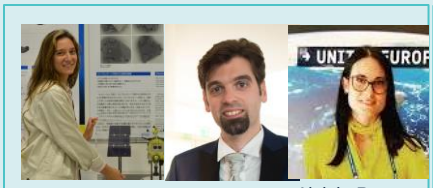
connected everything.

Manufacturing of 3D-printed morphing origami solar sails for the next generation of CubeSats

Project Team:

University of Liverpool



Stefania Soldini (Space Mission Analyst)

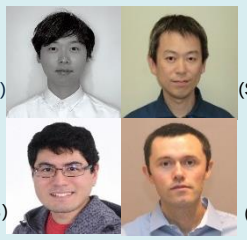
Paolo Paoletti (Robotics & AM)

Aloisia Russo, (Leading Researcher)

Oxford Space Systems

Juan Reveles (Deployable Structures)

Japan Aerospace Exploration Agency



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The project team and timeframe

The feasibility study team comprised of Dr Stefania Soldini (Principal), Dr Paolo Paoletti (Co) Investigators and Ms Aloisia Russo (Researcher) from the University of Liverpool, working in partnership with Dr Juan Reveles (Origami Deployable Structures) from Oxford Space Systems, in Oxford, and Dr Stephane Bonardi (Robotics), Dr Naoya Ozaki (CubeSat Design), Dr Ahmed Sugihara (Solar Sails) and Prof Osamu Mori (Solar Sails) from the Japan Aerospace Exploration Agency (JAXA) in Japan. The project started in October 2020 and was completed by April 2021. To learn more, watch the YouTube video project overview at the following link or via QR code.

https://www.youtube.com/watch?v=U5IhFIxZxZI

What does the project demonstrate?

The project explored Additive Manufacturing (AM) techniques to prototype a new morphing origami solar sail mechanism for next generation of self-reconfigurable CubeSats. A solar sail is an origami thin, lightweight highly reflective membrane capable of harnessing the effect of the Sun radiation pressure. It enables fuel-free propulsion by reflecting the intensity of the sunlight. This project demonstrated the feasibility of a new generation of origami solar sail's membranes that make use of 3D printable polymers and 4D shape memory polymers on a high reflectivity material to enable reconfigurability. The sail is deployed in space by harnessing the Solar Radiation Pressure through Polymer Liquid Crystal Devices, which are capable of changing local reflectivity and therefore create a torque for the autonomous deployment.

Origami Self-Reconfigurable CubeSats

Currently, spacecraft deployable structures (i.e. solar arrays, antennas, etc.) are deployed in-space utilizing origami-based designs. However, all such large devices are designed to maintain a fixed-shape once deployed and a single spacecraft usually mounts multiple structures for different purposes.
The project aimed to transforming the approach to space mission design from a single spacecraft towards a bio-inspired swarm of self-reconfigurable CubeSats that can coordinate and adapt to different situations like "ant colonies".

UKRI Engineering and Physical Sciences Research Council

Next Generation of Solar Sails

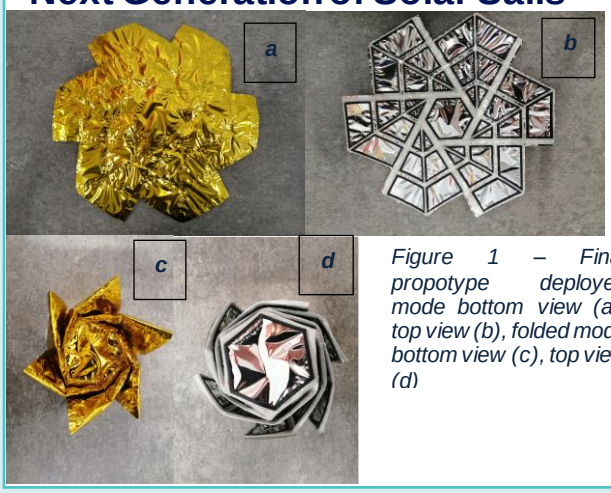

Figure 1 – Final propotype deployed mode bottom view (a), top view (b), folded mode bottom view (c), top view (d)