Project Requirements Document

CSE 481v AR/VR Capstone

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Rockit Physics

Hi 5

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Summary

Rockit Physics is a VR physics playground to help users with little knowledge of classical mechanics have a stress free and immersive environment to get acquainted with basic physics concepts. Our aim is to give a real-time connection to the concepts of Energy(mainly gravitational potential and kinetic), Forces(Newton's laws of motion), and the derivatives of position over time(position, velocity, and acceleration). Rockit Physics will focus on the high-level understanding of concepts, opting to familiarize users with basic concepts and relationships rather than focus on low-level computation and equations.

Deliverables

- VR application
  - VR physics playground controlled with Acer Motion Controller featuring a block that the user can interact with. There is a Head-Up Display featuring relevant data and physics concepts based on current user interaction, updating in real-time. We will also feature a Free-Body Diagram and allow the user to manipulate time and gravitational constant.
  - Demo user should be able to have a basic sense of gravity and relationship between GPE and KE given the effects of gravity.
  - Demo user should have a basic understanding of the difference between acceleration and velocity.
- Kickstarter style website tracking progress and demoing the current product
- Kickstarter style hype demo video

Critical Features

Minimum Viable Product

- Moveable block in an open room controlled via controllers
- Head-Up Display showing real-time Free-Body Diagram based on the current movement of the block
- Head-Up Display showing current block properties (acceleration+direction, velocity+direction, gravitational potential energy, kinetic energy, gravity)
- Ability to pause and continue time to see properties at a freeze-frame

Final Product

- Expandable Head-Up Display which gives more information for each property, describing the physics concepts behind the property and relationships with other properties
- Adjustable gravity setting allowing users to change gravitational constant

Stretch Goals

- Apply a pre-selected force then play the action
- Add atmosphere and drag force, with adjustable air density
- Add multiple objects and show more complex concepts, such as leverage, moment, and concepts of multi-object interactions, circular motion

Performance Metrics

- Functionality - Is the user able to complete the following tasks
  - Control the objects in the scene
  - See the properties of the objects at any time and position
  - Pause and unpause the scene
  - Set the physics variables of the environment
- Enjoyability - Is the user able to enjoy interacting in the playground?
- Teaching Moment - Is a user with no concept of classical mechanics able to gain any high-level understanding of the relationship between KE and GPE? Does the user understand more about mechanics after the demo?
- Ease of Use - Do the controls feel natural? Is the user able to interact with the environment and Head-Up Display effectively?

Milestones

Week 1 (Oct 1 - Oct 5)

Team interaction, scheduling, initial brainstorming

- Full Team

Week 2 (Oct 8 - Oct 12)

Project proposal and presentation, set up DevOps and UW-Gitlab repo

- Full Team

Week 3 (Oct 15 - Oct 19)

Initial Kickstarter style website, Project Requirements Document, build bare bones Unity project on Acer Headset

- Candice Miao - project management, assist Unity build
- Jeff Ranhao Xu - building project to Acer Headset with controllers API's downloaded
- Phoenix Youngman - website creation and design
- Ryan Smith - first draft PRD, assist website creation

Week 4 (Oct 22 - Oct 26)

Explore Unity 3D Physics, Colliders, Rigidbodies, and Physics Forces. Demo - Working block interaction with Dell VR Controllers

- Candice Miao - Explore SteamVR SDK for working with Dell VR Controllers
- Jeff Ranhao Xu - Explore SteamVR SDK for working with Dell VR Controllers
- Phoenix Youngman - demos using Colliders, Rigidbodies, and Physics Forces from Unity scripts
- Ryan Smith - demos using Colliders, Rigidbodies, and Physics Forces from Unity scripts

Week 5 (Oct 29 - Nov 2)

Concept of Gravity, and associated motion information built into the demo

- Candice Miao - Working HUD updating gravity information in real-time
- Jeff Ranhao Xu - Block reacting to gravity with tracking physics properties in real-time
- Phoenix Youngman - Working HUD updating gravity information in real-time
- Ryan Smith - Block reacting to gravity with tracking physics properties in real-time

Week 6 (Nov 5 - Nov 9)

Concept of Gravitational Potential Energy converting to Kinetic Energy built into the demo

- Candice Miao - Adding HUD elements for GPE and KE that co-interact
- Jeff Ranhao Xu - Calculating changes in GPE and KE as the cube changes the height
- Phoenix Youngman - Calculating changes in GPE and KE as the cube changes the height
- Ryan Smith - Adding HUD elements for GPE and KE that co-interact

Week 7 (Nov 12 - Nov 16)

Force Body Diagrams viewable overlayed on Rigidbodies

- Candice Miao - Calculating force applied (from gravity, friction, user input) with vectors
- Jeff Ranhao Xu - Calculating force applied (from gravity, friction, user input) with vectors
- Phoenix Youngman - Overlay 3D FBD near object using calculated values

- Ryan Smith - Overlay 3D FBD near object using calculated values

Week 8 (Nov 19 - Nov 23)

Expandable HUD elements with more information and concepts, User can pause time

- Candice Miao - Work out experience for HUD being richer
- Jeff Ranhao Xu - Implementation of additional HUD experience in the demo
- Phoenix Youngman - Work out experience for HUD being richer
- Ryan Smith - Implementation of additional HUD experience in the demo

Week 9 (Nov 26 - Nov 30)

Add ability to adjust constants (Gravity, potentially Friction)

- Candice Miao - Edit 3D scripts to allow and responds to different friction values, demo testing
- Jeff Ranhao Xu - Edit 3D scripts to allow changing gravity value, in-depth demo testing
- Phoenix Youngman - Edit 3D scripts to allow changing gravity value, in-depth demo testing
- Ryan Smith - Edit 3D scripts to allow and responds to different friction values, demo testing

Week 10 (Dec 3 - Dec 7)

Finalizing Demo, attempting to make styling and experience more professional

- Candice Miao - Testing, debugging, and design tweaks
- Jeff Ranhao Xu - Testing, debugging, and design tweaks
- Phoenix Youngman - Testing, debugging, and design tweaks
- Ryan Smith - Testing, debugging, and design tweaks

Materials and External Help

- Extensive use of Unity's physics scripts
- Extensive use of SteamVR SDK for controller interaction
- Reserve our budget for potentially adding more professional graphics, 3D models, or background textures to the demo

Risks

- **The user isn't engaging with physics and just playing without learning**
  We need to take care to direct user attention to the physics aspect of the playground and not just give them the impression that they are playing with a block aimlessly. This may require adding story elements that introduce the user to the experience or walk them through an intended interaction
- **The user is unable to relate the changes in the properties of the object to the physical concepts**
  Add a function to change the time scale so that the user is able to watch the changes in slow motion. Displaying the relationships between each property could also help the user to understand the relationships between the variables.
- **The user feels sick or dizzy using our experience**
  We need to take care to limit the speed of acceleration of objects in the playground and keep in mind that a static reference can help users not feel motion sickness with other elements are in motion