NAZARBAYEV UNIVERSITY
SCHOOL OF SCIENCE AND TECHNOLOGY

Computer Science Department
Senior Project Proposal

Proposer:	Hans de Nivelle (Associate Professor, Computer Science)
Topic:	Flight Simulation Program
Team Members:	Alisher Shakhiyev, Alen German, Auyez Zhumashev

Description

1. Project Description:

   Write a 3D flight simulator with 3D mechanics, 3D graphics, collision detection, terrain, and interactive user input.

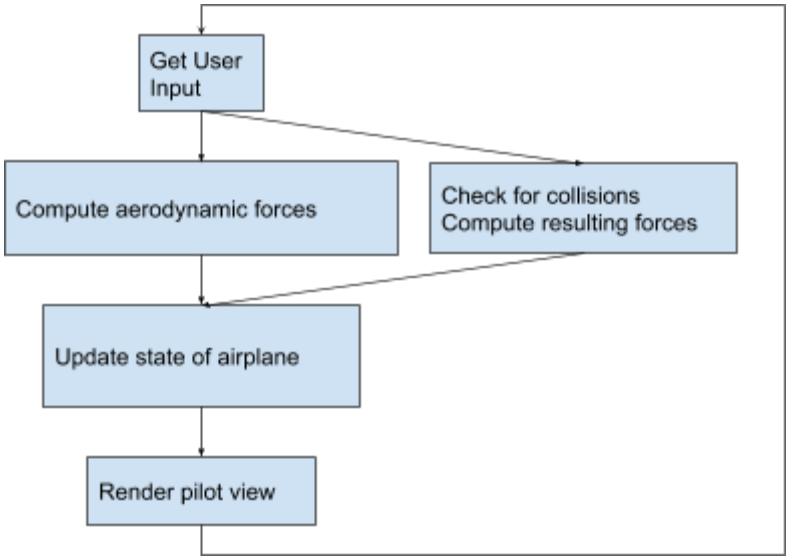
   The motivation and purpose is to make students understand the theory behind flight simulation, and to be able to implement it: Understand 3D mechanics, numerical real time differential equation solving, understand how to represent scenery,understand collision detection, how to detect user input, and the basics of computer graphics.

2. System Description:

   The project will consist of implementations of

   - a 2D flight physics model
   - a 3D graphics engine.
   - 3D models and shader assets (Spring semester)
   - a 3D collision detection system
   - terrain (Spring semester)
   - a 3D flight physics model (Spring semester)

3. System Design:
   Workflow Diagram



   ER Diagram
   The simulation won't keep track of any data, so ER Diagram is just an empty whitespace.

System modelling (How to model the problem of interest)

- 2D flight physics model from [0] will be used.

Methodology (Techniques that are used in the project and why choose them)

- Pair programming. The project will include some technically difficult tasks that can't be neatly divided among multiple people but are too hard for a single student.
- Students will review each other's code.

Functionality (How to implement the above techniques. there should be some diagrams.)

(Not applicable)

Optimization (How to optimize the techniques)

(Not applicable)

4. System evaluation criteria if any

   The simulation will be checked against an existing 2D model, and against published performance parameters. We will try simple manoeuvres (like take off and landing)

5. Plan B: basic 3D collision detection(no wheels, no friction) and simple 3D physics

Objectives

The main goal of this project is to create a real time simulation of an airplane. To achieve the main goal, the following objectives should be completed:

- Build real time application with 3D graphics support (Basic 3D game engine that can load models, support basic animation and lighting implemented using OpenGL)
- Build 2D flight physics simulation (2D flight simulation written in C++ using SFML library)
- Integrate with existing 3D collision detection solutions (Integrate with physics engines like ODE and Bullet), or implement our own collision detection
- Build 3D flight physics simulation

The main objectives that should be completed in 1st semester:

- Build 2D flight physics simulation (2D flight simulation written in C++ using SFML library)
- Build basic real time 3D application (Basic 3D game engine that can load models, support basic animation and lighting implemented using OpenGL)

- Integrate with existing 3D collision detection solutions (Integrate with physics engines like ODE and Bullet) or implement own collision detection. This will be decided in the beginning of the first semester.

Deliverables:

- 1st Semester:
  - 2D flight simulation written in C++ using the SFML library
  - Basic 3D game engine that can load models, support basic animation and lighting implemented using OpenGL
- 2nd Semester:
  - Full 3D flight physics simulation.
  - 3D collision detection with friction.
  - Improved renderer

Tasks to be Accomplished:

Week (1st week starts on 28th Jan)	Alisher	Alen	Auyez
1	Fix the existing 2D physics model	Design renderer architecture	Design renderer architecture
2	Study basic 3D collision detection theory	Make a beautiful sky	Heavily refactor renderer
3	Rewrite 2D physics into 3D	Make beautiful water	Implement shadows
4	Validate basic 3D simulation	Create scenery objects	Refactor terrain code Rescale terrain
5	Validate overall 3D simulation	Clean up renderer and terrain code	Render scenery objects
6	Validate overall 3D simulation	Make splatmaps affect terrain	Render scenery objects
7	Implement basic 3D collision detection	Try to load Kazakhstan's terrain	Implement beautiful clouds
8	Study advanced 3D collision detection theory (wheels, friction)	Study 3D collision detection code	Implement animations

9	Implement advanced 3D collision detection	Study 3D physics theory and code	Implement instrument panel
10	Implement advanced 3D collision detection	Fixing 3D collision and 3D physics bugs	Implement UI
11	Performance optimization	Bug fixing	Performance optimization
12	Final report, presentation, poster	Final report, presentation, poster	Final report, presentation, poster

Hardware and Software Requirements
The minimal achievement for the first semester is a two dimensional flight simulator which has a reasonably realistic flight model and controllability. This includes: ● Realistic lift and drag forces exerted on the plane ● Two-dimensional torque ● Realistic takeoffs and landings ● Keyboard or mouse input reading ● Environmental effects, at least the air pressure change with height In the second semester, the simulator must be extended to a three dimensional version. The minimal achievement consists of 3D graphics, and ground collision (contact) detection and adequate movement in 3D space.
References
[0] http://www.ii.uni.wroc.pl/~nivelle/teaching/flightsim2016/twodimensional.pdf

Term Schedule

		To be always filled by adviser during meeting with students		
Week Number	Task Assignment	Date Completed	Comments	Signature
2 (~Feb 8)	Renderer is refactored, perfectly working 2D model			
4 (~Feb 22)	Basic 3D physics model			
6 (~Mar 8)	Final terrain, reasonable full 3D physics model			
8 (~Mar 22)	Basic 3D collision,			
10(~Apr 5)	3D graphics, Terrain, 3D Collision Detection			
12 (~Apr 19)	Presentation accomplishments, encountered problems and proposed solutions. This is not a Technical presentation but rather advancement check, Interim Report (end of term paper) End of first term			