Design Proposal

Isn't it painful when you head all the way back to your room from iSim lab, and then you realize you forgot your prox in the lab? You have to go across the whole campus and climb up to fourth floor to retrieve it. Or, you could ask a friend to attach it to a frisbee and throw it window-to-window. Our proposed is to model a way to throw the frisbee appropriately so that next time this happens, we know exactly what

Possible Outcomes

Case 1: The frisbee and prox do not reach West Hall. This is a failure of the frisbee portion.

Case 2: The frisbee and prox do reach West Hall, but the prox swings out of reach when the frisbee arrives at the correct point. This is a failure of the pendulum portion.

Case 3: The frisbee and prox do reach West Hall, and the prox is in reach. This is success!

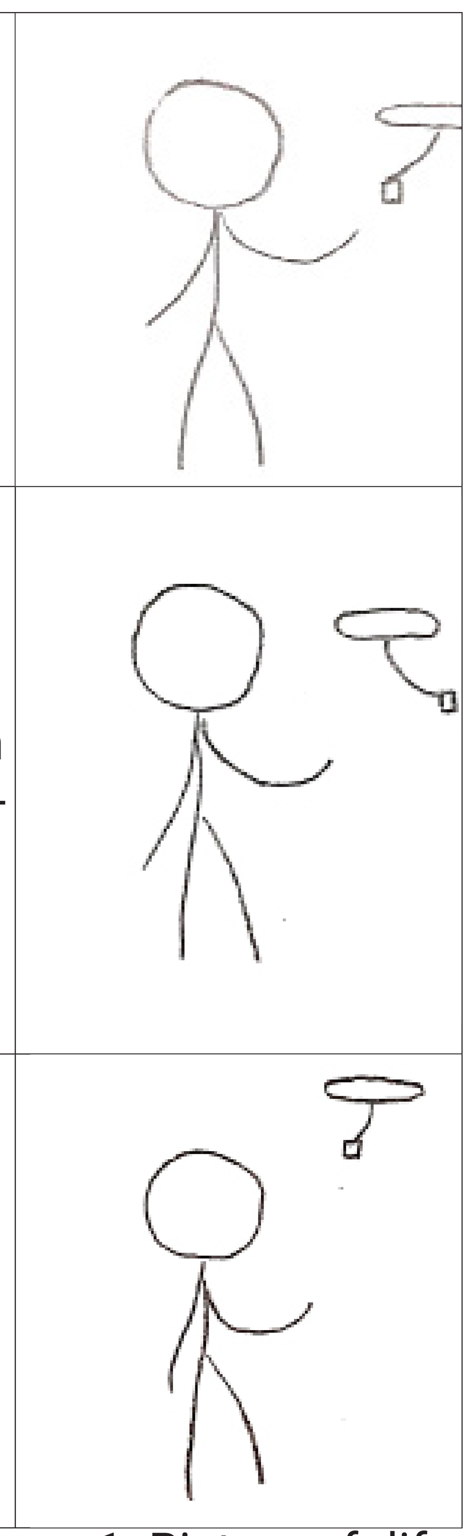

Figure 1: Picture of different types of expected motion

Physical Models

$$y''(t) = ((-mass * g) + \frac{1}{2} * \rho * x'(t)^2 * area * C_L * \alpha)/mass$$

$$x''(t) = (\frac{-1}{2} * \rho * x'(t)^2 * area * C_D * \alpha)/mass$$

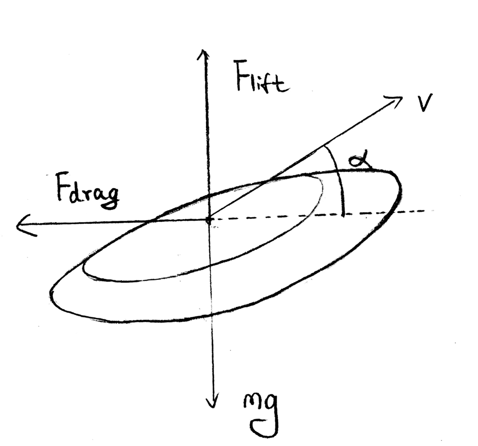

Figure 2: Free Body DIagram for Frisbee

When modeling the flight of the frisbee, we considered the forces of lift, drag, gravity, and the initial velocity on the disk, as illustrated by the free-body diagram.

a-PROX-imation

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ABSTRACT

In our model, we considered the problem of throwing a frisbee with a prox (student ID card) from the fourth floor of the Olin College Academic Center to the first floor of West Hall, one of the residence halls at Olin College. We modeled the frisbee as a projectile with a specific launch angle, launch velocity, lift, and drag. We also modeled the movement of the prox card as a dampened pendulum.

Optimal Velocities and Angles

We developed a model for both the frisbee and the prox separately, and then we combined both models such that we could track the motion of the prox as it moved with the frisbee. After doing that, we were able to create a function which returned the distance between the target and the point in the frisbee's trajectory closest to the target (in this case, the first floor of West Hall) and whether or not the pendulum is reachable. Using this framework, we created a three- dimensional plot of the distances based on velocity and angle and determined that the optimal initial conditions include having a **37 m/s launch velocity and a 7.5 degree launch angle**.

Minimum Distance from Target based on Launch Angle and Velocity

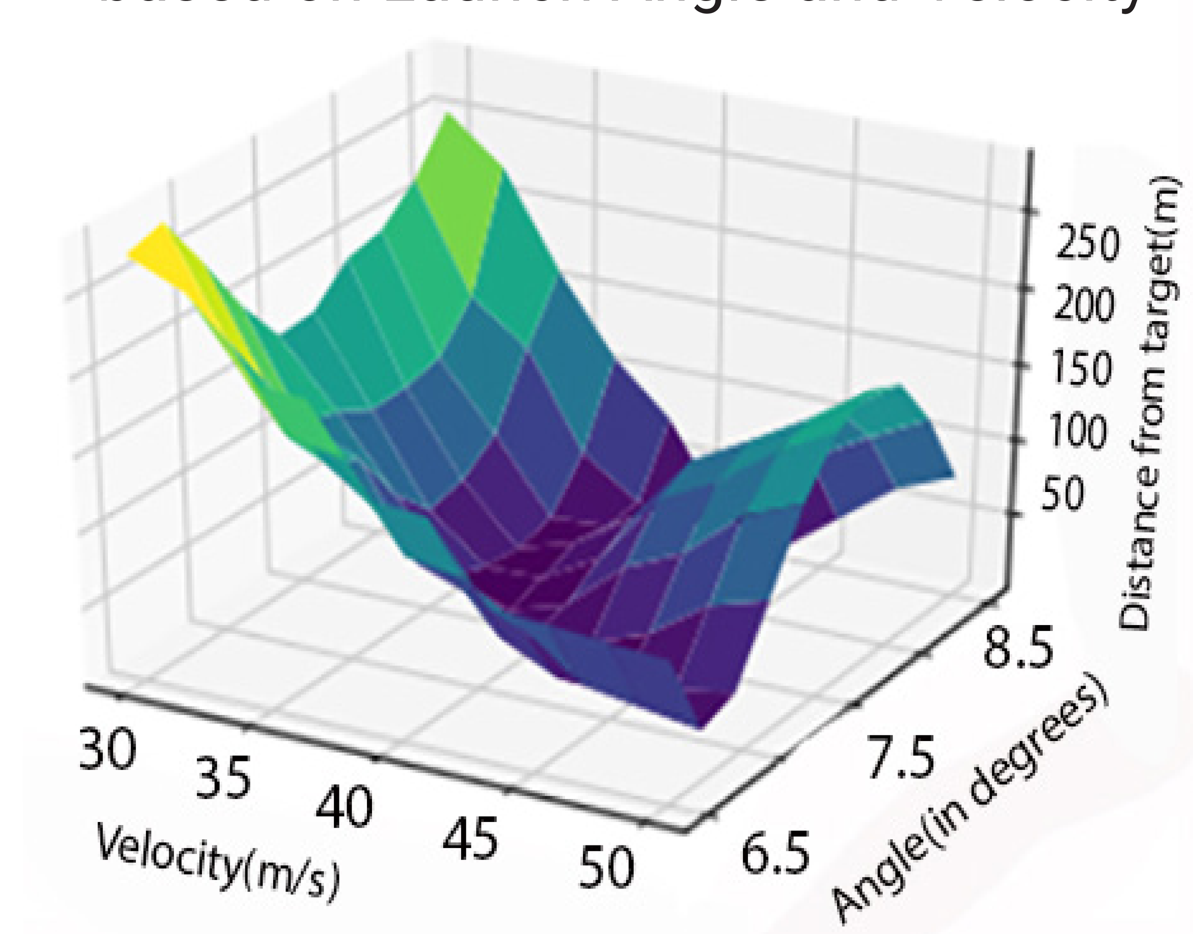

Figure 3: Distance from Target Heat Map for Launch Angles and Velocities

Assumptions and Limitations

We Assumed That:

1. While the frisbee certainly impacts the movement of the pendulum, the movement of the prox as it swings does not impact the flight of the frisbee.
2. The frisbee and prox's surface area, drag coefficient, and mass are fixed in value.
3. The movement of the prox is only considered in two dimensions.

To Extend Our Model, We Could:

1. Consider the impact of wind and how it impacts the movement of both the frisbee and the prox card.
2. Consider flights which are not direct, striaght-line path

Model Validation

Before trying to solve the actual problem, we independently experimented with both the frisbee model and the pendulum model to ensure that they accurately reflected the physical world - this required careful research and analysis through reading papers, making intermediate models, and empirical testing to determine the values of various coefficients and constants.

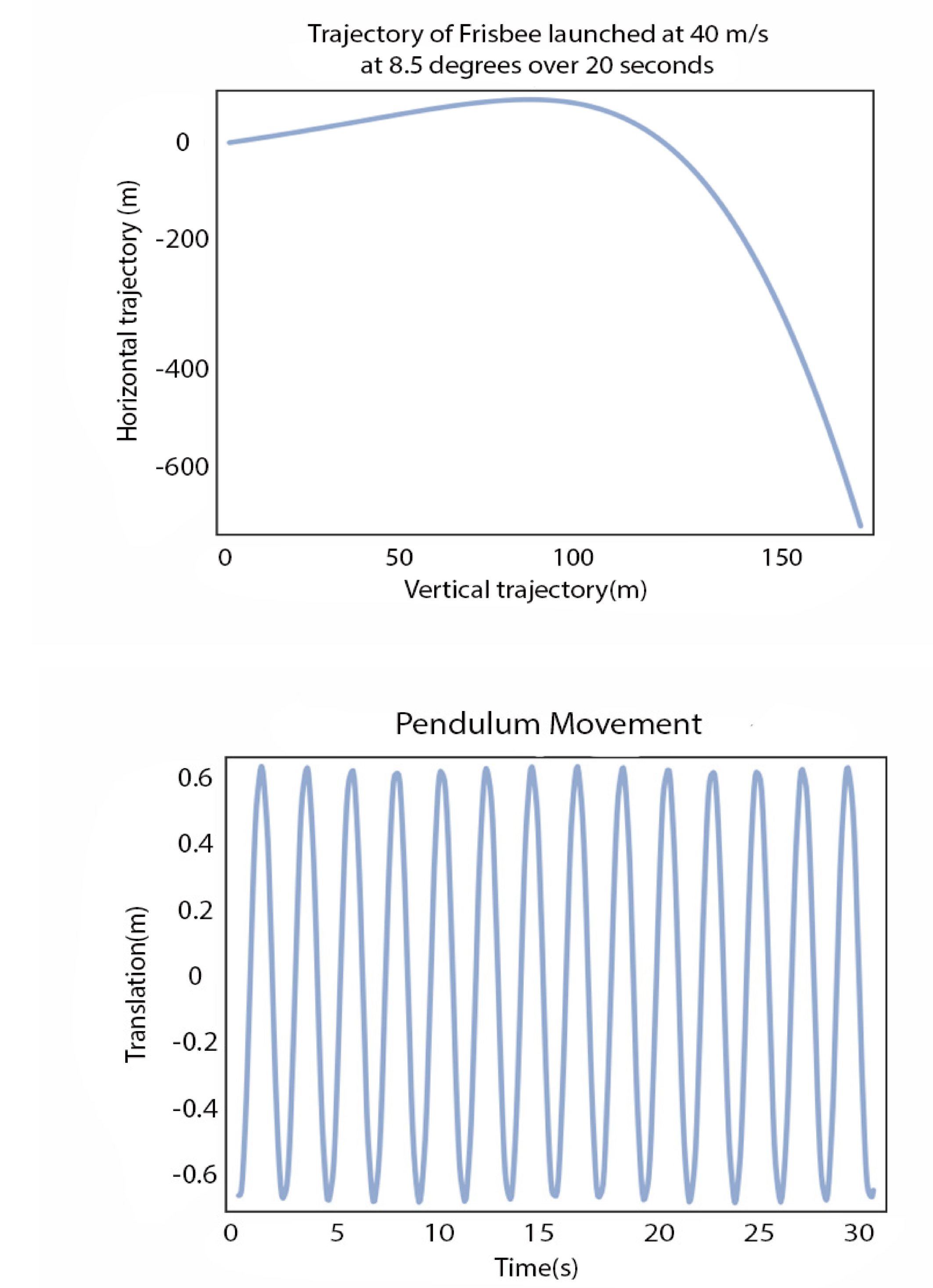

FIgure 4: Plots of Individual Model Validation

Conclusions

Our model reveals that the optimal launch velocity is **37 m/s and the ideal angle is 7.5 degrees**. Furthermore, save for some fluctuations of the pendulum, generally approaching these velocities and angles improves the trajectory. While our model indicates that reaching the point is possible, it also takes a great deal of ultimate frisbee skills to do so, so we better start training.