DEPARTMENT OF MECHANICAL ENGINEERING

TEAM 38

Laundry Lifters

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Problem Definition

Problem: An increasing number of elderly people are facing difficulties with carrying heavy loads while navigating the stairs safely.

15% of the world's population lives with some form of a disability

33% of older adults (over the age of 65) fall every year and suffer some sort of injury

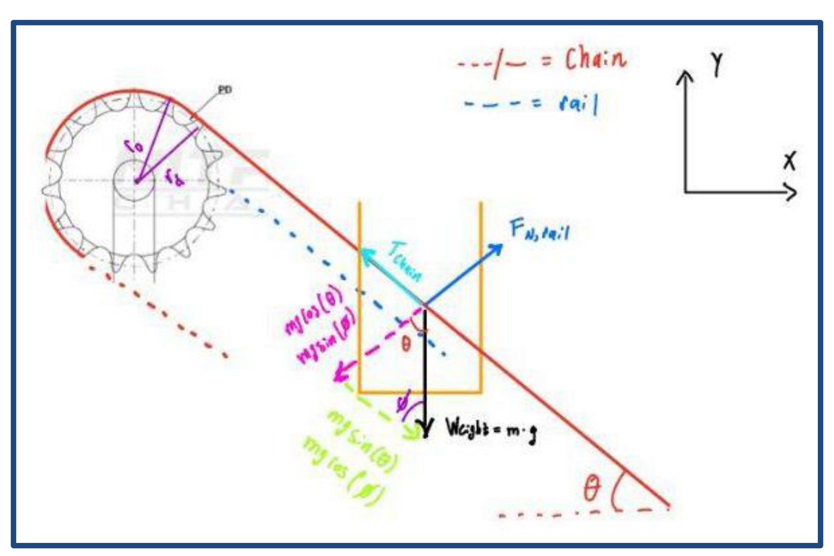
Stakeholder: James Seerey's grandmother, Ms. Seerey, who has limited mobility in her hands and struggles with bringing laundry up and down the stairs independently (stairs pictured above).

Current Solution That Doesn't Work: Laundry Cart

It is too difficult for people with limited strength to pull up the stairs, even though it has wheels that make it easier to pull up stairs.

Objective: To create a motorized laundry assistant that allows for the elderly to transport laundry up and down the stairs "hands-free" while walking up and down the stairs.

Design Calculations & Analysis



Necessary Motor Torque:

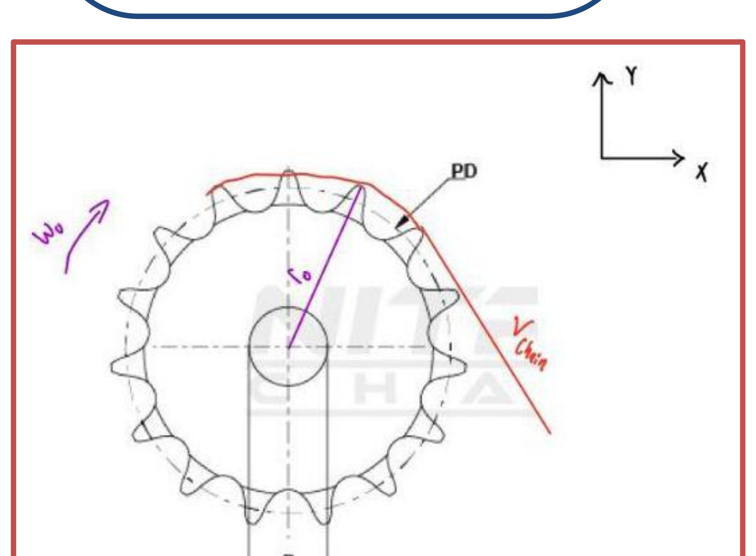
Our required torque was calculated to be 60.28 lbf*in, or 6.81 N*m, which aided us in finding the ideal motor.

- $\Theta = 40°$
- $\phi = 50$
- $r_d = 1.159$ in
- $r_o = 1.6335$ in
- T = cable tension
- m = 60 lbm
- $g = 32.2\ ft/s^2$
- $F_{N,Rail}$ = Rail Normal Force
- W = Max Design Weight

$$Weight = W = m * g = 60\,[lbm] * 32.2\,[\frac{ft}{s^2}] * \frac{1}{32\,[\frac{lbm*r}{s^2}]} = 60\ lbf$$

$$F_{motor} = T = W * cos(\theta) = 60\,[lbf] * cos(40^{\circ}) = 38.57\ lbf$$

$$\tau_{motor} = T * r_o = 38.57\,[lbf] * 1.6335\,[in] = 60.28\,[lbf * in] * \frac{0.11298\,[N*m]}{1\,[lbf]} = 6.81\ N * m$$



Necessary Sprocket Speed:

We need our system to ensure that her laundry gets done quickly. We estimated that it should take our system about one minute to ascend and descend the stairs.

- V_{Chain} = Chain Linear Velocity (in/sec)
- r_o = Outside Sprocket Diameter (inches)
- ω_o = Sprocket Angular Velocity (RPM)
- d = System Travel Distance (inches)
- t = System Travel Time (seconds)

$$V_{chain} = \frac{d}{t} = \frac{134.5\,[in]}{60\,[sec]} = 2.242\,[\frac{in}{sec}]$$

$$V_{chain} = r_o * w_o$$

$$w_o = \frac{r_o}{V_{chain}} = \frac{1.6335\,[in]}{2.242\,[\frac{in}{sec}]} = 0.72\,[\frac{rad}{sec}] * \frac{1}{2*\pi\,[rad]} * \frac{60\,[sec]}{1\,[min]} = 6.957\ RPM$$

Final Design

Control Panel:
Our control panel features three options:

- Forward
- Reverse
- Stop

The stop button is provided for use in case of emergencies.

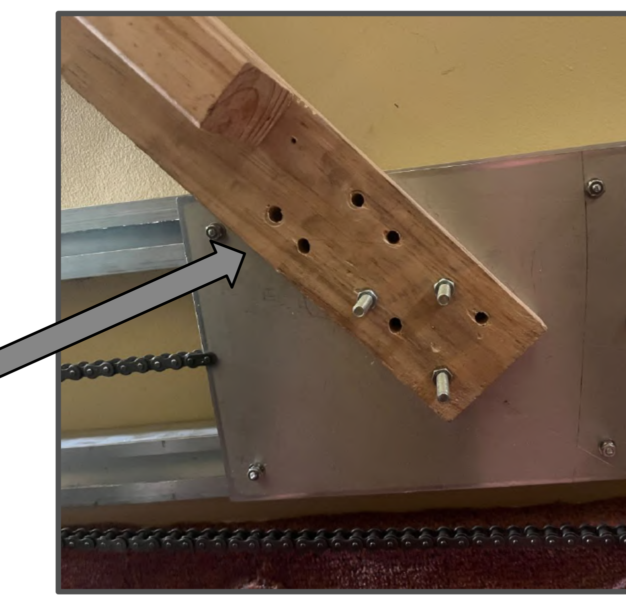
Transportation Mechanism:
Our sprocket is firmly secured to the motor with a adapter fitted with four M4 bolts as well as set screws opposite from each other.

Our sprocket and motor configuration in action.

Driven Sprocket (top)
Driving Sprocket (bottom)

Laundry Securing Mechanism:
Featured here is our 2-DOF laundry arm and tray which can store the mechanism when it is not in use, in addition to allowing simple and efficient activation.

System Securing Mechanism:
Laundry arm mounted to arresting plate via three additional M4 bolts. The arresting plate in turn is fitted to rollers slotted inside of aluminum rails.

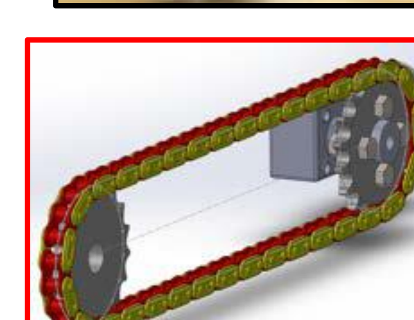


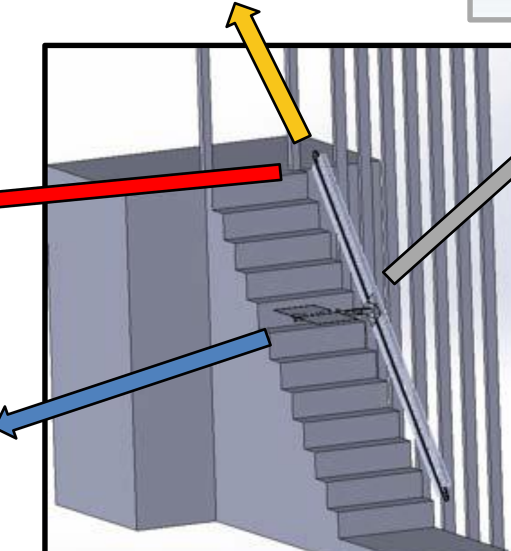
Our whole system only protrudes about 4 inches off the wall, allowing more than enough space for movement when it's being stored.

Transportation Mechanism:
These are the aluminum rails that span the whole length of the stairs.

Prototype & Test Results

Low-Fidelity Prototype:





CAD Model:

Weight Testing/ Electronics Testing

Laundry Ledge Rotation Testing

We also tested to make sure the roller plate would easily slide up and down the rails and ending up adding a silicone lubricant to make the wheels roll smoothly.

We also tested travel time and found it to be around 70 seconds to travel up and 50 seconds to travel down.