Design and simulation of slicing algorithms for the production of biomedical scaffolds by additive manufacturing.

M. Silvestri*,†, F. Corradini*

* Department of Engineering and Architecture
University of Parma
Parco Area delle Scienze 181/A, 43124 Parma, Italy
e-mail: marco.silvestri2@unipr.it, web page: http://silvestri.rocks

† Department of Innovative Technologies
University of Applied Sciences and Arts of Southern Switzerland (SUPSI)
Via Cantonale 2C, 6928 Manno, Switzerland
Email: marco.silvestri@supsi.ch

ABSTRACT

3D printable models intended for printing with fuse deposition modelling (FDM) or similar techniques, are usually created with a computer-aided design (CAD) package and then processed to convert the model into a series of layers, each of which consists of a path of the extruder of a thickness equal to the diameter of the extruded material. This processing phase is called *slicing* and plays a critical role for the entire process: on the one hand, it has a decisive impact not only on the micro architecture of the manufact, but also on the resulting macroscopic characteristics (stiffness, elasticity, weight / volume ratio), on the other hand, it strictly depends on the characteristics of the machine for which is implemented.

In the field of medical devices, the micro-architecture of scaffold produced by 3D printing is one of the most critical factor to control cells proliferation and even the functional differentiation of the growing tissue. Among the parameter influencing the cell behaviour, it is well known the critical role of porosity, surface area/volume ration (SAV), interconnectivity, channels average diameter, tortuosity, channel cross section and surface curve radius [2].

Unfortunately, the scale at which these geometrical quantities play a critical role is usually comparable to the 3D printer resolution and cannot properly be addressed by defining an ideal model on the CAD and neglecting the path actually calculated by the slicing algorithm.

The present work shows how some alternatives to commonly used algorithms have been designed and implemented. This study not only lays the foundations for the manufacture of innovative scaffolds, but constitutes an element for the digitization of such production.

Indeed by defining, beside the digital twins of the machine and of the product, the digital twin of the patient and of the tissue regeneration process, it become possible the creation of a full lifecycle data loop to integrate the stages of illness diagnosis, device manufacturing, device surgical application and course of treatment monitoring. [3]

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