Robotics – Tutorial for Assignment #1

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The Puma560 Simulator

- Software that simulates the Kinematics, Dynamics, Friction etc. of the Puma560 robot
- *pumasim* binary or Virtual-Box
- Provides a GUI for controlling, monitoring and configuring the simulation

Running the simulator natively

- Known to work on Ubuntu 20.04 and 18.04
- Download the pumasimulator-xxxx.tgz

  tar –xzvf pumasimulator-xxxx.tgz
  cd pumasimulator
- Read the *Readme.md* for installation instructions

Running the simulator with a VM image

- Install Oracle **Virtualbox 6.1**
  http://virtualbox.org/
- Download the Virtual Machine image (.ova) from ISIS
  - Tip: Do it on the campus net (ca. 2.6GB)
- Start the machine
- Login: student
- Password: student
- Open a terminal and type *pumasim*

Simulator internals

- Controller are called every 2 ms
- Predefined names
- The pumasim executable does not contain controllers, but loads them from the shared library *controlDLL.so*
- Pumasim first looks for the library in the current working directory, then in /opt/pumasim
- You only need to compile controlDLL.so

control.cpp

- Here you implement your robot controller
- **Important:**
  - File must also be compatible on the Real-Time-PC running QNX.
- `init…()` functions are called when you click on „Start“ (controller).
- `…control()` functions are called periodically in the servo loop with 500Hz.
- A lot of global variables are declared via the structure *gv*: they contain the simulator/robot’s state

data.mat

- Plain ASCII text file
- Each line is a timepoint:

time q(1..n) dq(1..n) qd(1..n) tau(1..n) x(1..m) dx(1..m) xd(1..m)

- n = DOF
- m = 7 in „6-DOF (quaternions)“ mode
  else m = DOF
- You can import it into Excel, Matlab, gnuplot, Octave, matplotlib, a.s.o. and make nice graphs

gains_*.txt

- Text file containing separate gains for all controllers for a specific robot mode
  - gains_1.txt = gains during 3DOF mode
  - gains_6.txt = gains during 6DOF quaternion mode
  - a.s.o.

- Please do not edit the text file manually, but use *Store gains* and *Load gains in the GUI*

Before you start coding

- **Read** *Notes and Restrictions on Coding.pdf* (available on ISIS)

- Information about available math library (vector, matrix, etc.), global variables, etc.

P-controller

- Important variables for the P-controller in the gv struct:

```
tau    : joint torques
q      : joint position
kp     : position gains for the current control mode
qd     : desired joint position
```

- You can tune your controller via the GUI
- You can visualize signals by writing them to a text file (.mat)

Compile System for controlDLL

- Cmake based compile template:

cd 1/

mkdir build

cd build

cmake ..

make

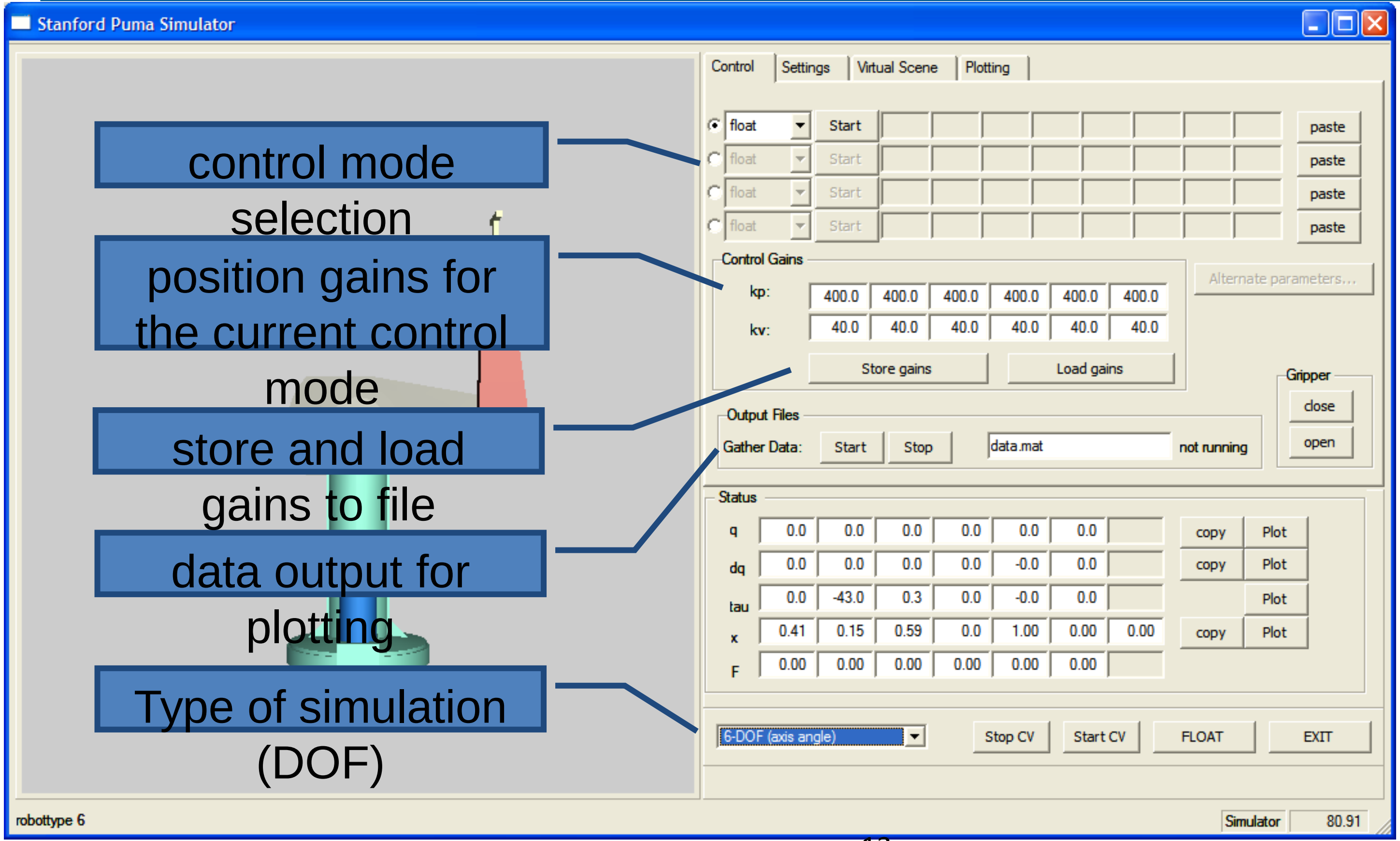
- This creates a controlDLL.so from control.cpp
- To use your controller, call *pumasim* in the *build/* directory:

pumasim

Q&A

- ISIS discussion forum
- teaching@robotics.tu-berlin.de

Puma Simulator



Puma Simulator Settings