Demo Abstract: A Smart Ring Monitoring Your Health using Hand-grip Strength

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ABSTRACT

Hand-grip strength is a widely recognized indicator of muscle strength and overall health of individuals, particularly among older adults. Hand-grip strength measurements are typically obtained using dynamometers or specifically tailored devices, limiting the context in which measurements can be taken to health checks and clinical settings. In this demo, we showcase a new smart ring, namely HIPPO. The smart ring implements an innovative approach that offers a non-intrusive and opportunistic way to extract hand-grip strength measurements from individuals. HIPPO re-purposes off-the-shelf light sensors available in existing wearable devices, e.g., smartwatches, and exploits the principle of light reflectivity, such that as an individual interacts with everyday objects, changes in their surfaces can be used to derive the hand-grip measurements.

KEYWORDS

Light reflectivity, Hand grip strength, Smart ring

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1 BACKGROUND

The human hand is an incredible natural engineering wonder that performs essential daily tasks and is a powerful indicator of our overall health. Hand-grip strength, measured by the force applied by hand muscles when squeezing an object, provides insight into the integrity of a complex network of muscles that extend beyond the hand itself. This seemingly straightforward measure goes beyond the hand, offering a valuable assessment of overall muscular strength and health. Research has shown that hand-grip strength is associated with several health conditions and diseases, including cardiovascular health, cognitive function, mortality and muscle loss to mention some [1].

Existing methods for assessing an individual's hand-grip strength pose usability challenges due to their limited applicability and their need for specialized equipment. For instance, the most common approach involves using a dynamometer, which provides a categorical assessment of hand-grip strength (e.g., weak, normal, strong) based on established reference tables derived from extensive clinical studies [1]. Using the dynamometer and other specialized devices limits the number of measurements taken over time as they require to be taken in a controlled (clinical) setting. In this demo, we showcase a new smart ring, namely HIPPO. The smart ring uses an innovative light-sensing approach to extract hand-grip measurements from individuals in a non-intrusive manner. Indeed, as people interact with various everyday objects, HIPPO leverages these interactions to obtain hand-grip measurements opportunistically. We demonstrate in this demo the performance of our smart ring to extract hand-grip measurements from different objects, including a disposable cardboard cup, plastic cup and washing sponge. Measurements are validated using a dynamometer baseline (ground truth).

2 THE HIPPO METHOD

The HIPPO [2] method to extract hand-grip measurements is illustrated in Figure 1. A light sensor (comprising a light source and a photoresistor) is worn on the user's hand (little finger), integrated into the exterior of a smart ring, and is used to measure changes in light reflectance as the user interacts with malleable objects (Figure 1(a)). When the object is held normally in the hand, its surface covers the light sensor, resulting in an approximately constant intensity of reflected light (Figure 1(b)). This constant value serves as the reference value to derive hand-grip strength. As the user applies grip on the object, the surface changes, influenced by the applied force and the object's material resistance (Figure 1(c)). These alterations in the object's surface impact the intensity of the reflected light, resulting in a fingerprint of reflection patterns on the object's surface. HIPPO monitors the changes in light reflectance and estimates the hand-grip strength from these changes.

3 SMART RING PROTOTYPE

Prototype: We have designed a prototype of a smart ring that incorporates light sensors consisting of a red laser diode (650nm, 5mW, 3-5V) and a photoresistor (5MΩ). These sensors are easily integrated into a flexible 3D printing ring design. The ring connects

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