SOCIAL ROBOTS' UMWELT

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OPEN QUESTION

B7 How can one build an agent aware of its environment?
What sensory modalities are imperative for an artificial embodied agent to be "aware" of its environment?
Does this significantly depend on (morphological, material, and/or other features of) the embodiment of the agent?
How can this be shown in a (hardware, software and/or wetware) model?

ABSTRACT

Sensing and interpreting interlocutor's social behavior is a core challenge in the development of social robots. Social agents require an innovative sensory apparatus able to perceive the *"social and emotional world"* where they have to act. This social perception apparatus has to be tuned and filtered on the peculiarities of the agent's body allowing a sort of embodied world interpretation. Animals display awareness of external sensory stimuli. Human beings are also aware of their own bodies' states and social related feelings. Social robots have to be able to do the same. In this work a preliminary implementation of a social scene analysis system together with a Damasio's theory inspired cognitive architecture for social humanoid control is presented. This implementation aims to extend the robot social capabilities allowing them to project their own "mood" into the social context on which they are trying to be involved.

DISCUSSION

Social and emotional intelligence is a key element of personal and service robots which allows them to express personalities conveying their attitudes and behavioral inclinations [1, 2]. For this reason interpreting interlocutor's social behavior acting with a contextualized approach is a core challenge of social robots development [3].

Emotional intelligence requires to be implemented not only as computational model but also as innovative sensory apparatus able to perceive the *"social and emotional world"* where the robot acts.

Damasio illustrates that emotions allow human beings to make decisions, since the process of monitoring the internal state of the body by the brain and the process of generating emotions are closely connected and involve the same brain areas. Emotions are perceived and expressed as a

complicated blend of body gestures, actions, involuntary behaviors and physiological correlates that represent a sort of human being hyper-state called *"proto-self"* [4, 5]*.*

How can a robot be social without feeling the **"social world"**?

We perceive the world through our senses that interpret it creating a subjective view of our environment. In their semiotic theories Uexküll and Sebeok define the concept of *"Umwelt"*; the "self-centered world". According to Uexküll organisms can have different Umwelten, even though they share the same environment [6].

Damasio's proto-self can be considered *"The other half of the embodied mind"* [7]*,* an *Umwelt* extension which includes also human being feelings, behaviors and emotions and their consequent body states; the *"Emotional Umwelt".*

Understanding the social world, "the body shapes the way we think"

Emotional Umwelt is not made of colors, sounds and objects' shapes. It includes high level data with social and emotional meanings. A robot observing people talking have to deduce who is the speaker, their facial expressions, their genders, their gestures, etc. All this information, in order to be interpreted, have to be analyzed through the "body filter", the robot's point of view [8].

The FACE android [9, 10, 11] has been equipped with a *Social Scene Analysis System* (SSAS) which acquires "the robot Umwelt" through cameras, microphones and other sensors extracting social related information [12]. SSAS creates the Social Meta Scene (SMS) which is the contextualized representation of FACE's Umwelt. The system extracts high level information (Figure 1) that can be "projected" into the FACE *proto-self.* This embodiment mediated interpretation of sensors allows FACE to *feel* the social scene it is trying to be part of.
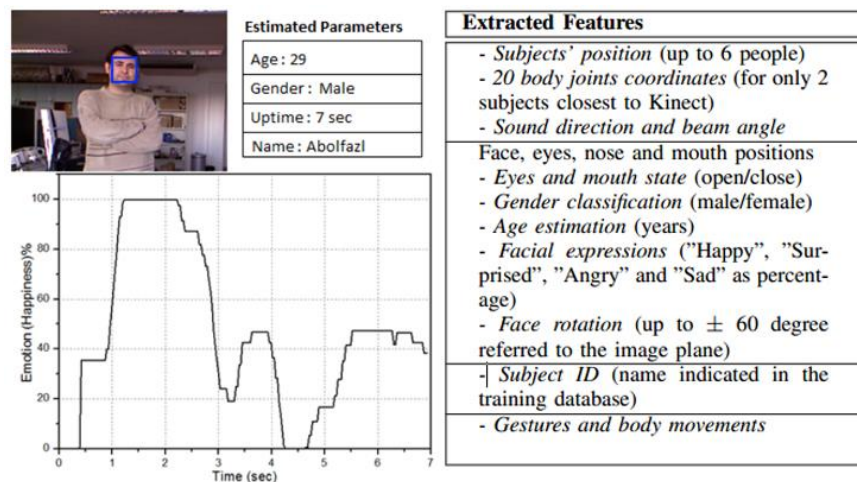

Figure 1: The FACE Social Meta Scene extraction

The FACE humanoid senses focus on human body analysis but sensor data interpretation isn't universal. For example, a worm-like robot will not analyze images but soil vibration inferring

bodies and objects' shape and size. Sensorial high level analysis has to be mirrored on the agent Umwelt.

The social robot awareness

Animals display awareness of external sensory stimuli. Human beings are also aware of their own bodies' states and social related feelings [13]. Awareness for social robots is not just being conscious of motors positions. It includes the capability to perceive the inner state *"unconscious proprioception"* evolved as consequence of the exteroceptive sensory stimulation. This loop of cognitive representations of induced feelings is the core of a possible social robot cognitive system which allows the agents to projects itself in the social context [14].

The robot inner sensory system could also be partially simulated giving the agents the possibility to perceive its own heartbeat, breathing rate, stamina, etc.. These in-silico parameters have to be continuously modulated according to the robots actions and behaviors creating a virtual proto-self extension.

In social context energy related interactions are fundamental. For example, human beings perceive stamina level as body feeling that affect mental and body activities. People unable to understand their interlocutors' tiredness is perceived as regrettable.

Stamina can be simulated in social robot creating a proper dynamic model which takes as input robot energy consumption. This dynamic energy indicator has to be considered more than a simple battery level indicator. It is a fundamental input for robot social interaction planning. For example, analyzing a social context, a robot could perceive if its stamina is compatible with the context required behavior and attitudes, deciding to take part or not. This energy related capabilities consciousness will allow robots avoiding social misalignments that will be perceived by the other interlocutors as frustrating.

The FACE cognitive systems has been designed following the Damasio's theory formalization reported in [15]. The system is based on a rule engine on which the FACE SMS is asserted as set of facts (Figure 2). New facts assertion (primary cognition) triggers rules which comport the assertion of new high level emotional and behavioral related facts (secondary cognition). This iterative multi-level process generates an extended fact base; the FACE proto-self [16].
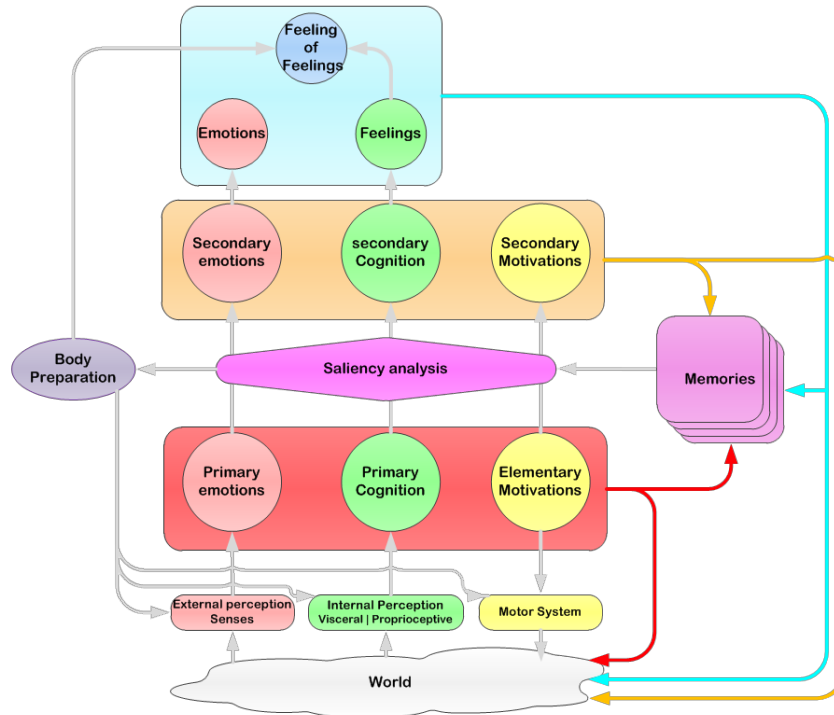
Figure 2: FACE cognitive system formal architecture

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