Thesis Defense

for

Master of Science Degree
in Computer Science

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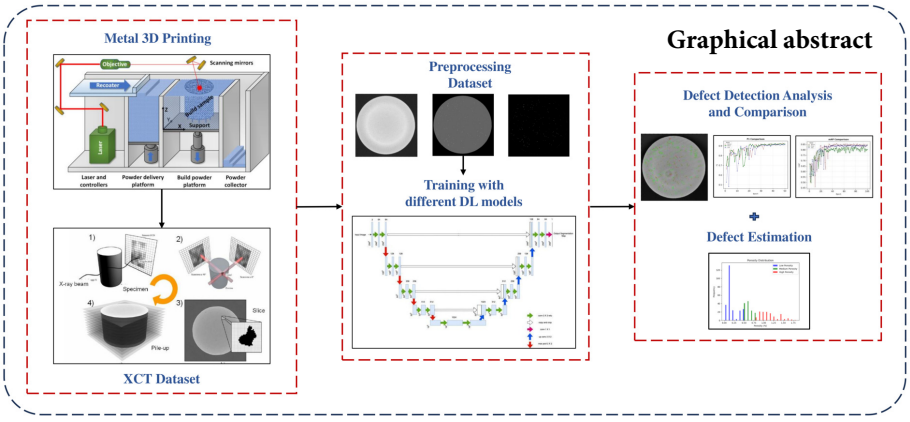
Porosity Prediction and Estimation in Metal Additive Manufactured Parts: A Deep Learning Approach

Over the past few decades, additive manufacturing (AM) or 3D printing (3DP) technologies have experienced revolutionary growth in the manufacturing sector. Metal AM techniques, par-ticularly Laser Powder Bed Fusion (LPBF), tend to suffer from porosity issues. The presence of pores can lead to detrimental effects, such as crack formation and eventual premature component failure. Consequently, there has been significant interest in research focused on defect detection and pore prediction at various scales. A straightforward, effective, and cost-efficient method for final part inspection involves using image-based porosity detection in existing systems. This thesis explores the potential of using U-Net and its novel network architectures, namely RU-Net and RAU-Net, for predicting porosity within an X-ray computed tomography (XCT) image dataset. The performance of these models is evaluated and compared across several metrics, including precision, recall, F1 score, mAP, IoU, and hybrid losses that combine BCG and Dice loss. RAU-Net is shown to surpass both RU-Net and U-Net across all metrics, identifying over 90% of actual pores while retaining 95% precision. While RU-Net and U-Net required additional training, RAU-Net achieved high performance in only 50 epochs, demonstrating its data efficiency and convergence. Due to its shorter training period, also leading to lower computational overhead, RAU-Net is suited for practical high throughput and low latency applications. Particularly in time-sensitive applications, RAU-Net can enable more widespread adoption of dense prediction networks. A custom script is developed for estimating the porosity percentage level in 3D printed metal components precisely, further enhancing final product inspection procedures. As a result, the entire quality control process is simplified, which allows for the quicker inspection of final components to deliver, by ensuring they meet required quality and reliability standards.



Thursday, March 21, 2024

2:00 - 3:00 PM

Engineering A-Wing Rm A309C

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