Remote Experimentation Lab for Learning Disabled Students

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***Abstract**: Recent survey by United States National Center for Education Statistics indicates that about 9 percent of undergraduates reported having disabilities in 1999–2000, and 22 percent of these students reported not receiving the services they needed. We have added new features in the Automated Internet Modelling (AIM) lab at RPI to help students with learning disabilities. These features include improved optional audio-visual instructions in You Tube compatible format and online live video feeds and additional capability to chat with fellow students using web-messenger. Using new collaborative AIM-Lab environment, students will learn to perform characterization of electronic devices, including diodes, bipolar junction transistors, LEDs and a CMOS test circuit. The laboratory constitutes a module in a senior/graduate course on device modelling and circuit simulation. With the added new functionality in AIM-Lab, learning process for learning disabled students will be more effective than in traditional limited time lab sessions.*

Introduction

There is an explosive growth in students with learning disability, for instance the percentage of full-time college freshmen who self-reported a disability increased from 2.3 percent in 1978 to 9 percent in 1998 in the United States (Henderson, 2001; National Center for Educational Statistics). In general, the learning disability disorder can be classified by one or more psychological processes involved in understanding or in using language, spoken or written. According to Janet and Frank (2005), the learning disability may manifest itself as an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The *No Child Left Behind Act (NCLB)* and the *Individuals* with *Disabilities Education Act (IDEA)* require states to provide these students with access to the general education curriculum. The students with learning disabilities often require special attention and need access to assistive technologies in order to keep up with their classmates. Although instructional strategies based on using audio/visual instructions, cooperative learning and peer mentoring were earlier proposed for learning disabled (LD) student but they were studied in limited size classroom environment. Current educational technologies such as integrated studio based learning (Millard, 2007), distance education (Willis, 1994) and remote experimentation (Fjeldly, 2003) are a huge success. Morevover, the advancement of internet technology and growing

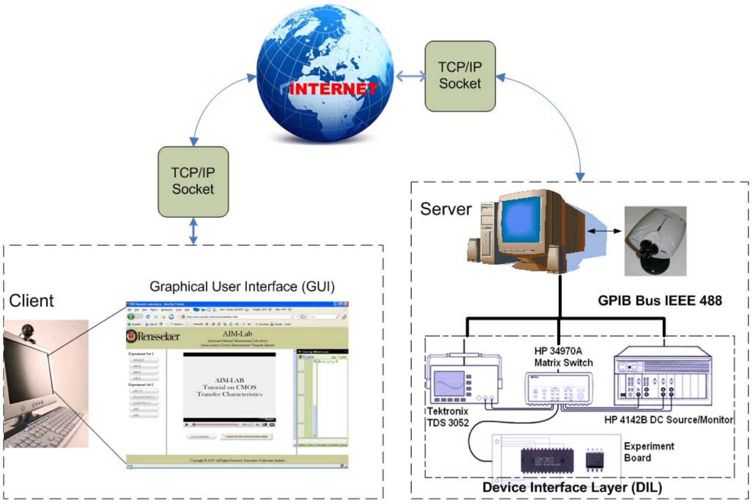

Figure 1: AIM-Lab system architecture.

popularity of social networking sites such as Twitter, Facebook and Myspace etc can lead to new opportunities to improve student's educational experience. Researchers in the field of learning disability began to put more focus on investigating the influence of social contexts on students with learning disability. Their results showed negative effect on the achievement of students with learning disability caused by reduced teacher expectations, insufficient support, or poor social relations with teachers (Miller and Riditi, 2001; Murray and Greenberg, 2001). WEB-based technologies could be used to compensate for some of these negative factors. Our work on remote lab systems for semiconductor device characterization resulted in development of AIM-Lab (Fjeldly and Shur, 2003); the novel learning tool designed to improve student's educational experience. The laboratory has been used in senior/graduate courses on device modelling and circuit simulation. It includes experiments involving characterization of diodes, bipolar junction transistor, light emitting diodes (LEDs) and complementary metal oxide semiconductor (CMOS) test circuits. In this paper, we discuss implementation of cooperative learning in AIM-Lab by adding improved audio/visual instructions and web messaging, which should make the AIM-Lab more suitable for the needs of students with learning disabilities.

System Architecture

The AIM-Lab core system architecture is shown in Figure 1. The student (client) opens the AIM-Lab website using his/her web browser. The welcome screen provides step-by-step instruction for navigating through the web-interface. The user has the option of choosing the list of experiments by pressing the buttons on the right-hand side of the tool bar. On the left-hand-side is the optional web-messaging interface. By pressing the button related to particular experiment the user runs a java applet, which opens a new pop-up client browser window requesting to enter parameters of the measurement to be performed. After entering the experimental parameters, the client submits the request and the commands are generated by the applet according to the parameter set specified by the user and then it is sent via TCP/IP client socket to the server over the internet. The TCP/IP server socket activates the driver interface layer (DIL). The DIL then sends the commands to the instrument driver-using GPIB (general-purpose interface bus). The experimental instrumentation in AIM-Lab consists of Hewlett-Packard (HP 4142B) direct-current source/monitor with one source monitor unit (SMU) for each separate voltage source or measurement node. These SMUs directly connect to the device test chip on the experiment board, which is designed and fabricated especially for AIM-lab. The output current-voltage characteristics of the devices are acquired by DIL via GPIB and the data is returned to the client via internet for further processing. The instructor can monitor and control the server process as well as modify the configuration of the instrumentation using the GUI interface. The AIM-Lab system is designed to maximize the server performance and efficiency; we developed the server as a windows-based MDI (multidocument interface) application, which is a multi-user, multi-experiment environment with a task queue. For each user, it records all the commands in a dedicated

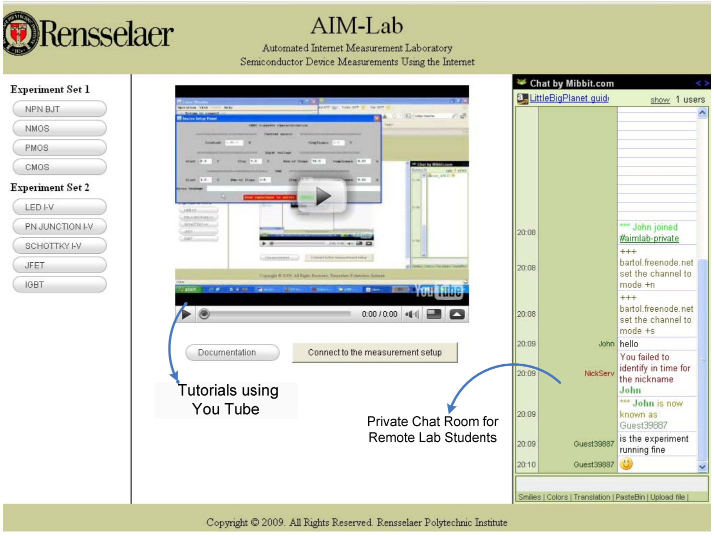

Figure 2: Graphical User Interface (GUI) on the client browser.

document window. According to the tests, the time needed to perform a complete experiment is less than 10 seconds, including sending the commands and plotting the data. Such a kind of system architecture is very essential to implement a collaborative learning environment and recent advances in internet technology, audio/video chats, message boards, online blogs, and online conferencing provide an array of channels for collaboration (Chivukula and Shur, 2008), which depend on learner concurrency and learning goal. Johnson and Johnson (1990) conducted study with all age groups of students over past forty years for diverse subject areas and wide range of tasks, it provides enough evidence that those participants who study together in groups gain more knowledge than people doing individual study. Therefore, we added new functionality to the client browser, which includes audio-visual instructions in You Tube compatible format and online live video feeds to provide information on the experiment being performed along with the capability to chat with the fellow students using a web-messenger. Learning disabled students would greatly benefit from such collaborative approach for remote experiments. The proposed new system will have video cameras installed at the site of experiment to provide online live video feeds, which offer a real time feedback to avoid confusion on the experiment being performed.

User Interface

A desktop Graphic User Interface (GUI) is being designed to accommodate various learning and collaborative components (as shown in Fig. 2). The GUI is developed using Hypertext Markup Language (HTML). One of the benefits of this approach is that user can customize their learning environment by re-arranging the number, positions, and size of each component in accordance to their personal learning styles. This is particularly useful when multiple learning components such as web messenger, video and audio conferencing capabilities are used at the same time. A special private chat room is created for remote lab students, which is based on Internet Relay Chat (IRC) open protocol that uses TCP. Open IRC service provider Mibbit (www.mibbit.com) provides the chat service. It is designed for group communication but also allows one-to-one communication via private message. In addition, it has many customizable features, which allows users to change skins and use real time language translation, image thumbnails and file exchanges. You Tube videos of each experiment provided detailed step-by-step instruction to the learning-disabled student (see Fig. 3). The course instructor records the You Tube videos after identifying the problems faced by the students performing experiment. In addition, the instructor designing activities for learning disabled students should discuss strategies to balance cognitive load as these students become familiar with the new remote experimentation system having many features (Sweller, 1988). In future, we plan to add live video feeds of the classroom lecture and optional video conferencing with peers, which will be based on user survey conducted at RPI.

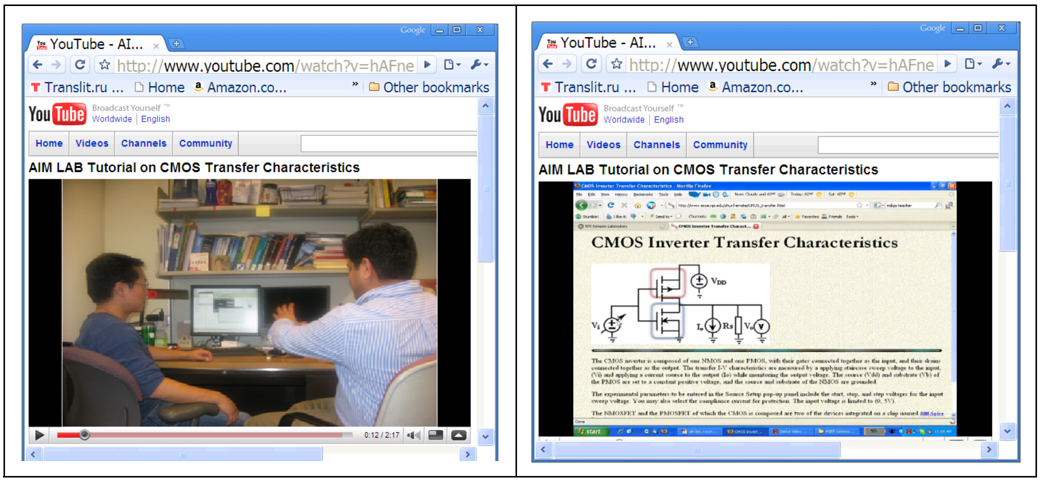

Figure 3: Examples of YouTube different tutorial screens.

Learning Disability in Professionals and Proposed Assessment for Addressing their Needs

Unlike the learning atmosphere in the high schools, the learning disabled students making transition in to postsecondary education and work need to strengthen their academic skills and build a sense of competence and independence in performing their tasks. Stacey (2001) reported the students with learning disability often experienced very high levels of stress on the first days at work. This can be attributed mainly to lack of training and feedback on how to perform a job and it demands the need for mentoring, training, and immediate feedback to succeed. In addition, Madaus et al (2002) observed that 90 % of the individuals graduating from college with learning disabilities reported difficulties related to writing skills, information processing, reading comprehension, time management, and organizational skills. Specific accommodations such as using remote experimentation labs could be used to make working easier. By adapting AIM-Lab, we plan to address the need of these individuals. After identifying the students at RPI who self-reported having specific learning disability, we plan to conduct individual interviews to obtain their feedback relating to features implement in our proposed laboratory. Further, our study will be targeted to the students taking undergraduate and graduate courses relating to electric circuits, microelectronics, semiconductor device modelling and electronic instrumentation. Interviews will be conducted after obtaining the consent from the student and the course instructor. All learning disabled students will be taught relevant science concepts, which will be followed by short tutorial describing the working of the laboratory. Each student will then be assigned specific experiment and successful completion of the experiment is an indication of the addressing their needs. In order to probe the educational outcome of the students using our remote laboratory in the long term, we will monitor their academic achievement such as grades, class participation by talking to the class instructor and their parents.

Conclusion

We have described the current AIM-Lab system architecture and implemented strategies to address the learning-disabled student needs. In the presently implemented system, these students can chat and discuss technical problems with fellow students and instructor while performing experiments in a remote setting. This approach will also help instructors by providing easier ways to deliver the guidance and to monitor the progress of a student more carefully.

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Acknowledgements

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