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Cloud Processing and Direction of Automated and Autonomous Characterization using Piezoresponse Force Microscopy

Automated and autonomous experiments can revolutionize scientific discover—such "labs of the future"process vast amounts of scientific data and use this knowledge to inform and direct on-the-fly experiments. However, the application of such rapid, computationally intensive data processing steps can be severely limited by hardware and processing speed, particularly where computer systems are designed primarily for machine operation.

To facilitate future self-driven experiments, allow new levels of cross-facility collaboration, and expand user capabilities, we have integrated three software ecosystems developed at ORNL and CNMS to enable cloud-directed autonomous experiments. Instrument-control software (AEcroscopy) is used to operate a commercial atomic force microscope to measure and characterize a model ferroelectric sample. A cross-facility orchestration software ecosystem (INTERSECT-sdk) is then used to transmit measurement updates and file locations to a cloud server, on which a machine learning package (GPax) is used to process the new experimental data and transmit new experimental parameters back to AEcroscopy via INTERSECT-sdk.

Such development, here used to investigate local switching behavior, presents a model for labs of the future, where data sourced from different machines, computers, or even facilities can be collated, processed, and utilized for future high-throughput autonomous experiments.

Topical Area

AI and data science

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