A Simulator for Origami-Inspired Self-Reconfigurable Robots

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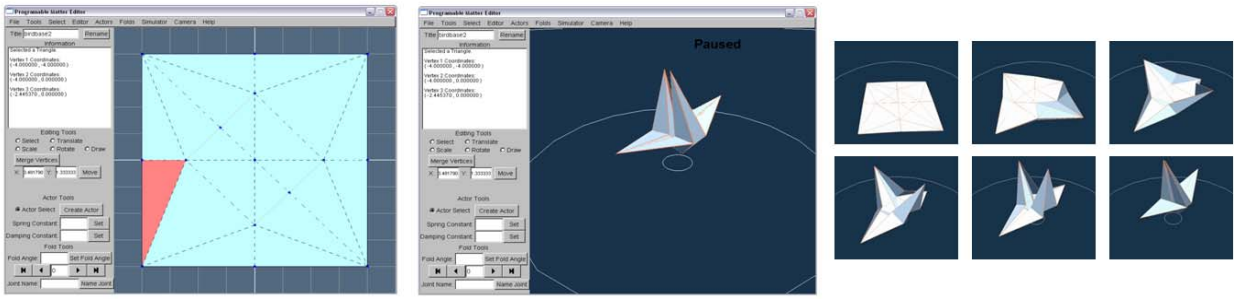
A\V requirements: Standard projector

Abstract:
The aim of folding programmable matter is to create smart, self-folding paper which can reconfigure into multiple desired forms. To facilitate the design and testing of programmable matter structures, it was decided to create an application, designated the Programmable Matter Editor (PME), for drawing and simulating rigid origami.

The mechanical nature of folding programmable matter imposes additional requirements on the simulator. The structures are comprised of flat, rigid sheets of non-negligible thickness, connected by revolute joints. A variety of actuators may be involved in the folding motion. The physical properties of the sheets and the actuators must also be taken into consideration. Accordingly, the Huzita axioms or geometric constraints are insufficient for this modeling. In contrast to kinematic origami simulators, the Programmable Matter Editor utilizes the nVidia PhysX package to create a real-time dynamic simulation of the folding procedure.

Two XML schemas are used to represent the necessary information to create a folding programmable matter object. One contains the physical parameters and crease pattern of the structure while the other contains the folding sequence. The separation of physical structure from folding further reinforces the notion of reconfigurability. The editor is used to draw (or import) a crease pattern. For a given crease pattern, the user defines sequences of folds and the physical actuator properties which guide those folds. The program can then be used to visualize the folding in real-time.



From left to right: (1) the Programmable Matter interface for creating crease patterns and fold sequences; (2) physical simulation in progress; (3) snapshots from the simulation.