**Project Plan: Physically-based Simulation**

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1. Motivation:

As shown in Figure 2, we want to create a slide alike construction which propels an object (a cart or sledge) into a pool containing a multitude of bodies and simulate how the collision of the wagon influences the scene. In the first place, the aim is to create a rigid body simulation where the pool is filled with a large number of little plastic balls. Producing a physical Environment which will create a similar result as a child jumping into a ball pit.

Everybody loves ball pits, so the motivation should be pretty clear (also see Figure 1).

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| Bildergebnis für ball pit |
| Figure 1: Ball pit. |

For a more scientific approach to explain our motivation for the project, consider the visualization in Figure 2 once more. Our simulation scenario can be broken down into two distinct parts. First, the entire 3D background, including the slide, lighting and the cart itself created using a suitable framework. Second and more important, the actual hard-coded physical simulation which will be constrained to a region around the pool. It will be challenging to create a working collision handling for creating a realistic scene, since a large amount of rigid bodies have to be simulated.

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| C:\Users\wueli\AppData\Local\Microsoft\Windows\INetCache\Content.Outlook\MYBASRKR\IMG-20161022-WA0002.jpg |
| Figure 2: Conceptual drawing of the scene. |

Once the minimal aim is achieved, the scene can be upgraded arbitrary. For the project, we target to get a working rigid body simulation with adjustable ball size, numbers and distribution. In addition, the rigid bodies could be replaced by different shapes or by bodies with different physical properties. The same applies to the cart itself, since an optimized carriage shape could improve the visible outcome. Summarizing, a second goal is to create a user interface to interact with the scene, applying different pool fillings or carts.

Eventually, a last but rather ambitious feature could be introduced by adding a figure to the cart for which we implement a hair and cloth simulation.

1. Theoretical Background:

Most likely, we will use one of the open source game engines (e.g. Unreal Engine 4) as 3D framework since they are known for good performance optimization and good functionalities. For the simulation itself, a (convex) rigid body simulation with emphasis on collision handling will be implemented. As starting point, we consider [1] as well as [2], [3] to get an overview on the subject. Intensify the literature review to find a high performance (real-time?) solver for the rigid body simulation.

1. Milestones:

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| **Date** | **Target** |
| 2.11 | Project plan due! |
| 9.11 | Exercise 3 due | Literature review completed Framework and Solver |
| 16.11 |  |
| 23.11 | 3D-Environment | Implementation of solver testing with separate particles |
| 30.11 | Integrate cart into solver environment. |
| 7.12 | Multiple body simulation |
| 14.12 | Visual representation |
| 21.12 | Project due! |

Minimal:

* Pool filled with balls (ball pit) collision with cart (simple geometry)
* Basic UI for adjusting ball number, size and distribution

Desired:

* Option to fill pool with varying objects (shape, properties, etc.)
* Add sophisticated cart geometry (integrated into UI)
* Add figure to cart

Optimal:

* Implement cloth simulation for figure
* Implement hair simulation for figure
* Option to fill pool with fluid (add fluid solver)

1. Bibliography

[1] D. Baraff, “Physically Based Modeling: Rigid Body Simulation,” 2001.

[2] J. Bender, M. Müller, M. A. Otaduy, and M. Teschner, “Position-based Methods for the Simulation of Solid Objects in Computer Graphics,” 2013.

[3] J. Bender, K. Erleben, J. Trinkle, and E. Coumans, “Interactive Simulation of Rigid Body Dynamics in Computer Graphics,” 2012.