Space Technology Research Grants

Fundamentals of 3D Deployable Mechanisms in Space

Completed Technology Project (2015 - 2019)

Project Introduction

Fundamentals of 3D Deployable Origami Structures in Space The primary objectives of my research are to study the application of 3D deployable origami structures in space. The study of origami has produced many innovative ideas and models that have direct application to the design of thick, deployable structures in space such as solar panels. However, the use of deployable structures faces several challenges that must be considered. Some of these challenges include designing structures that can provide the needed folding motion as well as dealing with vibration in flexible structures. Specifically, my work will focus on three major areas: 1.Creating Rigid Foldability 2.Surrogate Folds and Rigid Foldability 3.Vibration of Deployable Structures A useful characteristic of deployable structures is rigid foldability or the ability to fold without requiring any members to warp or stretch. This characteristic allows a folding structure to be manufactured out of inflexible materials such as steels or glasses as described by Homer et al. Other problems in the design of deployable structures include incorporating compliant surrogate folds into rigidly foldable structures and studying their vibration characteristics. Work in this area will help increase reliability, reduce part count and prevent premature failure. Zirbel et al studied the use of a flasher base in the design of a folding solar panel. Merriam describes the design of a compliant pointing mechanism based on spherical mechanisms which are found in origami. Fowler et al described a surrogate hinge suitable for space applications. Methods for designing rigidly foldable crease patterns will be developed to allow designers to manufacture these mechanisms from rigid components. Options such as adding creases/hinges to a design, removing panels and splitting hinges will be considered to create rigid foldability. Methods for designing rigidly foldable structures with surrogate hinges as well as techniques for controlling vibration will also be studied. Alterations to current models of rigid origami to account for crease behavior will be studied. Modifications that alter rigidity and damping characteristics will be investigated to control vibration. Research in deployable origami structures will contribute to achieving goals in the NASA Technology Roadmap. TA12.2 discusses expandable structures such as precision mirrors and solar/antenna arrays and can be benefited by work on these problems. Studying these structures can also benefit precision structure deploy mechanisms discussed in TA12.3.

Anticipated Benefits

Research in deployable origami structures will contribute to achieving goals in the NASA Technology Roadmap. TA12.2 discusses expandable structures such as precision mirrors and solar/antenna arrays and can be benefited by work on these problems. Studying these structures can also benefit precision structure deploy mechanisms discussed in TA12.3.

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Primary U.S. Work Locations and Key Partners

Organizations Performing Work	Role	Type	Location
Brigham Young University	Lead Organization	Academia	Provo, Utah

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Brigham Young University

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

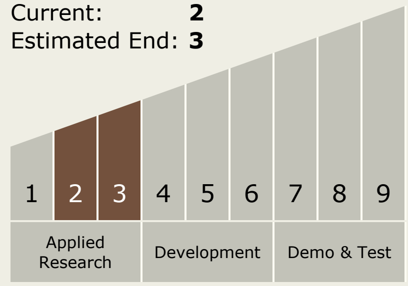
Larry Howell

Co-Investigator:

Alden Yellowhorse

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX12 Materials, Structures, Mechanical Systems, and Manufacturing
  └ TX12.3 Mechanical Systems
    └ TX12.3.1 Deployables, Docking, and Interfaces

Target Destination

Foundational Knowledge