Learning locomotion gaits through hormone-based controller in modular robots

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Outline

- Introduction
- Objectives
- Finding Locomotion Gaits
- Selecting Locomotion Gaits
- Implementation
- Results
- Future work

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- **Modular robot**: robot composed of several smaller robots, called modules.
- Each module has its own control and communication electronics, sensors, actuators, batteries, etc.
- Modular robots can be **reconfigurable**, changing their shape and abilities.

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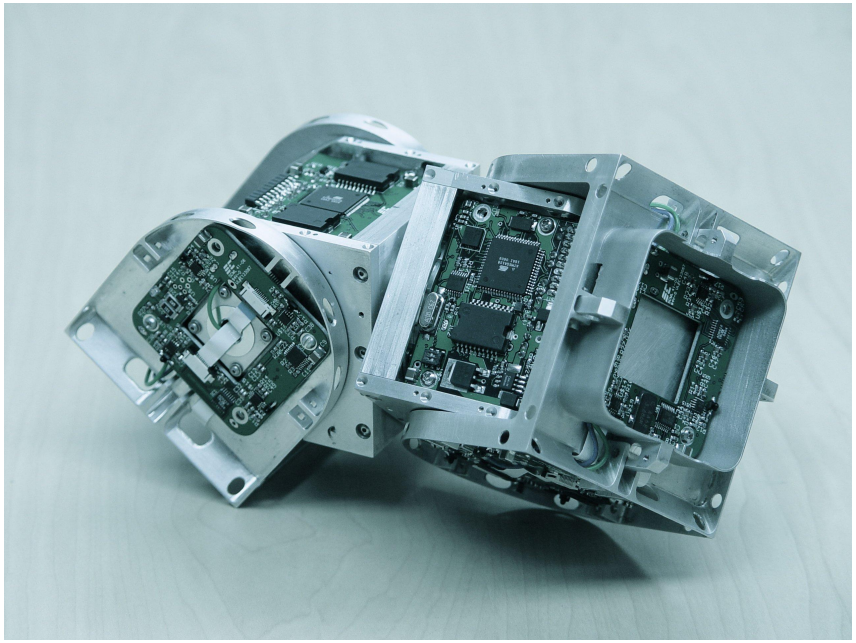
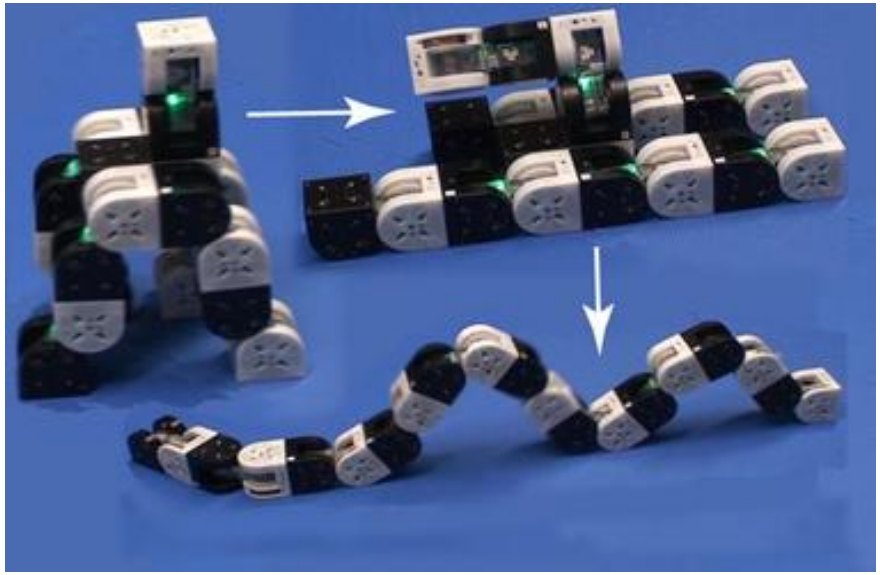


Superbot



M-TRAN

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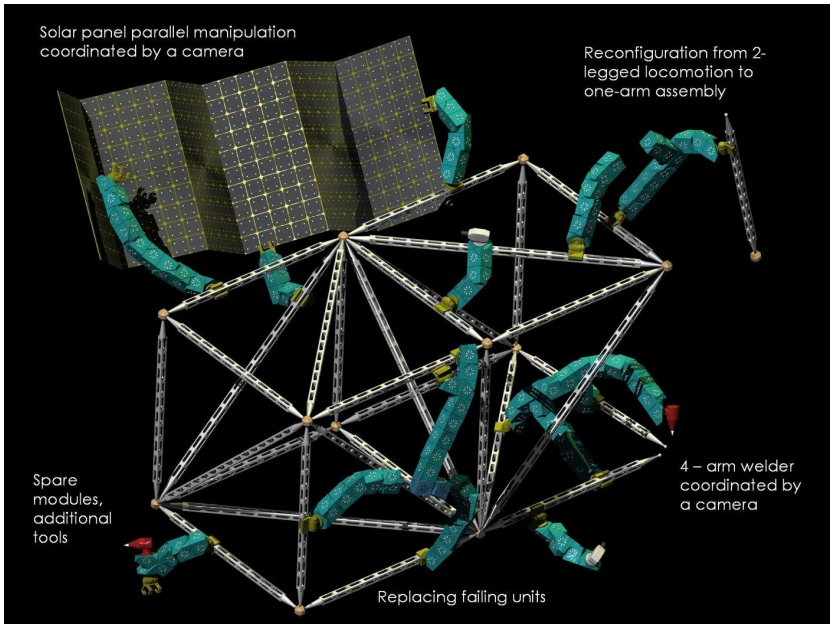
Flexibility



Space Applications

Unknown or unstructured terrains

Objectives

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1. To find optimal locomotion gaits for at least 3 configurations

2. To discover the robot configuration and to select the required gaits

3. Test the gaits and controller on a simulated robot

4. Test the gaits and controller on a real robot

Finding Locomotion Gaits

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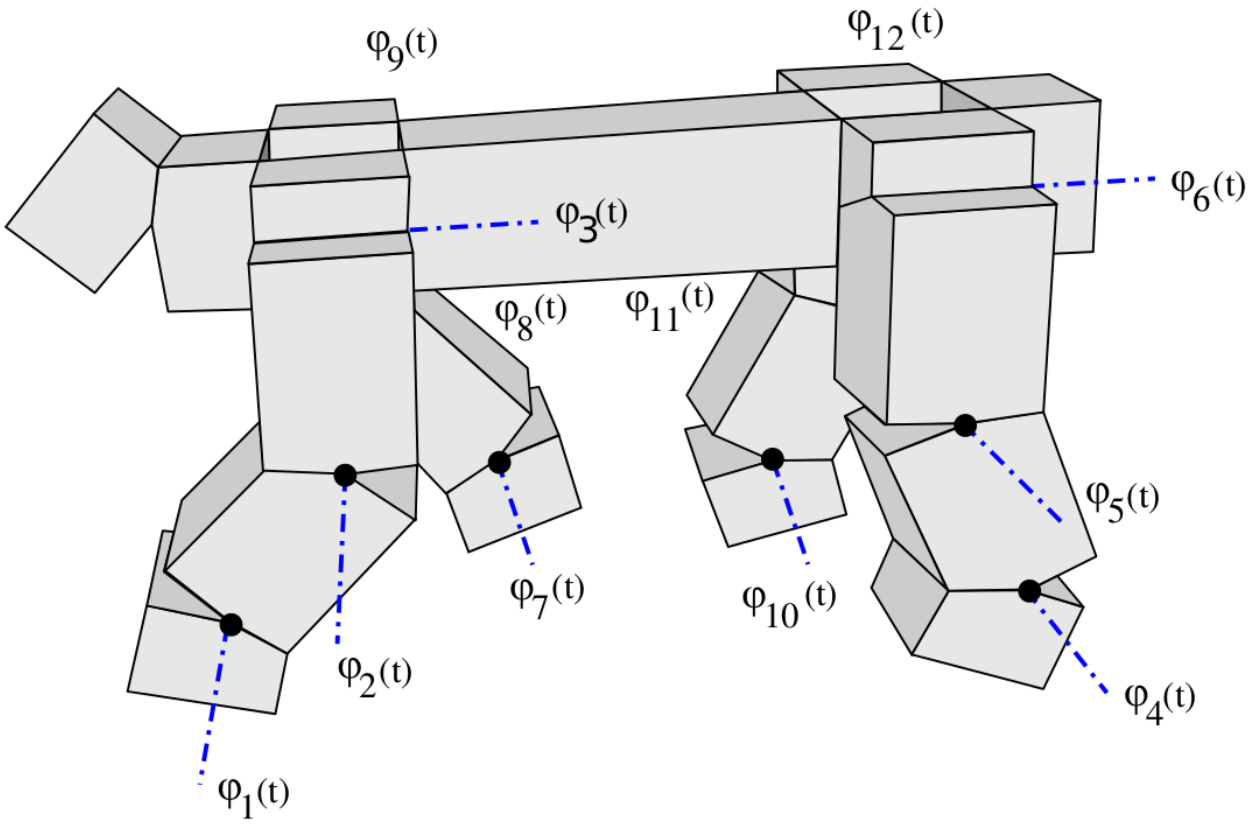
- **Problem**: to achieve coordination between modules



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- **Solution:** Sinusoidal oscillators

- Inspired by nature (Central Pattern Generators)

- Defined by 4 main parameters:
  - Amplitude
  - Offset
  - Frequency / period
  - Phase

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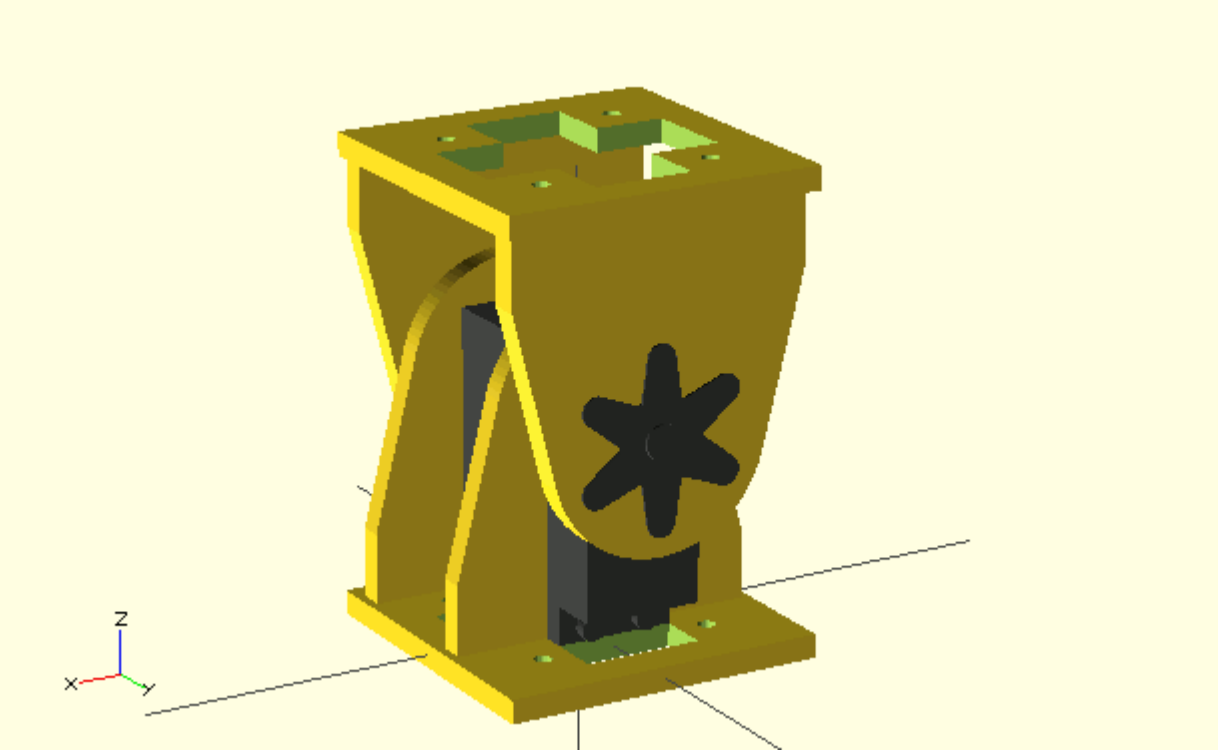

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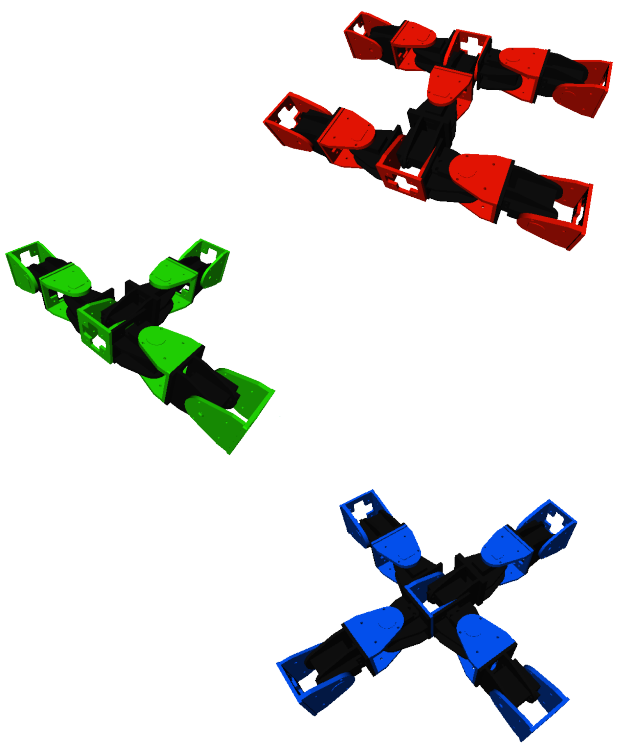
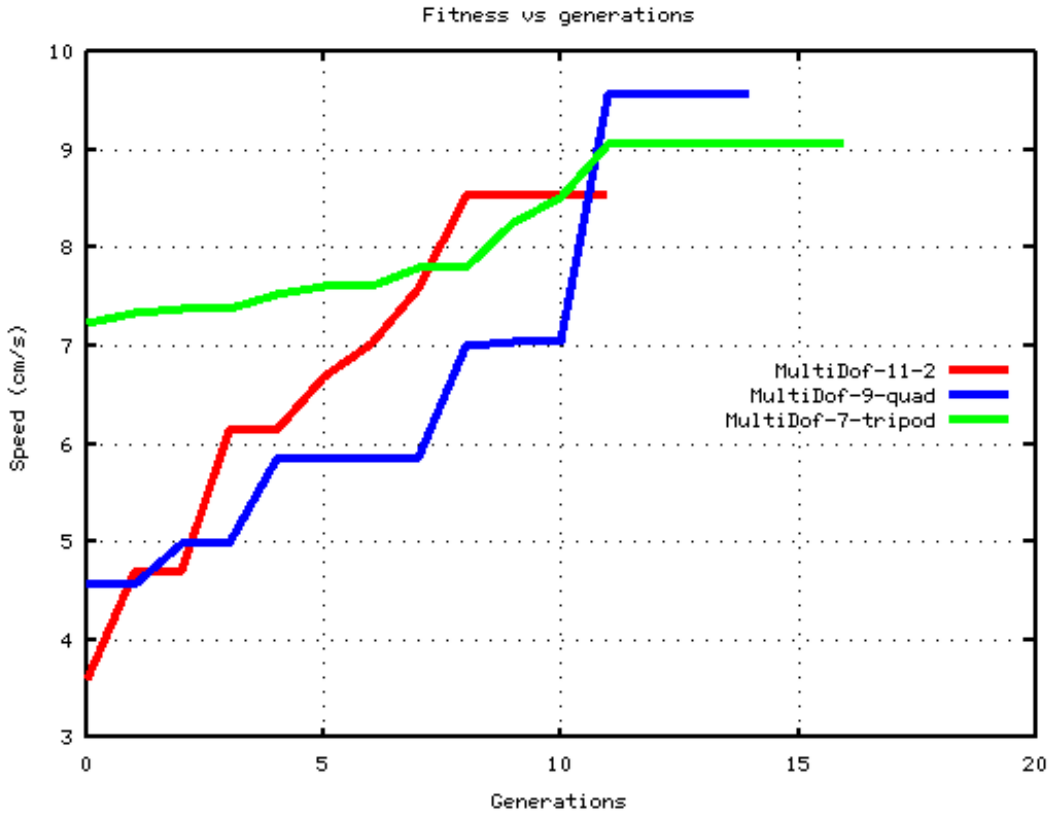
- Parameter optimization: Differential evolution
- Fitness function: distance travelled in 30 s





Selecting Locomotion Gaits

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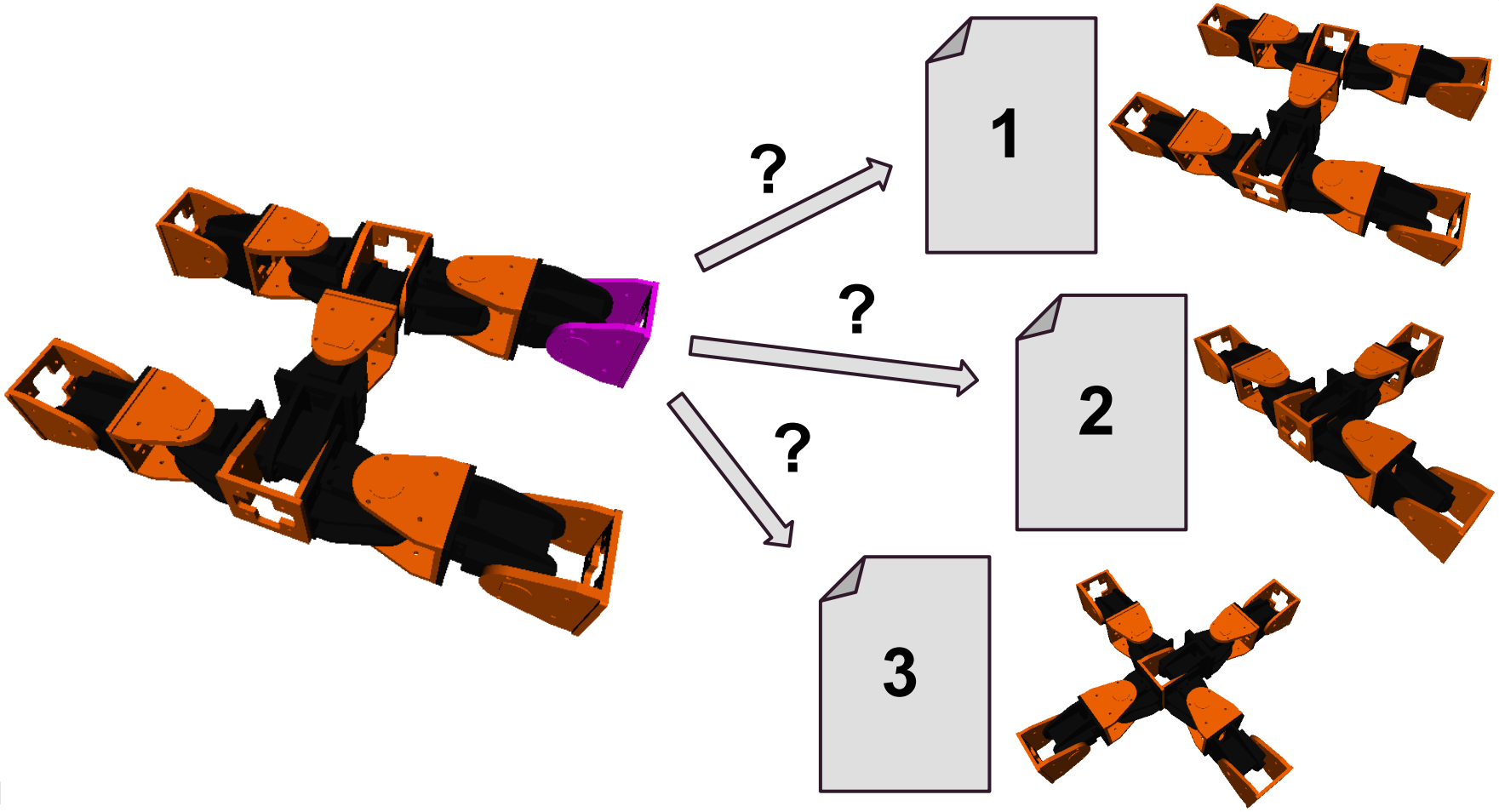
- **Problem**: discovering robot configuration and module function



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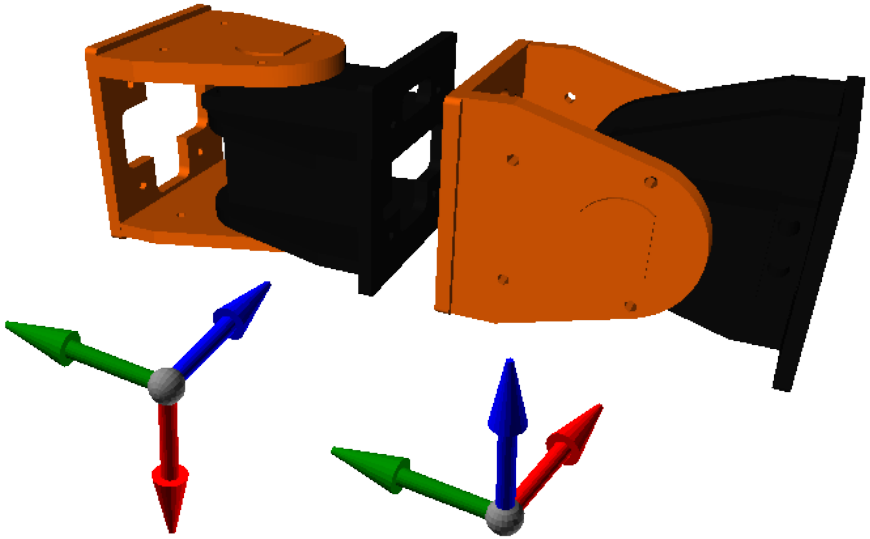
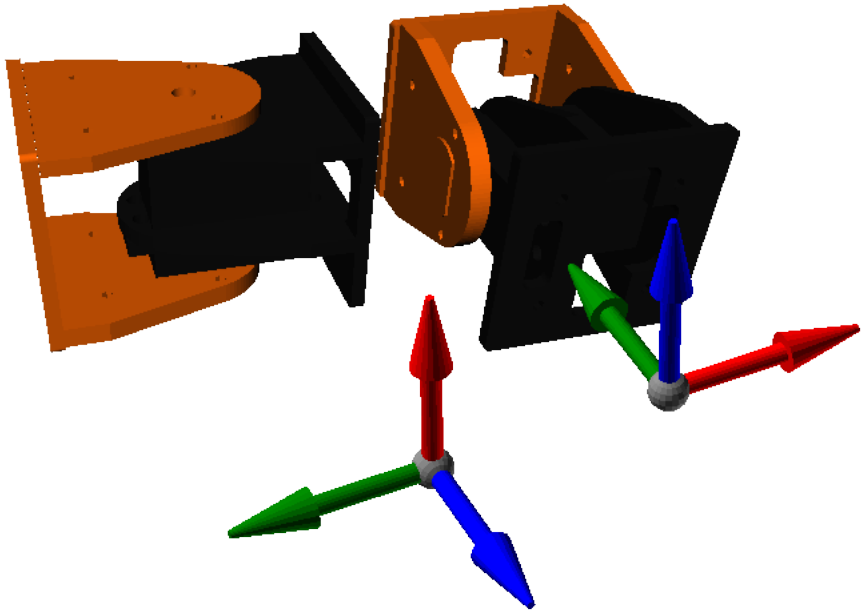
Module configuration encoding:





ID = f (Local connector, remote connector, relative orientation)

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Digital hormones:

- Do not have a fixed destination
- They have a limited lifetime
- They can trigger different actions on different receptors

Implementation: Software

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Software:

- Framework for testing gaits and controllers
- Developed in C++
- Explained in detail in chapter 4 of the Thesis

Implementation: Hardware

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Challenges:

- Large number of modules required
- Modules are expensive
- Not easy to manufacture

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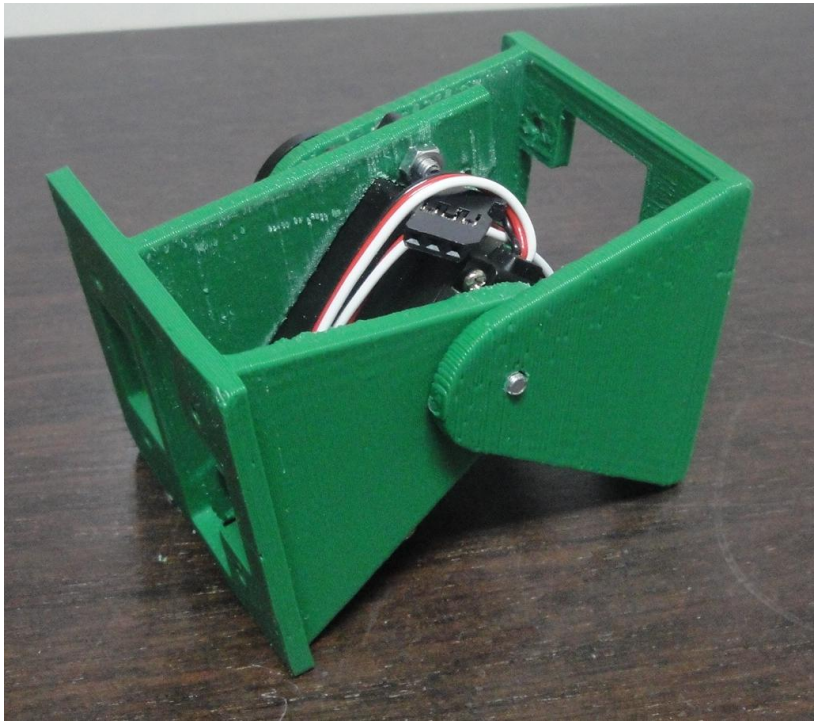
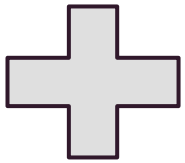
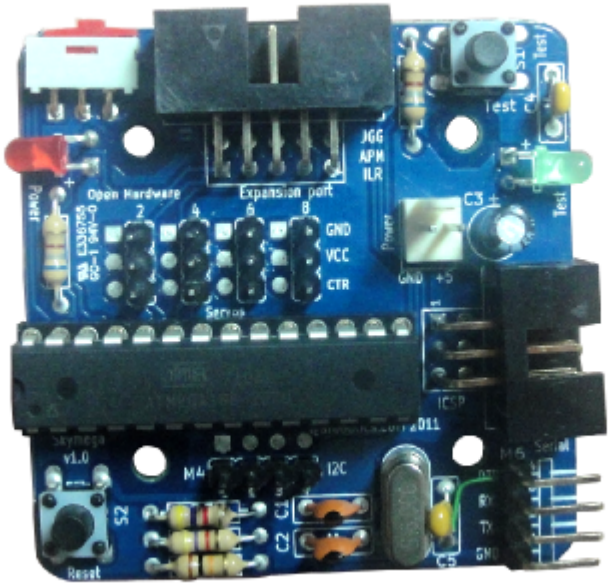
- Existing open platform designed by Juan Gonzalez-Gomez:



Y1 Module





SkyMega Board

Implementation: Hardware

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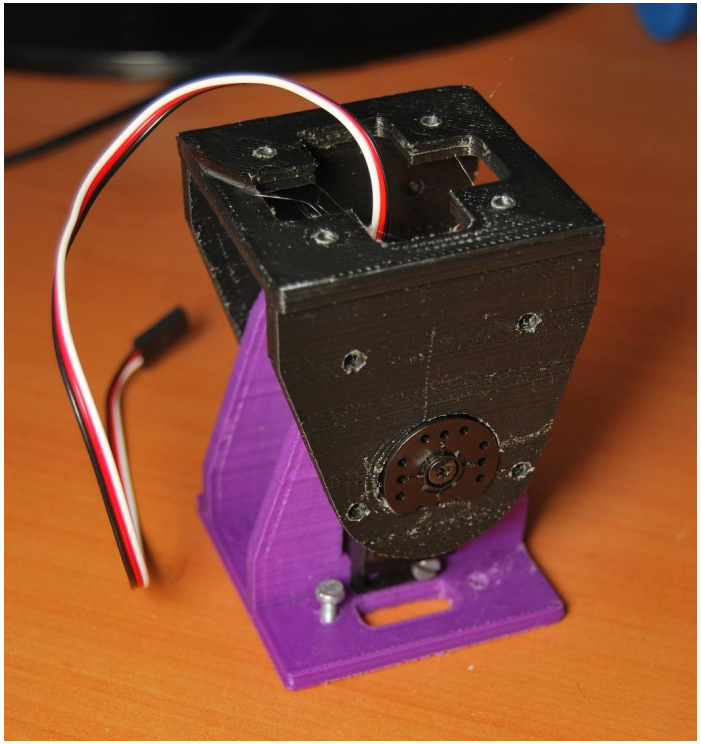
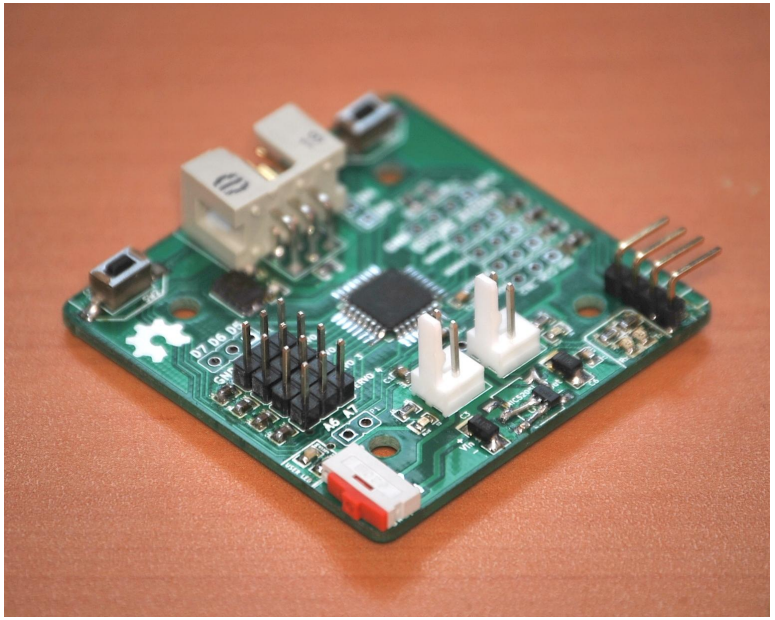
- Development of a platform based on the existing one



REPY-2 Module



SkymegaSMD board

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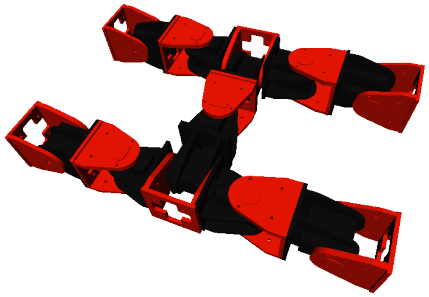

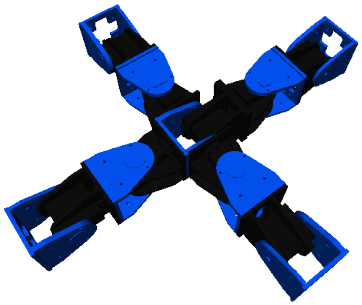

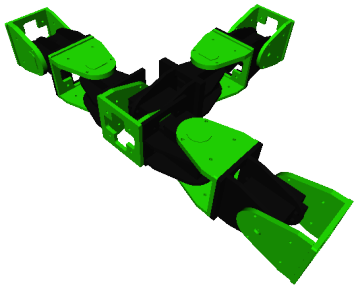

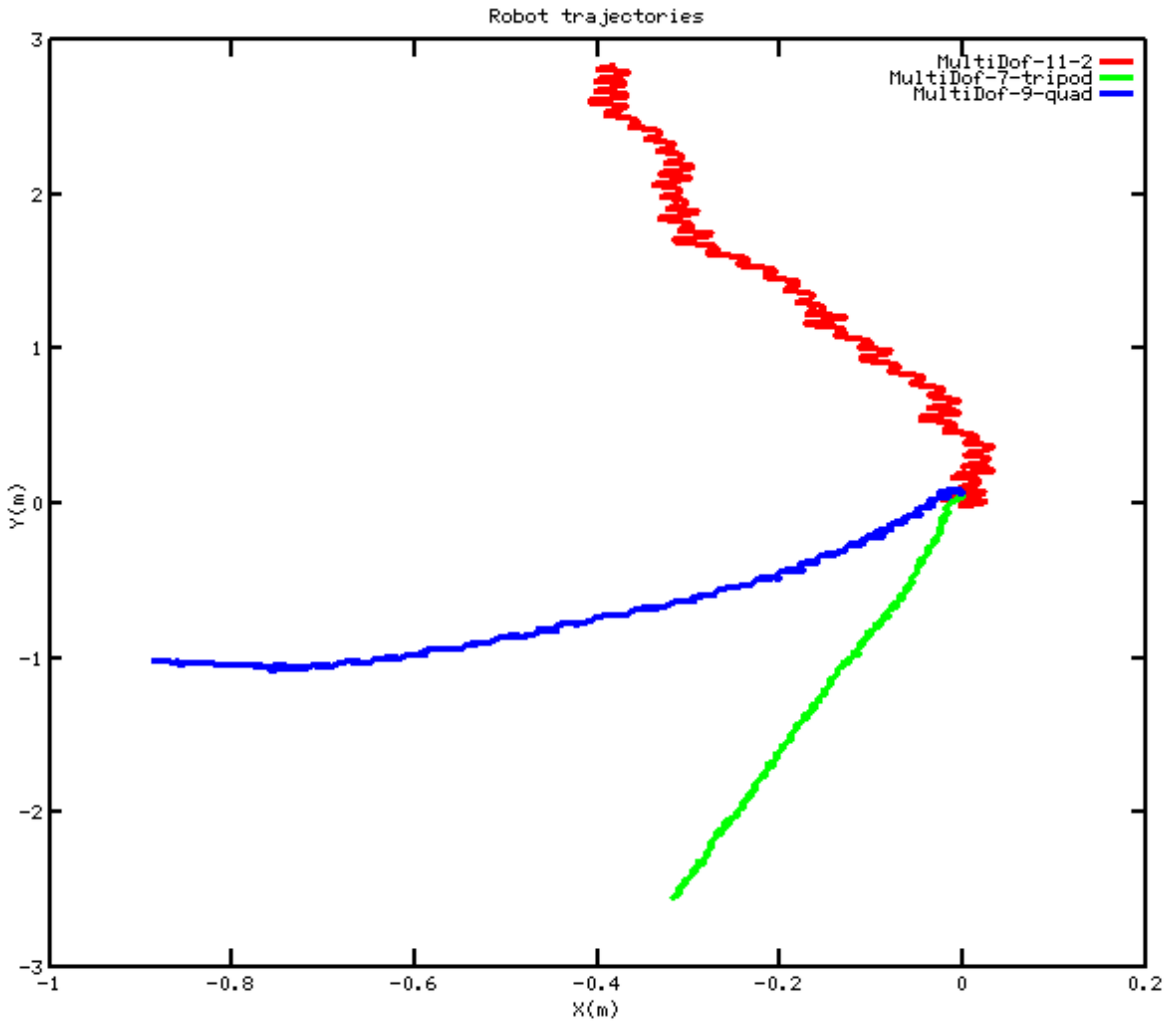

Future work

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- More advanced modules
- Adding sensory feedback
- More generic controller

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Thank you!

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