Joint Dual-Tasking in VR: Outlining the Behavioral Design of Interactive Human Companions Who Walk and Talk with a User

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ABSTRACT

To resemble realistic and lively places, virtual environments are increasingly often enriched by virtual populations consisting of computer-controlled, human-like virtual agents (VAs). These populations are thereby driven by crowd simulations, resulting in believable agent-environment interactions and agent-agent interactions with respect to locomotion behavior. To enable users to explore these enlivened scenes, travel techniques for virtual walking are typically provided. At the same time, limited user-agent interactions often enhance the user experience: VAs, e.g., adapt their trajectories to avoid collisions with the user or they engage in mutual gaze [9] and greet [6] on approaching and passing a user. In contrast, complex user-agent dynamics such as joint locomotion combined with a secondary task, e.g., conversing, are rarely considered yet. These dual-tasking situations, however, are beneficial for various use-cases. For instance, guided tours (e.g., [3]) and social simulations (e.g., [2]) will become more realistic and engaging if a user is able to traverse a scene as a member of a social group. Furthermore, platforms to study crowd and walking behavior (e.g., [1, 10]) will become more powerful and informative. Thus, closing a research gap by simulating the everyday situation of walking and talking together, will enhance the virtual reality (VR) experience while new fields of application will be opened up.

As stated in [7] and [8], a non-trivial interplay of non-verbal and verbal interactions is found when observing humans in dynamic social interactions. While walking itself is a complex endeavor consisting of situation-dependent speed and orientation changes, analyzing the spatial arrangement of all involved humans gives relevant insight into the organization of walking and talking: While the relationship among the humans is represented by the formation (e.g., following behind, guiding ahead, walking side-by-side), the formation adaptions allow smooth changes between mobile and stationary contexts (walking vs. standing) or changes of the addressee (individual vs. complete group). These observations indicate that walking and talking mutually shape each other, while the coordination of a human's actions need to be finely tuned.

To realize VAs who walk and talk with a user, this non-trivial interplay for walking-in-interaction needs to be simulated. Therefore, different areas of interaction dynamics need to be combined: First, suitable **kinematic parameters** for the VAs' navigation behavior are required. To this end, it needs to be validated, whether users walks with a group of VAs in VR the same way as they would walk with humans in reality. Initial findings already confirm this for a 1:1 constellation: a study analyzing a user's walk with a VA who expresses different emotions found the same user reactions in terms of spatial walking arrangements and walking speed [11]. However, more insight in the appearing navigation patterns are required. Next, **group shapes** in mobile and stationary contexts need to be considered [12, 13]. These shapes are highly dynamic. Mobile shapes, for instance, vary depending on the relationships of the group members, whether a coherent or an incoherent group behavior is realized or whether all group members know the goal of the navigation [12]. Stationary shapes are continuously adapted due to various environmental and conversational factors [5]. Furthermore, the talking and listening behavior of the VAs as **virtual conversers** needs to be plausible [4]. This comprises body orientation, gazing, (co-verbal) gestures, and speech. Finally, VAs need to be able to anticipate the user's intent (cp., e.g., [9]) allowing them to react in a human-like manner on a user's actions. The VAs' reactions can thereby be realized verbally or they can be silently embodied [7].

In our presentation, we will first provide an overview of the behavioral components required to design VAs who are able to walk and talk with a user. In a frank discussion with the audience, we then (a) reflect on potential use-cases for such a joint dual-tasking and (b) argue which behavioral components are considered superior to others for a believable and engaging VR experience.

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