

Remote and Local Delivery of Cisco Education for the Vision-Impaired

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ABSTRACT

Vision-impaired students face tremendous obstacles in their quest to access learning materials delivered in web-based and other electronic formats. The predominance of visual prompts, use of flash and animation and the inability of screen reading applications to interpret images all contribute to make much of the current e-learning materials associated with computing studies inaccessible by blind or vision-impaired students. This paper describes a university research project undertaken to improve the accessibility of Cisco e-learning materials for vision-impaired computing students. The network architecture which supports the delivery of the Cisco courses to both local and remote vision-impaired students is also presented.

Categories and Subject Descriptors

H.5.2 [Information Systems]: Interaction styles (e.g., commands, menus, forms, direct manipulation), Voice I/O

K.4.2 [Social Issues]: Assistive technologies for persons with disabilities

General Terms

Design, Human Factors.

Keywords

Vision-impaired, Screen readers, Universal Access, User interfaces, assistive technologies.

1. INTRODUCTION

The use of the Internet and web based instructional aids are now viewed as an integral part of the tertiary learning environment. Students receive unprecedented access to information and these presentation modes provide them with new learning opportunities. The merits of e-learning are extensive, however the rush to implement e-learning systems have resulted in students with

disabilities being left behind due to the lack of an accessible content delivery system.

While e-learning and web-based applications have opened opportunities for many students with disabilities, it remains primarily vision dependent, with increasing levels of inaccessibility for blind and low vision students [1] [2]. In particular, diagrams, images and visual cues are inaccessible by blind and vision impaired students [3] [4].

The nature of computing education curricula contributes added hurdles for the vision-impaired. Education in computing at tertiary level requires comprehension of theory in addition to practical application and hands-on exercises in order to develop a sound knowledge base. Computing theory is a combination of logical and physical abstractions, invariably taught to students using conceptual diagrams or figures containing shapes of different sizes together with other visual effects such as shading, color and sequence [1]. The more complex the model, the more complex the visual effects used, requiring spatial abilities to interpret motion and 3D images. Vision-impaired students are at a severe disadvantage in this type of learning environment, particularly those who have been blind from birth or an early age [5].

The combination of computing curricula delivered via digital and Internet-based mediums has resulted in e-learning materials in the field being dominated by visual-driven formats and sequences. The majority of this e-learning material requires sight to access, follow and comprehend the pedagogical aspects being delivered. Vision-impaired students have a limited array of tools available to assist access to computerized environments. The most common tools are screen readers or text magnification applications, and some students utilize Braille display units. Output devices such as PIAF printers are used to produce hard copies with raised print for tactile interpretation. These tools do not provide an equivalent speed and ease of use to their graphical counterparts. Screen reading applications translate text to voice, but are unable to access non-textual materials. Text magnification software is useful for students with some vision, but excludes access to those who are totally blind. Braille display units are expensive and only utilized by those who know Braille (commonly those with no vision at all). Other haptic devices involving transfer of information via tactile and force-feedback mechanisms are immature and low in number. Due to the content of the learning materials and the limited nature of these assistive technologies, vision-impaired students require more time to access materials and are excluded from accessing vision dominated materials.

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ITiCSE '07, June 23–27, 2007, Dundee, Scotland, United Kingdom.
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This paper discusses a project established to improve the accessibility of Cisco e-learning materials for vision-impaired students and provide local and remote access to these materials. A Cisco Academy for the Vision Impaired (CAVI) has been established to specifically research and improve accessibility to Cisco course materials for vision-impaired students. The structure of the learning environment is such that students can attend the academy physically in the classroom or connect via VoIP to lectures and laboratory sessions.

2. Cisco Academy for the Vision Impaired

The university has operated a Cisco Academy since 2001. The enrolment of vision impaired students in computing courses at the university had revealed problems with the accessibility of e-learning materials. A pilot program to teach computer networking to blind and low vision students was established in 2004 under the Cisco Academy for the Vision Impaired (CAVI). The pilot project involved a total of 19 legally blind students (all with <5% visual acuity and/or <10° field of view) progressing through converted versions of the Cisco e-learning materials. The success of this project inspired an expansion and a desire to ensure the sustainability of CAVI.

The aims of the current project are to develop solutions to improve accessibility of the Cisco e-learning materials, provide accessibility to both local and remote students, and establish an environment that can be independently maintained by one of the project partners, the Association for the Blind (WA). An overarching goal is to increase the employability of the participants on completion of the courses, providing them with industry standard qualifications relevant to the marketplace.

3. e-LEARNING MATERIALS

The focus of the e-learning materials used is the Cisco Network Academy Program. Cisco CCNA1 and 2 (Cisco Certified Network Associate) and IT Essentials 1 and 2 are taught to both sighted and vision-impaired students.

A number of teaching aids have been developed and used in the classroom and laboratory environments. Some simple tools used are pipe cleaners to describe sin waves, blocks of different shapes and sizes to illustrate network models such as the OSI model and packet headers, peg boards for binary conversions and the use of speakers instead of oscilloscopes to define frequency and amplitude. Network dominos are used to produce tactile network diagrams, and the students also utilize PIAF printers for raised hardcopy and Braille displays [5]. A network simulator called iNetSim has also been developed to assist the teaching of network configuration and operations.

Using assistive technologies vision-impaired students taking the CCNA courses within our institution are only able to access approximately 20% of the traditional e-learning resources – those sections which can be successfully translated by the screen reading software. Screen readers do not have the ability to interpret diagrams and other images, and bypass Flash and other animation techniques. Notwithstanding the efforts of many researchers in the area the development of assistive technologies is still in its early stages and usability of screen reading software in particular remains limited [6].

One of the core applications used in the CCNA courses is Packet Tracer (www.cisco.netacad.net). Packet Tracer is a Macromedia

Flash application which uses images, not text, to display information. As screen readers do not work with Packet Tracer, only sighted students are able to use it. This was a major problem needing to be solved in order to give vision-impaired students access to this material. iNetSim was developed to overcome this limitation.

3.1 Network Simulator

The iNetSim network simulator is based on Mac OS X Tiger, an operating system with an integrated screen reader called VoiceOver. iNetSim is intended to replace Packet Tracer and is a “universally accessible” network simulator now used by both sighted and vision-impaired students. It is used specifically in teaching how to configure routers, managing Cisco IOS (Internetwork Operating Software), configuring routing protocols and setting access lists for network security and policy implementation [7]. Using iNetSim all user interface and network topology elements are reachable with VoiceOver keys and provide a meaningful response when read by VoiceOver.

The system incorporates virtual network devices including routers, switches, hubs and PCs. Input of device configuration data is required for simulation. Each device may have several ports of different types including Ethernet, serial and console. The user creates a connection by specifying two ports to connect and a cable type. Removing a connected port disables the connection the same way unplugging a cable would in a real network [8].

A command line interface to devices provides control and feedback over the simulation. The interface acts in a similar way to the operating system for that device type (e.g. a generic DOS-like system for PCs and Cisco IOS for routers). A subset of the commands applicable to CCNA 2 allows the user to display and modify device configuration, establish routing protocols and ping, Traceroute or telnet to other devices. iNetSim maintains a representation of routing tables to simulate these tasks correctly. As an educational tool, iNetSim aims to simulate the results of these tasks as close to the real systems as possible.

The use of tables instead of dialog boxes or pop up windows is of particular interest. The tables allow rapid navigation of connections, devices and status for a screen reader user. If the more conventional approach of pop ups was used as in the case of packet tracer, the blind user would need to be alerted to the new dialog, then navigate through all open windows to the newly opened dialog box. This also has an advantage to sighted students, all information needed is available on the main canvas, there is no need to dig for information, one of the features proposed for the “Humane Interface” presented by Raskin [9]. Packet tracer relies on the standard devices produced by Cisco. iNetSim is more generic, a router is just that, users add any interface that is required by the laboratory session, the platform is irrelevant. Interfaces are simply added to the associated tables and may then be configured without switching to other pop up dialogs.

iNetSim can be used solely with the keyboard, alleviating the eye and hand issues faced by vision-impaired students. As a GUI is also available, sighted iNetSim users can alternatively use a more traditional drag-drop mouse-based interface. Particular design features were incorporated to ensure the GUI is accessible by both sighted and blind users [10]. The content read by VoiceOver appears as text in a floating window on the lower left of the screen display.

User involvement and testing are crucial aspects of design and development of tools for the vision impaired [11]. iNetSim has been fully developed, implemented and tested in the CAVI classroom and forms an integral part of the technical environment for all students – sighted, blind and low vision.

3.2 Laboratory Architecture

In order for students situated locally and remotely to access and participate in the lectures and laboratory sessions, a functional network architecture has been established (see Figures 1 and 2).

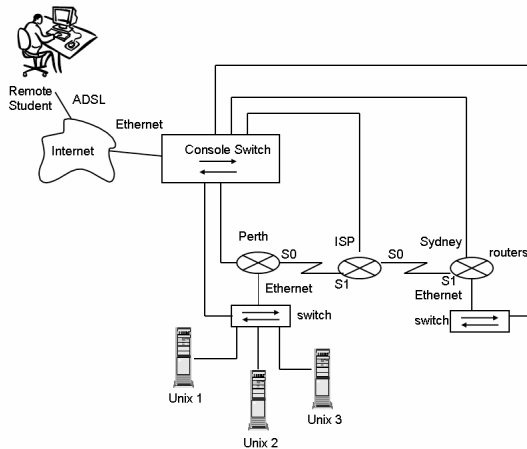


Figure 1: Remote Access for vision impaired students

Local laboratories generally consist of three routers and two switches. The configuration may be described as two branch offices, say Perth and Sydney, connected together via the ISP or Internet cloud. The edge routers are configured by the students to allow connectivity via the middle router (cloud or ISP). Local students interact directly with the routers' configuration via serial (console) interfaces. A problem exists when attempting to allow remote students access to 'real' routing hardware. The routers may not be placed on production networks for obvious reasons, therefore a remote lab solution was needed to be implemented.

One such system allowing 'real' access does exist, Netlab by NDG (<http://www.netdevgroup.com/>), however the cost of this system is a major factor in its adoption. Additionally, several features are not accessible by screen readers – namely the java based applications in Netlab, including the booking system, telnet client to interact with the network hardware and the server system. The CAVI group has since developed their own system costing less than 10% of Netlab. Whilst it does not offer advanced features such as equipment booking systems it performs all the required functions for the vision impaired class applications. In its simplest form it comprises of the standard CCNA laboratory bundle (3 routers and 2 switches, with several Linux PC servers running FTP, HTTP, Telnet and other associated services) that may all be accessed by the serial ports. A standard serial port or console switch is used to access the devices in the laboratory bundle. Remote students may telnet into the bundle, accessing the routers, switches and Linux servers from any locality worldwide. As the routers are on their own network, with all remote access attaching only to the serial ports, this system does not offer any security risk to the institution employing it. The wireless lab equipment is accessed in the same manner.

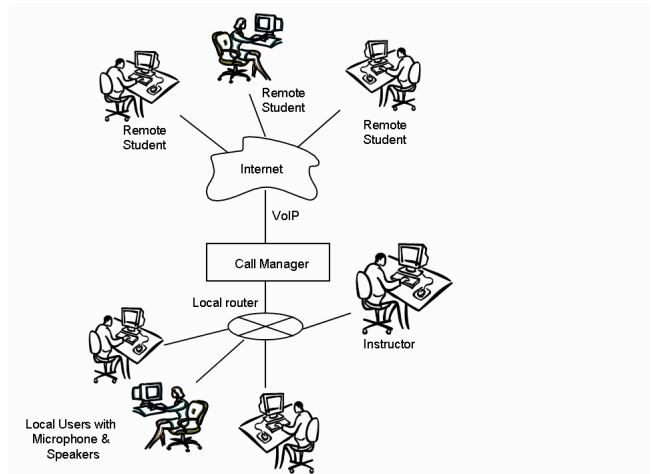


Figure 2: Local and Remote students in the virtual classroom

Local and remote students interact with each other in a 'virtual' classroom as shown in Figure 2. Remote students connect to the Cisco Call Manager system (CM) via the internet, thus avoiding high cost international calls, and the local students connect to the conference in the classroom. In this manner lectures, laboratories and discussions are shared with all participants interacting with one another, just as if all were in the same locality. This allows the lecturers to also conduct interactive quizzes with the students by utilizing the chat function. A question is asked of the entire class and replies are sent via CM only to the instructor. The instructor may then check the replies and provide feedback to the students as required.

3.3 Instruction

The project caters for a maximum of 30 vision impaired students with approximately half studying from remote locations. A small number of students involved in the pilot project will return and complete the Cisco courses.

Overall the results achieved by the vision impaired students in the pilot project were comparable with the results of the sighted students. Although the vision impaired students required a longer period to fully comprehend the materials (due to the limited nature of the assistive technology and delays in the translation of images to text) the average marks obtained by the two groups (vision impaired and sighted) were the same [12]. In addition evaluation of the pilot project highlighted different needs required by the totally blind in comparison to those with low vision.

One of the problems identified during the pilot project was that sighted instructors were not fully cognizant of the needs of vision impaired students with relation to the presentation of concepts and materials. It was found that the vision impaired students at a more advanced level were able to explain these concepts in a manner the beleaguered students could more easily assimilate. In the latter stages of the pilot project several of the more advanced vision impaired students assisted the sighted academics to teach the tutorial and laboratory sessions on a voluntary basis.

This approach was very successful and in the current project two blind instructors have been employed to present lectures and run laboratory sessions with the students. The blind instructors are assisted by a sighted teaching assistant who is experienced in the

needs of the vision impaired users. Academic staff manage the project and provide the usual laboratory technical assistance.

The learning materials are translated into Braille using a combination of Computer Braille and Unified English Braille code (UEBC). While much of the learning material can be presented using the contracted UEBC code a large proportion involves program code and technical matter requiring the letter for letter translation provided by Computer Braille.

The classroom environment consists of two laboratories, one containing a network of PCs fitted with assistive technologies, the other containing the routers and associated network equipment. Classes run two full days per week over the academic year, and the students anticipate completing the four Cisco courses over a twelve month period.

The academy is also supported by a number of researchers consisting of sighted and vision impaired postgraduate students undertaking research in learning and presentation styles, haptic software and hardware, simulation software, PDA interface design for the blind, and development of a range of assistive technologies.

4. CONCLUSIONS

The success of the pilot project has encouraged the authors to continue and expand the research into accessibility of e-learning for the vision impaired. Six of the original nineteen students involved in the pilot project have progressed to undergraduate and postgraduate studies at university. The new project has opened up teaching positions for two blind instructors and offers an opportunity for 30 vision impaired students to obtain Cisco industry level certification.

The use of VoIP has provided an avenue for remote students to participate in lectures and laboratory exercises. Tools such as the iNetSim network simulator allow the vision impaired students to access parts of the curriculum not previously accessible. The vision impaired students are instructed by similarly disabled instructors who understand their difficulties and provide insightful solutions.

At present the Cisco Academy for the Vision Impaired is situated within the university, however, over the next twelve month it will be physically moved to the premises of the Association for the Blind (WA). The blind instructors will move with the academy and continue to teach new intakes of vision impaired students provided continuing funding can be obtained for future operations.

The CAVI project has enabled the researchers to build a team of enthusiastic academics and students dedicated to providing vision impaired people the opportunity to gain industry recognized qualifications and provide prospective employers with Cisco qualified personnel.

5. ACKNOWLEDGEMENTS

The authors would like to acknowledge Cisco Systems, the Department of Employment and Workplace Relations and the Association for the Blind (WA) for their support in this project.

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