Research Topic for the ParisTech/CSC PhD Program

Fields: Design & Industrialization, Information and Communication Sciences and Technologies, Mathematics and their applications.

ParisTech School : Arts et Métiers Sciences and Technologies – Laboratory LISPEN Campus of Aix-en-Provence

Title : **Deep learning and multimodal declarative modeling for fast sketching of draft CAD models in the creative design phases**

Advisor(s):
Prof. Dr. Jean-Philippe PERNOT / jean-philippe.pernot@ensam.eu / https://lispen.ensam.eu
Dr. Arnaud POLETTE / arnaud.polette@ensam.eu / https://lispen.ensam.eu
Dr. Romain PINQUIE / romain.pinquie@grenoble-inp.fr / https://g-scop.grenoble-inp.fr

Short description of possible research topics for a PhD :
This PhD program addresses the way draft CAD models can be efficiently sketched from a combination of multimodal inputs. Such an approach is particularly interesting in the creative design phases when the shapes are not yet fully defined and when the designer may be interested in describing his/her shapes using multiple modalities. The main idea relies on the development of a new declarative modeling framework which will drive an existing CAD modeler, and/or research prototype software, from a user-specified description combining the use of a dedicated vocabulary/grammar as well as the possible use of low-cost interaction devices. Several modules are foreseen. In a first step, the designer will describe his/her shape using a vocabulary and grammar and possibly using interaction devices such as a Leap Motion or a Kinect. Here, a Convolutional Neural Networks (CNN) will be trained to be able to generate coarse 3D representations from 2D sketches. This will be made possible by means of an ad-hoc combination of shape descriptors. Then, this description will be processed and transformed in a generic shape description, i.e. a set of generic geometric operations that can be used to obtain the shape whatever the CAD modeler or research prototype software are. At this stage, the system will have to manage issues related to the possible incompleteness and/or inconsistency of the user-specified description. Finally, this generic shape description will be transformed in a set of geometric operations specific to a CAD modeler and/or research prototype software. The output of this modeling process will be a draft CAD model to be used and further refined in the later stages of the design process. The proposed framework will be implemented and validated on academic as well as industrial examples.

Required background: Computer science, geometric modeling, computer-aided design.

A list of 5 (max.) representative publications of the group:
Pernot J-P., Falcidieno B., Giannini F., Léon J-C., Incorporating free-form features in aesthetic and engineering product design: State-of-the-art report, Computers in Industry, vol. 59(6), pp. 626-637, 2008.
Gouaty G., Fang L., Michelucci D., Daniel M., Pernot J-P., Raffin R., Lanquetin S., Neveu M., Variational geometric modeling with black box constraints and DAGs, Computer-Aided Design, vol. 75-76, pp. 1-12, 2016.
Décriteau D., Pernot J-P., Daniel M., Towards a declarative modelling approach built on top of a CAD modeller, Computer-Aided Design and Applications, vol. 13(6), pp. 737-746, 2016.
Lupinetti K., Giannini F., Monti M., Pernot J-P., Content-based multi-criteria similarity assessment of CAD assembly models, Computers in Industry, vol. 112, 113111, pp. 1-20, 2019.
Li Z., Giannini F., Pernot J-P., Véron P., Falcidieno B., Reusing heterogeneous data for the conceptual design of shapes in Virtual Environments, Virtual Reality, Springer, vol. 21(3), pp. 127-144, 2017.