EXERCISE 1

1. Affine Transformations

(a) Write down a general translation matrix for 3D points. Explain the individual entries.

(b) Write down the general rotation matrices (one for each rotation axis) for 3D points and vectors. Explain the individual entries.

(c) Write down a general scaling matrix for 3D points and vectors. Explain the individual entries.

(d) Write down a general shearing matrix for 3D points and vectors. Explain the individual entries.

(e) Animation:
Let $\mathbf{p} = \begin{pmatrix} 1 & 2 & 3 & 1 \end{pmatrix}$ denote a 3D point.
Construct a time-dependent transformation matrix that rotates this point on a circle with

- radius $r = 1$,
- around the z-axis,
- at $z = 0$.

Use t for the elapsed time.

2. Scene Graph

(a) Construct a scene graph for a model of a car consisting of:

- Chassis,
- Body,
- 4 wheels.

(b) Consider row vectors. Specify the computation of the transformation matrix for the rear wheel on the left side.

Prof. Dr. Torsten W. Kuhlen <kuhlen@vr.rwth-aachen.de>
Dr. Tom Vierjahn <vierjahn@vr.rwth-aachen.de>