Introduction to Flight Simulation (List 3)

Due: 23 october 2012

1. Using the rocket simulator, try out different strategies to reach orbit, for example at 250 km altitude. Are some strategies more efficient than others? Is there a clear winner?

2. What influence does the exhaust speed have on the mass that one can bring in orbit? Try out a view speeds, e.g. $2500m.s^{-1}, 3000m.s^{-1}, 5000m.s^{-1}$ and see the effect.

3. Find, for every rotation that maps a cube to itself, a quaternion that describes this rotation.

4. LENU (local east, north, up) coordinates are defined as follows. defined as follows:

   X east

   Y north

   Z up.

   Airplane coordinates are always defined as follows:

   X To the right (starboard side) of the plane.

   Y Forward looking, in the direction of the plane.

   Z Downward, relative to the plane.

   Eye coordinates are always defined as follows:

   X To the right of the viewer.

   Y Upwards from the viewer's position.

   Z Backwards from the viewer's position.

   Since the viewer sees only things that are in front of him, he can only see things that have a negative Z-coordinate, when expressed in eye coordinates.

   (a) Suppose that an airplane takes of from Runway 18 in Frankfurt. (This runway looks south, you may assume that it is exactly south.) What is the quaternion that represents the orientation of the plane?

(b) During take off, the plane rotates by 15 degrees. Describe this rotation (relative to the previous orientation) as a quaternion.

The new quaternion could be obtained by multiplying the previous quaternion by the quaternion that represents the rotation.

(c) Give a quaternion that transforms LENU into the eye coordinates of the pilot, during the take of from runway 18.

(d) Paweł has booked seat 25F. Give a quaternion that transforms LENU into his eye coordinates.

(e) Agnieszka sits in seat 6A. Give a quaternion that transfroms LENU into her eye coordinates.

(f) If one knows the position of an object in eye coordinates, then what must be done, in order to compute its position on the screen?