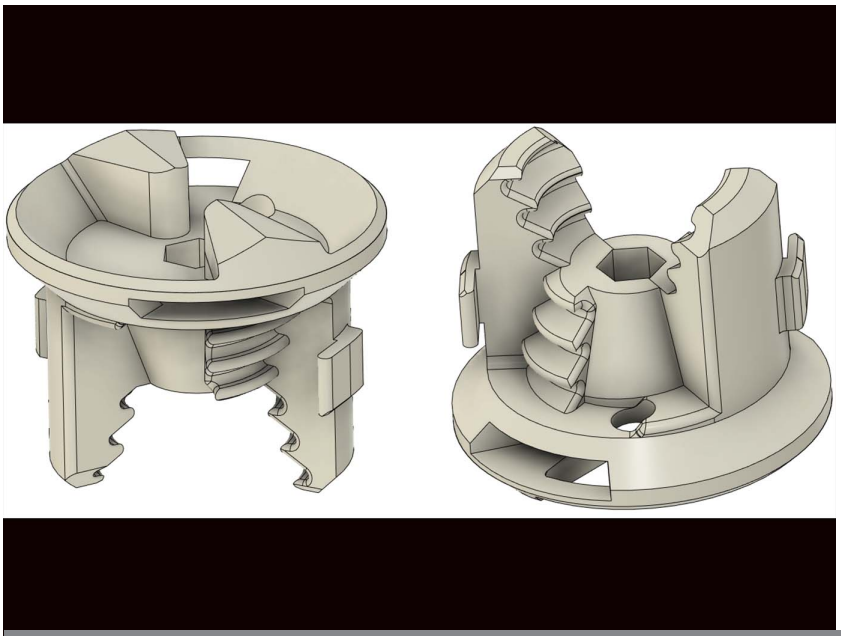


National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Robotics, Automation and Control

Reversible Androgynous Mechanical Fastener

Androgynous Fasteners for Robotic Structural Assembly

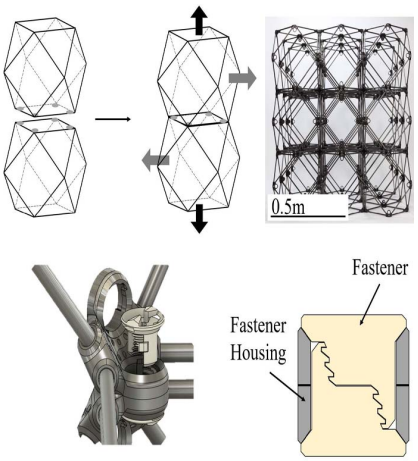
Researchers at NASA Ames Research Center have developed an androgynous fastener with high misalignment tolerance characteristics, which is suitable for robotic actuation. This fastener was developed in conjunction with a high-performance building-block structural system that can be robotically assembled by robust collective automated assembly into large, reconfigurable structures ranging from assembly of lunar habitats to terrestrial structures. The fastener mechanisms employ alignment principles similar to the International Berthing and Docking Mechanism (IBDM) in order to relax the positioning requirements of the assembly robots. This novel androgynous fastener provides the desired performance required for robotic assembly of the structural systems and also minimizes or eliminates the problems and disadvantages associated with conventional or traditional fasteners.

BENEFITS

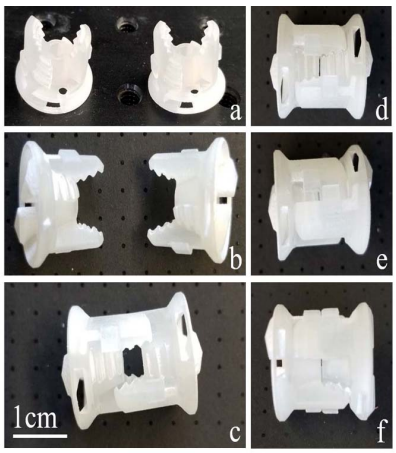
- Enables robotic assembly: The androgynous fastener's ease of actuation (i.e., low activation force, high holding strength) and high robotic end effector engagement tolerances allow for robotic assembly by small, mobile robots
- High strength and stiffness: NASA's lightweight fasteners enable the assembly of high strength-to-mass structures for use-cases ranging from assembly of lunar habitats to terrestrial structures
- Reversibility: A reversible mechanical connection enables fastener re-use and easy reconfigurability for modular structures leveraging the fastener
- Scalability: Can be manufactured at a broad range of sizes, meaning it can be utilized for coupling modular structural components at any scale

THE TECHNOLOGY

The androgynous fastener is lightweight and facilitates assembly through simple actuation with large driver-positioning tolerance requirements. This fastener provides a high-strength, reversible mechanical connection and may be used in high strength-to-weight ratio structural systems, such as lattice structure systems. The androgynous fastener resists tensile and shear forces upon loading of the lattice structure system thereby ensuring that the struts of the lattice structure system govern the mechanical behavior of the system. The androgynous fastener eliminates building-block orientation requirements and allows assembly in all orthogonal build directions. This androgynous fastener may be captive in building-block structural elements thereby minimizing the logistical complexity of transporting additional fasteners. Integration of a plurality of the androgynous fasteners into a high performance, robotically managed, structural system reduces launch energy requirements, enables higher mission adaptivity and decreases system life-cycle costs. The androgynous fastener is beneficial in any application where robotic end effectors are used to join structural components (or other parts) together. It may be particularly desirable for applications requiring frequent movement of hardware to an assembly site to replace joint connections.



Visualization of the lattice structure and method of joining



Fastener engagement: shown here are 3D printed prototypes, but the final design can be injection molded or machined

APPLICATIONS

The technology has several potential applications:

- Autonomous robotic assembly industries
- Fastener manufacturing
- On-orbit robotic fastening of modular structural components (e.g., aerospace structures, space structures, consumer products, etc.)
- Modular reconfigurable robotics industries

PUBLICATIONS

Patent Pending

https://ntrs.nasa.gov/citations/20200001891

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