Project Proposal for 'Dynamic Object Modelling for Advanced Touch Interactions'

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This report is submitted as partial fulfilment of the requirements for the Honours Programme of the School of Computer Science and Software Engineering, The University of Western Australia, 2013

Abstract

This is Jad Osseiran's Final Year Project Proposal for the development of a software application implementing Dynamic Object Modelling for Advanced Touch Interactions (DOMATI). This proposal will look into approaches for determining the strength of a touch on a multitouch display and its effect on a rendered 3D model. The application will run on affordable and ubiquitous hardware. Furthermore, the key steps to be undertaken for the proposed project and its possible risks are also detailed.

Keywords: Honours, Project Proposal, Software Engineering, Computer Science, Graphics, Mobile, Multitocuh
CR Categories:

Acknowledgements

This project idea was sparked from a discussion with University of Western Australia's Professor Amitava Datta. It has since been scoped to be a suitable final year project.

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CHAPTER 1

Motivation

Today's multitouch devices often have an awareness of their positions in 3D space and possess more than enough processing power to calculate advanced touch interactions. This allows their software content to react in real time. However very few applications of such a system exist and therefore this field has seen minimal development.

1.1 Existing & Upcoming Solutions

Using the strength of a touch has already been explored in the industry and a select few mobile applications have already been implemented [1]. An example is Apple's$^{\text{TM}}$ GarageBand iOS application where the drums will output different sounds depending on the strength of the tap. It can be hypothesised that this approach relies on the gyroscope and accelerometer and thus would be limited in a situation where the device's position is fixed.

Other upcoming solutions rely on having a pressure sensitive touchscreen [5]. For example a recently registered patent entitled 'Embedded Force Measurement' rely on touch strengths being detected by a pressure sensitive display.

1.2 Scientific Research

DOMATI and particularly its future improvements can be extremely useful in scientific research. For example in the case where a certain material under observation is rare or cannot be physically altered; it would be possible to measure such material and model it into the application. Once rendered users can experiment with various interactions such as pinching the material or 'hammering' it with strong touches. This would allow scientists to hypothesise viable physical experiments based on the simulation results.

1.3 Entertainment Purposes

Games could greatly benefit from a better interaction with modelled objects and the numerous possibilities of touches. For example a door may only open if it pushed with enough strength or a window could be shattered by tapping with the right intensity at the appropriate places.

1.4 Tangible Interfaces

Responding to the strength of a touch would allow for another medium of interaction with content. For example a hard touch will jump two levels in a stack whereas a normal touch will only move up one level. New tangible interfaces are explored in the industry such as Samsung's™ implementation of hovering over the screen to interact with content on its most recent devices [7].

CHAPTER 2

Project Description

In this project 'advanced touches' differ from standard touches in that the strength of a touch is taken into account on top of its location, phase, timestamp and repetitiveness. The project aims to improve the standard touch with common and affordable touchscreen devices through a software application which models the response to advanced touches in a simulated software environment. 'Dynamic Object Modelling for Advanced Touch Interactions' (DOMATI) consists of four main pillars:

Touch Recognition: Recognising a touch's strength, location, phase, timestamp, repetitiveness and the change of strength over repeated touches.

Object Modelling: A 3D render of an object which will respond to touch interactions.

Calibration: A solution to cater to the various users of DOMATI to ensure advanced touches are correctly recognised.

Hardware: Prevalent and affordable multitouch devices such as tablets and smartphones.

A mobile application entitled "DOMATI" will be developed for Apple™ iOS devices. Open technologies such as OpenGL ES 2.0 will be the basis for the modelling aspects to maximise re-usability. Detailed documentations will be provided for possible future expansions to other systems.

2.1 Touch Recognition

A touch event in DOMATI will store the strength, location, phase, timestamp, repetitiveness and the change of strength over repeated touches on the screen. The strength of a touch is calculated by combining factors such as duration and radius of a touch coupled with the movement of the device in 3D space. The location and timestamp of a touch will be recorded to determine the right area of the rendered object to re-model. The phase of the touch will be recorded to decide in which state (beginning, dragging, end) the touch is at a given time.

Rapid repetitive touches in the same location may occur with different strengths. DOMATI will register these occurrences and the net change in strength across the touches will be averaged for a smoother reflection on the modelled object. Furthermore it is possible that multiple touches occur at the same time, such as a pinch, and thus DOMATI will register and distinguish between a hard pinch and a soft pinch.

2.2 Object Modelling

The modelled object will be simulated using OpenGL ES 2.0. In this project a basic texture-less object will be rendered with a simple ambient light source. The object will be of a similar consistency of Play-Doh™ as it is a malleable material which will visibly reflect the strengths of touches. Keeping a 3D rendering as straightforward as possible will increase the performance of the simulation [3]. This simplicity will assist in keeping this project within a reasonable timeline.

2.3 Calibration

The fact that fingers differ greatly in size, and thus differ in touch radii, will hinder the measurement of a touch's strength leading to inaccurate representations on the rendered object. Furthermore the perception of a strong touch is subjective. For these reasons a calibration mechanism is necessary for this project and will be further explored. However, it is imperative that the solution is non-intrusive and quick to re-calibrate.

This will require collecting data about touches and performances of different modelling techniques. The collated data will then be examined and a final optimal calibrating solution will be extrapolated for use in the finished build.

2.4 Hardware

The hardware used for this project is easily attainable and affordable. Multi-touch devices are a commodity in contemporary times and most of them have well established Software Development Kits (SDK). This project will be using the Apple^{TM} iOS 7 SDK and catering for all its supported phone and tablet devices. This choice is justified because a single binary can be written for all iOS 7 devices eliminating fragmentation issues plaguing the Google^{TM} Android Operating System [6]. Furthermore, the supported devices all contain a gyroscope and accelerometer with the same Application Program Interface (API) which will be used to assist in touch strength calculations [2].

However as discussed in section 2.2 the software component will be based on open technologies and hence Google^{TM} and Microsoft^{TM} devices could easily adopt DOMATI.

CHAPTER 3

Project Schedule

This project is scoped to be of a suitable size for a final year project and thus it allows room for improvements. The scoped project will be broken down into milestones for the literature review, development of software, dissertation, poster and seminar components. Understanding the possible risks and preparing for their eventuality is also a key aspect of the project plan.

3.1 Milestones

There are four major milestones to this project which can be completed concurrently. These are listed in the following subsections.

3.1.1 DOMATI.app

The DOMATI.app will follow a strict Agile Software Development lifecycle with sprints every two weeks. Listed below are the major deliverables and their expected completion dates.

Application Skeleton - *Week 4, S2 2013*

A very basic concept of the application which will consist of the flow of the application and the core navigation components. A basic 3D object will be rendered but will not respond to touches.

Object Interaction - *Week 12, S2 2013*

A Play-Doh^{TM}-like object will be rendered and users will be able to interact with it by touch interactions. The position of the object in 3D space will be controlled by the user. However, the strength of the touch will not be taken into account in this milestone.

Touch Calculations - *Week 0, S1 2014*

In this milestone DOMATI will be able to intelligently determine the strength of a touch and relay that information on the modelled object. Calibration data will have been collated and several calibration solutions will be chosen. A different version of the application will be produced for each top calibration solution and sent to testers.

Testing - *Week 4, S1 2014*

A calibration method will be decided by this milestone based on the testing feedback. Minor improvements and bug fixes will be the only changes for this milestone.

3.1.2 Literature Review

The literature review will be completed concurrently with the software application and could provide some insight into possible approaches and touch calculation algorithms.

3.1.3 Dissertation

The dissertation paper will be written throughout the development of the software application. Data collected from the touch calibrations and object re-modelling will be recorded, compared, discussed and graphically presented in the paper. A template will be kept throughout the development and will be concretised before the draft is due.

3.1.4 Poster & Seminar

The poster and seminar will showcase the application and the results from various touch calculations and object modelling algorithms. Focus will be put onto the results from the different approaches and the process of choosing the final solution.

3.1.5 Gantt Chart

The Gantt charts for the proposed milestones are shown below.

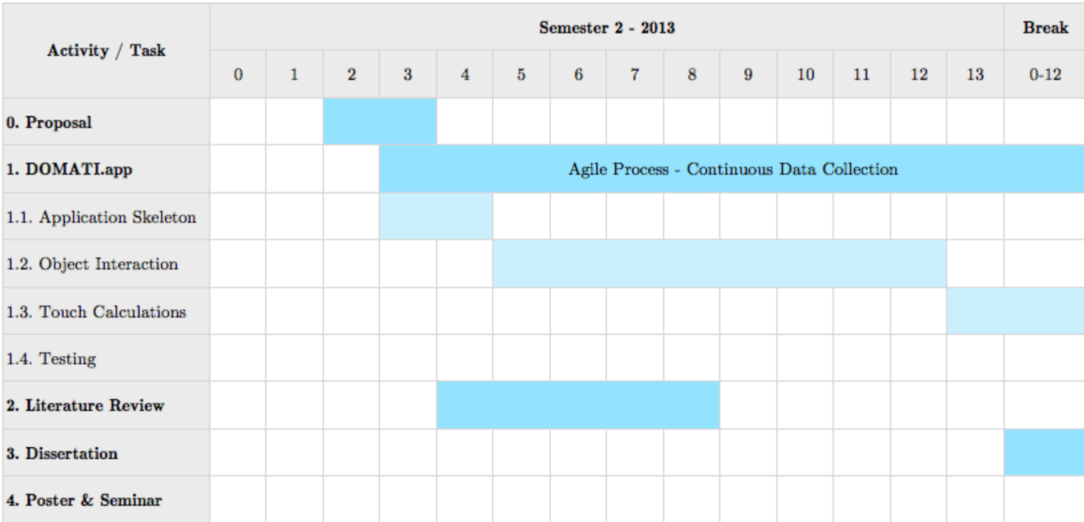

Figure 3.1: Gantt chart for semester 2, 2013.

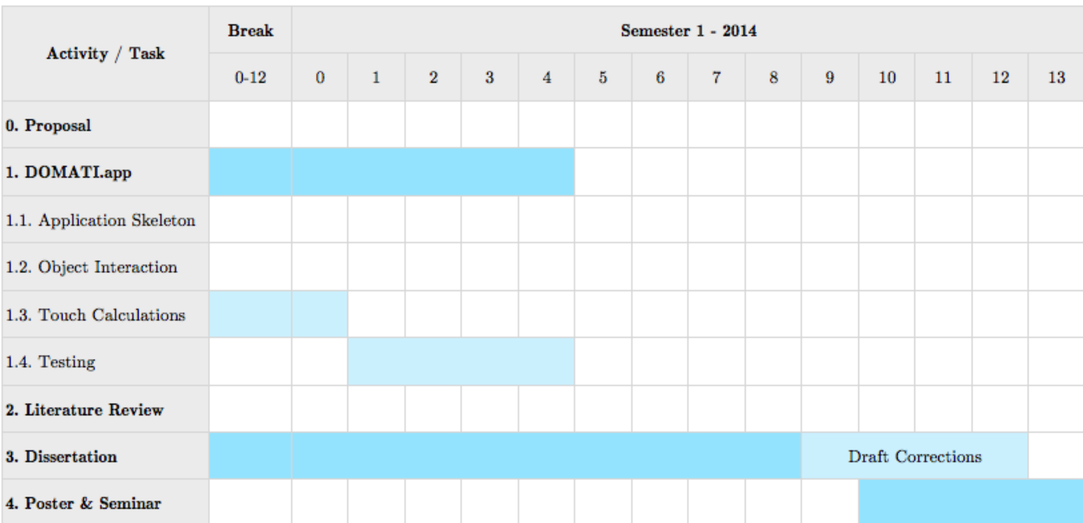

Figure 3.2: Gantt chart for semester 1, 2014.

3.2 Project Risks

The major risks for the project are listed below. The Australian standard risk factor is calculated from the likelihood factor and the rated consequence following a qualitative risk analysis matrix [4].

Potential Impact	Likelihood	Consequence	Risk Factor
Significant illness or period of unavailability	Possible	Moderate	High
Unable to find required information or data	Unlikely	Major	High
Unable to source required equipment	Unlikely	Major	High
Failure to design software within scheduled time	Unlikely	Major	High
Calibration algorithms do not point a single best calibration solution	Possible	Minor	Moderate
Not enough research papers for a literature review	Unlikely	Moderate	Moderate
Testing reveals implementation is fundamentally flawed	Unlikely	Catastrophic	Extreme
Cannot find enough testers	Possible	Major	High
Hardware unable to run complex OpenGL ES 2.0 effects	Unlikely	Catastrophic	Extreme

Figure 3.3: Risk table for the project.

3.3 Future Improvements

This project can be improved in many different ways. A major advancement which would be extremely beneficial is to specify pre-defined properties for any object for the software to render. This would make DOMATI very flexible and would allow it to be especially useful in scientific research as scientists could qualify material properties and model them in real time.

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