RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM
(one page maximum)

Field: Information and Communication Sciences and Technologies

Subfield: Design Engineering / 3D Modeling

Title: Geometric simplification of digital CAD mock-up using substitution and envelope generation techniques exploiting explicit and implicit semantic information

ParisTech School: Arts et Métiers Sciences et Technologies

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Short description of possible research topics for a PhD:

The digital mock-up is a key component in the innovative manufacturing product development process. It is an efficient support platform for multidisciplinary collaborative development of products which become increasingly complex and developed in an extended enterprise mode.

If the digital mock-up is mainly built the in product engineering phases, its progressive enrichment is leaded through its ability to unify all areas of the company with levels of details increasingly fine. This is an important objective to represent and simulate as close to reality the future product, manufacture it globally, but also assure its support all along its lifecycle, especially in an economic context where the supply chains are playing an increasingly critical role and where the markets targeted by companies become globalized. Therefore, this Digital Mock-Up becomes increasingly "heavy" particularly in terms of its geometric definition that is more and more detailed.

In this context, a challenge is to be able to exploit the 3D digital mock-up for all kinds of activities including computer simulation and visualization and using mobile media (tablets) more and more frequently used. For this, it is necessary to be able to simplify the 3D geometric representation of the model to make it compatible with the needs of the activity and with the associated constraints (size of problem, processing time, quality, real-time, ...).

Current simplification techniques are mainly based on defeaturing approaches (removal of characteristics forms on the parts that constitute more or less important shape details), or on decimation approaches (reduction of the number of triangles associated with the polyhedral representation of the different parts). All these approaches are generally well suited if you do not simplify too much the initial shape and they generally give poor or even unusable results when we need highly simplified form (or get a very simple shape that look like the overall initial form). In addition, all these approaches work mainly for parts and rarely for assemblies.

As a consequence, a first axis of this thesis work is to develop a new approach for the massive simplification of huge digital mock-ups based on a principle of shape substitutions (analysis of the initial shape and replacing it by one or more simple substitution shapes). Initially, work will focus on the part level (component) and can be extended / generalized to assemblies (assembly level).

Required background of the student: 3D CAD modeling, programming language, computer graphics, machine learning basics

A list of 5 (max.) representative publications of the group:

https://scholar.google.fr/citations?user=qZ6InYkAAAAJ&hl=fr