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3D framework for machine learning

Kjartan Akil Jónsson M.Sc.

Leiðbeinendur: dr. Tómas Philip Rúnarsson, prófessor og dr. Hjálmtýr Hafsteinsson, dósent

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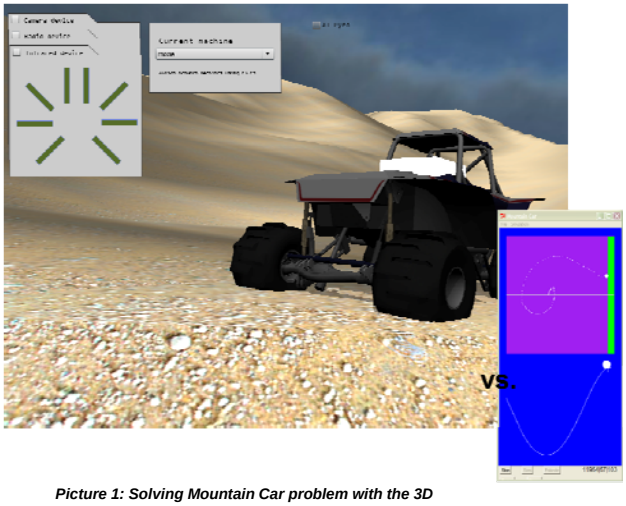
Motivation

Science has made dramatic progress within the field of robotics and other types of adaptive machines. The future direction seems to be targeted at learning machines being able to cope in real world environments.
The aim of the work presented in this thesis is to create a realistic 3-dimensional world using open source libraries.
From the machine learning perspective the goal is to learn how to drive in an all terrain environment, by controlling the vehicles' acceleration and steering. There has been quite some interested in the machine learning community on learning the control of vehicles, both in the simulated and real world. These solutions often use simplified physics, for example by neglecting fiction. With this work the aim is to make these learning environments more realistic and hence more challenging for the machine learning methods.

Mountain Car problem

Consider the task of driving an underpowered car up a steep mountain road. We assume that gravity is stronger than the car's engine, so that even at full throttle the car cannot accelerate up the steep slope. Thus the car has to drive back and forth to build up momentum in order to make it up the slope.
This well known problem is typically solved in 2D where the vehicle is simulated as a point on a sinus curve.
Our framework allows the user to see the machine in 3D with enhanced physical realism. In fact the exact same solution could be used in a real robot using the Pyro library. This demonstrates the importance of realism for simulated environments when solving learning problems such as the Mountain Car problem.



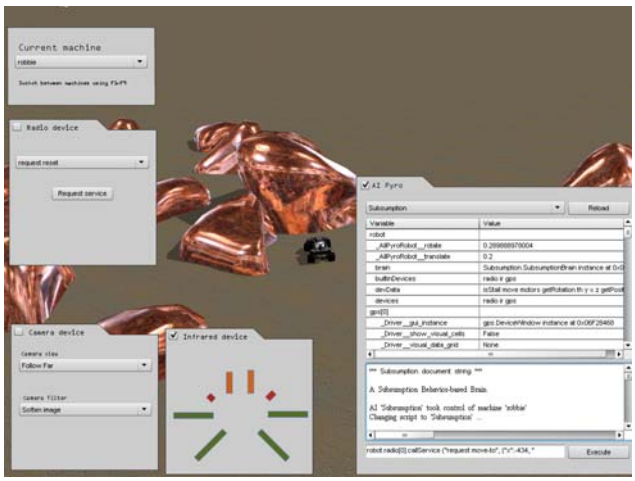
Picture 1: Solving Mountain Car problem with the 3D framework vs. commonly used simulation in 2D

Results

This thesis demonstrates a software framework for working with machine learning methods using open standards. The framework uses the Pyro machine learning library and the PhysX physics engine, resulting in a realistic 3D environment for testing and learning artificial intelligence. The environment offers authors of machine learning methods a challenging environment in which to test learning methods.
The software is accessible online at

`http://www.machinerace.com`

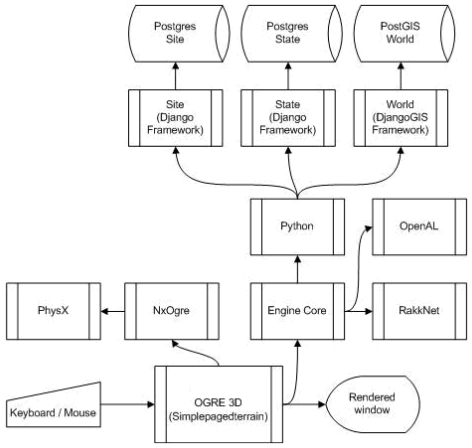
Framework



Picture 2: Vehicle driving around the landscape

Graphics rendering in the framework employs tools used by game developers. This allows designers to use state-of-the-art graphics technology for advanced visual effects. The rendering technology is connected to the physics library making items in the environment interactive. The framework uses the Pyro machine learning library, resulting in a script based environment for testing and learning artificial intelligence. The system uses three online servers to store user state and they are accessible through the project home page.

Architecture



Picture 3: Architecture overview

Architecture of the open source libraries
The above image depics the architecture of the open source libraries and their relations to each other.
OGRE 3D is a rendering library and runs the main loop calling Python, a script library, that in turn updates the online servers. Pyro is written in Python allowing us to use it when scripting AI behaviors. These behaviors depend on the physics library, which is handled by the NxOgre wrapper and it forwards the calls to the NVIDIA PhysX physics library.