VIRTUAL LABORATORY EDUCATION FOR PERSONS WITH VISION DISABILITIES

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ABSTRACT

The Virtual Laboratory (VLab) is focused on providing same-time different-place group-interactions, allowing full real-time virtual-interaction of voice/video/data information of the Internet, communication systems, and multimedia equipment and facilities for vision disabled persons. The VLab interactive-monitor uses piezoelectric technology for graphical display and includes a novel braille markup language (BML) interface with the wireless application protocol (WAP) and the hyper-text markup language (HTML). The BML interface enables conversion of all types of existing web sites and facility/equipment control information to be displayed on the VLab interactive Braille monitor.

1. INTRODUCTION

Virtual Reality technology: The term 'Virtual Reality' (VR) was initially coined by Jaron Lanier, founder of VPL Research (1989), 'Artificial Reality' (Myron Krueger, 1970s), 'Cyberspace' (William Gibson, 1984), and, more recently, 'Virtual Worlds' and 'Virtual Environments' (1990s).

The proposed VLab system will enable persons with visional disabilities to receive applied-science and engineering education including all telecommunications and networking laboratory experiments to their full extent in real-time.

Traditional Lab: In this session of the Telecommunication Laboratory class taught at the Oklahoma State University, the students are required to connect their individual PCs and create a local LAN. This requires all the students to actually be present in the lab. Each LAN is connected to Extreme Summit 48i (Giga-bit Ethernet) switches or 3COM CellPlex7000 (ATM) switches. The students configure the switches in order combine their sub-networks successfully to the routers.

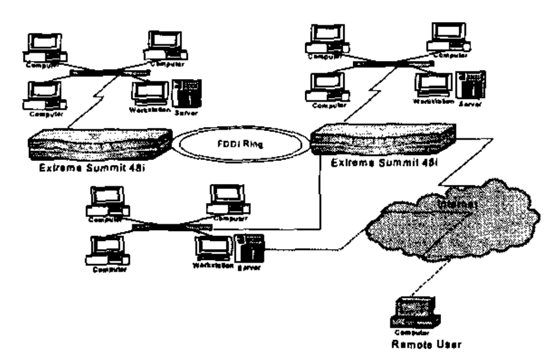

Fig. 1-1. Interconnected LAN setup

Parts of this project and the VLab project have been funded in part by the U.S. Department of Education (DoE) and also in part by Southwestern Bell, Inc.

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Virtual Lab: The VLab was developed to enhance the virtual interaction of the distance students to enable more effective distance education for laboratory experiment based courses. In the figure, the dotted line represents a direct connection between the remote student and the Linux terminal in a room at the local site. However, there is no direct connection between the Extreme gigabit Ethernet switch and the remote student. It is the task of the local as well as remote students to configure and enable the ports in the switch for connectivity to the Internet. The basic accessibility of the remote student to the local LAN is via the Linux terminal.

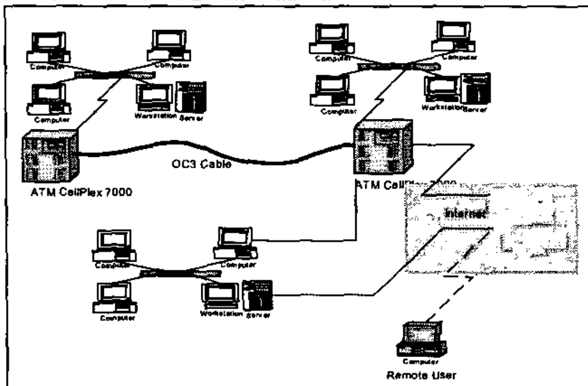


Fig. 1-2. ATM LAN Emulation setup

Remote accessibility: Shown below is a typical setting in which a remote user connects through the Internet into a local laboratory. Continuity of voice and video is established and maintained using remote video conferencing equipment.

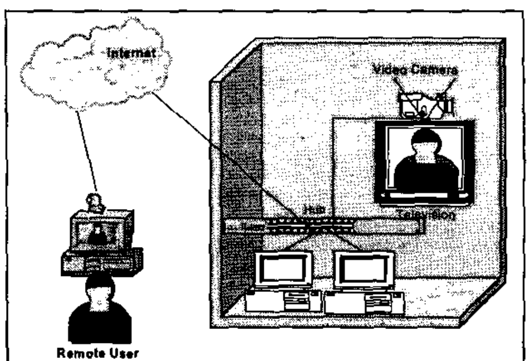


Fig. 1-3. A setup of remote local interaction using video conferencing equipment

This paper is organized as follows. Section 2 gives the summary of existing Braille systems, Section 3 describes our proposed system and technical specs, Section 4 provides the details of the software design accessibility for visually impaired users. Finally, the conclusion of the research is provided in Section 5.

2. TECHNICAL SUMMARY OF EXISTING SYSTEMS

1. **Braille Lite Millennium M20 (Visuaide, Canada):** Braille Lite M20 includes a 56K modem, e-mail capabilities, word processing which includs quick one key-commands, and a speech synthesizer .
2. **Braille Lite Millennium M40 (Visuaide, Canada):** This is a Grade 2 Braille translation in the Braille input mode, and the output to the Braille embosser.
3. **Jaws for windows (Magnifying America Products):** This is a screen reader for the visually disabled. Full computer navigation activated only through voice.
4. **Dragon Nationally speaking professional (Magnifying America Products):** This product acts as a voice recognition as supplement to the keyboard.

All the above modules with the exception of Braille Lite Millennium M40 and Braille Lite Millennium M20 allow simplex communication i.e. only outputs from the device. This is not beneficial for real-time experimentation where user input is needed at almost every step. Our proposed touchpad will incorporate the beneficial features of these abovementioned modules and will also overcome the shortcomings of these modules.

3. TECHNICAL COMPONENTS OF OUR PROPOSED SYSTEM

In this section a description of the Braille Piezoelectric Touch Pad and Monitor is provided. This system will be used as the primary interface to view the display contents and also will be used as the data input and control system to the Internet and VLab systems. The conceptual illustration is provided in Fig. 3.1.

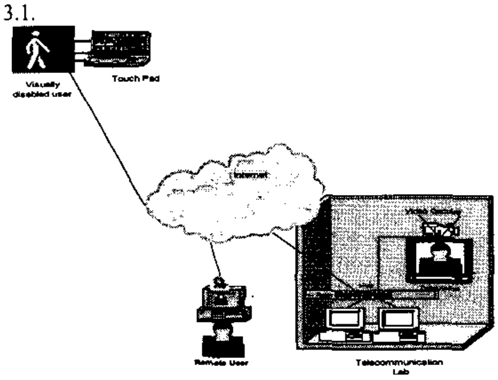


Fig.3.1. A conceptual illustration of the Braille monitor system and interaction with the Internet and remote systems.

3.1 Piezoelectric Pad

The Piezoelectric Pad module is divided into the following sub-parts: piezoelectric cell, electronic switch & circuit, and piezo sensor & signal conditioner.

A. Piezoelectric Cell

Piezoelectric cell is the basic component of the Braille monitor's Piezoelectric Pad's Graphics Display.

Technical Approach: A pressure applied to a polarized crystal produces a mechanical deformation, which in turn results in an electrical charge. The piezoelectric microphones turn an acoustic pressure into a voltage. Alternately, an applied charge will produce a mechanical deformation. This basic property of piezoelectric crystal will be utilized by the Braille monitor application under development.

B. Electronic Switch

The function of this switch is to sense any variation in voltage across the piezoelectric cell. The variation is caused due to a small pressure applied to the piezoelectric cell. If the piezoelectric cell is not pressurized, the switch connects the cell to the voltage amplifier circuit that receives data from the microcontroller. Pressure applied to the piezoelectric cell will cause the switch to connect the cell to the signal conditioning circuit. As a result of this, a low voltage signal will be applied to conditioning circuit, which will be amplified by the conditioner circuit. The following diagram shows the conditioner circuit.

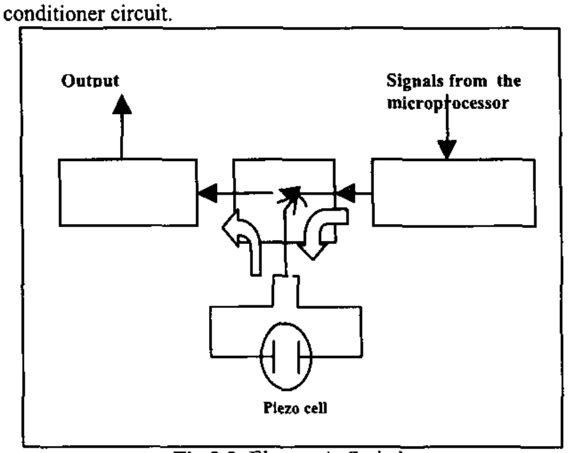


Fig.3.2. Electronic Switch

Piezo sensor signal conditioner

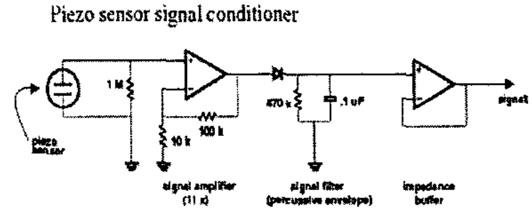


Fig 3.3. Circuit of a Piezo sensor signal conditioner.

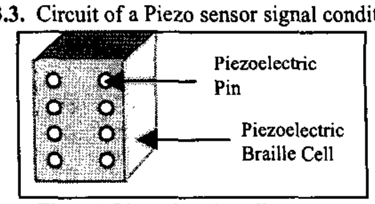


Fig.3.4. Piezoelectric cell structure

3.2 Piezoelectric Text Reader

This module is the text-only reader, which displays any text corresponding to the button pressed in the graphics display pad. With the help of this unit, a visually impaired person will be able to feel the graphical page using his fingers.

Technical Approach: The Piezoelectric Text Reader uses the piezoelectric cells with a different cell format. The cell will have 8 piezoelectric pins. This will enable display characters to be in Braille format. This text reader will be an output-only display. A general layout has been provided below in Fig. 3.5.

3.3 Keyboard Software

There are certain requirements set by the National Accreditation Council for agencies developing systems to serve the blind and visually handicapped, in which the authors will closely work together to identify these details (e.g., the dot specifications and spacing) and include them into the development process.

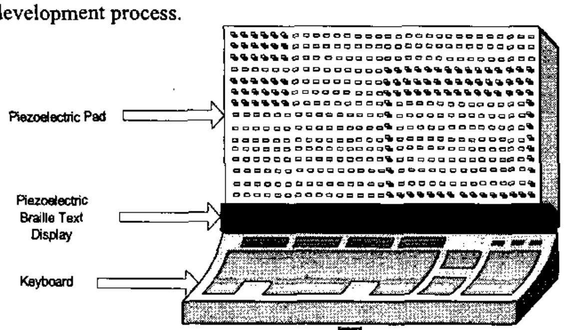


Fig.3.5. Layout of the touchpad

4. SOFTWARE DESIGN ACCESSIBILITY FOR VISUALLY IMPAIRED USERS

A novel software language named Braille markup language is under development to enhance the active interface of the user and the unit display. The browser software (e.g., HTML or Java) on the PC monitor will be converted into BML, which is a new interoperating language proposed for the development of the Braille input/output interface systems. The main purpose of this coding is to interact with the proposed piezoelectric model. This serves as a programmable unit that works with mechanical features of the pins. This conversion is achieved by writing software, which resides in the memory of the PC. The sample flowchart for the conversion software is specified below (Fig. 4.1.)

While BML works for configuring the Peizoelectric Unit, WML helps to get a smaller graphical output, which will be easy to configure. This unit also includes the wireless modules to be interfaced later. Browsers for advanced wireless portable digital devices use eXtended Markup Language (XML), which has more flexibility for data transfer and is hardware and software independent, which makes application development more convenient.

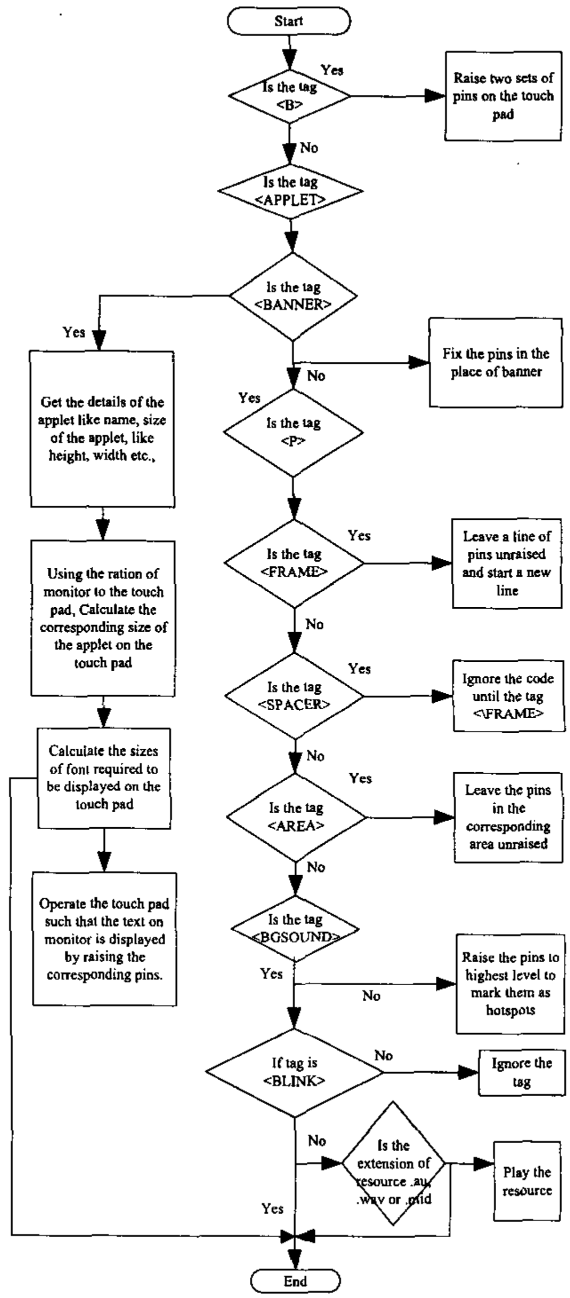


Fig.4.1. Proposed BML interface operational flowchart.

A. WML's four major features/functional areas

HTML is far too complex of a language to use to display content on a wireless device-viewing screen (constraints include memory size, processing power, and download time). The solution to this problem was to create WML. WML is

Here we summarize WML's four major features:

(a) Text presentation and layout -includes text/image support, including a variety of formatting and layout commands;

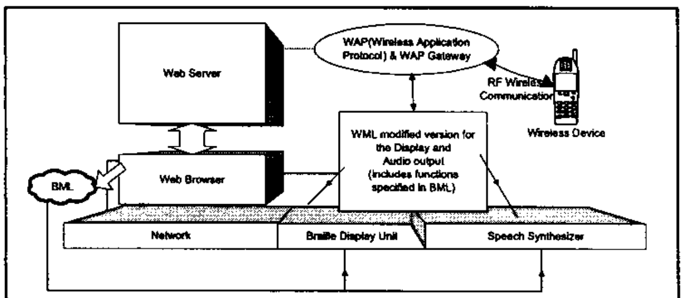
(b) Deck/card organizational metaphor - all information in WML is organized into a collection of cards and decks;
(c) Inter-card navigation and linking - includes support for explicitly managing the navigation between cards and decks;
(d) String parameterization and state management - all WML decks can be parameterized, using a state model.

B. The system components under development:

(a) Output terminal: Braille display unit (text), piezoelectric graphical display (image), speech synthesizer (audio).
(b) Microprocessor: Piezoelectric control unit.
(c) Browser: WML (interface with XML) modified for the Braille display unit with the help of cascading style sheets (CSS).

Interface Design Between the Different Applications: The system is interoperable with handheld devices like mobile phone, personal device access, etc. The wireless low-powered unit uses WAP as its interface to communicate with the web browser.

The Fig. 4.2 provides a view of the future WML interface to be developed and also the coding features for graphical display. The mark up language used in the experimental network and wireless unit will be similar except that the wireless unit will accesses the web server through the WAP gateway.




```
<? XML version?>
< <! DOCTYPE wml PUBLIC "-
//WAPFORUM//
  DTD WML 1.1//EN" "http://
www.wapforum.org/DTD/wml_1.1.xml"
>
<card id = "Project 1"
title="Interconnected Networks">
<p><timer value=40>
<do type="accept" label="Select the
choice of Design">
<go a
href="Interconnected_Networks.wml"/>
<a href = " LAN_1_Design.wml">
<a href = " LAN_2_Design.wml">
<a href=  " Design options">
</p>
</card>
</wml>
```

```
Text Programming:
<STYLE type="text/css">
<! This module converts for Braille text
Functions that is used are EM
{ padding: 2px; margin: 1em; border-width:
medium;border-style: dashed;line-height: 2.4em;
                    }>
</STYLE>
Aural Programming:
<STYLE type="aural/css">
<! This module is to program for speech synthesizer
output Voice characteristic properties:
'speech-rate', 'voice-family', 'pitch', @media aural
{};   is used.>
</STYLE>
Graphics in Braille Display Unit:
<STYLE type="img/css">
<! This module is to program for Img.
Characteristics used are similar to that
of positioning, compression of image size >
</STYLE>
```

Fig.4.2. The Proposed BML monitor and system modules interface operational program structure.

5. CONCLUSION

The VLab interactive-monitor that will be developed for vision-disabled people will use navigation buttons that have Braille characters, 8-celled Braille display units and voice outputs to the user. In addition, the user will be able to interact through this Braille monitor. The input by the user is processed by a microcontroller. The graphical display will use piezoelectric technology. The research also includes the development of a novel BML, which interfaces with HTML and WAP. WAP is the programming language used to simplify Internet web pages for cellular phone and personal data/digital assistants (PDA) monitor screens. The BML that interfaces to HTML and WAP will assist the conversion of all types of existing web sites to be displayed on the VLab easy-to-read interactive braille display monitor. Therefore, everything that is controllable through networking access (all Internet web site information as well as experimental test/measurement equipment) will be controllable by the proposed VLab Braille display monitor

6. REFERENCES

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