Analyzing Patterns of Eye Movements in Social Interactions

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1 Introduction

Eye gaze plays an important role in human communication. One foundational skill in human social interaction is joint attention which is receiving increased interest in particular in the area of human-agent or human-robot interaction. We are focusing here on patterns of gaze interaction that emerge in the process of establishing joint attention. The approach, however, should be applicable to many other aspects of social communication in which eye gaze plays an important role.
Attention has been characterized as an increased awareness [1] and intentionally directed perception [2] and is judged to be crucial for goal-directed behavior. Joint attention can be defined as simultaneously allocating attention to a target as a consequence of attending to each other's attentional states [3]. In other words: Interlocutors have to deliberatively focus on the same target while being mutually aware of sharing their focus of attention [2] [4].

2 Our Contribution

2.1. Study

In a study with 18 pairs of participants (i.e. 36 different participants in total), we recorded eye movements while participants were solving a visual search task based on a verbal description of the experimenter and a communication task where they both had to cooperate on agreeing on a specific target stimulus.

2.2. Automatic labeling of fixation targets

Each pair of participants had to solve 32 tasks, which took about 30 minutes, resulting in 18 hours of mobile eye movement videos. Annotation time was reduced to zero by mapping from fixations to semantic regions automatically based on the EyeSee3D approach [5].

2.3. Analysis of interaction patterns

Our approach for the analysis is to define several indices to describe basic gazing behaviors, such as

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Figure 1: Interaction scenario of our study: Two participants, both eye-tracked, have to solve cooperative tasks. Eye movements were recorded to analyze patterns of eye gaze interaction.

- Searching $\frac{|fixations(other\ stimuli)|}{|fixations(all)|} \rightarrow 1$
- Identifying $\frac{|fixations(target\ stimulus)|}{|fixations(all)|} \rightarrow 1$
- Looking at partner $\frac{|fixations(partner)|}{|fixations(all)|} \rightarrow 1$
- Looking for help $\frac{|fixations(other\ stimuli)|+|fixations(partner)|}{|fixations(all)|} \rightarrow 1$
- Helping $Identifying \gg Looking\ at\ partner$
- Following $Looking\ for\ help \gg Looking\ at\ partner$

This provides an abstraction of the concrete gazing behavior, which will then be used for the analysis of dyadic patterns. We will present the results of this analysis and discuss our approach with existing alternatives.

3 Discussion

We present an approach to characterize and analyze eye movement data in a way that is compatible with an online analysis. The EyeSee3D approach [5] can be applied to studies in the domain of social interactions, to significantly reduce the time required for the analysis of the eye movement data. In combination, the index-based classification and EyeSee3D will allow us to interpret gaze patterns of interacting persons in real-time, which is highly relevant for realizing human-agent interactions.

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