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From the Virtual to the Robotic: Bringing Emoting and Appraising Agents into Reality

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Abstract

A classical appraisal model of emotions extended with artificial metabolic mechanisms is presented. The new architecture is based on two existing models: WASABI and a model of Microbial Fuel Cell technology. WASABI is a top-down cognitive model which is implemented in several virtual world applications such as a museum guide. Microbial fuel cells provide energy for the robot through digesting food. The presented work is a first step towards imbuing a physical robot with emotions of human-like complexity. Classically, such integration has only been attempted in the virtual domain. The research aim is to study the embodied appraisal theory and to show the role of the body in the emotion mechanisms. Some initial tests of the architecture with humanoid NAO robot in a minimalistic scenario are presented.

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Keywords: virtual agents; robots; autonomy; emotions; artificial metabolism; appraisal theory

1. Introduction

In order to “transfer” a virtual agent into the real world a lot of complex problems should be solved. The main problems which are usually tackled are related to perception and action. Another important aspect, which has not drawn much attention till now is the fact that robots have physical bodies which have physical limitations. For example energy level should be kept in appropriate limits, body integrity should be maintained and damages should be avoided. In the virtual case that task is trivial and it is usually solved by just adding one more parameter in the system related to the agent-environment relation, which dynamics is very simple.

The goal of this research is to use a model of a virtual human and apply it to a real robot. For that purpose we are developing a hybrid architecture. We extend a classical appraisal model of emotions by incorporating artificial metabolic processes. That hybrid architecture is aimed to be implemented in humanoid robots which should have the possibility to perform complex tasks and have the same flexibility and adaptiveness as humans. One of the main applications of such architecture could be in service robotics where the robots are designed to work in human environments and communicate with humans. In that case an anthropomorphic body and human-like emotions could facilitate the communication. Another application could be any task in remote environments (e.g. extraterrestrial world exploration) where the robot should be autonomous and care about its energy level and bodily integrity [1]. Several studies have shown that emotions fulfill an important role in a biological organism’s autonomy. Similar mechanisms could be useful for autonomous artificial creatures as well [2].

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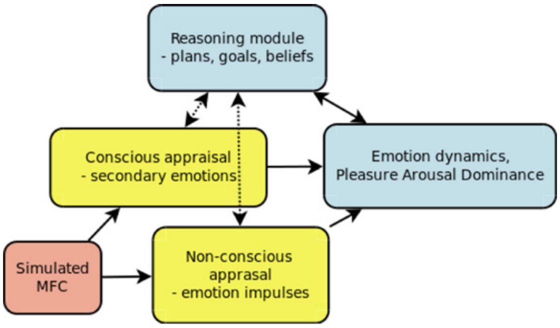

Fig. 1. The basic components of the new architecture.

2. The proposed solution

Many of the models of emotional mechanisms are based on the appraisal theory [3]. The general components of these models are appraisal and response. The appraisal part contains evaluation of the changes in the inner or outer conditions according to agent's intentions and beliefs which leads to a change in the emotional state. The response part is a change in the behavior or internal state which has some adaptive role in the current situation. The appraisal process usually contains an unconscious part which provides fast reactive responses and a slower conscious (deliberative) part. Classical approaches usually study the evaluation of the environmental state without considering the body. But for real robots evaluation of the situation regarding to the levels of crucial body parameters is very important.

We are developing new architecture which is based on two existing models - WASABI and a model of a MFC. WASABI (Wasabi Affect Simulation for Agents with Believable Interactivity) is a top-down cognitive model based on classical appraisal theories of emotion [4]. WASABI is chosen as a base for several reasons. It is psychologically plausible and it includes the full spectrum of emotions which humans have. From another side it has been successfully implemented and tested in several applications with a virtual human as a museum guide and a card game partner, respectively.

MFC (Microbial Fuel Cell) is mechanism of an artificial metabolism [5]. The technology allows robots to convert fuel (food) into usable energy. That process is based on chemical reactions using bacteria. Although MFC technology does not implement real (animal) metabolic activity it is biologically relevant. There is only an implementation for a wheeled robot (Ecobot) at the present state of the art and we use a model of MFC (not the real system) in a NAO robot which has regular battery and charging capabilities.

The module with artificial metabolism model (Figure 1) is simulating the dynamics of energy flow related to the availability of the resources and the energy consumption of the robot (regarding its movement). The module sends the energy and the food levels of the robot to the appraisal modules of WASABI. The unconscious appraisal module uses that information to generate some positive/negative impulses and drive the emotion dynamics. From another side the reasoning module sends the estimation of the energy cost of each action to both appraisal modules. That information is used together with the environmental state to evaluate the expected energy loss/gain and generate appropriate primary and secondary emotions.

3. Tests

Some initial tests are considered to be done in the nearest future with a virtual and a real NAO robot in a minimalistic scenario (Figure 2). The robot stays in a room with three objects - food, water and goal location. Food and water are needed in order to keep its energy level in the necessary limits. The third object - symbolizing the work to be done, is an explicit goal to the system. Several experiments will be performed varying some internal parameters (like metabolism ones) and observing of the behavior the robot - how efficient it is in maintaining its energy and reaching the goal. This scenario is based on McFarland's concept for basic cycles. Every autonomous robot should switch efficiently between working, finding fuel and refueling. Performance evaluation of basic cycles of NAO in this minimalistic scenario will help us develop the architecture for more complex scenarios.

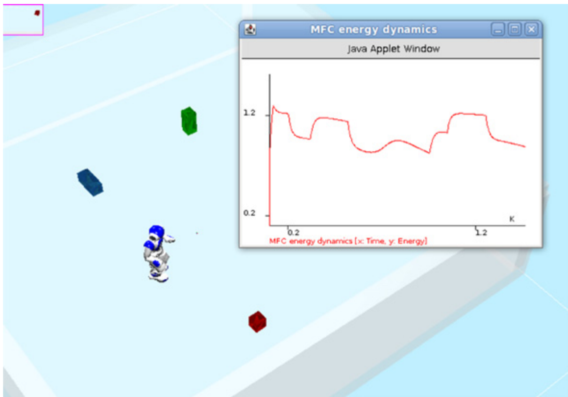

Fig. 2. NAO in a test scenario. The energy level history for the MFC is showed in the graph.

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