Artificial Affective- and Self-Protective Actions
RobotDoc Task 4.3

Nicolas Navarro
University of Hamburg
Dept. of Informatics, Knowledge Technology

http://www.informatik.uni-hamburg.de/WTM/

October 25, 2010
Supervisors Grounding

Stefan Wermter
University of Hamburg
Dept. of Informatics, Knowledge Technology

http://www.informatik.uni-hamburg.de/WTM/

October 25, 2010
Why is this topic relevant?

- Computational models of mammalian and human learning could contribute enormously to future robot generations.

- Affective mechanisms are important to understand cognitive processes and play a key role in the development of intelligence. [Arbib and Fellous, 2004]

- Many affective responses are hard-coded, but often humans and animals learn to associate neutral stimuli with emotionally charged stimuli to elicit affective responses. [Fellous, Armony and LeDoux, 2002]

- Stimulus detection-and-response organizing systems are building blocks of affective mechanisms. [Fellous, Armony and LeDoux, 2002]
How does it relate to RobotDoc Task 4.3?

- Study of neural emotion-action integration based on animal and human affective evaluation of stimuli.

- Development of a stimuli-action associative architecture, integrating affective states, sensory inputs and actions.
Outline

- Research question
- Approach
  - Neuroscience
  - Computational Modeling
- Framework
- Initial experiment
- Expected results
Research question

- Which innate responses of animals are important for an artificial organism?
- How can we build an embodied affective system able to identify harmful and safe situations?
- How can affective judgements of situations be learned?
Neuroscience approach
Computational approach

Prescott et al. 1999 - Layered organization of neural mechanisms of defense

- Cognitive analyses
- Context
- Complex neutral stimuli
- Neutral stimuli
- Species-specific threat stimuli
- Sudden distal stimuli
- Noxious or contact stimuli
- Sensory input

- Frontal cortex
- Hippocampus & septum
- Sensory cortex
- Thalamus
- Midbrain & hypothalamus
- Hindbrain
- Spinal cord

- Amygdala

- Response suppression
- Conditioned emotional responses
- Species-specific responses, e.g. freeze / flight / fight
- ‘Startle’ responses
- Reflexive withdrawal

- Motor, autonomic & endocrine output
Computational approach

- Spatial memory
- Affective state

- Hippocampus
- Sensory cortex
- Thalamus

- Midbrain and Hypothalamus

- Hindbrain
- Spinal cord

- Body

Context
- Complex neutral stimuli
- Neutral stimuli
- Specific threat stimuli, e.g. starvation, body temperature
- Sudden stimuli, e.g. instability
- Noxious or contact stimuli

Conditioned affective responses
Specific responses e.g. freeze, run, seeking for energy
Fall avoidance or preparation
Reflexive withdrawal

Nicolas Navarro
Towards artificial self-protective mechanisms
Computational approach

Known image and data processing techniques

Recurrent neural networks for affective evaluation of stimuli and affective state

Reinforcement learning

Hard-coded responses

Nicolas Navarro

Towards artificial self-protective mechanisms
Framework
Initial experiment – Seeking for energy

Expected results

- Implement robust, reliable and scalable artificial affective protection mechanisms tested on a simulated and a real humanoid robot.
- Time-varying behaviors, i.e. basic behaviors modified or overwritten by superior artificial cognitive processes.
- Develop an API of the model to be used on other intelligent systems, not only as an input-output module.
The end

Thank you for your attention.
Any question?

Literature: