Task 4.1
Affective representation and anticipation: 
Grounding emotion appraisal in autonomous humanoids

Kiril Kiryazov (ESR 7)
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FEEL&WANT node

RobotDoC
Robotics for Development of Cognition
Background

• Master degree in Computer Science – Artificial Intelligence
  – Sofia University, Bulgaria

• Experience as a programmer:
  – CLAWAR (software system for simulating and training a position controlled robot)
  – MindRACES (interface module for a cognitive model and an AIBO robot)

• Center for Creative Training, Sofia
  – leading a course of Robotics for children

• Balkan Bulgarian TV
  – Co-Editor and Scriptwriter in a TV-show series for popular science
# Work and training in RobotDoC

<table>
<thead>
<tr>
<th>Robert Lowe</th>
<th>Giorgio Metta</th>
<th>External supervisor visit - IIT, Italy, Genoa, 23.05 – 27.08, 2011</th>
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</thead>
<tbody>
<tr>
<td>U. of Skövde</td>
<td>U. of Genoa</td>
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<td>Tom Ziemke</td>
<td>C. Becker-Asano</td>
<td>U. of Freiburg</td>
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<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Details</th>
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<tbody>
<tr>
<td>Artificial Life conference, Denmark, August, 2010</td>
<td>Denmark, August, 2010</td>
<td>Poster “Energy-Motivation Autonomous Humanoid Robot”</td>
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<tr>
<td>Fourth EUCogII Members Conference, Greece, April 2011</td>
<td>Greece, April 2011</td>
<td>Poster “Towards an Emotional Autonomous Humanoid Robot”</td>
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<td>Summer schools: VVV10 – iCub summer school</td>
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<td>Courses at the University of Skövde:</td>
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<td>VVV11 – iCub summer school</td>
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<td>NN and Evolutionary Algorithms</td>
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<td></td>
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<td>Emotion and Affect</td>
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<td>Adaptive Robotics</td>
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<td>Standards in Emotion Modeling workshop, Netherlands, August, 2011</td>
<td>Netherlands, August, 2011</td>
<td>Talk and paper</td>
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Motivation and methodology for the research

- Somatic emotion theories (James, Damasio, Prinz)
- Emotion mechanisms in biological systems
  - provide value system
  - plan management under limited resources
  - communication
- Main challenges for robotic autonomy
  - work in unstructured environments under time constraints
  - deal with limited resources like energy and computational power

Future Plans

- Develop energy anticipation mechanism for grounding prospect based emotion like hope, disappointment- develop and adapt the learning mechanisms
- Compare the existing data with the one from experiments with a model of Microbial Fuel Cell technology for artificial metabolism
- Explore the role of emotions for dealing with the other limited resources in robotics and biological system like computational power. Study the effect of the emotions on plan management
- Explore the benefits of the emotional expressions to human-robot interaction
- Apply the architecture in virtual game environment to study the differences between behavior in a simulated and real world
- Apply the architecture in more complex scenarios like the one for CHRIS project with iCub robot.
- Ground the other parts of the emotion model, like Pleasure into approach/avoidance behavioral mechanisms
Career Development

Through my ongoing multidisciplinary training in cognitive robotics (autonomy, development, emotions, humanoids), I plan to work in R&D, e.g.

• ESA's Automation and Robotics: applications for extraterrestrial mission robots. Robots outside of remote human control require high degree of autonomy

• Mobile Robotics Inc: service robots for surveillance, delivery in hospitals, etc. The robots will work in partly known environment under time constraints and interacting with people
Thank you for your attention!

Kiril Kiryazov (ESR 7)
University of Skövde
Motivation for the chosen methodology for modeling emotional appraisals

- Bottom-up models: difficult to get to higher cognitive-emotional states
- Top-down models: difficult to be implemented in real world applications
- Hybrid approach – ground top-down model in bottom-up processes
WASABI (WASABI Affect Simulation for Agents with Believable Interactivity)

Non-conscious appraisal and PAD dynamics in WASABI

External events’ appraisal:
- Evaluation of utterances
  - offensive
  - praising
- Evaluation of vision system
  - skin detection
  - fast movement

Emotional impulses
awareness likelihoods regions for primary emotions
Why WASABI?

• A psychologically plausible model
• Includes the full spectrum of emotions which humans have
• Implemented and tested in several applications with a virtual human (MAX)
  – museum guide
  – card game partner
• Based on one of the most popular theories of emotions – appraisal theory
The hybrid architecture

- REASONING module
  - BDI component
  - conscious appraisal
  - anticipations

- PHYSIOLOGY module
  - movement
  - perception
  - arousal impulses

- EMOTION module
  - PAD space
  - mood

Connections:
- beliefs update
- actions
- emotional impulses
- active emotion
# Grounding PAD: arousal

Arousal impulse = Energy * (Cue\textsubscript{work} * Deficit\textsubscript{work} + Cue\textsubscript{fuel} * Deficit\textsubscript{fuel})

<table>
<thead>
<tr>
<th>Cue\textsubscript{work}</th>
<th>The distance between the robot and work (when the robot is facing towards it, otherwise =0)</th>
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</thead>
<tbody>
<tr>
<td>Deficit\textsubscript{work}</td>
<td>The work urgency level (between 0 and 1)</td>
</tr>
<tr>
<td>Cue\textsubscript{fuel}</td>
<td>The distance between the robot and energy station (when the robot is facing towards it, otherwise =0)</td>
</tr>
<tr>
<td>Deficit\textsubscript{fuel}</td>
<td>10 - battery energy level (10 is the maximum energy possible in the battery)</td>
</tr>
<tr>
<td>Energy</td>
<td>The battery remaining energy level</td>
</tr>
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Grounding PAD: arousal

- The effect of the arousal on behaviour
  \[ \text{RobotSpeed} = F(\text{Arousal}) \]

- The effect of the arousal on decision making
  \[ \text{LowEnergyThreshold} = \text{BASE\_LEVEL} + k \times \text{Arousal} \]
  \[ \text{HighEnergyThreshold} = \text{BASE\_LEVEL} - m \times \text{Arousal} \]

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Basic cycles

- If the robot is to be self-sufficient and economically viable then there are two basic resources that must be provided by the robot environment. ... energy ... and [work]”
- “Behavioural stability implies that the agent does not succumb to an irrecoverable debt in any vital re-source.”

Test scenarios
Arousal / work deficit
Basic cycles
**Plan for the remaining time of the project**

- Develop energy anticipation mechanism for grounding prospect based emotion like hope, disappointment- develop and adapt the learning mechanisms

![Diagram of Homeostasis and Allostasis](image)

- Compare the existing data with the one from experiments with a model of Microbial Fuel Cell technology for artificial metabolism

- Ground the other parts of PAD space, like Pleasure into approach/avoidance behavioral mechanisms

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RobotDoc Midterm Review Barcelona, 7 Sept 2011
Plan for the remaining time of the project

• Explore the role of emotions for dealing with the other limited resources in robotics and biological system like computational power
  – study the effect of the emotions on plan management
• Explore the benefits of the emotional expressions to human-robot interaction
  – experiment in game scenario where emotional communication is compared to “artificial” one
• Apply the architecture in virtual game environment to study the differences between behavior in a simulated and real world
• Apply the architecture in more complex scenarios like the one for CHRIS project with iCub robot.

Thank you for your attention!

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? Task title
? Schools etc
? ...i plan to work in...

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