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Continuum Robot Incorporating Bistability - ASAN

What?

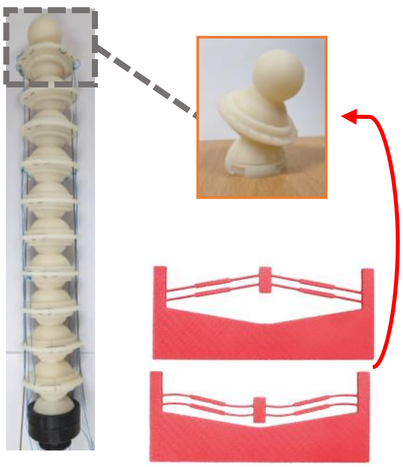
- Design and fabricate a continuum robot for cavity-based non-invasive surgery.
- Research novel concepts to improve characteristics of ball-joint based continuum robot design or to add useful features.

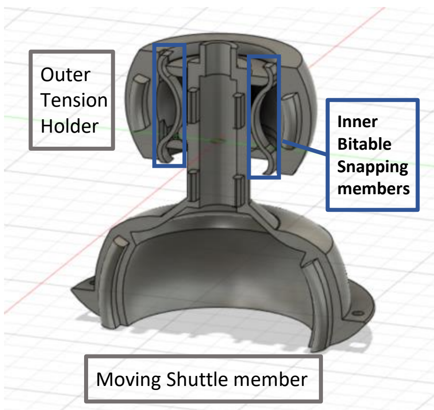
How?

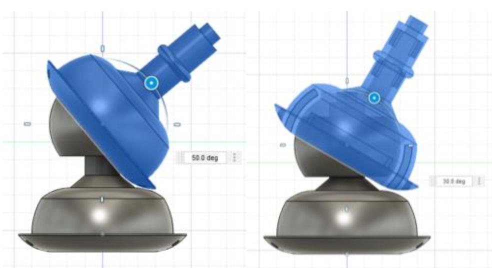
- Did a review of the concept of **Bi-stability** to see whether a bistable mechanism can be incorporated into the design.
- Used **Fusion 360** and **3D Printing** to iteratively design and make a working prototype.

Results?

- A Bistable-snapping mechanism was incorporated, using which an extension length of 7-8mm was achieved. (Adjustable based on design characteristics)
- Design variations were made and different versions were prototyped. These either incorporated locking or increased the ROM from 25° to 40° (per segment).







Mapping Catheter Extensions Holder - ASAN

What?

- Design and fabricate a housing for changes and extensions made to an endoscopic mapping catheter.
- The housing must attach to the Holder, have sufficient space for the sensor boards and must be easily openable to troubleshoot issues.

How?

- Used **Fusion 360** and **3D Printing** to design and make the Holder while incorporating feedback over the course of the design process.
- Reviewed literature on how to incorporate snap-fit joints into plastic-based designs

Results?

- A housing was designed which attached to the base of the catheter and which had adequate space for both sensor boards (including all the wires coming off from them)
- A **print-in-place hinge** and a **cantilever snap-fit joint** were incorporated into the design for easier handling of the Holder.

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Origami-based Support Device - KAIST

What?

- Design a light-weight compact wearable Upper limb support device utilizing origami to assist stroke patients in performing activities of daily living (ADL).
- The support device must provide assistance against gravity to hold the arm during abduction while still allowing it to horizontally flex or extend.

How?

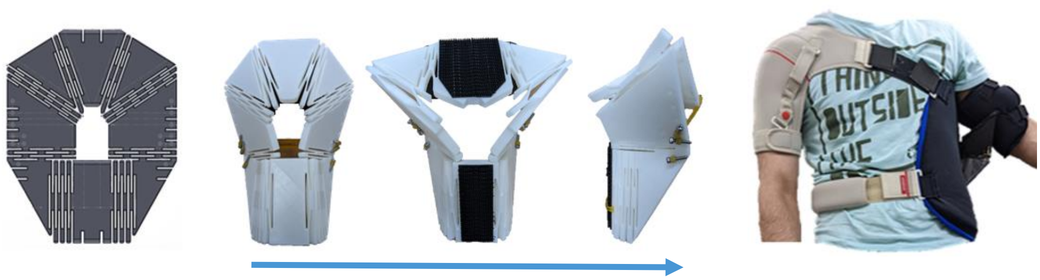
- By incorporating a **collapsible origami mechanism** (as a passive tension mechanism) with a wearable brace.
- After performing a literature review on origami patterns and their applications, a **novel origami pattern** (modified from a water bomb pattern) was developed.
- Using **Solidworks** and **3D printing** prototyping of the origami pattern was done in thick (non-paper material to test its characteristics.

Results?

- Manufactured a monolithic version of the aforementioned pattern utilizing torsional parallel **surrogate folds** with an inherent stiffness.
- Designed and manufactured an ergonomic wearable brace to allow for the mechanism to be easily and comfortably mounted on the patient's body.
- The device provides vertical support of 27N. It also achieves 55°/24° of horizontal abduction/adduction and 52° vertical abduction DOF (comparable to similar active devices).

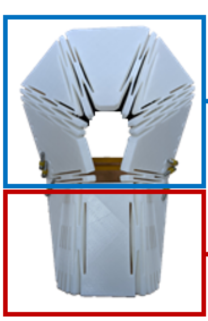
Wearable Brace

Origami Mechanism



Design Process

The device was able to **fulfil the criterion** of providing support against gravity.



Abduction Motion and Adjustability

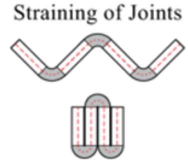
Horizontal Flexion and Extension Motion

Size	180x120x70mm
Weight	~0.5kg
Stiffness	0.137Nm/deg
Thickness	7 mm
Support Force	27.1N
Joints	8
Symmetry	Yes

Wearable

Compact

Straining of Joints



Simple Manufacturing

Session	Abduction (Degrees)	Horizontal Flexion (Degrees)	Horizontal Extension (Degrees)
Required for ADL [2]	108	105	65
Soft Shoulder Support [5]	55.1	56.7	28.3
Origami	51.7	55	23.5

ROM for 83% ADL

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Bio-inspired Hybrid Soft Actuator - NUST

What?

- Design, fabricate and experimentally validate a hybrid bending actuator inspired from the biological mechanism of crustaceans such as shrimp.
- The actuator must provide sufficient grip force to allow stroke patients who have lost the use of their hand to perform basic gripping tasks.

How?

- The design was modeled using **Solidworks** and composed of a soft inner tube and rigid outer shells which were pinned together over the tube.
- FEM analysis was done in **ABAQUS** (Simulai, Dassault Systems) was done to evaluate the range of motion and maximum pressure of the inner tube.
- Lastly the outer shells and pins were manufactured using **3D printing** and the inner hollow tube was molded using silicone.

Results?

- When actuated using pneumatic pressure, the biomimetic actuator was able to produce forces (which is within the required criteria of 8N for palm grasping) up to 11.5 N at 135 KPa.
- With regards to the actuator weight to Payload capacity ratio, our actuator has a given weight of 112g and the load it can lift under a maximum actuation force of 135kPa is 537g (5 times its own weight).
- The actuator was utilized as a supernumerary **sixth finger for rehabilitation** and as robotic grippers (as shown below).