Collection and Analysis of Additive Manufacturing Signatures for Proliferation Detection

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Background

The emergence of technologies like Additive Manufacturing (AM) have posed concerns regarding the fabrication of dual-use or exporting controlled components for nuclear proliferation. The landscape of AM is characterized by a diverse set of seven processes, each containing distinct attributes and implications.

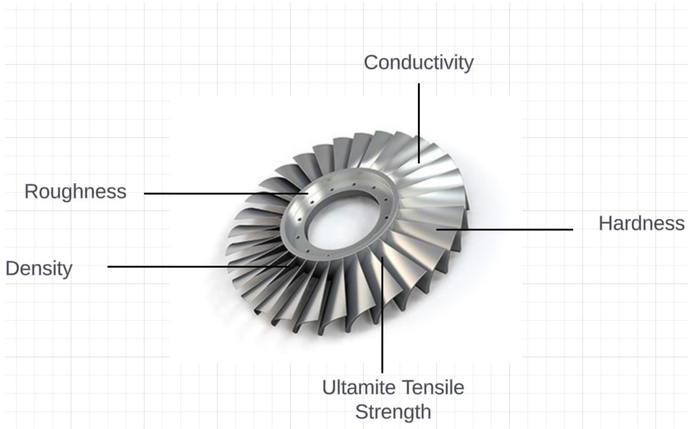

Figure 1. Titanium part from Sciaky Inc. with capturable signatures.

Goals & Objectives

The primary aim of this project is to present a potential analytical tool calibrated for dissecting AM process signatures, offering a means in detecting which specific AM processes are used in part fabrication. The availability of such a tool has the potential to yield high effectiveness in future inspector verification activities within the domain of nuclear non-proliferation in hopes of preventing the use of AM for dual use and exporting control printing.

Methods

By selecting and gathering several properties (forming temperature, young's modulus, density, tensile strength, hardness, etc.) of different materials from the comprehensive amount of literature pertinent to AM processes and materials, we can build a database with ranges of possible values parts could have for analyzing signatures and differentiating among AM processes.

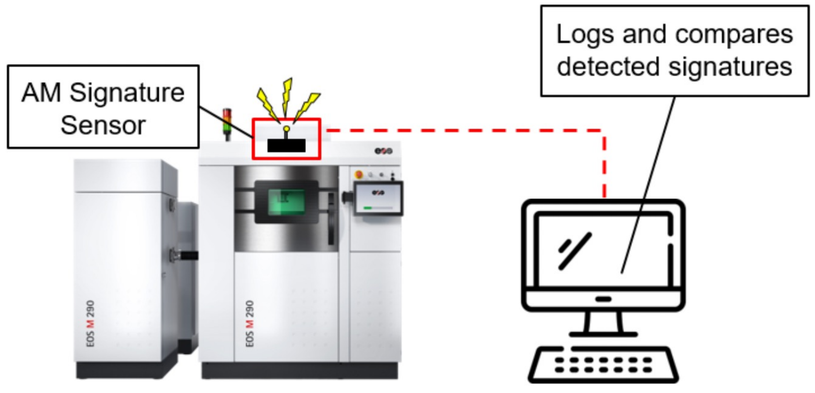

Figure 2. Once the signatures have been captured, they can be compiled and compared in the database.

Results

The researchers developed a database which is currently published in the Texas Data Repository. The database consists of 19 material properties such as density, hardness, surface finish, yield strength, tensile strength, young's modulus, and conductivity for 4 different AM methods for a total of 76 possible individual features. Across these 4 AM processes (powder bed fusion, material extrusion, binder jetting, and direct energy deposition) data has been gathered on 20 materials.

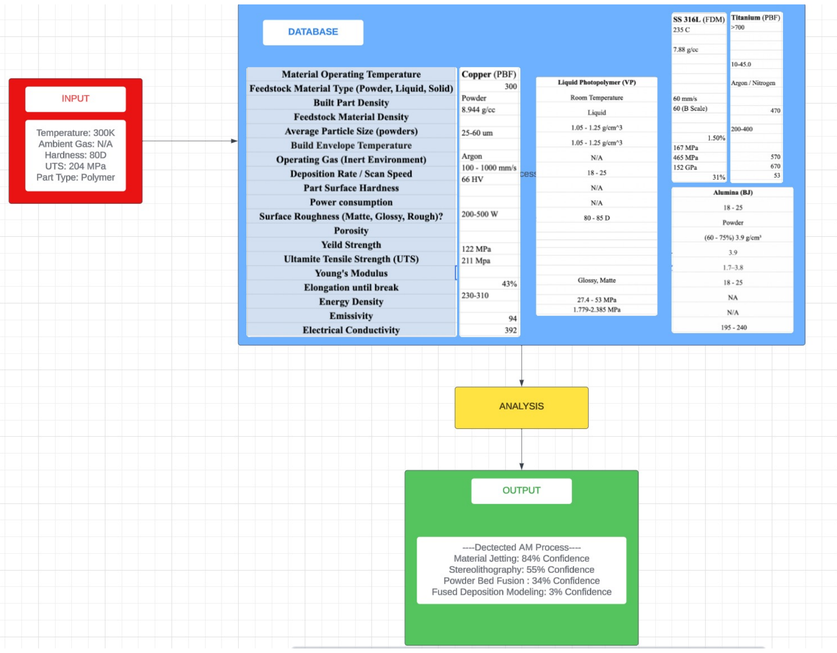

Figure 3. A simple schematic of the webtool that will accept signature inputs, analyze the database, and output confidence intervals for each AM Process

Future Direction

Future work for this project focuses on the creation and development of an automated web tool to operationalize the database. The comparison of detected AM signatures to the established descriptors can be used to determine a likely AM process. We also plan to expand the database to include the other known AM processes of vat polymerization, material jetting, and sheet lamination as well as AM methods that could be developed in the future to increase beyond the current 76 possible individual features.

Acknowledgements

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