ADAPTIVE REMANUFACTURE OF DAMAGED COMPRESSOR TURBINE BLADES

Project by Leonardo Mestre Galofre
lmestregalofre2@uni.brighton.ac.uk

Supervised by Dr. Yan Wang

Summary

The project was set up to review and enhance current remanufacturing processes in industry for compressor turbine blades. Consequently, a methodology to perceive improved adaptive remanufacturing processes was developed. This technology is based upon the integration of the coordinates system between the original and damaged blade CAD model.

Status of Art of Research

There are various existing remanufacturing methods currently in use for the remanufacture of compressor turbine blades:
- Laser Deposition: Inverts melted powdered metal into the damaged region by following the path generated for the broken region.
- RECLAIM: Automated method based on Laser Deposition for the repair of damaged turbine blades.
- GTAW: Gas Tungsten Arc Welding
- Cold Spray: Metal powder coating method for damaged blocks with cracks.
- Others: Automated Robot: Future techniques based on the development of a robot capable of going through the various repair stages of the remanufacturing process without external input.

Compressor turbine blades are exposed to extreme and tough working conditions. They are commonly subjected to:
- High temperatures and pressures.
- Stresses due to the centrifugal force of the high rotational speed blade disks.
- Vibrations from the engine itself, since it is turning at high rpm.

Despite being manufactured and tested to high standards in order to comply with the Federal Aviation Administration regulations, compressor turbine blades do fail. The most commonly suffered failures are caused by stress, creep, fatigue, ingestion of objects, hard landings, corrosion, and erosion.

Methodology

The proposed methodology was developed over prior 2D and 3D simulations. This allowed the methodology to be established and consequently, applied for the repair of damaged aerospace engine compressor blades as a case study.

Aim and Objectives

The overarching aim of the project is to carry out a 3D reverse engineering process while developing a methodology to automatically identify the geometry of a worn out blade and enable adaptive repair via Computer Aided Manufacturing (CAM) software.

The objectives of this project are:
- I. Review and analyse the status of art of the remanufacture of compressor turbine blades.
- II. Develop a methodology to automatically identify the worn out area of compressor turbine blades based on the integration of a pre-defined iteration process for a given defined step of integration.
- III. Demonstrate and verify the proposed methodology using three-dimensional (3D) reverse engineering processes such as 3D scanning and 3D printing.

Introduction

Remanufacturing offers an alternative and more sustainable form of production to extend the life of a product than manufacture or recycling. Nevertheless, there is currently a big concern in industry due to the limitations of the remanufacture industry, where product mass production is not possible. This is primarily due to the lack of connection between the various remanufacturing stages, therefore resulting in higher time-consuming and labour intensive processes.

2D and 3D Simulation

The proposed methodology was developed over prior 2D and 3D simulations. This allowed the methodology to be established and consequently, applied for the repair of damaged aerospace engine compressor blades as a case study.

Conclusions and Further Work

I. The proposed method can match the broken area of a compressor turbine blade to be repaired at any given failure location and mesh size (see Figure 5).
II. Adaptive dimensional measurement, repair, surface finish and coating is achieved. Therefore, less time consuming and labour intensive processes enables a higher ability to remanufacture at similar costs to mass production.
III. Inconclusive results, as the identification of multiple damaged areas in the same turbine blade was not tested.
IV. A promising principle that could be implemented in current existing remanufacturing processes for compressor turbine blades.

Results

I. The proposed methodology can match the broken area of a compressor turbine blade to be repaired at any given failure location and mesh size (see Figure 5).
II. Adaptive dimensional measurement, repair, surface finish and coating is achieved. Therefore, less time consuming and labour intensive processes enables a higher ability to remanufacture at similar costs to mass production.
III. Inconclusive results, as the identification of multiple damaged areas in the same turbine blade was not tested.
IV. A promising principle that could be implemented in current existing remanufacturing processes for compressor turbine blades.

References