Algorithms for 3D Printing and Other Manufacturing Processes

Final project

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Spring 2017

Guidelines

- Keep it small!
- More important than the size:

The project needs to be thorough and sound

- Must have a software component
- The software needs to be robust and testable
- The final report shall be succinct and include a review of existing solutions or similar tools

Important dates

All submissions are to Efi Fogel as with the standard assignments

- June 23rd, 2017: submission of the project plan (one page)
- July 31st, 2017: submission of a progress report (one page)
- August 31st, 2017: submission of the final project, including
  - A report summarizing the project, up to five pages, starting with an abstract; in English or Hebrew as you prefer
  - The software that has been developed, well documented and with clear operating instructions
  - 3D printed parts you can leave on the table near the Ultimaker, in a designated tray, with your name attached to the object (attach photos of the objects to your report)
  - If you prefer to hand in the project in person, write to Danny before August 31st to Schedule a meeting

Suggestd projects

Interference Diagram for multi-step translations in the plane

- Devise an interactive graphic program to answer the partition problem for query multi-step-translations paths for polygonal parts in the plane. Analyze the complexity of each step.

Remarks:

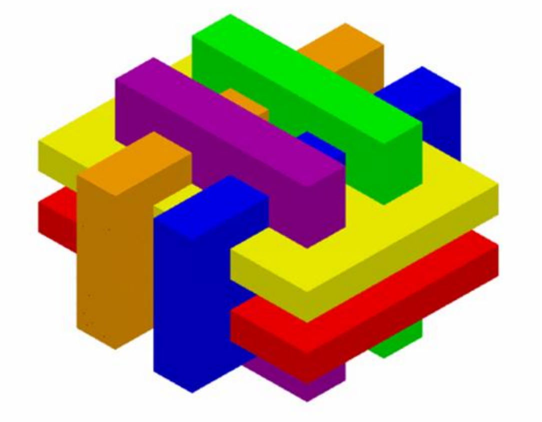
- The ID is given almost for free with CGAL (Minkowski sums + arrangements of segments)
- Challenge 1: construct an efficient version of the ID (not all details in a Minkowski sum may be necessary)
- Challenge 2: allow for tight passages in the partition paths

Strong-connectivity tests with look-ahead

- Recall: One can use the knowledge about the sequence of insertions and deletions of edges in all the DBGs together to improve the amortized running time of a strong-connectivity test to $O(n^{1.376})$ [Khanna-Motwani-Wilson ‘98]
- Implement a variant of efficient amortized multi-strong-connectivity tests and apply it to M-space of single translations of polygonal parts in the plane
- Show experimentally how much you gain by comparing the naïve strong-connectivity tests vs. this amortized variant

(Model,) adapt and 3D-print a 3D puzzle

- Take a model of a 3D puzzle. Write a program that insets the model parts so that one can assemble and then solve the puzzle. 3D print the puzzle to demonstrate the adequacy of your approach



Remark

- It may be challenging to decide what exactly is the needed insetting, and to choose a meaningful procedure that would also be reasonable to implement

From GearGenerator to 3D mechanism

- Design a scaffold for simple spur-gear-mechanisms. Take the output of GearGenerator and translate it into a printable full-fledged mechanism. 3D-print a couple of examples.

Remarks

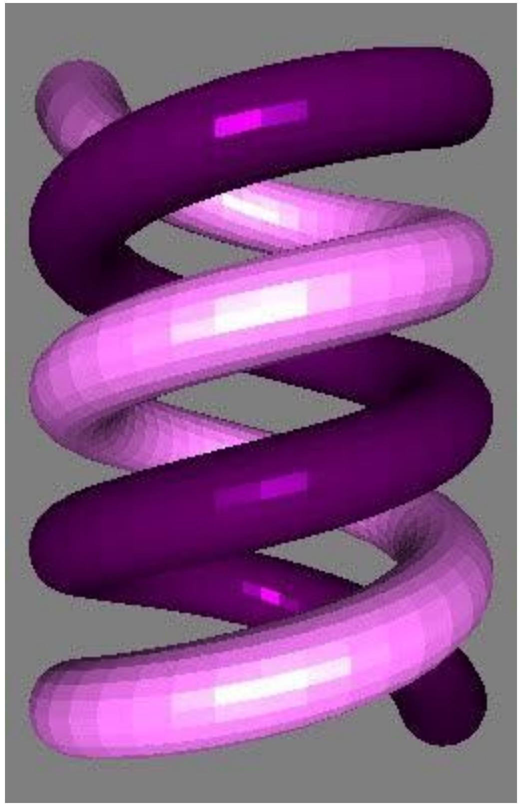
- In full generality this could be a huge task. You may restrict yourself to a small subset of simple mechanisms, which you will specify.

Reflecting Gaussian maps (CGAL)

- The objective is to develop code that accepts the Gaussian map of a polyhedron P and produces the Gaussian map of -P
- The Gaussian maps are represented by CGAL 2D Arrangements
- In particular, the students are asked to develop two functions:
  - 1.1. A function that accepts a 2D arrangement and produces a reflection of the 2D arrangement. The function must work on arrangement on surfaces.
  - 1.2. A function that accepts a Gaussian map of a polyhedron P. It uses the function above. In addition it has to update the primal points associated with arrangement faces and primal normals (or planes) associated with arrangement vertices.
- The task includes other CGAL requirements (details will be supplied by Efi Fogel)

Model fixing

- Issues that came up with models in the plaster printing project
- Project 1: Repairing a model that has holes
- Project 2: Repairing a model that has degenerate walls



Projects suggested by students

- Castability of 3D models
- Nesting 2D parts using genetic algorithms
- 2D part orienting
- Planning attachable base for given models

Bio-3D-printing, Prof. Sachi-Fainaro’s Lab

- Complement model, support model
- Generating models of blood vessels
- In situ quality control via slice images
- Identifying cancer cells in detailed maps

THE END

[Gaither, ArtByAI, CGAL arrgs]