The use of morphological methods for the extraction of topographical features from complex additive manufactured surfaces

Shan Lou*, Xiangqian Jiang, Wenhan Zeng, Hussein Abdul-Rahman, Paul Scott

EPSRC Centre for Innovative Manufacturing in Advanced Metrology, School of Computing and Engineering, University of Huddersfield, Huddersfield, HD1 3DH, UK

Email: s.lou@hud.ac.uk

Additive manufacturing (AM) processes have the potential to produce highly complex, customisable and multifunctional parts at lower material and energy costs. However the AM processes, particularly using metal powders, are far from perfection. The complex nature of powder AM processes tends to produce component surfaces that are very rough, showing significant defect features, including large isolated “bumps” due to partially melted particles attached to the surface, repeating steps generated by successively adding layers, surface pores and re-entrant features. These defect features are often superimposed on the complex form of the AM products. Following the existing evaluation methods for traditional machined surfaces and using extant standards, current industrial practices and research work cannot achieve credible results due to insufficient understanding of the non-Euclidean nature of AM surfaces. It is proposed in this work to use morphological methods to suppress the impact of surface form and extract surface topographical features.

The morphological operations with circular structuring elements are applied to approximate the general form of the complex surface. Closing operation will suppress deep valleys and opening operation will remove sharp peaks. These operations or their combination effects will generate a smooth reference surface such that surface topographical features can be excluded. Instead of following the traditional route which takes the assumption that the surface is planar and normally subtracts the “form” from the primary surface to obtain the residual surface, topographical features are defined as the height function over the reference surface, i.e. each sample position is attached with a height value. The morphological watershed segmentation based on Maxwell’s theory and Pfaltz graph is then performed on the “heights” aiming to result the reasonable boundary of these topographical features. A primary example of using the proposed method is the extraction of bump features from the complex AM surface. Characterising the bump features can be useful for detecting process malfunction.