Modeling Origami and Beyond

Tetsuo Ida

We discuss some aspects of the computational origami as a new kind of science of shapes. The computational origami is closely linked to traditional art, industrial art, geometry of all levels, and furthermore computer science. In this talk we present models of origami for computer assisted construction of and reasoning about origami.

The origami construction is a sequence of fold steps, each consisting in folding an origami paper along a line. We formalize the origami construction. We first model an origami paper by a structure consisting of a set of faces and the relations of overlay and adjacency over the set of faces. We call the structure abstract origami. A fold line is determined by a specific fold method. We adopt Huzita's axiomatic definition of fold operations for our purpose. By the fold along the fold line, the abstract origami is transformed. Namely, some faces are divided and rotated, and new faces are created. The two relations over the faces change accordingly. The changes of the abstract origami are formalized as algebraic graph transformation. The construction induces two kinds of graphs. One is the origami graph derived from the structure of the set of faces and the adjacency relation, and the other is a (face) layer graph. The layer graph is derived from the quotient set of the faces and the overlay relations over the quotient set. The one step fold corresponds to one step graph rewriting of the two graphs.

We illustrate some origami examples as the application of our formalism. They exhibit non-trivial aspects of origami. The modeling is the abstraction of the core of the computational origami environment called Eos (E-origami system). We further discuss the directions of future research of computational origami along this line of formalization.