Flight Simulation

What is in this Course?

On one side, this is a serious course, and you will learn serious things here:

Philosophy is written in this grand book I mean the universe which stands continually open to our gaze, but it cannot be understood unless one first learns to comprehend the language in which it is written.

This book is written in the mathematical language, and the symbols are triangles, circles and other geometrical figures, without whose help it is impossible to comprehend a single word of it; without which one wanders in vain through a dark labyrinth.
(Galileo Galilei)

Why did I put this quote here: Because I often meet students who say things like:

- I like to be a game programmer, but I don't like mathematics, or
- I like to do sound processing, but I try to avoid the mathematics.
- I like physics, but I don't like the mathematics.

My answer to that is: Don't fool yourself: Mathematics is needed almost everywhere.

Apart from this, we want to have some fun as well:

I have a somewhat working program. I showed it during ZOSIA 2010.

I will use parts of it in exercises later in the course.

I want to go much deeper into the theory of aircraft stability than last year.

There will probably be an excursion to Dresden.

Overview of Lectures

- Remembering Newton mechanics. Basics of differential calculus. We will do some calculations on trajectories of planets and rockets.
- Quaternions and vector calculus. Quaternions are used for representing rotations. They are used in computer graphics, and we also need them for representing the orienation of airplanes. I will do the basic derivations and prove that quaternions do indeed represent rotations.
- Laws of motion for rigid objects. I will do the derivations. We will prove and numerically test that they are correct.
- Basics of Computer Graphics. It is not my speciality, and there others in this faculty who are very good at CG, but it is clear that CG cannot be avoided in a class on flight simulation.

- Representation of the world. Coping with the fact that the earth is round. Dealing with coordinates, computing the direction of gravity.
- Detecting collisions and intended interactions with the solid world. Computing aerodynamic forces.
- Design of autopilots.

Computer Graphics

We will use Open GL (See on the homepage of Andrzej Łukaszewski, `http://www.ii.uni.wroc.pl/~anl/dyd/PGK/`)

For the interface to open GL, we use Simple and Fast Multimedia Library. `http://www.sfml-dev.org/` .

Why Flight Simulation?

Two applications need to be distinguished, serious applications and games.

Serious applications:

- Training difficult conditions can be dangerous. (Technical failures, bad weather, difficult aiports.)
- Some training conditions are rare in real. For example, landing in stormy weather, wind shear, or fog.
- Training in a simulator is a lot cheaper than training in a real aircraft.

Nowadays, simulators are the main tool for training pilots. Simulators are used for recreating accident conditions. They can be used for testing pilot-friendlyness of instruments and controls.

Flight Simulation as Game

Flight Simulator on home computers (as game) was introduced by Bruce Artwick in 1979.

His thesis (A Versatile Computer-Generated Dynamic Flight Display) was about 3D-graphics for flight simulation. It was completed in 1976. After that, he rewrote his software for the 6800 microprocessor which was just developed.

In 1977, he founded the company SubLOGIC, which started selling SubLOGIC Flight Simulator.

In 1982, SubLOGIC Flight Simulator was the most sold software package for the Apple][. (B.t.w, the Apple][had 64 Kbytes of Memory, a 6502 processor with 1Mhz clock frequency.)

In 1982, a small company called Microsoft, bought the rights to port Flight Simulator 2 to the IBM PC, which was being introduced at that time. They thought that it would be nice to have a few games on the new platform.

In 1996, the rights to Flight Simulor were bought by Microsoft, so now the game is called 'Microsoft Flight Simulator'.

The future is a bit unclear. It is possible that microsoft develops a new simulator called 'Microsoft Flight'. It is also possible that it will sell the rights.

Please read `http://en.wikipedia.org/wiki/History_of_Microsoft_Flight_Simulator`

Games are also Serious

Flight Simulator has been quite big business for Microsoft, although I could not find any information on how much they earn with it.

In addition to Flight Simulator itself, there are a lot of additional products available. Additional software, scenery, airplane models, specialized hardware, and there exist enough people who buy this.

Some people take this game very serious. See on `http://www.fsweekend.com/`, what these people are capable of.