Reducing Energy and Materials Usage

3D printing part characterization for quality assurance

The project will design and characterize test artifacts that can assess the ability of 3D printing technologies to produce parts with the intended geometry and performance.

- In comparison to conventional manufacturing, additive manufacturing (or 3D printing) reduces energy use, resource demands, carbon emissions and pollutants [1].
- There is a need to assess the capability of various technologies to reliably produce parts as designed in order to increase yield and lower waste.
- Current test artifacts are complex and do not provide metrics to compare different technologies.
- There is a need to provide metrics to manufacturers to assess the ability of different technologies to produce parts that meet their product's requirements.

Developing easy-to-use and highly efficient quality assurance tools will enable parts manufacturers to fine tune building parts, quickly validate part quality, and compare outputs across technologies.

Defining a printer’s capability through test artifacts

- Dr. Chang and her students have developed suites of geometric element test targets (GETTs) that offer graphical measurements of a printer's resolution. We are validating the performance across technologies and are developing ways to make accurate measurements.
- This project seeks to expand GETTs to reflect the effect of spatial frequency of the geometric patterns and to extract the print process’ modulation transfer functions which will enable simulation and optimization of the printed parts shape.

Creative Approach to Building Quality Assurance

- Dr. Chang has previously published in this area [4].
- In addition, she has over 25 years of experience in the corporate sector developing printing technologies.
- Her research group have access to electron microscopes, surface probes, a Keyence© VHX-2000E 3D microscope, Epson 10000xl scanner and a variety of additive printers.
- This project will be a collaboration with National Institute of Standards and Technology.

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The project explores graphical and frequency modulation test patterns to examine a 3D printer's dimensional capability.
Proposed research: Create quality assurance standards that can be understood by researchers, engineers, sales and service representatives, and customers.

There is currently a need for easy-to-use and accurate methods for comparing 3D printers and in-line process control. The establishment of such a methodology will lead to answering a number of practical questions:

- How can parts manufacturers know that they produce consistent parts?
- How can parts manufacturers monitor the accuracy of a machine and track its performance over time?
- How can the printing engine manufacturers market their products?
- How can customers evaluate various printing machines?

The project’s objective is to develop targets that enable the prediction of the part’s shape from the digital input file and to demonstrate the prediction capability across technologies. With this capability, the part shape can be more precisely controlled and its quality can be assured.

**The project is to measure and predict the quality of a print engine.**

Aim 1: GETTs can be developed into a universal artifact that can be the benchmarking tool to meet quality assurance requirements.

Aim 2: Modulation transfer functions exist for 3D printing and can be attained through assessment of frequency modulation GETTs.

The project will utilize 3D printing technologies at RIT campus. We will design graphical and statistical GETTs and explore their parameter space to identify failures as a function of process parameters. Measurements will be images of GETTs captures with Keyence© VHX-2000E 3D microscope, Epson 10000xl, or inline sensing. Dr. Chang and her students will develop image analysis algorithms.

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<th>Activity</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
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<td>Design broad application GETTs</td>
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<td>Demonstrate GETTs benchmarking feasibility within a technology</td>
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<td>Demonstrate GETTs benchmarking feasibility across technologies</td>
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<td>Design FM GETTs</td>
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<td>Demonstrate measurement of FM GETTs</td>
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<td>Demonstrate accuracy of FM GETTs</td>
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<td>Develop GETTs in-line measurement techniques</td>
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<td>Demonstrate in-line measurement feasibility</td>
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<td>Conference and journal publications</td>
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**Bibliography**


