Blink-Sync: Mediating Human-Robot Social Dynamics with Naturalistic Blinking Behavior

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ABSTRACT

This short paper discusses the utilization of naturalistic eye blinking behavior in social robotics and gives an overview of the application possibilities. It proposes an integrative blinking model and gives an outlook on its implementation.

Keywords

Social robotics, iCub, naturalistic blinking behavior, embodied social interaction

1. Introduction

One way to make future interactions between humans and robots comfortable and reassuring for the human interaction partner is to model the movements and behaviors of the robots as naturalistic as possible. Specifically in the field of elderly and health care the social component communication between the robotic companion and user is going to be considered very important [1]. The application of technology in this area is based on the necessity to counter effect the demographic change characterizing industrialized societies [2].

In order to avoid to build robots that "fall" into the "uncanny valley" [3] we have to focus not only on the appearance of the robots, but also on their movements. This is specifically important when constructing humanoids. While raising the expectation of being human like, they are likely to be perceived as uncanny when exhibiting unnatural movements and behavior [4]. Besides the necessity to ensure a positive perception of the robot, in order for it to be accepted as a companion, the intuitiveness of the interaction interface is of high importance for a successful application of the technology. In the case of humanoid robotic companions this interaction interface would be the entire body, including body language, facial expressions and verbal communication.

The work we will introduce here focuses on one aspect of nonverbal and partially involuntary behavior: naturalistic eye blinking. We propose that for a comfortable conversation with a robot that has an expressive face, naturalistic eye blinking plays a very important role. In this short abstract we will describe the background of the empirical research on eye blink in humans and give a short overview of how eye blinking has been used so far in HRI research. On this basis, we will introduce our experimental approach, and explain its relevance for behavioral coordination between humans and robots.

2. Background

Research concerning the various dependencies of human eye blinking behavior on different physiological and psychological factors produced a variety of results that can be used to model blinking in social robots. Ford et al. [5] showed for example that blinking is strongly linked to onsets and offsets of communicative facial behaviors and verbalizations. Based on their findings, they proposed the "blink model" for HRI, which integrates blinking as a function of communicative behaviors. Doughty [6] described in his work three distinct blinking patterns during reading, during conversation and while idly looking at nothing specific. Lee et al. [7] proposed a model of animated eye gaze that integrates blinking as depending on eye movements constituting gaze direction. Neurological findings showed that responses to facial movements such as blinks can be measured in an observer's brain [8], a result that hints at the social importance of eye blinking for the synchronization of behavior between the interlocutors.

In summary, it can be said that blinking has been described as: (1) a function of physiological variables, such as the average speed of a single blink, the average blinking rate and the average length of the inter eye blink intervals (IEBI); (2) a function of system state variables, such as changes in facial expression and verbal communication behaviors; (3) a function of social context information, such as reading and being in a conversation; (4) a function of the behaviour of the social interlocutor.

In order to achieve naturalistic blinking in the iCub robot, we plan to integrate the above mentioned variables into our blinking model "Blink-Synch".

Specifically for robots, featuring pronounced eyes - like the iCub - authentic eye blinking behavior can have a profound impact on the interaction comfort [9]. Eye lids have been implemented into different social robots [e.g. 10, 11, 12], but the blinking behavior has mainly been added randomly to the social interaction with these robots. Based on the already encouraging findings from this research, we will focus on the empirical validity of the behavior.

An interesting application comes from research with children with autism. In various studies it has been shown that using eye blinking attracts the children's attention towards the eyes and helps maintain engagement in the therapeutic setting [13]. These results are interesting, because autistic children usually avoid looking into the eyes of their interaction partners. Utilizing the effect with naturalistic eye blink patterns in this context might help to teach these children to better interpret and understand the facial expressions of their social partners, which is something that is very difficult for people with autism [14].

In general it can be said that the information transferred by the movement of the eyes and eye lids is crucial for the interpretation of social situations. A stare for example can be perceived as threatening and intimidating and constant blinking as being nervous. It is important to understand blinking only as part of this information transmission channel. Eye gaze direction is at least equally important [15, 16]. We see the modeling of naturalistic blinking as a first step towards a more integrated nonverbal social communication approach.

3. The “Blink-Sync” Model

The robotic platform we are using for our approach is the iCub robot (see Figure 1). It has very pronounced eyes and eyelids that can be moved in a human like fashion.

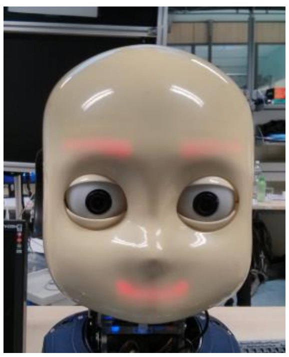

Figure 1: The iCub head with pronounced eyes and eye lids

In our model we will use three different dimensions of information – context, system, and social (see Figure 2). During the presentation we will describe in detail these dimensions and their role in the “Blink-Sync” model.

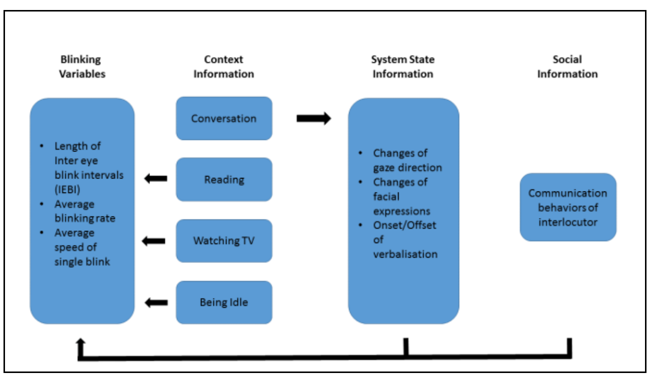

Figure 2: Information Dimensions involved in the Blink-Synch Model

The goal of the implementation of this model is to create convincing human-like behaviors for robotic home companions. As research has shown, specifically elderly people do not expect from a companion to only fulfill fetch-and-carry tasks, but to also keep them company. In order to achieve this, robot companions need to express appropriate behaviors not only during conversations, but also while “just” being around and watching TV with its user or reading the newspaper to its user.

Research questions we address with this work are: (1) Are people sensitive to differences in blinking pattern when exhibited by the iCub robot? (2) If yes, are people able to describe these differences in terms of the different contexts, like reading and conversation? (3) Can naturalistic conversational blinking facilitate a more natural conversational interaction between the robot and a human?

After the implementation of the behavior patterns on the robotic platform we will attempt to answer our research questions by proposing different questionnaires to people. In order to answer our last research question we devised an interaction scenario in which we will confront participants with the robot.

4. Approach

Our method is based on analyzing human social behaviors, modeling them in a humanoid robot (i.e. the iCub) and then performing tests in Human-Robot interaction contexts. We initially make use of an optimization approach for refining the “Blink-Sync” parameters such that the implemented behaviors on the iCub mostly resemble the ones of human counterparts. Then, a synthetic approach will be applied for the testing of these behaviors in natural environments. Through this dualistic methodology we both aim to build better social robots, i.e. robots with a more convincing social presence and at the same time test existing psychological paradigms about their integration in human society.

Our method is based on analyzing human social behaviors, modeling them in a humanoid robot (i.e., iCub) and then testing them in Human-Robot interaction contexts, we therefor use both an optimization approach for the behaviors on the robot and a synthetic modeling approach for the testing of this behaviors natural environments. Through this dualistic methodology we firstly aim to build better social robots, i.e. robots with a more convincing social presence and at the same time test existing psychological paradigms about their integration in human society.

Placeholder

Behavior synchronization is achieved through the observation of the behaviors exhibited by the social partner. The processing of this behavior might happen consciously or unconsciously, but the result remains a behavioral synchronization that facilitates the conversational coordination between the interaction partners. Hence for robots it might be enough to achieve behavior synchronization with their users, to be able to observe and appropriately respond to the observed behaviors. It has been shown that this form of nonverbal exchange of information has a long evolutionary history and can be found at least also in human primates, and dogs.

The development of the “Blink-Sync” model can be useful also in basic science, for example to synthetically study the effects of these blinking behaviors in social interactions real-life environments [17]. It is for example thinkable, following our current research, to study how blinking behaviors influence social interactions, by using the “Blink-Sync” model in human-robot interaction contexts (testing different blinking patterns in different situations).

Applicative fields of the “Blink-Sync” model, and of the “synthetic social studies” it can allow, are many, and include the above mentioned robot assisted therapy for autistic children and elderly and health care.

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