

Robotic Origami Folding

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Origami, the human art of paper sculpture, is a fresh challenge for the field of robotic manipulation, and provides a concrete example for many difficult and general robotic manipulation problems. This paper will describe the first origami-folding robot, a complete fold-sequence planner for a simple class of origami, and the kinematics of more complicated folds. The robot has folded a simplified paper hat, a paper cup, and a paper airplane, with fold-sequences that were automatically planned.

We do not argue that origami is a practical application of robotics. However, there are many compelling reasons to explore and better understand folding manipulation, and origami provides a useful starting point. Automated manufacturing with rigid bodies has been the driving application for the study of robotic manipulation; tasks include grasping, fixturing, pushing, sorting, and feeding. In real factories, manufacturing is not limited to rigid bodies – paper bags, fast-food containers, sheet-metal, and car airbags are motivating examples. Building products out of thin sheets may reduce material costs, and allow storage in small volumes.

Some of the problems discussed involve practical manipulation of origami. Humans use strategies to manipulate paper without the need for precise or complete sensing, and without the need for a complete model of paper behavior. Other problems involve representing the state of flexible or foldable materials. For the simplest classes of origami, a simple discrete representation of the direction of creases and the relative ordering of the facets is useful. More complicated origami requires a model of facet bending; we show, for example, that common paper shopping bags cannot be folded without bending or crumpling facets in locations where the paper is not pre-creased.

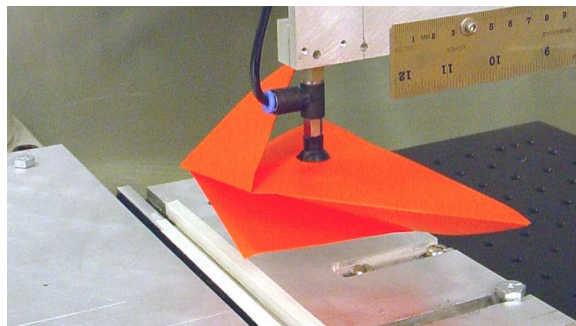


Figure 1: A simplified samurai hat being folded by a robot.