doi:10.1017/S143192762002098X
Microsc. Microanal. 26 (Suppl 2), 2020

Online Throughput Monitoring of Transmission Electron Microscopy Research Centers

Lambertus Michael Alink, Robert Gheorghita, Edward Eng, Mykhailo Kopylov, Bridget Carragher and Clint Potter

New York Structural Biology Center, New York, New York, United States

Large transmission electron microscopy centers make very substantial investments in the very high-performance instruments. Recent developments have greatly increased the number of scientists wanting access to cryo-electron microscopy (cryoEM) which leads to long wait times for gaining access to the highest end instruments. The high costs and high pressure for access translate directly to the goal of maximizing instrument uptime and efficiency of data collection. To support these goals, we have developed an architecture of automated and robust sensors that track, organize and report key facility metrics.

The right metrics can be used to extract valuable information and gain insight into the daily operation of every transmission electron microscope (TEM). We track the output of every instrument, as well as the support architecture and environment (e.g. LN2 consumption, ambient temperature, humidity, etc.) This feedback enables instrument performance to be optimized and throughput to be maximized. The laboratory environment monitoring system is setup around the well-known Raspberry Pi. This provides dedicated sensors and processing software installed as close as possible to the source to be measured. The data is buffered locally and sent over a hardwire to a central server for storage in a database. Data is then served to online web pages that provide instant snapshots of the current status as well as reporting tools that can be used to understand any barriers to efficiency. For example, the sensor network monitors LN2 tank levels, predicts tank empty and failure conditions, sends alerts and advises on preventative maintenance actions that might be needed. This monitoring helps avoid catastrophic events like a sample loss due to system warming up due to lack of LN2 and also helps determine if tanks are being filled more often than necessary, thus reducing data acquisition throughput. Similarly, the temperature and humidity in each room is continuously monitored and alerts are sent if parameters are outside specifications. Raspberry Pi allows for easy scalability and addition of additional metrics (e.g. oxygen levels, water temperatures, vibrations, etc.)

We will present the design of the system and show how the metrics have helped improve the reliability and efficiency of the instrumentation housed at the Simons Electron Microscopy Center, home to 12 TEMs.

Funding support from the Simons Foundation (SF349247), NYSTAR, and the NIH National Institute of General Medical Sciences (GM103310).

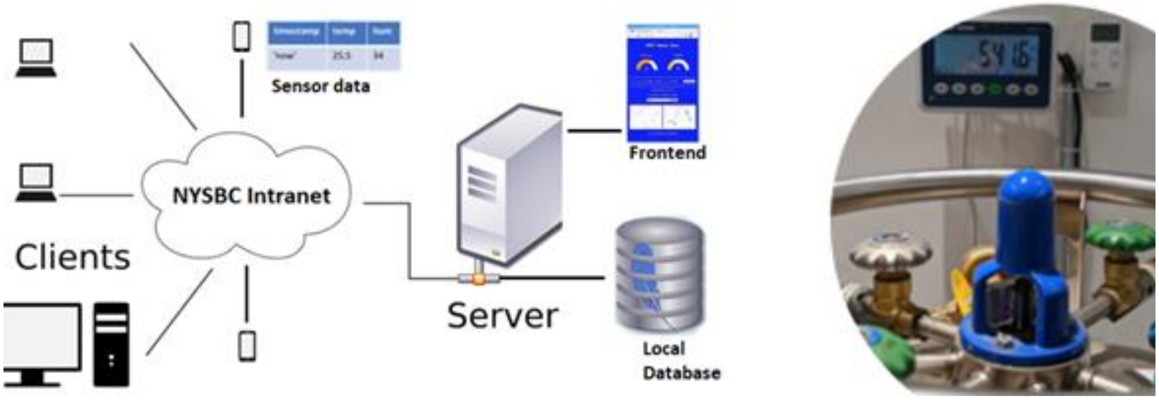

Figure 1. Left: Architecture of sensor monitor network. A range of sensors is available e.g. temperatures, humidity, LN2 weight etc. The software is multi-threading to be responsive to network request and data handling. Right: Typical LN2 tanks for supplying cooling of microscope. Weight is monitored in real time and sent over sensor network. High/low thresholds trigger email alerts to be sent by central server. LN2 consumption is measured and checked against historic numbers and against installed base.

References

Cheng, Anchi, Edward T. Eng, Lambertus Alink, William J. Rice, Kelsey D. Jordan, Laura Y. Kim, Clinton S. Potter, and Bridget Carraggher. 2018. "High Resolution Single Particle Cryo-Electron Microscopy Using Beam-Image Shift." BioRxiv, April, 306241. https://doi.org/10.1101/306241

https://doi.org/10.1017/S143192762002098X Published online by Cambridge University Press