An Isogeometric Analysis based Approach to Computer Aided Tools for Additive Manufacturing

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ABSTRACT

The dominant CAD-tools today are based on boundary structures where a solid object is represented by the surfaces of the inner and outer hulls of an object. This is very efficient when designing for subtractive/abrasive manufacturing processes where the shape manufacture is produced by removing material from a solid block of raw material. In additive manufacturing the object is built layer by layer by locally depositing material that is melted (laser, plasma) and so gradually the object evolves to it final shape. Currently there are more than 20 different additive manufacturing technologies targeting a wide range of materials: Metals; Polymers; Ceramics; Biological. In design for subtractive/abrasive manufacturing the manufacturing process knowledge is intrinsic background knowledge, thus it is not to a large extent explicitly addressed in the CAD-system.

For additive manufacturing intrinsic process knowledge is very limited, not wide spread, and often related to specific additive processes. The need for tools providing process knowledge already during design is essential for efficient use of additive manufacturing in industry. Some of the challenges to be addressed already at design stage for additive manufacturing are:

- Limitations of the intended manufacturing technology with respect to building directions, and the influence of building direction on object properties
- Design of internal voids and lattice type structures to reduce weight and the influence of these on the object properties
- Anisotropic material properties
- Design of necessary support structures for the manufacturing process, and the influence of these on thermal stresses and possible resulting object deformations.

CAD-technology based on boundary structures cannot easily be extended to address these challenges. There is a need for a 3-variate shape representation that can both represent variable material and anisotropic material properties, and be easily interfaced to analysis. Analysis based design systems built on the ideas of IsoGeometric Analysis are very promising with respect to most of the challenges above, although extensions are needed to properly address lattice type inner structures.

The CAxMan-project [1] addresses the above challenges by addressing analysis based design for additive manufacturing based on the representations and approach of IsoGeometric Analysis, taking aspect of additive processes into consideration already during design. The approach builds on the extension of ISO 10303-209 edition 3 [2] with respect to IsoGeometric Analysis and locally refined splines. The talk will address the approach of CAxMan and present results achieved. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680448".

REFERENCES

[1] http://www.caxman.eu

[2] https://www.iso.org/standard/59780.html