A gesture system for social robots

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I. INTRODUCTION

Since social robots will cooperate and assist humans in a variety of daily life situations, interacting with these kind of robots must be easy and intuitive for all kind of users, ranging from children to elderly. Therefore, in the design of social robots, the human must be placed central and thus, social robots need to be equipped with human-like social and communicative skills. Human communication has been an important research field; in particular, the field of facial expressions has been studied intensively. Ekman and Friesen developed the Facial Action Coding System (FACS), a method that decomposes different human facial expressions in the activation of a series of defined Action Units (UA), which are the contraction or relaxation of one or more human muscles. The method is widely used, including in social robotics for the generation of realistic human-like facial expressions to enhance the human-robot interaction. Examples of robots using this method are Eddy, Kismet, Saya, Roman and Probo. Besides facial expressions, also gestures and body language are important non-verbal cues. Gestures and body language have a great influence on the meaning of words and contribute to the general context in which social content can become more meaningful. Therefore, the implementation of gestures and body language in robots also benefits the interaction between humans and robots.

II. GESTURES FOR ROBOTS

Gestures will be important for all kind of social robots, such as entertainment, assistance or household robots. The use of gestures can even be useful for industrial robots, to increase safety in collaboration with humans. In noisy environments, or situations where large distances make the interpretation of speech and facial expressions impossible, gestures remain a possible form of communication. But in contrast to facial expressions, no generic method for the taxonomy and generation of gestures exists. The gestures implemented in the current state of the art robots (like Leonardo, Jusin, WE-4RII, Nexi and Infanoid) are always limited, often preprogrammed offline and dependent on the morphology or generated by human motion tracking. A generic method for the generation of gestures by social robots would be useful for different research teams in several fields.

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III. THE BODY ACTION CODING SYSTEM

We are currently developing such a method, which we called the Body Action Coding System (BACS). Similar as the FACS defines a number of (Facial) Action Units, a set of Body Action Units (BAU's) is defined. While the Facial Action Units are defined as muscles or a muscle group, our Body Action Units are based on the human terms of motion. BAU 1 is for example defined as the flexion/extension of the neck, BAU 6 as the transversal rotation of the spinal column. An extendable database containing the most commonly used gestures and body poses was developed. The body postures corresponding to these gestures and body poses are based upon data measured by motion capture. These body postures were subsequently taxonomized into the activation of a set of Body Action Units. Since this method is based on the human muscular system, it is independent of the configuration of the robot. The method can therefore be used for different kind of robots, whereby nevertheless the execution of the poses and gestures will be robot specific. When a certain pose of gesture is to be performed by a specific robot, the joint angles for every degree of freedom will by calculated by a method that converts the human joint angles into robot joint angles, taking into account the relative size of the different robot body parts and the available degrees of freedom. When, for example, the expression of a certain emotion includes showing facial expressions and movement of both the arms and legs, but the involved robot has no actuated head, the movements will be restricted to the arms and legs. The consideration of the relative sizing is especially important for the arms, since the position of the hands is mostly essential for the adoption and recognition of gestures and body language.

IV. CURRENT AND FUTURE WORK

Currently, the Body Acton Coding System is tested on a set of virtual models. The first step is the validation of the method on a human mode, to check whether a user's expectations of how gestures are generated by a person are met. In the second step, the method will be tested on the virtual model of different types of robots, including mechanical looking robots like Robonova and Nao, a minimalistic robot like Keepon and humanlike robots, like Justin and Probo. In a next stage, the method will be implemented on the real model of several of the aforementioned robots.