Multi-robot Action Understanding based on the Neural System

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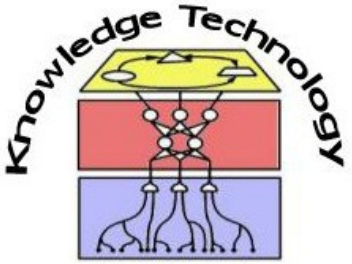

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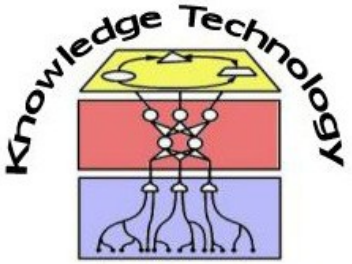

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Background Motivation

- Previous research on MNS mainly focused on motor action imitation
- Action understanding by MNS within multi-robot system is not fully developed, especially with consideration of multi-modal information
- MNS computational model benefits multi-robot cooperation without communication

Task Descriptions

Task 7.4 Neural Cognition Integration

- Build an integrated model including canonical neurons and forward model
  - For map building, multiple robots should be able to cooperatively do the exploration and the action understanding simultaneously
  - Different multimodal input will be considered

- Examination of the development of action understanding
  - Active Map Building

Expected Contributions

- Action understanding and prediction from robot peers inspired by mirror neuron system
- Future work: group behaviour synthesis with action understanding and learning

Mirror Neuron System

- Discovered in F5 area of monkey cortex. When observing other's action, the action will be understood or imitated (G.Rizzolatti and L.Craighero, 2004)

Mirror Neuron System

- Action Understanding:
  - Neurons discharges also when the stimulus-triggering features were hidden (M.A.Umilta et al, 2001)

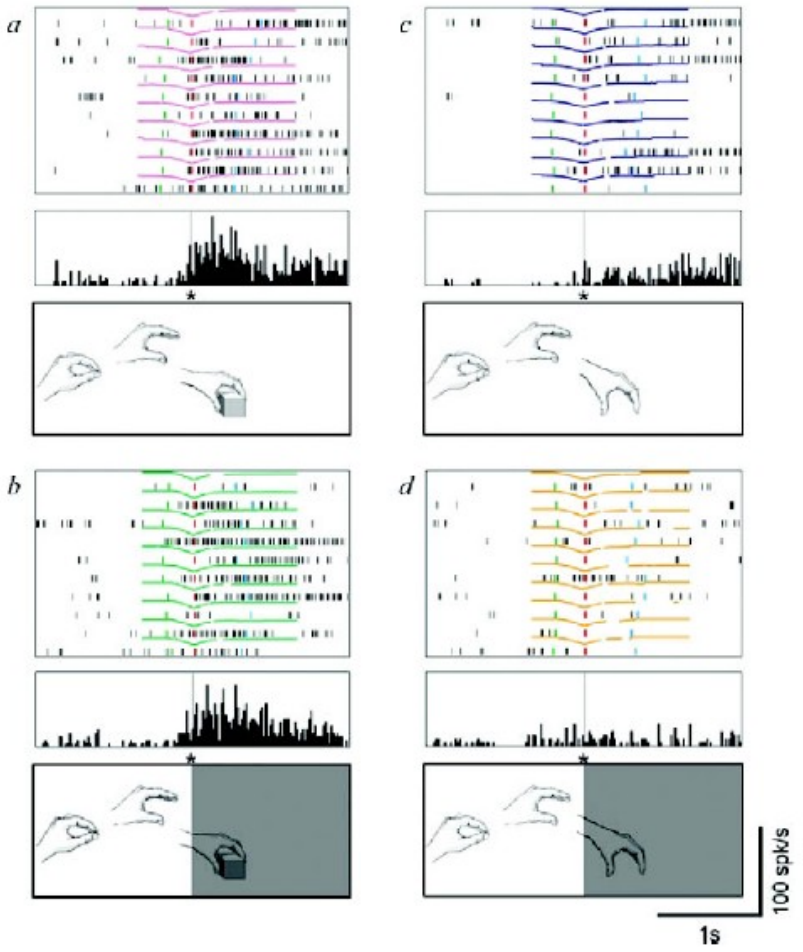
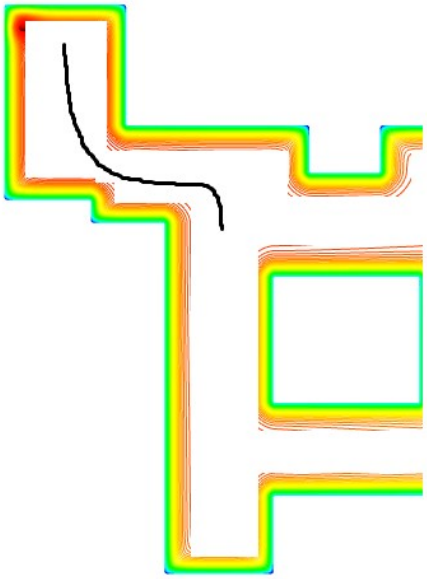


Figure: Extending the mirror neuron system model, I (J. Bonaiuto, E. Rosta, M.Arbib. 2007)

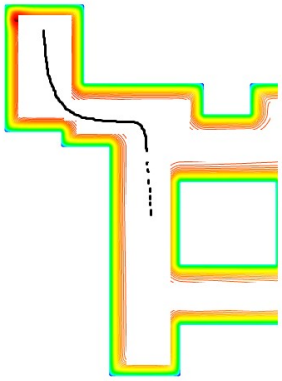
Research Questions

- Domestic room exploration: route selection for map building
- Is it possible to realize multi-robot cooperation using action understanding?
  - Robot A: Behaviour1
  - Robot B: Behaviour2
  - Robot B: {Sense(Robot A Behaviour1(t)) + Environment Affordance} → {prediction(Robot A Action(t+1)}
  - Robot B: Behaviour2 changed to Behaviour2" because of prediction

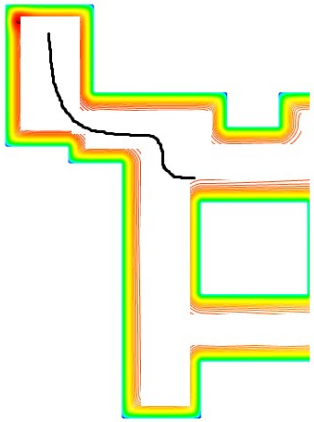
Research Questions



Robot A: Observation (t)



Robot A: Recognition



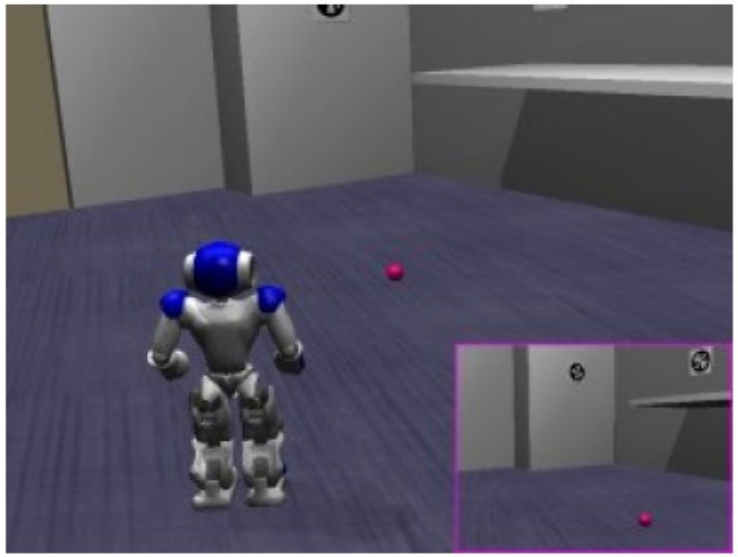
Robot B: Behaviour (t+1)

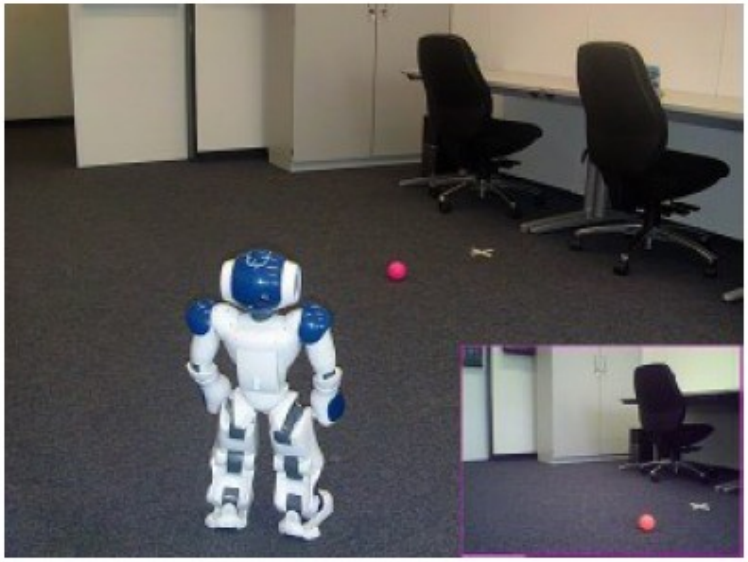
Scenario: Multimodal Context-based action prediction

- How to design the forward model (M.Haruno et al, 1998; D.M.Wolpert and M.Kawato 2003) to recognize the action goal and predict the following action of another robot from its history (trajectory, vision, sound)?

Research Questions

- Experiment platform (Webots and domestic environment)

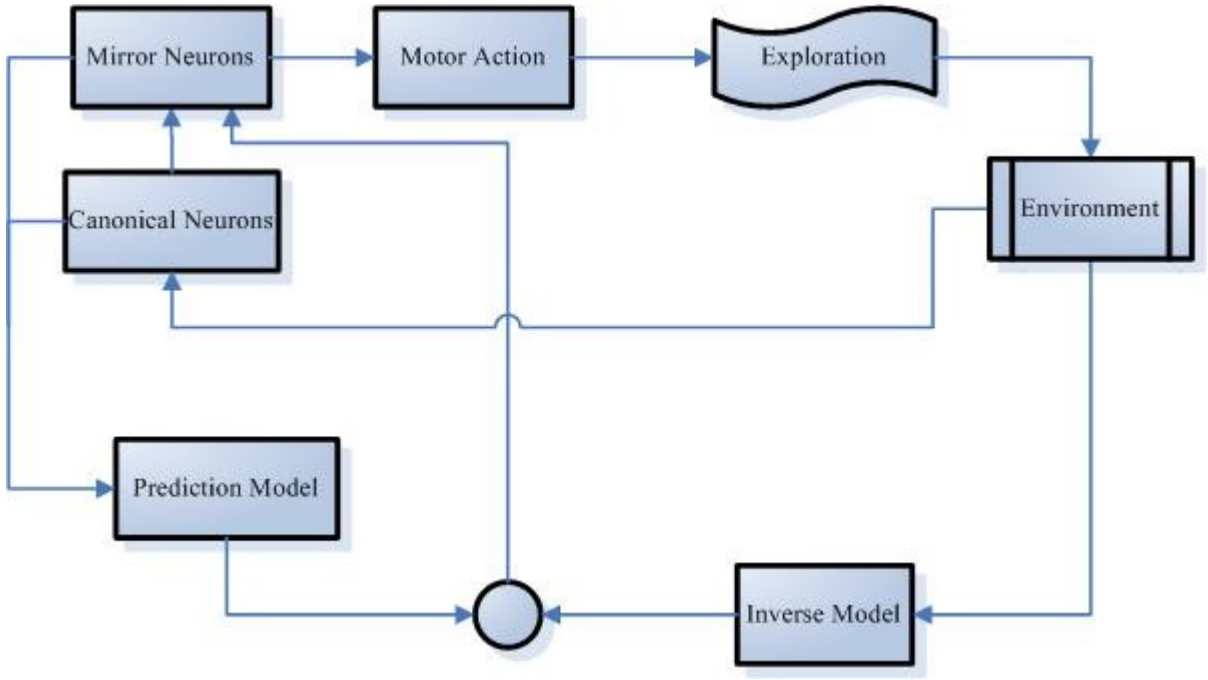




- Multi-robot Demo

Methodology and Experiments

- Active Mapping Experiment: Information gain / Exploration time
- *understand* other robot's action with *forward-inverse model* for cooperation



Methodology and Experiments

- Starting point: Action learning and understanding by extended RNNPB (J. Tani et al, 2004) with multimodal sequences

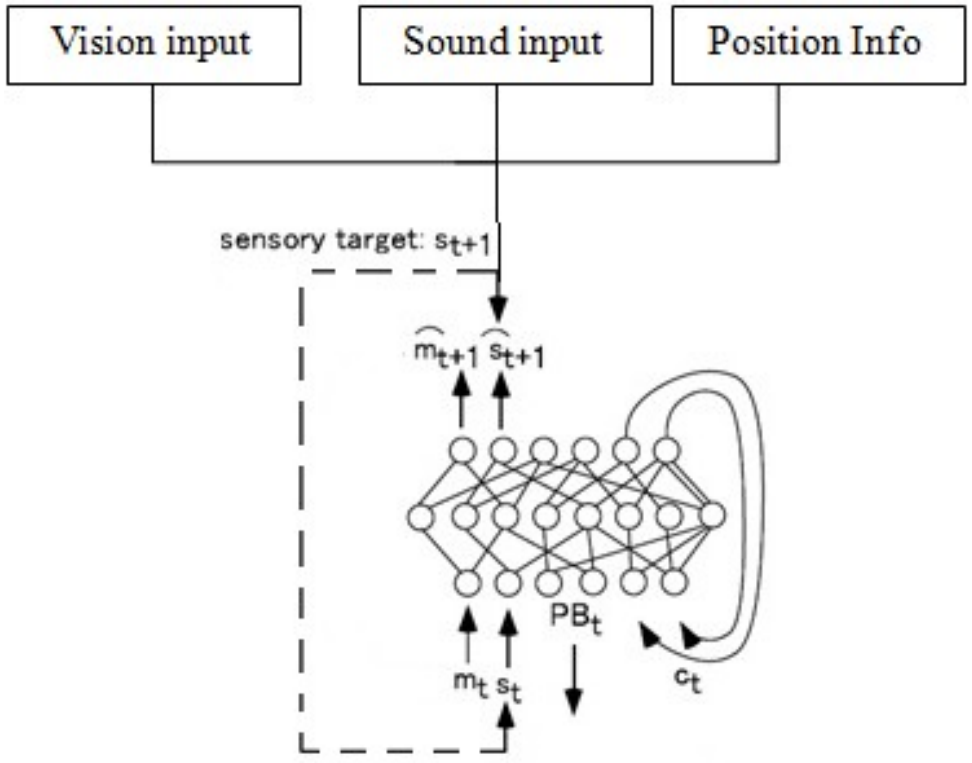


Figure: Self-organization of distributedly represented multiple behavior schemata in a mirror system: reviews of robot experiments using RNNPB.(J. Tani, M. Ito, and Y. Sugita. 2004)

Novelty and Expected Contribution

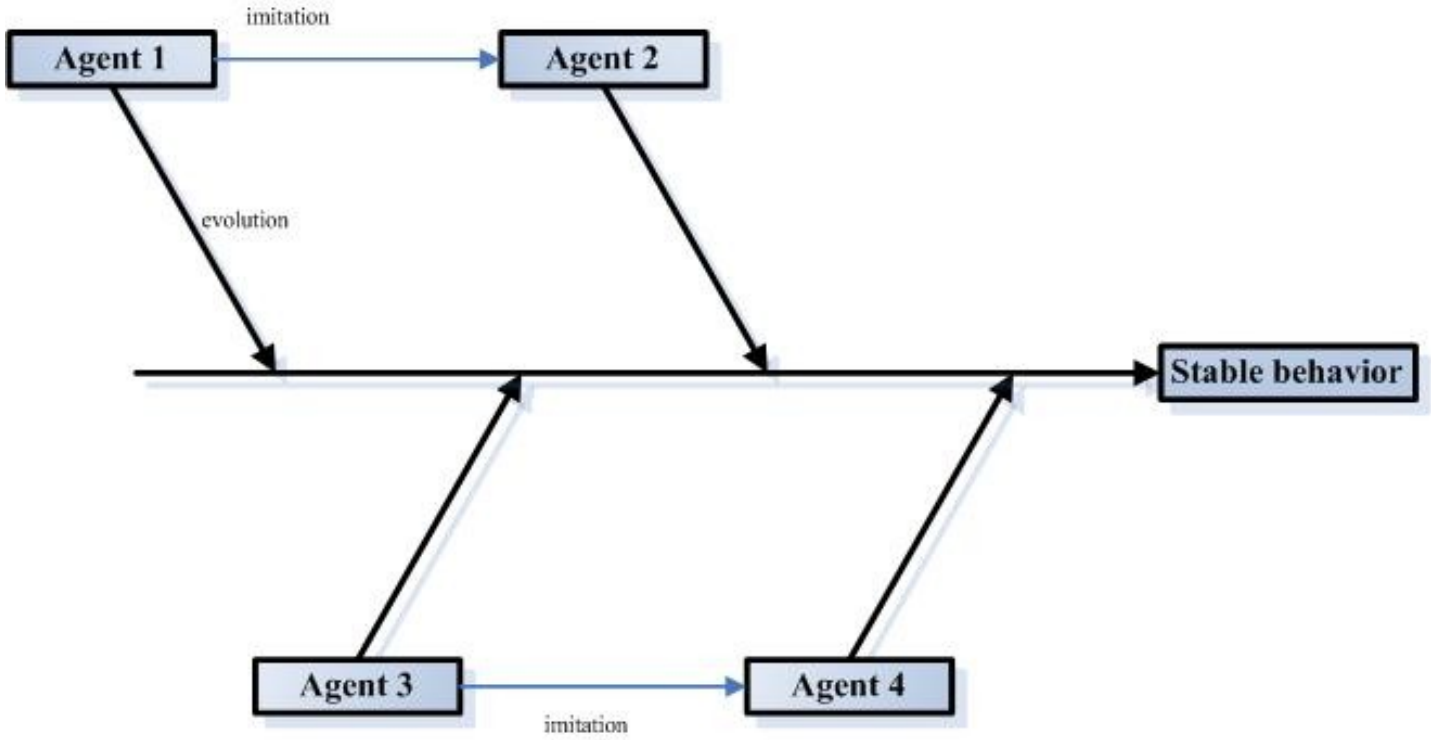
- Action understanding by MNS within multi-robot system is emphasized, with the consideration of multi-modal information

- Start from the basic experiment with two-agent framework

- Predict future actions based on environment affordances and action understanding

Future Work

- Self-organize to synthesize of group behaviour



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