

Computational Haptics Laboratory

Project Presentation

Chai3D meets Unity3D

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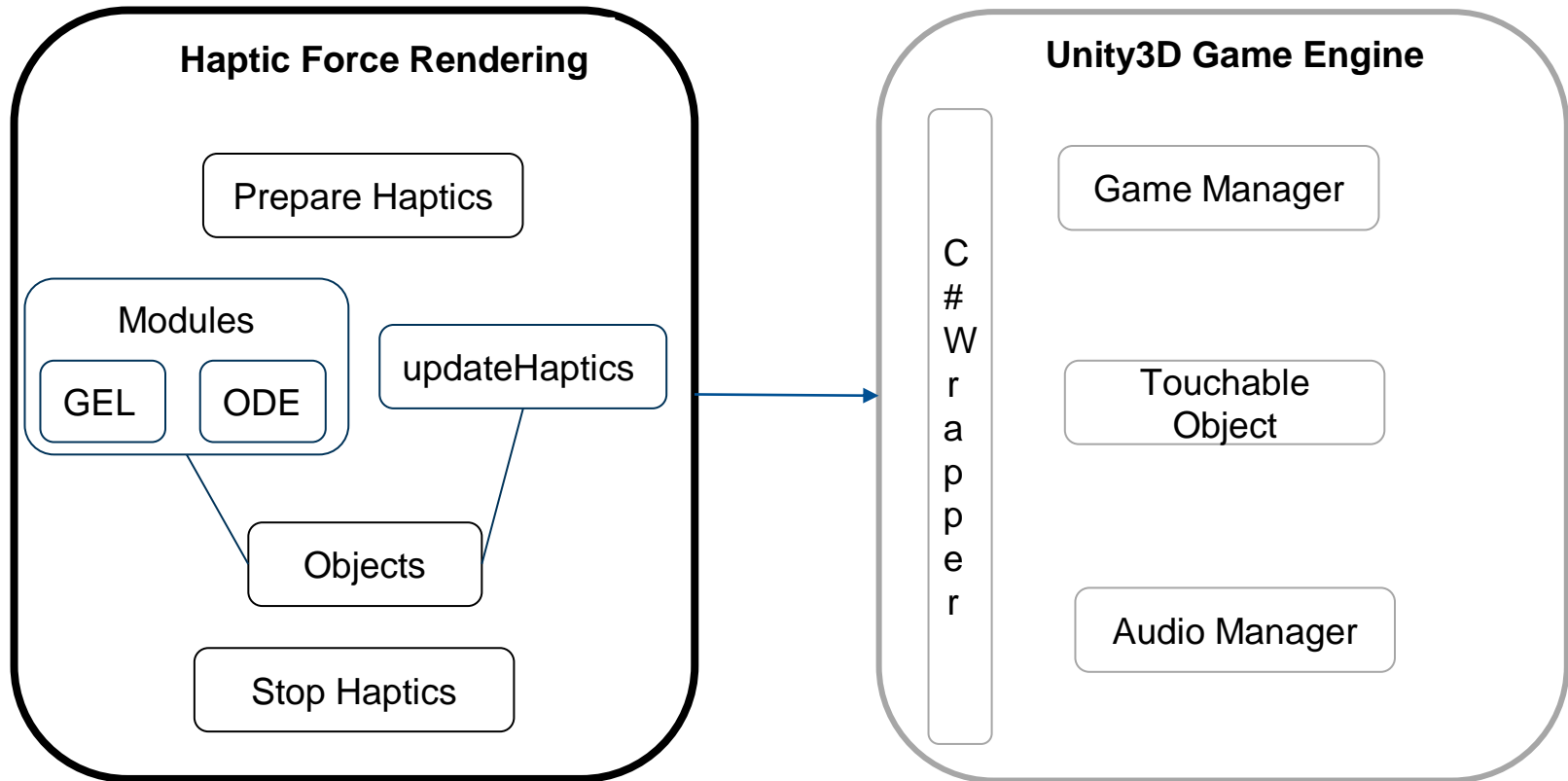
Munich, 26 September 2022



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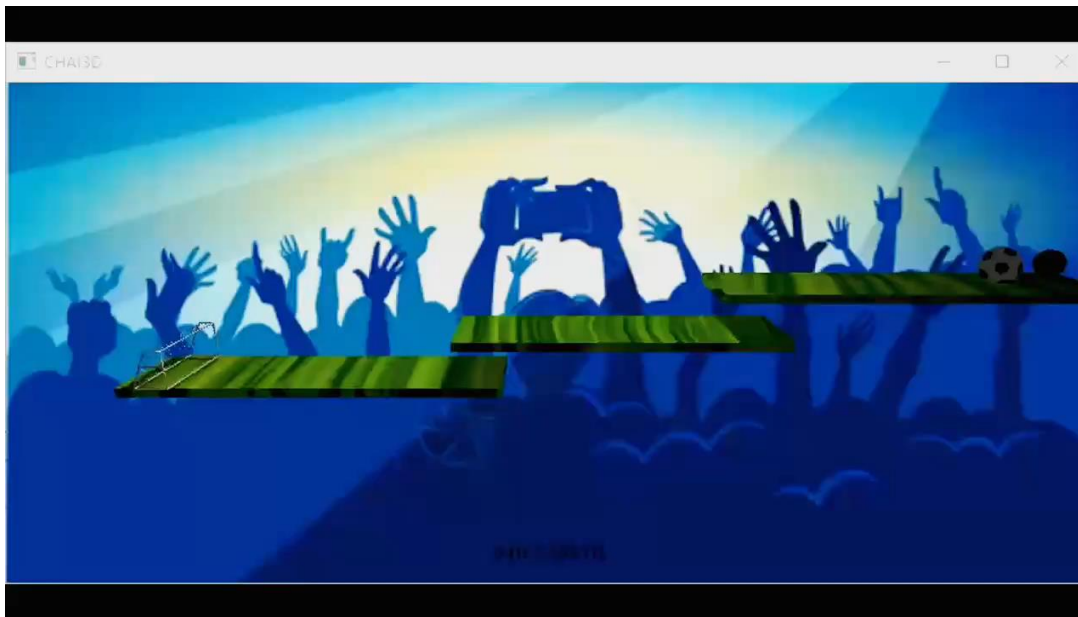
Introduction



Haptic Force Rendering

Stick-Slip friction

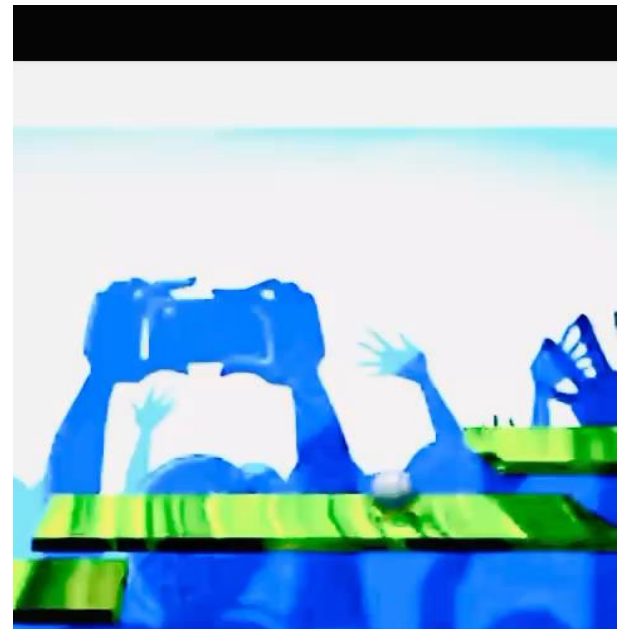
- Surfaces alternating between sticking to each other and sliding over each other, with a corresponding change in the force of friction.
- Implement: $f_{r_{static}} > f_{r_{kinetic}}$



Haptic Force Rendering

Stone track

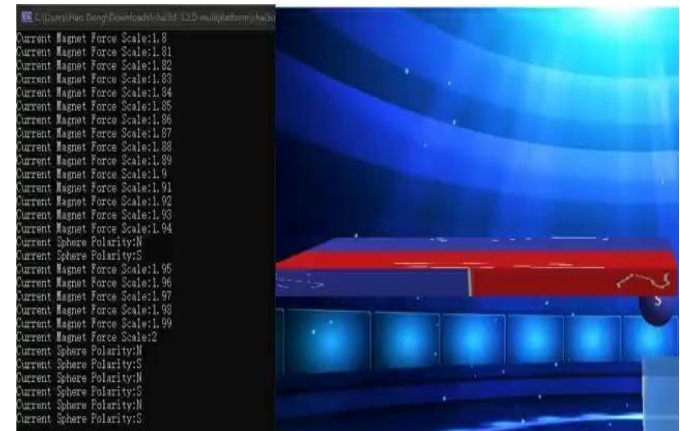
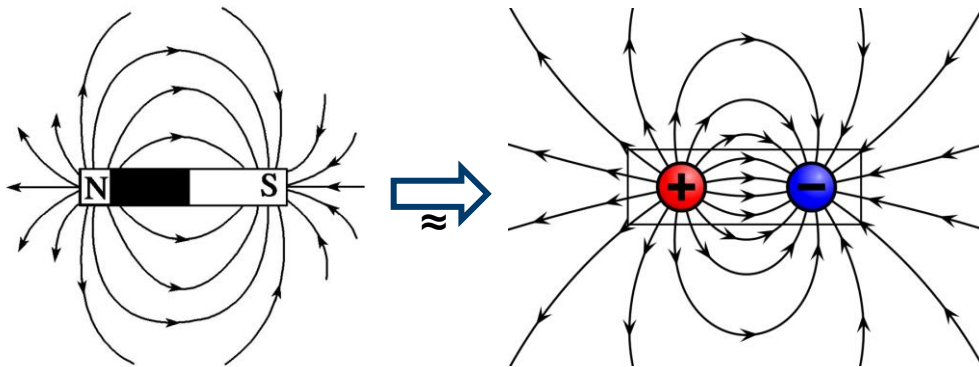
- Simulate a stone track with rough surface
- Implement: set a big stiffness on the object / add vibration effect on the object
- Plan to do: try to use a rough surface model and set stiffness to the dynamic mesh of object



Haptic Force Rendering

Magnet Bar

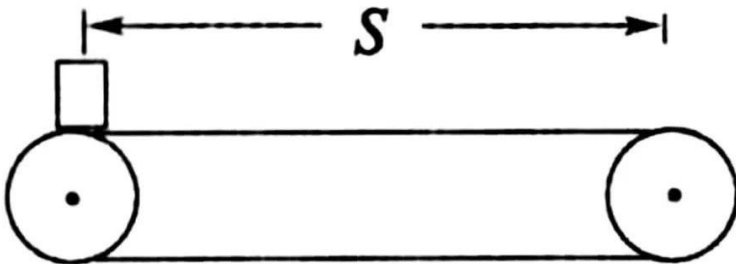
- Simple model: Use electric field to approximately simulate the outer magnet field
- Option:
 - field strength changeable
 - magnet pole switch(including texture switch)
- Plan to do:
 - Create visual field lines using a group of arrow meshes



Haptic Force Rendering

Conveyor Belt

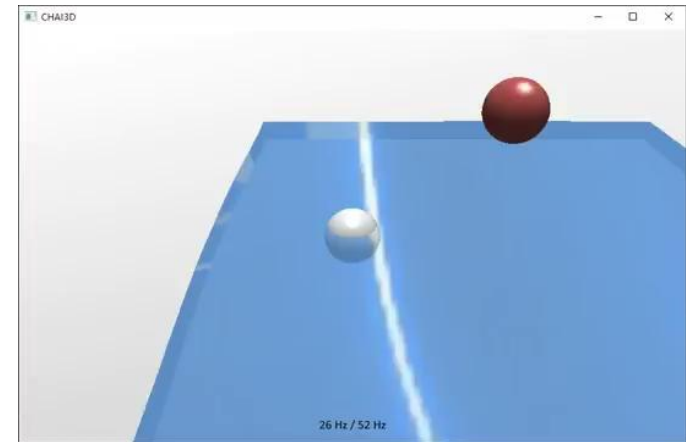
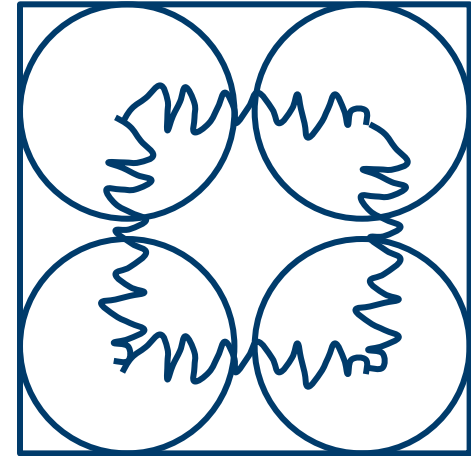
- How it works: Depending on the velocity component of the dynamic object in the running direction of the conveyor belt when it touches the conveyor belt, give the object the corresponding dynamic friction, until it has the same velocity as the conveyor belt in the running direction.
- Option: Velocity direction and scale
- Plan to do: Dynamic texture that fits the running velocity of the conveyor belt



Haptic Force Rendering

Deformable Object

- GEL Model
 - Map the mesh with group of spheres which are connected with springs.
- Skeleton:
 - skeleton node: sphere
 - skeleton link: spring
- Issues:
 - Frame Drop:
Loop through all the elements of the Skeleton
 - Penetrate Through:
Force too large or object too small

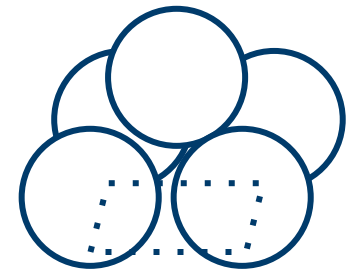


Haptic Force Rendering

Deformable Object

Possible Solutions tried:

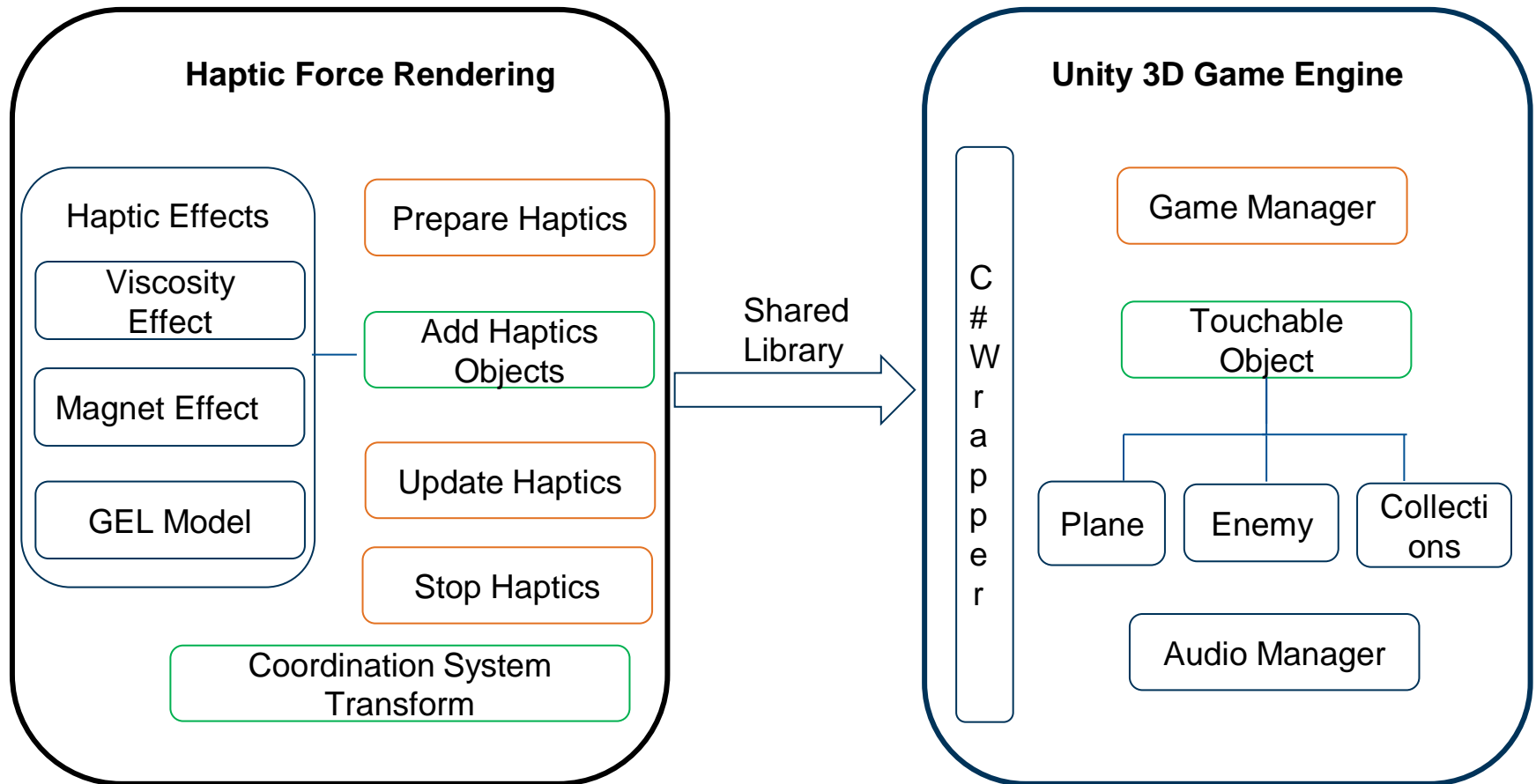
- Create additional mesh at the surface of the deformable object
 - + : Mesh is created beforehand
 - : Mesh is again deformable, leads to further significant frame drop
- Only create mesh at the place where the deformable object is going to be penetrated through
 - + : Mesh very simple
 - : Mesh is created and removed repeatedly during the simulation loop
 - : Flat mesh gives no smooth tactile impression
 - : Additional search process drops frames



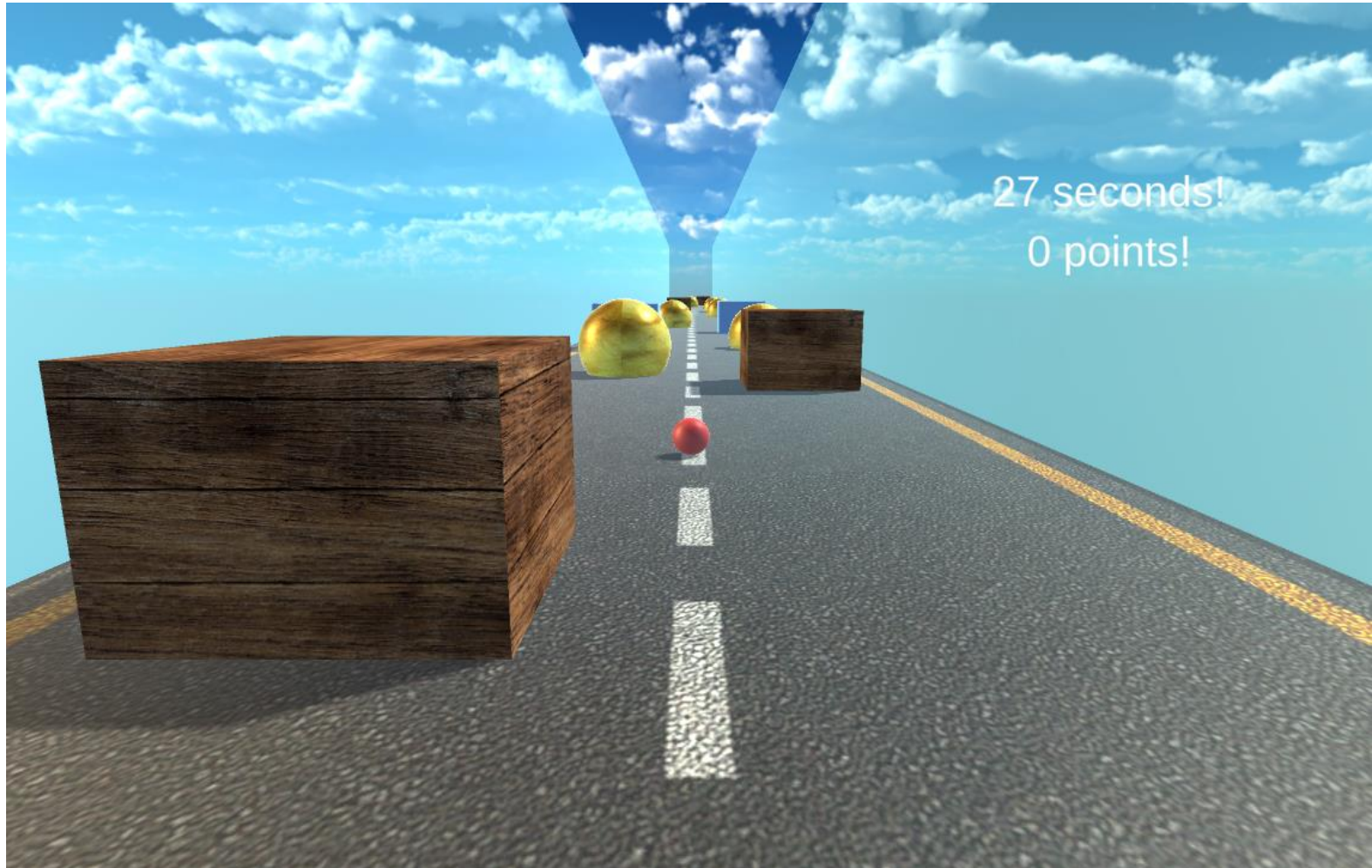
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Framework of Integration



The Racing Game



How it works

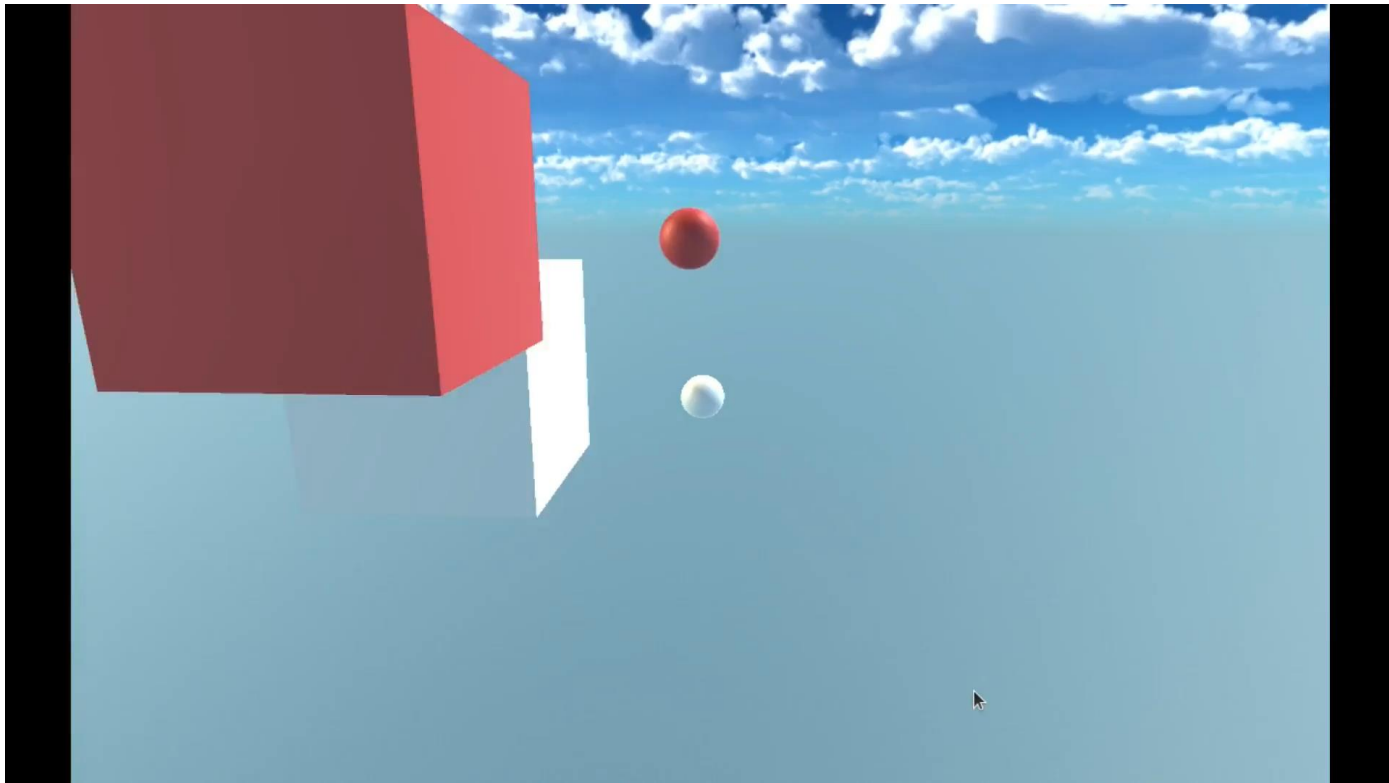
- **Common ideal:**

- Game user position in Unity3D world == tool position in haptic world
- Add stationary touchable mesh in Unity3D graphic world and Chai3D haptic world
 - User can feel the feedback force as they visually touch the object
 - Bad game experience for a racing game

- **Our ideal:**

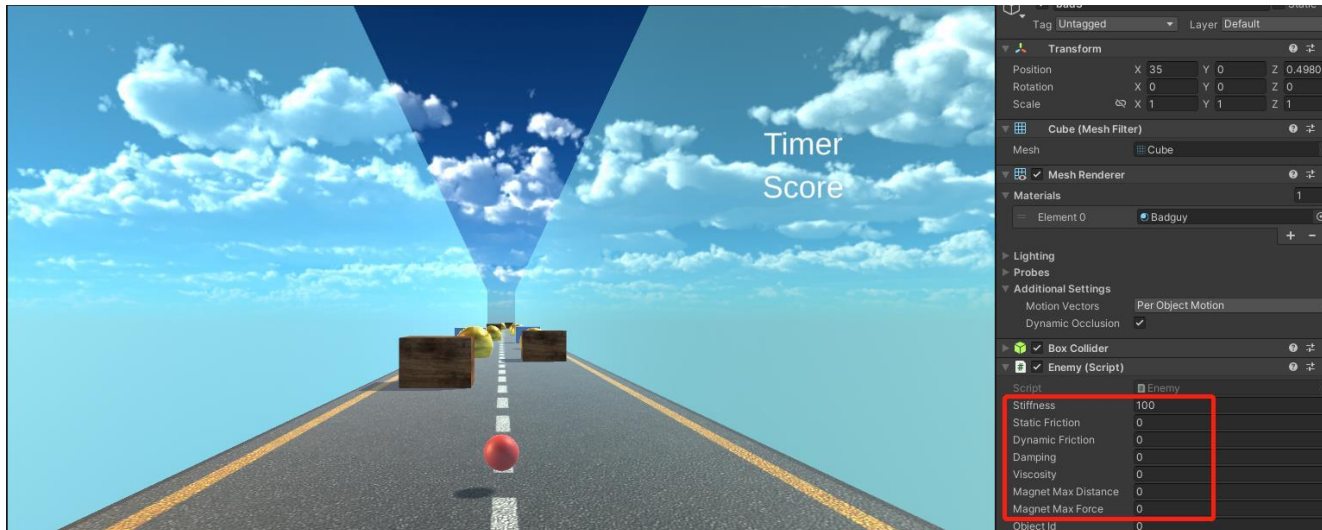
- Update mesh object position in haptic world for stationary object in Unity3D world
- Keep relative position between haptic device and haptic mesh the same as the relative position between Unity3D user and mesh
 - Game user position in Unity3D world != tool position in haptic world
- User can still feel the feedback force as they visually touch the object

Debug Tool



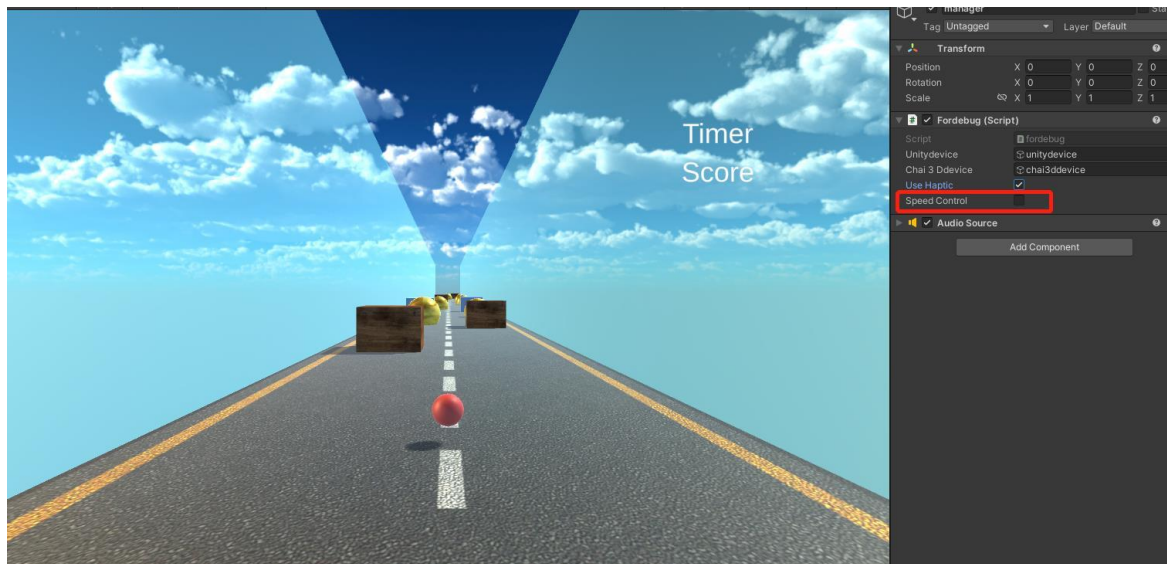
Game Design

- **Touchable Objects (parent class)**
 - UI to drag and define haptic properties
 - In inherit objects define different reaction functions after touching detection
- **Road**
 - Haptic mesh with high stiffness and friction
 - Press downward the device to get the feedback force
- **Plane**
 - Turns red and sounds an alarm after being touched



Game design

- **Enemy**
 - User stop moving forward after touching (collision detection by Unity3D)
 - sounds
- **Collection**
 - With low stiffness
 - Disable graphic rendering
 - Sounds
 - Disable then in haptic world
- Movement of device control position of user in z axis and the velocity in x axis.

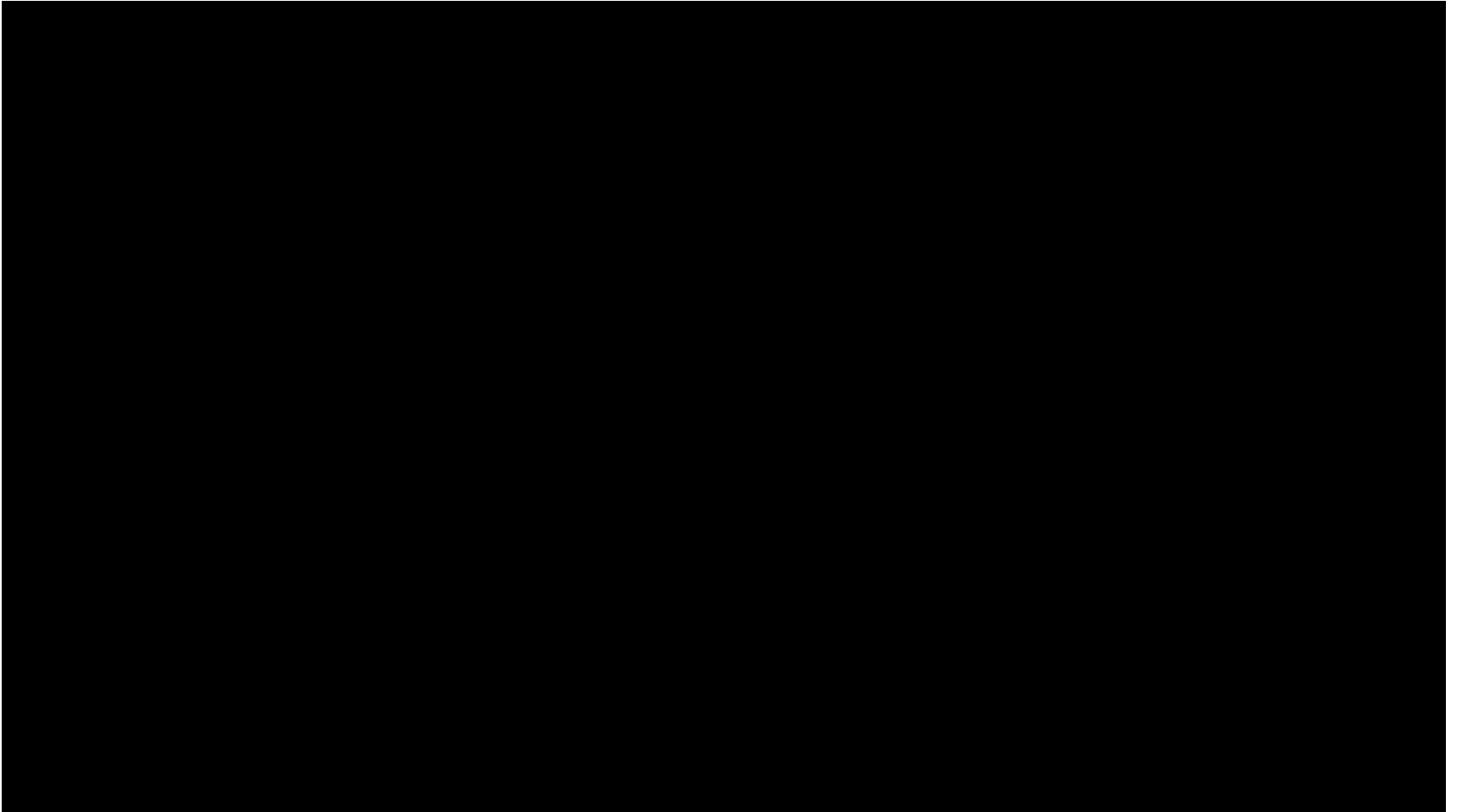


Others

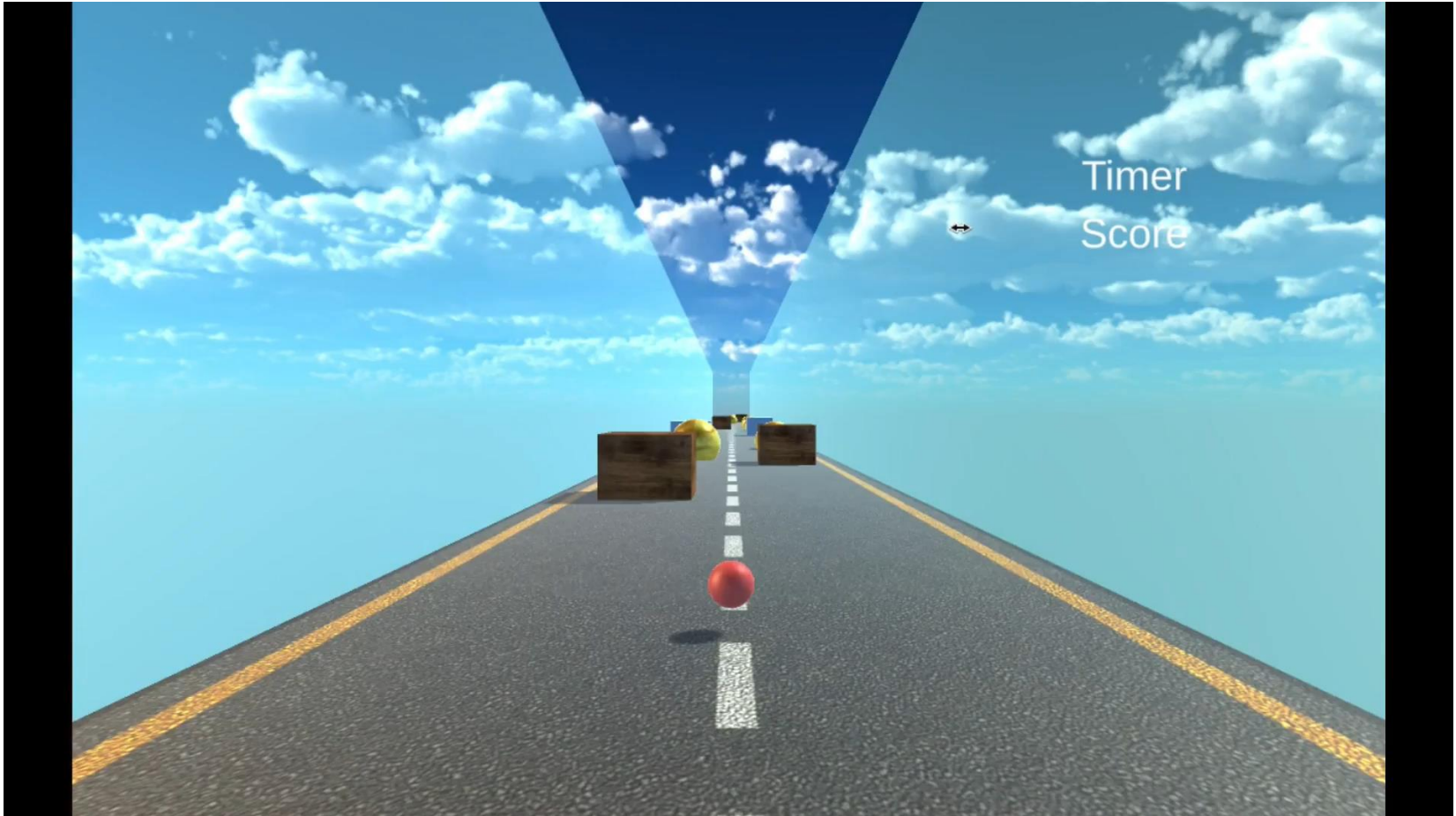
- Start Menu
- Audio for touching, background and game over
- Camera follower
- Timer
- Score counter
- Skybox Background



Game Demo



Game Demo



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Summary

- Integration chai3D as a plugin for game development using Unity3D
- Practical demo to be further developed for other haptic games

Future Work

- Add deformable objects to realize an ocean game scene
- Haptic rendering frequency \neq graphic rendering frequency
- Crashing problem

Thank you!