# Holding Hands for Short-Term Group Navigation in Social Virtual Reality

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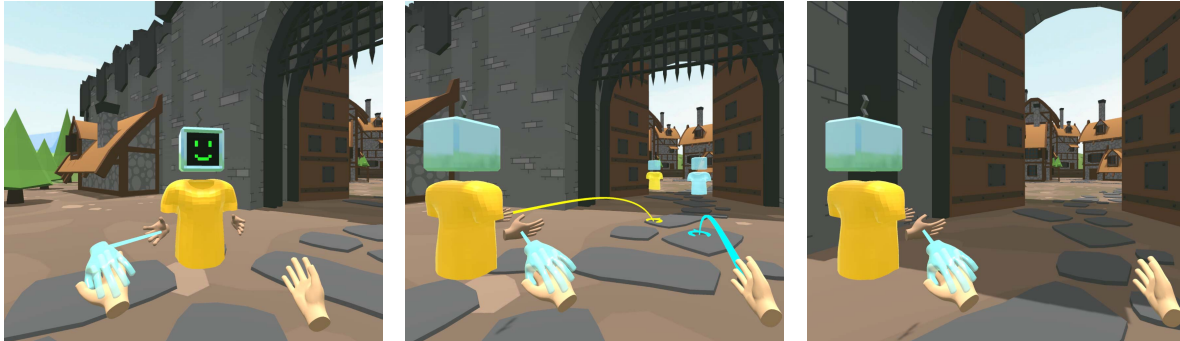Virtual Reality and Visualization Research, Bauhaus-Universität Weimar

Figure 1: We suggest the metaphor of holding onto another user's virtual hand for short-term group navigation. *Left:* Once both users are holding hands, the grouping is visualized by a ghost hand and a connection line. *Center/Right:* For group navigation, preview avatars allow both users to predict their future positions and orientations before actually being teleported there.

## ABSTRACT

Prior research has shown that social interactions in VR benefit from techniques for group navigation that bring multiple users to a common destination together. In this work, we propose the metaphor of holding onto another user's virtual hand for the ad-hoc formation of a navigational group and report on the positive results of an initial usability study in an exploratory two-user scenario.

**Index Terms:** Computing methodologies—Computer graphics—Graphics systems and interfaces—Virtual reality Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Collaborative interaction

## 1 INTRODUCTION

Social VR systems allow multiple users to meet in a shared virtual environment. A central requirement for successful collaboration in larger environments is getting from one location to another together. To this end, prior research proposed techniques for group navigation that consider all participants being on the same virtual movement platform controlled by a single navigator [3]. These techniques can be subdivided into mechanisms to form navigational groups (forming), distribute navigational responsibilities (norming), specify the group's movements (performing), and split up again (adjourning) [2]. While prior research mostly focused on studying techniques for performing, results also indicated that several collaborative activities can benefit from mixtures of individual and group navigation, which requires forming and adjourning to be especially lightweight [2, 3]. The systematic evaluation of the corresponding design space for different use cases is subject of ongoing research.

To contribute to this discussion, we suggest the metaphor of holding onto another user's virtual hand for forming a navigational dyad

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and letting go when arriving at the intended destination for adjourning. This idea is inspired by the corresponding gesture in the real world when close friends or partners want to show each other around. We implemented an initial variant of the hand-holding metaphor and report on the results of an initial usability study with six participants. In particular, our work led to the following contributions:

- the introduction of virtual hand holding for the fast formation and adjournment of navigational dyads in social VR

- the results of an initial usability study indicating particularly positive ratings in the categories *attractiveness*, *perspicuity*, and *stimulation*

Our results underline the importance of lightweight forming and adjourning techniques and motivate a systematic analysis of alternative implementations for different use cases and group compositions.

## 2 GROUP NAVIGATION BY HOLDING HANDS

We implemented the hand-holding metaphor within a distributed virtual environment which users could explore with a head-mounted display. In this system, users are represented by basic avatars consisting of head, body, and hand geometries (see Figure 1) and can communicate verbally using a built-in audio connection. Individual navigation is enabled by a conventional short-distance teleportation technique with a parabolic ray for target specification and a preview avatar as additional pre-travel information.

To team up for short phases of joint navigation, two users have to overlay their virtual hands and each hold down the grip button of the corresponding controller (forming). Letting go of their respective grip button allows both users to quickly adjourn the grouping. To avoid physical exertion during joint navigation, users are not forced to keep their hands in the initial position. Instead, the initiated grouping is constantly visualized by a ghost hand and a connection line leading to the other user (see Figure 1, left). When a user now activates their teleportation ray for performing, a teleportation preview for both users will be shown in a similar way as suggested in prior work [4]. It consists of the two user avatars and an additional secondary parabola for the passenger from their controller towards their target location (see Figure 1, center). The navigator can adjust the position of the preview by pointing with their parabolic

ray and its orientation by tilting the controller sideways. Once confirmed, both users are teleported to match the previewed positions and orientations (see Figure 1, right).

## 3 INITIAL USABILITY STUDY

We believe that the hand-holding metaphor is a fast and intuitive way of forming and adjourning navigational dyads. To investigate the usage and acceptance of our technique, we conducted an initial usability study with one female and five male participants (mean age: 28.8 years, $\sigma = 3.4$ years), who all had prior experiences with the use of head-mounted displays.

### 3.1 Procedure and Measurements

Participants independently came to our sanitized lab, put on the prepared head-mounted display, and joined the remote experimenter inside a virtual medieval town. They were informed about the purpose of the study and gave their consent for participating. Afterwards, the experimenter explained the technique from Section 2 and allowed the participant to try it out before introducing the following recorded task. In particular, participants were asked to bring the experimenter to four distinctive locations in the town indicated by arrows, where one of three collaborative activities had to be performed. These activities included the arrangement of furniture, a picture puzzle, and the placement of objects into a container. We found this mixture of collaborative navigation and manipulation helpful for provoking frequent forming and adjourning to study the suitability of the hand-holding metaphor in this regard. We recorded the total task completion time as well as the duration people spent holding hands. After all four activities, the experimenter asked the participant to fill in three questionnaires on their desktop monitor: the System Usability Scale (SUS) [1], the User Experience Questionnaire (UEQ)[1], and a custom questionnaire on demographics and general comments.

### 3.2 Results and Discussion

The average completion time of the recorded task was 251.6s ($\sigma = 98.5$s), during which participants formed and adjourned a navigational group for 5.16 times on average ($\sigma = 0.37$ times).

The SUS yielded an average score of 78.3 ($\sigma = 16.5$), which corresponds to a percentile rank of 83 in the benchmark dataset of the 446 SUS studies published by Sauro [1]. This means that on average, our system was rated more usable than 83% of the systems in the dataset, which indicates an overall good usability. However, the small sample size and large standard deviation demand more in-depth analyses in future work.

The results of the UEQ are visualized in Figure 2 and show particularly positive scores on the sub-scales *attractiveness* (mean score: 2.06, $\sigma = 0.56$), *perspicuity* (mean score: 2.33, $\sigma = 0.86$), and *stimulation* (mean score: 2.00, $\sigma = 0.22$). This indicates that users had a positive overall impression of our system, found it easy to get familiar with its use, and considered it both exciting and motivating. In our concluding quesionnaire, participants especially appreciated the ability to take another user along easily [P2, P4, P5, P6] and valued the close connection of the hand-holding metaphor to real-world situations [P4, P5, P6]. The remaining sub scales of the UEQ *efficiency* (mean score: 1.29, $\sigma = 1.28$), *dependability* (mean score: 1.29, $\sigma = 0.93$), and *novelty* (mean score: 0.91, $\sigma = 0.77$) had slightly lower scores but were still above average when compared to the benchmark dataset. Despite giving them more awareness about the grouping, participants found holding the button too exhausting [P1, P2, P3, P5, P6] and sometimes let go of it accidentally [P5], which could explain the detriments in terms of *efficiency* and *dependability*. Regarding *novelty*, the observed scores appear reasonable since all participants were aware of similar existing techniques for group navigation in the literature [3].
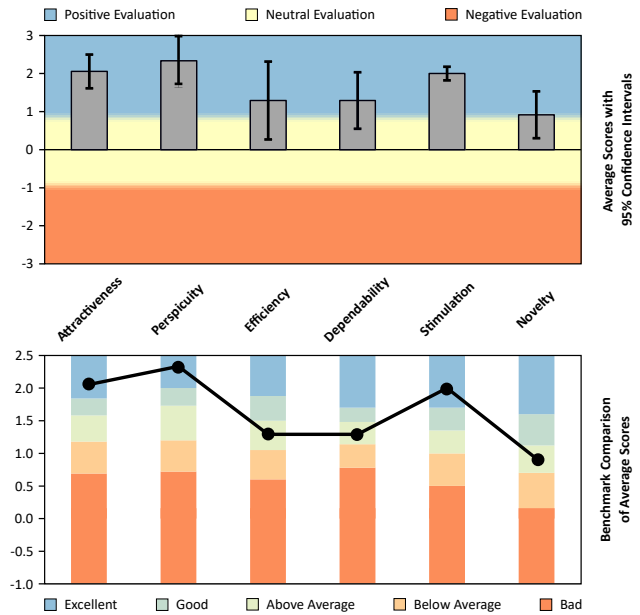
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[1]https://www.ueq-online.org/



Figure 2: Results of the UEQ in terms of means and confidence intervals (top) and their relation to the benchmark dataset (bottom).

## 4 CONCLUSION AND FUTURE WORK

Based on the positive results of our study, we conclude that the hand-holding metaphor is a usable and appreciated method for the ad-hoc formation and adjournment of navigational dyads in social VR. It is a direct and playful metaphor suitable for closer friends, which was rated especially attractive, perspicuous, and stimulating. The main suggestions for improvement revolved around avoiding the constant press of the grip button for maintaining the grouping. This introduces a trade-off between reducing physical exertion and giving constant explicit consent to maintain the grouping further. We believe that the latter is especially important to emphasize a short-term commitment rather than a persistent grouping over a long time. Future work should evaluate different button mappings within this design spectrum.

The hand-holding metaphor might not work similarly well for larger groups than dyads. Therefore, future work should also consider alternative techniques for the lightweight formation and adjournment of larger user groups navigating together. Moreover, the idea of holding virtual hands might feel unpleasant if the participating users are strangers or on different professional hierarchy levels. Therefore, the systematic exploration, comparison, and evaluation of forming and adjourning mechanisms for different social settings and use cases remain an important aspect of future research as well.

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