Master internship

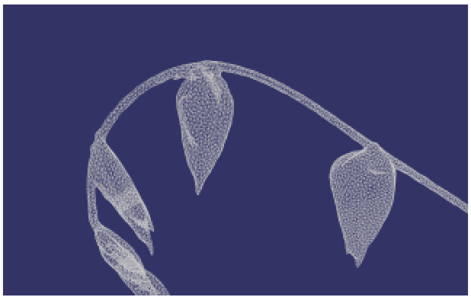
Skeleton and feature computation for plant growth tracking

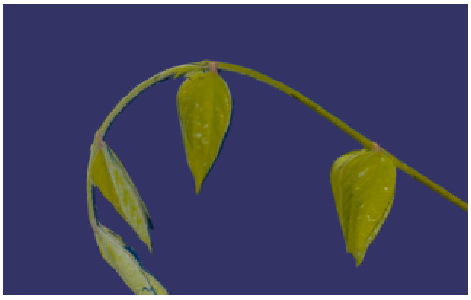
Host team: IGG team (Computer Graphics and Geometry) at **ICube** lab, Strasbourg

Advisors: Franck Hétroy-Wheeler (hetroywheeler@unistra.fr), Julien Pansiot (Inria Grenoble, julien.pansiot@inria.fr).

Context

Together with biophysicists and computer vision experts, we aim at constructing a virtual space-time 3D model of a growing plant and using this model to give accurate measurements about the plant motion. Of particular interest is the *Averrhoa Carambola*, which possesses a nutation motion of unknown origin. Targeted measurements include this nutation motion, as well as the growth along the spine of a leaf.





So far we have been able to create independent mesh models at each time step (see the images above) based on multiple video capture. In order to recover the motion of the plant, leaves should then be tracked over time. Since we focus on the motion of the leaf spine, we propose the following approach: first, compute a 3D *skeleton* [1] inside the leaf spine at each time step, detect and match *features*, and finally bind these features to the skeleton to track it through time. Features can be 2D (in the original images) or 3D (on the mesh model) and should ideally combine geometric and appearance information. We have already started working on these three steps with the help of previous interns. Unfortunately, major problems still remain:

- the skeleton computation algorithm needs to be refined since the computed skeleton is not accurate enough around leaflets;
- SIFT features as well as other 2D features based on appearance only are not reliable for our purpose;
- the binding between features and the skeleton is still to be done carefully.

Objectives

Building on the work of the previous interns, the Master student will perform the following tasks:

- Refine the skeleton computation algorithm, for example by automatically segmenting the leaflets from the mesh [2];
- Investigate feature computation and matching to make them reliable in our context. Features based on geometric [3,4] and appearance [5] information should both be considered;
- Design a robust binding algorithm between these features and the skeleton;
- Use the approach to accurately measure not only the growth along the leaf spine, but also the nutation motion.

Keywords

Shape tracking, geometric computation, skeleton, feature.

Student profile

- Master student – preferably in Computer Science or Applied Mathematics.
- Creative and highly motivated.
- Solid programming skills; the project involves programming in Python and using Matlab.
- Solid mathematics knowledge, especially in linear algebra and discrete geometry.
- Prior courses or knowledge in the areas of computer vision, mesh processing, computational geometry is a plus.
- Fluent English or French spoken.

Duration: Up to 6 months.

Start date: From January 2018.

Bibliography

[1] G. Aujay, F. Hétroy, F. Lazarus, C. Depraz. Harmonic skeleton for realistic character animation. *ACM SIGGRAPH/Eurographics Symposium on Computer Animation (SCA)*, 2007.

[2] A. Shamir. A survey on mesh segmentation techniques. *Computer Graphics Forum* 27(6), 2008.

[3] A. Bronstein, M. Bronstein, M. Ovsjanikov. Feature-based methods in 3D shape analysis. In *3D Imaging, Analysis and Applications*, 2012.

[4] Y. Guo, M. Bennamoun, F. Sohel, M. Lu, J. Wan. 3D object recognition in cluttered scenes with local surface features: a survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence* 36(11) , 2014.

[5] X. Li,W. Hu, C. Shen, Z. Zhang, A. Dick, A. van den Hengel. A survey of appearance models in visual object tracking. *ACM Transactions on Intelligent Systems and Technology*, 2013.