Turning Bracelets into Socks
for post-stroke gait rehabilitation

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Introduction

Advances in technology create new opportunities for small, powerful, wearable systems. One of the aims of this research is the design, development, testing and evaluation of wearable devises for assisting with gait rehabilitation. These devises will monitor at a fine grain the motions of people with neurological conditions and provide appropriate haptic cues to assist with gait rehabilitation and the restoration of mobility.

After a person suffers a neurological condition (e.g. a stroke), improving their gait is of paramount importance. This may help to prevent dangerous complications such as joint degeneration, and decrease the risk of falls that can cause hip and bone fractures.

Early pilot studies with stroke survivors suffering from hemi paretic gait also show very promising results, indicating that haptic cueing has great potential in gait rehabilitation with immediate walking benefits [1]. More specifically, the participant's step length was found to increase, while a range of other measures such as: the paretic, hip angle at toe off, peak knee flexion during swing and ankle range of motion showed significant clinical improvement indicating improved gait movement.

Haptic Bracelets

Haptic Bracelets were designed and developed at the Open University, having primarily music-related applications in mind [2]. This meant that this first Haptic Bracelet prototype was extremely accurate at delivering a rhythmic haptic signal, providing a steady tempo for walking; essentially acting as a haptic metronome.

Pilot studies with stroke survivors show promising results [3] with participants being able to feel the rhythm of the haptic cueing and use it to provide a walking rhythm.

Haptic Bracelets II

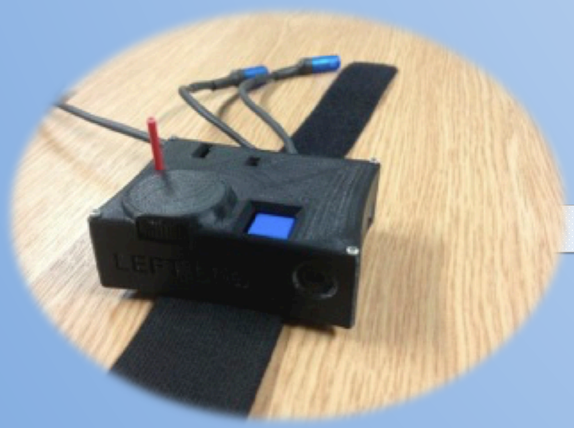
This new generation of Haptic Bracelets was designed specifically for assisting with gait rehabilitation of people who suffer from hemiparetic gait, for example after a stroke.

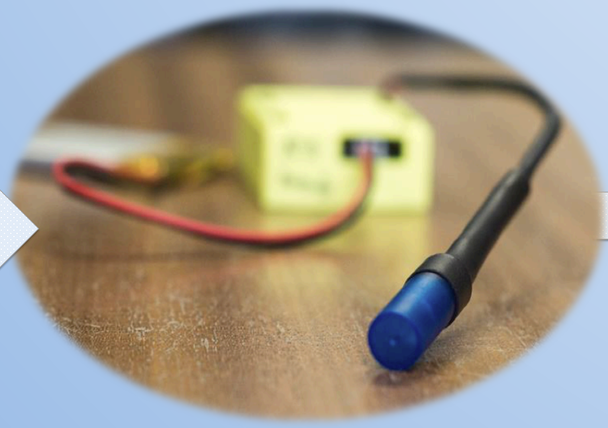
They use high fidelity sensors to measure the way the person wearing them is walking, and are capable of providing a rhythmic haptic cue through low-latency vibrotactile actuators whenever needed.

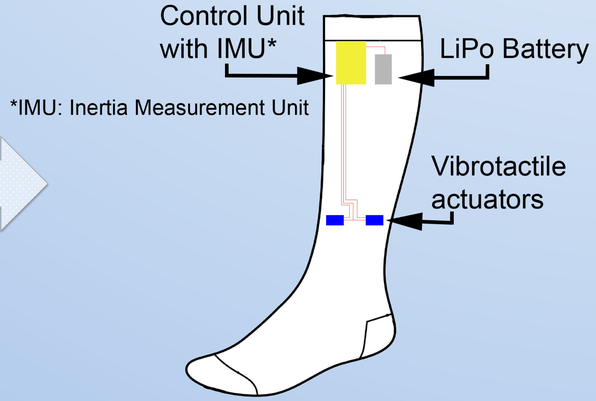
Pilot studies [3] using this generation of the haptic bracelets helped us rethink their overall design from the user's point of view; leading to the conceptualisation of the Haptic Sock.

Haptic Socks

The idea of the Haptic Sock came after interviewing a number of stroke survivors and medical practitioners specialised in gait rehabilitation [3]. The Haptic Sock will be capable of monitoring the gait patterns of the person wearing and react if irregular gait patterns are detected by producing a rhythmic haptic cue to help and correct these irregularities. The rhythmic haptic cue will be delivered by an array of high fidelity and low latency tactile actuators.
Overall the Haptic Sock is designed to be lightweight, confortable to wear and easy to put on, without compromising its capability of gait monitoring via high-resolution data collection.







References

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2. A. Bouwer, S. Holland, and M. Dalgleish, "The Haptic Bracelets: learning multi-limb rhythm skills from haptic stimuli while reading," in Music and Human-Computer Interaction, London, UK: Springer, 2013, pp. 101–122.
3. T. Georgiou et al., A blended user centred design study for wearable haptic gait rehabilitation following hemiparetic stroke, 2014, Manuscript submitted for publication.