

MICRO-515: Evolutionary Robotics

RoboGen Group Project

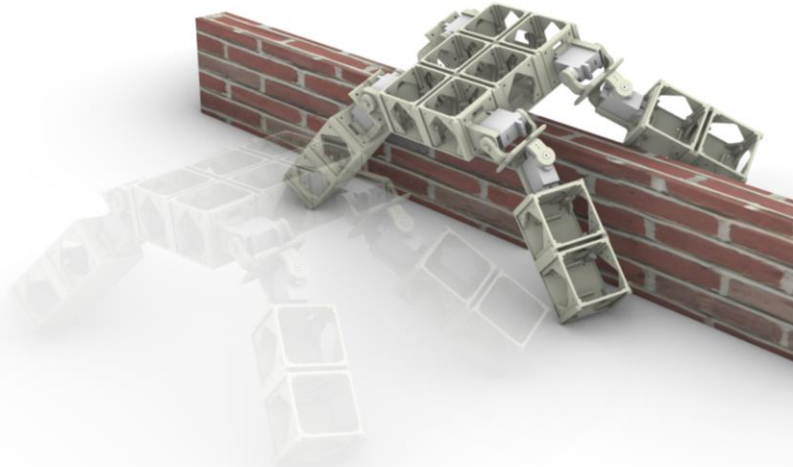
RoboGen Group Challenge



We want you to design a robot challenge!

- Your task should be interesting yet simple enough so you can evolve it in RoboGen.
- Evolve a legged robot solving your self-designed task

Examples



Parkour:
Climb over a wall



Escape the Forrest:
Navigate through a
cluttered environment



Hiking the Swiss Alps:
Climb a slanted terrain

Grading Information

- **Method:** The method includes describing the problem, your fitness function and how this relates to the problem, and description of the parameters that were used. It also includes your creativity (i.e. for the scenario) and your scientific approach.
- **Clarity:** The clarity of your presentation includes clear and concise slides and description of your study.
- **Completeness:** The completeness includes evidence of investigating the effects of changing parameters, different fitness functions, generalisability of your solution, and whether both the brain and the body have been evolved.

Criteria	Weighting
Method	50%
Clarity	25%
Completeness	25%

Time Schedule

2nd May:

- i. **BS160** (10:30am – 12:00am) – Hardware handout, finishing previous exercises

16th May:

- i. **DLL** (9:15am – 12:00am) – Project Coaching

23rd May:

- i. **BS160** (9:15am – 10:00am) - Lecture by Prof. Floreano
- ii. **DLL** (10:15am – 12:00am) – Project Coaching

29st May:

- i. **Online** (23:59) Upload of files (scenario files, robot description file, presentation slides as PDF and PPTX)

30th May:

- i. **BS160** (9:15am – midday) – **Final graded presentations**

Robotics Best Practices

Unit test your
hardware

- Do sensors and actuators work as expected? Are the sensor values consistent and cover the expected range? Are the servo motors operating properly (the given servo motors should move approx. 180°)?
- Are the electric connects sufficiently soldered (→ continuity test)?
- GPIO is generating unexplainable values → sometimes grounding pins help

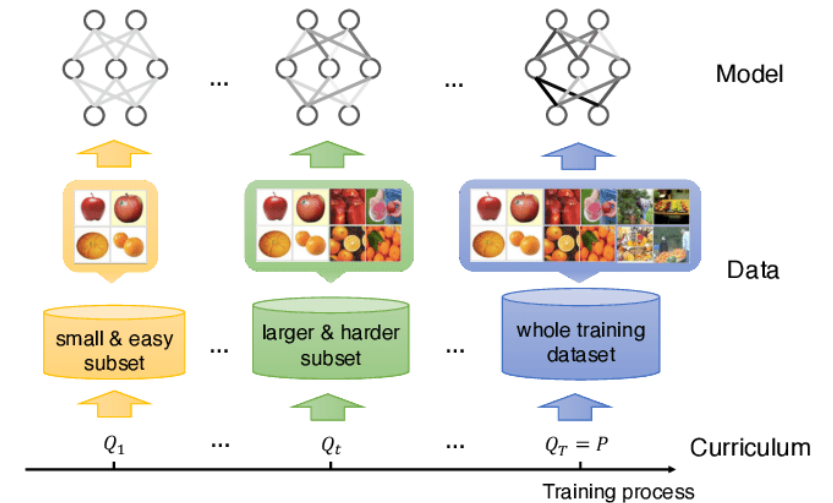


Robotics Best Practices

Increase
difficulty
iteratively

- Divide your target task in subtasks and check if your system / robot can solve this subtasks before tackling the main problem
- Iteratively increase difficulty
- Adapt fitness function to guide through different difficulties

→ design a curriculum



Wang, Xin, Yudong Chen, and Wenwu Zhu. "A survey on curriculum learning." *IEEE Transactions on Pattern Analysis and Machine Intelligence* 44.9 (2021)

Robotics Best Practices

RoboGen tips

- Use multiple runs with different random seeds, evolutionary algorithm are stochastic (sometimes you are lucky, sometimes not)
- Save and share good candidates (save JSON files and use JSON converter for re-use) with your group
- Keep evolution running even if fitness is plateauing (e.g. for another 50 – 100 Generations)
- Tune your fitness landscape by improving your fitness function
- Mind the (*sim 2 real*) gap!
- Run the simulation on multiple computers

Where do I find information?

MICRO-515
Evolutionary robotics
MT - Master

Moodle

- Lecture slides
- Exercises
- File “Project: Hardware files and tips”

<https://robogen.org/docs/>

RoboGen™
INTRODUCTION TO ROBOPEN

Introduction to RoboGen

RoboGen™ is an open source platform for the co-evolution of robot bodies and brains. It has been designed with a primary focus on evolving robots that can be easily manufactured via 3D printing and the use of a small set of low-cost, off-the-shelf electronic components. The Robogen Software Suite features an evolution engine and a physics simulation engine. Additionally, it includes utilities for generating design files of body components, and for compiling neural network controllers. The Robogen hardware consists of an Arduino microcontroller board, 3D printed modular parts and servo-motors.

Software Suite

- Evolution Engine
- Simulator

Hardware

- Electronics
- Actuators
- 3D printed Components
- Robogen Robots

RoboGen Software Suite

The Robogen software is designed to perform artificial evolution for the Robogen project. The evolution engine is responsible for the most of the conceptual part of the evolution process (e.g. population generation, selection, mutation, and reproduction), while the simulator is only there to do the fitness evaluation. The two components work together to perform the artificial evolution of Robogen robots. They are executed as two independent processes that communicate over the network.

More information on Robogen Software Suite is available here.

Hardware

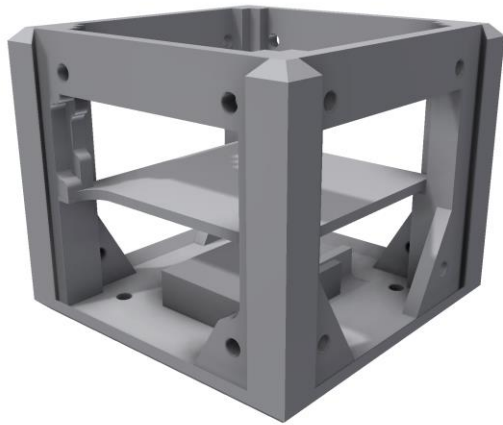
Once you have a robot that behaves the way you would like in the simulator, it is time to build it. For this you will need some electronic components, a set of standard 3D printed parts, and a set of custom parametrized parts that you will need to 3D print. More details on how to get a hold of these parts are available at 3D print and

Online Documentation

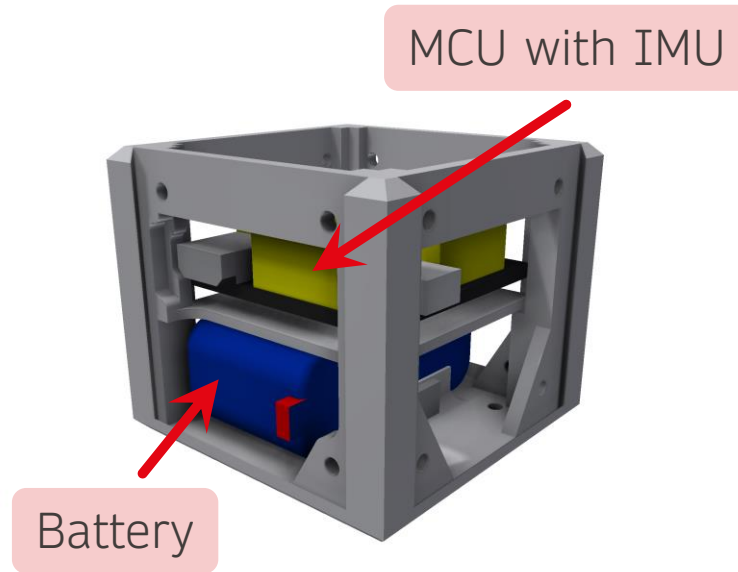


Teaching Assistants

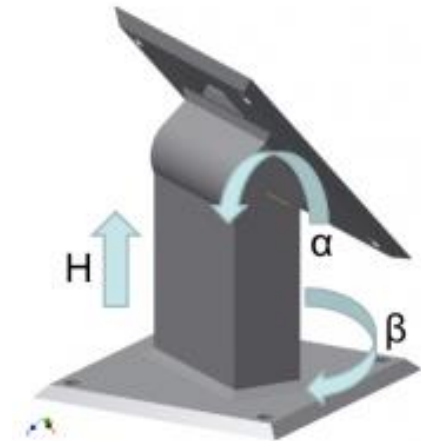
Contents Hardware Box



10x Fixed Brick

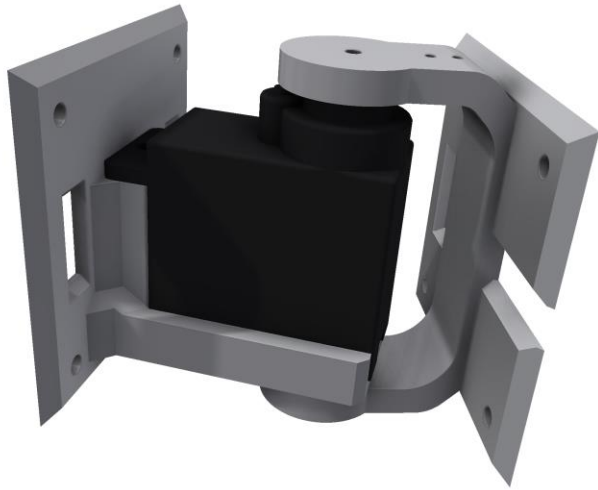


1x Core Brick

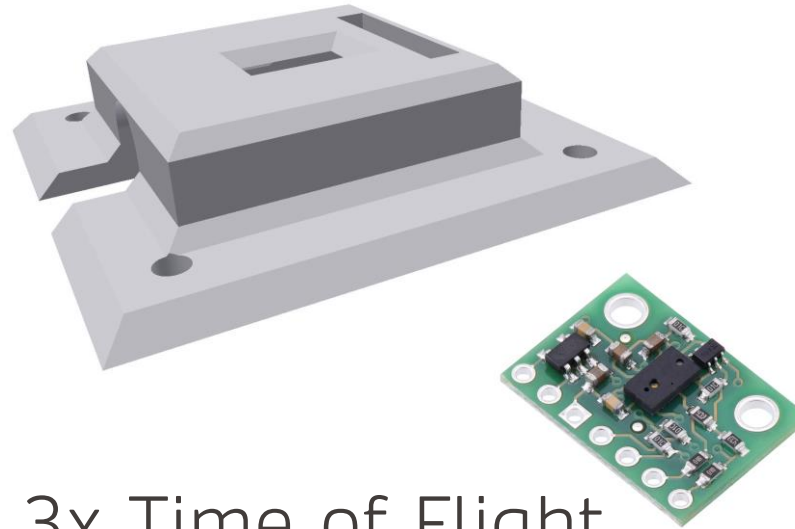


0x Parametric bar joint

Contents Hardware Box



6x Active Joint with
Servo Motors



3x Time of Flight
Sensors

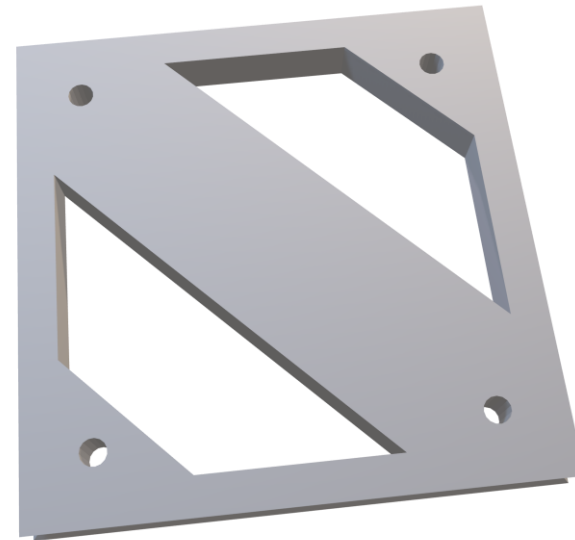


1x Battery
1x Voltage Regulator

Contents Hardware Box



6x Connector Slots



5x Connector Plates

Contents Hardware Box

To-Dos now:

- Check the component list of your box!
Do you miss something?
-

- You can discuss some ideas for
potential challenges now.
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