GPU-programming for fast Collision Detection and application to Soft Robotics

Context:
The DEFROST team at Inria is specialised in simulation of soft robots for design and control. Soft robots are traditionally made of silicone, but the team is investigating the use of 3D-printed meso-structure materials to construct new soft robots. In particular, the team is using the software IceSL (icesl.loria.fr) to print meso-structure in the shape of stochastic foams (such as described in https://hal.inria.fr/hal-01697103/document). Simulating the behaviour of materials with such intricate geometry represents a challenge, not only because it is hard to create a mesh matching the geometry of the inner-structure, but also, if we want to consider self-collisions, which are collision of the material on itself, typically when it is under compression. In this context, the detection of the self-collisions are very important since they influence the deformation of the material dramatically. However, with such complex geometry, a very high number of collisions may arise and this will not be tractable in real-time.

Illustration 1: Example of 3D-printed meso-structure using a stochastic foam

Short Work Description:
The DEFROST team is developing its simulation tools in the open source framework SOFA (https://www.sofa-framework.org). The work will consist in updating the current implementation of collision detection in SOFA onto the GPU. An old implementation will be available to get inspired by.

Skills:
- Programming: Familiarity with C++, Python, and CUDA/OpenCL
- Some knowledge about Numerical Simulation and the Finite Element method is a plus.

Contact:
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Expected start date: around March 2020.