Receiving Station for Drone Delivery

Design for Sustainability - D4S-2

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A Receiving Station for Drone Delivery. . . *But Why?*

- UAVs first used in early 20th century in military.
- Civilian usage of drones erupted with popularity in the early 2000s with miniaturized and affordable models.
- On CBS *60 Minutes*, Jeff Bezos, CEO of Amazon, announces to the world of *Amazon Air Prime*.
- *Amazon Air Prime* - concept of utilizing a fleet of drones to deliver packages .
- Since Bezos' announcement, many other transportation logistics companies such as UPS, FedEx, DHL, and even the USPS are doing R&D on utilizing drones for expedited deliveries.

Main Challenges for Drone Delivery

- Drone maneuverability around a crowded residential property is the biggest concern
- Most homes have obstacles such as trees, light posts, bushes, gates and fences around them
- All these obstacles pose a problem for the drone to identify a safe and open landing spot. The higher the drone is above the property, the less obstacles it will encounter.

Assumptions / Constraints to our Design

- To clear most obstacles, we designed our system to stand **18 feet** above ground level.
- Maximum tolerable wind speed: **5 mph**
- Maximum package weight: **50 lbs**
- Maximum horizontal velocity of the drone upon releasing: **2 mph**
- Gravitational Acceleration (g) = **32.2 ft/s^2**
- Materials perform to their theoretical mechanical properties e.g. tensile strength, yield strength, durability, etc

Problem Statement / Problem Definition continued

The purpose of our design is

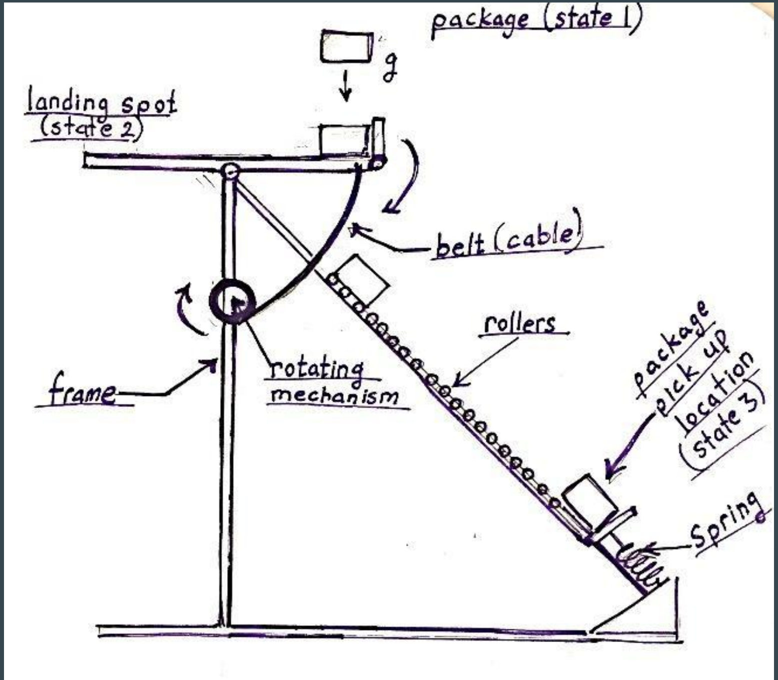
1. To safely catch the package dropped in free fall by a drone from 18 feet from ground level
2. To transport to an intended location for the recipient

* The scope of our design begins after the drone had dropped the package

Conceptual Designs

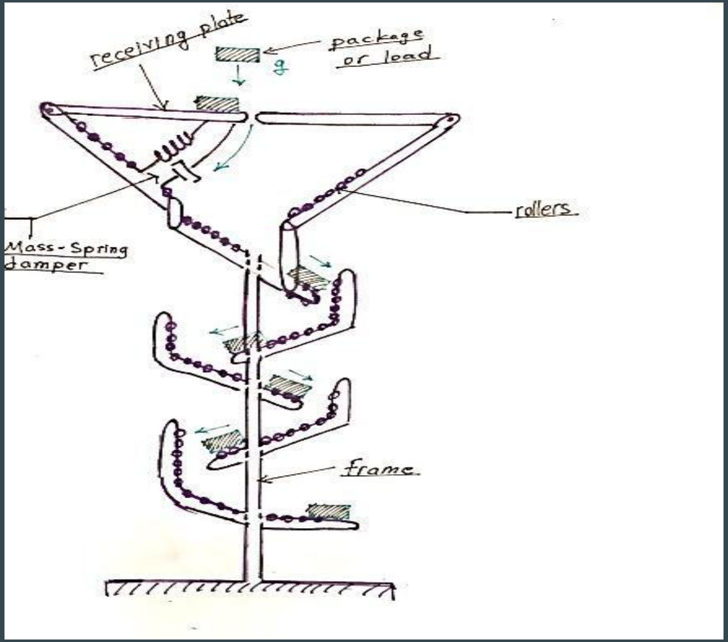
Motivation / Inspiration for Design

- 18 feet above ground, emphasis on avoiding obstacles (trees, light posts etc)

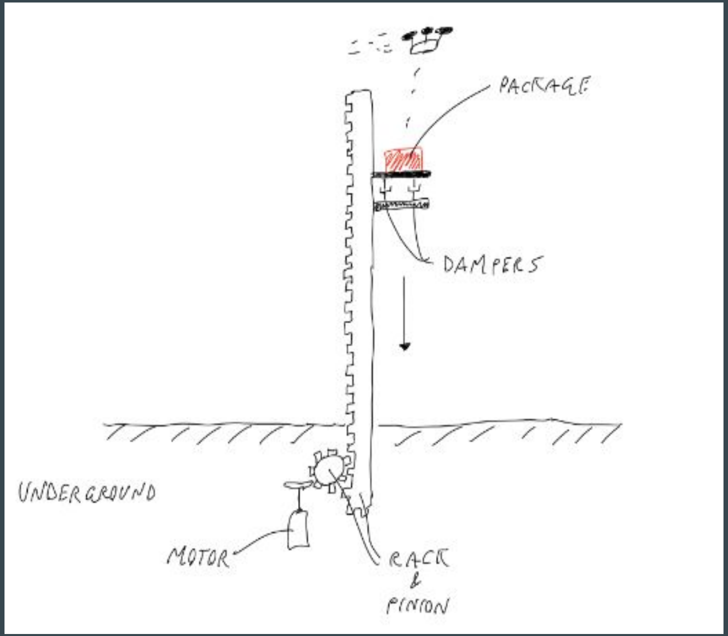


Design #1 T-Pivot Mechanism

Conceptual Designs continued...

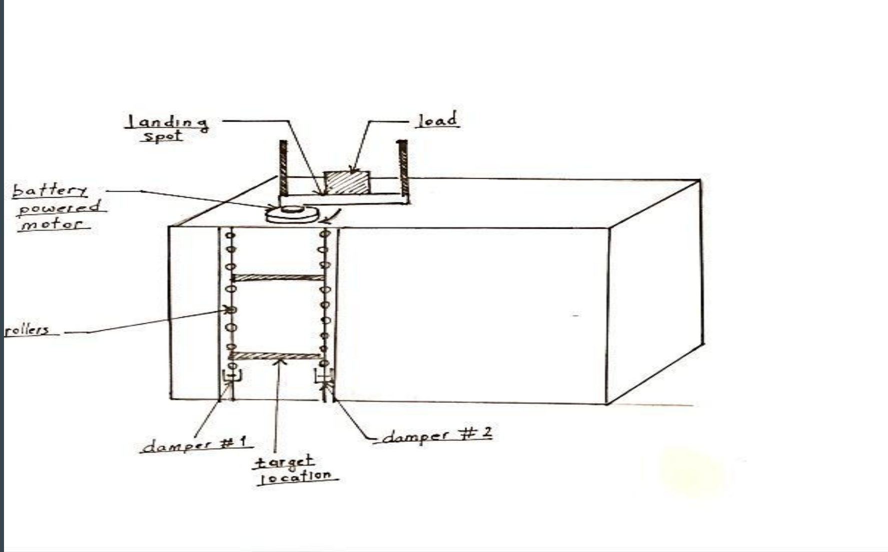


Design #2 Roller Guided System

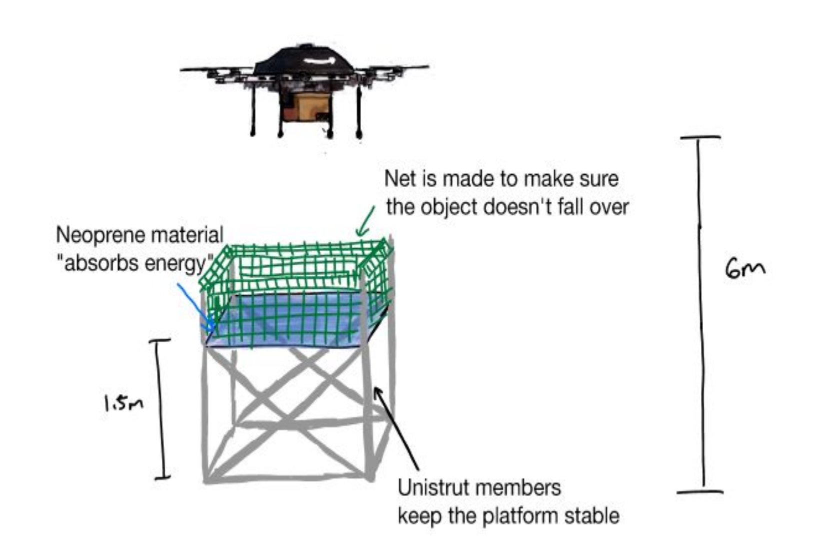


Design #3 Motor Driven Rack and Pinion

Concept Designs continued...



Design #4 Rooftop Receiver

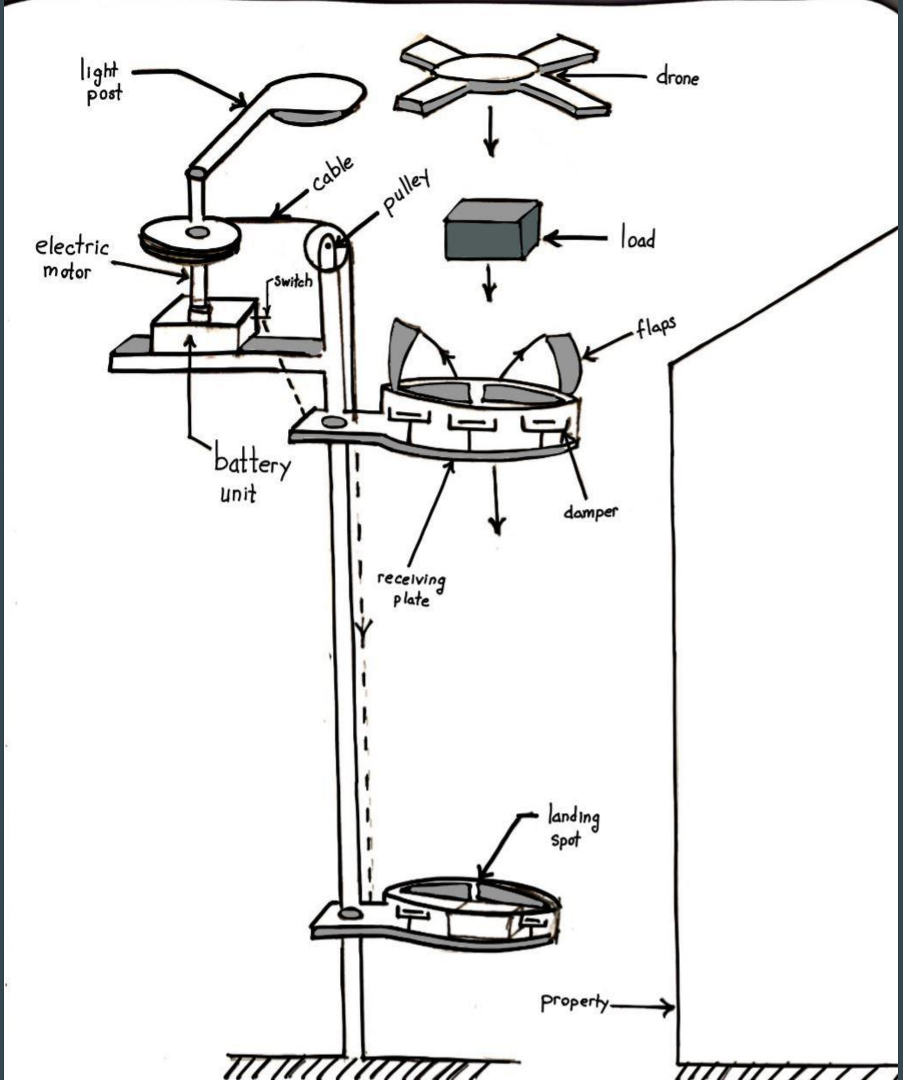


Design #5 Elevator Stand

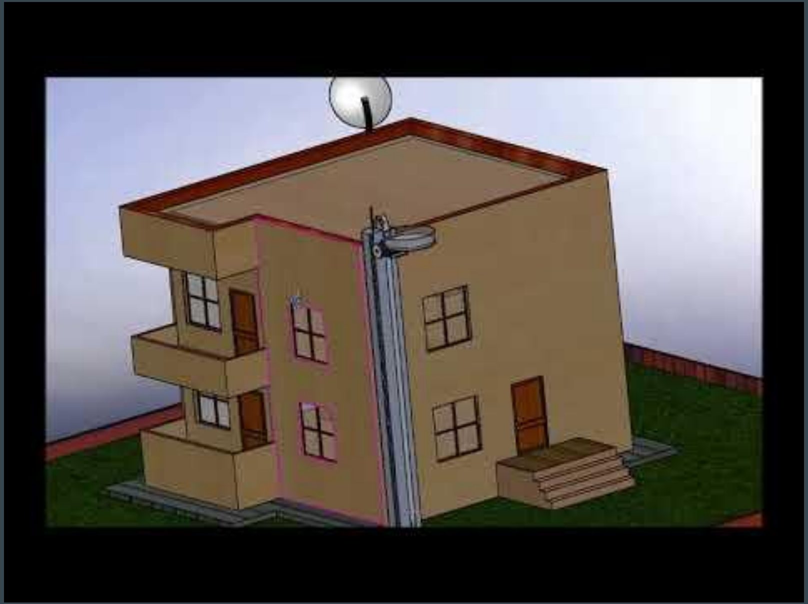
Proposed Conceptual Design

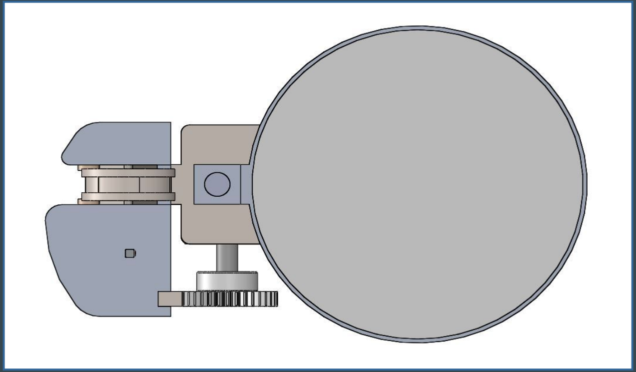
Motivation / Inspiration for Design

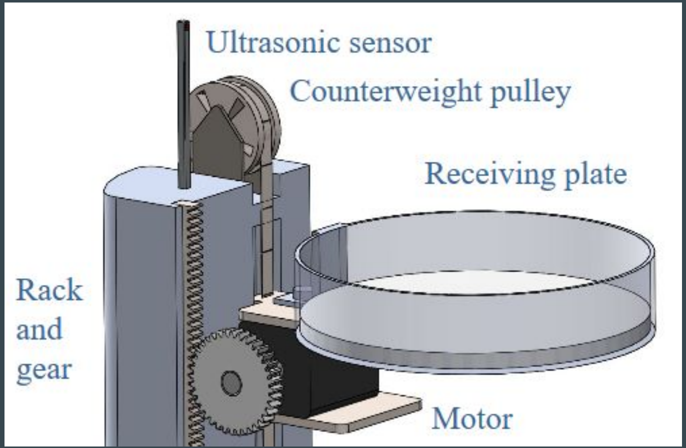
- 18 feet above ground, emphasis on avoiding obstacles (trees, light posts etc)

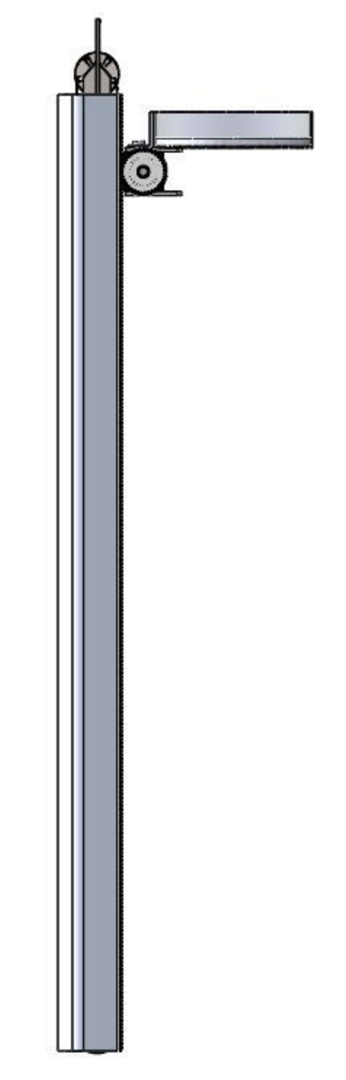


Our Design Solution - Virtual









Kinematics and Dynamics

$h = 12.5\ feet$ = distance from mass to the catching location

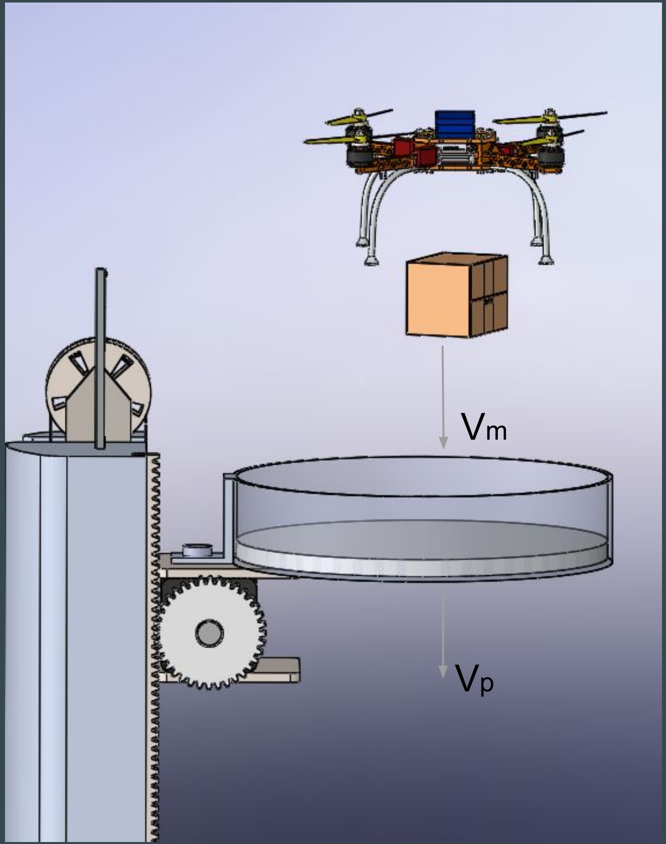
$$mgh = \frac{mv^2}{2}$$

$$V_{mass} = \sqrt{2gh}$$

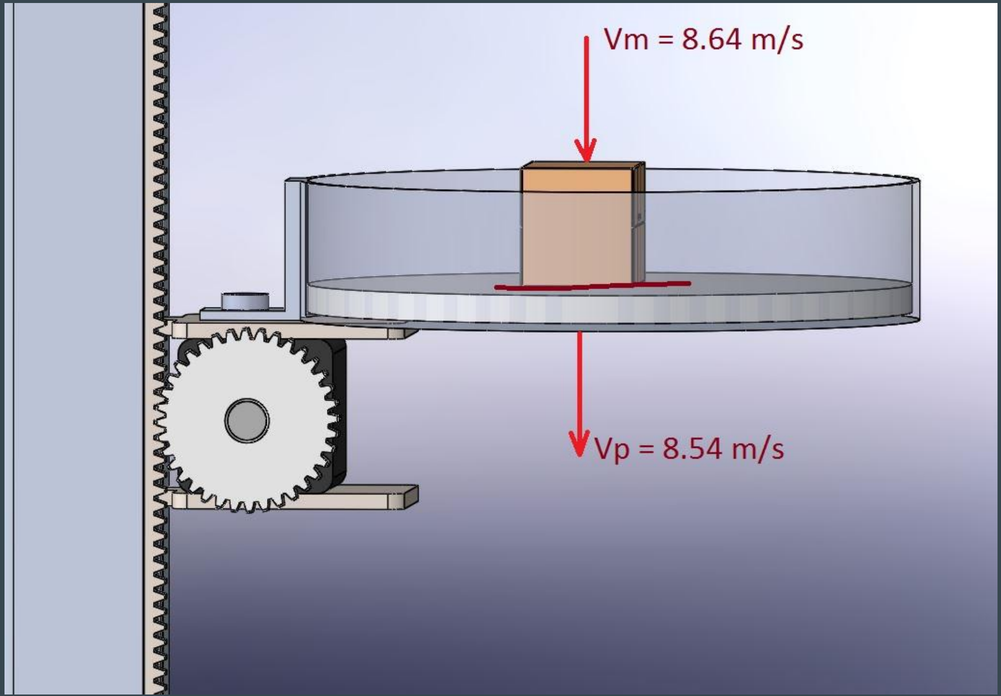
$$v = \sqrt{2 * 32.2\frac{ft}{s^2} * 12.5\ feet =} 28.37\frac{ft}{s} = 8.64\frac{m}{s}$$

Thus, the velocity be slightly less than $8.64\frac{m}{s}$

The motor should accelerate the plate to attain a velocity of $8.50\frac{m}{s}$



Impact Analysis

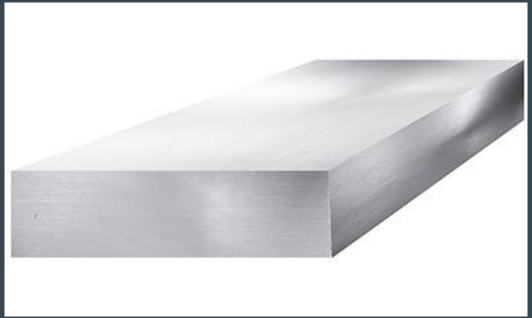


Average Force Exerted

Weight: 50 lbs = 22.67 kg

$$\bar{F} = m\left(\frac{V_f - V_0}{\Delta T}\right) = 22.67\ kg\left(\frac{8.64\frac{m}{s} - 8.50\frac{m}{s}}{1\ s}\right) = 3.17\ N$$

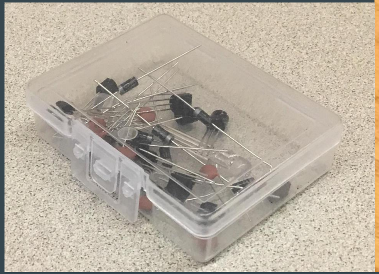
Building Process

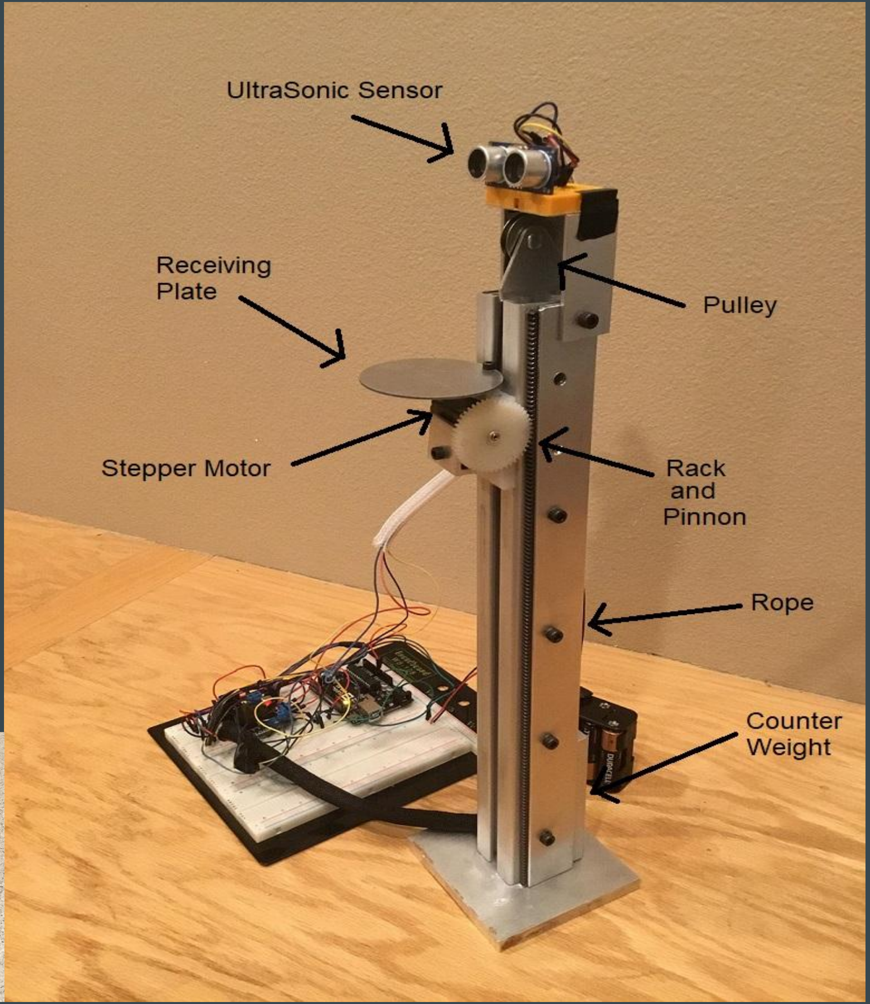


Physical Prototype 1:10 Scale

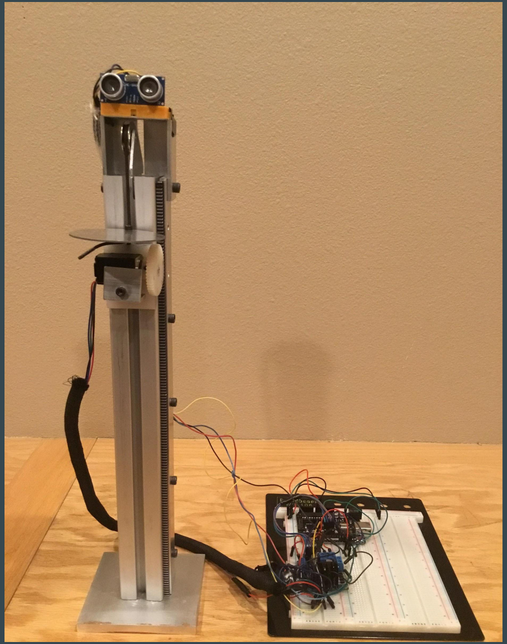
- The purpose of a Physical Prototype is to create a scaled down model that can detect the velocity of a falling package and obtain it with a receiving plate operated by a stepper motor.

Falling Package

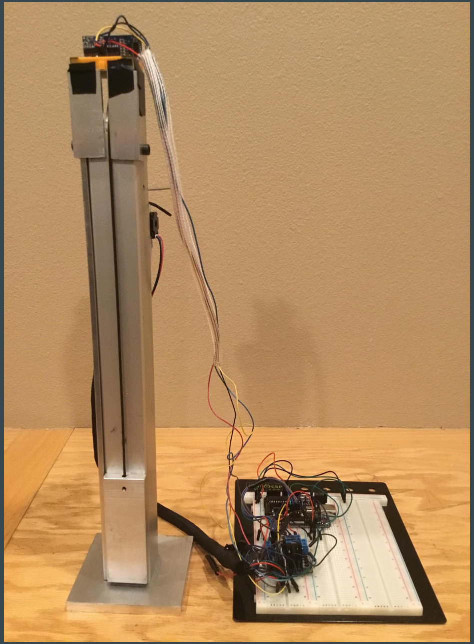




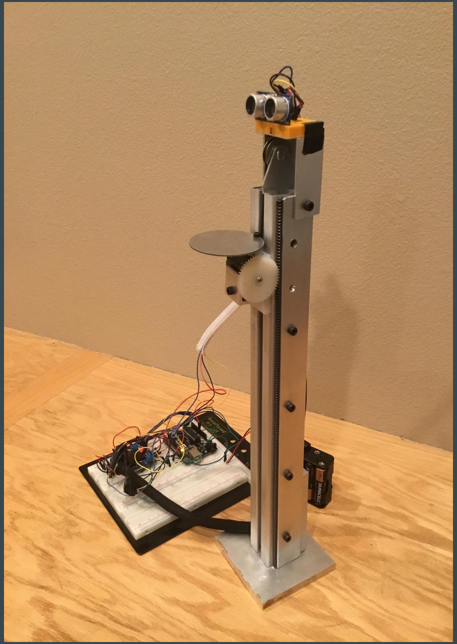
Our Design Solution - Physical



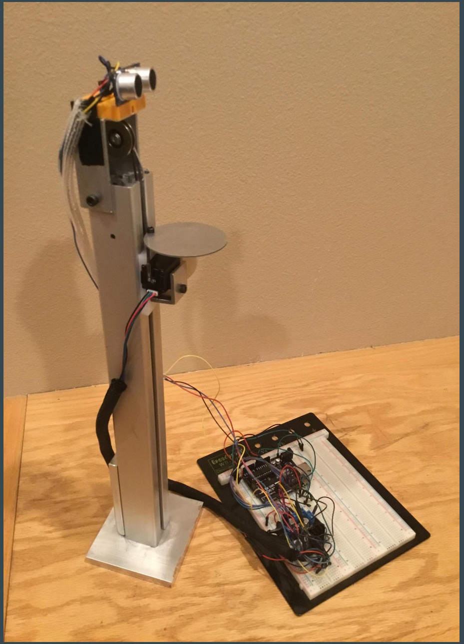
Front View



Back View



Left Angle View

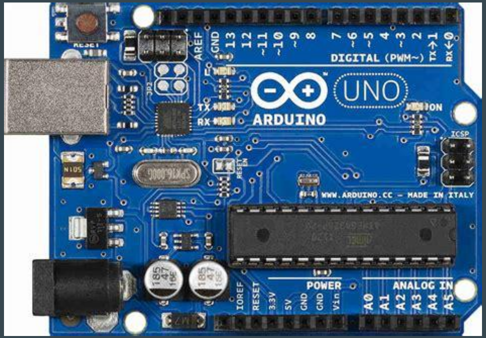


Right Angle View

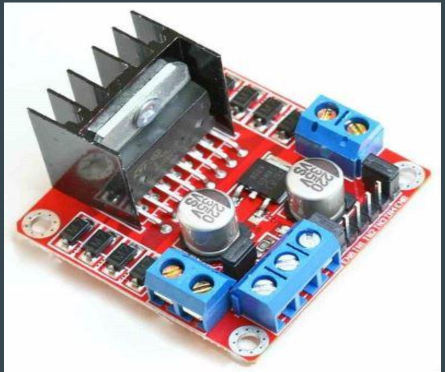
Physical Prototype Control Components

Stepper Motor: Bipolar, 200 Steps/Rev, 20×30mm, 3.9V, 0.6 A/Phase

Ultrasonic Sensor - HC -SR04:

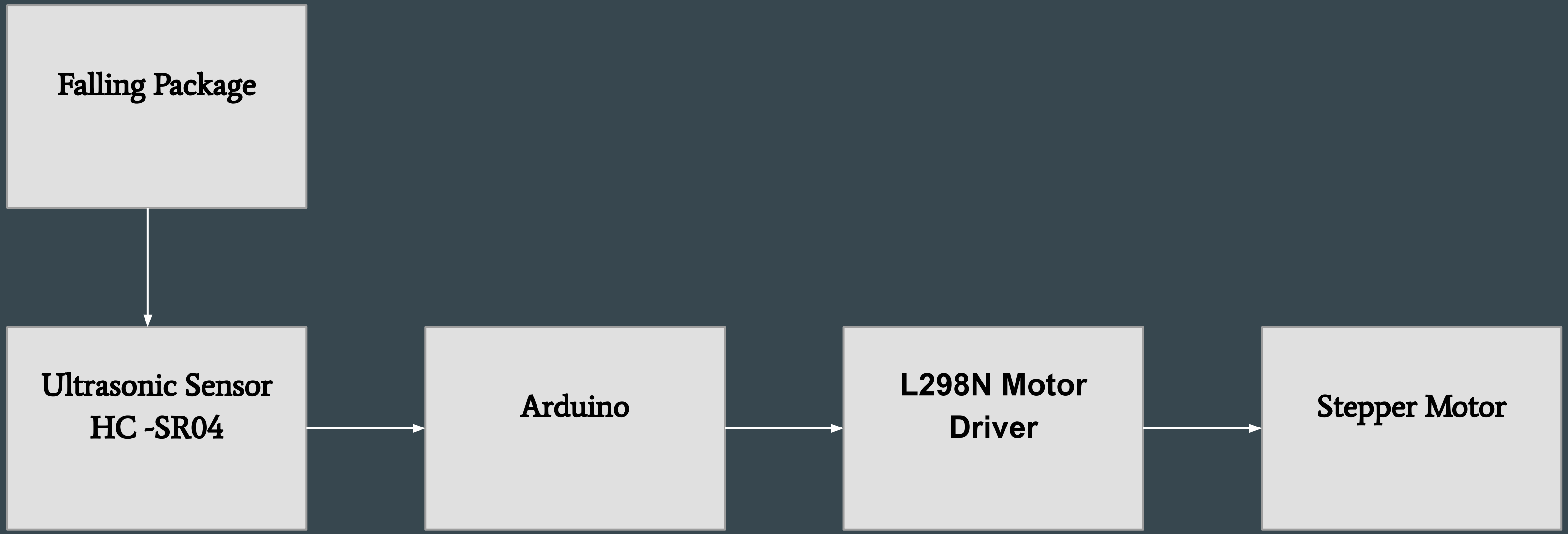


Arduino Uno



L298N Motor Drive Controller Board:

Basic Control System



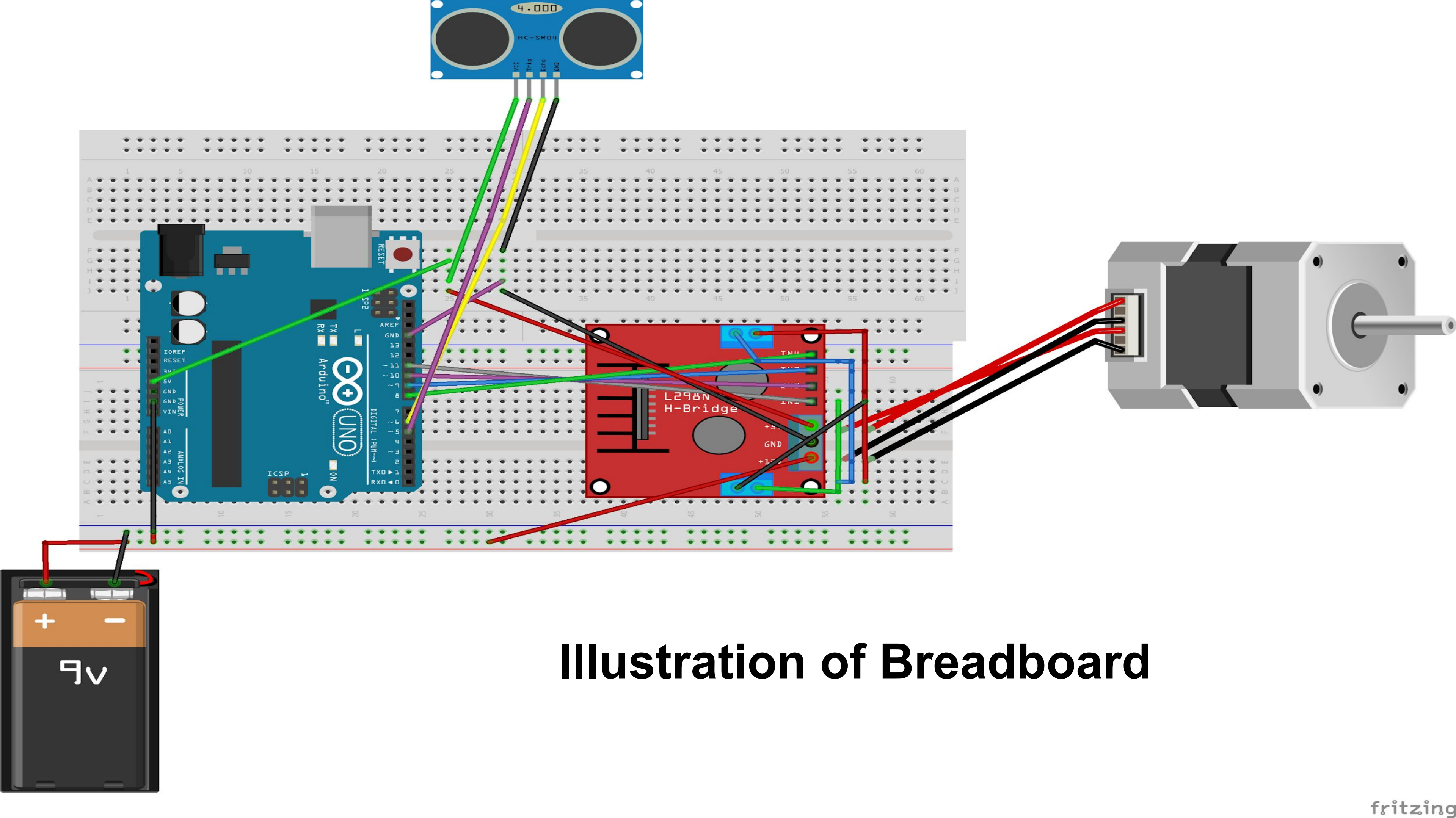
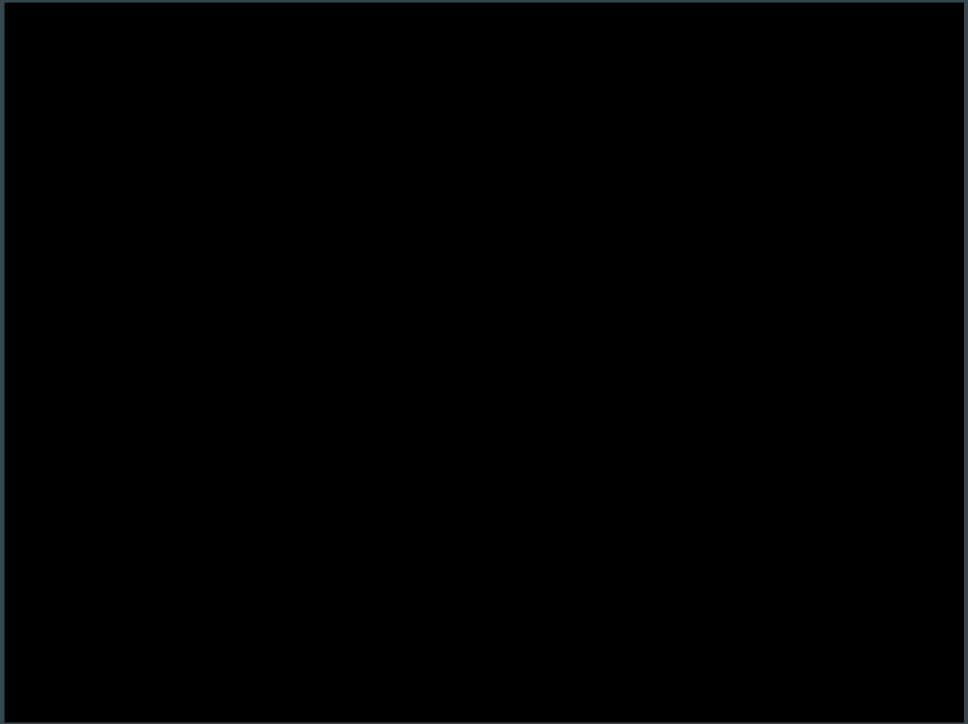


Illustration of Breadboard

Physical Prototype

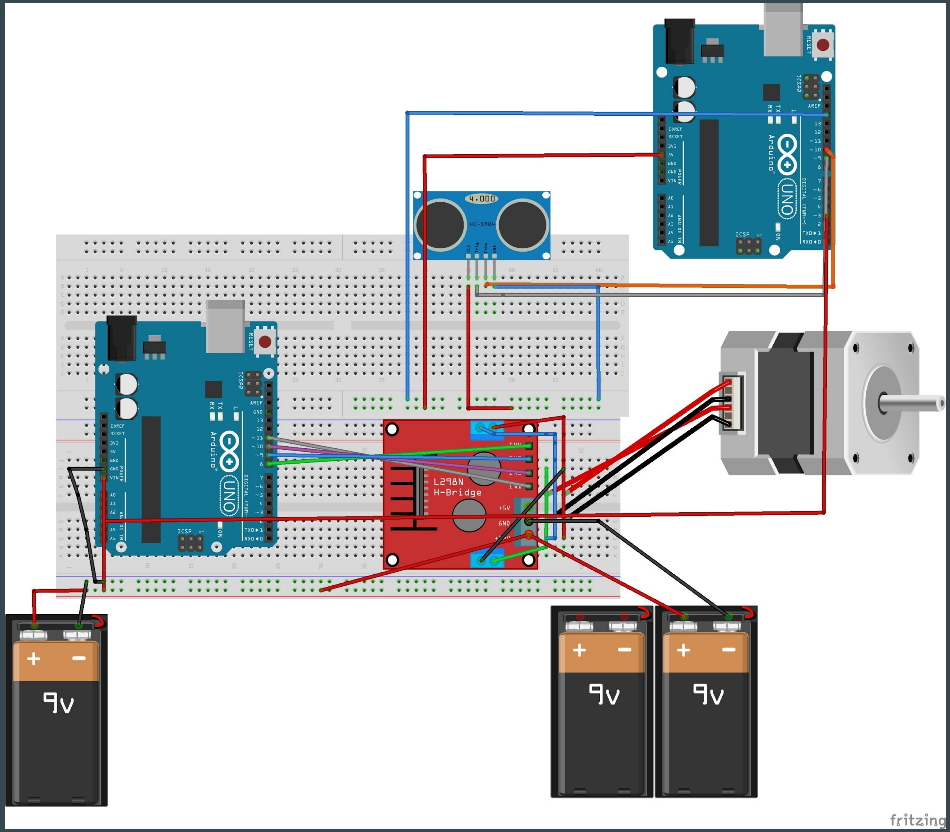
- Proof of Concept (we simplified some mechanisms as well as removed some unnecessary mechanisms to just show the main concept)
- 1:10 scale



Conclusion

Physical prototype

- Friction build up of gear/rack
- Slippage of gear along rack
- Power requirements
- Delay on ultrasonic sensor
- Tolerances



Questions?

Special thanks to....

- Our Senior Design advisor, James Sawyer
- Machine Shop, Matt and Steve