Chair of Aerodynamics and Fluid Mechanics
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Surface treatment simulation with Lagrangian particle methods

M. Sc. thesis proposal

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Introduction

Surface treatment is been used in every manufacturing process to improve the surface of components for specific applications. Amongst others, surface treatments include roughness removal from surfaces after printing parts or coatings for tailored surfaces. Although proven to be effective, the various treatments require prior application in industrial environments significant amounts of testing and optimization. Also, often various surface finishing treatments need to be combined in order to achieve the desired part qualities. Besides reduction of experimental testing, digital twins of surface finishings would allow the design of tailored treatments with reduced costs.

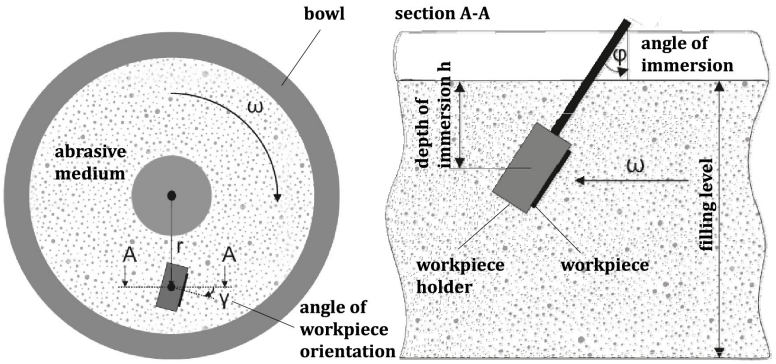

Figure 1: Schematic view of the stream finishing machine. Taken from Schulze, Volker, Jens Gibmeier, and Andreas Kacaras. "Qualification of the stream finishing process for surface modification." CIRP Annals 66.1 (2017): 523-526.

In this thesis, a prototype for a virtual surface treatment process is to be developed for an industrial use-case. The considered treatment is yet to be defined but will focus on roughness treatments by particulate flows. Therefore, the computational methodology will rely on Lagrangian particle methods.

Method

The Discrete Element Method (DEM) describes the motion of individual macroscopic particles with inter-particle interaction mechanism to govern the physics of the respective media. The Lagrangian framework of such particle methods offer strong advantages for the aforementioned problems, e.g., the capabilities to handle discontinuous media or to handle complex deforming geometries. In this project, a digital twin of a surface finishing process is to be developed within a DEM simulation framework. Overall, an effective toolchain from raw CAD data to a predicted surface cleaning result needs to be developed and demonstrated in the thesis. Although we have some tools available for Lagrangian particle interactions, in a first step a literature / web survey needs to be performed to select the proper software package to use (considering various aspects like performance, TRL, licencing, capabilities, etc.). Then, starting from CAD data a simulation configuration should be generated and prepared for simulations. Ideally, the pre-processing as well as the actual simulation and post-processing can be automized to include the workflow in an optimization process. As demonstration, the project partner Oerlikon AM will provide a real test example with experimental data for comparison.

Please contact Dr. Adami (stefan.adami_AT_tum.de) to express your interest in the topic and for further details. The thesis can start anytime beginning from October 2023.