SRI2○24

Contribution ID: **9**   Type: **Contributed talk**

Image Processing for Exascale Synchrotron Science

Thursday 29 August 2024 12:45 (15 minutes)

Today, light source facilities worldwide are evolving into the fourth generation, equipped with diffraction-limited storage rings that have much higher brightness, much lower emittance, and much better coherence. Thanks to such evolution, experiments are transitioning from two-dimensional static characterization into high-throughput, multimodal, ultrafast, and in-situ experiments with dynamic loading, which pushes the temporal and spatial resolution of experimental images to new limits and enables characterization of dynamic structural and functional changes across multiple length scales and modalities.

However, such transition inevitably imposes immense challenges on the software and algorithm end at these facilities. The volume of data, which could reach exascale (billions of gigabytes) each year, is becoming a serious concern. Although welcome progress in image processing techniques, including implementations using machine learning algorithms at light sources facilities has been made, the field remains far from being able to tackle the escalating challenges. In this talk, we first investigate how advanced image processing methods developed in other data-intensive fields such as neuroimaging, cryogenic electron microscopy (cryo-EM), surveillance and autonomous driving, can help address the big data challenge encountered at light source facilities. Then, we present our latest results in developing and applying cutting-edge noise reduction, super-resolution and data reconstruction algorithms on scientific big data. Lastly, we conclude that to address the big data challenge, we are integrating effective algorithms into our self-developed experimental control and data acquisition software framework Mamba to collect, manage, visualize and process big data. We envision Mamba as the operating system of High Energy Photon Source (HEPS). Together, we contend advanced image processing algorithms have all the potential to tackle the exascale big data challenge at next-generation light source facilities.

I plan to submit also conference proceedings

Yes

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Session Classification: Mikrosymposium 3/1: Data, Automation and the Use of AI

Track Classification: 3. Data, Automation and the Use of AI