2ZF-03

Increasing the Motivation of Walking Exercise: 3D Personalized Avatar in Augmented Reality

Sungjae YOO† Jiro TANAKA†

Graduate School of Information, Production and Systems, Waseda University

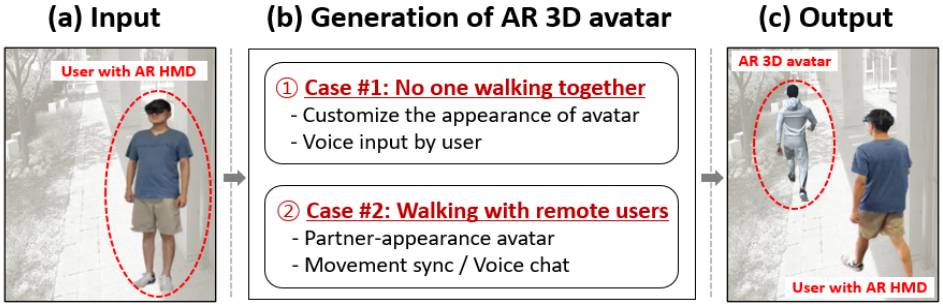


Fig. 1: Approach: (a) Input: Real scene through the AR HMD. (b) Generation of AR 3D avatar depending on the case. Each case has different avatar's appearance and the trigger of avatar's action. (c) Output: User can walking exercise with AR 3D avatar as a virtual partner.

1. Increasing the Motivation of Walking Exercise

Walking is easily accessible and effective exercise so that it can be participated in daily life. However, due to the changes in social structure, e.g., increasing the single-person households and hectic lifestyle, we found the problem in which people often decrease the motivation when they walk alone. According to the research in physical exercise, lack of the motivation can be overcome by exploiting its social aspect which cooperation and competition with partner or group [1].

2. 3D Personalized Avatar in Augmented Reality

We designed a 3D personalized avatar as a virtual walking partner. The 3D avatar is implemented in the form of a full-body human in Augmented Reality (AR). Proposed a 3D avatar can be provided the sense of presence as a virtual partner to the user. AR technology is applied for realistic interaction with a 3D avatar. Few studies have investigated regarding the motivation of walking exercise directly using an avatar. Unlike the study of physical robots and virtual pet [2], we proposed full-body 3D avatar in AR for immersive walking exercise together experience to the user in this study.

3. Use Cases

System has two use cases; *(1)Case #1*: User does not have a real walking partner in the same location, *(2)Case #2*: User has a partner who can walk together at the same time, but partner is in long-distance remote location. Both cases have corresponding AR 3D avatar which is different the appearance and the trigger of avatar's movement. (see **Fig. 1**)

3.1 Case #1. Walking with AR 3D Avatar

User can customize the appearance of avatar. User-friendly avatar can be provided better user experience [3]. And then, user can interact with AR 3D avatar while walking together. Case #1 is divided into three types of walking interactions: *(1)Normal*: In any course, user can walking exercise with an AR 3D avatar, *(2)Pacemaker*: In routine course, user can comparative walking with user's previous record, *(3)Competition*: In certain distance, user can compete with AR 3D avatar with simple rule e.g. firstcomer wins the competition. (see **Fig. 2**)

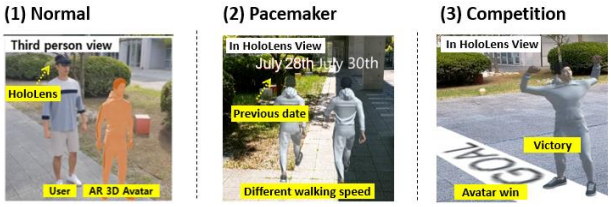


Fig. 2: Three types of walking interaction

3.2 Case #2. Walking with Remote User

We proposed the novel interaction which is walking together experience between local and remote user. To provide the sense of mutual presence between two users, we proposed the novel method of movement synchronization and voice chat in real-time. It is provided using partner-appearance 3D avatar. **Fig. 3** shows the concept of the novel interaction between two users. The movement of the 3D avatar is synchronized by remote user's location data using camera position of Head Mounted Display (HMD) without extra sensors, e.g., motion capture, etc.

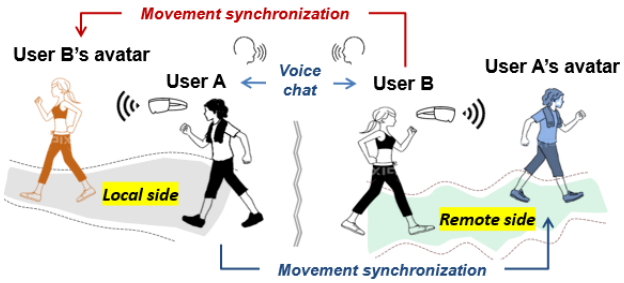


Fig. 3: Concept of walking exercise with remote user

Our system recognizes the change of coordinate value of HoloLens 2's camera as a change in the user's position. And it changes the action of the avatar according to the user's position change. It is necessary to initialize the current position to the previous position every time. Thus, in the code level, we implemented an algorithm for determining of user's movement. It is determined by the value of the current position is greater than the previous position. Specifically, C# code is executed to initialize the current position with the previous position in every frame. As a further consideration, the AR 3D avatar walk along the course of their own location's course regardless of the different course on both sides. In addition, the issues that different status or level of walk depending on user's gender and age, are resolved by changing the walking speed of avatar.

4. System Overview

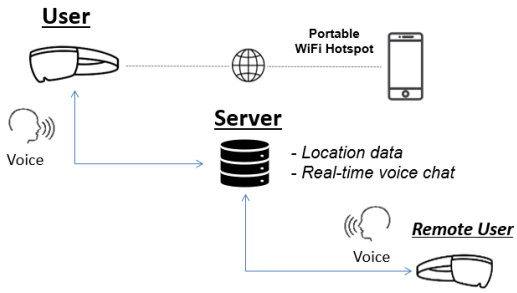


Fig. 5: System components overview

We implemented our system using HoloLens 2 (see **Fig. 5**). User can place an avatar with AR in physical space calculated by Spatial awareness feature of HoloLens 2. In case #2, server is used for real-time movement synchronization and voice chat. We developed AR system using 3D personalized avatar to provide immersive interaction with virtual walking partner. Our system implementation has three points: *(1)*Authoring of realistic 3D personalized avatar for the sense of presence of a virtual walking partner, *(2)*Movement Synchronization for the mutual presence between two users, and *(3)*Implementation of realistic interactions in walking scene. **Fig. 6** shows system implementation scene. User can see AR 3D avatar in front of vision when system is initialized. In case #2, user can walking together with remote user using AR 3D avatar which synchronized by remote user's movement.

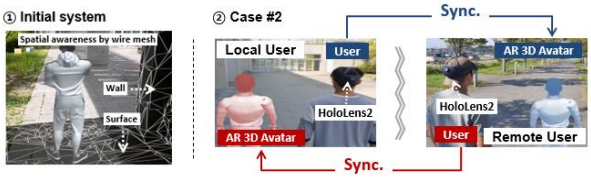
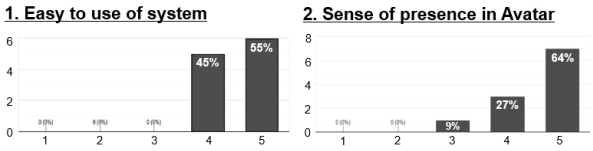


Fig. 6 System implementation

5. Preliminary Evaluation

We conducted preliminary evaluation to investigate effects and participants' perception and behavior. We recruited 8 participants. Participants were given a brief introduction of the study and conducted user study by two cases. We analyzed following two points of our system: *(1)Easy to use of system*, *(2)Sense of presence of AR avatar*. **Fig. 6** shows the questionnaire response, we found most of the participants response positively.



Rating: 1 (negative) ~ 5 (positive)

Fig. 6: The result of questionnaire response

6. Conclusion

In this paper, we presented an AR system for increasing user's motivation of walking exercise using 3D personalized avatar as a virtual walking partner. We proposed a novel interactions that user enables realistic walking experience with a virtual partner. In case #2, we proposed a novel method of movement synchronization using the HMD alone without extra sensors. In the future, we plan to evaluate comparing the duration and distance of walking exercise with or without system for quantitative analysis.

References

[1] Baldi, T. Paolocci, G., Barcelli, D. and Prattichizzo, D. (2020). Wearable Haptics for Remote Social Walking, IEEE Transactions on Haptics 13(4). 761-777.
[2] Norouzi, N. Kim, K. Lee, M., Schubert, R., Erickson, A., Bailenson, J., Bruder, G. and Welch, G. (2019). Walking Your Virtual Dog: Analysis of Awareness and Proxemics with Simulated Support Animals in Augmented Reality, IEEE ISMAR19. 157-168.
[3] Freeman, G., Zamanifard, S., Maloney, D. and Adkins, A. (2020). My body, my avatar: How people perceive their avatars in social virtual reality. Extended Abstracts of CHI2020. 1-8.