SwingCraft

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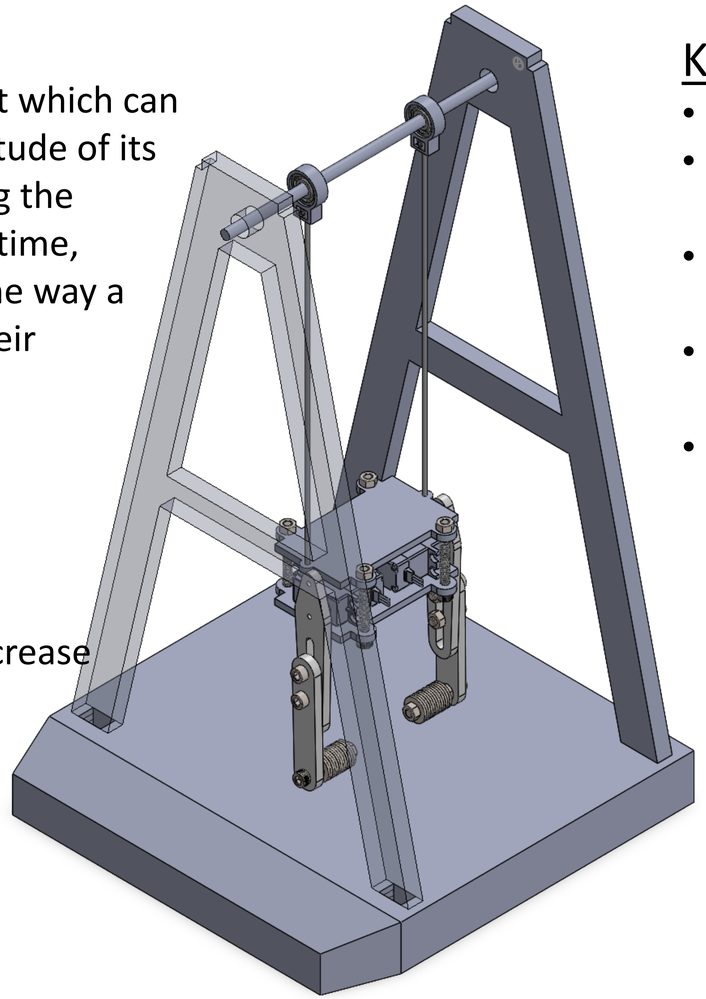
Summary:

This project aims to create a miniature swing set which can drive itself to resonance and increase the amplitude of its motion after receiving a slight push. By changing the effective length of the pendulum at the correct time, energy can be pumped into the system, the same way a child on a swing pumps their legs to increase their amplitude.

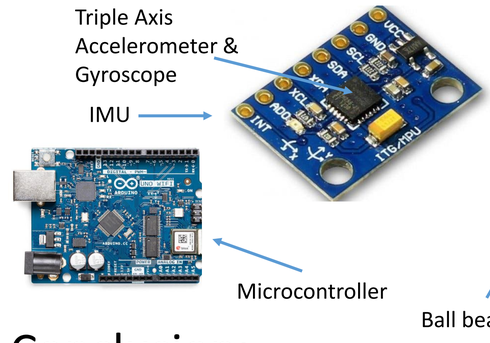
Project Objectives:

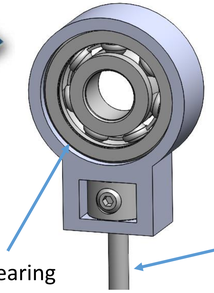
- Create a desktop sized model swing that demonstrates the principles of parametric resonance.
- The swing will be autonomous and able to increase the amplitude of swinging motion
- Use Microcontroller and IMU to sense swing position and adjust system accordingly

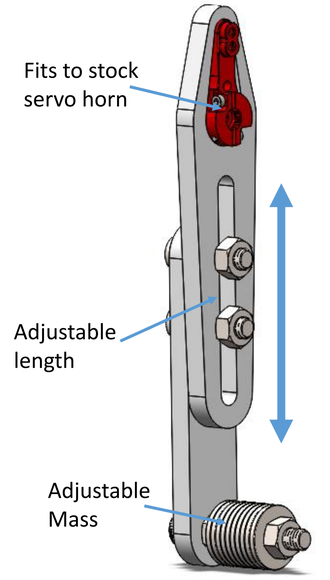


Key Features:

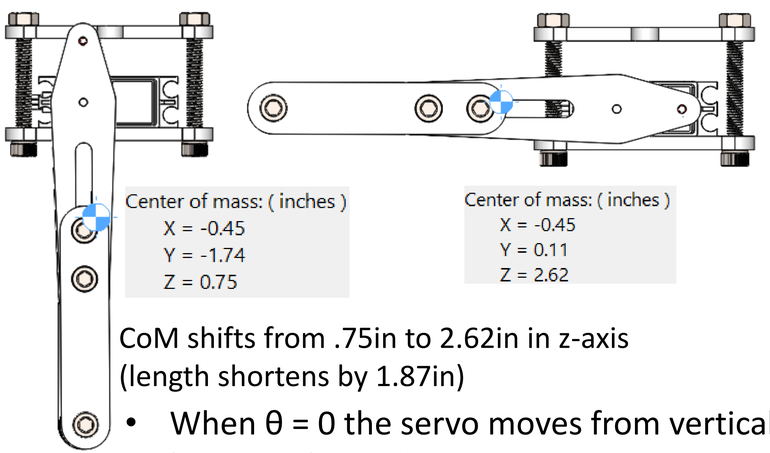
- Adjustable Pendulum Mass and Length
- 2 independent servos to control pendulum
- Bearings allow full 360-degree range of frictionless motion
- Operates for upwards of 30 min on a single charge without stopping
- Microcontroller and IMU to control system





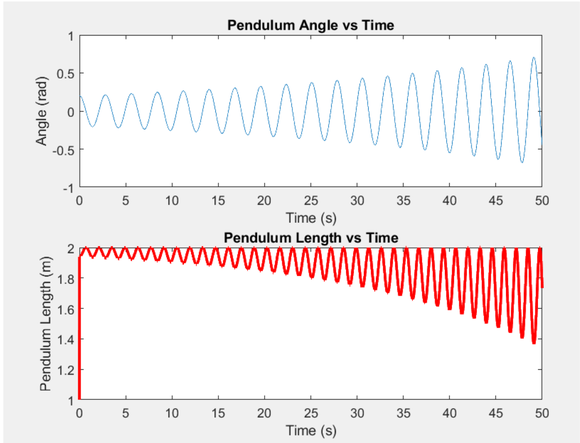


Engineering Analysis:



CoM shifts from .75in to 2.62in in z-axis (length shortens by 1.87in)

- When θ = 0 the servo moves from vertical to horizontal position
- When ω = 0 the servo moves from horizontal to vertical position



MATLAB simulation shows how changing the length of the pendulum can increase amplitude through parametric resonance.
Length Function: $L(\theta) = Lmin+(Lmax-Lmin)\cdot(0.5\cdot(1+\cos(2\theta)))$

Conclusion:

Next steps/PoC: Use prototype to begin testing control system and experiment with pendulum parameters (length and mass) to optimize system.
An improvement we could aim for is giving the user full control over the swing's amplitude. There are also concerns regarding the non-uniform shape and weight of the servo housing causing irregularities in the swing's movement.