Computer Vision Image Analysis for Defect Detection and Material Characterization of Additively Manufactured Electromagnetic Components

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This work exhibits the use of computer vision in the analysis of additively manufactured electromagnetic components. This computer vision system employs image analysis to detect defects in the manufactured components to provide feedback for manufacturing and additionally provide detailed topologies to increase simulation accuracy.

For this work, X-band (8 – 10 GHz) spiral elements were printed of silver thermoplastic polyurethane (Ag-TPU) ink on a polypropylene substrate using a pressure driven gantry printer. The spirals were tessellated in a hexagonal lattice to act as a stop-band spatial filter. These spiral elements were chosen for their sensitive response to slight variations in parameter changes and defects. Due to the nature of the manufacturing process and materials, tools were developed to provide feedback verifying the accuracy of the print job and quantitative data categorizing defects in printing. Among these tools, computer vision and image analysis were employed to provide binary images of individual spiral elements from the lattice. These binary images were then used to analyze arm length, arm width, and deviation from the intended print path. An example of this binary image decomposition is shown in Fig. 1.

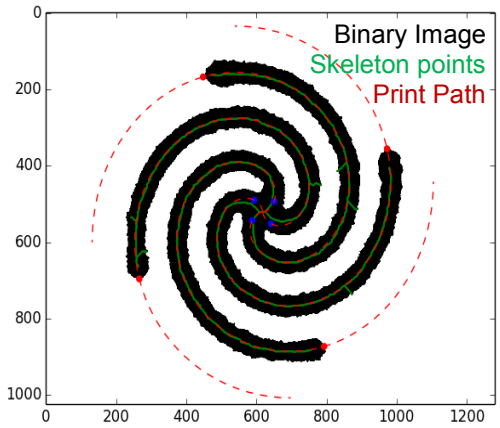

Figure 1: Binary image of a single spiral element containing comparison of skeleton points and ideal print path (scaled in μm)

These binary images are typically processed in batches of 400 and are used to quantify data about the printed geometric parameters and map the density and magnitude of defects within the lattice. These binary images can then be imported into an EM solver by tracing the outline to provide a “real” element for simulations with imported material properties. These simulations have shown to corroborate measured data of filtering response from fabricated samples.