Remote Scripting for Microscope Control Applications on the Tecnai TEM

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Several years ago we developed the emScope library [1], a portable and extensible set of tools and applications for remote control of a TEM. The library was developed to support the Philips CM series of microscopes but was designed to be portable across a variety of instruments. We have now extended the library to provide support for the FEI Tecnai series microscopes. The emScope library was designed so that applications on remote computer platforms could control the microscope over a network. For example, this distributed computing and instrumentation model is used for the Leginon automated image collection system [2]. One advantage is that application development is independent of the particular computer system controlling the microscope therefore allowing software development in an environment the developer is comfortable with. Additionally, this does not require that user-developed application packages be installed on the computer controlling the electron microscope.

In the original emScope library, communication from the application software to the microscope was accomplished via a serial line. The library was designed in multiple layers with the instrument dependent functions at the lowest level (see Fig. 1). High level applications, such as Leginon, can call the library directly or via a middle layer that supports more complex tasks, for example autofocus. Applications communicate to the instruments (microscopes and cameras) only through the emScope library (see Table 1). This allows complex applications to be developed independently of a particular instrument.

The Tecnai series of microscopes uses a computer running Windows NT/2000/XP and has a rich library of microscope control functions built into the system that are accessible through the Tecnai scripting interface. We took advantage of this environment by developing a Remote Procedure Call (RPC) library to this interface. ONC-RPC is a standard protocol [3] that is available on most computer platforms and is either included as part of the operating system (UNIX, Linux, etc.) or is freely available (Windows). Fig. 2 illustrates how the new RPC layer has been incorporated into emScope. The bottom layer of the existing library was replaced with an interface of function calls that communicates using ONC-RPC with the computer controlling Tecnai. To accomplish this task an RPC server was implemented on the Tecnai computer. EmScope connects to this server via an RPC client implemented on the application computer platform. A similar protocol was developed to support the Tietz camera that is attached to the Tecnai microscope. It can be extended for other camera types.

This extension of the emScope library using remote procedure calls allows the Leginon system to acquire data on the Tecnai microscope without any modifications required at the application level.

References:

[1] Kisseberth, N et al. (1997) Journal of Structural Biology, 120, 309-319.

[2] Carragher, B., et al. (2000) Journal of Structural Biology, 132, 33-45.
[3] RFC 1831: Remote Procedure Call Specification Version 2
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Table 1: Examples of function calls to the emScope library:

emcOpen	emcClose
emcGetGoniometerPosition	emcSetGoniometerPosition
emcGetBeamTilt	emcSetBeamTilt
emcGetIntensity	emcSetIntensity
emcGetDefocus	emcSetDefocus
emcGetAstigmator	emcSetAstigmator
emcGetBeamShift	emcSetBeamShift
emcGetImageShift	emcSetImageShift
emcGetHighTension	emcSetHighTension
emcGetBeamBlank	emcSetBeamBlank
emcGetSpotSize	emcSetSpotSize
emcGetMagnification	emcSetMagnification

Figure 1: Existing microscope control library.

Figure 2: Expanded microscope control library