USING AN ONLINE SEM TO INCREASE ACCESS TO MICROSCOPY EDUCATION

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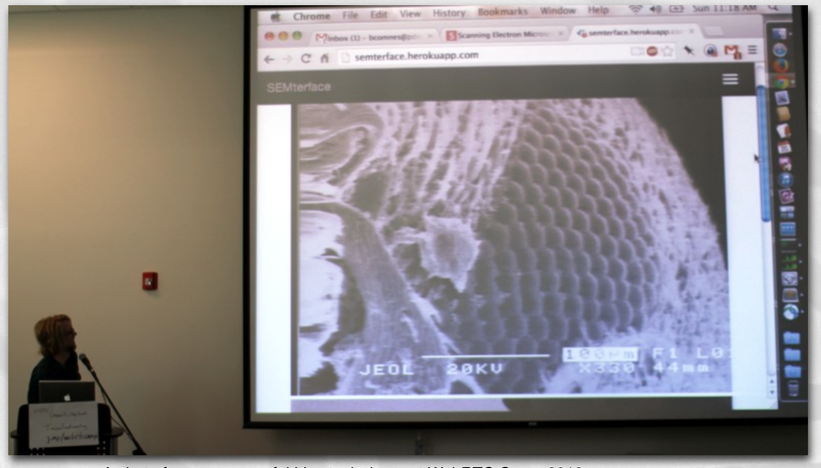
Abstract

The Online Scanning Electron Microscope Project in the Sánchez Nano-Development Lab aims to modify a JEOL JSM-6300F Scanning Electron Microscope so that it can be remotely viewed and operated anywhere in the world over the internet. The project is interested in the viability of using these new remote capabilities in education and research environments. The "SEMterface" software is written on top of Node.JS and uses modern browser APIs like Websockets and WebRTC to enable plug-in free real-time control of the microscope through any modern web browser. The project wishes to increase the accessibility and convenience of research equipment that are traditionally difficult to access not only for the researcher but for the student. This project should enable students to have much greater access than what is typically available in microscopy centers, with the focus on student education.



A photo from a successful Live tech demo at WebRTC Camp 2013.

How will this be good for education?

Many microscopy instruments, such as SEMs are costly to run and difficult to schedule time to use due to limited run schedules. In a traditional educational microscopy lab environment, time on the machine is often divided up between many students and it is common that extra time on the machine would be beneficial to truly familiarizing students with running the SEM. This project would allow students to access the microscope at off hours and extend access to students that cant be in the physics vicinity of the microscopy center.

Additionally, by having a remote interface to build off of, we can build in tutorial modes that provide information to help teach proper operation of the microscope through contextual information. Students would be walked through the different functions of the microscope via contextual messages, sample videos and demos, enabling appropriate functionality at the right time as well as enabling assistance when students loses the image or become stuck. When the student becomes familiar with the operation of each control, the additional information and help bubbles can be removed to simulate the actual control interface of the microscope.

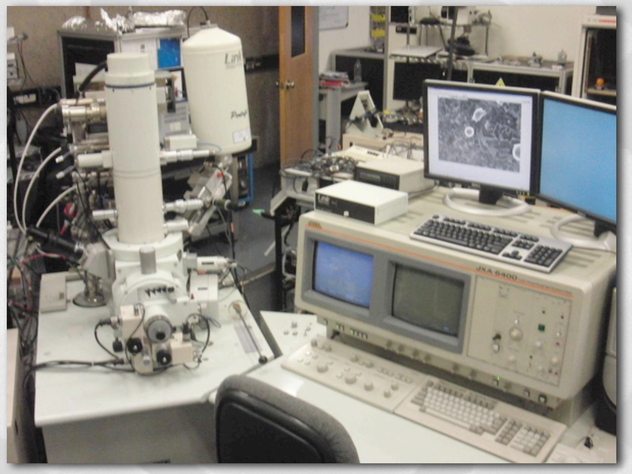
What works today:

- Robust, low resolution live video feed via peer to peer WebRTC connection
- Prototype of remote control system for XY positioning of samples
- Hardware Server with robust hardware detection
- Initial control routines for controlling microscope focus, stigmation and zoom.
- Plugin Free remote client work in any modern web browser

This screenshot of the SEMterface is showing a live video feed of the microscope over the internet which the user has control over.

What Comes Next:

- Improved XY sample stage control
- Account system for identifying users
- Administration panel for authorizing specific user accounts
- Automated scheduler that allows specific users access to the microscope
- Integration with existing imaging software to enable remote high resolution imaging.
- Education mode that provides contextual lessons that enables granular introductions to different microscope functions.
- Modularization of software and standard API for use with other instruments



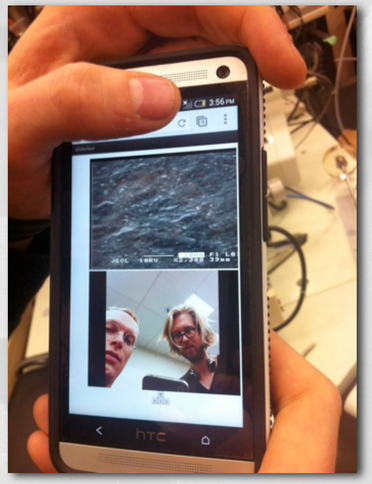
The JEOL JSM-6300F Scanning Electron Microscope used in this project.

How will this be good for research?

While the remote operator has no control over the physical loading of microscope, this project would open up the opportunity for receiving samples from outside parties who may not live near institutions that have access to an SEM or where access to such an instrument is too costly. Such an arrangement might provide additional revenue for microscopy centers if they implement something similar. Additionally, remotely accessible microscopes offers a huge amount of convenience to researchers by allowing them access to the machine even when they are in a different lab or when they are at home. For example additional images could be made when writing reports or papers.

Project Specs:

- JEOL JSM-6300F Scanning Electron Microscope
- Custom high resolution imaging software
- Custom node.js Signaling server used for Message passing and signaling
- Direct P2P connections used for realtime video and audio communication using WebRTC
- Custom node.js hardware control server for RS-232 serial communication with microscope and stage control.
- Open Source: https://github.com/bcomnes/SEMterface



Remote interface working on Android Device.

Conclusion

Our initial prototype looks promising. Latency is acceptable, even without any specialized optimization and video quality remains clear even over long distanced (tested between Portland OR, and San Francisco). A number of live successful technical demos have been performed, even on restricted guest wifi networks, so client connectivity appears to be robust. A large portion of work remains to be done on the web application side but this should be reusable for future instruments or hardware. We are interested in putting together some preliminary Educational tutorials using our system and then testing the students remote experience on the actual hardware.

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