Online Adaptation of Locomotion Control to Changes in Body Structure

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Motivation

• Improve the robot locomotion by making it aware of its body.

• Allow injured robots to keep moving.
Outline

• Robotic Platform : Roombots
• Tools and Strategy for the Project
• More details : Graph Representation
Roombots

• Reconfigurable robots for adaptative furniture.

• At the module level:
  • Three degrees of freedom
  • Ten connectors

• At the metamodule level:
  • Four connection types.


A piece of adaptative furniture [Sproewitz, 2010]
Locomotion control and optimization

- Locomotion is controlled by **Central Pattern Generator (CPG)**
  - Network of coupled phase oscillators
  - One oscillator per degree of freedom
  - Servo inputs derived from state variables of CPG

- Evolution of CPG parameters using **Particle Swarm Optimization (PSO)**
  - Population-based optimization method based on cooperation
  - Fitness computed from locomotion velocity

This is implemented in the Biorob Optimization Framework by Jesse van den Kieboom.
Tools

Robot Structure Analyzer

Limb/Body Finder

Symmetry Finder

Similarity Finder

CPG Generator

CPG

PSO
**Graph Representation**

- **Topology**
  - CPG Network
  - Parameters

- **Search Table**
  - CPG Network
    - Graph Representation
    - Topology
    - Parameters

- **Robot**
  - Webots files provided by Soha Pouya.

- **Optimization**

- **Similarity Measure**

<table>
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Geometrical Graph Representation

Implemented by Stéphane Bonardi.

• One node per module.

• Ten connector types per module.

• Four connection types between modules.

Webots files provided by Soha Pouya.
Body / Symmetry Finder

Implemented by Stéphane Bonardi.

- Find body
- Label connections
- Find symmetries

Webots files provided by Soha Pouya.
Geometrical Graph Representation

Quad5_PER

Quad6_PAR

Webots files provided by Soha Pouya.
Functional Graph Representation

- One node per module
- Ten connector types per module
- Four connection types between the modules.

- One node per sphere
- Two connector types per sphere
- Four connection types between the spheres.

Single module picture [Pouya, 2010]
Webots files provided by Soha Pouya.
Future Work

Robot Structure Analyzer

Body/Limb Finder

Symmetry Finder

Similarity Finder

Rules

CPG Generator

CPG

PSO
References

- (1) http://www.nature.com/nrn/journal/v6/n6/images/nrn1686-f1.jpg
- (3) http://www.gamasutra.com/features/20051213/figure2.gif