Exploring the foot augmentation in lucid dream manipulation

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ABSTRACT

Lucid dreaming is a state in which people become aware that they are dreaming, allowing them to influence their dream content consciously. By controlling dream content, people can gain both mental and physical health benefits. However, acquiring the ability to manipulate dream content as desired often demands significant time and practice. We see an opportunity to address this challenge through foot augmentation, which presents a lower risk of awakening dreamers. We propose a novel foot-based lucid dream manipulation system designed to increase the level of control over lucid dream content. Our design aims to help users experience the benefits of lucid dream control, and we hope to inspire human-computer interaction researchers to explore both foot augmentation and lucid dreaming in their work.

CCS CONCEPTS

• **Human-centered computing → Interaction devices**.

KEYWORDS

Lucid dreaming, dream, sleep, dream control, dream manipulation

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1 INTRODUCTION

Lucid dreaming is a state in which individuals become aware that they are dreaming [1]. Lucid dreamers can control their dream content, which has been associated with having fun, alleviating recurrent nightmares, solving problems, training skills, finding creative inspiration, mental healing, and offering a controllable environment for dream experiments [11, 21, 24].

However, achieving control over dream content requires time and effort to practice [12, 13]. In parallel, research in foot augmentation has been gaining traction [25]. These technologies have demonstrated their strengths in mixed reality applications [25], which makes it hold the potential for dream engineering [2]. Furthermore, stimulating the feet presents a lower risk of awakening users, as the feet have a smaller cortical representation than other body parts [19]. Based on these insights, we propose a foot-based lucid dream manipulation system to assist lucid dreamers in evoking desired dream content. The system would first detect when a user enters a lucid dream state and subsequently trigger stimulation on the feet to influence dream content.

Our approach involves providing predetermined haptic and thermal feedback to the feet, aiming to enhance dream controllability while maintaining sleep stability. Through this work, we seek to expand the interactive technology landscape for lucid dreaming and inspire the HCI community further to explore the intersection of foot augmentation and dream engineering.

2 RELATED WORK

To understand how to design the lucid dream manipulation system on the feet, we drew insights from prior work in dream and foot augmentation.

2.1 HCI dream research

We drew insights from prior HCI dream research, including Dormio [6], an interactive sleep interface that primes individuals to think or dream about specific topics during hypnagogia (the transition from wakefulness to sleep); Dozer [22], a system that detects drowsiness in EEG signals and then uses auditory and electrical brain stimulation to ease users into sleep; and Lucid Loop [9], a closed-loop lucid dream simulation in virtual reality (VR). Collectively, these projects illustrate how external cues could be used for dream induction. However, they primarily focus on other sleep stages rather than lucid dreams specifically, or they rely on dream simulations without evidence that these simulations offer the same benefits as actual lucid dreaming. Our work aims to address this gap.

Further inspiration comes from Virtual Dream Reliving, a generative AI–driven immersive experience that helps users recall and reflect on dreams [14], and Personal Dream Informatics, a self-information system that supports dream tracking, recall, and dreamwork to facilitate self-discovery [7]. While these initiatives demonstrate how interactive technology can enhance users' dream experiences, they concentrate on dream reflection upon waking. In contrast, our focus is on increasing the probability of lucid dreaming itself.

Virtual Transcendent Dream [15] offers an embodied VR experience of flying dreams, mapping head-mounted display (HMD) orientation to locomotion. A related study [20] found that engaging

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in a flying dream induction task increased the presence of flying- and gravity-related dream themes. While we learned from this work that the pre-sleep experience influences the dream content, this paper focuses on how the external stimulation on feet could influence dreams.

2.2 Foot augmentation research

Elvitigala et al. investigated a foot-tickling design to evoke laughter and reduce stress [5]. In their study, they identified the most ticklish locations and provided relevant system implications. Notably, the potential for stress reduction aligns with the benefits of lucid dreaming. Therefore, by integrating foot-tickling sensations into lucid dreaming, we believe we could achieve a more substantial effect on stress reduction.

Impacto is a device that provides haptic feedback through a solenoid and electrical muscle stimulation (EMS) [16]. While the solenoid produces a tapping sensation on the skin, EMS contracts users' muscles to simulate the muscle movement of being hit. We see the potential for combining solenoid and EMS to influence lucid dream content, proposing that this combination could replicate the walking experience in lucid dreaming due to its realistic haptic feedback.

ThermalGrasp introduces a novel approach to providing thermal feedback without obstructing the grasp and walking experiences [17]. Using a thin material on the sole redirects the Peltier-generated heat to the intended area. From this work, we learned that a Peltier module is a suitable candidate for providing thermal feedback; however, care must be taken to avoid obstructing other experiences.

In summary, while manipulating lucid dream content is under-explored, prior research on foot augmentation offers insights into delivering feedback through interactive technologies. We believe that foot augmentation has the potential to influence dream content while minimizing the risk of awakening users. Consequently, we aim to begin our lucid dream manipulation design with foot augmentation.

3 LUCID DREAM MANIPULATION THROUGH FOOT AUGMENTATION

We aim to design a foot-based lucid dream manipulation to influence users' dream content. First, we need to determine whether users are lucid dreaming; then, the system will provide stimulations to shape dream content. Thus, we present our approach with lucid dream detection and three potential stimulations.

3.1 Lucid dream detection

To verify people's lucidity, a common method is to ask them to move their eyes from left to right four times (LR signal [4, 10]) during lucid dreaming. We adopt this approach, capturing the electrooculogram (EOG) data with an OpenBCI Cyton board and 2 electrodes on the side of the eyes [23]. The data undergoes a band-pass filter and a rolling filter to reduce noise. After preprocessing, we extract the maximum and minimum values and their indices to determine the direction of the gaze. Once the LR signal is detected, the system triggers one of the following three stimulations to users' feet, selected according to their desired dream content.

3.2 Simulating the walking experience through impact

While the sensation of the immobile physical body can prevent lucid dreamers from walking in their dreams [3, 18], one solution would be providing feedback to simulate the walking experience. We propose delivering impacts to the soles, aiming to replicate the sensation of stepping on the ground. We plan to generate these impacts using a solenoid, similar to the approach by Lopes et al. [16]. Continuous impacts could help users walk more naturally in their lucid dreaming.

3.3 Changing the environment through thermal feedback

If users wish to experience a particular environment in their lucid dreaming, we believe thermal feedback on the feet would be beneficial. For instance, providing a cold sensation might evoke the feeling of swimming in the ocean, whereas a hot sensation could mimic climbing to the top of a volcano. Thermal feedback would be delivered by a Peltier module [8], placed on the instep to leave room for other stimulation devices. Once the lucid dream state is confirmed, the module is activated to generate heat or cooling sensation, depending on the current direction of its circuit. An H-bridge can be used to control the direction of electrical flow, providing the appropriate thermal feedback.

3.4 Evoke positive emotions through tickling

When users want to improve their emotions, tickling the feet during lucid dreaming could be an effective way [5]. Inspired by Elvitigala et al. [5], we propose integrating tickling actuators with brushes on the soles of the feet. Whenever users experience negative emotions, such as depression or sadness, the tickling sensation can help them laugh and improve their emotional state during lucid dreaming.

4 CONCLUSION

This paper proposed a concept for a lucid dream manipulation system. We plan to use impact, thermal, and tickling stimuli to help users experience their desired lucid dream content. We begin with foot augmentation due to its lower risk of awakening users. Moving forward, we will develop a dedicated user interface and incorporate additional modalities into the system. Our goal is to enable people to design their own lucid dreaming experience, and we hope this work also inspires further research on integrating foot augmentation with lucid dreaming.

5 AUTOBIOGRAPHY

Po-Yao (Cosmos) Wang is a two second-year Ph.D. student at the Exertion Games Lab at Monash University, Australia, supervised by Florian 'Floyd' Mueller and Nathan Semertzidis. His current research interests revolve around interactive technologies that facilitate playful sleeping experiences, with a particular focus on lucid dreaming. Prior to chasing his "dream", Cosmos conducted research on illusions, games, augmented reality, and virtual reality. He earned his Master's degree from the Computational Physicality

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