS II and the Emona FOTEx boards.

1) NI ELVIS II

The NI ELVIS II is a design and prototyping platform that integrates 12 of the most commonly used laboratory instruments including the function generator and oscilloscope, all on a compact board that is compatible with a compute [10]. Using a USB connection to one's computer, the NI ELVIS II uses LabVIEW graphical programming language and also allows the user to add third party plug-in boards such as the Emona FOTEx and Emona DATEx boards. The compatibility with these plug-in boards and its wide functionality made the NI ELVIS II the perfect choice for experimentation.



1	When I am doing an iLab I feel like I am doing an experiment in the laboratory.
2	For all the iLabs I have done I have clearly understood the concepts being demonstrated.
3	Allowing me to run multiple relevant experiments in one session would enrich my experience
4	When doing an iLab I can visualize the physical connection of the set up based on the block diagram.
5	If I were given an opportunity to make the connections myself, it would help me understand the concepts better.
6	This would make the lab easier to do

Key for Student Response Axis

Figure 4: Graph of Student Response to Survey with Key of Sample Question

2) *Emona FOTEx*

The Emona FOTEx board is an add-in module that can be integrated on the NI EVIS II platform and is fully compatible with the LabVIEW programming language [9]. It supports a number of modules which can be accessed and controlled using the NI virtual instruments. It consists of couplers, transmitters and receiver modules connected by optical patch cables which allow the user to implement several fiber optic communications concepts.

B. SOFTWARE INTERFACE

The software was built on the iLabs Shared Architecture (ISA), a web service infrastructure that supports online laboratories. It is made up of three tiers: a Lab Server, Service Broker and Lab Client.

1) *The Lab Server and Service Broker*

Windows Server 2003 (Win2K3) operating system, Standard Edition, Service pack 2, was used for both the Lab Server and Service Broker.

SQL Server 2000, a database system, was used to manage the system databases. The Microsoft Visual Studio development environment for platforms supported by the .NET Framework was used to provide editing, debugging and web design services.

LabVIEW is a development environment that uses a graphical programming language to support access to the NI ELVIS II and Emona FOTEx instrumentation [8]. This was used to build and run the virtual instruments to access the hardware and also run experiments on the Emona FOTEx and NI ELVIS II platforms. LabVIEW 2009 was used.

The Equipment drivers used included; the NI ELVISmx Drivers 4.0.1 were installed to enable access to the 12 instruments of the NI ELVIS through the NI-ELVISmx Instrument Launcher. The EMONA FOTEx drivers were also installed to allow access to the FOTEx modules.

2) *The Lab Client*

a) *Visualization*

In order to develop an interface/soft front panel of the Emona FOTEx, Fig. 5, that allowed greater user interaction with the existing lab client, visualizations/sketches were designed and basing on a combination of the two designs, Fig. 6, a composite client with an integrated EMONA FOTEx board, its components and pertinent components of the NI ELVIS II platform were designed and visualized using the Adobe Illustrator CS3 and Adobe Photoshop CS3 platforms. These visualizations were converted to .png and .bmp images.

Figure 5: The Emona FOTEx Board

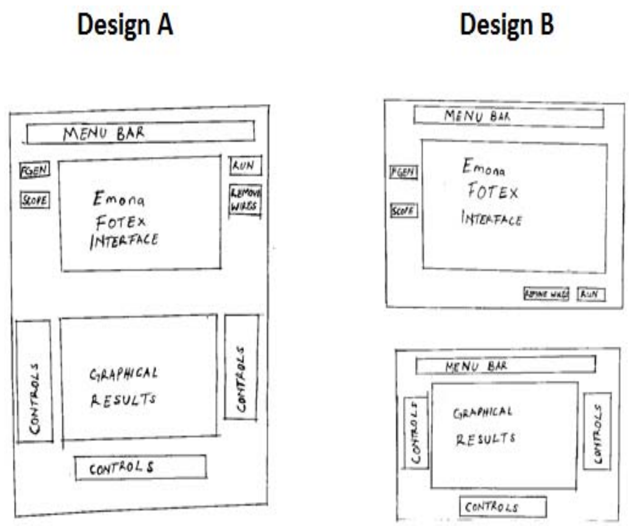


Figure 6: Integrated Emona FOTEx Interface Design Sketches

b) *The Web Application*

The integrated Emona FOTEx soft front panel was built using a number of software development tools; an HTML (Hypertext Markup Language) base for the web application content. Cascaded Style Sheets (CSS) was used for all the interface styling. It was also developed to closely imitate the colors of the iLabs Service Broker. The whole interface was developed using the Adobe Dreamweaver CS3 web development application.

c) *Interactivity*

The interactivity on the soft front panel was achieved using JavaScript libraries and logic. To allow the user make wire connections from one terminal to another, the WireIt JavaScript library was employed. Other interactivity including toggling switch states, choosing between experiment setups and verification of wiring configurations was achieved using the jQuery JavaScript library. The WireIt-0.5.01 and jquery-1.7.1 releases were used.

d) *Experiment configuration validation*

Validation algorithms were created for the case where different experiments are available to the user. On completion of wiring the user selects the *Verify* option on the Controls panel to check whether the wiring is correct; once configuration is validated, the user can then access the java applet to configure the hardware instruments, in this case the function generator and oscilloscope, run the experiment, view results and download them.

e) Web Browsers

The Emona FOTEx interface was developed for computers operation on windows operating system, with new releases the Mozilla Firefox and Chrome web browsers, and an updated version of Java Runtime Environment (JRE).

IV. USER EXPERIENCE: TESTING WITH SAMPLE EXPERIMENT

A. LogIn

On opening the Service Broker at the URL *10.0.6.13/servicebroker*, (based on the University Intranet), the home page is presented to the user; here they can either register or login if they already have an account with the Service Broker, Fig.7. An experiment is selected from a group according to one's membership in the available groups, Fig. 8. Selecting an experiment in turn opens the *My Labs* page which allows the user to launch the integrated interface.

B. Wiring the Interface

The Fiber Optics Bidirectional Communications experiment was chosen as the sample experiment to test the developed soft front panel. The experiment setup was made available under the Configuration option, which allows the user to make wiring connections according to the available documentation/ experiment manual/guide. In case of any wrong connections, the user will receive a message informing him/her of the incorrect connections. Until validation is complete, indicating approved connections, access to the Java Applet is not given. Once connections are approved, the *LAUNCH APPLET* button is enabled and the user can configure hardware instruments and run the experiments, Fig.9 and Fig.10.

C. Configuration of instruments

The function generator and oscilloscope are configured via dialogue boxes, Fig. 11, and the experiment is submitted to the labserver via the service broker. The labserver then configures the hardware, runs the experiment and returns the results to the client through the service broker.

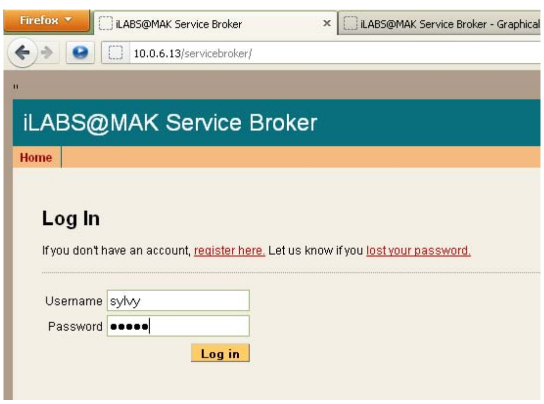


Figure 7: Selecting a Group

Figure 8: Log In/ Registration Page

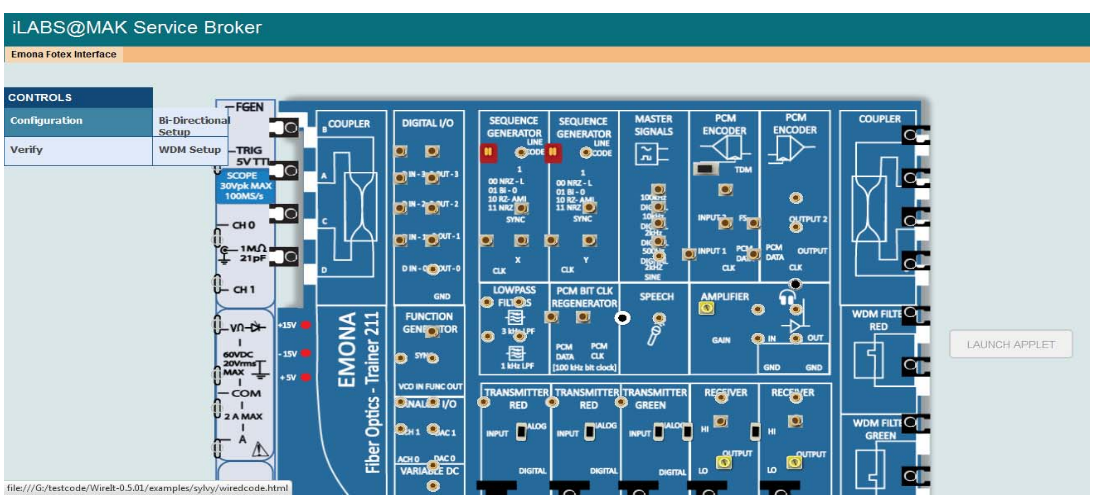


Figure 9: Emona FOTEx Interface

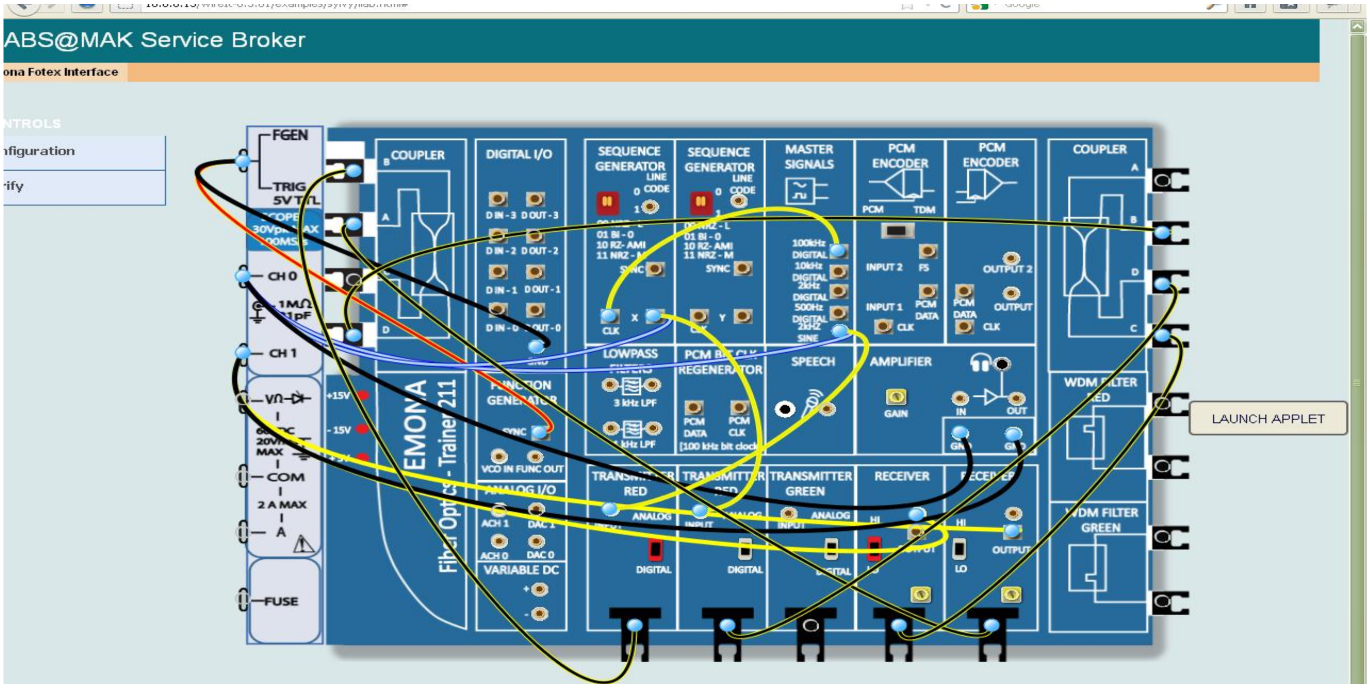


Figure10: Wired Interface, similar to physical connections on Emona FOTEx Board

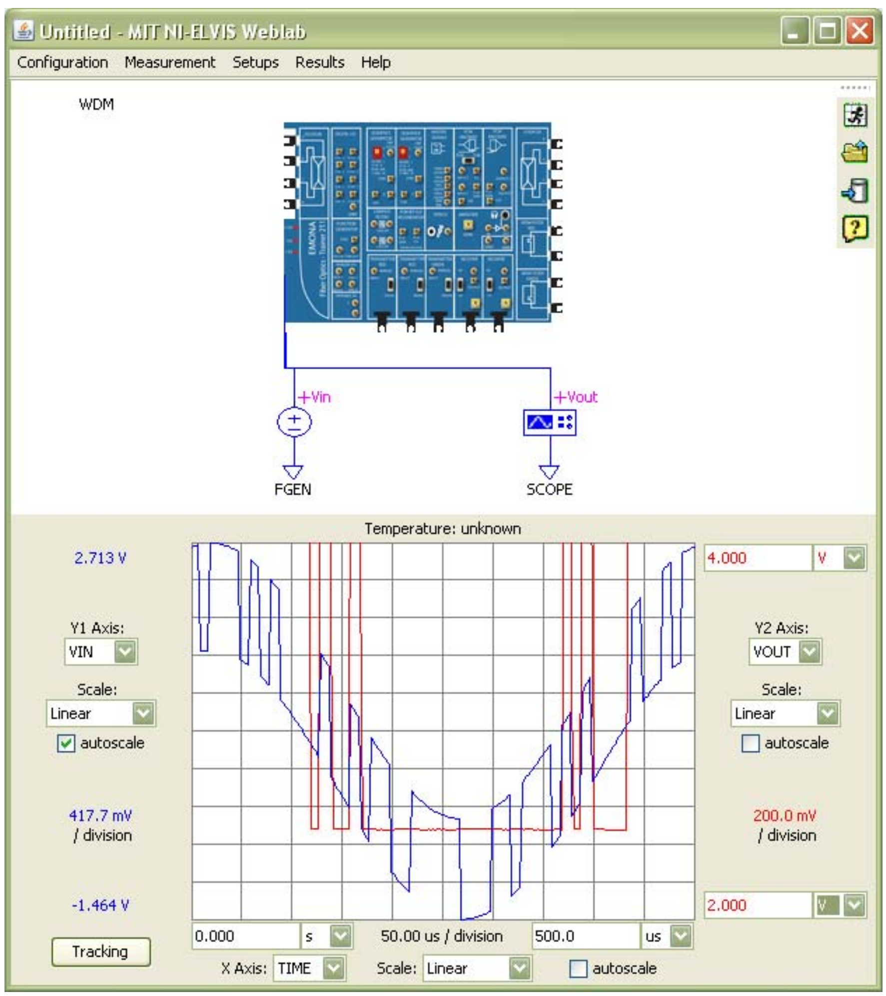


Figure11: Experiment Results after Correct Configuration

CONCLUSION

This paper presents a soft interface developed for the EMONA FOTEx board. It will improve the laboratory experience of the user performing laboratories developed on the EMONA FOTEx board by adding virtual reality to the batched client creating a platform for the user to do wiring configurations that mimic the conventional laboratory in terms of setting up a lab. It will also inform the possible development of soft interfaces for other add-on boards for the NI ELVIS and other hardware.

ACKNOWLEDGMENTS

The authors would like to thank the entire iLabs@MAK team, particularly the Principle Investigator, Prof. Sunday Tickodri-Togboa, for their dedicated guidance and support. They would also like to thank the entire team at Center for Educational Computing Initiatives at Massachusetts Institute of Technology and the teams at Emona and National Instruments for their technical guidance. Special thanks go to the President of Uganda, Y. K. Museveni and the Carnegie Corporation of New York for their continued financial support.

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