Tap4Light: Smart Lighting Interactions by Tapping with a Five-Finger Augmentation Device

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Figure 1: Tap4Light is an interaction technique based on finger tap gestures, designed to control smart lighting systems. In this photograph, five Philips Hue lamps are mapped to the five fingers of the hand, and are controlled, via the Tap Strap 2 wearable device, with tap gestures: a tap with one finger turns on, turns off, or selects the corresponding lamp, according to context; a tap with two fingers increases the brightness of the currently selected lamp; see Figure 2 for the entire gesture set.

ABSTRACT

We introduce Tap4Light, an interaction technique for controlling smart lighting systems with finger tapping gestures captured with a five-finger augmentation device. Tap4Light employs simple tap input that, when combined across all of the five fingers of the hand, enables a rich gesture vocabulary for controlling applications, systems, and services in the context of Ambient Intelligence environments. We demonstrate Tap4Light with a set of eleven tap gestures, the Tap Strap 2 wearable, and Philips Hue smart lamps.

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CCS CONCEPTS

• **Human-centered computing** → **Gestural input**; **Ambient intelligence**; **Ubiquitous computing**.

KEYWORDS

Gesture input, tap input, wearables, finger augmentation devices, smart lighting, ambient intelligence

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1 INTRODUCTION

Lighting systems come in many flavors with a diversity of options to control their functions, from the simple on/off switch to natural

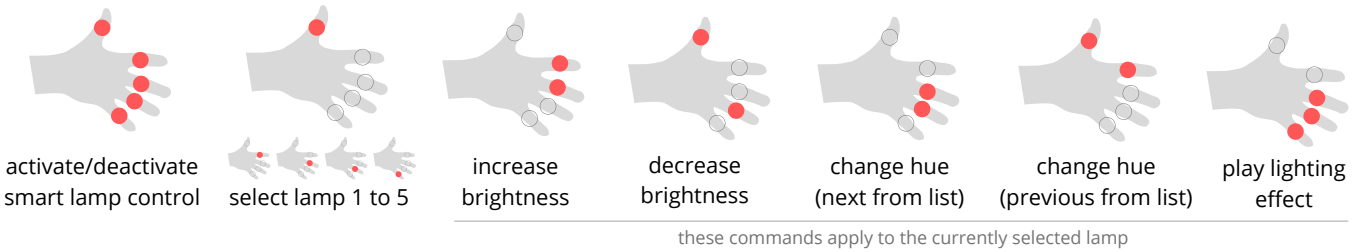

Figure 2: The Tap4Light gesture set. A filled circle next to a finger represents a tap gesture performed with that finger, e.g., increasing the brightness of a lamp is performed with the index and middle fingers tapping simultaneously.

input involving gesture and speech commands; see, for example, the control systems introduced by Ueki *et al.* [6] and Seničar *et al.* [5], the use of AR for the control of smart lighting [3], and user-centered gesture design for lighting systems [4]. In this paper, we present Tap4Light, our gesture-based interaction technique for controlling a lighting system composed of up to five independent smart lamps. Tap4Light employs a five-finger wearable device to map fingers to lamps, and employs a vocabulary of tap gestures to control various light parameters, such as brightness, hue, and effects.

2 TAP4LIGHT

We implemented Tap4Light in the form of a mobile software application that enables users to interact with a smart lighting system from the same Wi-Fi network via tap gestures captured by a five-finger augmentation device connected to the user's mobile device. Unlike electronic rings that capture gestures performed with one finger only [2], we are interested in gestures of all of the five fingers of the hand. A *simple tap* gesture is a quick movement of the finger downward and upward, which can be easily picked up by an accelerometer affixed to that finger. A *compound tap* gesture is tapping performed by multiple fingers simultaneously, e.g., tapping with the index and ring finger. A large vocabulary of thirty-one gestures is available with simple and compound taps, as follows: five simple tap gestures, ten combinations of two fingers tapping, ten combinations of three fingers tapping, five combinations of four fingers tapping, and all of the five fingers tapping at once.

To demonstrate Tap4Light, we employed several commercial off-the-shelf devices. An Android application connects via Bluetooth to the Tap Strap 2 controller,[1] a wearable keyboard and mouse device with built-in tap gesture sensing, and via Wi-Fi to a Philips Hue HUB, to which several Philips Hue Go lamps[2] are connected; see Figure 1. We employed the Tap Strap 2 gesture vocabulary[3] to map finger taps to system functions of smart lighting systems [4]; see Figure 2 for our gesture set. For example, the "activate" gesture instructs the Tap4Light system to listens for commands to control the individual lamps; selecting a lamp is performed by tapping with the finger associated with that lamp; increasing the brightness of the currently selected lamp is performed by tapping with the index and middle fingers, which corresponds to the "up arrow" key from the Tap Strap 2 keyboard vocabulary; finally, a lighting effect is activated by tapping with the middle, ring, and little fingers.

3 CONCLUSION AND FUTURE WORK

Tap4Light is ongoing work that explores interaction techniques for smart lighting systems via simple gestures enabled by finger augmentation devices. Future work will consider usability evaluations of the Tap4Light gesture set, but also further technical development. For example, other types of tap input, e.g., rhythmic tapping [7], and other types of gestures, e.g., mid-air stroke gestures [2] detected with the finger-augmentation device, or using a second, similar device for the other hand for "in tandem" input [1] will expand the design space of possible gesture interactions for Tap4Light.

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