<name>
<College>
<CRSID>

Diploma in Computer Science Project Proposal

Interactive Sculpting of 3D Objects

<date>

Project Originator: This is a Model Project Proposal

Resources Required: See attached Project Resource Form

Project Supervisor: *<name>*

Signature:

Director of Studies: *<name>*

Signature:

Overseers: *<name>* and *<name>*

Signatures: *<no need to obtain Overseers' signatures yourself>*

<This proposal refers to the language Java. This language is used only as an example; it is perfectly reasonable to use a different language. Likewise other specific features described may be taken simply as examples.>

Introduction and Description of the Work

This project involves the implementation of a system that will allow the user to interact with a three-dimensional object, sculpting the object with a variety of tools.

Such a system is described in the paper referenced below [1]. It allows the user to take a basic polygon mesh model (such as a sphere) and use simple tools to deform the mesh. The basic deformations are either pushes or pulls of the surface. Furthermore, sections of the surface can be selected for mesh refinement to give finer control of the shape. The basic actions are augmented with several models describing how the adjoining areas of the mesh are affected by the deformation of their neighbours.

Resources Required

No special resources will be required unless a ray tracer is employed in an extension to the project. The public domain ray tracer *POVray* is available for download from `www.povray.org`. Output images can be viewed using a standard viewing tool.

Starting Point

<This is the place to declare any prior knowledge relevant to the project: for example any relevant courses taken prior to the start of the Diploma year.>

Substance and Structure of the Project

The project would involve writing software to maintain the polygon mesh structure, load and save it to disk, and pass the primitives to the rendering routines. The tools (e.g. sphere, cylinder, and box) have to be tracked and any collisions with the mesh detected. This can be done with a varying degree of intelligence, with obvious tradeoffs between complexity of program and data structure and speed. The results of actions on the mesh would also need to be implemented.

The mesh refinement could be implemented either explicitly or automatically where polygons become too large, or surfaces too curved, with both mesh refinement and surface

interpolation techniques required. To reduce rendering costs, sections of the mesh could be selected for display only, again using the selection tool.

The viewing direction would also need to be controlled, so that the user could move the model around to look at it from various directions.

The project has the following main sections:

1. A study of the algorithms required for generating the objects, refining the polygon mesh, displaying the mesh, detecting intersections between the tool and the mesh, and deforming the mesh. A number of references are given in the Bibliography of the 1996 Diploma Dissertation, *Computer Sculpting of 3-D Objects*, by Richard Nevill.
2. A study of the facilities for developing a graphical user-interface in Java.
3. Developing and testing the code for the algorithms referred to in (1).
4. Evaluation and the preparation of examples to demonstrate that the implementation has been successful.
5. Writing the dissertation.

If time allows there is scope for arranging that output could be sent as input to a higher quality renderer such as the ray tracer *POVray* (`www.povray.org`). Another extension would be to allow the user to paint colours on to the mesh with a paintbrush tool.

Reference

[1] *Computer Sculpting of Polygonal Models using Virtual Tools*, J. R. Bill and S. K. Lodha, Technical Report, University of California, Santa Cruz, UCSC-CRL-94-27. (`http://citeseer.ist.psu.edu/166785.html`)

Success Criteria

The following should be achieved:

- Store and display polygon meshes
- Read polygon meshes from files on disk and write them to files on disk
- Implement at least two separate tools
- Demonstrate that these tools interact appropriately with the polygon mesh
- Demonstrate mesh refinement

Timetable and Milestones

<In the following scheme, weeks are numbered so that the week starting on the day on which Project Proposals are handed in is Week 1. The year's timetable means that the deadline for submitting dissertations is in Week 34.>

<In the Project Proposal that you hand in, actual dates *should be used instead of week numbers and you should show how these dates relate to the periods in which lectures take place. Week 1 starts immediately after submission of the Project Proposal.>*

<The timetable and milestones given below refer to just one particular interpretation of this document. Even if you select exactly this interpretation you will need to review the suggested timetable and adjust the dates to allow as precisely as you can for the amount of programming and other related experience that you have at the start of the year. Take account of the dates you and your Supervisor will be working in Cambridge outside Lecture Term. Note that some candidates write the Introduction and Preparation chapters of their dissertations quite early in the year, while others will do all their writing in one burst near the end.>

Before Proposal submission

<This section will not appear in your Project Proposal.>

Submission of Phase 1 Report Form. Discussion with Overseers and Director of Studies. Allocation of and discussion with Project Supervisor, preliminary reading, choice of the variant on the project and language <*Java in this example*>, writing Project Proposal. Discussion with Supervisor to arrange a schedule of regular meetings for obtaining support during the course of the year.

Milestones: Phase 1 Report Form (on the Monday immediately following the main Briefing Lecture), then a Project Proposal complete with as realistic a timetable as possible, approval from Overseers and confirmed availability of any special resources needed. Signatures from Supervisor and Director of Studies.

Weeks 1 to 5

<Real work on the project starts here (as distinct from just work on the proposal). A significant problem for Diploma candidates is that this critical period largely coincides with the Christmas vacation. There is no guarantee that supervisors will be available outside Lecture Term, but Diploma students take much less of a Christmas break than undergraduates do, and so have some opportunity for uninterrupted reading and initial practical work at this stage. It is important to have completed some serious work on the project before the pressures of the Lent Term become all too apparent.>

Study of the relevant algorithms. Generation of some simple test Java code to get a feel for what can be done. It is critical that you get to grips with Java's 3D graphics library.

Milestones: Simple test code which demonstrates an understanding of Java and its user-interface libraries. This code will probably not be used in the final project implementation.

Weeks 6 and 7

Design data structures for storing the polygon mesh. Implement algorithms for managing this data structure. Implement simple prototype method of displaying the polygon mesh. Design an implement a test scenario.

Milestones: Working code to manage the data structure, demonstration of the program displaying a test polygon mesh.

Weeks 8 to 10

Refine display algorithm. Begin implementation of sculpting tools.

Milestones: Demonstration of the user interacting with an object on the screen in a simplistic way and demonstration of the user interacting with an object on the screen with one or more tools.

Weeks 11 and 12

Refine the code already written. Review remainder of project plan in view of program development to date and adjust as necessary. Write the Progress Report drawing attention to the code already written, incorporating some examples, and recording any augmentations which at this stage seem reasonably likely to be incorporated.

Milestones: Basic code now working, but probably with some serious inefficiencies, Progress Report submitted and entire project reviewed both personally and with Overseers.

Weeks 13 to 19 (including Easter vacation)

Implementation of mesh refinement algorithms. Ensure that routines to read objects from and write objects to files are written.

<The Easter break from lectures can provide a time to work on a substantial challenge (perhaps going beyond your initial plan) where an uninterrupted week can allow you to get to grips with a complex task. This is a good time to put in some quiet work (while your Supervisor is busy on other things) writing the Preparation and Implementation chapters of the Dissertation. By this stage the form of the final implementation should be sufficiently

clear that most of that chapter can be written, even if the code is incomplete. Describing clearly what the code will do can often be a way of sharpening your own understanding of how to implement it.>

Milestones: Demonstrations of improved interaction with the object, mesh refinement of an object, saving an object to a file, and restoring an object from a file. Preparation chapter of Dissertation complete, Implementation chapter at least half complete, code performs tolerably well and should be in a state that in the worst case it would satisfy the examiners with at most cosmetic adjustment.

Weeks 20 to 26

<Since your project is, by now, in fairly good shape there is a chance to use the immediate run-up to examinations to attend to small rationalisations and to implement things that are useful but fairly straightforward. It is generally not a good idea to drop all project work over the revision season; if you do, the code will feel amazingly unfamiliar when you return to it. Equally, first priority has to go to the examinations, so do not schedule anything too demanding on the project front here. The fact that the Implementation chapter of the Dissertation is in draft will mean that you should have a very clear view of the work that remains, and so can schedule it rationally.>

Work on the project will be kept ticking over during this period but undoubtedly the Easter Term lectures and examination revision will take priority.

Weeks 27 to 31

<Getting back to work after the examinations and May Week calls for discipline. Setting a timetable can help stiffen your resolve!>

Evaluation and testing. Finish off otherwise ragged parts of the code. Write the Introduction chapter and draft the Evaluation and Conclusions chapters of the Dissertation, complete the Implementation chapter.

Milestones: Examples and test cases run and results collected, Dissertation essentially complete, with large sections of it proof-read by Supervisor and possibly friends and/or Director of Studies.

Weeks 32 and 33

Finish Dissertation, preparing diagrams for insertion. Review whole project, check the Dissertation, and spend a final few days on whatever is in greatest need of attention.

<In many cases, once a Dissertation is complete (but not before) it will become clear where

the biggest weakness in the entire work is. In some cases this will be that some feature of the code has not been completed or debugged, in other cases it will be that more sample output is needed to show the project's capabilities on larger test cases. In yet other cases it will be that the Dissertation is not as neatly laid out or well written as would be ideal. There is much to be said for reserving a small amount of time right at the end of the project (when your skills are most developed) to put in a short but intense burst of work to try to improve matters. Doing this when the Dissertation is already complete is good: you have a clearly limited amount of time to work, and if your efforts fail you still have something to hand in! If you succeed you may be able to replace that paragraph where you apologise for not getting feature X working into a brief note observing that you can indeed do X as well as all the other things you have talked about.>

Week 34

<Aim to submit the dissertation at least a week before the deadline. Be ready to check whether you will be needed for a viva voce *examination.>*

Milestone: Submission of Dissertation.