Remote Control of a Scanning Electron Microsocpe Using Asynchronous Transfer Mode

Nancy R. Smith, Don Pardoe, Corinne Pelote, Mark Honer, and Christopher L. Morgan: California State University, Hayward, CA

California State University, Hayward has successfully demonstrated remote control of a scanning electron microscope (SEM) using Asynchronous Transfer Mode (ATM). The development of digital imaging technology has lead to exploration and testing of networking strategies for sharing scientific instrumentation.[1,2,3] The concept of shared instrumentation is appealing to both academia and private enterprise. Networking access presents the opportunity to teach scanning electron microscopy to a large number of students using multiple desktop computers.[4] Video images can also be projected onto large screens in classrooms or as a distant learning resource. Remote shared access to scientific equipment provides certain advantages such as access to a wider variety of resources, direct interaction without hazard to people or equipment, ability to combine resources into larger virtual instruments, rapid access to available resources, and pooling of knowledge by a larger community.The advent of high speed networks such as ATM offers the possibility of integrated solutions to communication and control.

ATM provides a high speed Virtual Circuit (VC) switched environment. Connection set-up of a VC may be arranged either as a Permanent Virtual Circuit (PVC) or as a dynamic Switched Virtual Circuit (SVC). Data passed to a VC is segmented into 53 octet quantities called cells (5 octets of an ATM header and 48 octets of data). The small fixed-length packet size provides a basis for high speed switching and transport of video, data and audio. Multiplexing equipment allows various combinations of digital information streams to be mixed into one connection for transmission over the ATM network.

An ATM network attaches the Hayward campus to an ATM switch that also serves other CSU campuses, including San Francisco, San Jose, and Fullerton. This network is a mixture of OC3 (155 Mbps) and DS3 (45 Mbps) transmission lines. The resulting network offers multiplexed, high speed connections at DS3 speeds. The connection to Hayward is actually carried by OC12 (622.08 Mbps) on an optical fiber which is capable of much higher capacity for future expansion. Currently, only Permanent Virtual Circuit (PVC) service is available. This service provides a set of dedicated links to the CSU system. Presently, the network is controlled by individually configuring each node to create connections among links. This is done by one CSU network management person, operating via telnet sessions to each switch. This individual must carefully manage the entire CSU network to conform to carrier bandwidth limitations on each link.

The microscope used in this study is a Philips XL-40 SEM. It is equipped with an IXRF X-ray microanalyzer and digital imaging system. The SEM is controlled by a 486 PC and runs Windows-based software to control the microscope over a SCSI interface. Currently, as many as 5 samples can be loaded at the same time. Another specimen stage is being designed so that as many as 16 samples can be loaded. The user interface of the SEM consists of a 17 inch monitor to display the image while graphic control functions are overlaid on top of the image. The video signal can also be displayed separately on larger monitors in classrooms. Microscope operations, including movement of the motorized stage, are accessed using Microsoft Windows. A set of programs in the Windows environment allows users to control the position of the samples and other parameters such as magnification, accelerating voltage changes, spot size changes, brightness and contrast, etc. The few functions requiring local, manual access to the microscope are sample insertion, tilting of the stage and Z-axis control. The attached X-ray microanalyzer is separately controlled by a Pentium 90. Video output and data transfer from the SEM is available through several types of network access including the cmpus Ethernet backbone, closed circuit video on campus, community cable TV, Integrated Services Digital Networking (ISDN), and ATM.

The SEM was acquired through a National Science Foundation/Improvement in Laboratory Instrumentation award. The proposal was submitted by Richard Tullis and Nancy Smith of the Department of Biological Sciences and Nancy Fegan of the Department of Geological Sciences. The grant, entitled "Interactive Curriculum Using a Scanning Electron Microscope", consisted of two phases. Phase I is to bring remote control of the SEM into classrooms on the Hayward campus. Phase II is to remotely control the microscope from other CSU campuses. Phase I has been successfully demonstrated from classrooms within the building housing the SEM and from the distant learning classroom located approximately one-half mile away. So far, demonstrations have been conducted operating the SEM on the Hayward campus from the San Jose campus. Control of the instrument is transmitted over a data channel and the visual output is carried over a 10 Mbps compressed video channel. Both types of signals are carried over the same ATM connection. Attempts to control the SEM from San Francisco are planned.

The successful demonstration of remote control of the SEM using ATM used the following configurations. The PC at the San Jose site was equipped with PC Anywhere software to control the Windows software on the SEM. The video was carried over the CSU CalREN ATM between the campuses and control of the SEM was over the CSU T1-based Intercampus connection.

The deployment of the SEM is a first step in providing students in the CSU system with remote interactive shared access to scientific instrumentation. Current instrumentation interfaces open the way to remote sharing of expensive equipment. Support in the form of curriculum development, ATM network access, and matching funds for the microscope have been provided by the Distributed Learning Resources (DLR) project funded by Pacific Bell and a DELTA/DLR grant from the CSU System. Further information can be obtained from our web page.The URL is http://www.mcs.csuhayward.edu/sem/. ■

1. T.A. Dodson, et al., Proc. 53rd. Meeting of MSA (1995) 16.
2. M.H. Ellisman, Proc. 53rd Meeting of MSA (1995) 66.
3. N.J. Zaluzec, Proc. 52nd Meeting of MSA (1994) 390.
4. S. Chumbley, et al, (1995) Micro Res & Tech. 32:330.

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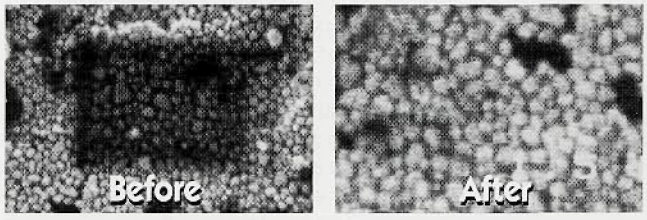

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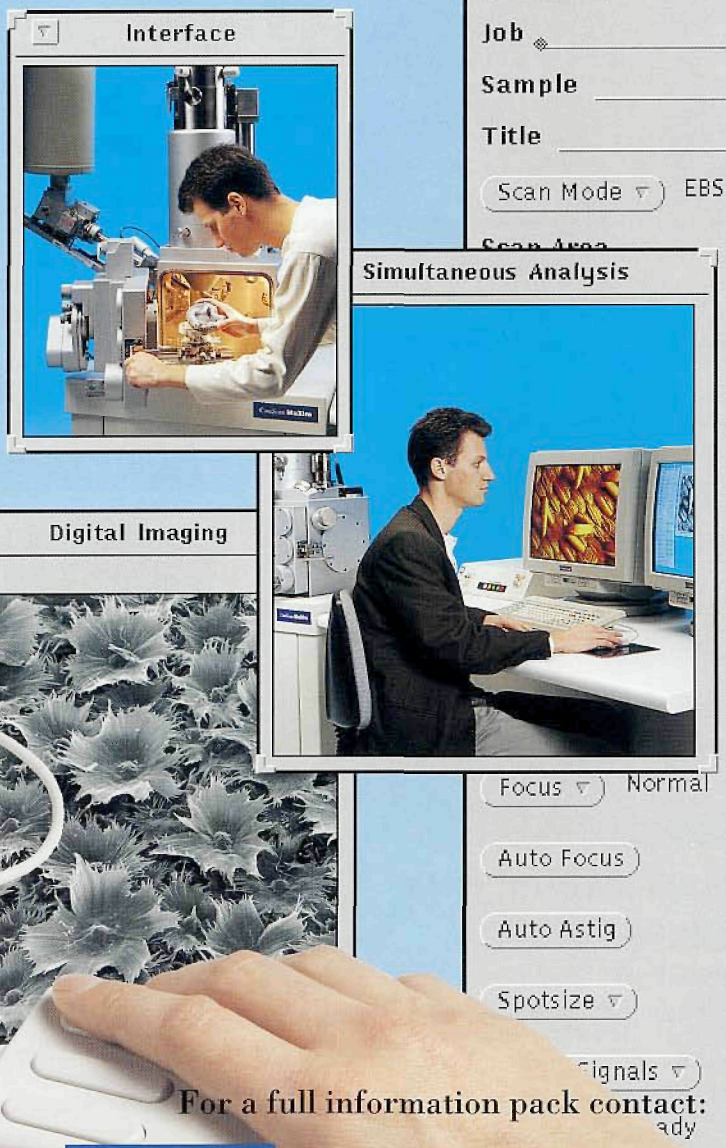

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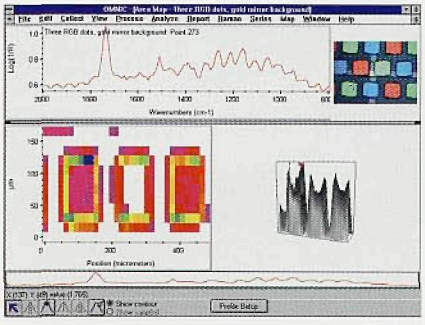

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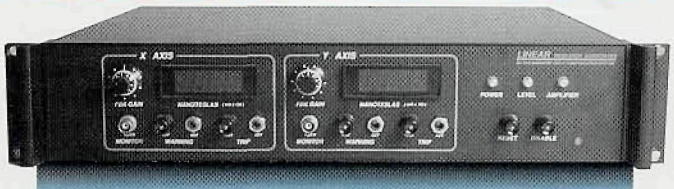

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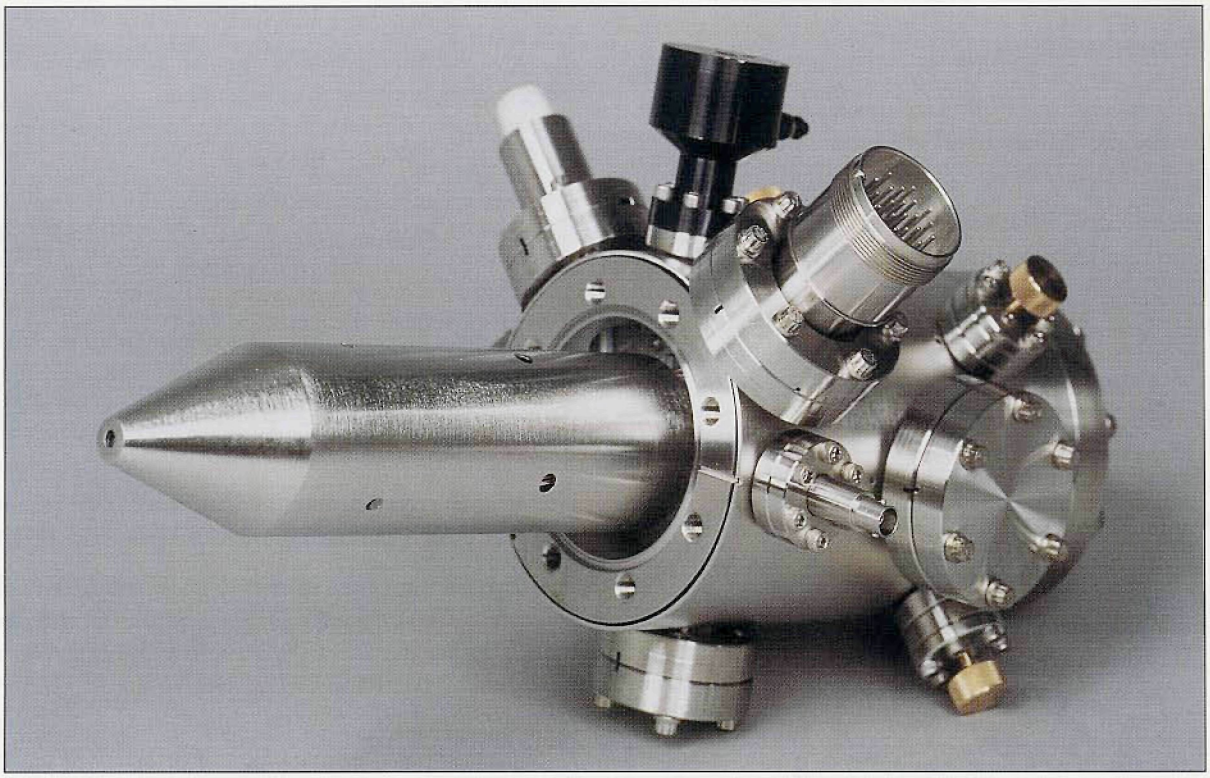

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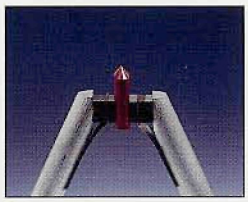

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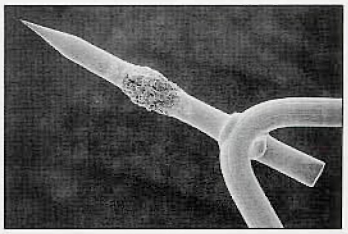

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