grounds
wide
Tele
Tutoring
System

gwTTS - A grounds-wide Tele-Tutoring System for the University of Virginia

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I. Overview

Interactive multimedia technology provides the exchange of video, audio, and images in real-time over long distances and makes possible applications such as video-conferencing, tele-teaching, tele-medicine, and distributed collaboration tools. Common to these applications is that they provide the notion of ***tele-presence***, that is, users of the applications can communicate as if they were present at the same location.

The proposed project will bring interactive multimedia technology to the UVA grounds. We propose to develop and test a scalable interactive multimedia application that enables an installation of a grounds-wide tele-tutoring system (gwTTS). gwTTS will support the simultaneous exchange of digital video, digital audio, still images, and annotation of images between groups of people in real-time, using ubiquitous desktop computers and computer networks. gwTTS is intended to support the following applications:

- Electronic Office Hours
- Digital Video Broadcasts of Lectures
- Virtual Classroom
- Remote Study Groups.

There is no doubt that interactive multimedia applications will have a major impact on teaching at both the undergraduate and graduate level. Currently, the development of interactive multimedia applications is feasible with of-the-shelf hardware; however, the ability to develop and use these applications is still limited to researchers in this area. With this project, the PI attempts to convert his experience in multimedia technology into useful and usable application for the entire university. It is expected that gwTTS will find a high level of acceptance within the university community.

II. Design Goals

The design of gwTTS provides a set of desirable features. Part of the design of gwTTS is a very high degree of ***interoperability*** across different computer systems and networks, reflecting the heterogenous equipment pool at UVA. To increase the acceptance within UVA's community with different degrees of computer literacy, ***ease-of-use*** is made a central design goal of gwTTS; for example, users can launch gwTTS applications from within widely accepted browsing software for the Internet, e.g., Mosaic or Netscape. A modular design makes gwTTS ***extendible*** for including new applications; likewise, existing applications can be modified without interfering with applications currently being executed. With the ***scalable*** design of gwTTS we can support an unlimited number of simultaneous users. Note, however, that certain applications, such as remote study groups, may limit the number of participants of a particular application. Even though a certain cost will be involved in making a desktop workstation gwTTs capable, the costs are limited to cameras, microphones, and the controller cards that interface these devices to desktop workstations (Note that new desktop workstations are increasingly equipped with audio and video hardware). Since the upgrade of a workstation is limited to a few hundred US dollars, we regard gwTTS as a ***low-cost*** alternative to existing multimedia solutions offered on the commercial market.

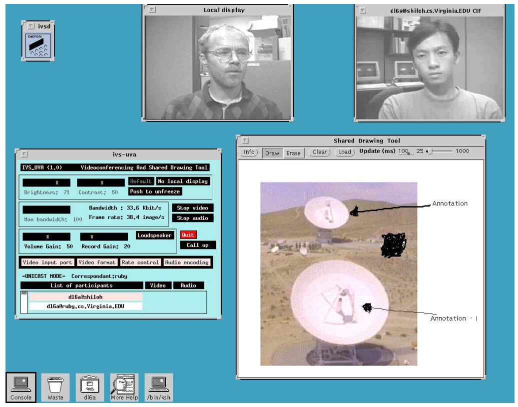

Figure 1: Snapshot of Electronic Office Hours.

III. Supported Multimedia Applications

The **grounds-wide tele-tutoring system** will support an entire suite of interactive multimedia applications. Here we briefly outline the applications that are supported by `gwTTS`.

• ***Electronic Office Hours:*** In the *Electronic Office Hours* instructor and students with access to a multimedia capable computer system can communicate electronically over arbitrarily long distances. The means of communication between student and instructor are modeled after the interactions in a traditional office hour scenario: bidirectional compressed digital video and digital audio enable instructor and student to see each other and talk to another. A *shared electronic whiteboard* supports communication similar to a traditional whiteboard. The electronic whiteboard can display digital images which can be annotated by both instructor and student.

In Figure 1 we show a snapshot of an *Electronic Office Hours* as it would appear on the monitor of the instructor's desktop workstation (The display of the students's desktop workstation will look similarly). The top portion of the image shows the video image of the instructor (top left) and the student (top right). The electronic whiteboard is shown on the right of Figure 1; it depicts an digitized image of an radar array, that has been annotated by the instructor and/or the student. On the left of Figure 1 we see a control panel for adjusting the quality of the video and audio display.

Digital Video Broadcast of Lectures: This application enables a grounds-wide dissemination of a course lecture. The application operates similar to analog video distribution over satellite networks: Instructor and students are located in a traditional classroom setting. Trained staff operates analog audio-visual equipment for recording the lecture. The recording is sent to a `gwTTS` capable workstation, from where the recorded lecture can be transmitted to any `gwTTS` capable workstation on grounds.

Virtual Classroom: The *Virtual Classroom* application within `gwTTS` consists of a tele-teaching application. The instructor of a course and the students reside at different geographical locations, but interact as if they were located in an traditional classroom. Our tool will support a simultaneous exchange of multiple streams of motion video, voice, data, and graphical images. In the 'tele-classroom', the instructor employs her/his desktop workstation to write on an electronic whiteboard, or display digitized images of previously digitized transparencies. Students of the V*irtual Classroom* sit at their desktop terminals, also at different locations, and listen and view the audio/video/image stream from the instructor.

Remote Study Groups: The *Remote Study Group* application enabling groups of student to jointly work on class project using their desktop workstations only. Students could use the remote study group feature of `gwTTS` to have group meetings while each student is in her/his dormitory room. The *Remote Study Group* application offers audio-visual communications, joint editing of files, and an electronic whiteboard. Each participant of a remote study session can receive voice and video from other participants of the session. If a participant displays an image on the monitor of his/her workstation, the image will also appear on the monitor of all other participants. Any participant in the collaboration session can annotate the displayed images with drawings and text.

IV. Components and Feasibility of Project

Since a complete technical description of the project is not feasible within the given constraints we focus on a brief description of the key features of `gwTTS`. Below is a list of the software platforms and formats that are necessary for a grounds-wide `gwTTS` system. Unless otherwise indicated, the software platforms are available to the PI; the PI has extensive experience with all of the software listed here:

Operating Systems:	Irix, AIX, SunOS, Windows NT *(if equipment available)*, Apple *(if equipment available)*.
Graphical User Interface (GUI):	X, HTML based (Mosaic, Netscape).
Video compression:	H.261, CUSeeMe, nv.
Audio Digitization:	PCM, ADPCM.
Digital Image Format:	GIF, JPEG, TIFF.
Network Protocols:	TCP/IP, UDP/IP, IP Multicast (Mbone).
Graphical User Interface (GUI):	X, HTML based (Mosaic, Netscape).

Users of `gwTTS` need not be familiar with the software components that make `gwTTS` run. The only requirement imposed on the user is that she/he is familiar with browsing software for the World-Wide-Web such as *Mosaic* or *Netscape*. In Figure 2 we present two Mosaic-style pages from the user interfaces of `gwTTS`. The image on the left of Figure 2 depicts the initial screen with which users of `gwTTS` select one of the applications discussed in Section III. The image on the right depicts the selection screen for the *Remote Study Group* application. As shown in the image, a user merely must fill in a few entries if she/he wishes to participate in a *Remote Study Group* session.

A crucial part of `gwTTS` is the ability for multicast communications, that is, communications between groups of users. Using recently developed Internet compatible communication software, `gwTTS` will be build on a multicast paradigm. Since not all systems on the UVA grounds include multicast capable network software, `gwTTS` will offer to those machines so-called *reflectors*, that is, systems software that can emulate a multicast communications for a limited number of workstations. The design of appropriate reflector software will be part of the project.

Since `gwTTS` should achieve a very high degree of interoperability across a large set of hardware platforms, any hardware and systems software dependencies should be hidden from the user of `gwTTS`. This requires modifications to the system software. Currently, a key factor for an implementation of `gwTTS` is the availability of sufficient hardware systems and sufficient manpower to implement and evaluate `gwTTS` on various platforms.

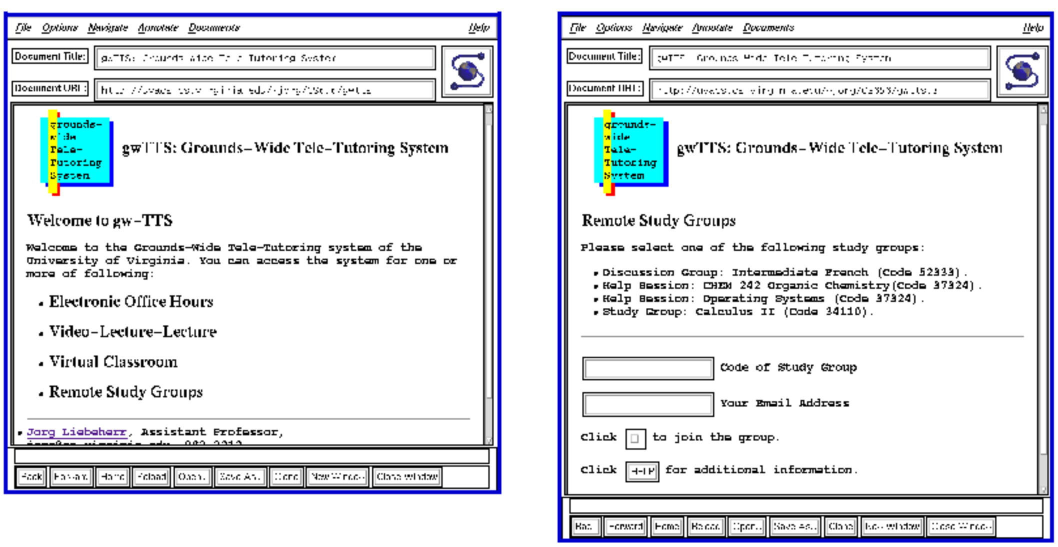

*Figure 2: Access to **`gwTTS`** applications via Mosaics.*