Look There! Be Social and Share

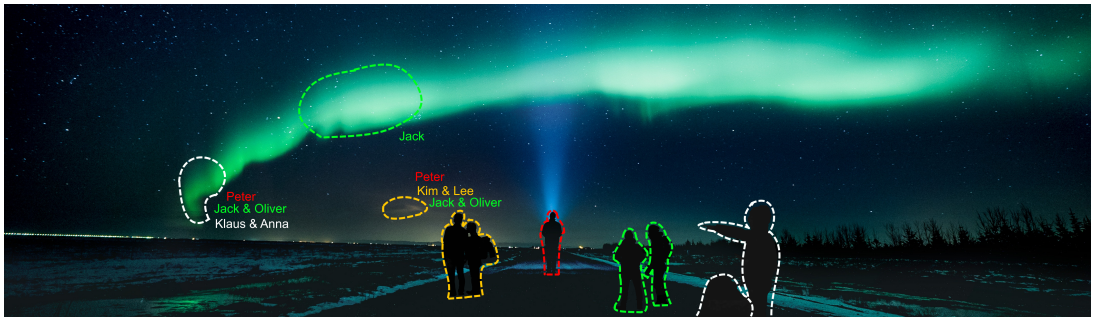

Figure 1: Illustration of a tourist group using eye tracking enabled HMDs during Northern Light Chasing (Red: local tourist guide; Yellow, green and white: tourist sub-groups and there views).

Fabian Göbel, Tiffany C.K. Kwok, David Rudi*
Institute of Cartography and Geoinformation
ETH Zurich
Zurich, Switzerland
goebelf,ckwok,davidrudi@ethz.ch

*All authors contributed equally to this research.

ABSTRACT

This paper discusses the social challenges posed by a future wherein humans are using Head-Mounted Devices (HMDs) in their everyday lives. Factors causing a negative attitude towards HMDs today, such as privacy concerns and hardware limitations, are no longer an issue, due to technological advances and increasing distribution and familiarity within society. Thus, the debate of social acceptance of HMDs has moved towards their impact on human-human interaction. We explore the potential of utilizing gaze as an implicit input to HMDs, in order to enhance social engagement among individuals and groups. In particular, we identified three crucial aspects that can benefit from gaze input in order

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to improve social and shared experiences, namely, automating (sub-) group identification, sharing private information with others and motivating inter-group interaction.

KEYWORDS

Head Mounted Displays, Eye Tracking, Gaze-Based Interaction, Collaboration

INTRODUCTION

The availability of Head-Mounted Displays (HMDs), such as augmented and mixed reality glasses is growing as technology advances [17, 18, 26]. Correspondingly, the use of HMDs in confined spaces, such as at home, in museums or within companies, is becoming increasingly popular (e.g., [12]). However, the "Glasshole debate" from 2014 showed that wearing HMDs in public spaces is not as socially accepted [4]. There are multiple reasons motivating this distrust, with the most obvious being: **(R1)** HMDs are clunky and cover the users' faces and eyes, whereas the latter constitute a very critical aspect in human-human interaction [28]. **(R2)** Privacy concerns exist, considering that most HMDs need to record the environment continuously to provide augmentation. **(R3)** Already today, people get distracted from mobile devices, thus immersive solution such as HMDs may amplify this effect. **(R4)** Not knowing what someone is seeing or doing may cause additional discomfort.

Past technological advances suggest that HMDs will become smaller, more lightweight and powerful, thus reason (R1) will presumably no longer be an issue in the near future. Furthermore, we assume that an increasing familiarity and distribution of HMDs within the society will alleviate the privacy concerns (see R2) as it was the case with mobile phones and social networks. Although we assume that (R3) will still be relevant in the future, we focus on (R4). This vision paper discusses the issues of how individuals with HMDs can share private Augmented Reality (AR) environments with external individuals to support social engagement.

In particular, we suggest utilizing eye tracking in order to support social interaction among HMD users. A very critical aspect in human-human interaction is eye contact [28]. For instance, it can indicate whether a person is being spoken or listened to in a conversation [24]. Furthermore, it has been shown that sharing gaze among users can support collaborative task solving [7].

While the use of gaze to facilitate human-human interaction in Virtual Reality (VR) has been extensively explored [8, 13, 23, 27], AR research has primarily focused on utilizing gaze for interactions with the system [11, 14, 25]. In this work, we explore gaze-based human-human interaction in AR. We motivate our approach with an example describing a group of tourists wearing HMDs while chasing the northern lights.

CHASING NORTHERN LIGHT WITH HMDS

Chasing the northern lights is a popular tourist activity in the northern hemisphere (e.g., in Tromsø [3]). The tour groups are usually composed of socially distinct sub-groups that are guided by a local (see Figure 1). It is either the guide or one of the tourists, who spots the northern lights first. The guide

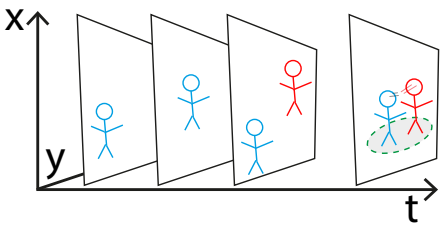

Figure 2: Identifying groups (green circle) dynamically based on space (x,y), time (t) and eye contact.

usually tries to notify all participating tourists about the sighting, while individual tourists tend to communicate primarily with their peers. Both scenarios require effective communication and thus pose similar social challenges. In fact, neither the guide nor the individual tourist can ensure that the other participants (i.e., either all or the peers) are looking in the right direction, or if the others perceived the notification about the lights (e.g., in a scattered group).

By utilizing HMDs with built-in eye trackers, an individual noticing the northern lights (Jack, green) could simply highlight the Area Of Interest (AOI) using a combination of eye gaze and hand gestures. Jack could then share his view with others, either within (green area) or across groups (yellow and white area), just by looking at them. Moreover, an indication on where the individuals are looking (i.e., searching) and who already looked at highlighted areas could be provided. These novel gaze-based interactions supplement the existing means of communication (i.e., voice and gestures). These interactions may even overcome social barriers, as participants could engage in conversations on who noticed a specifically beautiful polar light or allow to introduce gamification (e.g., finding the northern lights first). Additionally, the guide (red) could ensure that the tourists are not mistakenly highlighting or gazing at a cloud (a common mistake when chasing northern lights) and intervene.

CONCEPT

We suggest utilizing gaze-based interaction in order to create a social and shared experience when using AR devices across heterogeneous social groups. The system is intended to: identify (sub-)groups, enable private information sharing and enhance group interactions.

Automated Group Identification

For a system to provide an adequate sharing mechanism, it is necessary to identify socially related groups. Group indicators include complex aspects such as spatial and temporal proximity, and social components like interactions and communication between humans [6]. In fact, group detection is even more challenging as groups may change in size dynamically [19].

As gaze is considered a good indicator for visual attention [16] and can even be used in real-time for interest detection [5], we suggest utilizing gaze as an implicit input to determine social relations. Moreover, social groups could be detected by obtaining cues from gaze patterns (e.g., by detecting eye contact [20, 22]). Voice inputs could be used as an additional explicit indicator for engagement between humans and thus for detecting a dynamically changing group (see Figure 2).

Sharing private information

While wearing HMDs, each individual is able to see and interact with her private space and public real-world elements (e.g., via gaze [1, 21]). However, instead of staying in her “digital bubble”, a user should be able to share information among her peers easily (e.g., sharing an identified and highlighted

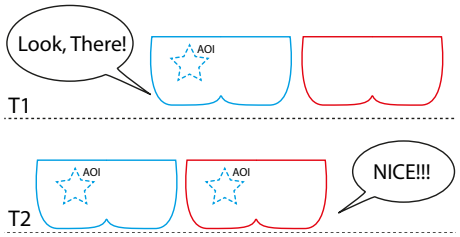

Figure 3: Sharing a private annotation (T1) with peers through gaze and voice command (T2).

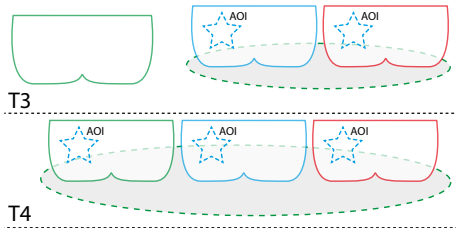

Figure 4: Social interaction between two different sub-groups (T3) can result in widening and merging of the two sub-group (T4)

northern light). Assuming the system has already identified the different sub-groups, a quick voice command such as "Look there!" would allow sharing the private AOIs with the members (see Figure 3). Aside from sharing only the private view, we suggest sharing also current gaze points among members, as this can improve collaboration and clarify communication [2, 7]. Furthermore, sharing scanpaths, which is a history of gaze points, could provide valuable cues for orientation [9].

Motivating inter-group interaction

In socially distinct groups, interactions between sub-groups are difficult. Additionally, traditional HMDs without eye trackers can disrupt the interaction with potential new group members further, as the digital content can draw attention away from social interactions. Utilizing gaze can help to detect conversations among groups and prevent interruptions from the digital world. On the other hand, explicitly looking at people and including them into the shared experience can encourages interactions between different social groups and increase knowledge for the individual sub-groups (see Figure 4). For instance, visualizing who has already looked at an AOI can help the tour guide to act accordingly. Furthermore, an editing function to modify highlights by individuals (e.g., by tour guide) or groups will not only allow to correct mistakes, but also motivate collaboration and strengthen the sense of togetherness.

CHALLENGES AND DISCUSSIONS

Eye tracking is a promising input modality for adaptive interfaces [10] and HMD interaction [25]. In this vision paper, we identify four reasons for discomfort with HMDs and propose to utilize gaze-based interaction in order to address R4 by identifying groups of users, initializing private content sharing, and encouraging social engagement among HMD users. However, gaze-based interactions do have limitations that need to be resolved, such as the *Midas Touch* problem [15] which describes the unintentional triggering of an action with gaze. Therefore, our approach encompasses multiple input techniques (gaze, voice and gestures), and incorporates a natural and explicit way of interaction.

Moreover, this multimodal approach can support collaboration, e.g., by letting a user choose which elements of her private view other can view and/or edit. This raises questions about the implementation of a rights management system, which takes into consideration gaze, proximity and spatio-temporal constraints. Finally, the question arises, how people will use gaze-adapted HMDs in the future and how this would change their social behavior.

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