TEESSIDE UNIVERSITY
SCHOOL OF COMPUTING

ICA SPECIFICATION

This form should be attached to the front of the ICA specification and include all details.

Module Title: Physics Simulation	**Module Leader**: Julian Warren **Module Tutor:** Wen Tang
	Module Code: VIS3068
Assignment Title: Component 2 Efficient Broad- phase Collision Detection Algorithms	**Deadline Date:** 22nd April 2013
	Deadline Time: 5pm
	Submission Method: Online

Central Assignments Office (Middlesbrough Tower M2.08) Notes:

- All work (including CDs etc) needs to be secured in a plastic envelope or a folder and clearly marked with the student name, number and module title.
- An Assignment Front Sheet should be fully completed before the work is submitted.
- When an extension has been granted, a fully completed and signed Extension form must be submitted to the SCM Reception.

Online Submission Notes:

- Please follow carefully the instructions given on the Assignment Specification
- When an extension has been granted, a fully completed and signed Extension form must be submitted to the SCM Reception.

FULL DETAILS OF THE ASSIGNMENT ARE ATTACHED INCLUDING MARKING & GRADING CRITERIA

Physics Simulation In-Course Assessment – Component 2

Overview

This In-Course-Assignment (ICA) document describes the second individual component of the ICA for the final year Physics Simulation module (VIS3068). The Component 2 assessment is weighted 30% of the overall assessment. A resubmission opportunity will not be offer on this ICA component.

You are required to research efficient **broad-phase** collision detection algorithms by conducting literature reviews and identifying a spatial partitioning algorithms, which could extend the capability of your Rigid Body Simulator for processing large number (say, >500) of 3D rigid objects in real-time. The final submission is a technical report based on your research findings. You must write a technical report using a pre-defined format (see attached report format) with correct references, and minimum 4 pages and maximum 8 pages. No actual program implementation is required. The main objective is to demonstrate the use of on-line resources and academic research publications to conduct literature review and the ability of self-directed study within the context of games physics programming, more specifically real-time rigid body simulations.

Scenario:

You are a physics programmer in a games studio. Your technical director has assigned you a task to extend your Rigid Body Simulator by adding a **broad-phase** collision detection strategy, so that the simulator will be able to deal with thousands of 3D rigid interactions in real-time. We assume that your current Rigid Body Simulator already handles narrow-phrase model- based collision detections effectively, for example it processes bounding spheres and bounding box and it does point-triangle and edge-edge collision detections and responses. You are given a 5-weeks research time to come up with a technical report, detailing an implementation plan with emphasis on efficient **broad-phase** collision detections. Therefore, you need to: 1) conduct a literature review of broad-phase collision detection based on spatial partitioning algorithms; 2) select one spatial partitioning algorithm that you are going to implement; 3) compare and contrast the selected algorithm with other existing algorithms to demonstrate your understanding of these algorithms; 4) design implementation steps (data structure, pseudo-code, UML diagrams, flow-chart etc.); 5) summarize results of stages from 1) to 4) into a technical report (**minimum 4 pages and maximum 8 pages**).

Minimum requirements

To obtain a pass level assessment, you should *attempt* to do all the following:

1. Conduct an appropriate literature review and investigation on broad-phrase collision detection methods. Show a good understanding of a chosen spatial partition algorithm through a clear and concise description about the chosen algorithm.
2. Clear descriptions about what kind of rigid body simulation scenarios that you are aiming at and how the chosen spatial partition algorithm would help to achieve target simulations in real-time.
3. Identify advantages and drawbacks of the chosen algorithm and put these into the context of your target simulation scenarios.

4. Correct design of data structures and implementation steps. Show how to integrate the design with your current rigid body simulator.
5. Provide accurate references throughout the report and a short clear summary of your research findings.

Note: A technical report that meets above pass level minimum requirements which is well-written and documented can earn substantially more than a pass grade. Equally, a report which has opaque descriptions and poorly referenced could still fail even it meets the minimum page requirement.

Guidance

Develop your report incrementally. The tutorial sessions will provide opportunities for discussions on research methods and the guidance on technical report structure and writing. This ICA document also supplies a technical report format to help you structure your report. The follow section shows how different parts of the report can be organised.

A significant contribution to marks comes from documenting your research and literature review efforts adequately. Do not leave yourself short of time to document the research and design work you have done. In particular, the report will have a major section on your investigations into the existing spatial partitioning schemes and their applications, as well as a discussion of your planned implementation.

Make sure you have completed the base-line requirements before you spend time on value-added (and credit-added) features.

Opportunities for further credit

The assignment is partially open-ended to allow enough room to obtain higher grades. Here is a non-exhaustive list of possible additions:

- Investigate the scope of the approach and possibility of improving existing algorithms to deal with more complex physics simulations or handling rigid body collision detections more efficiently.
- Discuss the selected broad-phase collision detection approach with implementation strategies for real-time simulations.
- Investigate and/or identify capabilities of the chosen algorithm for advanced physics simulations, for example deformable objects such as hair, cloth, or fluids by assuming that vertices of a deformable object must be updated at each simulation step and a spatial partitioning based broad-phrase will help to speed up collision detections.
- Discuss parameters of the chosen spatial partitioning algorithm and how these parameters would affect collision detection computations.
- Demonstrate awareness and understanding of the chosen algorithm for different types of state of the art physics simulations or graphics applications.

Assessment Criteria and Deliverables

Marks are weighted according to the following criteria:

A Technical Report (minimum 4 pages and maximum 8 pages)
This should include:

a) Title & affiliation
You must give a short and appropriate title to your technical report. Please put your name, User ID, email address and associated information under the title.

Tip: The title should be short and clear to give a clear message what the report is about.

b) Introduction (20%)

In this section discusses how important is broad-phrase collision detections and how widely applicable is broad-phrase collision detection schemes in physics simulations and interactive techniques. Describe in detail objectives of your technical report, topics of literature review and outcomes presented in this technical report as a result of the literature review and your investigation/research. If any, you can emphasis on the amount of novelty, originality of your own ideas/improvements to an existing algorithm. It is important to make it clear in the introduction section.

The introduction section describes the overall objectives of the report and main outcomes of the report. It should make a lay person understand what the report is about, what problems the report addresses, why should we care about the problems, and what solutions exist to address these problems.

Tips: Convince readers that the problems are important; convince readers that the problems can be solved by using your proposed/chosen algorithm and make reader want to read the rest of your report.

c) Previous work and background (25%)

This section should give a bird eye view of general approaches to collision detection algorithm with a focus on broad-phrase collision schemes. At this stage, it is better to show your awareness of the state of the art approaches and compare and contrast with clear concise descriptions. You can use a top-down approach to identify your chosen algorithm. No need to go over a great length to describe all existing methods. Instead, concentrating on a few of the most relevant approaches to your target simulations and describing these approaches clearly. This would be a better strategy than a broader and more general description that only scratches the surface. Chosen a spatial portioning algorithm that you are going to implement and discuss the algorithm in details. In this section, elaborate reasons why you choose this particular algorithm and describe the simulation applications which you will apply this algorithm to. Be through, be fair, and support your claim and understandings about shortcomings/ advantages with references if available.

You can use diagrams, images to help explain. Make sure correct references to any images that you have taken from other papers or on-line resources. Readers of your report should

understand from figures and captions. Be thorough, demonstrating your understanding of your chosen algorithm. There is no need to show a long list of all existing algorithms.

Tips: Using figures to demonstrate the problem you are solving and use diagrams to visually aid your explanations and existing approaches.

d) Planned implementation (35%)

This section can be divided into few sub-sections, typically, two main aspects should be discussed in this section:

i) **(25%)** This subsection is the place for you to document your implementation decisions, any problems that might be encountered and how you would overcame these problems. It is good to include small pseudo code fragments to help clarify what is being said in your report. No need for actual source code. It is important to discuss the genesis of your planned implementation and your ideas, the rationale and the intentions - even they are not realised at this stage. This subsection can include the design and any associated UML diagrams to indicate your planned work. You can use diagrams, images to help explain your ideas. You can also use further subsections to discuss different aspects of your planned implementation, for example, pseudo code and how this will be integrated with your current rigid body simulator, etc.

ii) **(10%)** This subsection could include a discussion of possible testing methods and the design of testing examples, for example what parameters are to be tested with and what are the target results you hope to achieve. You could point out the benefit of your testing.

Tips: Point out anything you want to be noticed and summarize in words what you aim to achieve.

e) Conclusion (15%)

In this section, summarize what you have achieved in this report and re-iterate limitations for possible improvements.

f) References (5%)

It is important to cite /discuss **the most relevant work** that you have found in on-line resources and/or research papers.

List of marking criteria:

1. Are the presentation and explanation clear? How could these be improved?
    - If the report is poorly written, it may get marked down, even if your planned implementation idea is good and novel.
    - Make sure the logical structure and organization of your technical report is clear.
2. Are the advantages and limitations of the chosen existing method clearly described?
3. Are the references adequate? Are there any additional references needed?
4. Is the planned implementation clear and all important details discussed adequately? Are these details can be used by other students to implement the chosen algorithm?
    - Mention important implementation details, constants and parameters.

- Discuss drawbacks or limitations or possible improvement in conclusion

5. Is there any novelty or originality in the planned implementation?

6. **Submission of ICA- component 2**

   A technical report in a pdf format.