Centripetal Force Simulator

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Interview

Client Interview - Ideas

Physics Simulator to explore and gain a deeper understanding of centripetal force

Which of the following should be made adjustable?

- [x] Mass
- [x] Centripetal Force
- [x] Centripetal Acceleration
- [x] Radius
- [x] Other: Period of Rotation, Coefficient of Friction, Position of objects

Does the data need to be saved for later use (i.e written to a file)

- ( ) Yes
- (•) No

Is there a need for a grid based system to track position?

- (•) Yes
- ( ) No
- ( ) Maybe

What colour palette should the UI use?

B&W

Should there be outside forces acting on the object?

- (•) Yes
- ( ) No

What graphs should be produced?

No

How important is the design of the program?

	1	2	3	4	5	
Unimportant	○	○	◉	○	○	Critical

What other data should the program display?

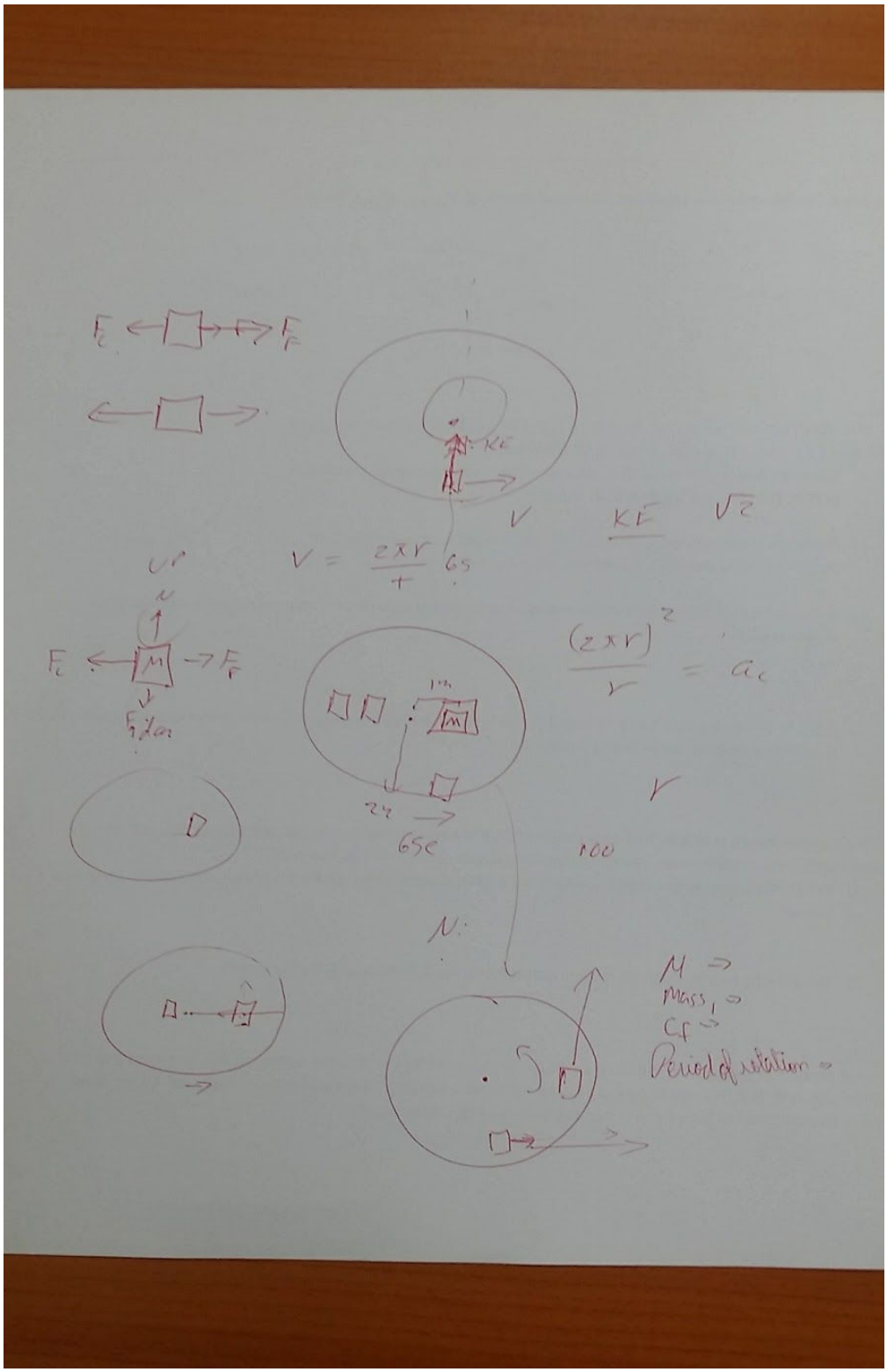
- [ ] Kinetic Energy
- [ ] Momentum
- [x] Free Body Diagram
- [ ] Other:

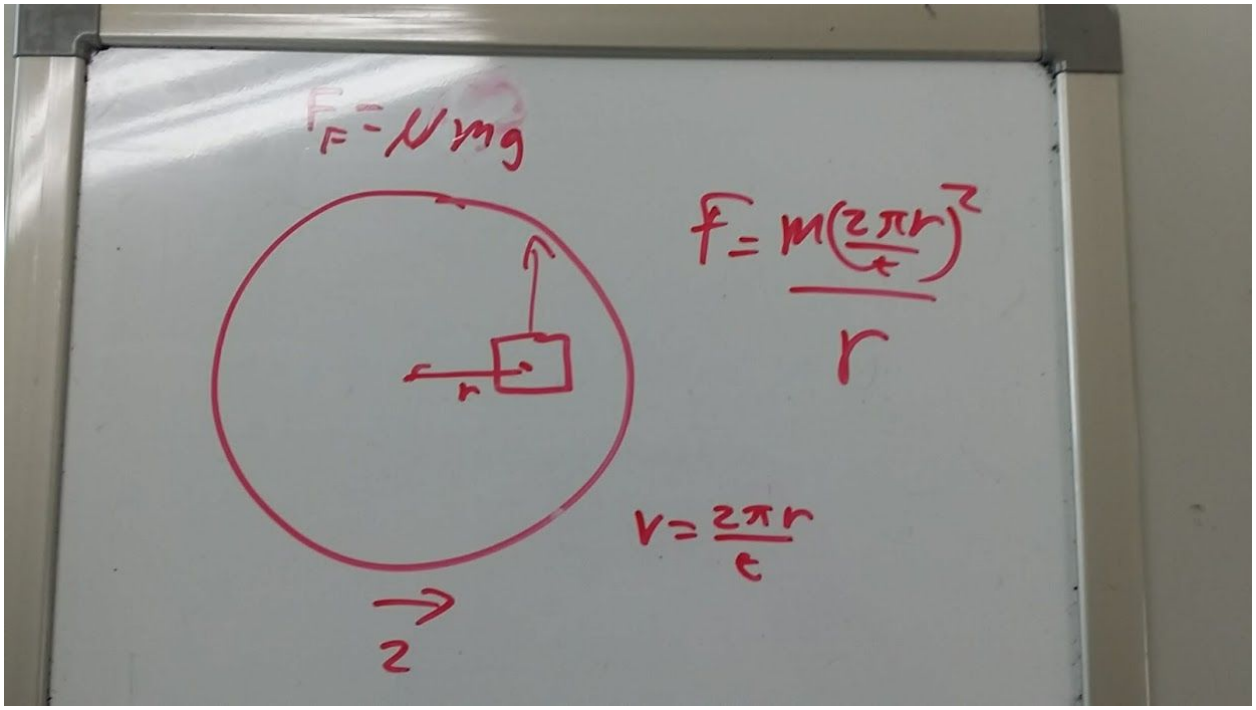
Should it allow solving for variables (i.e the user enters radius and force, and the program calculates the acceleration and draws it)?

- ○ Yes
- ◉ No
- ○ Other:

Other suggestions?

Sketches

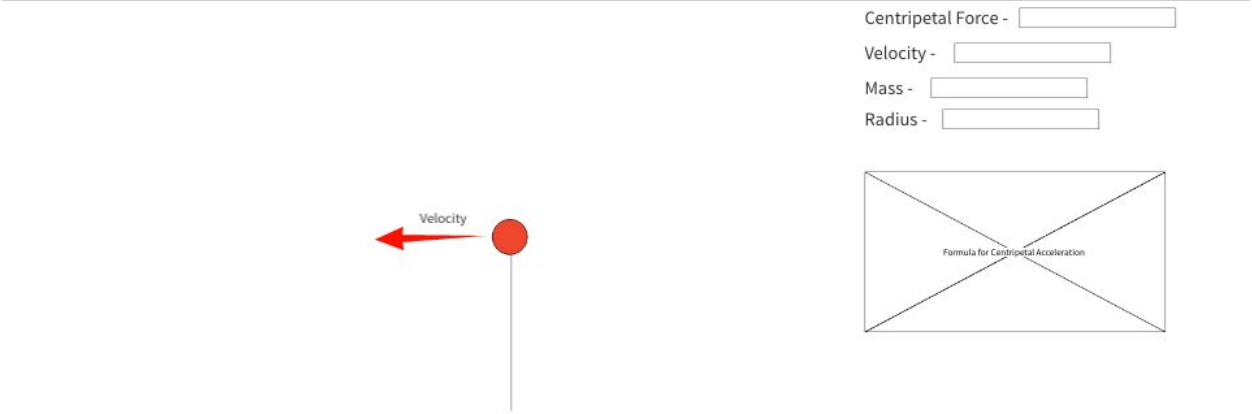




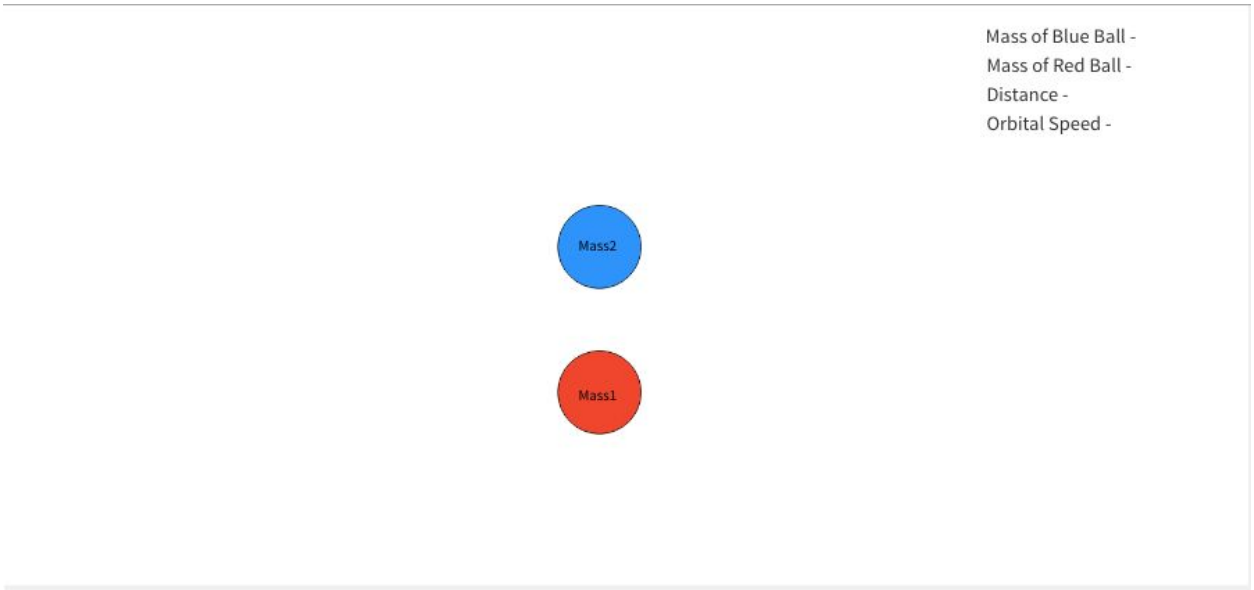
Specifications

- Incorporate static friction
- The size of the object is dynamic with respect to its mass
- Allows the placement of multiple objects on the platform
- Generates a free body diagram for each object
- Simulates the movement of the object depending on friction and centripetal force
- Allow the development of lab activities based around the software
- The speed of rotation is adjustable

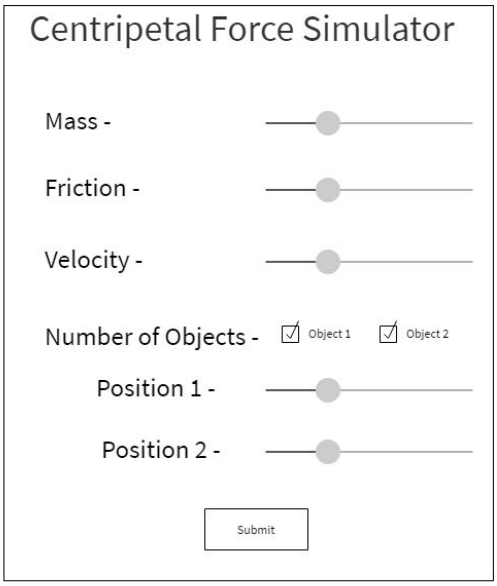
Designs

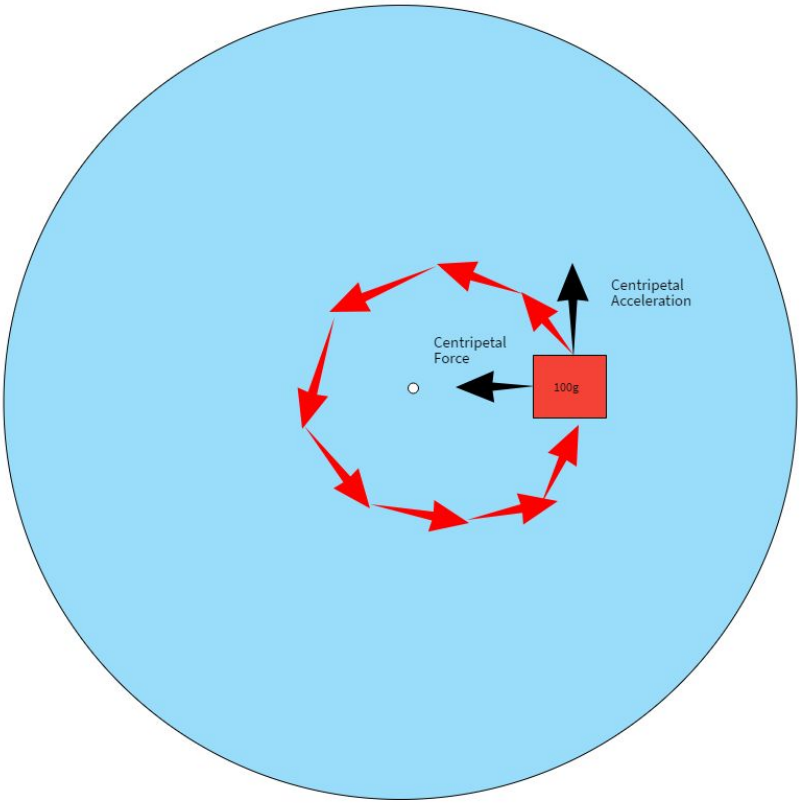


The user enters in three of the datafields at the top right, and the program calculates the last one. In order to prevent the user from entering bizarre information, the program never allows the user from entering all four data fields at once by automatically calculating the last one. Using this information, the ball that is attached to the string spins. This can be done by using a canvas and having the program calculate the position of the ball on the canvas. In order to make it move in a circular path, the program calculates all possible positions of the ball given the current radius. As it spins, a dynamic free body diagram is generated for the ball in order to demonstrate the forces acting (such as centripetal force and velocity). The image contains the formula for centripetal force.



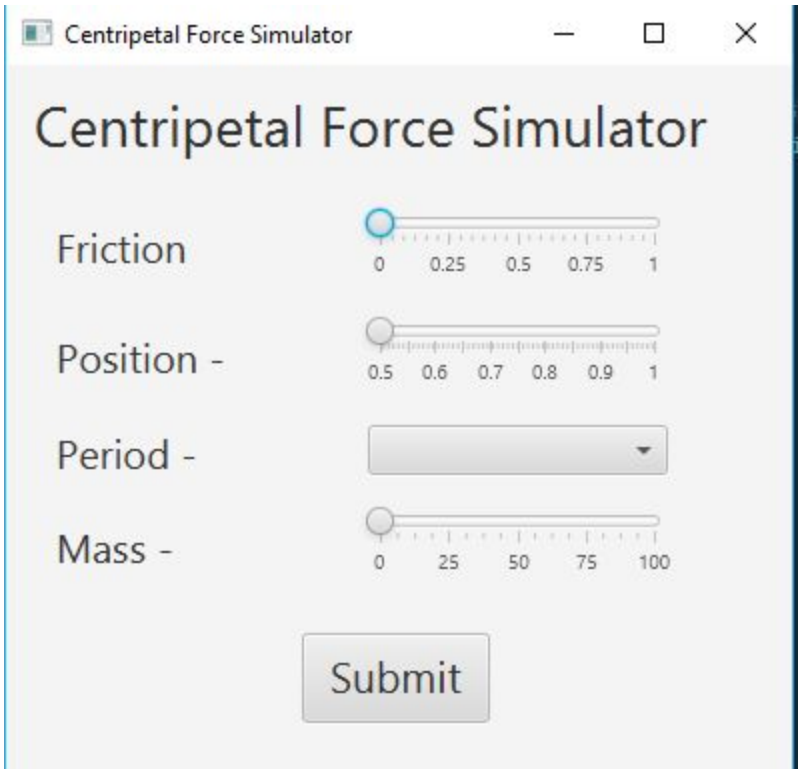
The user enters in at least three of the datafields at the top left, and the program calculates the rest. Using the mass of the two balls, the program determines the force of gravity for both balls. Depending on the gravity and set velocity, the balls move in relation to each other. For example, if the red ball is very large and blue ball is very small and is moving fast, the blue ball orbits the red ball. If the velocities are high enough, the two balls should be able to collide. In order to prevent the user from entering physics-breaking data, the data will be validated to make sure that is not breaking any laws of physics.

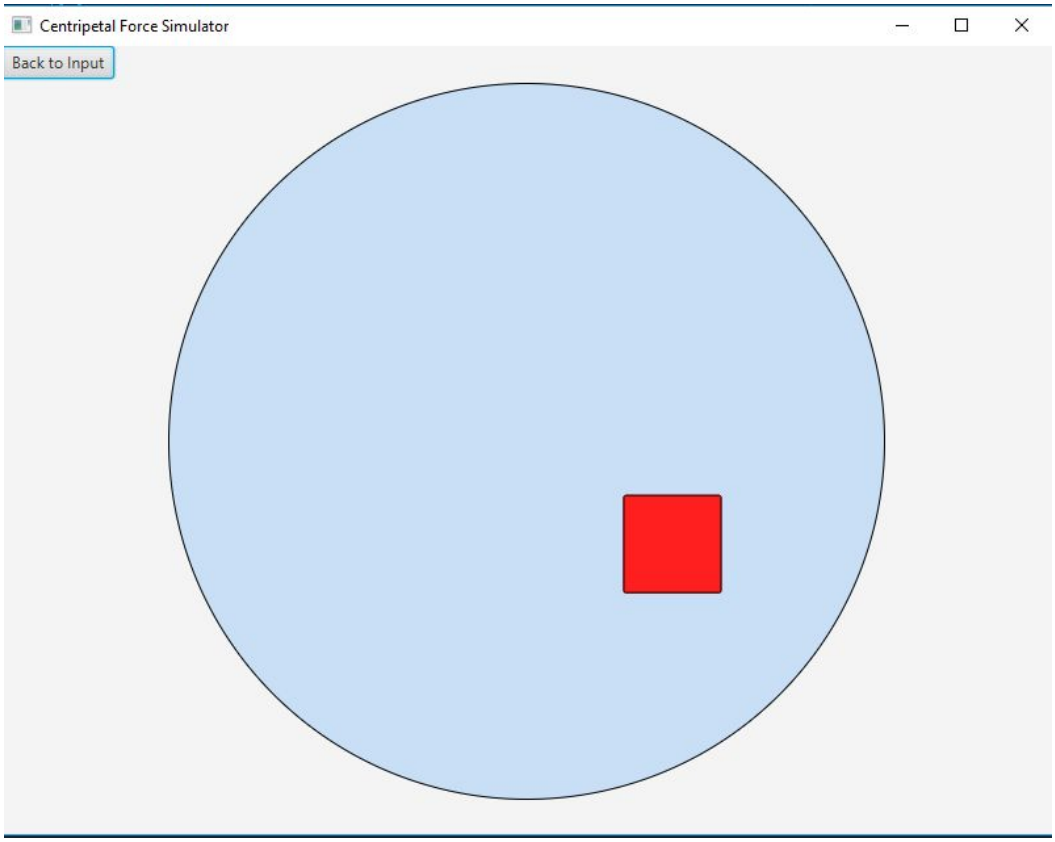


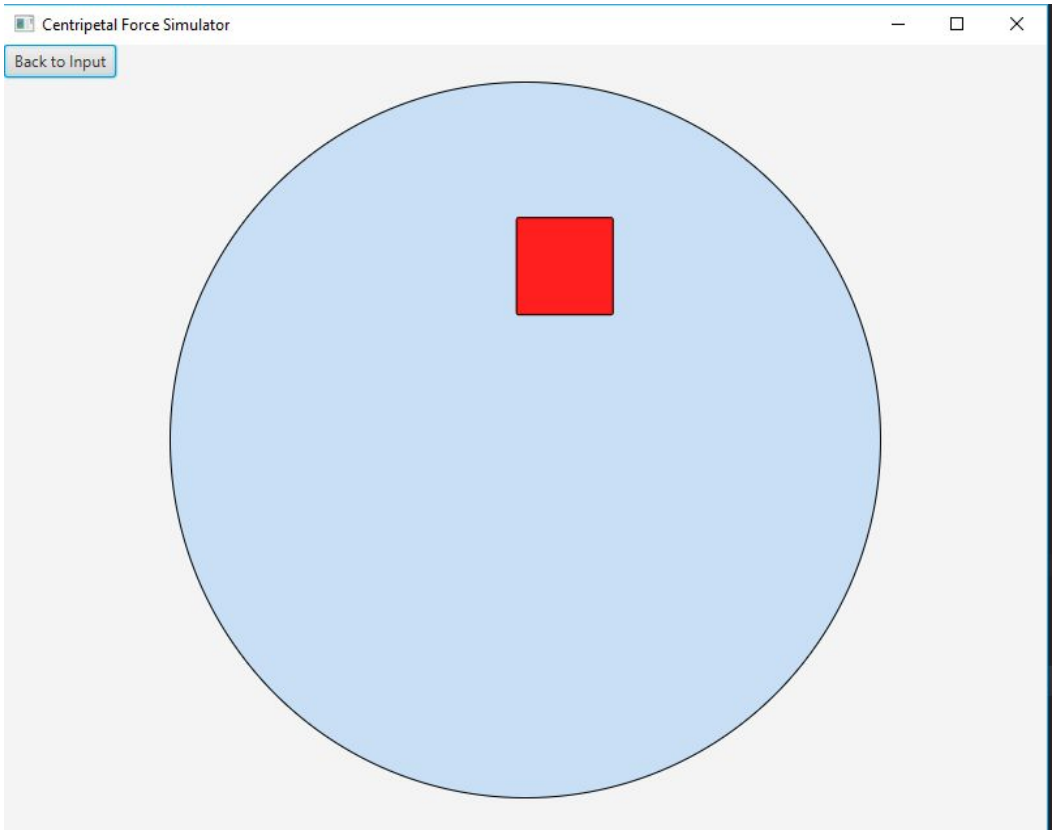


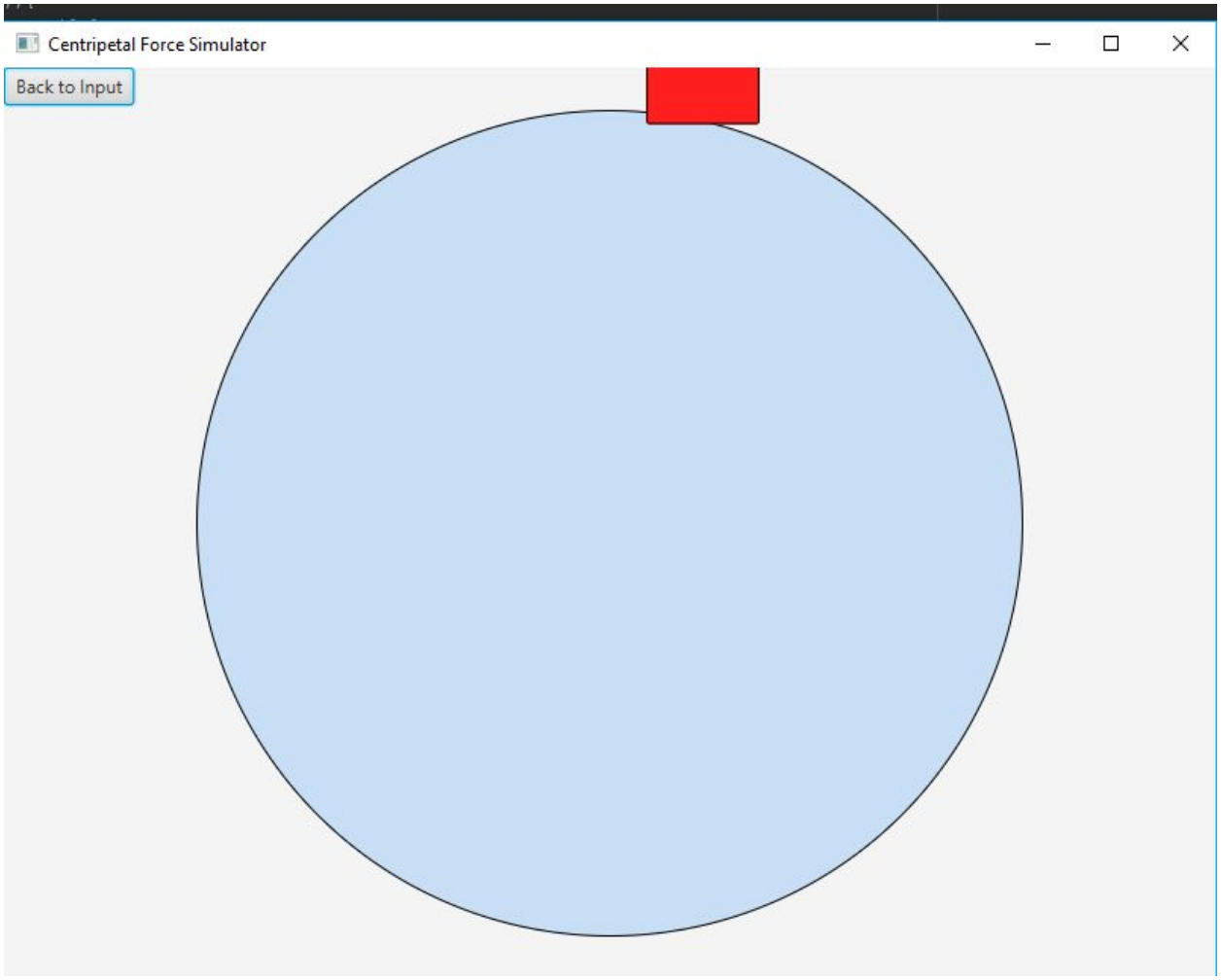
The user needs to enter all the data in the input screen as specified in the first screenshot. Once the user clicks on submit, the program will retrieve all the data as it was entered. Based on the set friction level, position and period, the program will calculate the static friction force and the centripetal force. If the force of friction is greater than the centripetal force, the object needs to follow a curved path off screen. Otherwise, the object needs to travel in a circular path around the centre with the velocity depending on the period that the user selected. The purpose to demonstrate the relationship between friction force and centripetal force.

Protoype 1


Centripetal Force Simulator
Centripetal Force Simulator
Friction
0 0.25 0.5 0.75 1
Position -
0.5 0.6 0.7 0.8 0.9 1
Period -
Mass -
0 25 50 75 100
Submit


Centripetal Force Simulator
Back to Input


Centripetal Force Simulator
Back to Input


Centripetal Force Simulator
Back to Input

Testing

Survey

Prototype 1 - Feedback

What are some design modifications that you think are necessary?

Display the data from the input screen on the animation screen,

Should the platform itself rotate?

- (●) Yes
- ( ) No

How is the movement of the box off the screen simulated?

Have it move in a curved path off the platform

Should the mass and the centre point be indicated on the screen?

- (●) Yes
- ( ) No

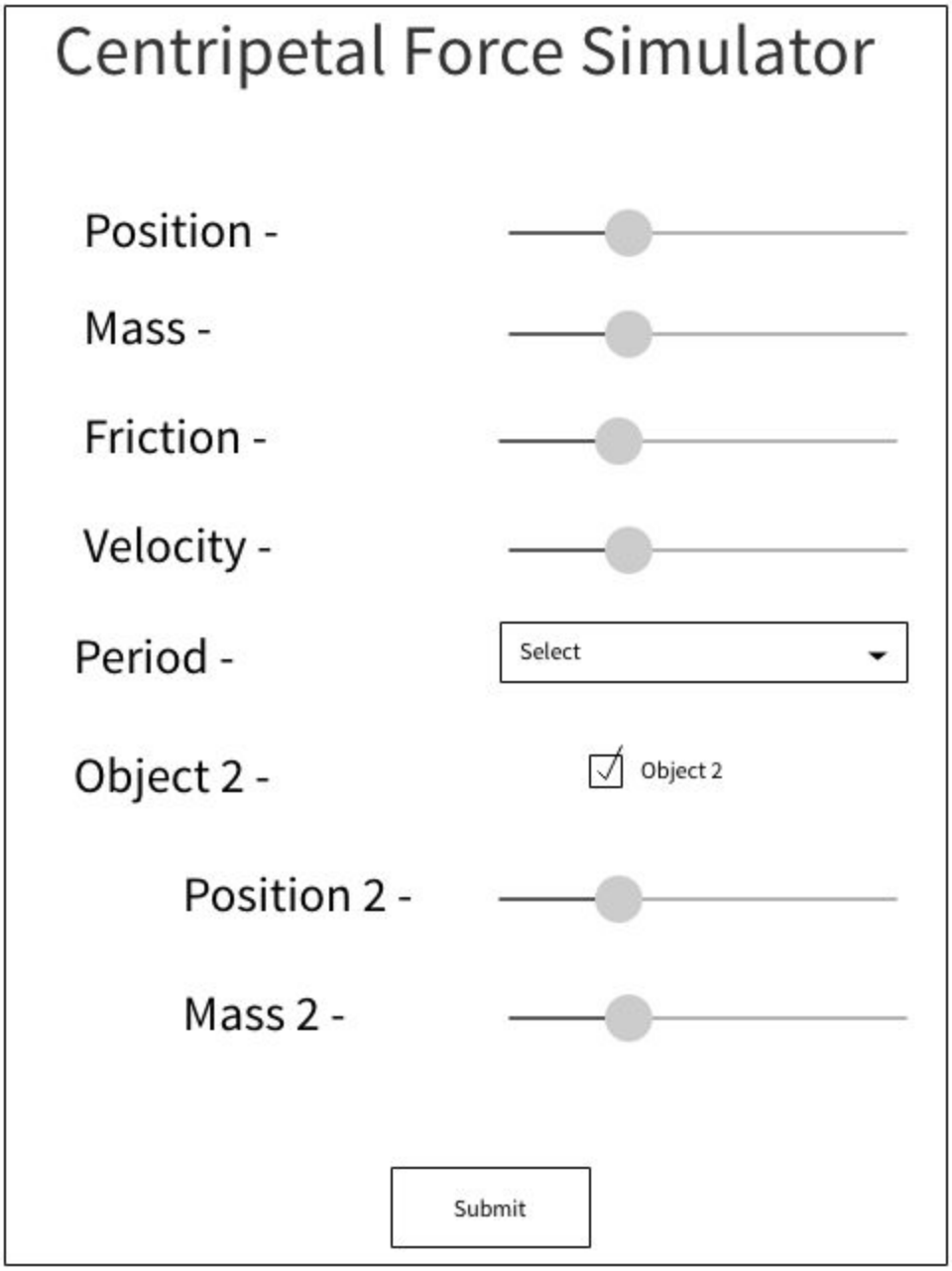
Suggestions?

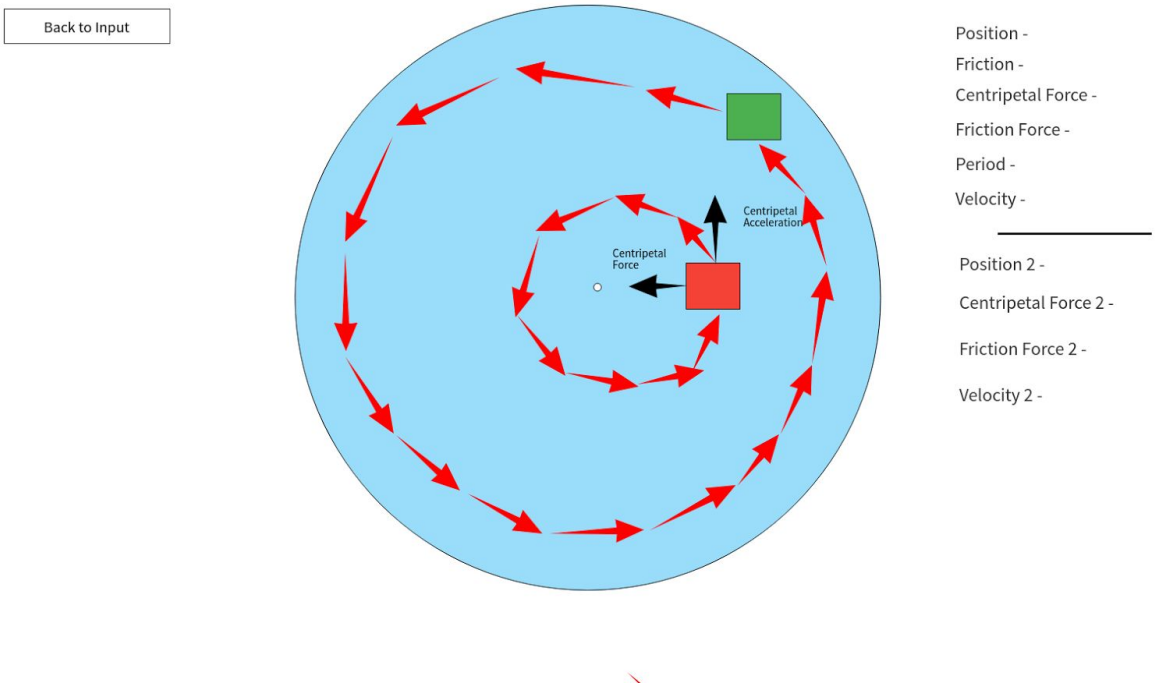
Determine min, max for each type of force and set it to overlap, use arbitrary values if necessary, Show free body diagrams

Testing Report

The client was generally pleased with the progress shown in prototype 1, but had some important critiques. The client detailed that he wanted the data that the student enters to be displayed on the animation screen in order to clearly show what was entered. The client also mentioned that he would prefer the sliders to snap to key values instead of being completely smooth. In the event that the client that the box needs to slide off the platform, the client detailed that he would like the object to follow a valid curved path off the platform rather than simply have it move off screen. He also expressed concerns that the parameters necessary to make the friction force exceed centripetal force was too stringent, and advised that using arbitrary values are still valid as long as they are used consistently.

Design 2

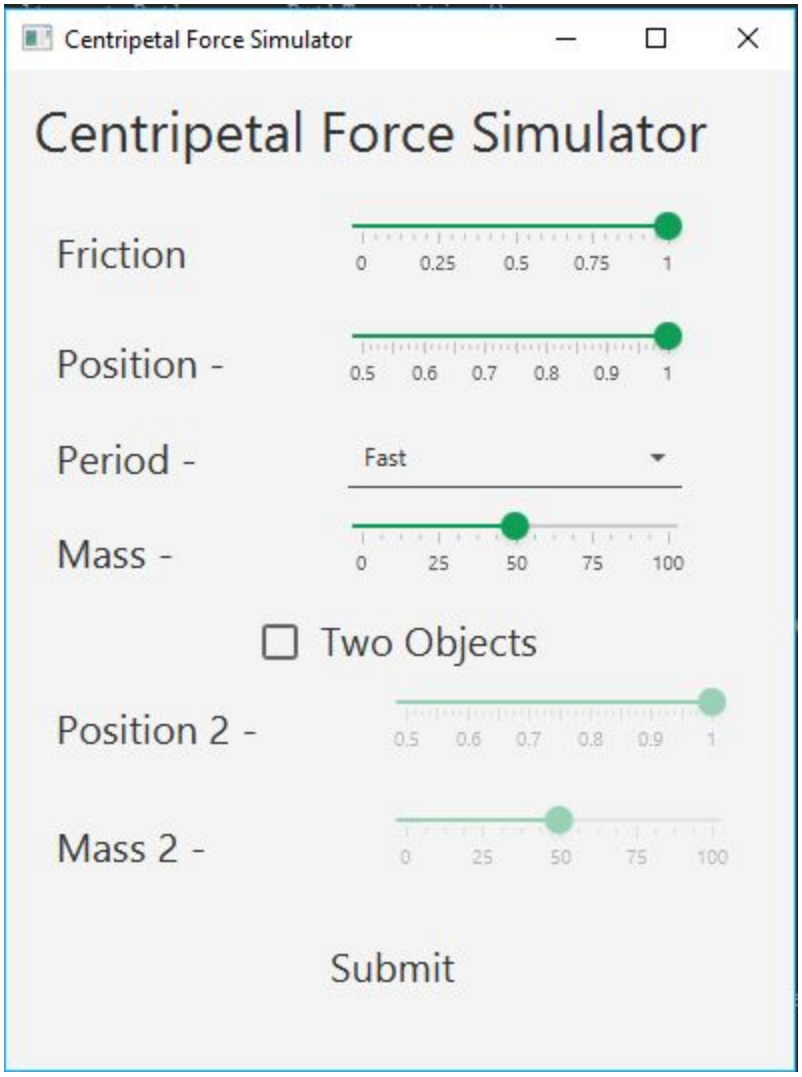

Centripetal Force Simulator
Position -
Mass -
Friction -
Velocity -
Period -
Select
Object 2 -
Object 2
Position 2 -
Mass 2 -
Submit

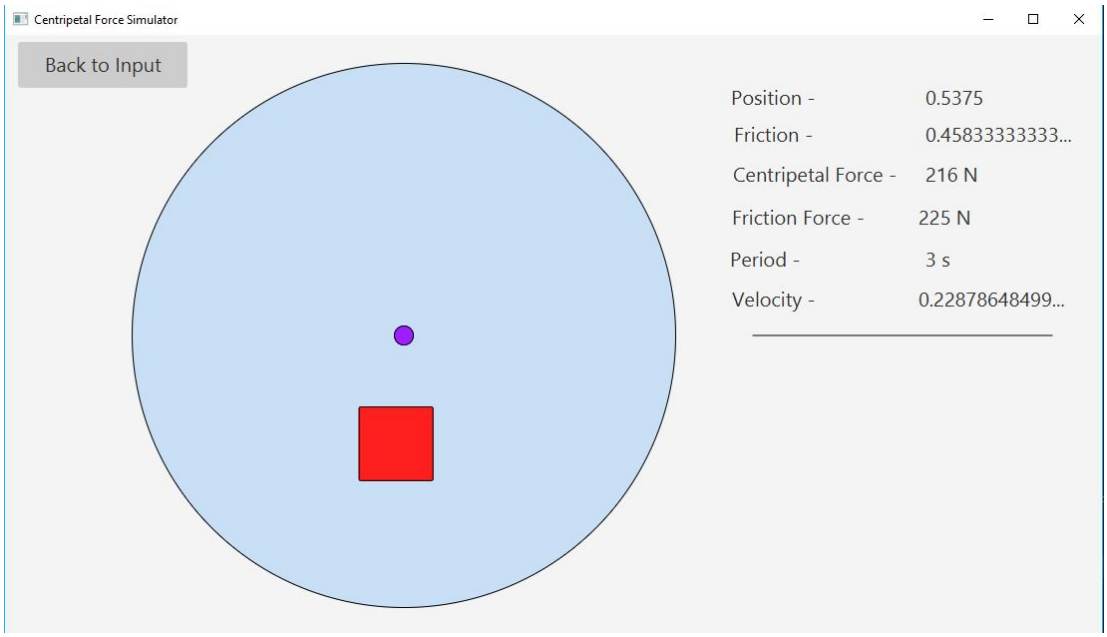


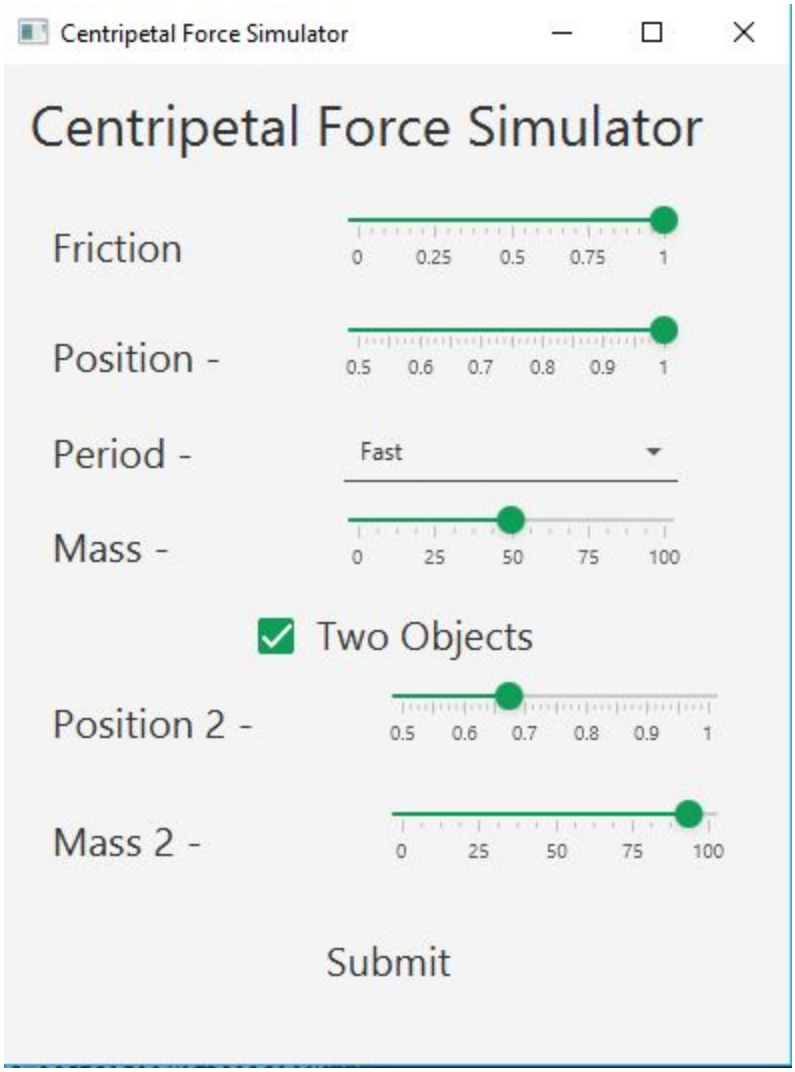
The input screen allows the user to enter the necessary information required to run the simulation. Initially, the object 2 checkbox is unticked and the sliders pertaining to that are disabled. Once the user enables object 2, the sliders are activated and the user is allowed to access them.

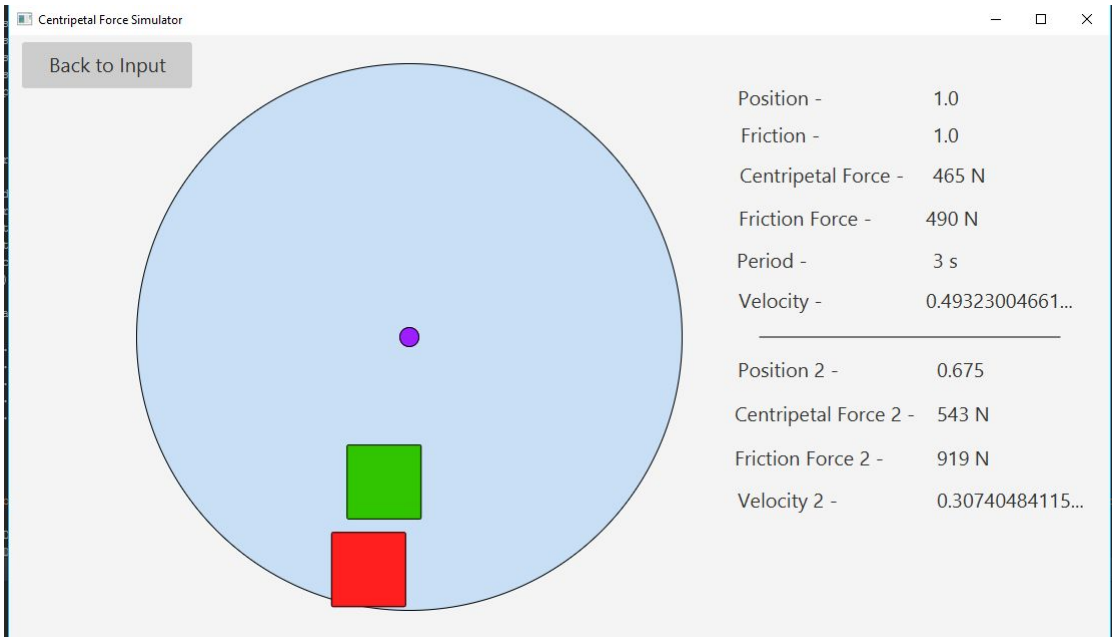
The simulation screen is mostly unchanged from design 1. Some additions include the information being presented on the right hand side of the screen. This is to allow the user to view the exact data that is being used to run the simulation. The second object is simulated in much the same way as the first object. A button is added to the top left that allows the user to stop the simulation and return to the input screen in order to change the data.

Protoype 2


Centripetal Force Simulator
Centripetal Force Simulator
Friction
0 0.25 0.5 0.75 1
Position -
0.5 0.6 0.7 0.8 0.9 1
Period -
Fast
Mass -
0 25 50 75 100
Two Objects
Position 2 -
0.5 0.6 0.7 0.8 0.9 1
Mass 2 -
0 25 50 75 100
Submit


Centripetal Force Simulator
Back to Input
Position - 0.5375
Friction - 0.45833333333...
Centripetal Force - 216 N
Friction Force - 225 N
Period - 3 s
Velocity - 0.22878648499...


Centripetal Force Simulator
Centripetal Force Simulator
Friction
0 0.25 0.5 0.75 1
Position -
0.5 0.6 0.7 0.8 0.9 1
Period -
Fast
Mass -
0 25 50 75 100
Two Objects
Position 2 -
0.5 0.6 0.7 0.8 0.9 1
Mass 2 -
0 25 50 75 100
Submit


Centripetal Force Simulator
Back to Input
Position - 1.0
Friction - 1.0
Centripetal Force - 465 N
Friction Force - 490 N
Period - 3 s
Velocity - 0.49323004661...
Position 2 - 0.675
Centripetal Force 2 - 543 N
Friction Force 2 - 919 N
Velocity 2 - 0.30740484115...