

Humanoid Robots

Exercise Sheet 1 - GIT and Linear Algebra

Exercise 1 (6 points)

In the tutorials for the humanoid robots course, we will use the source control system *GIT* for distributing the exercises and for handing in the solutions:

- Official homepage: <http://git-scm.com/>
 - Beginner tutorial: <http://rogerdudler.github.io/git-guide/>
 - Advanced tutorials: <https://de.atlassian.com/git/tutorials/>
 - Tortoise GIT (a popular GIT client for Microsoft Windows):
<https://code.google.com/p/tortoisegit/>
 - GIT is available in all Linux package managers and can be used directly from the console.
 - There are many graphical user frontends for all operating systems and most development environments (Eclipse, Visual Studio, etc.) directly support GIT.
- a) Make yourself familiar with GIT. You should be able to use at least the basic GIT commands `git init`, `clone`, `add`, `commit`, `push`, and `pull`.
 - b) Clone your personal GIT repository. We will send you the URL and account credentials when you register for the tutorials via e-mail.
 - c) Add a new file `src/01_git/hello.txt` with the content “hello world”.
 - d) Commit and push your changes to the GIT server. The server will automatically build your package, test the code, and write the output to the Wiki of your GIT repository. This process will take a few seconds to complete.
 - e) Check the results of this exercise in your project’s Wiki at <https://gitlab.igg.uni-bonn.de/>.

Exercise 2 (14 points)

Linear algebra will be a prerequisite for many applications in the humanoid robotics lecture. A popular library for linear algebra algorithms is *Eigen 3*:

- Official homepage: <http://eigen.tuxfamily.org>
- Getting started tutorial: <http://eigen.tuxfamily.org/dox/GettingStarted.html>

You will find a copy of Eigen (licensed under the Mozilla Public License 2.0) in the directory `src/includes/Eigen/` in your repository. The library is ready to use, you don't have to build anything first.

Make yourself familiar with the Eigen library and then implement the missing parts of the file `src/02_linear_algebra/src/LinearAlgebra.cpp` according to the following instructions:

- a) Find out how to fill vector and matrices with elements, then complete the functions `vectorA()`, `vectorB()`, and `matrixM()` so that they return the following values:

$$\mathbf{a} := \begin{pmatrix} 2 \\ 1 \\ 3 \end{pmatrix} \quad \mathbf{b} := \begin{pmatrix} -1 \\ -5 \\ 2 \end{pmatrix} \quad \mathbf{M} := \begin{pmatrix} 1 & 2 & 7 \\ 0 & 2 & 0 \\ 1 & 0 & -1 \end{pmatrix}$$

- b) Find out how to get the *inverse* of a matrix, then complete the function `invMatrixM(M)`.
- c) Find out how to get the *transpose* of a matrix, then complete the function `transposeMatrixM(M)`.
- d) Complete the function `detOfMatrixM(M)`, which returns the *determinant* of matrix M.
- e) Find out how to compute the *dot product* (also known as *inner product* or *scalar product*) and complete the function `dot(a,b)`.
- f) Complete the function `isLinearIndependent` for determining whether two vectors are linearly dependent or not.
- g) Find out how to solve linear systems and solve the equation

$$\mathbf{M}\mathbf{x} = \mathbf{a}$$

for \mathbf{x} and complete the function `solveLinearSystem(M,a)`.

As always push your changes to the GIT server and check the results in the Wiki.

Deadline: Thursday, 11 April 2019, 11:59 am