Undergraduate Research Projects with Prof. Hongyi Xu

Project 1: Uncertainty quantification in design for Additive Manufacturing

Additive Manufacturing (AM) opens up an entire new opportunity of building metamaterial/structure designs of complex geometrical features. Design for AM is an emerging research area that attracts great attentions. Our mission is to develop computational methods to tackle the following research challenges:

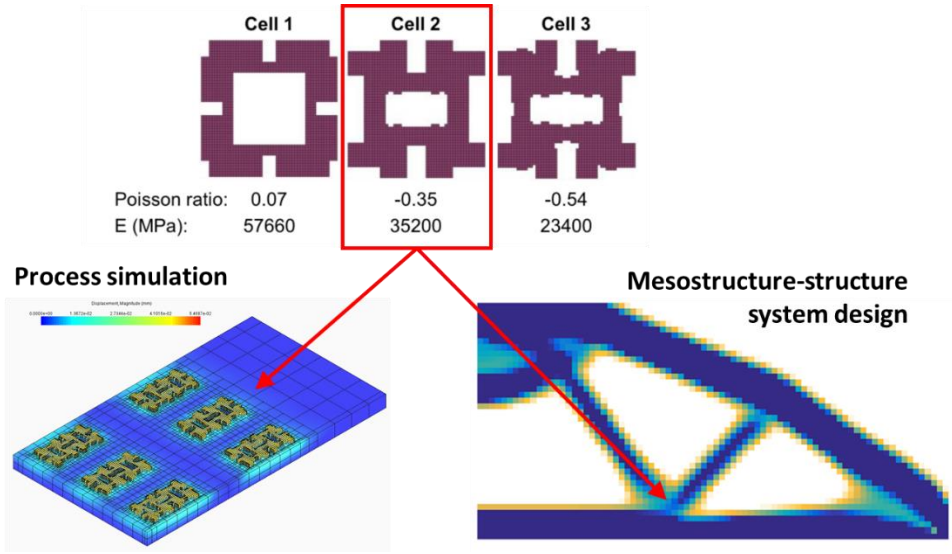
- Quantifying the uncertainties (randomness) in the additive manufactured structures, such as distortion, porosity, etc.;
- Establish simulation models to predict the structural performances with consideration of all the input uncertainties;
- Investigate multi-fidelity optimization methods for the design of mesostructure-structure system.

In this project, the students will:

- Conduct literature study to understand the state-of-the-art methods/techniques/tools;
- Investigate software packages of AM processing simulation and structural performance analysis;
- Develop a benchmark problem of mesostructure-structure design to test the simulation tools;
- Learn statistical analysis methods and apply them to analysis the data collected from the benchmark problem;
- Practice scientific presentation and writing.

Quantifications:

- ME 3255 Comp. Mech.;
- Experiences in using commercial FEA software packages (e.g. ANSYS, ABAQUS, LS-DYNA) is a big plus;
- Coding skills: MATLAB or Python;
- Strong interests in quantitative methods.



Project 2: Image-based microstructure characterization and modeling

The major goal of Computational Materials Science is to obtain fundamental insights and understanding of material behaviors and properties across different scales to enables cost-effective design of materials with targeted properties. As material's microstructure morphology strongly affects its properties, the objective of this research to develop computational methods to characterize and reconstruct the heterogeneous microstructures for material property prediction and uncertainty quantification. Our missions include:

- Develop image processing and statistical characterization methods to obtain statistical descriptors from the microscopic images;
- Develop efficient stochastic reconstruction methods to generate random but statistically equivalent microstructure models for property analysis in FEA.

In this project, the students will:

- Conduct literature study to understand the state-of-the-art methods of microstructure characterization and reconstruction;
- Develop codes for microscopic image analysis and statistical characterization;
- Create microstructure reconstructions and conduct FEA simulations;
- Practice scientific presentation and writing.

Quantifications:

- Coding skills: MATLAB or Python;
- ME 3255 Comp. Mech. is a plus;
- Coursework on statistics is a big plus;
- Strong interests in quantitative methods.