ETH

Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

CRL
Computational Robotics Lab

Semester Project or Master Thesis

Computational Design and Optimization of Rigidly Foldable Origami Structures

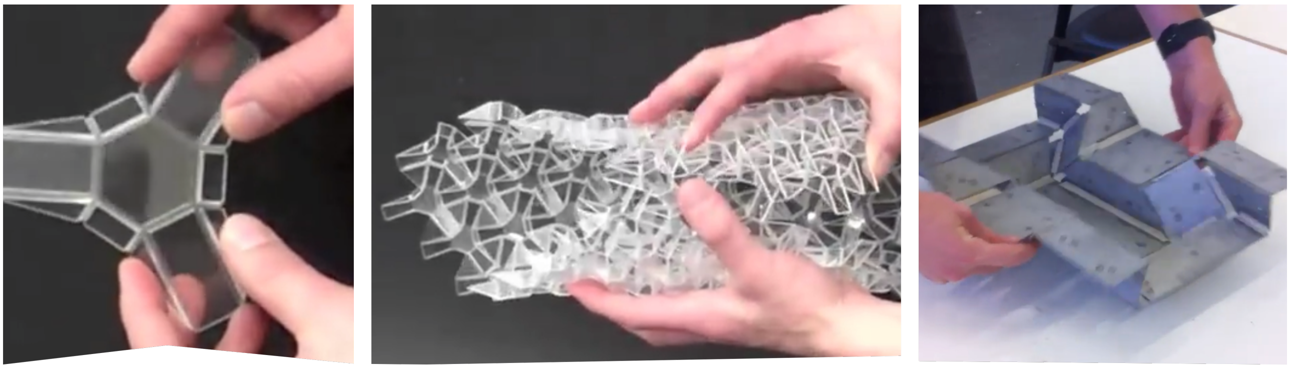

Figure 1: A rigidly foldable Origami unit (left) is used to build a complex articulated surface (middle). A sheet metal Origami design deploys into a 3D shape using a single degree of freedom for actuation (right).

Introduction

Origami, the ancient art of paper folding, has evolved into a contemporary field of research with applications ranging from engineering to material science. Rigidly foldable origami structures, in particular, have garnered significant attention due to their potential in designing deployable and adaptable structures in various fields. This project aims to take a computational approach to the analysis and design of rigidly foldable origami.

Objectives

1. **Computational Analysis of Existing Rigidly Foldable Origami Designs**
   - Review and analyze existing rigidly foldable origami designs in the literature.
   - Develop computational models to simulate the folding behavior of these structures. An existing simulation framework available at CRL can be adapted for this purpose.
   - Identify key parameters influencing foldability and structural stability.
2. **Adaptation of Crease Designs**
   - Investigate the impact of modifying crease patterns on the rigid foldability of origami structures.
   - Develop algorithms to iteratively adapt crease designs for improved performance.
   - Explore how changes in crease angles and lengths influence the folding process.
3. **Development of an Inverse Design Tool**
   - Design and implement an inverse design tool capable of determining optimal crease parameters for a given foldability criterion.
   - Utilize optimization-based techniques to automate the crease parameter determination process.
4. **Validation**

- Validate the computational models and the inverse design tool through physical prototyping and experimentation.
- Optimize the crease designs for specific applications such as deployable structures or packaging.

Methodology

The research will involve a combination of literature review, mathematical modeling, algorithm development, and simulation. The inverse design tool will be implemented using numerical optimization algorithms to automate the process of determining optimal crease parameters. Validation will be conducted through physical prototypes and comparison with existing experimental results.

Skills

- Experience in computer graphics and/or geometry processing
- Experience with numerical simulation and/or optimization
- Very good programming skills in C++

Remarks

This thesis is overseen by Prof. Dr. Stelian Coros and is supervised by Dr. Bernhard Thomaszewski.

Contact

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