2013

Team J

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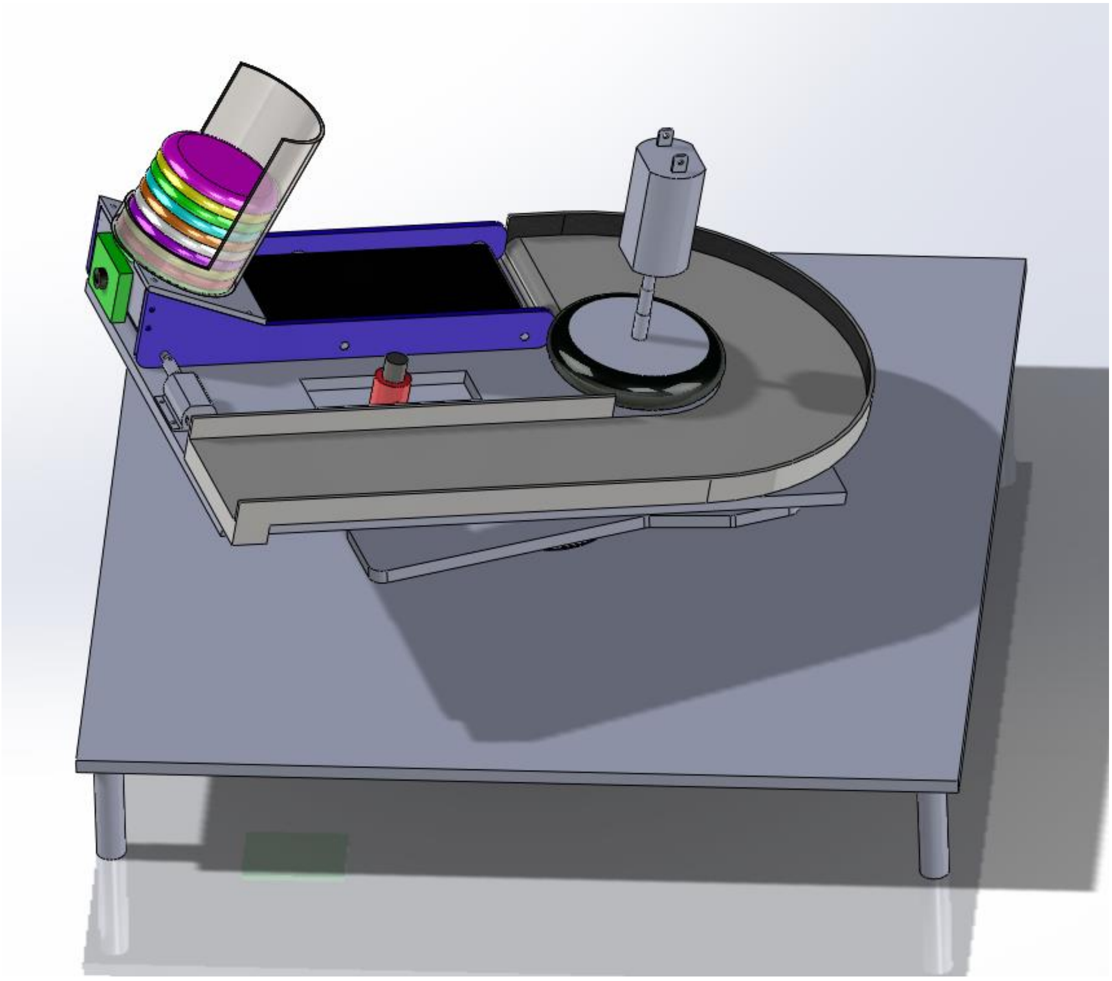


[FRISBEE THROWER]

Task 1: Design Concept Proposal

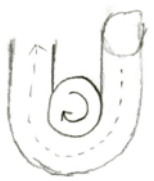
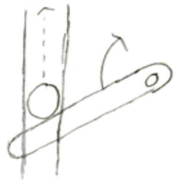
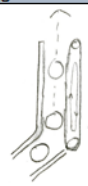
24-778 Mechatronic Design

Contents

Design Concept

The goal of this project is to develop Frisbee Thrower that accurately and consistently launches Frisbees through targets 10 feet away. To accomplish this, the mechanism must be able to locate the target, aim and position the launcher, and launch the disc consistently. Four different launching techniques were considered and compared in a Pugh Chart as shown in Table 1. The techniques were evaluated based on expected accuracy, consistency, simplicity, controllability, and disc velocity. The chosen technique is a launcher that uses a rotating fly wheel to propel the discs. It is believed that this technique will result in the best accuracy and be the simplest to produce. This firing apparatus will be placed on an adjustable platform that is aimed using motors and an Aruduino microcontroller. A camera on the front of the mechanism will be used for targeting. A hopper will feed the discs to the launching mechanism one at a time.

Table 1. Pugh chart

Pugh Chart					
Design type		**Rotating Fly wheel Launcher**	**Rotating Arm Without Track**	**Rotating Arm With Track**	**Straight Belt Launcher**
Sketch					
Criteria	**Weight**				
Accuracy	3	1	0	1	0
Simplicity	2	1	1	0	1
Controlabillity	2	1	-1	0	1
Disc Velocity	1	0	1	1	0
Consistency	3	1	-1	1	0
Net Score		10	-2	7	4

System

Overview

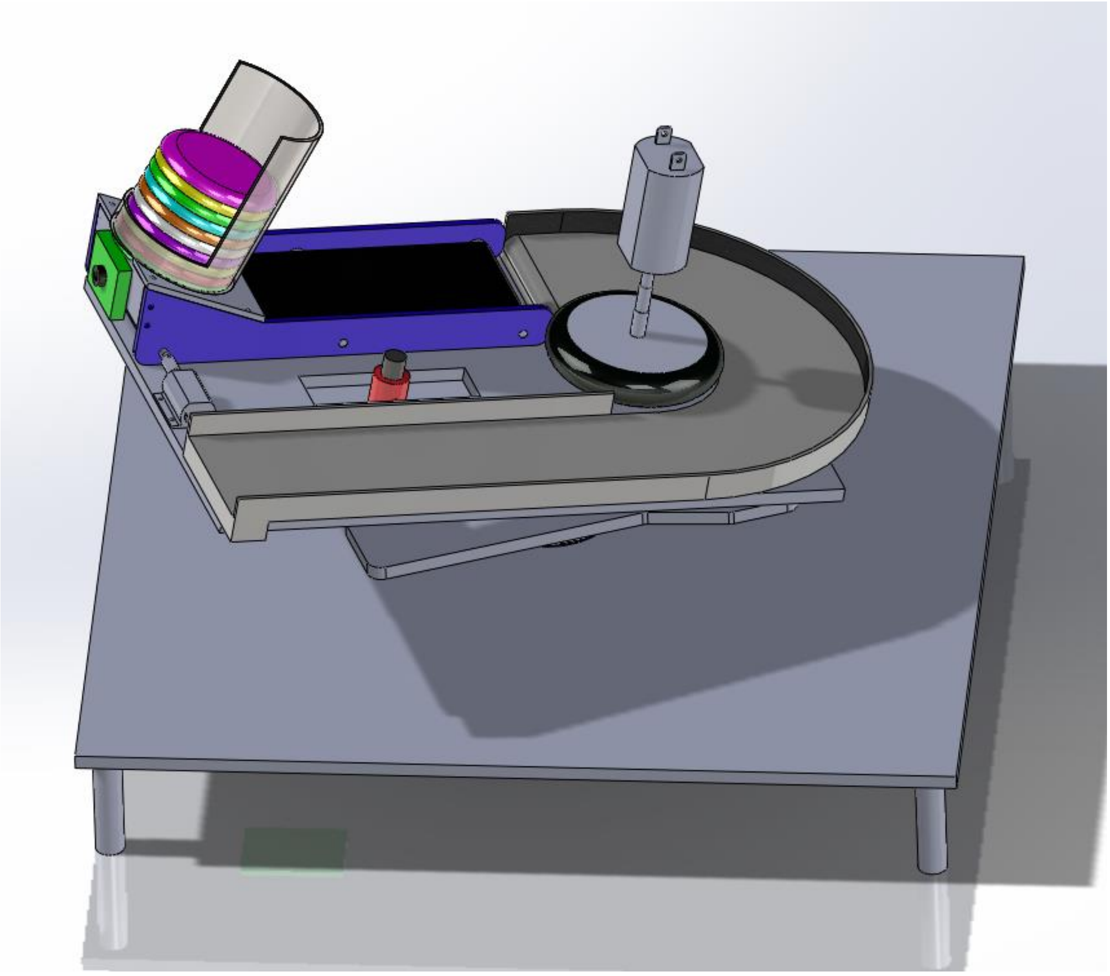


Figure 1. Overall-view of concept design

The primary function of our design is to accurately throw Frisbee-type discs at targets. These discs are 3.5” in diameter and made of a relatively lightweight, flexible plastic. Additional requirements include the ability to fire on targets in a 4’ wide x 3’ high area at a distance of 10’. The targets will be of varying sizes 1.5x, 2x, and 3x the disc diameter and will be marked with colored retro-reflective tape. Our machine must fit within a 2’x2’x2’ cube and be able to receive a manually loaded stack of at least three “Frisbees.” Finally, the loading must be done in less than 15 seconds; the machine must be able to fire 3 “Frisbees” in 20 seconds and must have 80% accuracy firing at the 3x targets and about 50% on the 2x targets. Additional features to the design are encouraged and will be considered as “coolness” factors.

Given these constraints and requirements our team has developed a preliminary design with a variety of actuation and sensing capabilities to enable it to achieve these goals.

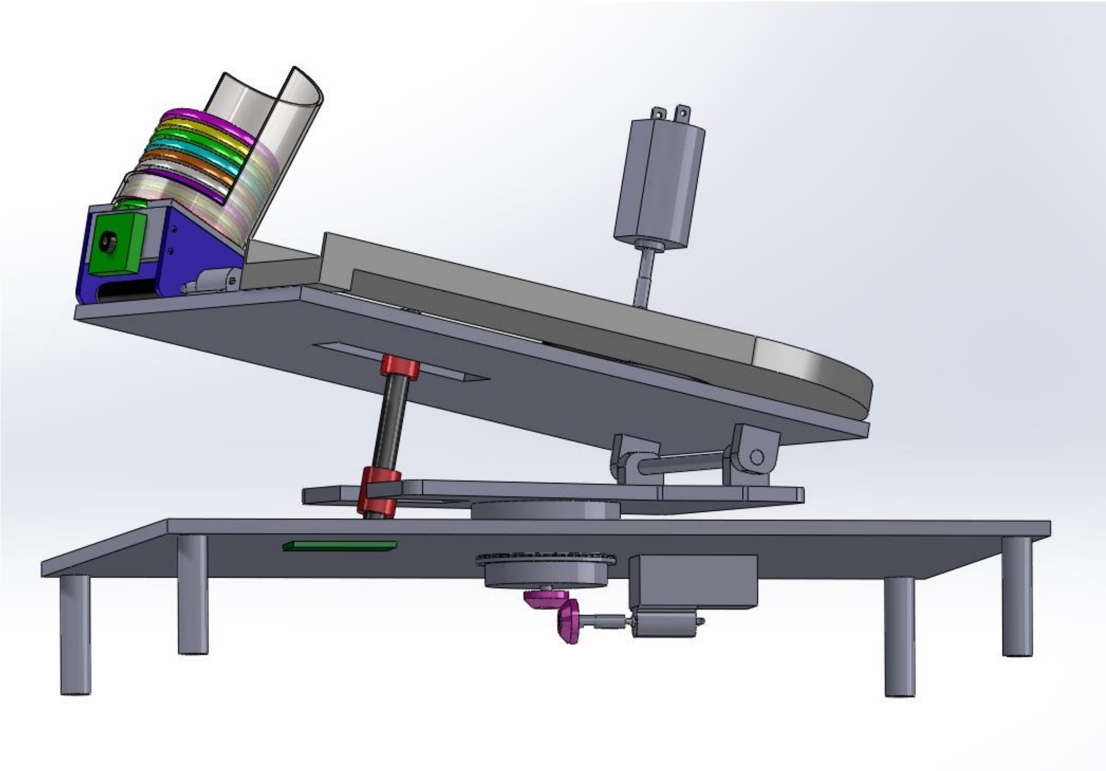


Figure 2. Side-view of concept design

Figure 1 and Figure 2 show the overall system with all of the components, which include: “Frisbee” hopper/loading system, the launching system, the rotational mechanism, elevating mechanism, and the sensing device (CMU cam.) Other components which are not pictured in the CAD include the Arduino board which will be acting as the microcontroller subsystem and the power supply subsystem.

Sensing

The CMU cam can be seen in Figure 2 as the green component attached to the hopper/loading subsystem. We will be using this device given its relative ease of use in interfacing with the Arduino microcontroller in addition to the fact that this device can be acquired by our team for free and budget concerns are very important for this project. There is currently a design debate occurring within our team in relation to the placement of the camera, whether to have it attached to the launching mechanism so that the camera moves and rotates with the system, or to mount the camera to the frame of the system where it will not be able to move. The basic debate is over the complexity of the coding and communication between the Arduino and CMU cam. This design decision is pending until we have heard the CMU cam presentation Monday January 28, 2013.

Another sensing design decision that needs to be determined is how the machine will “know” that a Frisbee has loaded, been launched, and ready to be reloaded. There has been some debate to whether or not we need sensing or can simply time the motors to spin at a set rpm which will allow the discs to constantly launch without any sensing being necessary.

Elevating

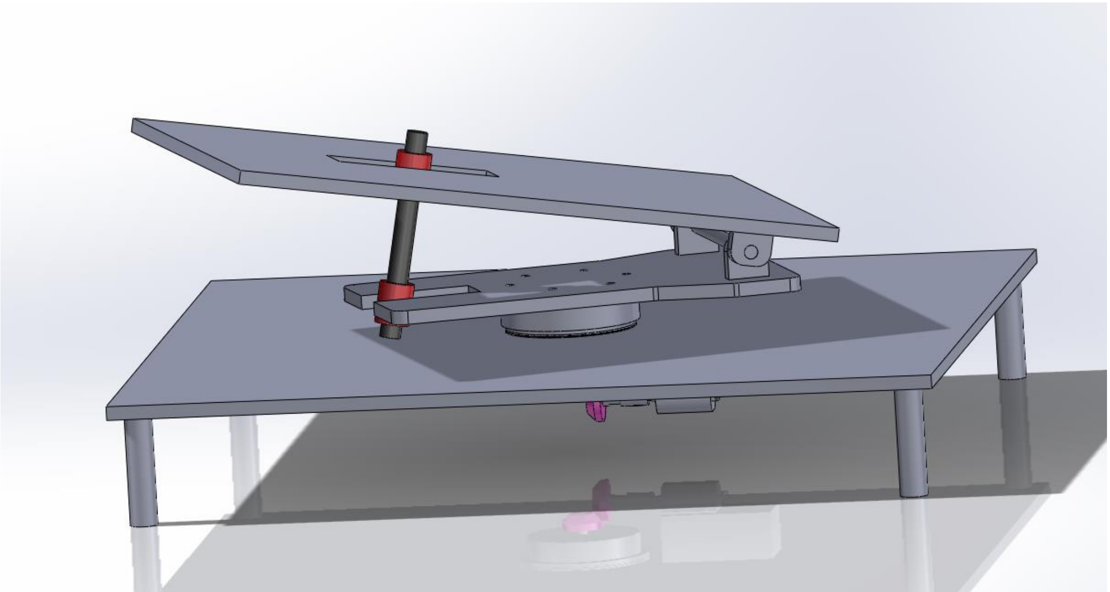


Figure 3. Elevating subsystem

The elevating subsystem will play in integral part in our devices capability to address the accuracy constraints given in the project description. The initial angle in projectile equations is a key piece of information that will play a major role in our targeting system. For our design we have opted to use a ball screw mechanism that is powered by a servo motor. We selected this mechanism due to the fact that angle will be able to be adjusted very slowly and will allow for precision of 0.1°.

Loading

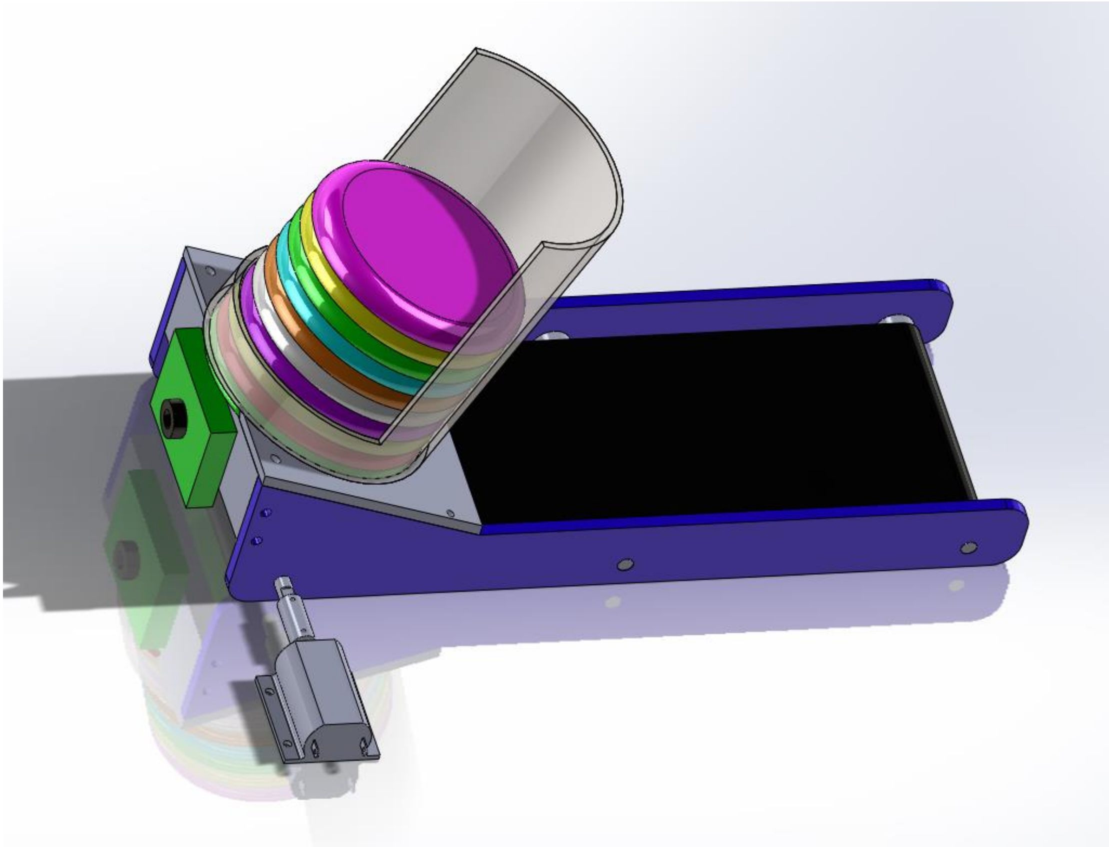


Figure 4. Hopper/Loading subsystem

Our hopper/loading mechanism will utilize a timing belt type of conveyor that will bring the disc towards the launching subsystem. We will have an additional point of actuation within the hopper that allows just one disc to drop down to the belt at a time which is why the hopper appears to be sitting at a 30° angle with respect to the conveyor belt.

Additionally, our team decided that the “coolness” factor we wanted to tackle, assuming that we will have the time, is to develop a catching subsystem that can be added onto the hopper/loading mechanism. We would be designing the catching subsystem under the assumption that it would only be catching “Frisbees” from devices built by other groups based on the design constraints presented in the project description. Under this assumption we can develop a hole the same size as the targets we will be shooting at and use retro-reflective tape around it to allow the other devices to “see” the target/catching mechanism.

Launching

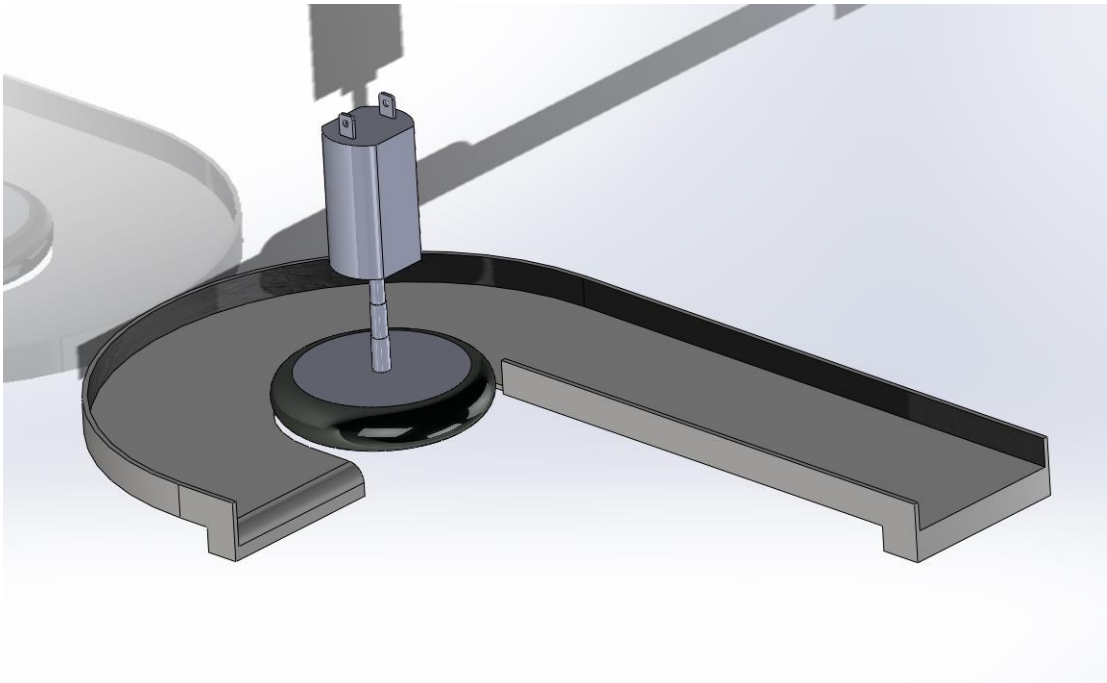


Figure 5. Launching subsystem

The launching subsystem is of relatively simple design. We will have a spinning wheel in the middle powered by a large motor spinning at a to-be-determined rpm. The width of the channel shown in Figure 5 will be 3.5” so that the “Frisbee” fits snugly and will not vibrate or jostle around leading to inaccuracies. A design decision that still needs to be solidified is the placement of the motor powering the wheel. In the figure it is shown as attached on top of the wheel, however, pending the final dimensions of the design the motor may be placed underneath the wheel. By having the motor under the wheel the design would be more aesthetically pleasing overall and also reduce the necessary length of the wiring which is always ideal.

Rotating

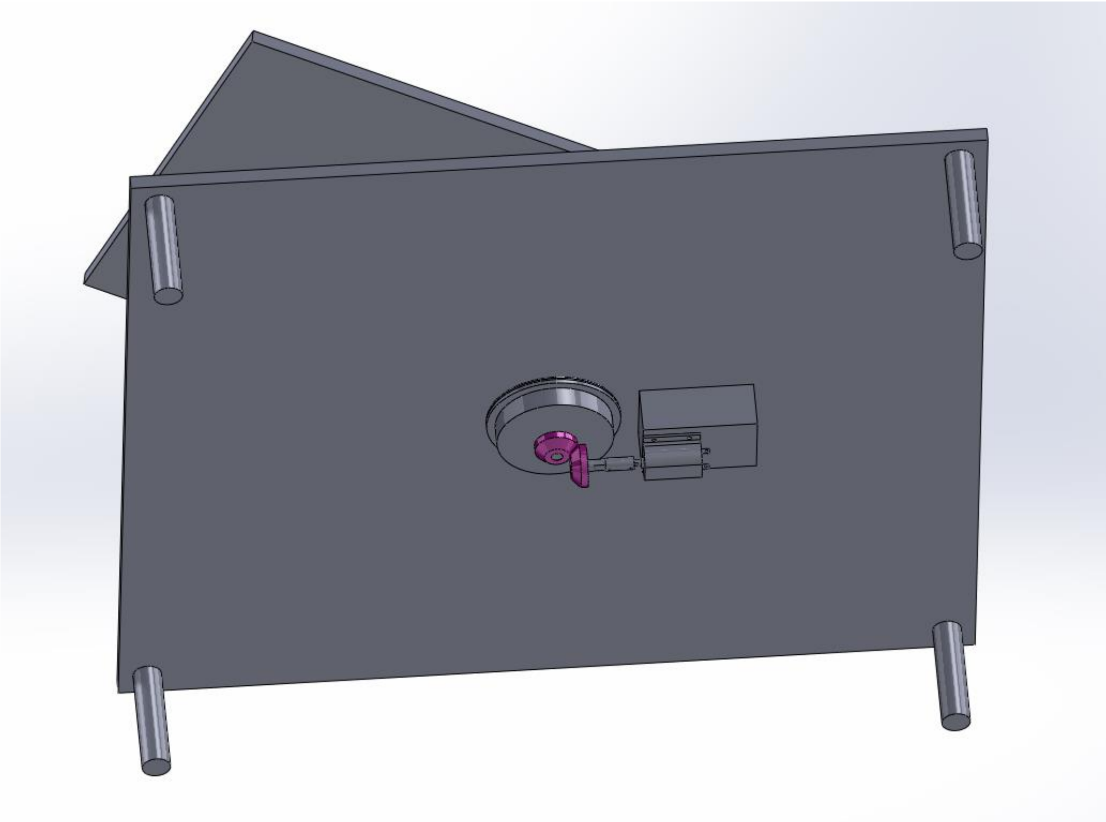


Figure 6. Rotating subsystem

Lastly we have the rotating subsystem outlined in Figure 6. The current CAD model depicts a thrust ball bearing that is geared by a servo and allows the entire system to rotate so that the x-axis component of the targeting system can be realized. Currently we are still debating the exact mechanism to use for this subsystem as there is debate of simple coupling the servo directly to the shaft that will rotate the launcher.

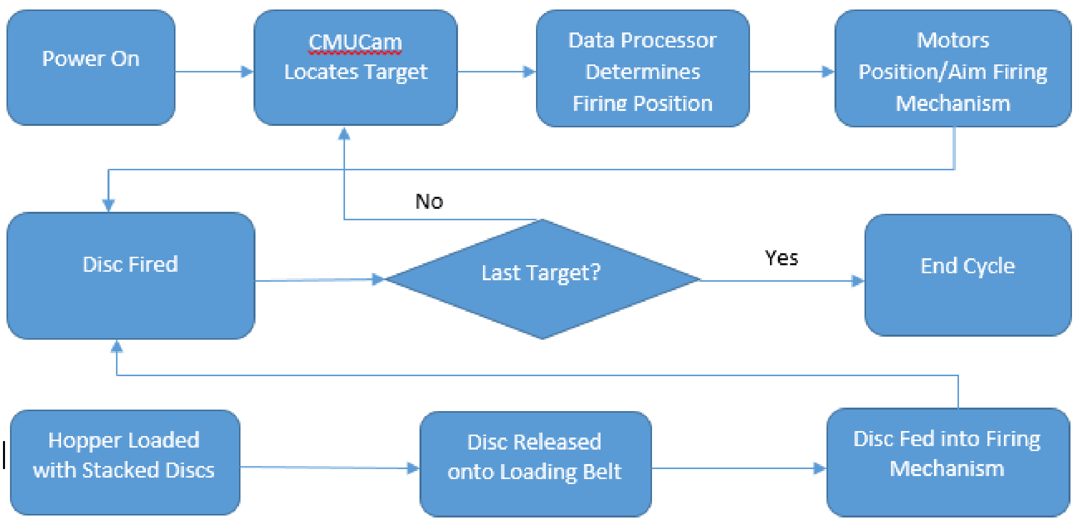
Architecture

Functional Architecture

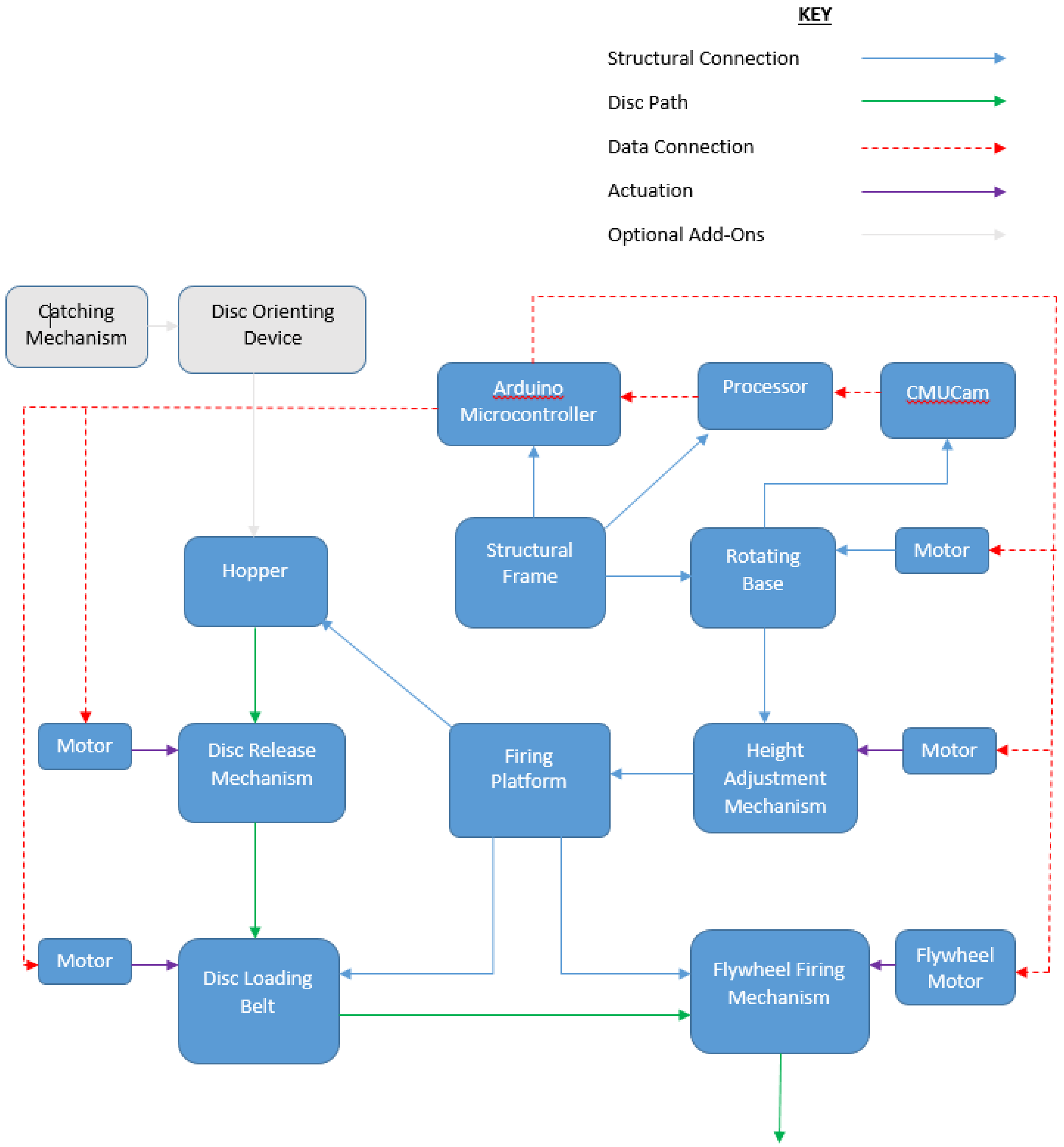
Prioritized List of Functional Goals

1. Accurately and consistently throw the discs
    - Accurate positioning of firing mechanism
    - Consistent disc linear and angular velocity
2. Accurately and quickly locate the target
3. High firing rate
    - Fire three discs in 20 seconds
    - Quick turnaround between hopper release and fire
    - Efficient positioning after target is located

Functional Block Diagram



Physical Architecture



Provisional Parts List & Budget

Parts	Cost (USD)
Arduino Uno board	provided
CMU cam	provided
~20ft of multi-colored wire	free
High speed servo motor	~50
Large servo full rotation	13.95
Large Servo	12.95
Battery/Power Supply	~50
Medium Servo	10.95
Wheel	20
2x 24” Al Rod	~12
Shaft coupling	~10
40’ 6061 Al 90deg Angle	~100
48”x48” 6061 Al Sheet	~125
Hardware (nuts/bolts)	~20
Total	~420

Risk Management

Lack of Electrical/CMU cam Experience

All of our team members come from a mechanical engineering background. We are willing to learn and use the necessary knowledge to then apply to the Frisbee Thrower, but chances are we will need more than we can absorb within the limited time. Hopefully our friends from the Electrical and Computer Engineering department can provide some assistance in this area. We might seek advice from the TAs as well.

Unknown Frisbee Properties

Given the current issue of quality of the currently selected “Frisbees” and the fact that the design proposal is due before this important component is ironed out. There can be expected to be some changes to the design pending a change in the “Frisbee” the machine is expected to throw. Granted these changes will most likely just be dimension based changes it is possible that a significant increase in size would require the reinvestigation of some of our design decisions.

Control Issue

Aiming is a major concern for the Frisbee Thrower project description and a certain level of accuracy is to be expected. With this in mind there will come the necessity of a variety of controls to be put into place for the storing, feeding, and launching phases of the functional architecture. This control will need to undergo significant troubleshooting to ensure optimum results.

Over Budget

A budgeting deficit could occur due to unexpected changes in design, overly optimistic estimation of cost, and mistakes during fabrication. We are hoping to scavenge as much of our materials as possible to ensure remaining within the provided budget of the course.

Unsuccessful Schedule Execution

Given the large number of tasks and assignments due every week the possibility of falling behind schedule is a definite concern. However, by providing our schedule with several time “cushions” we can provision some time for the unexpected to happen which will in turn allow us to stay on schedule and complete the project, tasks, and assignments within the defined times and schedule provided in the syllabus.

Semester Schedule

Week	Goals	Assignments
01	Form teams Decide project topic	Task 0: Teaming info document
02	Brainstorming Design mechanism	
03	Detail system discussion Finalize design Prepare for mock-up & control demo	Task 1: Design concept proposal
04	Finish mock-up & control prototype Survey necessary sensor Learn usage of CMUcam	Task 2: Mock-up demo Task 3: Motor control demo
05	Finish sensing system Build & test state machine	Task 4: Sensing demo
06	Finish state machine implementation Start integrating machine	Task 5: State machine demo
07	Finish frisbee thrower 1.0 Prepare design presentation	Task 6: System demo #1
08	Test & adjust the thrower Plan for 2nd half of semester	Task 7: Design presentation
09	Spring Break – buffer week	
10	Finish frisbee thrower 2.0 More testing & iteration	Task 8: System demo #2
11	Finish frisbee thrower 3.0 More testing & iteration	Task 9: System demo #3
12	Finish frisbee thrower 4.0 More testing & iteration	Task 10: System demo #4
13	Finish frisbee thrower 5.0 More testing & iteration	Task 11: System demo #5
14	Finish frisbee thrower 6.0 More testing & iteration	Task 12: System demo #6

15	Finish frisbee thrower 7.0 Final testing week Prepare final demo	Task 13: System demo #7
16	Finish frisbee thrower 8.0 Fix minor bugs if any Prepare public demo & final report	Task 14: Final system demo
17	Proudly present frisbee thrower 8.0 Finish final report	Task 15: Public presentation Task 16: Final report
18	Update team website for the last time Celebration party	Task 17: Team website

Team Member Responsibilities

Yannick Poffet	Control Lead: in charge of motor & system control
	Teamwork: mechanism design, fabrication and testing
Jeff Quackenbush	Positioning Lead: in charge of machine aiming
	Teamwork: mechanism design, fabrication and testing
Evan Walden	Feeding Lead: in charge of frisbee storing & feeding
	Teamwork: mechanism design, fabrication and testing
Jackie Yang	Launching Lead: in charge of frisbee launching
	Teamwork: mechanism design, fabrication and testing