PhD Position in Computer Science
Optimization of 3D reconstruction using images

Abstract

3D reconstruction is a technique that involves creating a representation of a 3D model. It is one of the most important techniques in computer graphics. It is used by many industries such as modelling virtual humans for video games, special effects for cinema, industrial drawing, virtual reality, etc. The work of this thesis aims to develop a tool for creating a 3D model from a 2D image. This image is composed of two-dimensional curves lying on a plane; these curves represent the silhouette of the model to be reconstructed.

Despite the existence of numerous research works, 3D reconstruction remains a difficult task; the difficulty comes from the fact that much of the information to build the 3D model is not present in the 2D image. In particular, we can identify the following two problems:

- **Calculation of the hidden parts of the model to be reconstructed:** only the visible parts of the model shape are available on the images. This implies that a large part of the model's silhouette is not available; one stage of the thesis will be to propose a solution to reconstruct these data which are absent from the images.
- **Calculation of 3D coordinates from 2D image data:** the second major challenge concerns the reconstruction of the 3D surface of the model from the 2D silhouette on the image. This problem is under-determined, that is to say, there are an infinite number of 3D surfaces whose silhouette corresponds to the same image.

Two approaches will be explored for 3D reconstruction. The first will consist in formulating the 3D reconstruction as an optimization problem with constraints. The objective function will be defined so as to optimize certain criteria such as the compactness, symmetry or orthogonality of the 3D model. The constraints will make it possible to impose that the silhouette of the 3D model corresponds to the curves of the image. The main difficulty will lie in the dimensionality of the problem will be very important. An important part of the work will consist in developing optimization methods, based on hybrid metaheuristics, capable of solving this non-linear problem of great dimensionality.

The second approach will be to develop techniques based on deep learning to calculate the possible shape of the hidden part of the silhouette on the image and to estimate the 3D coordinates of the model from its silhouette. 3D reconstruction works using deep learning have already been proposed for facial reconstruction [1] or reconstruction from several images [2]. In relation to this work, the objective will be to develop approaches that work on a larger range of shapes and using a single image.

References

[1] Xiaoguang Han, Chang Gao, Yizhou Yu: DeepSketch2Face: a deep learning-based sketching system for 3D face and caricature modeling. ACM Trans. Graph. 36(4): 126:1-126:12 (2017)
[2] Zhaoliang Lun, Matheus Gadelha, Evangelos Kalogerakis, Subhransu Maji, Rui Wang: 3D Shape Reconstruction from Sketches via Multi-view Convolutional Networks. 3DV 2017: 67-77

Requirements

- Master degree in Computer Science or Applied Mathematics.
- Good knowledge of metaheuristics and learning techniques.
- Working knowledge of programming in Python/C++.
- Good command of English.

Hosting institute and work place: IRIMAS laboratory (https://www.irimas.uha.fr/), University of Haute-Alsace, Haut-Rhin, France

Staring date: September/October 2020.

How to apply : Send your CV with transcriptions of your academic records (undergraduate and master courses) and one or more recommendation letters to this email address: application.for.thesis.uha@gmail.com.