Soft Physics Deformation Script Documentation

Overview

The Soft Physics Deformation Script is a Unity component designed to produce dynamic, wave-like deformation effects on 3D meshes during collisions. It simulates soft, elastic responses for visually engaging interactions in real-time.

Installation

1. **Add the Script: Attach the script to a GameObject with the following components:**
   - **MeshFilter: Holds the mesh to be deformed.**
   - **MeshCollider: Enables collision detection.**
   - **Rigidbody: Provides the physics interactions required for deformation.**
2. **Verify Mesh Compatibility: Ensure the GameObject uses a deformable mesh (set to dynamic if applicable).**

Script Parameters

Deformation Properties

- **waveAmplitude**
  Defines the intensity of vertex displacement caused by collisions. Higher values create more dramatic deformations.
- **waveFrequency**
  Controls the wavelength of the deformation waves. A lower frequency creates broader waves, while higher values produce finer ripples.
- **waveSpeed**
  Adjusts the propagation speed of the deformation waves across the mesh.
- **smoothing**
  Determines the smoothness of vertex interpolation. Higher values result in softer transitions between deformed and non-deformed areas.
- **waveSpread**
  Specifies how quickly the deformation dissipates from the point of impact.

Physics Properties

- **damping**
  Gradually reduces the collision force over time, simulating energy loss.

- **stiffness**
  Regulates how the collision force translates into deformation. Higher stiffness values produce more resistant materials.
- **gravityInfluence**
  Adds a vertical deformation bias, enhancing the effect at higher positions relative to the ground.
- **maxWaveForce**
  Sets a cap on the maximum deformation force to prevent unrealistic distortions.
- **collisionCooldown**
  Prevents repeated collision processing in quick succession, ensuring stable performance.

Customization Tips

- **Material Behaviors:**
  - **Increase waveAmplitude for rubbery or soft material effects.**
  - **Reduce smoothing for sharp, jagged deformations.**
- **Wave Characteristics:**
  - **Use lower waveFrequency and slower waveSpeed for more dramatic, slow-motion effects.**
  - **Increase waveSpread for broader, more diffuse deformations.**
- **Gravity Effects:**
  - **Experiment with gravityInfluence to create visually dynamic top-heavy or ground-based deformation behaviors.**

Performance Considerations

- **Best Mesh Types:**
  Designed for low-polygon meshes to ensure smooth, real-time performance.
- **Optimization:**
  The script is lightweight and optimized for minimal computational overhead, making it suitable for most real-time applications.

Example Use Cases

- **Soft Body Simulation:**
  Simulate objects like jelly, rubber, or other flexible materials.
- **Dynamic Mesh Deformation:**
  Add realism to interactive objects like collapsing walls or deformable terrain.
- **Impact Visualization:**
  Create visually engaging collision effects for gameplay or visual demos.

Limitations

- **Simplified Physics:**
  The script is not a complete soft-body physics simulation but focuses on wave-based deformation.
- **Mesh Complexity:**
  High-polygon or overly complex meshes may impact performance or reduce visual quality.
- **Realism:**
  Works best for stylized effects rather than precise material behavior simulations.

Troubleshooting

1. **Required Components:**
   Ensure the GameObject has a MeshFilter, MeshCollider, and Rigidbody attached.
2. **Dynamic Mesh Settings:**
   Check that the mesh is set to dynamic or deformable in Unity’s settings.
3. **Parameter Adjustments:**
   Fine-tune parameters like waveAmplitude and waveSpread to achieve your desired effect.