

The Interactive Classroom

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Abstract: Computer programs have been developed that enable students in a classroom to interact with and take control of the computer the instructor is using to present the class material. From their seats students can request to connect their laptop computers over the network to the main computer that is being used to project the course material. Once connected, at any time they can send messages to the instructor and request control of the main computer's mouse and/or keyboard. This enables students to perform actions such as: unobtrusively ask questions, move to another slide in the presentation, make annotations on the main screen to help clarify their questions, participate actively in online simulations, type in answers to questions, and an almost endless number of other tasks that require remote manipulation of the computer the instructor is using. At all times the instructor determines whether a student is permitted to take control of the system and can override that control as needed. The server program running on the main computer also allows the instructor to easily perform administrative tasks such as maintaining a list of authorized students, their logon IDs and passwords, as well as the IP addresses to be used.

Introduction

In most universities and colleges large lecture sections have become very common. Unfortunately that kind of environment is not very conducive to meaningful interaction between students and the instructor. Ideally the instructor of a large lecture section should be able to move freely about the room to interact as needed with students as he or she is presenting the material to be learned. In addition it would be beneficial if students could have the possibility of interacting directly with the material being presented without having to leave their seats. We have developed a relatively inexpensive, Windows/PC-based "virtual blackboard" system that can be controlled at a distance by a classroom instructor and/or students in the class. [1] One component of our system is a wireless mouse emulator that is implemented using a software-controlled standard red laser pointer. With this system the instructor is no longer tethered to the computer, but is free instead to roam the classroom and interact with students as needed. The second component is an electronic system of communications between students and instructor. With this system any student can temporarily take control of the mouse and/or keyboard of the instructor's computer. This is a tested, full-featured implementation of the prototype communications system described in the paper "The Classroom of the 21st Century." [2] Figure 1 is a diagram illustrating conceptually how the system is used in a classroom. Figure 2 illustrates how it is set up.

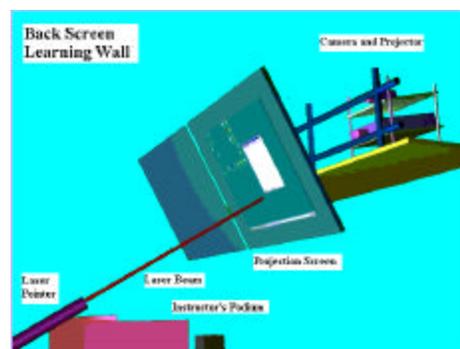
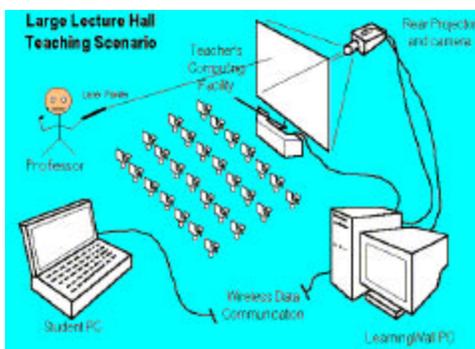


Figure 1. The interactive classroom in action.
The Electronic Communication System

Figure 2. Back-screen camera/projector setup

In this paper an electronic communication system between students and instructor is described. It is assumed that the instructor is using a computer projection system as the main mechanism for presenting the educational material. The instructor may, for example, be delivering a PowerPoint™ presentation, showing material from the World Wide Web, running a simulation that he or she wants students to be able to use, or executing any number of different programs on the main computer. With recent advances in networking technology it is becoming very common to have Internet connections available at every seat in the lecture hall. So quite commonly many students bring their own laptop computers to class. Our system enables any student in the class to use his or her laptop computer to send an electronic message to the instructor, and, with the instructor's permission, take control of the mouse and/or keyboard of the instructor's computer. This enables students do perform actions such as: unobtrusively ask questions, move to another slide in the presentation, make annotations on the main screen to help clarify their questions, participate actively in an online simulation, type in answers to questions, and an almost endless number of other tasks that require remote manipulation of the computer the instructor is using.

The keys to the system are two Microsoft Visual C++ programs that we have developed and tested. One of them (ClickServer) runs on the instructor's computer, and the other (ClickClient) runs on each student's laptop computer. It is assumed that all computers are connected to some sort of a TCP/IP-based network. This could be a wired or wireless LAN.

The user of the ClickServer program (the instructor) is presented with a window that has, among others, an "Options" menu item containing "Accept Connections", "User Management", and "Configuration" submenu items. Within "User Management" the instructor, acting as administrator, can add users (user name, password, IP addresses from which the student can connect) and indicate whether or not the user is authorized to request taking control of the mouse and/or keyboard. Within this same dialog the administrator can edit the current list of users or delete users from the list. Figure 3 shows the initial ClickServer screen, Figure 4 the "Options | User Management" Window, and Figure 5 the "Add User Information" dialog box.

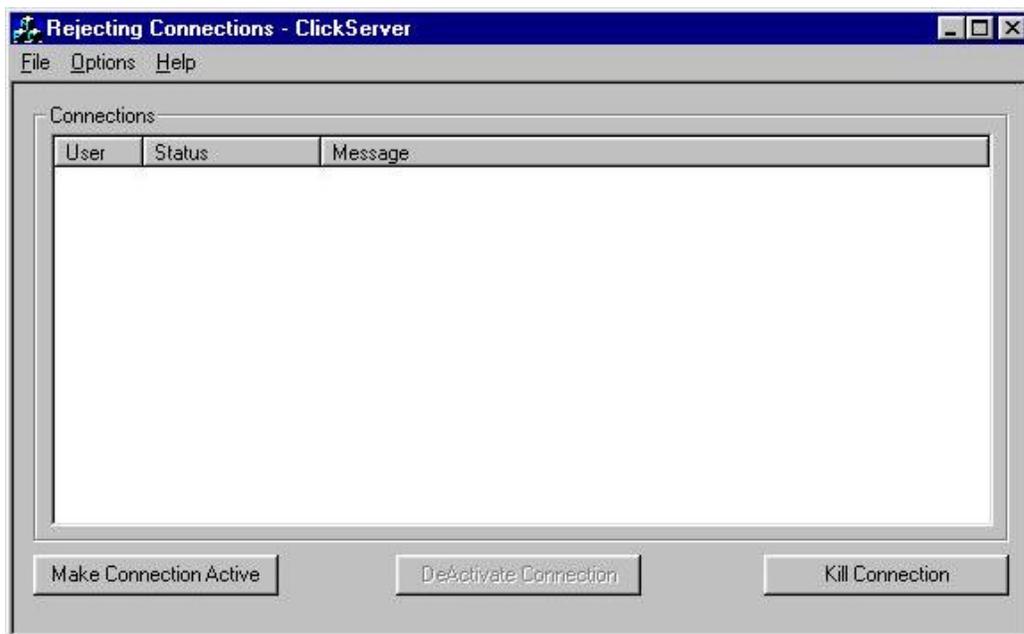


Figure 3. The initial ClickServer window.

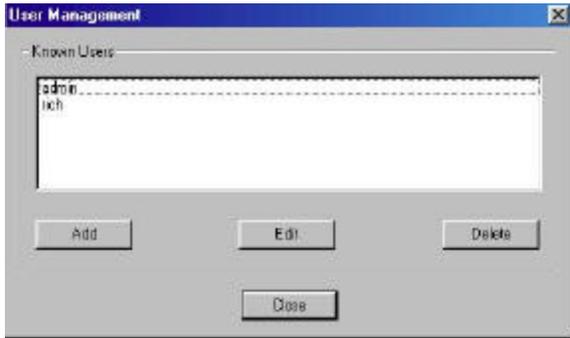


Figure 4. The “User Management Window”.

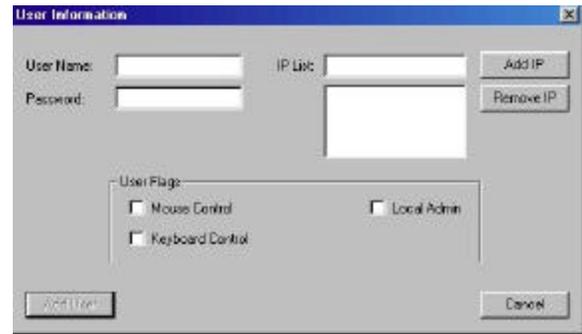


Figure 5. The “Add User Information” dialog box.

ClickServer defaults to rejecting connections when first executed. To allow connections from student clients the instructor selects the “Options | Accept Connections” menu item, which puts the program into “Active Connection” mode. From that point on students can connect to the server program. A list of students who have connected appears within a large “Connections” window. Any messages sent by any student will appear along side that student’s name, in addition to a “status” flag that indicates whether or not a given student has taken control of the main computer’s keyboard and/or mouse. The instructor can, at any time, click on a button that will “activate” or “deactivate” a student, thereby enabling or disabling that student from taking control. In addition there is a “Kill Connection” button in which a selected student can be disconnected from the server. It should be pointed out that at all times, regardless of whether or not a student is controlling the main computer’s mouse and/or keyboard, the instructor also has the capability of local mouse/keyboard control. Furthermore, at any time the instructor can override student control of the system.

ClickServer’s “Configuration” menu allows the instructor (administrator) to set certain system parameters such as the TCP/IP port to be used, to configure “hot key” combinations, and to set or alter other system parameters. In most cases the instructor will not need to invoke this menu item.

When students run the ClickClient program on their laptop computers, they are presented with a window that allows them to enter their user ID, password, and the IP address of the ClickServer. Figure 6 shows the ClickClient screen that appears on a student’s laptop when he or she starts the program.

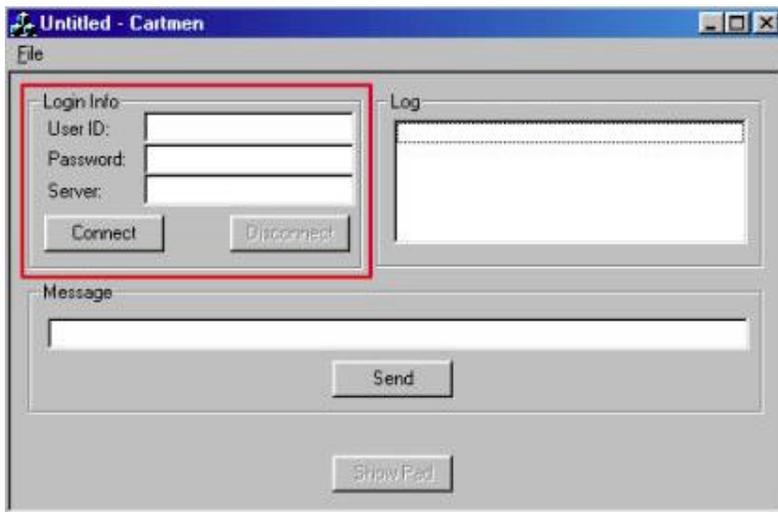


Figure 6. The initial screen that appears on a student’s laptop when ClickClient is run.

When students want to connect to the instructor’s computer, they can click a “Connect” button. If they are authorized users, are plugged into the network, and ClickServer is running in “Active Connection” mode on the instructor’s computer, the student will be connected to the server. Messages that specify what is occurring will appear in a “Log” window. Figure 7 shows the typical response that occurs when a student is connecting to the ClickServer.

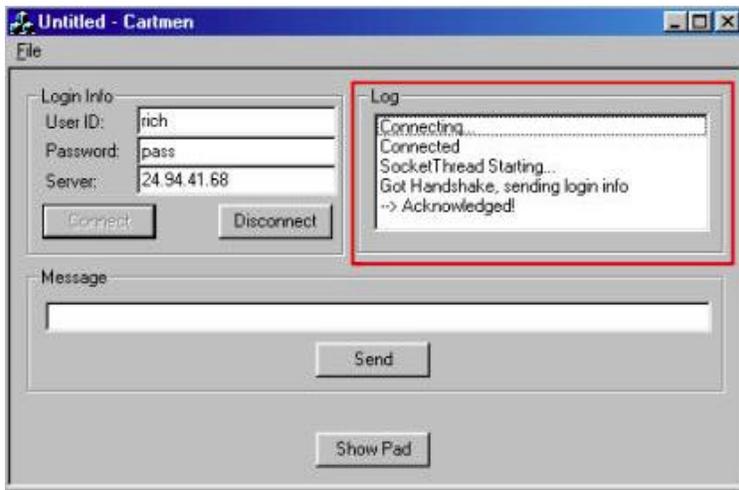


Figure 7. The ClickClient connection dialog.

At any time a student can send a message to the instructor by typing a line of text into the “Message” edit box and then clicking the “Send” button. Figures 8 and 9 show the student’s screen and the instructor’s screen immediately after a student has sent a message to the instructor.



Figure 8. A student sends a message.

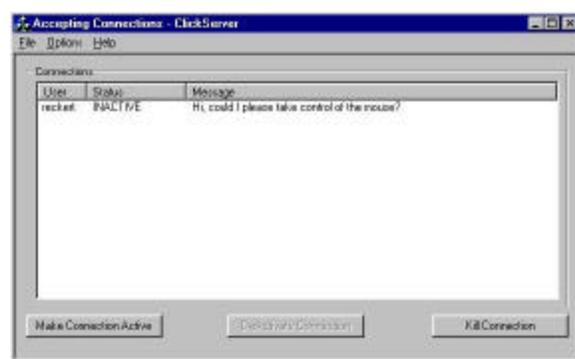


Figure 9. The instructor receives the message.

If a student wants to take control of the main computer’s mouse and/or keyboard, he or she can send a message to that effect. If the instructor is willing to grant that control to the student, he or she can do so by clicking on the ClickServer’s “Make Connection Active” button. Then, on the instructor’s screen, the “Status” of the student who has been given control changes from “INACTIVE” to “ACTIVE”. The student’s “Log” box will reflect the fact that the student has assumed control by displaying a “Mode set ACTIVE” message. That student can then click on a “Show Pad” button to actually take control. At that point a large rectangular “mouse pad” area will appear on the student’s laptop screen, and subsequent mouse movements and clicks while the cursor is over the pad area will cause the corresponding mouse actions to occur on the instructor’s computer and be reflected on the projection screen. In addition, any student keyboard actions will also be directed to the main computer. Figure 10 shows the mouse pad that is displayed on the student’s screen when he or she has

taken control.



Figure 10. The “mouse pad” that appears on a student’s laptop when he or she has taken control of the instructor’s computer.

If the student tries to use the main computer’s mouse and/or keyboard and is not the current active user (i.e., has not been given control by the instructor), messages to the effect that mouse and keyboard control are unauthorized will appear in the log window. At any time, in the program’s main window, the student can click on a “Disconnect” button, in which case the server will close the connection of that student’s computer to the server.

A demonstration of the ClickServer and ClickClient communication system will now be given.

Conclusions

The ClickClient and ClickServer software have been tested in several university settings. Both students and instructors have commented that it is relatively easy to use and that it really does enhance interactivity in the classroom. It can be especially useful in those kinds of classes where it is important that students be active participants – for example in situations where the student needs to actually use the instructor’s computer to do something. It has been ideal for allowing student manipulation of simulations. One example is a computer graphics ray tracing algorithm animation program that was developed by the author and one of his students. [3] The instructor explains and demonstrates the system at the main computer’s projection screen, and then, from their seats, individual students are allowed to work with the ray tracer animator, while the professor guides them and explains what is happening in the animation.

References

1. Richard R. Eckert, Jason A. Moore, "An Interactive, Remote-controlled Computer Projection System for Use in a Large Classroom Environment," *17th International Conference on Technology and Education*, (Tampa, Florida, October 10-13, 1999).
2. Richard R. Eckert, Jason A. Moore, "The Classroom of the 21st Century," *ACM SIGCHI Bulletin*, 32:2, 33-40, (April, 2000).
3. David A. Goldman, Richard R. Eckert, Maxine S. Cohen, "Three Dimensional Computation Visualization for Computer Graphics Rendering Algorithms," *Proceedings of the Twenty-Seventh Technical Symposium on Computer Science Education*, ACM Press, (February, 1996).