LASERSINTERING LOW COST PROCESS MONITORING (LC-ProMo)

Most of the modern Polymer Lasersintering machines are not equipped with relaiable and automated process monitoring systems. Still the process monitoring is a very critical aspect for serial production, as even small coating errors can lead to part failure. The objective of this project is to design and implement a retrofittable monitoring system for the EOS P3 platform, which is capable to detect false powder spread, the recoater filling level and inform the operater, if an event has been detected.

PROJECT OVERVIEW

DURATION

2020 – 2021

PARTNER

- Particle Technology Group (PVT)
- Database and Information Systems (DBIS)
- Software Innovation Lab (SI-Lab)
- DMRC partners

FUNDED BY

DMRC funding cycle 2020

RESEACHER

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DMRC RESEARCH INNOVATION EDUCATION
DIRECT MANUFACTURING RESEARCH CENTER

Problem description

Serial production is only possible if the process runs sufficiently stable. The part properties must not vary too much if manufactured with identical machine settings. However even very small coating errors like agglomerates, recoater stuttering, foreigen particles or uneven powder spread in general can lead to high variation within the part quality. Some of those failures are detected directly after the part depowdering, as shown in Figure 1. Then again, some failures are located in the middle of the material and cannot be seen in the final part.

Nowadays, this is most often overcome by additional test parts located side by side with the actual part. This solution is not only expensive, due to the additional parts and tests, it is also unsafe, as this method never gives 100% confidence for no failures in the actual part volume. With the powder spread process monitoring system those failures can be detected and the part is rejected before it is assembled or shipped.

SLM powder spread monitoring systems

Powder spread monitoring systems are already state of the art for the selective laser melting (SLM) technology. Here a machine vision high resolution imaging system is equipped at the top of the build chamber and detects powder spread issues and part curling problems based on different light reflections. The gathered information is fed to a machine image analysis software which gives online information on the build job.
It is possible to use this information in an open loop or even as closed loop control unit for the manufacturing process. However, it is not possible to simply transfer those systems to the polymer lasersintering process. In the SLM process the build camber is not heated and the hardware does not have to be protected in the same way as it is required in lasersintering machines. Furthermore, the light set up is different, as the raw material shows other reflection coefficients and without the IR heating units additional interference radiation needs to be taken into account.

Approach and methodology

The system developed here shall be retrofittable to all EOS P3 systems. Therefore, the changes at the machine itself should be reduced to a minimum. The image sensor will be assembled as an exchange unit for an existing build chamber light. Additional light sources will be installed and shall surround the build plan. A sketch of the installation concept is shown in Figure 2. Images taken with different light directions will deliver enough information of potential failures as the resulting shadows change form related to the detected failure. This is shown in in Figure 3 where the light is coming from the front side along the y-axis. A machine vision system can detect the prominent shadow much better than the groove itself.

Analysis process

The high-resolution images will be analysed with a shape of shade or contour detection approach. Hereby it is most critical to preprocess the images and tune the system to get relaiable results. The system needs to deliver a high failure detection rate with very low or no false alerts.

Working together at the DMRC

For this project the Paderborn University Chairs from Prof. Hans-Joachim Schmid – Particle Technology Group (PVT) and Prof. Dr. Gregor Engels – Database and Information Systems (DBIS) are working together to obtain the best outcome for the job and the partners.
The PVT is supporting with its deep knowledge on the process and is responsible for the hardware implementation and gathering of analyzable information.
The DBIS realize the required software components of this project. This covers the automated analysis of the data and interpretation of the outcome. Based on this information, the operator is informed or the specific layers and positions are highlighted afterward in a system for operator confirmation.

FIGURE 1 Recoater Failure Initiated Part Failure

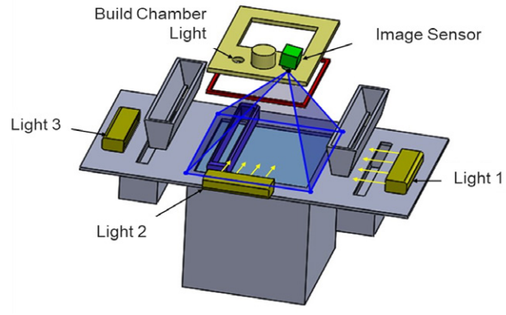

FIGURE 2 Monitoring Concept Sketch

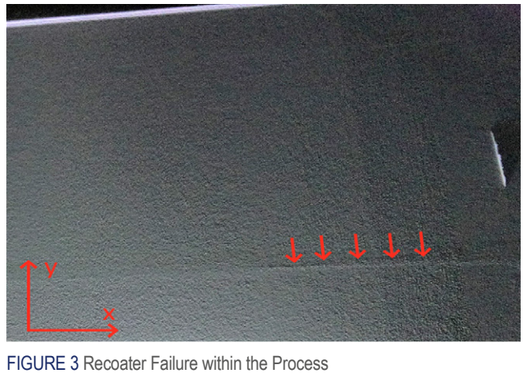

FIGURE 3 Recoater Failure within the Process