Developing artificial intelligence for defect detection

Saber Nemati, Hao Wen, Brian P. Tsai, Louisiana State University

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What is the outcome or accomplishment? (1-2 short sentences describing it and why it is transformative; 50-word maximum suggested)*

Supervised Machine Learning (ML)-based algorithms are being developed by researchers with the Louisiana Materials Design Alliance (LAMDA) for crack detection in X-ray tomography images. Using this method, a large number of images can be segmented with accuracy after training with just a limited number of manually segmented images.

What is the impact? (1-2 simple sentences describing the benefits for science, industry, society, the economy, national security, *etc.*; suggested 50-word maximum)

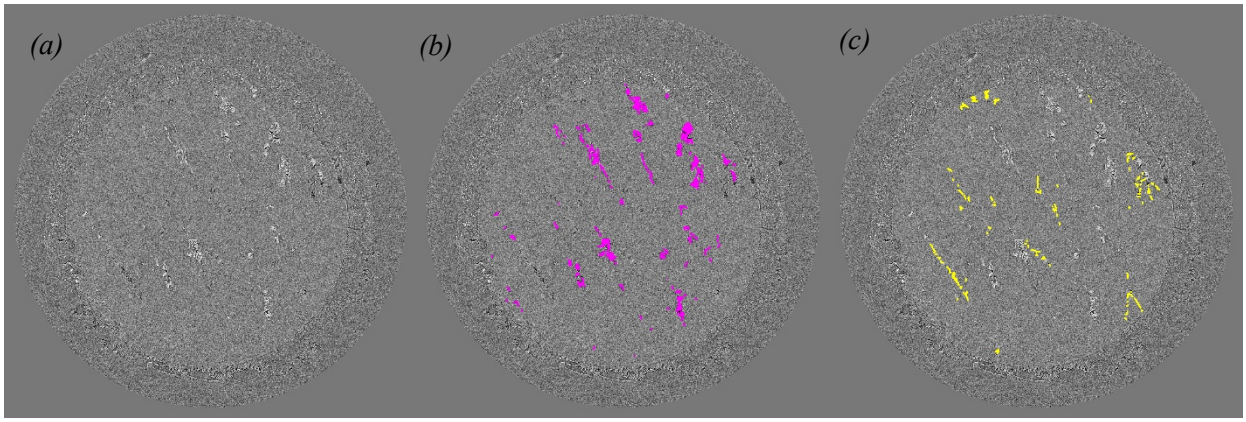
The ability to efficiently detect the cracks and different types of inclusion in tomography images is a key component in evaluating and optimizing additively manufactured (AM) parts in the testing stage. This paves the way for developing faster and more intelligent algorithms with minimal supervision, which consequently leads to a more optimized way of designing stronger, premium alloys.

What explanation/background does the lay reader need to understand the significance of this outcome? (1-2 paragraphs that might include, for example, more on who, when, where; NSF's role; support from multiple directorates/offices; what makes this accomplishment unique; additional intellectual merits; or broader impacts such as education, outreach, or infrastructure improvement that are integral to this outcome; suggested 150-word maximum)

Creating suitable additively manufactured alloys for different applications is a challenging task, as it depends on many parameters during the designing, manufacturing, and testing processes. One of the most challenging phases of this process is the evaluation of the parts since defects in AM parts are hard to detect and cumbersome in nature. Tomography is a well-known nondestructive method for observing the defects inside 3D metal parts on micro scale. Due to recent advances in machine learning, there are a lot of efficient algorithms that can identify these defects and categorize them into different classes. With the implementation and validation of such algorithms, several days of manual work can be completed in a couple of seconds. Because

of LAMDA's interdisciplinary nature, the collaboration of experts with different scientific backgrounds is inevitable. One of the most valuable yet challenging outcomes of LAMDA is building a synergetic framework that makes use of each groups' capabilities.

Louisiana State University graduate students, Saber Nemati, Hao Wen and Brian P. Tsai evaluating different network architectures.



Sample algorithm segmented image. (a) original image (b) Fe-Inclusions (c) Mg-inclusions.