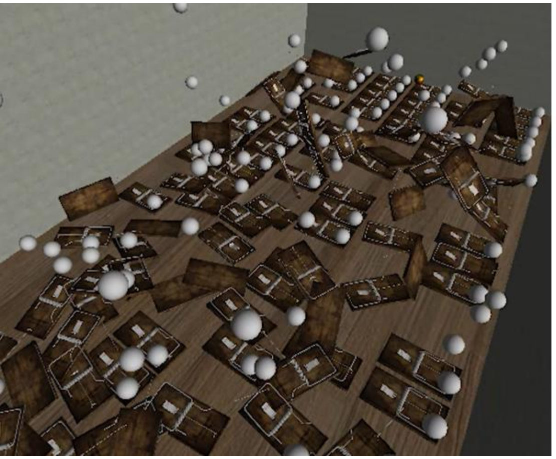
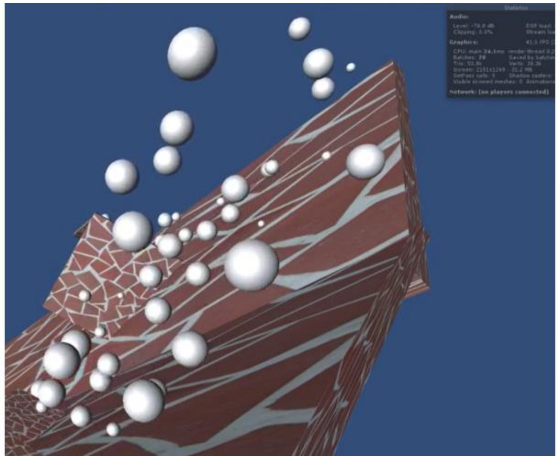
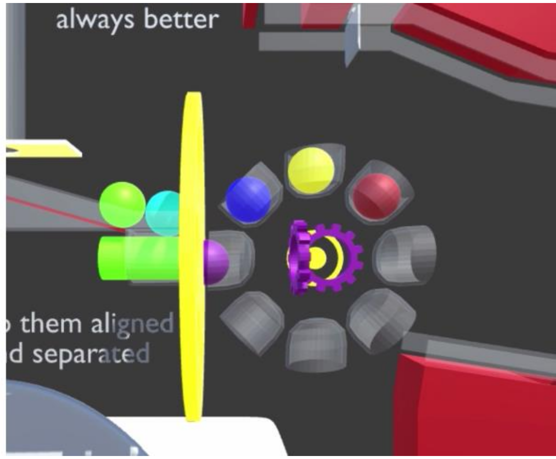
DD1354

Models and simulation







http://www.csc.kth.se/~chpeters/projects.html

Projects Overview

Christopher Peters

CST, KTH Royal Institute of Technology, Sweden

chpeters@kth.se

http://www.csc.kth.se/~chpeters/

Project Steps

1) Form groups (where desired)
2) Specification
3) Feedback (iterative)
4) Blog
5) Implementation
6) Presentations
7) Submission

1. Form Groups

- Recommend groups of 2
  - No more than 3 per group
- Decide on a group name
- Decide on your general topic
- Recommendation: Do this as soon as possible

2. Project Specification

1-2 pages

Group name and members (clearly identified)

KTH email addresses

Project title

Specification details

Grade range your group is aiming for

2. Project Specification

PDE Project ideas workshop:

- Coming soon in VIC

Advice: start as soon as possible

Submit through Canvas

- Only one group member needs to submit on behalf of the group
- Clearly label group members (names, email addresses) on spec.

You can get feedback in lab sessions too

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1. Some background to the area/problem

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   Technologies, physics problem, constraints

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   And how they might be avoided/minimized

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   To what degree will the simulation use existing physics libraries versus being implemented from the ground up

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7. Link to blog containing first blog entry

   Hint: your specification and a representative image can be your first blog entry

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Specification Example

Rope Bridge Simulation using Unity and Mass-Spring Systems

Specification of project in Models and Simulations, DD1354,
Royal Institute of Technology KTH.

February 23, 2016

1 Background

Mass-spring systems are used as a basis for many different physical models. From ropes to cloth simulation, the usage differ with the purpose of the simulation. When simulating rope using mass-spring systems a set of points are defined, every point interacts with two neighbouring points via a mass-spring model (except anchor points). The spring between two points need to have a high spring constant to make the simulation realistic, if the spring constant is too low the rope will behave in an elastic manner when moved. With a high spring constant a small timestep is needed, raising the bar for creating a realistic real-time simulation further (Garrido 2004). Another way to simulate a rope is to use the model Brown et al. (2004) used for the purpose of knot tying. The model for the rope took a more geometric approach, it considered the rope as a cylinder that bends smoothly while enforcing a set of physically motivated constraints.

With inspiration from a lab given in the course DD1354, Models and Simulations at KTH, and from simulation videos such as the ones listed below the idea to simulate rope bridges using mass-spring systems was born.

Mario rope-bridge made in Unity.
https://www.youtube.com/watch?v=Otxgsi6usGo&feature=youtu.be&t=35
2D Rope bridge simulation
https://www.youtube.com/watch?v=hyHSERddOWQ

2 Problem

The main problem is to create a realistic interactive real-time simulation of a rope bridge, modelling ropes as a mass-spring system, with a limited amount of ropes and planks, and to find out which physics are most important to make it realistic.

3 Implementation

As a start we will implement a simple rope bridge with 3 ropes and interaction between the ropes (see fig. 1). The bridge should be able to swing in three dimensions.

Fig. 1

When we have a fully working three-rope-bridge, we will implement a bridge with planks and a sphere interacting with the planks (fig. 2). The sphere should be able to fall off if the planks starts to tilt. In the first stage, we will not care about collision with the vertical ropes.

Unity will be used to visualize the simulation. This includes rendering, lights and loading models into a scene. We will create scripts in Unity to implement the physics, integration method and eventually collision detection.

3.1 Specification ideas

Below is a list of essential components and some of their properties that we came up during a brainstorming session.

- Rope
  - Spring mass system
  - Adjacent points (both current rope and connection points)
  - Mass
  - Affected by gravity and spring force
  - Length between joints
  - Friction
- Connection point
  - Anchor points
  - Connection points between ropes
- Planks
  - Affected by gravity
  - Collision detection between plank and sphere
  - Tilt depending on the sphere
  - Spacial partitioning (1D, planks only collide with neighbouring planks)
  - Mass
- Sphere
  - Start with a ball
  - Collision with planks
  - Gravity
  - Center of gravity
  - Rotation
  - Mass
  - Should not be able to collide with the ropes.
- Integration method
  - Runge kutta 4
  - Start with explicit method

Fig. 2

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Specification Example

Rope Bridge Project Specification
2016-02-23

Extensions

Extensions will be implemented if there is enough time.

1. The bridge can break if the tension is too high.
    a. Color the points with high tension.
2. The anchor points of the bridge can be moved.
3. Change the ball to a cylinder (fig. 3)

Fig. 3

References

Our project blog for updates:
http://epicropebridge.blogspot.se/

Brown, J., Latombe J., Montgomery, K. (2004). *Real-time knot-tying simulation*. Stanford-University & Stanford-NASA, USA. DOI: 10.1007/s00371-003-0226-y

Garrido, R (2004) *A real-time rope model suitable for game engine usage*. Master thesis. Noval Postgraduate School. California. http://hdl.handle.net/10945/1425

3. Feedback

At specification workshop and through Canvas

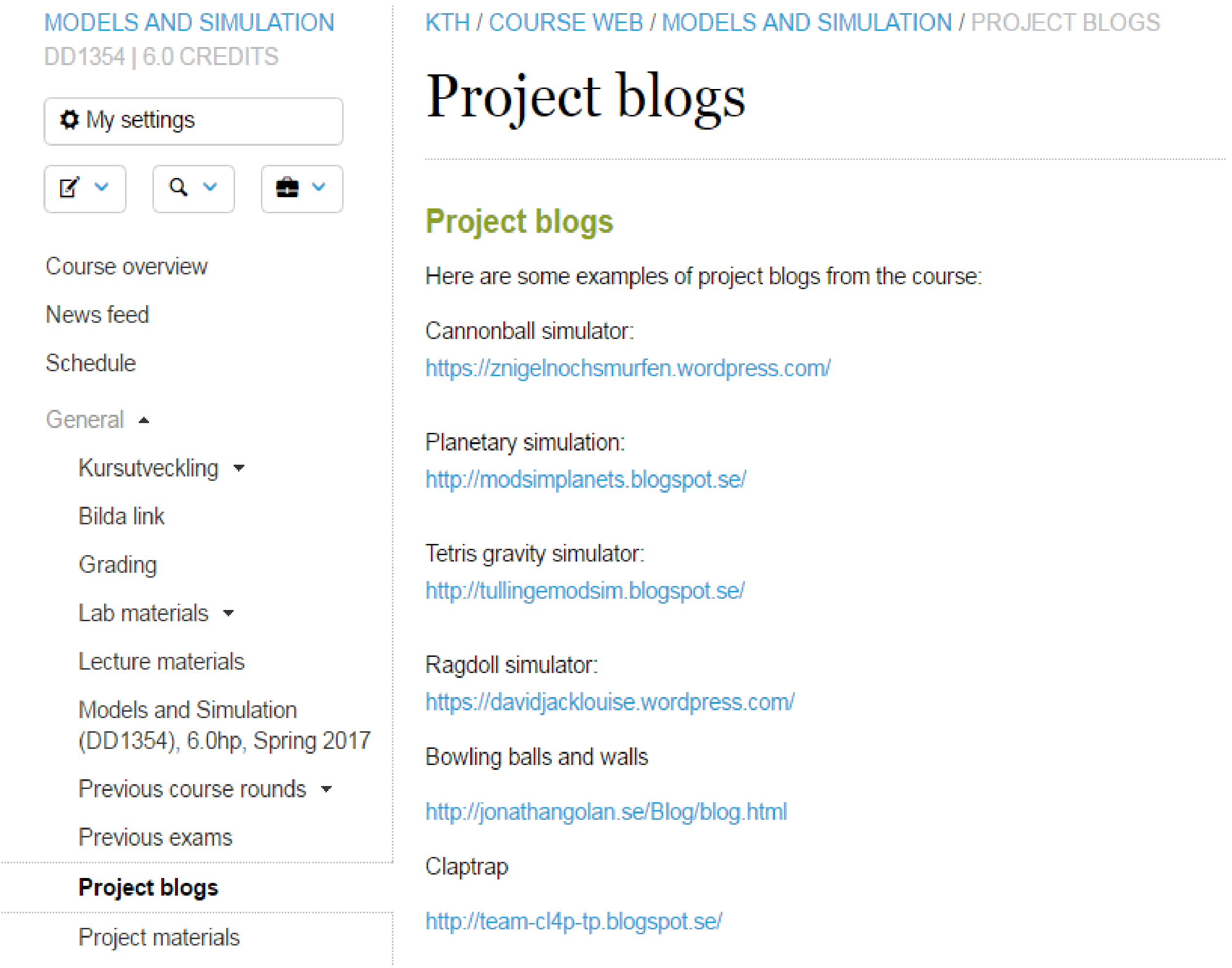
Beyond the above, it's up to you to seek feedback

The lab sessions are a good place to do so

After next week, lab sessions will focus on project work

4. Blog

Create and update a blog



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5. Implementation

Critical phase in the project

Things will go wrong

Attend the lab sessions in order to get feedback and guidance

- Course team can give you feedback on what you need to do to reach your desired grade
- You need to ask them
- Show them specification

6. Intermediate Presentation

Each group will present work-in-progress on their project

5 minutes

Slides (project idea) + sketches/video demo

Date:

Late Feb (Wed 27th TBA)

VIC Studio

6. Final Presentations

You will need to present your project

Likely date:

- 13-15th March
- You will still have time to do some additional work afterwards
- Slides describing the project
- Blogs and video demonstrations will be very useful for this session

7. Submission

Deadline:

Friday 15th March

Project and labs

Submitted to Canvas as two separate archives

Project: Implementation files + report in one archive

You do not have a lot of time

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Grading

1	**A-F**	**Sophistication of physics modeling and simulation problem/solution**
2	A-F	Quality of report and presentation materials
3	P/F	Results are somehow visualised
4	P/F	Blog

If you are aiming for A or B grade, pay attention especially to 1.

Get feedback from us through specification

Exemplar

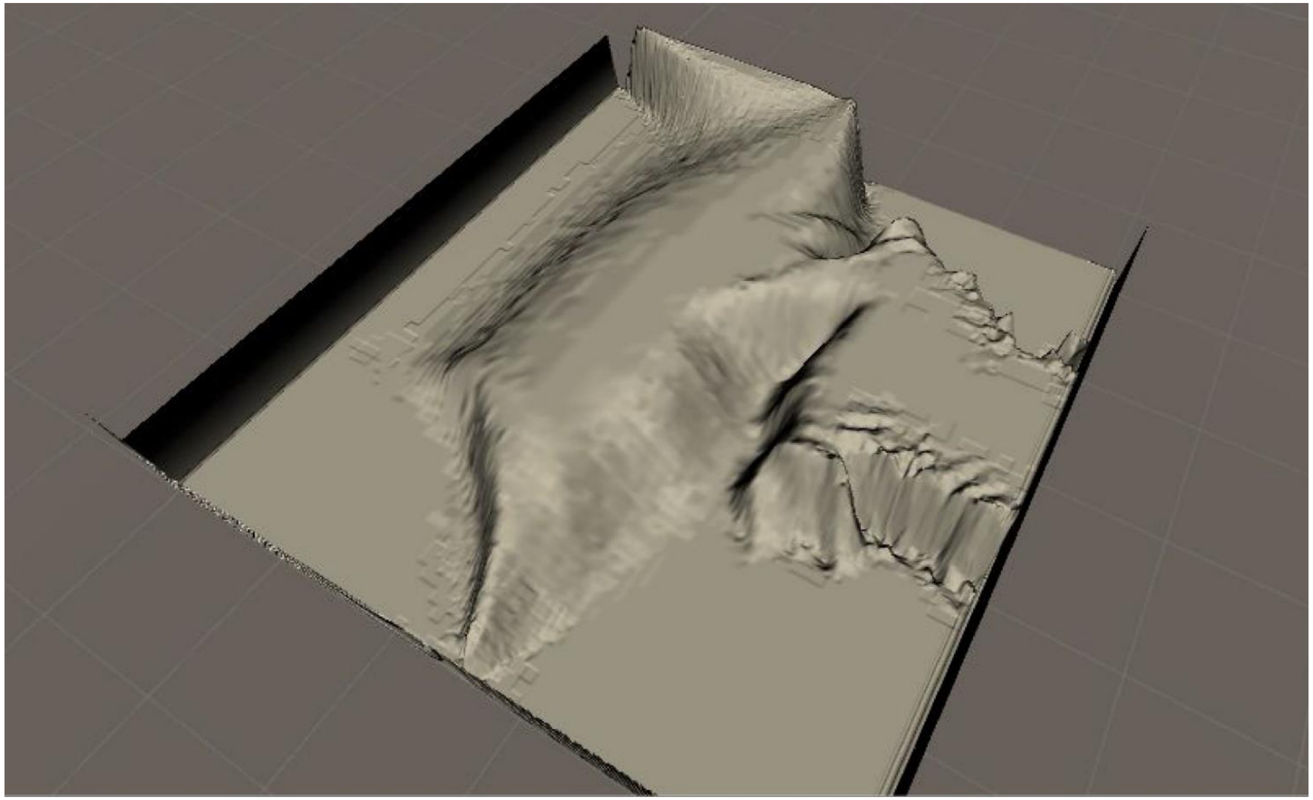

Plate tectonics simulation

http://tectonicheightmap.blogspot.com/

A Grade Project Ideas

PDE-based modelling and simulation

Thursday 14th Feb, 10:00-12:00 (VIC)

PDE-based projects

Friday 15th Feb, 10:00-12:00 (VIC)