Report

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PH XXX: Mini Project XX

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LOREM IPSUM DOLOR SIT AMET CONSECTETUR, ADIPISCING ELIT AD ALIQUAM.

by

[Name of the Student] (IXXPHXXX)

Under the Guidance of
[Name of the Professor/Supervisor]

Semester XX
Month 20XX - Month 20XX

DEPARTMENT OF PHYSICS
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CERTIFICATE

This is to certify that the mid-semester report entitled Lorem ipsum dolor sit amet consectetur, adipiscing elit ad aliquam. has been duly completed and presented by [Name of the Student] (IXXPHXXX) in the X Year (Semester XX) of 5 Year Integrated MSc (Physics). This report is found to be complete and satisfactory in all respects. and their work is satisfactory.

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ABSTRACT/OBJECTIVE

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1 Understanding Game Physics

We can define "Game Physics" as the way of simulating the laws of physics within a simulation or video game using programming logic to implement these laws. One could say that it is a derivative of a physics simulation but with an element of fun and creativity and used in the form of entertainment instead of research and development.

But one thing that needs to be noted is that Game Physics is not accurate as every developer changes the effects as per their needs. Another main reason is that the games take up a lot of CPU resources to process the calculations, thus increasing the CPU requirements and reducing the audience. This can usually be seen in competitive FPS games such as Counter-Strike and Valorant as their main focus is to reach the game to as many audiences as possible, thus cutting down or reducing the physics in the game.

One thing we need to understand is that video games have always had physics, but how it's used has changed. Initially, each game had its physics programmed individually. Now, games are more complex and have multiple physics simulations running per frame, requiring a game physics engine, a universal code adapted by developers to fit specific games. The newer game physics engine (such as Unity, Unreal Engine & Gadot) have multiple physics simulations already coded into them.

2 Rigid Body Dynamics

In-game physics, we want to animate the game objects on the screen and have them display realistic physical behavior. This can be done by producing an animation with numerical computations applied to the theoretical laws of physics. For these animated objects to move/display motion on the screen, we need the object to update its physical state multiple times per second such that its physical state gets updated every frame.

2.1 Particle Dynamics

To understand this better we take the example of a single particle moving in an enclosed surface like a closed box. The movement of the particle is governed by three parameters that are:
$position : p = (p_x, p_y)$
$velocity : v = (v_x, v_y)$
$acceleration : a = (a_x, a_y)$

But in video games/simulations, the particle moves at a specific frame rate (FPS: frames per second),
$Frame f \rightarrow f + 1$

We can calculate the time between each frame as
$\Delta t = \frac{1}{\text{FPS}}$

Now suppose we have one particle with mass m, position $p(t_i)$, and velocity $v(t_i)$ at an instant of time ti. A force $f(t_i)$ is applied to that particle at that time. The position and

velocity of this particle at a future time $t_i + 1$, $p(t_i + 1)$ and $v(t_i + 1)$ respectively, can be computed with:
$dt = t_{i+1} - t_i$
$v(t_{i+1}) = v(t_i) + a(t_i)dt$
$p(t_{i+1}) = p(t_i) + v(t_i)dt$

The motion of rigid bodies can be used by formulating Newton's Three Laws of Motion (also known as Newtonian Mechanics) which describe the relations between the forces acting on the object and the object's motion:

1. Inertia: If there is no force applied to a body, its velocity shall not change and the body will be at rest
2. Force, Mass & Acceleration: The force acting on a body is equal to the change in momentum per change in time. This is given by the formula of force $F = ma$ and momentum $p = mv$.
3. Action & Reaction: Every action i.e. the force has an equal and opposite reaction. This means that the force a body experiences is from interactions with other objects/bodies.

3 Car Racing Games

Racing Games can be defined as a genre of video games in which a player takes part in a racing competition. This may vary from the type of racing game which are:

1. **Arcade-style Racing**
   This genre has less emphasis on realistic handling or physics, and more emphasis on fast-paced action and speed. The physics in these games is pretty liberal as its objective is to keep the player on the track and have fun. A few examples of this are that a car will have to reduce its speed in order to make the turn but in this sub-genre, the player can just somehow make the turn without slowing down much or they can just drift through the turn. The same goes with collisions as in these games the collisions are either exaggerated or just very minimal.
2. **Simulation Racing**
   Simulation racing games aim to replicate the handling and mechanics of a real-life vehicle. They often license real cars and race tracks to make them more realistic. As simulating the real-world experience is key the games tend to focus on the game physics and car physics more than visuals and other things.

   But if a player with not have much experience in this genre they can use various assists to make the experience enjoyable. Some common assists found are traction control(TC), Anti-lock brakes (ABS), steering assistance, damage resistance, clutch assistance, etc.

   Another aspect these games focus on is the "Sound", as funny as it may sound is an important aspect of the game. Players want the engine and tire sounds to be physically

happening with the car i.e. it matches with the surroundings. The three main elements of car audio are intake, exhaust, and internal engine sounds.

References