EML 4501| Spring 2020 | Group 21
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Patient Assisting Lift System

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Product Overview

PALS utilizes a fully computer-controlled pneumatic weight management system. A pneumatic linear actuator in a closed-loop feedback system driven by a force sensor maintains a constant force offset on the patient. With the actuator running at 150 psi, more than 700 lbs of lift can be applied while being able to cycle approximately 6 inches every second. An electric winch is used to lift the patient from his or her wheelchair while also acting as a safety feature should the patient fall. The force generated by the linear actuator is imparted to the patient using an overhead nylon lift strap attached to a carbon fiber sling bar with two attachment points whereby the harness for the patient is secured. The nylon harness is adaptable to patients with a waist range between 81.0 and 122.0 cm, and provides support about the torso, underarms, and shoulders of the patient for increased stability and comfort. All these systems are neatly contained in a mobile frame system light enough to be moved by a single physical trainer. The system presented, therefore, is a significant contribution in the improvement of functional electrical stimulation (FES) patient rehabilitation.

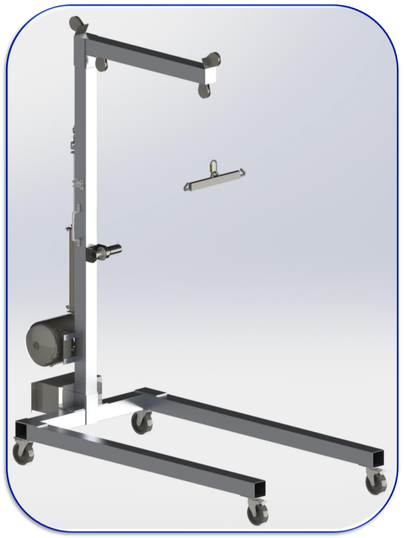
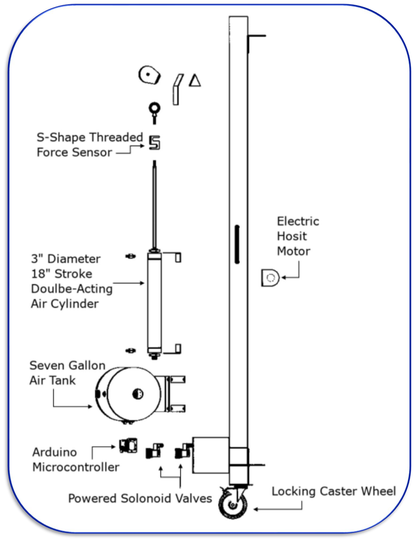


Photo-Quality Rendering of Frame and Pneumatic System

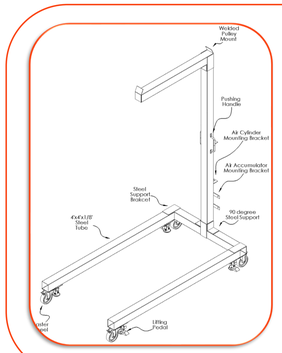


Exploded Diagram of Pneumatic Lift Components

Product Narrative

PALS utilizes a pneumatic lifting system connected to a steel lifting cable to control the user's position. The user places themselves below the harness and is strapped in. They are then lifted into position via electric winch. Once the user is in place, the frame is moved into position and the pneumatics take over. The machine is operated by a handheld controller to allow the user to set the desired weight offset. Information from a force sensor is continuously being processed and relayed to the pneumatic system in a closed loop.

Frame Subsystem



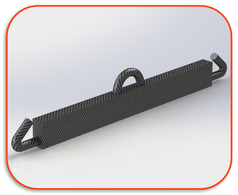
Line drawing of frame subsystem

- Constructed from 4x4'' and 1/8" thick steel tubing
- 4" Caster wheels and pedal brakes allow for mobility as well as stability
- Welded brackets reinforce areas of high stress
- Fits through standard doors
- Push handles allow for easy maneuvering

Weight Management Subsystem

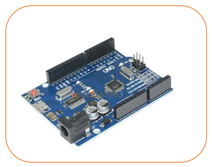
Pneumatic Reservoir and Actuating Cylinder

- Steel lifting cable used to support weight of user
- Hollow aluminum sling bar attaches to harness
- Pneumatic actuator allows for precise control of user's positioning



Hollow Aluminum Sling Bar

Controls Subsystem



Arduino UNO Microcontroller

Six Pushbutton Controller

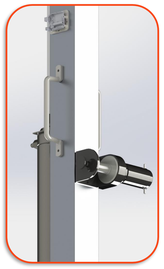
- Implemented using an Arduino Uno board, powered with a 12V AC-to-DC wall adapter with a Bluetooth module to allow for wireless connection to a computer for parsing force and pressure data to a control environment such as LabVIEW to maintain Pneumatic Pressure through closed loop proportional control.
- A proportional control valve solenoid is connected to both to the pneumatic actuator and to the Arduino board to control the weight offset.
- A hand-held button controller connected to the Arduino with a receiver module and decoding output module would act as the user interface

Cost Overview

Total Cost of PALS - $3179.85*

Frame - $1079.41 Harness - $100.16 Weight Mgmt. - $1511.71
Controls - $353.57 Safety - $135.00

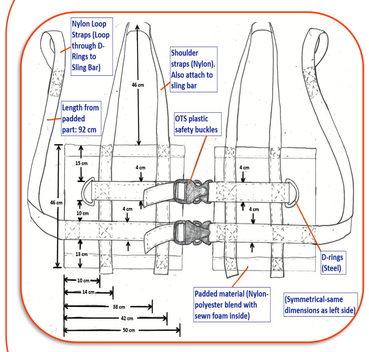
Safety Subsystem



Electric Hoisting Motor

- Hoist provides necessary tension to counter a free-fall scenario should the harness straps fail.
- Lifts patient from wheelchair, remains attached to harness during use.
- When handle is released after initial placement of the patient, an automatic break will hold the load.
- Max Working Load: 880 lbs.
- Factor of Safety: 2.35
- Total Cost: $135 (Off-The-Shelf)

Harness Subsystem

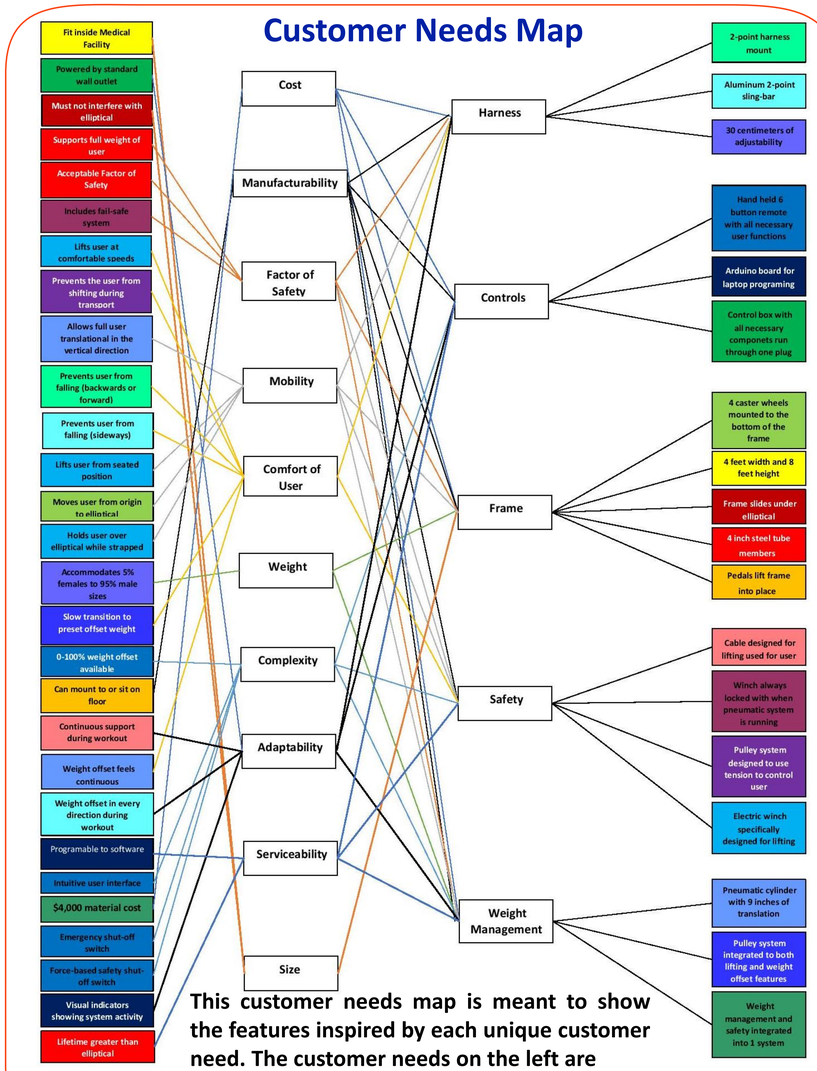


Technical Drawing of Harness

- Composed of nylon fabric with padded sewn foam inserts
- Nylon straps and safety buckles fit an individual with a torso size ranging 81.0 cm to 122.0 cm
- Looped straps wrap patient through the D-rings and attach to the patient support bar above
- Round aluminum stock welded to sling bar where nylon straps secured

* - The reported cost values for each subsystem includes OTS parts, raw materials, manufacturing and MFG labor, energy consumption, and assembly labor.

Customer Needs Map



This customer needs map is meant to show the features inspired by each unique customer need. The customer needs on the left are mapped to the metrics that were weighed for each subsystem. The metrics map to each subsystem and those are mapped to the unique features.

Thank You! The PALS team extends our greatest gratitude towards our sponsors Northrup Grumman & Cummins Inc., the Non-Linear Controls Group, and the MAE Design Faculty for helping us contribute to the improvement of FES patient rehabilitation.