2-Dimensional Physics Simulation Environment (Sandbox)

Software Design Document

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**Introduction:**

The project is a 2-dimensional (2-D) physics engine. The goal is that it can be interacted with by the user. There will be a Graphical User Interface (GUI) that the user can interact with that will show a User Interface (UI) version of the physics simulation. There will be a gravity that can be toggled between using global (base earth gravity of 9.81m/s2 (1)) or particulate gravity (gravity based around the weight and distance of the particles). The reasoning behind this project is to help better understand how physics operations work, but also provide entertainment of providing an interactable 2-D physics simulation, known as a physics sandbox. This document will explain what the requirements of the program are (Table 1) and will list several test cases to test those requirements (Table 2).

**Background information:**

DAT files are a common type of ‘Comma Separated Values’ (CSV) file.

Known physics formulas in use for this project:

Gravitational Constant: (1)

Force between two gravitational bodies: (2)

Acceleration due to gravity: (2)

Force: (2)

Law of Cosines: (3)

Inelastic Collision Formula: (4)

**Requirements:**

Table 1: Requirement Specifications

|  |  |
| --- | --- |
| **ID** | **Requirement Specification** |
| 1 | As a user I want to be able to create new shapes. |
| R1. The user shall open the spawn menu while right clicking, in which they can spawn new shapes. |
| 2 | As a user I want to be able to remove shapes |
| R2. The user shall have the option to remove shapes by right clicking them |
| 3 | As a user I want to be able to move shapes |
| R3. The user shall have the option to move shapes by clicking and dragging them |
| 4 | As a program designer I want to simulate 2d physics in an appropriate and realistic way. |
| R4. The outcomes of the program shall be mathematically **provable** to be correct following the gravity physics formulas previously mentioned. |
| 5 | As a program designer I want to provide different shape options to the user. |
| R5. The user shall have the option to create different shapes. |
| 6 | As a program designer I want to provide an accurate GUI layout that ensures the program can be navigated easily. |
| R6. There shall be UIs that the user can control the simulation from. |
| 7 | As a user I want to be able to save simulations to a file. |
| The user shall have the option to save the simulations to a file in the pause menu. |
| 8 | As a user I want to be able to reload simulations from a file. |
| The user shall be able to open simulations from a file in the main menu. |
| 9 | As a program designer I want to be able to easily edit various constants and settings for the program externally from the code. |
| R9. There shall be 2 DAT files embedded within the project that shall store data for the programs use. |
| 10 | As a user I want there to be a menu for interacting with the entire program. |
| R10. There shall be a ‘main menu’ screen that allows the user to edit settings and chose to launch either a new simulation or launch a previously saved simulation. |

**Test Cases:**

Table 2: Test Cases and Results

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Req’t**  **ID** | **Test**  **Case**  **ID** | **Initial**  **Conditions**  **And Input** | **Expected Behavior**  **Or Output** | **Actual**  **Behavior**  **Or Output** | **Pass**  **Fail** |
| 1 | 1 | \*In simulation\* \*User right clicks on screen\* | Menu Opens, Console prints “Opened Spawn Menu” | \*Window Titled ‘Spawn Menu’ Appears On Screen\* Console prints “Opened Spawn Menu” | PASS |
| 1 | 2 | \*In simulation\* \*in spawn menu\* Mass = 1 Size = 25 Click Spawn Ball | Menu Closes, Ball appears on screen, Console prints “Spawned ball with mass 1 and size 25” | Menu Closes, Ball appears on screen, Console prints “Spawned ball with mass 1 and size 25” | PASS |
| 1 | 3 | \*In simulation\* \*in spawn menu\* Mass = 1 Size = 50 Click Spawn Rectangle | Menu Closes, Ball appears on screen, Console prints “Spawned rectangle with mass 1 and size 50” | Menu Closes, Ball appears on screen, Console prints “Spawned rectangle with mass 1 and size 50” | PASS |

Note: All test cases require debug mode to be ON/TRUE (Setting 5 in Settings.DAT)!

**References:**

1: COMSOL Physical Constants Reference <https://doc.comsol.com/5.5/doc/com.comsol.help.comsol/comsol_ref_definitions.12.025.html>

2: United States Naval Academy Physics Chapter 13 PDF  
<https://www.usna.edu/Users/physics/finkenst/homepage_files/SP211/Chapter_13.pdf>

3: Wikipedia: Law of Cosines <https://en.wikipedia.org/wiki/Law_of_cosines>

4: Wikipedia: Inelastic Collision <https://en.wikipedia.org/wiki/Inelastic_collision>