CS 391R Robosuite Tutorial

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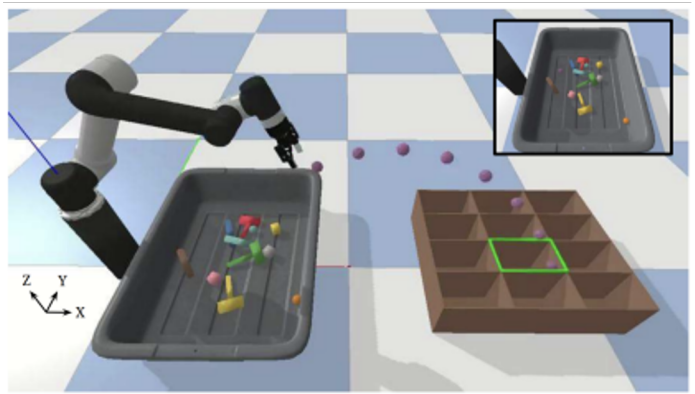
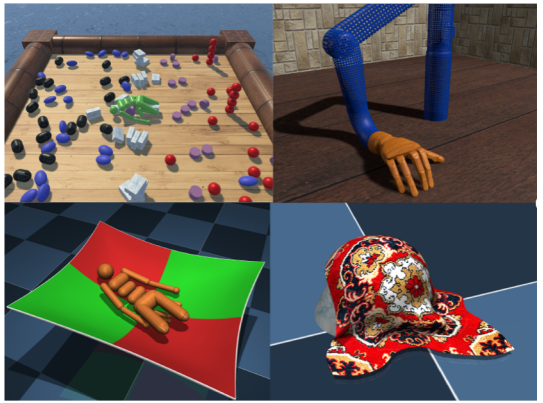
Physical simulator

- The simulation of systems of objects that are free to move, usually in three dimensions according to Newton's laws of dynamics.

- MuJoCo
- Bullet
- Chrono
- ...





Pros and Cons of Physical Simulator on Robotics

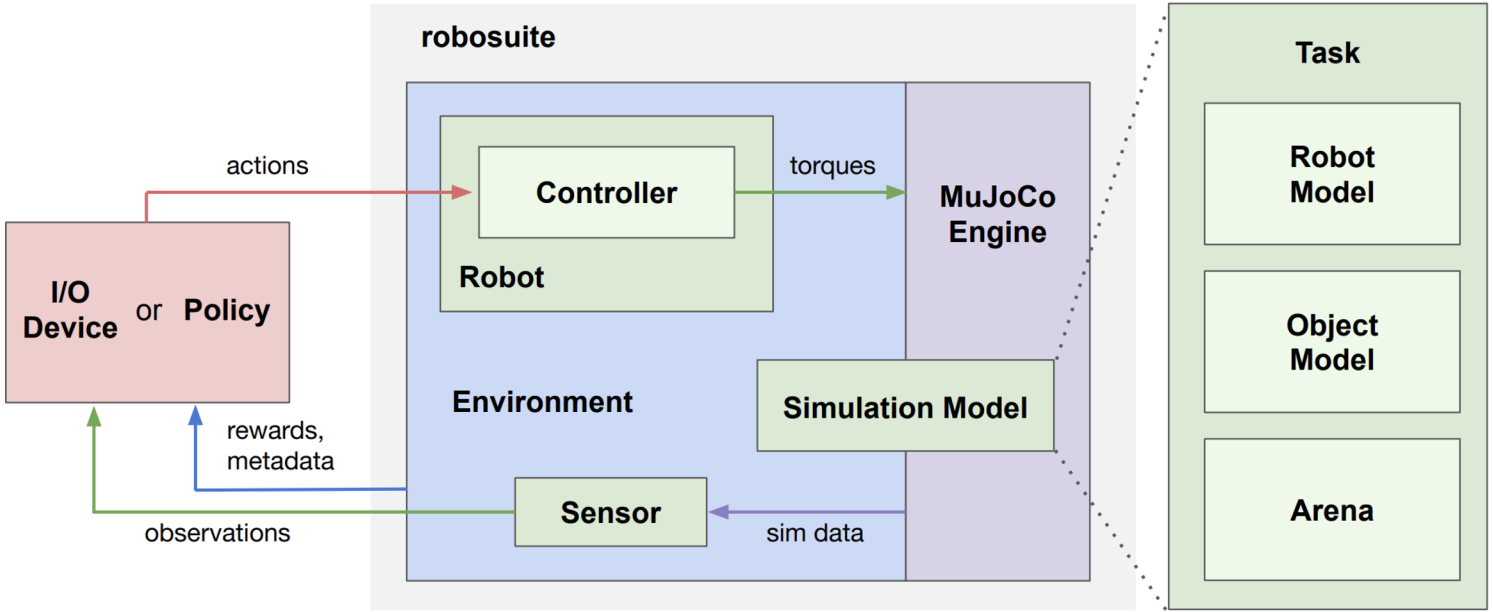
- Pros
  - Low cost
  - High speed
  - Safe and highly controlled
- Cons
  - Inaccurate
  - Slow when simulating complex models

Robosuite Overview

Mujoco - Robosuite (Zhu et al., 2020)

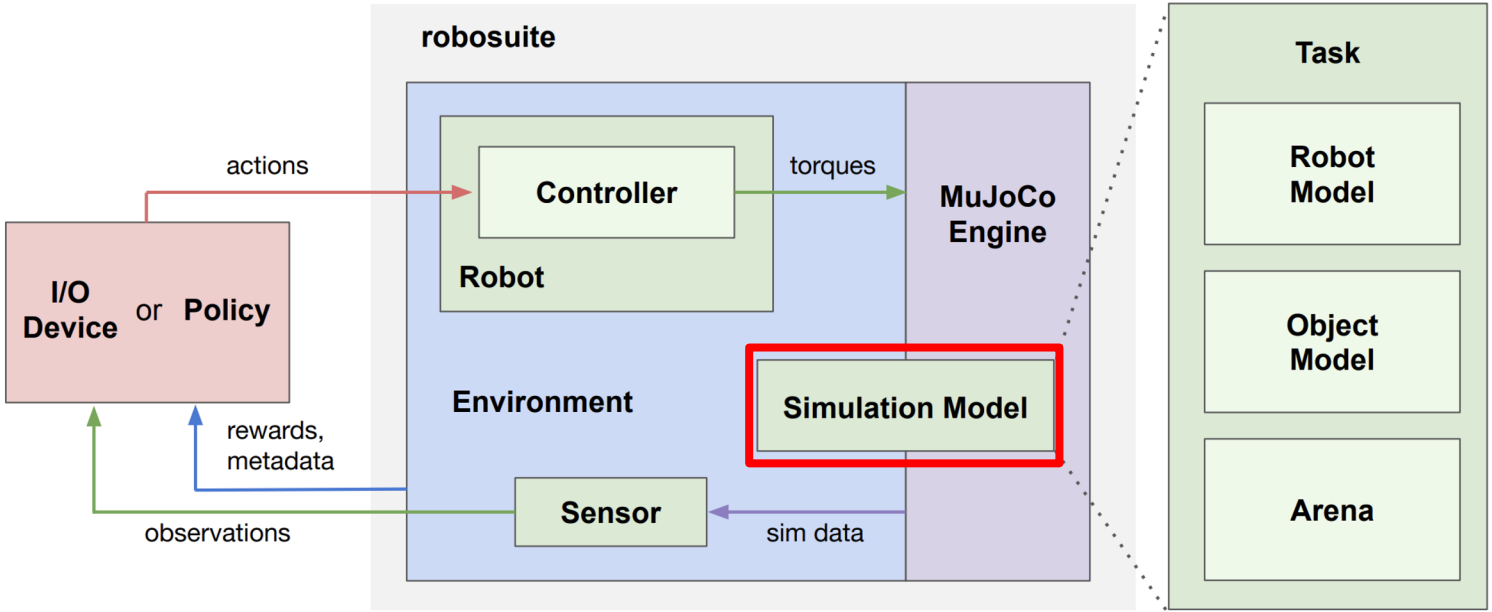
- Designed for Reinforcement Learning / Imitation Learning.
- Efficient simulation of objects with simple geometry.
- Easier to create procedurally generated scene.

System diagram



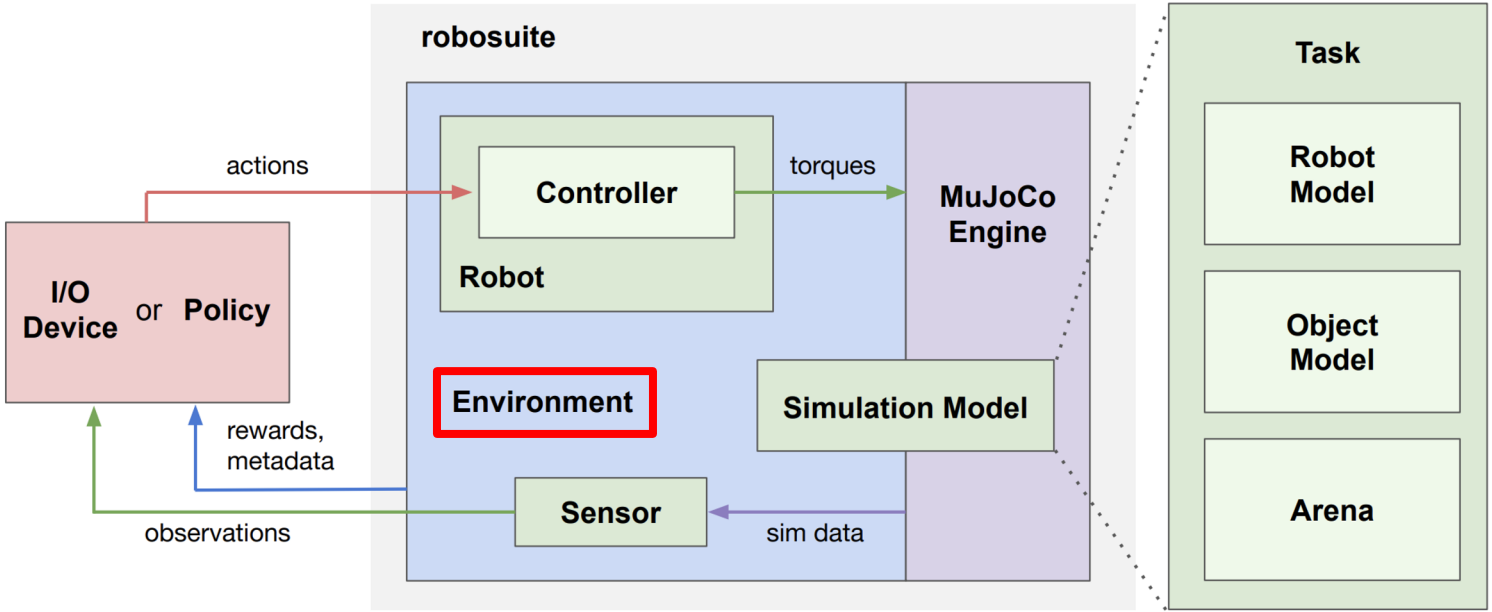
- **Modeling APIs**: defining simulation environments in a modular and programmatic fashion
- **Simulation APIs**: interfacing with external inputs such as from a Policy or an I/O Device

System diagram



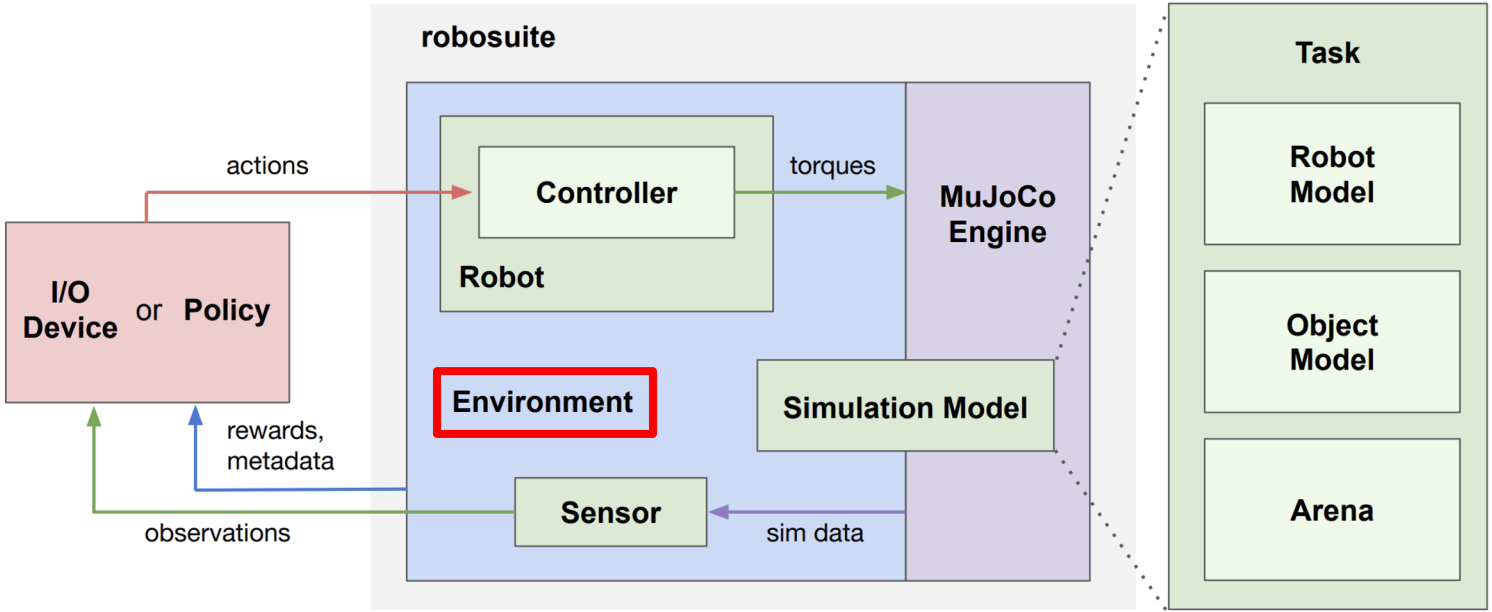
- Instantiated by the MuJoCo Engine
- To create a simulation runtime, called Environment.

System diagram



- Generates observations through the **Sensors**
- Receives action commands from policies or devices through the **Controllers** of the **Robots**.

System diagram



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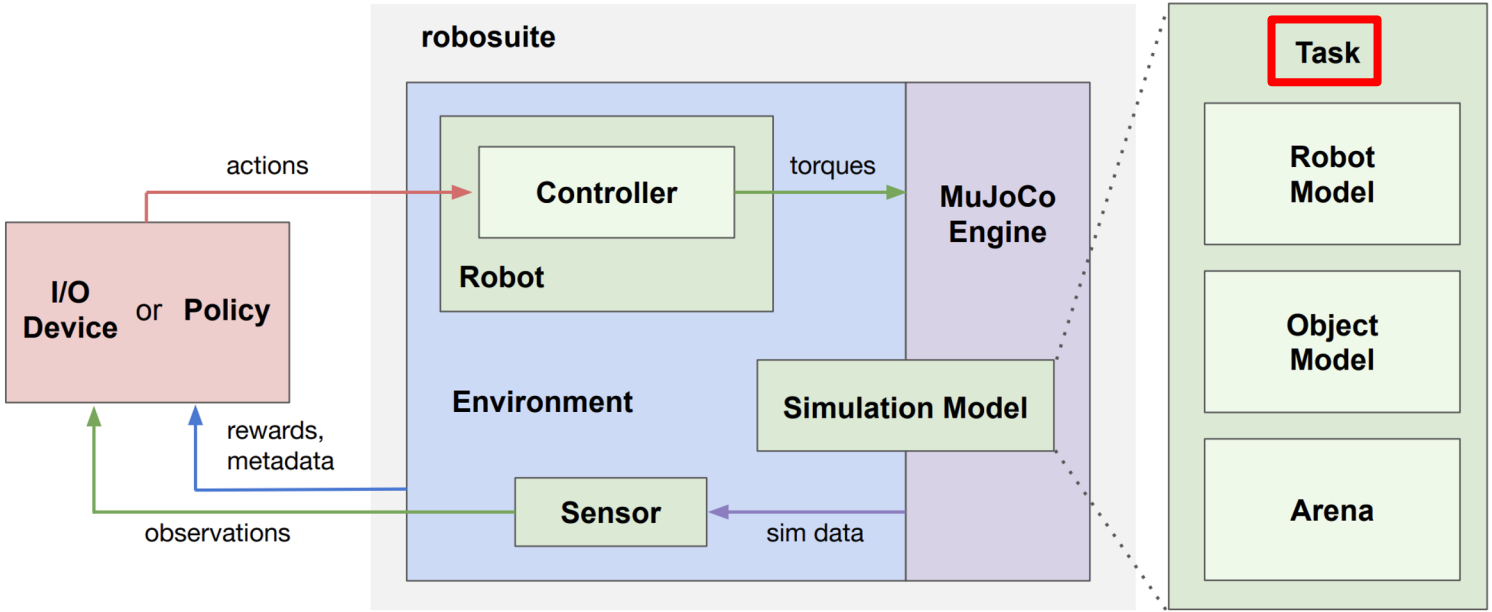

- encapsulates three essential constituents of robotic simulation: Robot Models(1+), Object Models(0+), and Arena(1).

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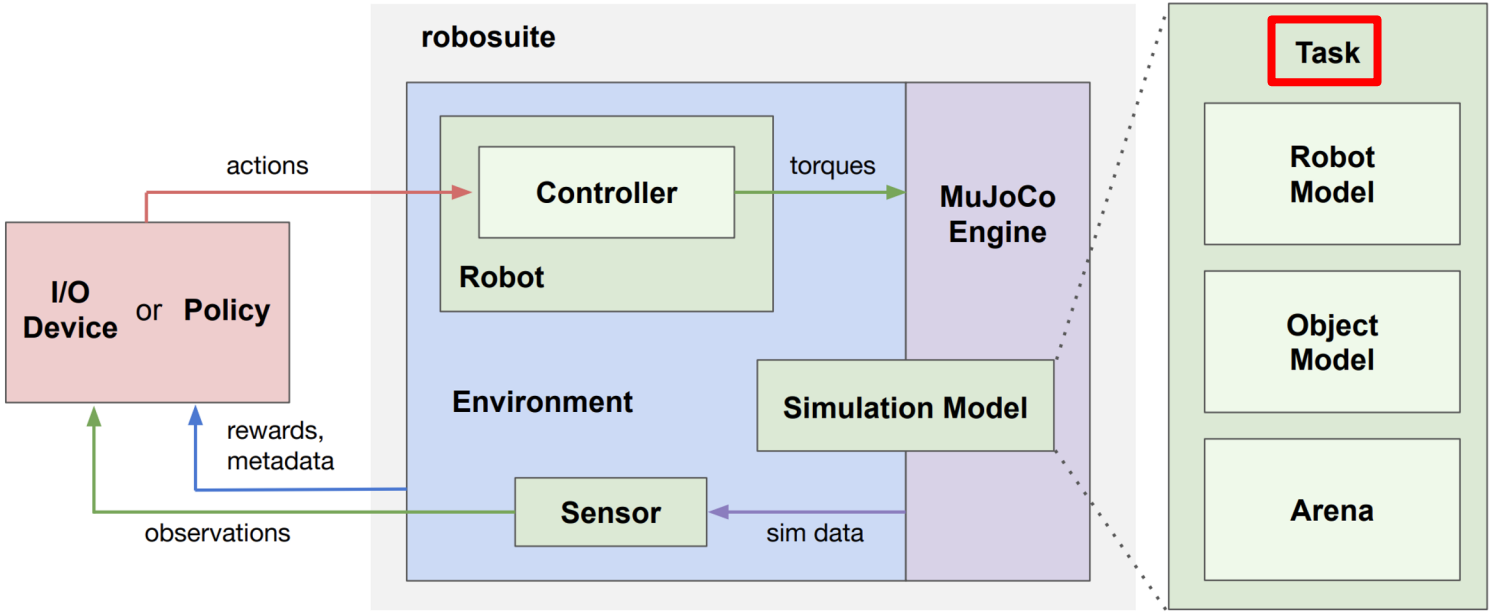

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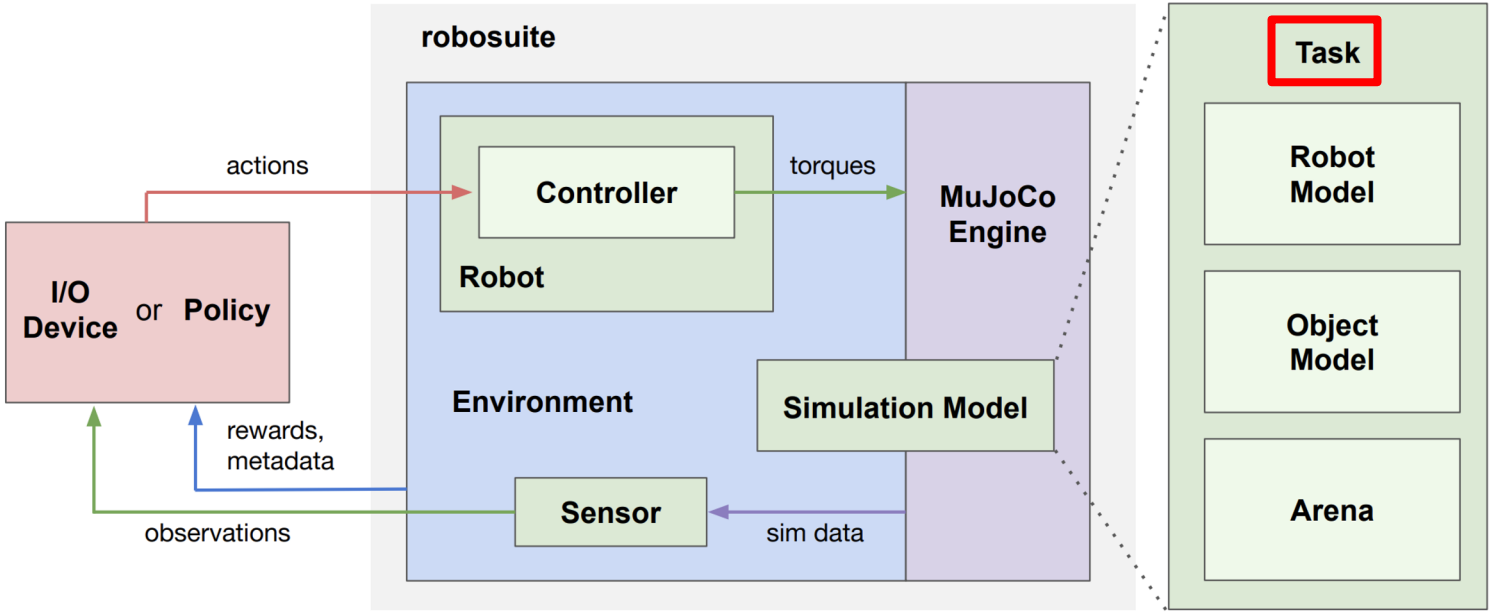

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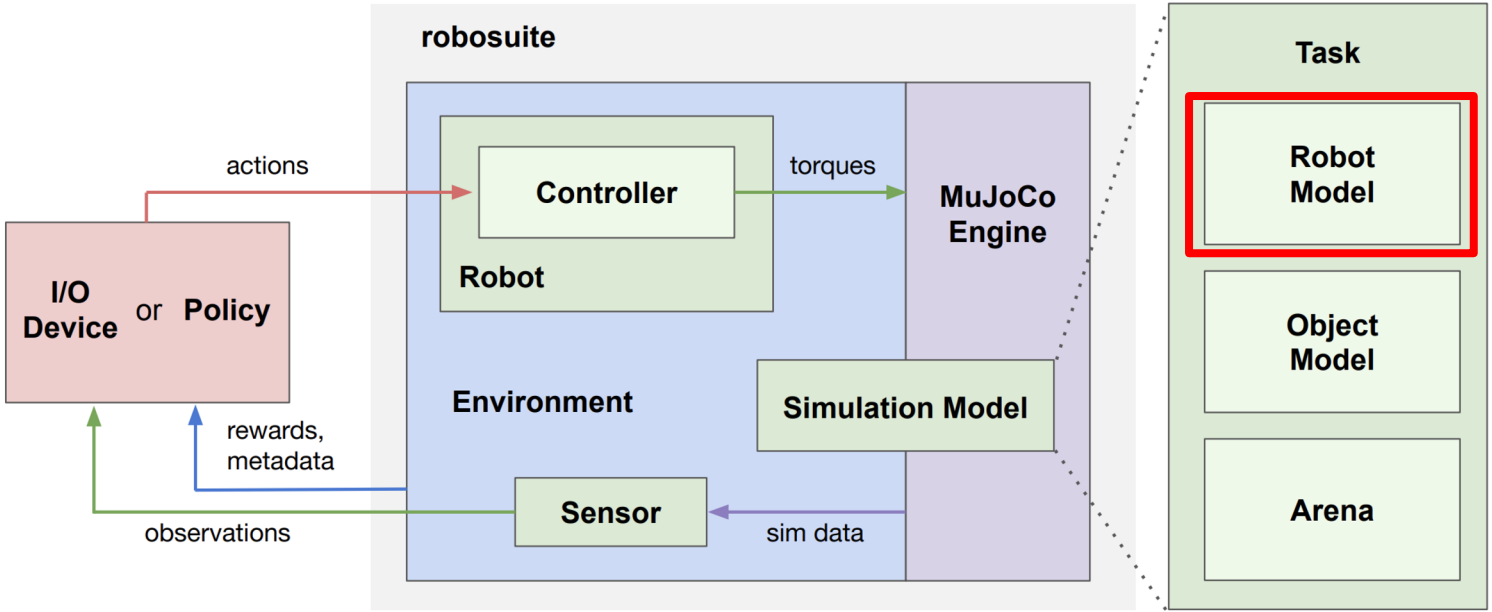
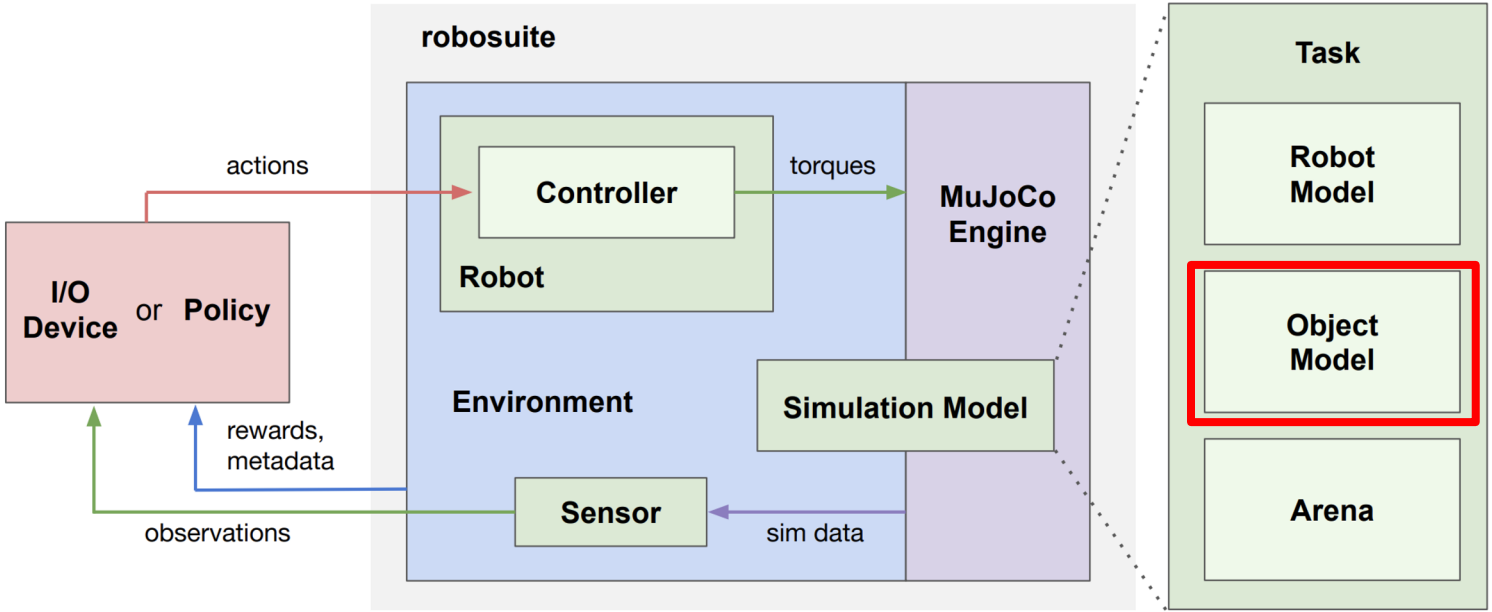


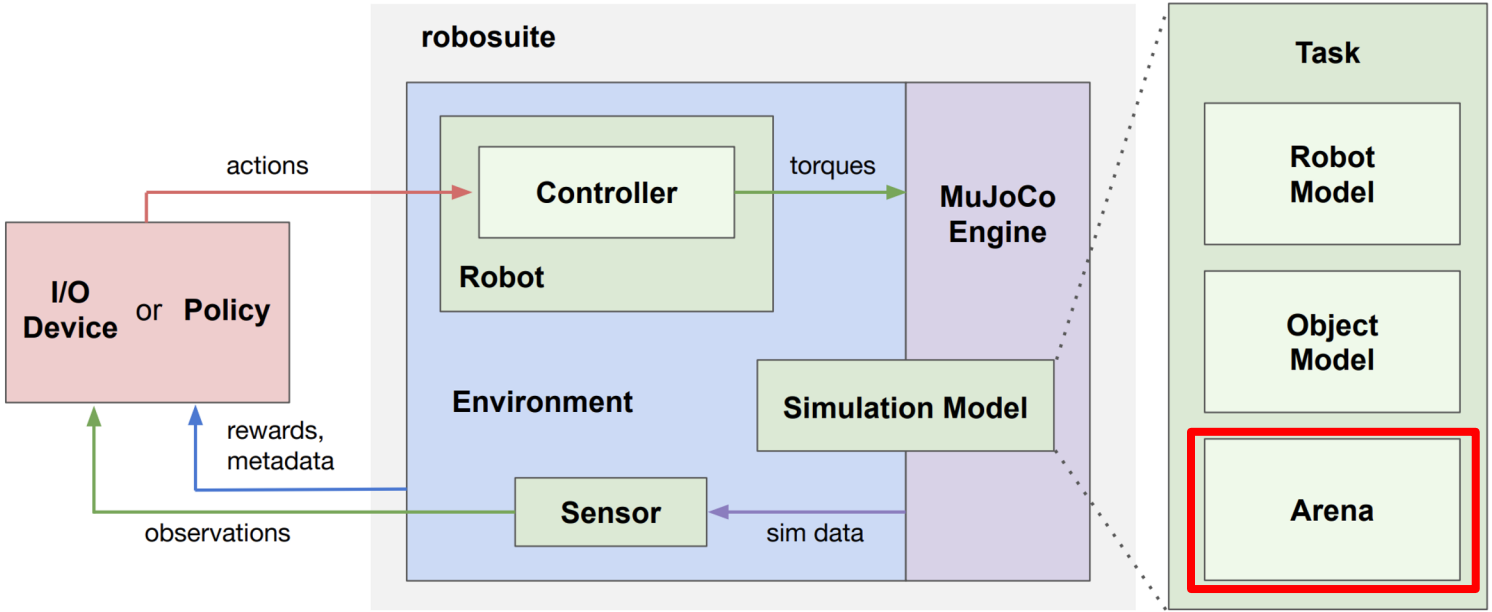
- loads models of robots and optionally other models as well
- e.g. the Manipulator robot model also loads corresponding Gripper Models from XML files

System diagram



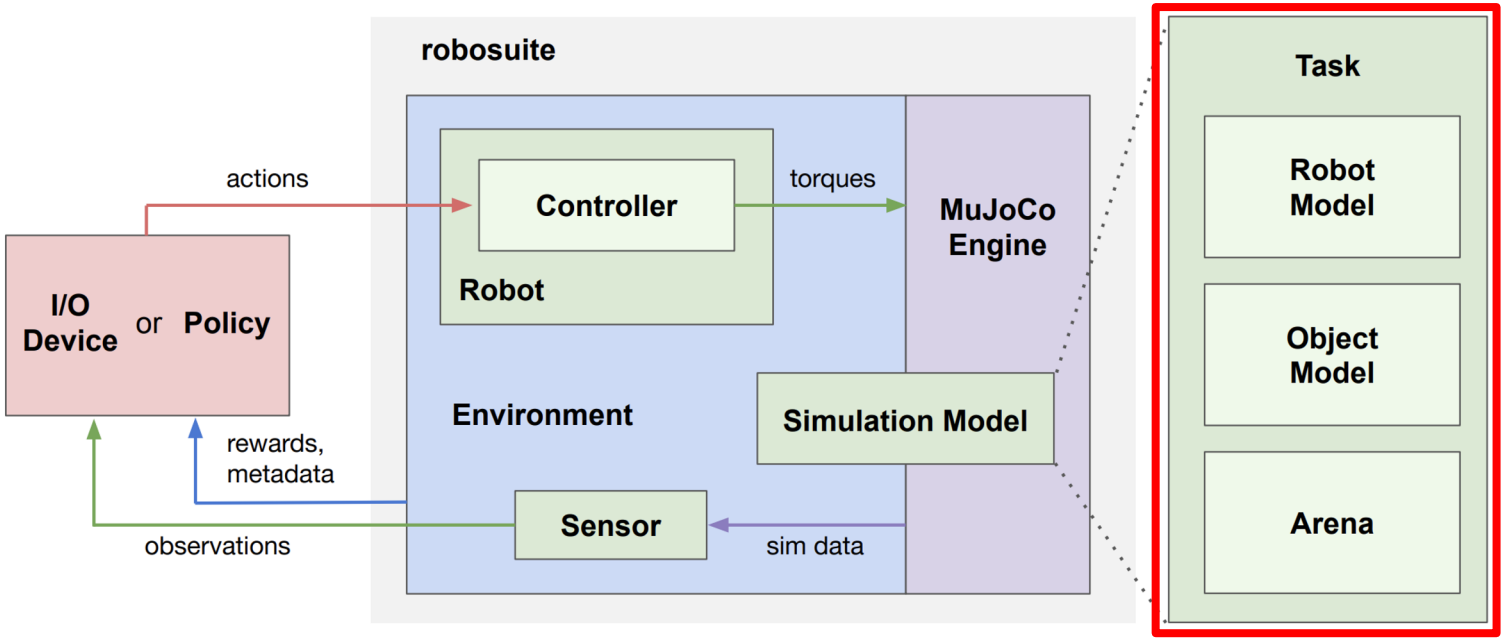
- loaded from 3D object assets
- procedurally generated with programmatic APIs

System diagram



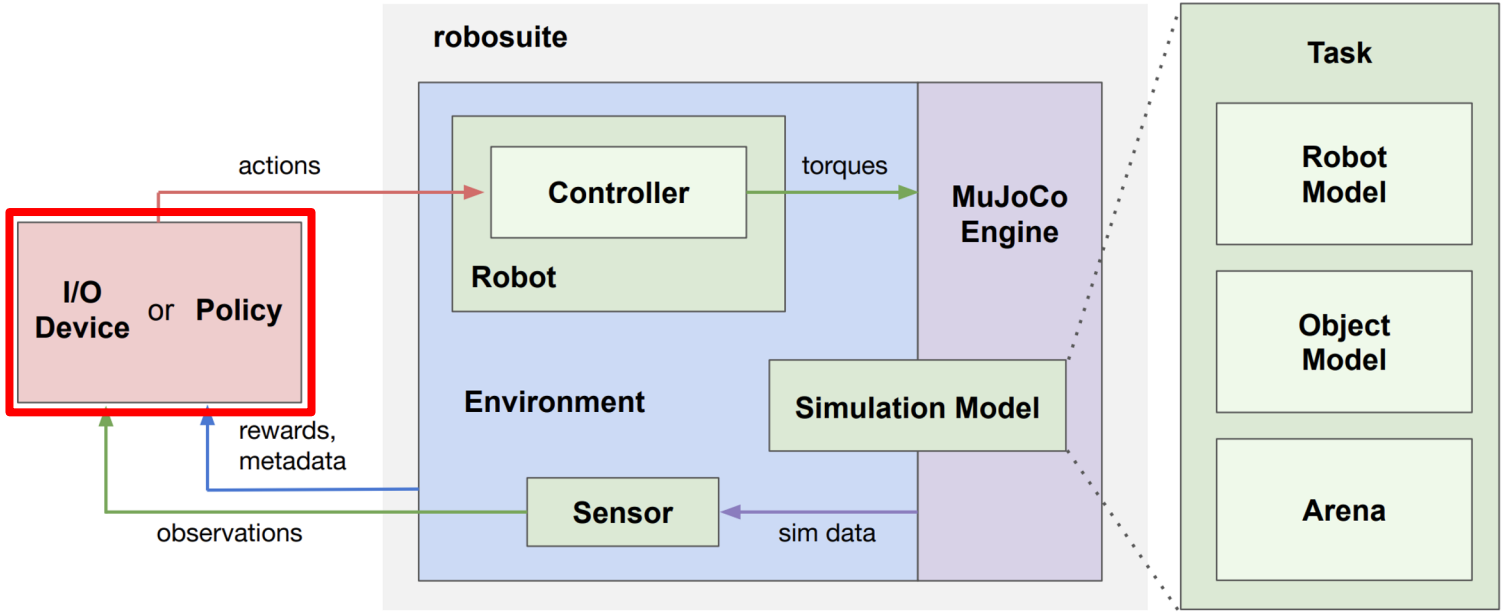
- defines the workspace of the robot, including the environment fixtures, such as a tabletop, and their placements

System diagram



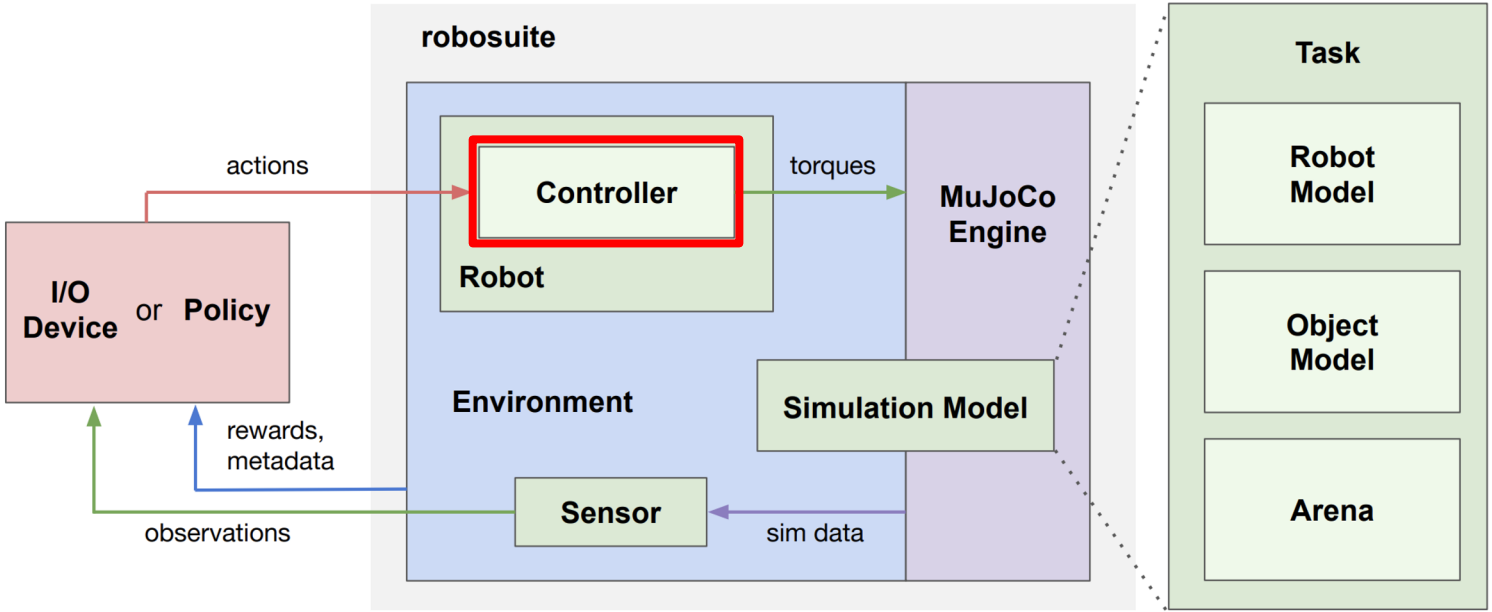
- The task class combines these constituents into a single XML object.
- This MJCF object is passed to the MuJoCo engine to instantiate the MjSim object for simulation runtime.

System diagram



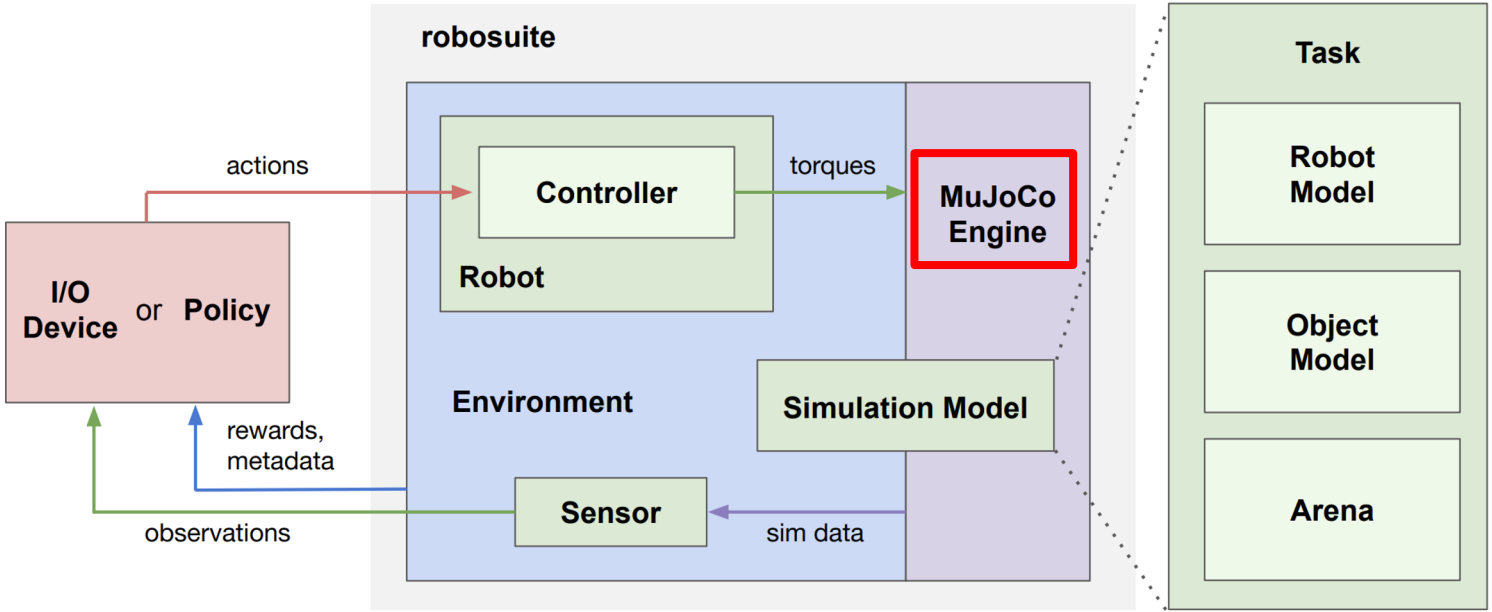
- Generate actions from human teleoperation (I/O device) or policy.

System diagram



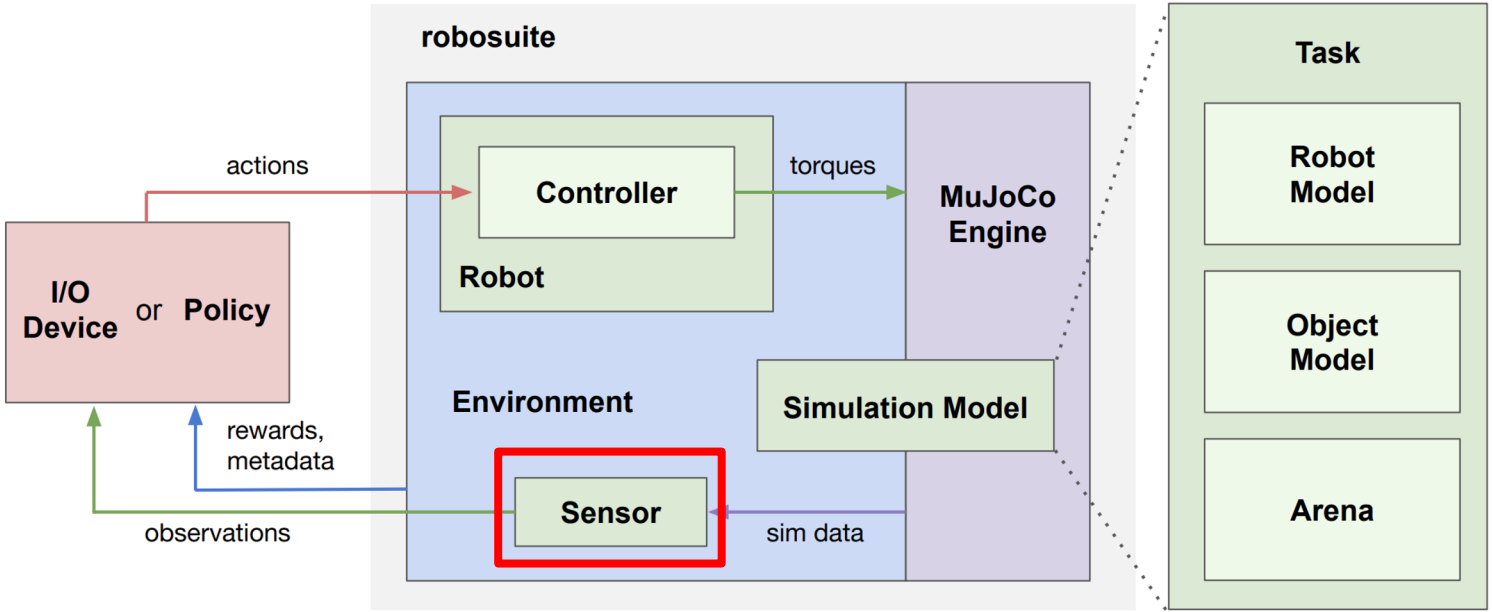
- Interpret the action commands and transform them into the low-level torques passing to the underlying physics engine

System diagram



- Step simulation

System diagram



- Retrieve information generate observations as the physical signals such as RGB-D cameras, force-torque measurements, and proprioceptive data.

Robomimic

- A framework for robot learning from demonstration
- Broad demonstration datasets
- Related learning algorithms