

Apply Deep Learning to Powder Bed Fusion Process Physics in 3D Printing for Smart Calibration and Control

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- Smart calibration of 3D printing processes can involve the understanding of thermal fusion of powder, from powder melting, phase change, to fusion.
- Engineering-informed deep learning of powder bed fusion can be efficient alternative to the first principles based approaches.
- This study for the first time applies deep learning to quantitatively model powder bed fusion process physics.

Challenges

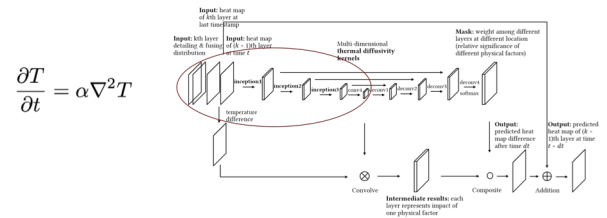
- Physics-driven modeling of 3D printing process is computationally challenging under complicated constraints. Process physics is not well understood.
- Black-box deep learning provides little process knowledge for end-product quality control.

Solution

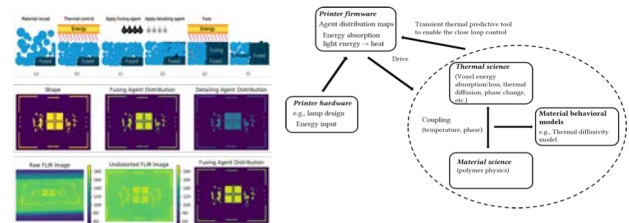
- Built a Conv-LSTM based deep neural network for predicting the transient fusing layer thermal behavior with print process resolution.
- Built a CNN to learn the heterogeneous material thermal diffusivity for prediction of

Contribution to CPS

- The study contributes the physics-informed data science for design and control complicated CPS.

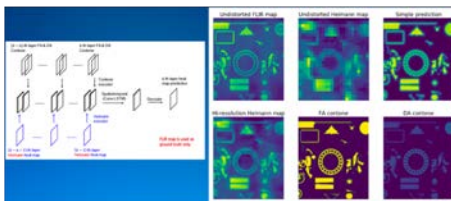


transient heat flux and thermal behavior over time.



Broader impact – Applications

Enable better prediction and control of thermal fusion



Broader impact – Education

- Academia-industry liaison
- Summer internship for PhD students.
- Workforce training: a PhD graduate joined HP Labs as research scientist for this research

Broader impact

- Generate online digital twin for 3D printing process
- Integrate with offline digital twin for 3D printed products

Luan, H., Roca, J., Zeng, J., Huang, Q., Murrphy, D., and Paula, T., 2018, "Apply Deep Learning to Powder Bed Fusion Process Physics in 3D Printing.," ACM Journal on Emerging Technologies in Computing (JETC), under review.