Virtual home for college couple in long-distance romantic relationships

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Abstract. College students form a significant portion of all couples that are engaging in long-distance romantic relationships. The physical separation has made maintaining Long-Distance Romantic Relationships especially difficult for college couples. In order to provide design solutions to help college couples in Long-Distance Romantic Relationships better overcome challenges in their relationships, this paper concludes through surveys that the most pressing issue facing Long-Distance Romantic Relationships is feeling and understanding their significant other's emotions. Based on the unique offerings of Virtual Reality (VR) technologies and the limitations of existing social VR technologies, the author proposes the design solution of a virtual HOME that emphasizes co-presence, empathy promotion, and collaborative activities.

Keywords: Virtual Reality, Long-Distance Romantic Relationships, Collaborative Virtual Environments, Co-Presence, College Couples.

1. Introduction

Long-distance romantic relationships (LDRRs) are generally defined as relationships between couples who are unable to see each other frequently in person because they are geographically far apart from each other. For couples in LDRRs, the time they spend next to each other physically is very small compared to the time they are on their own. There are generally two types of LDRRs: the first being couples who meet online and the second being couples who are separated by certain circumstances. This paper focuses mainly on the second type of LDRRs. Among all couples in LDRRs, college students are a major group. Many young couples are physically separated from their partners because of college and as a result of that, college students make up 32.4% of all LDRRs[1]. Moreover, LDRRs are prevalent among college students as study has shown that 34.2% of all college couples are in LDRRs [2].

The lack of face-to-face interaction as a result of physical separation makes maintaining LDRRs challenging because long-distance relationships (LDRs) may increase relational uncertainty. More specifically, as couples are physically far apart from each other, they generally have very limited information about what their partners have done, and it is difficult to verify whether what their partners have told them is true. This gives rise to partner uncertainty, which in turn can cause couples to feel insecure about their relationships. This further raises the uncertainty of relationship as couples start doubting the future of the relationship itself. As uncertainty accumulates, the ambiguity about the partner and the relationship may cause a LDRR to come to a stop. This is only one of the many scenarios in which distance raises more concerns for couples in LDRRs. Many other factors, such as the lack of

physical intimacy, delayed responses, and the inability to provide much-needed help and companionship in a timely manner, may all contribute to a shaky LDR.

Managing a LDRR is even more difficult among college students. First, communication is essential for couples in LDRRs as they are unable to meet face-to-face, which means that they may have to take more effort to maintain communications of the same quality as couples who can meet face-to-face frequently. However, college work may require a considerable amount of commitment from students, making it difficult for college students in LDRRs to balance their academic life and their relationships. Second, college couples may yet have the financial capability to travel long distances to visit their partners, which further reduces the frequency of meeting each other in person. Third, college is a place where students will meet lots of new people. Possible temptations from other students can trigger the increase of relational uncertainty. Fourth, as it takes several years to complete a college degree, the future of the relationships among college couples in LDRRs is largely ambiguous.

The extremely challenging environment faced by the current LDRs results in approximately 50% of LDRRs failing [3]. Although college couples nowadays can leverage convenient and efficient communication technologies, existing common communication technologies are often insufficient to help couples significantly maintain their LDRRs. Current common communication technologies are limited in the information they can provide and in the level of interactivity they enable. Second, they are not designed specifically to address the problems faced by couples in LDRRs.

The goal of this paper is to provide design solutions through the use of virtual reality (VR) technology to address the most significant problem faced by college couples in their LDRRs.

2. Questionnaire

In order to understand the problems that college couples in LDRRs are most concerned with, the survey questions were designed mainly in three dimensions.

- Revolving around things that are prevented from happening at a long distance, for example: what is the one thing you would most like to do with your significant other but could not because of geographic limitations?
- The most significant relational problem(s) faced by college couples in LDRRs, e.g. What is the problem that bothers you the most in a long-distance romantic relationship?
- Factors critical to maintaining a LDRR, e.g. What are the problems that arise during a long-distance relationship that would make you consider ending the relationship?.

A total of sixty useful responses were collected and analyzed. Twenty-four out of sixty (40%) responses stated communication as a significant problem in their LDRRs, while twenty-seven out of sixty (45%) responses stated the lack of co-presence as a big concern. Further breaking each problem down into subcategories, under the problem of communication, fifteen out of twenty-four responses (62.5%) mentioned that a LDRR has made conveying and understanding precisely each other's feelings very difficult, while the remaining nine (37.5%) responses mentioned that resolving quarrels in a timely manner is especially challenging. Under the problem of a lack of co-presence, twenty out of twenty-seven (74.1%) responses stated the inability to meet face-to-face, and the remaining seven (25.9%) responses stated the absence of physical engagement.

According to the results and analysis, the problem of difficulty in accurately conveying and understanding each other's feelings is the biggest concern of LDRRs. It is the root cause of communication problems, and helping couples in LDRR to better understand each other's emotions may help them resolve conflicts.

3. Design process

3.1. Virtual reality (VR)

Features unique to VR technology provide opportunities for enabling co-presence and enhancing understanding between college couples in LDRRs. VR offers a real-time, high fidelity three-dimensional (3D) virtual space with 360 degree content[4]. This will allow users to see their partners in 3D rather

than the two-dimensional person in video calls. Moreover, VR technology uses sensors and cameras to track users' bodily movements and reflect them on users' avatars in real time. For example, head-mounted displays (HMD) can track head movement in six degrees of freedom (6DoF) and haptic devices can track arms and finger movements[5]. This means that a highly realistic reconstruction of users' actual movements will be made in the digital environment, which will offer more room for interactivity between two users and between users and objects. In addition, various haptic devices will simulate the sense of touch, which recreates the physical engagement that is missing between college couples in LDRRs to a certain degree.

These technical features of VR offer users a highly immersive experience that cannot be acquired by other technologies. VR allows college couples in LDRRs to experience face-to-face interactions in multi-sensations that are similar to those in the physical world, especially in sensing physical contact with other users. Moreover, VR provides ample opportunities for collaborative virtual environments (CVEs) in which users will engage in a wide variety of activities–inclusive of things that are impossible in the physical world–together with their partners [6].

*3.2. Limitations of existing social VR platforms*

Many couples in LDRRs today have already had experiences using existing social VR applications such as AltspaceVR, Rec Room, and VRChat. Though these platforms offer a new way for social interaction, they are generally inadequate in crucial experiential qualities. More importantly, they are not designed specifically to address the problem of difficulties in feeling and understanding their significant half's emotions, so they lack features that can facilitate conflict resolution and improve the significant half's mood.

Existing social VR platforms generally fail to offer an authentic sense of co-presence. Avatars of users can be customized, but they do not display the physical appearances of the users. As co-presence emphasizes people engaging in face-to-face interactions, not being able to see and interact with realistic representations of users' partners will not make up for the lack of co-presence that is absent in their physical lives. Moreover, users' facial expressions are not reflected completely. This further increases the difficulty of understanding users' partners' emotions, as facial expressions carry many clues about one's feelings. The sense of touch is also largely absent, preventing users from having the physical engagement that they crave.

Another major limitation of existing social VR platforms is that they lack features that can enhance users' understanding of their partners' emotions. They are unable to inform or provide hints about users' emotions, and therefore they will not be able to address the problem that college students engaging in LDRRs face difficulties in feeling and understanding their significant halves' emotions.

4. Design solutions

The current limitations of existing social VR platforms are largely a result of technological constraints. More advanced technologies, both in development and in conception stage, are needed to effectively address the difficulties in feeling and understanding partners' emotions. Therefore, the concept of virtual homes for college couples in LDRRs proposed in this study is based on a futuristic perspective. The core elements of the design solution are shown in Figure 1.
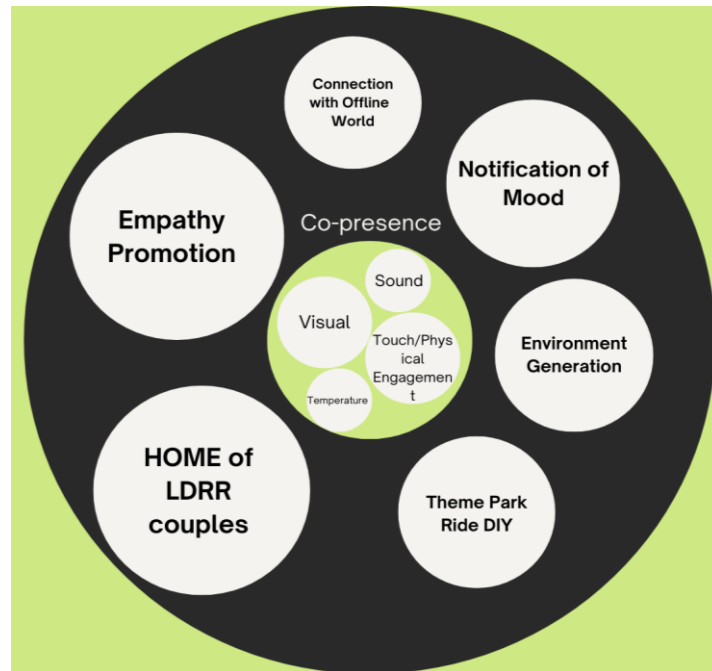
Figure 1. Core elements of the virtual HOME

4.1. Core functions

4.1.1. Co-presence. Co-presence is at the center of the design as it is the foundation that determines how immersive and engaging is the virtual interaction and therefore whether college couples in LDRRs will want to use the Virtual Home. As co-presence in virtual reality is a sense of being in the same place as another virtual being and having mutual awareness and attention from others, multi-sensations feedback will be used to recreate face-to-face interaction for college couples in LDRRs in a virtual way that is very similar to that in the physical world.

Multi-sensations are achieved through four dimensions–visual, touch, sound, and temperature. As humans rely heavily on visual to process information, the design should emphasize the most on what users see to enhance co-presence as much as possible [7]. The avatar of the user will appear in full body, which is an exact reconstruction of the user's body in the physical world. The cross-game avatar platform Ready Player Me may be used to generate 3D avatars from users' photos. The face of the user's avatar should reflect exactly the facial expressions of the user in the physical world in real time. Furthermore, gestures of the user's avatar should reflect exactly the gestures made by the user, in the physical world, including head orientation, body pose, arms movement, etc. Additionally, users will be allowed to customize their avatars, as well as hair style and hair color, makeup, outfit, accessories, and height and weight of the avatar.

To enhance the experience of physical engagement, the sense of touch will be augmented through a full-body haptic suit covering every part of the user's body from shoulders to calves. The haptic suite simulates touch made by users' partners with different forces and areas as well as skin textures. This recreates physical engagement such as holding hands and hugging to a certain extent, enabling more intimate behaviors between LDRRs couples. Moreover, the full-body haptic suit also simulates the body temperature of the users' partners, further augmenting co-presence. In terms of sound, spatial audio will be used, and the original voice of the users' partners will be heard.

4.1.2. Empathy promotion. Empathy is the ability to feel and understand the emotions another person is experiencing. Promoting the empathy of the users helps them better find out and understand their partners' emotional changes in a more efficient way. This aims to tackle the problem of difficulties in

understanding a partner's emotions. There are three features to promote empathy, biometric information analysis and visualizations, visual representations of the partner's mood, and haptic representations.

- Biometric information analysis and visualizations

Heart rate and stress level in the scale of relax, calm, anxious, and stressed will be displayed in real time with the use of sensor fusion[6]. Artificial Intelligence (AI) will be employed to analyze the user's biometric information and categorize the emotion(s) the user is experiencing. By analyzing the user's past behaviors, AI suggests possible reasons or triggers of emotional change. These results will be displayed for the user's significant half.

AI will also be used to generate a multi-sensational experience of the user's partner's emotions. Based on the analysis of the biometric information, AI generates one or more possible scenarios allowing the user and partner to progress through the experience from a first-person perspective. These scenarios can be used to demostrate possible events that would cause emotional changes in the user's partner. In additonal, it can also make the user feel the emotion(s) similar to those felt by their partner. This will allow the user to stand on the point of view of their partner and therefore better understand what their partner has experienced. Moreover, the AI character can imitate the interaction between the user and the partner, and perform further operations and responses based on the user's or partner's response. During the process, the user can listen to the user's partner's heartbeat.

- Visual representations of the partner's mood

Weather outside the user's HOME will be used as the indication of the partner's mood. For example, a sunny day represents the blithe emotion and the happier the user's partner, the fewer the clouds and the brighter the sun. A cloudy day may represent a normal mood, a rainy day for depression, and strong winds for anger. Users can set the weather to represent different emotions. A bulb in the user's HOME will also represent the user's partner's emotions. For instance, a dim and flashing bulb represents sadness and a bright warm bulb represents happiness. Users can set the colors and status of the bulb to represent different emotions.

- Haptic representations

Temperature of the user's haptic suit changes according to the emotions of the user's partner. A low temperature of the haptic suit that makes the user feel cold could represent despair and a warm temperature that makes the user feel warm could represent delight.

4.1.3. Notification of mood. To facilitate college couples in LDRRs to resolve their relational conflicts timely, it is necessary to notify them of their partners' emotional changes especially when they are offline. They will receive notifications on their phones or watches when there are emotional changes within their partners and when their partners invite them to HOME. The notifications will display information about the emotions detected and the color and status of the light bulb mentioned earlier.

4.1.4. Connection with the offline World. To ensure a seamless VR experience, users will be able to connect to the physical world when they are immersed in the virtual world. Users will be able to access the internet just like how they do in the physical world and the purchases they make online such as food deliveries and clothes while they are in the VR environment will be delivered to their addresses in the physical world. This eliminates the need to log out from the digital world when users want to buy something for their partners.

4.2. Core activities

4.2.1. HOME . HOME is the place couples will be at when they enter the virtual world. It is a free to explore and construct space that aims for couples to do daily activities and spend time together privately.
In HOME, users can customize their houses, they can choose to build from scratch, or choose from a large pool of different houses cases, or have AI generate home for them by entering keywords, or change

any part of the home is about the existing houses from either the pool or AI generation. But the HOME building will only be enabled when both couples are in the virtual world.

Users can send invitations to their partners to invite them to enter HOME. In addition, users will be able to watch the same videos together, enjoying the real-time synchronization of videos. Any actions applied to the video by the user will simultaneously reflect on their partner's videos at the same time. Users can access various video platforms and upload their own media, and also adjust the size of the interface displaying the media.

4.2.2. Environment generation. Environment outside the user's HOME can be changed at any time to enrich users' immersive experience in VR. Environment can be generated by AI by typing in keywords and users can choose and switch art styles at any time. Moreover, users are free to combine different environments to customize the environment they desire. They will be able to enter the environment by exiting their HOME and they will be able to interact with the environment. The environment feature will be activated when one user enters the HOME.

4.2.3. Theme park ride. Theme Park Ride offers users fun activities and entertaining experiences that can only be craved in the physical world in the past. This aims to enrich the collaborative activities that can be enjoyed by the college couples in LDRRs and to provide additional ways to improve users' partners' mood.

Rides can be generated by AI by typing in keywords or by customizing the rides by building rides from scratch or editing and combining existing designs of rides. Theme Park Ride feature is activated when one user enters the HOME.

4.3. Hardware

Hardware is fundamental to the operation and the quality of the experience of HOME. The following VR technologies will be needed to support and maintain a smooth and immersive experience in HOME for the users, including VR headset, haptic gloves, haptic suits, omnidirectional treadmill, and high-tech haptic chair.

VR headset allows users to see and feel immersed in the virtual environment by beaming low-power lasers directly onto the user's retinas[7]. The following points provide some key features that are anticipated from more advanced VR headset.

- High quality images reproduced on users' retinas.
- Built-in headphones that enable sound from the virtual home to be heard by users.
- Built-in microphones that enable verbal messages to be transmitted between users.
- Built-in outwards facing cameras that track the user's facial expressions and body movements and have them reflected on the user's avatar.
- Built-in electroencephalography (EEG) that tracks users' brain activity to collect information for emotion analysis.

Haptic gloves transmits the user's hand movement and actions to the avatar and transmits the in-HOME experiences of the avatar to the user.

- Simulate the experience and feeling of touching for users when the avatar's hands are having contact with virtual items in the virtual world.
- User's hand and finger movement will be transmitted to the avatar so that the avatar performs the actions the user desires.

Haptic suits provide haptic feedback to all body parts under the user's neck.

- Provides lag-free feedback to the user.
- User's body movements will be tracked and reflected on the avatar.

An omnidirectional treadmill allows the user to move in any direction while wearing the VR headset, allowing the simulation of real walking and running for users in the virtual world[8].

A high-tech haptic chair that is suspended by two jointed robotic arms and that can rotate the chair on all four axes.

- The chair can rotate in any direction, enabling the user to experience rotations when the avatar rotates in situations such as riding the roller coaster in the Theme Park Ride.
- The chair can vibrate, simulating what the avatar is experiencing even further.

5. Conclusion

This paper identified and defined the problem statement that college students engaging in LDRRs face difficulties in feeling and understanding their significant half's emotions, and the result is that conflicts are not resolved timely and their significant half's mood is not improved timely. It then detailed the design process to address the problem identified by looking at the unique affordances of VR technology, limitations of existing social VR platforms, and providing the design solution–HOME–which emphasizes mainly creating co-presence, promoting empathy, and offering collaborative activities for college couples in LDRRs.

This paper is lacking in information about prototypes and tests of the design solutions provided. The effectiveness of the design solutions is not evaluated at this stage. Features of HOME described are overall very general and their feasibility is not tested as well.

For future work, I plan to look into the development of each feature of HOME. Prototypes will be made after confirming the use of specific technologies like the type of sensors that can fulfill the feature requirements. A preliminary case study will be conducted by having a group of users trying the HOME and having their feedback analyzed. New design and development directions will be based on the analysis of the results of the case study.

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