ADAPT: SPIFI data collection, curation, and control

Who we are: ADAPT is a Mines-based industry-academia consortium that advances data informatics for Additive Manufacturing (AM). Faculty from several departments at Mines including Computer Science are affiliated with the consortium. Field-Session projects have the potential to lead to research opportunities for CS undergraduates.

Project Background: **SP**at**I**al **F**requency Modulated **I**maging (SPIFI) is an imaging technique with several properties that make it attractive for in situ imaging in AM and other harsh environments. Passive, CCD/CMOS array cameras capture light reflected from objects within their field of view (FOV). This requires an unobstructed line of sight to the object being imaged. In metal AM, the thermal barrier, which forms from vaporized metal and from thermal distortions–such as those visible in Schlieren imaging–prevents imaging of the melt pool using passive imaging systems. Unlike passive systems, SPIFI imaging is an active technique and does not require a direct line of sight to the object being imaged. Data is collected as a frequency-encoded signal from a photodiode–that is, each point along the line turns on and off at a different frequency–and since the location on the line is known for each frequency, the frequency space maps to position. This imaging approach allows for high (sub-micron) resolution of the reconstructed image. This project will construct a user interface and control software for a SPIFI-based metrology system built by a Mines senior design team in Fall 2018.

Task: The software that is to be developed will collect SPIFI data, perform a Fourier transform that maps the data to real space dimensions, stitch together "frames" (individual lines) into a 2D or 3D image, and present that to the operator and convert the signal into a more traditional image format, e.g. TIF. This project could expand to real-time control of the data collection platform, including three translational axes and one rotational axis. The successful project will include the following:

- (required) Provide a user interface for controlling, presenting, and saving SPIFI data.
- (required) Stitch together consecutive images. This feature will require providing adjustment controls for line angles (two off-normal and one in-plane), signal processing controls, and line length. More details will be provided when the team is introduced to the SPIFI system.
- (required) Serial port I/O including control of servo/stepper motors and reading raw voltage data. If this is not part of the project, synthetic data should be used to demonstrate the functionality of the other requirements.

Although an initial tech stack has been developed for control of a student-built metals additive manufacturing system, this infrastructure should be assessed by the team to assess its viability moving forward with this project.

Team Size: 3-4 students.
Location: right here on campus.
Clients: Profs Kappes (Mech Eng) and Dinesh Mehta (Computer Science).