Department of Mechanical Engineering
THE UNIVERSITY OF UTAH

Self-Clasping Hoist Clamp

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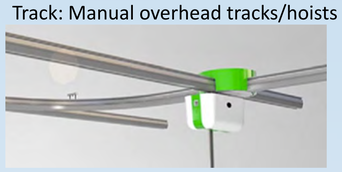
Project Description:

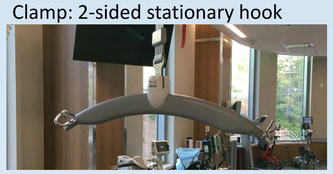
Existing systems to transfer quadriplegic, paraplegic, and tetraplegic patients are cumbersome and require a lot of manpower. Patients do not have independence of movement from bed to chair.

Current Systems:

Track: Manual overhead tracks/hoists



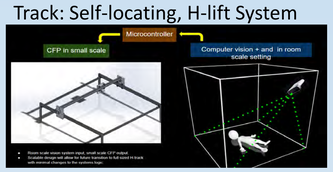
Clamp: 2-sided stationary hook



Harness: 8-loop sling harness

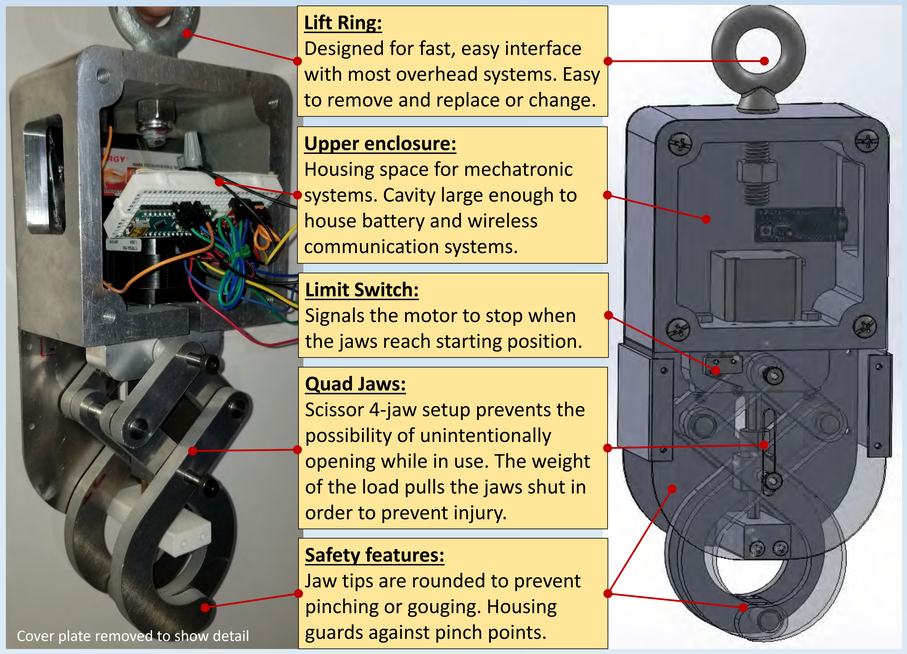
Revised System:

Track: Self-locating, H-lift System



Clamp: Self-Clasping Hoist Clamp

Harness: Single-loop lift garment



Lift Ring:
Designed for fast, easy interface with most overhead systems. Easy to remove and replace or change.

Upper enclosure:
Housing space for mechatronic systems. Cavity large enough to house battery and wireless communication systems.

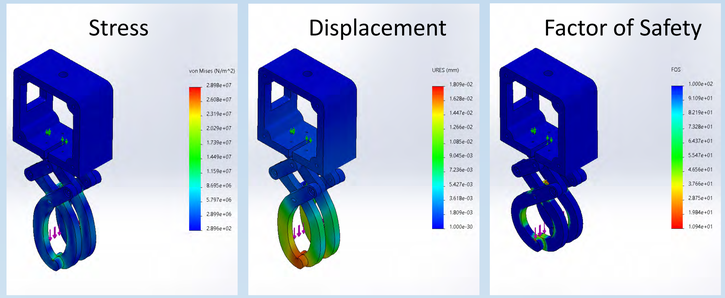
Limit Switch:
Signals the motor to stop when the jaws reach starting position.

Quad Jaws:
Scissor 4-jaw setup prevents the possibility of unintentionally opening while in use. The weight of the load pulls the jaws shut in order to prevent injury.

Safety features:
Jaw tips are rounded to prevent pinching or gouging. Housing guards against pinch points.

Strength Modeling (FEA):

Modeled with 120 kg load under different jaws connection.



Results Summary:

Max Stress:

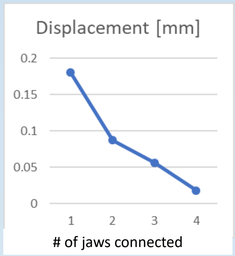
28.9 MPa

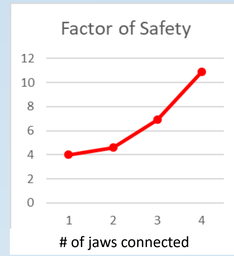
Max displacement:

0.018 mm

Factor of Safety:

10.94





Functionality Test:

Clamp tested at rotation angles representing patient position to test connection to loop

Summary:

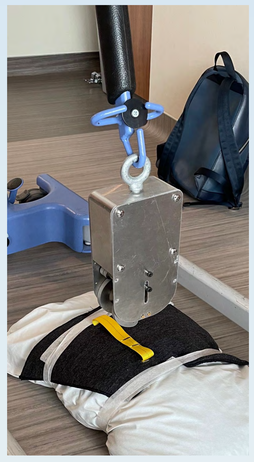
Only one full (4 jaw) connection

All others connected 2 jaws minimum

FEA test indicates 2 jaws still safely support full load

		Horizontal Rotation			
		0	15	30	45
Vertical Rotation	0	C	P	P	P
	15	P	P	P	P
	30	P	P	P	P
	45	P	P	P	P

C = Complete Connection - all claws attached
P = Partial Connection - Only 2-3 claws attached

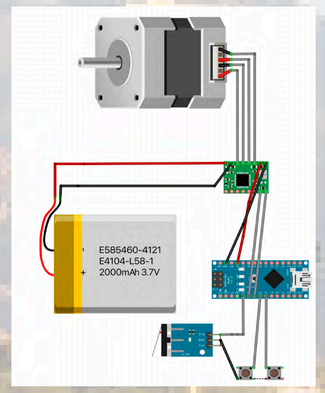


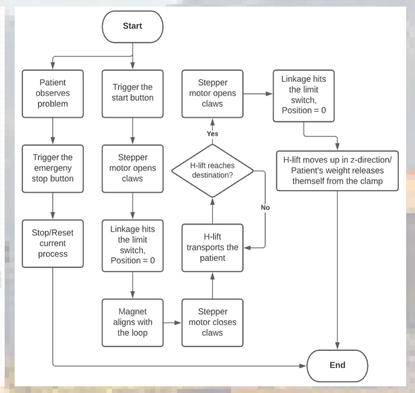
Project Synergy:

Solving the problem of independence of movement requires three projects working in harmony. The clamp must actively connect the Smart Lift System and the Lift Clothing.

- **Self-Clasping Hoist Clamp**
  employs a magnet to actively lift the clothing loop into position for the jaws to close. Command from the user will close the jaws. The top of the clamp is fitted with a lift ring to engage standard crane hardware.
- **H-lift system**
  self-locates directly over the user with voice command using computer optics.
- **Lift Clothing**
  comfortably and safely supports the user from a single attachment point in the center of the chest.

Mechatronics:





Conclusions / Path Forward:

We were mostly successful in designing a device which can connect the Smart Lift system and the lift clothing reliably and repeatably hands-free.

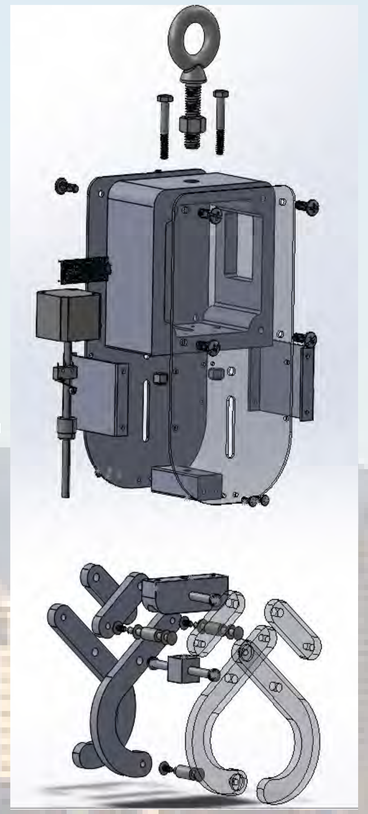
Functional testing shows we can make full (4-jaw) connection when oriented in the optimum position of 0° angle and incline, and a partial (2-3 jaw) connection up to 45°

FEA shows it can reliably carry 10 times the required load of 120 kg (264 lbs.) with a complete 4-jaw connection. And 4 times the load with only a single jaw

The control system requires further refining in order to be hands-free. The current system requires a push button to activate the device, and an emergency stop button in case of error.

While this design performs the prescribed function, we recommend the following updates:

- The control system be updated to be operated by sip and puff, or by voice.
- The jaw tip geometry be refined for a complete connection from larger angles.
- Overall design be made more compact and aesthetically pleasing.



Hysteresis Tensile Test:

Per ISO 10535-2006: Target load 120 kg (264 lbs)

Test at 150% of load for 20 minutes

No sign of failure or yielding