Ambient Living Media as Haptic Proxy Interfaces for Virtual Reality

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Figure 1: The varying physical properties of plants could serve as haptic proxy interfaces for immersive virtual environments.

ABSTRACT

As ubiquitous members of our environment, plants live in their own timeline as silent, prevalent lifeforms. Interest is growing in understanding them as active beings rather than overlooked objects. In research towards empathetic living media, both real and artificial plants have been engaged as ambient notification interfaces. In this position paper, we put forward the notion of utilizing the living environment around us as haptic interfaces for immersive virtual environments. While different types of plants provide varying types of haptic feedback, they are mostly self-sustaining and ensure a degree of aesthetic integration within their environment. To present our idea, we shortly review established literature on empathic living media in the context of ambient interfaces and propose discussion points to further research in the area of living media as haptic proxy interfaces.

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CCS CONCEPTS

• **Human-centered computing** → **Human computer interaction (HCI)**; **Ubiquitous computing**; **Haptic devices**.

KEYWORDS

Ambient interfaces; living media; intimate technology; proxy objects; virtual reality; position paper.

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1 INTRODUCTION

The growing accessibility of virtual reality (VR) hardware is making immersive virtual experiences integral parts of our everyday lives. During such experiences, the addition of haptic feedback has been shown to increase realism and to enhance the user's sense of presence. As existing approaches usually require specialized hardware to provide appropriate feedback, their scalability and applicability for the home environment remains to be questioned. Here, everyday objects, such as plants, could bridge the gap between the need for appropriate haptic feedback and the limitations created by the user's personal environment.

Recently, research has shown an increasing interest in understanding plants as active beings rather than overlooked objects part of our environment. As living media promotes human empathy, plants serve as ideal subjects for ambient interfaces, for example to provide more effective ambient notifications or as living displays that reflect a user's achievements [7]. Additionally, as plants grow, their integration within the environment becomes a continuous process, ensuring an aesthetic value.

We envision the use of plants as haptic interfaces in order to make interaction with virtual objects more realistic and desirable. In this position paper, we review selected literature on haptic feedback for VR and living media as ambient interfaces. To frame our concept of living media as haptic interfaces, we list discussion points to further research in the area of living media as haptic proxy interfaces for VR.

2 RELATED WORK

In the following section, we provide an overview of work related to our concept.

2.1 Haptic Feedback for Virtual Reality

Research towards haptic feedback in the context of VR has considered a variety of different approaches to convey a virtual object's physical properties such as shape, size, weight, or texture. A commonly used taxonomy positions existing methods in the Active-Passive Haptics continuum based on the degree of involved computer-controlled actuation [27]. The continuum ranges from active haptic solutions, which usually involve robotic actuators conveying forces on the user [25, 26], to passive haptic approaches which leverage physical proxy objects [15, 24]. One mixed approach is Dynamic Passive Haptic Feedback (DPHF), which aims to combine the flexibility of actuation with the realistic feedback conveyed through physical props [27, 28].

Besides the tactile perception of surfaces through the sensors in our skin, also our visual impression of an object plays a central role when the brain combines the sensory input of our visual and tactile sensory system during touch. When the visual and tactile stimuli seem to mismatch, the sensory channels are combined in a way that weighs them according to their reliability [11]. Since the visual senses are usually rated very high, the visual appearance of objects we interact with can affect how we perceive them. This phenomenon is typically referred to as the visual dominance effect [14]. Previous research investigated how visual dominance can be leveraged for enhancing the perception of virtual objects, e.g. through novel interaction techniques manipulating our visual perception [2, 17]. Studying texture perception, researchers explored how physical materials are perceived when overlaid with different virtual texture renderings [16]. Building on this, fabrication has been shown as a medium to create custom physical surface structures with varying roughness and hardness properties to influence a user's sense of material perception when combined with visual information [10], see Figure 2.

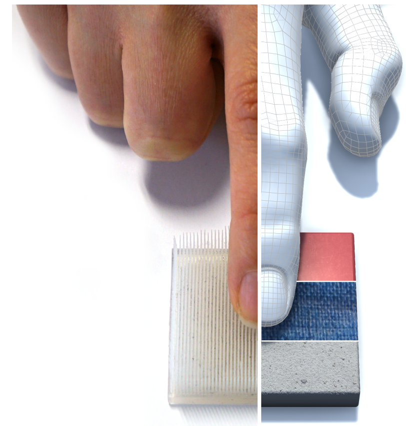

Figure 2: Augmenting texture perception by overlaying a fabricated hair-like structure with different virtual textures, from [10].

2.2 Living Media as Ambient Interfaces

As living media promotes human empathy [6, 12], research has considered understanding plants as active beings [1]. By considering the behaviour of plants, empathetic biological media aims to construct interfaces for augmented human-plant interactions [18, 20, 22]. Here, examples can be found with the prototyping of ambient media [19] and the creation of plant-based displays [13] which used the natural movement response to touch of thigmonastic plants, such as the Shameplant. This builds upon the concept of *intimate technology*, which was originally showcased by a real domestic plant capable of conveying lifelike behaviors through actuation [23]. The human empathy effect was further used to represent smoking activity in a room by making the leaves of a plant hang lower in order to bring awareness of smoking habits [21]. Similarly, the nutrition of real-world physical plants was changed based on how regularly the user achieved their daily step goal [7].

Besides real plants, artificial plants have been used to create more real-time interfaces while aiming to maintain the human empathy effect. An early approach is "Office Plant #1", a robotic plant responding to a user's e-mail activity through slow and rhythmic movements as well as ambient sounds [5]. In augmented reality plants have been used to convey information about the status of a coffee machine [3, 4]. Depending on upcoming tasks such as refilling the water or required maintenance, the virtual plant changed its appearance such that people were able to successfully identify the issue and act accordingly. Actuated robotic skeletons "overgrown" with artificial plants have been used to provide ambient notifications in ubiquitous environments [8, 9], see Figure 3.

3 PLANTS AS HAPTIC PROXY INTERFACES

As everyday objects, we envision plants to be ideal candidates to serve as passive haptic proxy interfaces and consider the following discussion points.

Passive Haptic Plants. Due to the construction of their individual parts, different types of plants are able to provide different types of

Figure 3: The *Overgrown* prototype where an endoskeleton is "overgrown" with artificial ivy [8].

feedback. Considering the texture perception approach in [10], one can imagine the use of cacti, see Figure 1 (left image), as rough haptic feedback proxies, while succulents, such as the one in Figure 4, can convey smooth, hard surface properties, and others might vary in thickness, such as Figure 1 (right side). Of course, an integration of plants as haptic interfaces would lead to novel research questions such as how to implement interactions in a way that is safe for both the user and the living proxy. Not damaging the plant during VR experiences might be of special importance for example when the plant does not represent a living medium in VR and the user's awareness of the living proxy might be lowered.

Intimate Technology. As plants incite a human caring function towards them, the use of living media for haptic feedback has the potential to further enhance interaction within a virtual environment as users might realize the interaction is taking place with an object of interest outside the virtual environment. The use of plant proxies could eventually lead to applications in which users take care of the plants, e.g., by watering them or removing old leaves, unnoticeable while performing well-designed interactions in a virtual environment, e.g., in a game context. Central research questions here might also be how VR systems can communicate that a virtual object is represented by a living proxy and which types of virtual entities should be represented by plants, e.g., virtual

Figure 4: A succulent plant.

plants or even virtual characters, in order to leverage the empathy effect best.

Aesthetic Integration. While the use of Head-Mounted Displays is increasingly becoming an accepted element within the home environment, varying aesthetic preferences users have might be a hurdle for purchasing more VR peripherals. By engaging plant-like material for virtual experiences, the more natural integration taking place would allow for a more diverse user configuration.

4 CONCLUSION

In this position paper, we have presented our concept of using living media, i.e. plants, as passive haptic proxy interfaces to enrich immersive virtual environments. Often overlooked as active beings, plants are silent, ubiquitous lifeforms with varying physical properties in terms of shape, size, weight, and texture. As intimate technology, they have been shown to generate human empathy towards themselves. We encourage future work to study whether this caring effect has the potential to positively influence the user's perception of the feedback provided when plants are used as haptic proxies for VR. Accepted as aesthetic elements in our living environment, the appropriation of plants as haptic proxies could ensure a continuous integration of VR periphery into the everyday environment of users, leading to less technologically-focused setups.

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