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Authors

Liu, Peiyao

Xie, Chenxing

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Designing Between Virtuality and Reality: Improving Inclusiveness in Hybrid Spaces

Experience Report

Peiyao Liu

North Carolina State University, Raleigh, NC, United States, pliu23@ncsu.edu

Chenxing Xie

North Carolina State University, Raleigh, NC, United States, cxie4@ncsu.edu

This experience report designs and introduces an application, PlantNet, which is based on hybrid spaces and combines Augmented reality (AR) to help enhance the inclusiveness of mobile application design and reduce social inequality. PlantNet is a hiking-focused application incorporating virtual plant cultivation and collection aimed at non-disabled users and users with physical disabilities. This report first introduces the theoretical basis of this application, and then introduces its main functions and gameplay. Finally, this report discusses the possibilities of hybrid spaces and AR to enhance the inclusiveness and experience of applications. The report concludes by describing the limitations of the current design and making recommendations to provide a foundation for future design.

CCS CONCEPTS • Human-centered computing • Empirical studies in accessibility

Keywords: User Experience Design, Hybrid Space, Accessibility, Augmented reality, Design, Locative media

1 INTRODUCTION

Hiking has become one of the most popular sports in many countries, and many enthusiasts use this physical activity as a significant way to return to nature [4]. Research has shown that hiking is one of the most important activities to create an emotional connection with the environment [12], which means exploring the surrounding nature and seeing wild plants is also an integral part of the hike. However, although increasing recreational leisure activities is equally effective in increasing social inclusion and improving the health of people with disabilities, participation in recreational leisure activities remains very low and mostly consists of passive indoor activities (e.g., reading or watching television) rather than outdoor activities [20]. Although exploring the wilderness is difficult for some users, improving a small range of outdoor activities and indoor activities can still be helpful for people with disabilities. To reach these goals, we designed a hiking app for wilderness exploration based on actual geographic locations of plants, PlantNet.

Hybrid spaces are proposed as the main theoretical basis to help improve the user experience during interaction with nature and plants. Hybrid space was introduced in 2006, and the concept was defined as a new hybrid space created when virtual communities were migrated into physical space due to mobile technology [6, pp. 59]. In other words, mobile technology acts as an intermediary blurring the traditional boundaries between virtual and digital spaces. As Saker and Evans [29] point out, location-based apps have the potential to combine digital and physical spaces to create new kinds of experiences and social connections. Hybrid space is not just an overlap or combination of physical and digital space, and "hybrid spaces were created by the ongoing and emerging networked relationships between people, spaces, and mobile

technologies [7]". In our practice, we recognize the potential of hybrid spaces to create more inclusive and diverse spaces that mitigate social inequalities and support human communication and interaction. The possibility of using hybrid spaces to increase inclusiveness and to help users with disabilities explore the outdoors from hybrid spaces and join the online community was explored in this study.

In addition, our research takes a critical perspective on user experience (UX), combining hybrid spaces with accessible user experiences (AUX) to provide a more enjoyable, enriching, and equalizing digital experience for people with disabilities. AUX focuses on integrating accessibility into user experience design and practice to provide a more inclusive, high-quality digital experience for users with and without disabilities [14]. As with many forms of applications, people with disabilities are excluded from hiking and field exploration applications, in large part because of the numerous barriers they face in participating in outdoor recreational activities. For example, although programs such as the adaptive hiking program exist to help people with physical disabilities participate in outdoor activities in the natural environment, these activities are more dependent on volunteers and staff for people with disabilities to participate in these activities [18]. Despite these geolocation-based apps having many advantages, many need to consider the problem of uneven mobility [9]. Based on this unsolved problem, we designed PlantNet to improve this situation.

2 LITERATURE REVIEW

2.1 Accessible user experience design

Accessible technology is defined by Lazar et al. [21] as "technology that can be utilized effectively by people with disabilities, at the time that they want to utilize the technology, without any modifications or accommodations." As for web technology, web accessibility refers to the web that enables "people with disabilities can use them. More specifically, people can perceive, understand, navigate, and interact with the Web" [16]. The six factors that influence accessibility include: auditory, cognitive, neurological, physical, speech, and visual [16]. Meanwhile, web accessibility also "benefits people without disabilities" [16]. Therefore, designing an inclusive application is not only a way to improve the inclusiveness for people with disabilities, but also to improve the user experience for people without disabilities.

Many UX researchers have conducted research on the impact of user experience through improved user interface (UI) in many different fields, such as video games [19], virtual reality (VR) [30], and augmented reality (AR) [17]. Although many dimensions of UX have been explored by technical communication scholars, such as emotion [28], technology [34], and adaptability [33], limited research focused on the UX principles for people with disability [14].

Therefore, Graham and Chandrashekar [14] proposed a framework that can be used to evaluate the accessible user experience (AUX). Their framework evaluates the AUX from five dimensions: comfort, likability, autonomy, agency, and pleasure [14]. Sloan [10] defines accessible user experience (AUX) as "combining accessibility standards and usability processes with real people ensures that web design is technically and functionally usable by people with disabilities." In the field of AR, some tools have been developed to improve accessibility for people with disability. For instance, Coughlan and Miele [3] developed AR4VI, an AR tool that can assist people with visual impairments. Although AR has been considered to help improve product accessibility and inclusiveness, there is still a lack of exploration in practice, and this paper proposes to use AR in new areas to help improve the experience of people with disabilities to fill the gap in this field.

2.2 Explore the hybrid space

The hybrid space is defined as "mobile spaces, created by the constant movement of users who carry portable devices continuously connected to the Internet and to other users [6, pp. 262]." This means that users experience both physical and

digital space by connecting themselves to the Internet and interacting with geographic locations, which also offers the possibility of creating new forms of mobility. Applying AR in a hybrid space and exploring how this combination can improve the user experience became the focus of this project. One of the unique aspects of AR applications is that they combine virtuality and reality to provide new spaces for users to explore. Hybrid spaces allow us to redefine our view of the existing living space and support human communication and interaction [6]. This also means that location awareness based on the user's real geolocation is a way further connect people with physical spaces, rather than disconnect from them. This mixed feeling produced by both reality and virtual reality also creates a sense that the user is playing a game in the real world rather than a virtual experience [25], which is considered a primary key to helping improve the user experience of this project.

Hybrid space, which includes both physical and digital elements, has the potential to assist individuals with disabilities in connecting and interacting with their surroundings. The places created by digital applicants are perceived as "continually enacted, negotiated, and renegotiated across multiple levels of media engagement" [32, pp. 579]. Hybrid space can improve the accessibility and user experience of people with and without disabilities from the dimensions of extended physical space and social interaction [8]. On the one hand, hybrid spaces provided by AR applicants can help people with physical disabilities explore the spaces that were hard for them to explore before. On the other hand, hybrid spaces can foster social interaction by facilitating connections between individuals with disabilities and their peers. Virtual components, like online forums and social networks, can bridge the physical gaps and provide opportunities for people with disabilities to engage in discussions, share experiences, and form supportive communities. In her research on Pokémon Go, de Souza e Silva [8] explained how this augmented reality technology can influence the social interaction between users. Meanwhile, the social, cultural, and political factors in the real world also influence the development of hybrid space created by digital applications. By comparing COVID-19 apps in Singapore and Australia, Goggin [13] discovered that the different sociocultural environments in these two countries influenced the design of health-tracking apps.

2.3 Bring Augmented Reality into the game

Games are a complex form of entertainment, and the development of games in a hybrid space that connects the physical and digital becomes even more complex. AR refers to "an enhanced version of the real physical world that is achieved through the use of digital visual elements, sound, or other sensory stimuli and delivered via technology" [2]. In other words, AR "involves overlaying visual, auditory, or other sensory information onto the real world to enhance one's experience" [2]. Because of the unique UX created by AR technology, AR has been applied in various fields, such as design and manufacturing [24], branding [27], and games [8]. And previous location-based AR games, for example, Pokémon Go, have also been widely successful in the market and have brought this genre into the mainstream. AR-based games help users navigate using mobile apps while walking in reality, which turns the user's everyday environment into a part of the game [1]. More precisely, AR transforms the surrounding environment into a game space, and this can also help users with a limited range of activities to have a new play experience in their daily life space.

Considering that AR can help build a whole new environment over existing ones, it can be helpful for people with physical disabilities to improve the experience of accessing location-based applications. People with physical limitations are challenged in terms of fine motor control, strength, and range of motion, which ultimately reduces their participation in outdoor and leisure activities [22]. AR technology further helps to lower the threshold of activities and increase the fun of activities for disabilities. And this benefit is not only for people with physical disabilities, but AR can also provide support for people who are unable to access virtual services and experiences due to geographic distance [5]. Therefore, our

research proposes a new exploration to utilize AR on a hybrid space framework to help enhance the user experience for people with and without disabilities.

3 PROGRAM DESIGN

PlantNet is not about developing an entirely new project from scratch but more about developing it further based on existing theories and apps. Mobile networks create a connection between people and networks. This study speculates whether it is possible to develop an app at the intersection of humans, networks, and nature, which will help users explore the connection between mobility, physical space, and virtual space. Brian House [15] did an interesting experiment where he used an app to record his longitude and latitude coordinates once every few minutes, which he eventually converted to music. Bringing this design into nature, each plant in the wild has its own unique coordinates, and the trails are the pathways that link these nodes. Plants and trails become the most important nodes and networks in the wilderness, and bringing humans into the plant network is the original intention of the design.

3.1 Main features of PlantNet

PlantNet is a map-based location-aware app to help users explore wild plants and go on hikes. This app has four main features: hiking trails, plant information, AR, and community. As the basis of this application, the original purpose of this program is to help increase users' enthusiasm and gameplay for plant exploration and hiking. For this purpose, the main function of this application is to create hiking routes and follow existing ones. First, users can create their own hiking routes based on the specific locations of plants through the route creation function, and they can create routes in two main ways: real-time location tracking and drawing routes on a map (Figure. 1). A survey on the purpose of hiking showed that

Figure. 1: Drawing the route and following it hiking

47% of people hike to enjoy nature, with most of them saying their preferred destination for hiking is a variety of natural locations, and only 16% said they would hike in urban areas [26]. This study proves that the exploration and discovery of nature is one of the main purposes of people hiking, so searching and discovering plants within nature is a way to increase people's participation and enthusiasm for hiking.

In addition, in order to enhance the fun of hiking and provide more ways for hikers to play, we created a collection book for users to photograph and record the plants that appear along the way during the hike (Figure. 2). The presence of collection systems in games is quite widespread, with people expanding their personal collections by finding specific items in the game. A typical example is that people discover and collect Pokémon in Pokémon Go by walking up the street and going through the map and camera. This gameplay helps to improve the user's game experience and enhance game

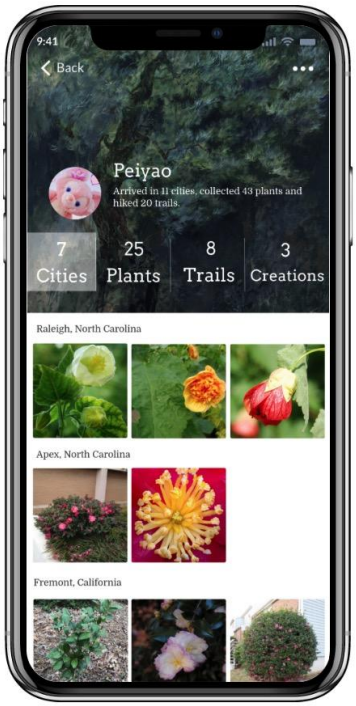

Figure. 2: Discovering plants during the hike and adding them to the collection book

participation. Additionally, when the user collects a plant, PlantNet provides a wealth of information about the plant (Figure. 3). This application provides comprehensive information on plants for plant enthusiasts, including descriptions, growing problems, and growing conditions, and this app also provides many plant pictures, and users can upload their photographs of plants taken in the field in the comments section to share with others.

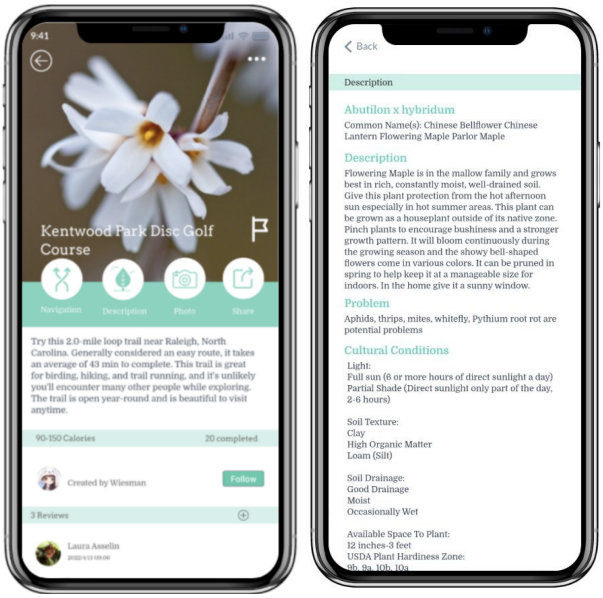

Figure. 3: Learn more about plant information

The last feature is the community (Figure. 4), which allows users to communicate with each other, and users can also use the community to share unique plants or problems they encounter. The app also offers a community where people can share the results of their explorations. There is also a collection leaderboard to encourage users to explore plants in the wild more often. A thriving online community helps to encourage users to voice their opinions to increase engagement, and active participation helps to increase user loyalty and satisfaction with the online community [23]. These features also contribute to the continued growth and prosperity of the application.

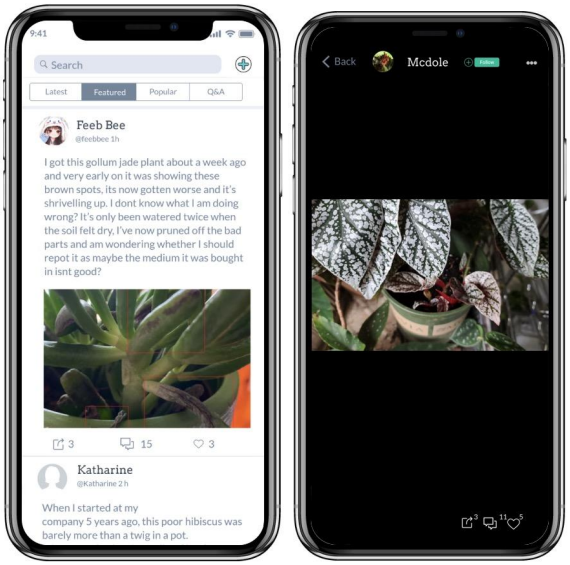

Figure. 4: Share information and pictures through an interactive community

3.2 Creating a more inclusive hybrid space

Many location-based mobile games and applications continue to ignore the difficult mobility issues that users face. Despite geolocation-based apps having many advantages, many do not consider the problem of uneven mobility [9]. Considering this gap, we believe that the combination of hybrid space and AR games can help groups that lack mobility, especially those with physical disabilities, to get a fuller opportunity to participate in plant collection and experience the fun that comes with hiking applications. Adults with physical disabilities may have fewer opportunities for favorable communication, which can also negatively impact their mental health and well-being [31]. To increase the participation of people with physical disabilities in the online community and to reduce the neglect of people with physical disabilities in the field of hiking and plant collection, we propose to include AR games (Figure. 5) in the application to help users to collect, plant, and gather plants virtually. We consider that hiking and going out to explore the wilderness is not something that every user can do, and no user should be excluded from exploring nature.

In addition, we also take into account that going out to play games may be a risky behavior for many users. Users may be concerned about various risks, and some may even engage in geolocation spoofing in geolocation-based apps. PlantNet allows players who can not or do not want to leave their homes to grow plants without any actual geographic location. While the fundamental purpose of PlantNet is to facilitate access to and interaction with nature's network, it is more critical that this motivation does not create an inherent inequality. Users should have fully equal access to the network and experience the game regardless of their location. At the same time, studies have also shown that while mobile networks have connected people more closely, there are many people who choose to disconnect, or avoid communication with others (Posti et al., 2014). The inclusion of gaming features in the app also caters to people seeking solitude.

Figure. 5: Grow plants and join leaderboards through AR games

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