HUman behavioral Modeling for enhancing learning by Optimizing hUman-Robot interaction (HUMOUR): concept and preliminary results

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www.humourproject.eu

CONCEPT

The HUMOUR project aims at investigating and developing efficient robot strategies to facilitate the acquisition of motor skills.

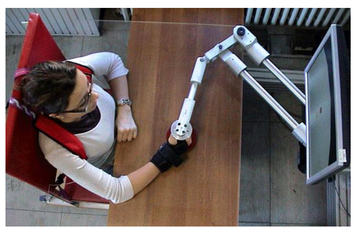
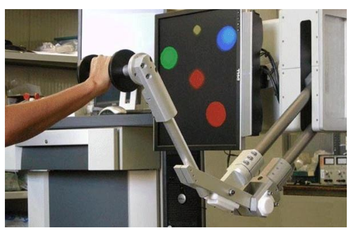
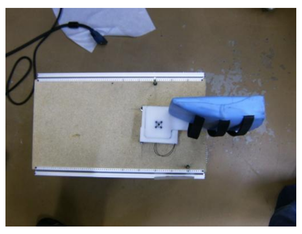
We address both the (human) trainee and the (robot) trainer sides, by combining behavioural studies on motor learning and its neural correlates with design, implementation, and validation of robot agents that behave as 'optimal' trainers, which efficiently exploit structure and plasticity of the human sensorimotor systems.

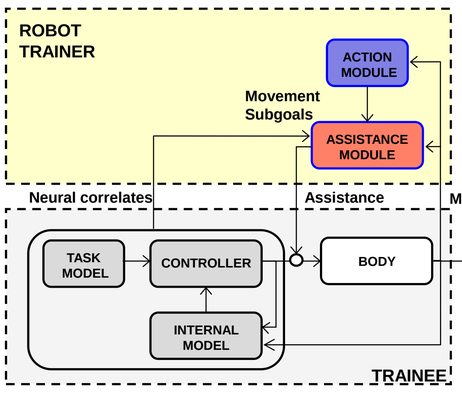
MOTOR SKILL LEARNING THROUGH PHYSICAL ASSISTANCE

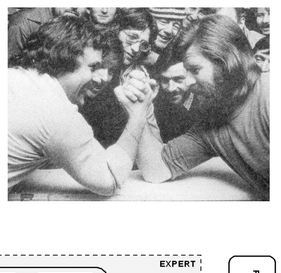


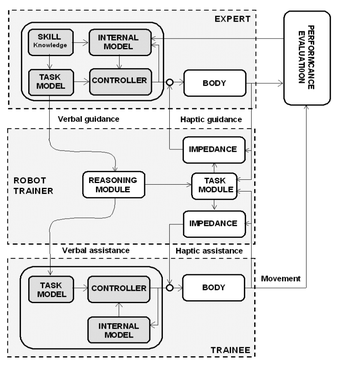

We will focus on the cognitive and neural mechanisms underlying the acquisition of a variety of motor skills, by specifically aiming at understanding the way humans physically cooperate in acquiring a motor skill and how physical assistance affects motor learning. Experiments will enable us to identify determinants and dynamics of the learning process in representative motor tasks, and will provide the foundations for designing efficient schemes of assistance.

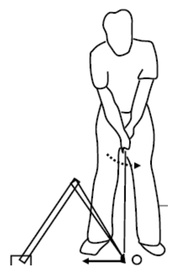
GENERAL OBJECTIVES

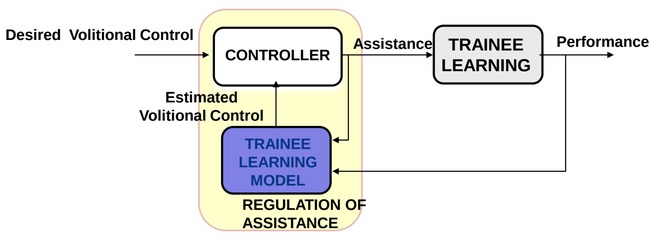










1. **Robot trainers.** To develop robot agents based on an advanced understanding of human neuromotor control, its development, and skill acquisition, which will enable them to mimic (and surpass) human trainers in supporting motor skill learning and neuromotor rehabilitation
2. **Application to motor skill learning and rehabilitation.** To validate robot training agents for a number of different motor skills, modalities of interaction and rehabilitation applications
3. **Brain-computer interfaces.** To extend the domain of Brain-Computer Interface (BCI) technologies to the fields of motor learning and neuromotor rehabilitation
4. **Behavioural studies on physical interaction and motor learning.** To understand how physical interactions affect motor learning and – on this basis - to develop a general theoretical and technological framework for more effective motor skill learning

RESULTS (first year)

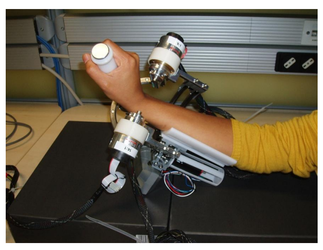
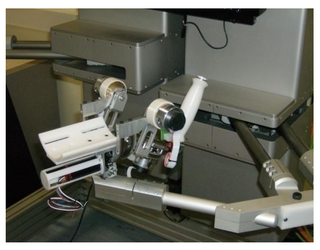
Modular robot system:
- ❑2-arm planar manipulandum
- ❑3D wrist device
- ❑1D hand device

Common software platform:
- ❑Device-independent
- ❑Multiple devices
- ❑Multi-OS (Windows, Linux)
- ❑Open Source, GPL (built on top of H3D, www.h3d.org by SenseGraphics)

Analytic and modeling tools
- ❑Performance evaluation
- ❑Optimal schemes of assistance
- ❑Model of robot-assisted motor recovery after stroke

Robot-assisted motor skill learning:
- ❑Redundant tasks (putting, handwriting transfer) – **Poster #127**
- ❑Visuomotor rotation – **Poster #114**

Neural correlates of assistive force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  <state id="1" name="moving"/>
  <state id="2" name="stopped"/>
  <state id="3" name="feedback"/>
  <state id="4" name="back"/>
  <!-- STATE TRANSITIONS -->
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    <gt type="double" field="velocity" value="0.05"/>
  </transition>
  <transition from="moving" to="stopped">
    <and>
      <timer delay="1"/>
      <lt type="double" field="velocity" value="0.05"/>
      <lt type="double" field="distance" value="0.01"/>
    </and>
  </transition>
  <transition from="stopped" to="feedback">
    <timer delay=".1"/>
  </transition>
  <transition from="feedback" to="back">
    <timer delay="1"/>
  </transition>
  <transition from="back" to="init">
    <and>
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      field="distance_from_center" value="0.01"/>
    </and>
  </transition>
</automaton>
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```
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<!– THE DEVICE (robot end effector and attached tool-->
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    <IMPORT inlineDEF="device" exportedDEF="HDEV" AS="HDEV"/>
…
<!– THE TARGET-->
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    <Appearance>
      <Material DEF='tgtColor' ambientIntensity='0.1'
      diffuseColor='1 1 1'
      shininess='0'/>
    </Appearance>
    <Sphere radius='0.01'/>
  </Shape>
 </Transform>

<!–A SOUND (used as cue or feedback) -->
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  <AudioClip DEF="Ask" url="ding.wav"/>
 </Sound>
…

</Scene>
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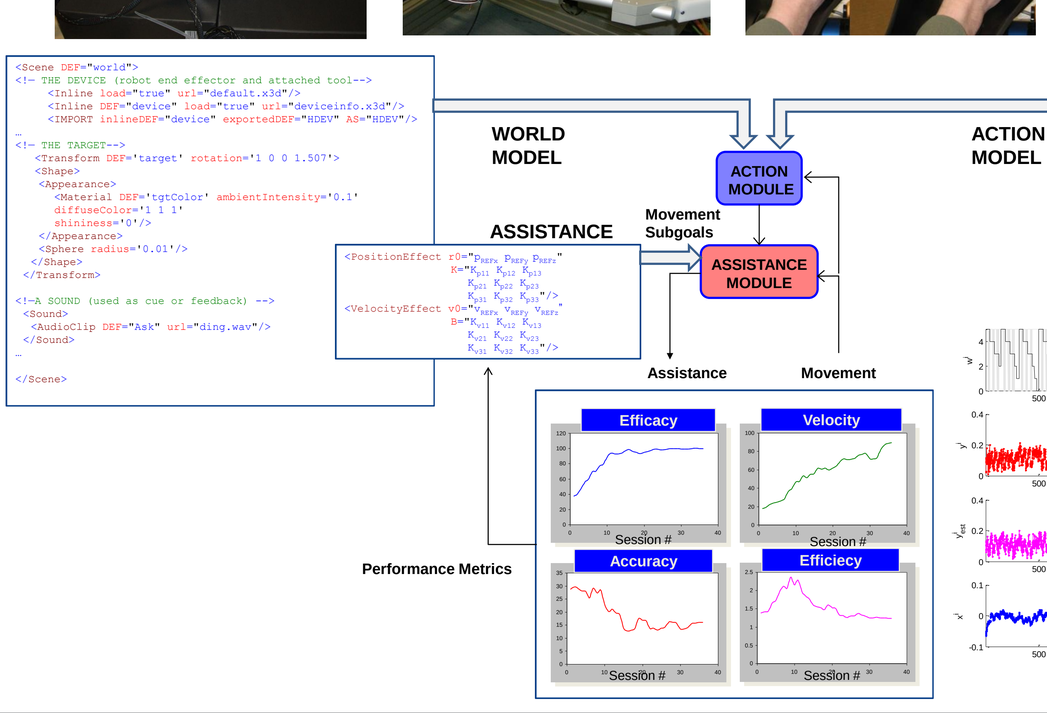

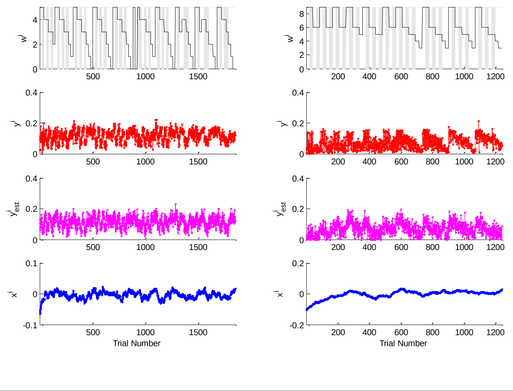

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