University of Liège - Faculty of engineering

Master thesis

Simulation of complex actuators

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Abstract

Lorem ipsum dolor...

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Chapter 1

Introduction

1.1 Introduction

This is the introduction

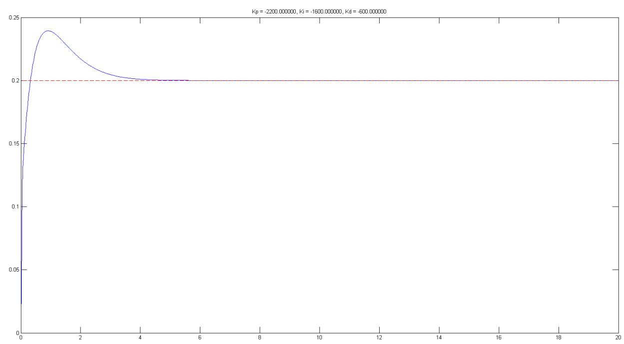

Figure 1.1: best pid

Chapter 2

Simulator

In this chapter we discuss the choice of V-rep as the simulation tool for this project. We begin by explaining the basics of rigid body dynamics simulation, take a survey of some of the existing simulators and finally test some of them.

2.1 Simulation of rigid body dynamics

2.2 Available simulators

The basis of the simulation is the ability to simulate the dynamics of the robot and the friction with the soil. So, something bare-bone as Matlab or bullet could be used,

[1] The list of physics simulating engines is quite long, but the most popular ones are, in no particular order :

1. Bullet
2. ODE
3. DART
4. Simbody
5. PhysX
6. Havok

Bullet was chosen because while it does not distinguish itself when it comes to pure physical simulation [2], a 3D modelling application called Blender is built atop of it, providing excellent tools for fast and easy robot modelisation. Blender also provides access to Bullet through a well document Python API.

2.3 Tested simulators

Blender is originally a 3D modelling and rendering software. It uses the Bullet physics engine to simulate realistic physics in animations. It has a Python interface which can be used to script a simulation.

Engine	**License**	**Coordinates**	**Origin**	**Editor**	**Solver type**
Bullet	Free	Maximal	Games	Blender	Iterative
ODE	Free	Maximal	Simplified robot dynamics, games		Iterative
DART	Free	Generalized	Computer graphics, robot control		
Simbody	Free	Generalized	Biomechamics		
PhysX	Proprietary	Maximal	Games		
Havok	Proprietary	Maximal	Games		

Table 2.1: Features comparison

Simulator	**License**	**Physics engine(s)**	**Integrated editor**	**Modelling**
Blender	Free	Bullet	Fully fledged	Internal
V-REP	Free (educational license)	Bullet, ODE, Newton, Vortex(10s limit)	Limited	Can import .COLLADA
Gazebo	Free	Bullet, ODE, Simbody, DART	Limited	SDF format
Webots	Proprietary	ODE	None	SDF format
Matlab	Proprietary	None	None	Mathematical

Table 2.2: Comparison of simulators

V-rep integrates a simulator that can run on different physics engines and supports remote operation.

2.4 Choice

Chapter 3

Modelling tools

This chapter covers the tools used in order to create a model of the robot, from the placement of the servos and joints to the incorporation of accelerometers.

3.1 Blender

The modelling of the robot starts in Blender, where the servos and the joints are be positioned. The justification is that it is faster to do it in Blender than in V-Rep, because of its better interface.

In preparation of the import operation into V-REP, the model is exported to the COLLADA format.

3.2 V-REP

V-Rep can import COLLADA files. What is left now, is linking the servos together and adding the sensors.

3.2.1 Servos

Servos are simulated by joints.

3.2.2 Joints

Joints are a basic block in v-rep, and they link two objects together.

3.2.3 Sensors (accel, cog)

The COG is computed through a script inside V-Rep, attached to a piece of the model and made available through the remote interface.

3.2.4 Springs

Chapter 4

Simulation

4.1 Interface (api)

4.2 First simple simulations

4.3 Robot design

4.4 Application ! stand up routines

Chapter 5

Physical validation

5.1 Mode expérimental

5.2 Experiments

5.3 Servo tuning

5.4 Results

Chapter 6

Conclusion

Bibliography

[1] Herman Bruyninckx. Blender for robotics and robotics for blender. *Dept. of Mechanical Engineering, KU Leuven, Belgium*, 2004.

[2] Tom Erez, Yuval Tassa, and Emanuel Todorov. Simulation tools for model-based robotics: Comparison of bullet, havok, mujoco, ode and physx.