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"HaptiComm", a Haptic Communicator Device for Deafblind Communication

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Abstract

When people are deaf and blind, daily life is made difficult owing to the lack of linguistic communication that is normally mediated by sight and hearing. The project described herein aims at helping deafblind individual overcome this communication barrier. We describe a tactile communication apparatus that is capable of rich and efficient reproduction of the tactile signs employed by several tactile deafblind languages.

keywords: haptic device, deafblind, communication, tactile, actuators

1 Introduction

With a view to facilitate communication with people who are deafblind, a most urgent need is to make linguistic interaction possible without the help of others. Here, we describe the prototype of a tactile communication device for the deafblind community that is motivated by the latest discoveries regarding "early touch" [4,5]; while following a minimalist design approach for robustness, ease of replication, and low cost.

2 Deafblindness

Deafblindness is a disability where the combined loss of vision and hearing fundamentally impact one's ability to communicate freely. In Western countries, the incidence of Deafblindness is surprisingly high. Broad criteria identifying significant repercussion of dual sensory loss put the incidence of Deafblindness to one person in 250. Stricter criteria put this number at 1:1000. However, in countries like Canada and Australia, it is estimated that indigenous populations, and those with limited medical access, have an even higher incidence of Deafblindness.

2.1 Inclusion and communication

Deafblind individuals face many challenges, including orientation, inclusion in society, and even access to ordinary communication and transport options. Frequently, these challenges result in isolation and risk of mental health sequelae.

This form of disability motivates the need to develop techniques of communication that are not based on vision or audition. Deafblind languages are not as widespread as, for instance, visual sign languages. It follows a lack of technological support for the deafblind community. Existing technological aids, such as Braille tablets, are inconvenient for most deafblind individuals. Moreover, tactile signers cannot interpret speech to more than one deafblind individual at a time and for sessions that can last no longer than 45 minutes, reducing further the possibilities to communicate with others.

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2.2 Languages

The variety of aetiologies leading to deafblindness and the linguistic, national, and personal circumstances has led to a state of affairs where the deafblind communication techniques have become highly diverse across cultures and countries. One of these techniques, which is that on which the `HaptiComm` system focuses on, is known as 'deafblind tactile fingerspelling'. By touching the sensitive inside region of the hand to communicate, a signer produces tactile symbols that correspond to letters, words and ideas. These symbols are based on brief finger taps and swipes, as exemplified in Fig. 1.

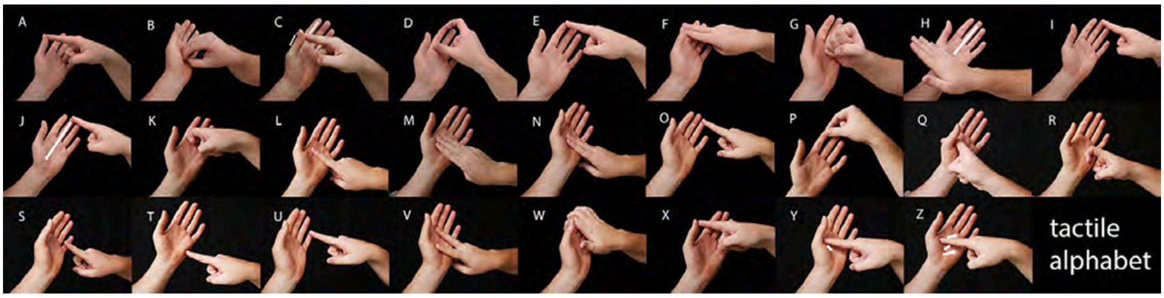

Figure 1: The Australian deafblind tactile fingerspelling.

The expressiveness of some of these techniques, such as deafblind tactile fingerspelling, is similar that of speech. There is prosody, emphasis, and other forms of modulation similar to those of speech that operate at the lexical, grammatical, and semantic levels, in addition to non-lexical short-hand symbols, smileys, geometric figures, directional cues and so-on. The technology that we develop can address these forms of modulation.

3 Haptic Display

The `HaptiComm` project recognises that haptics should supports linguistic communication within the deafblind community. It is a hardware and software platform that is highly flexible in its design, is inexpensive, and easy to reproduce. Predominantly 3D printed and able to be customised, the HaptiComm platform supports a broad range of applications when coupled to speech recognition, text messaging, or optical character recognition inter alia. The device is shown in Fig. 2.

3.1 Overview

The HaptiComm hardware operate from first principles with an array of strategically located actuators facing the receiver's hand. These actuators, see [3] are simple, yet efficiently cater to the two required modes of mechanical interaction, namely, tapping and swiping on the skin, and have large dynamic and frequency ranges.

They can tap at twenty four loci in the volar region of the hand, dissipating an impact energy similar to that of a real tapping finger. Each actuator can also apply a gentle bias force on the skin and vibrate it within the full vibro-tactile frequency range.

These operations can be repeated many times per second and per actuator to reproduce with fidelity the sensation of fingers tapping and sliding over the volar region of the hand. Since elemental signals, including tap, place-and-hold and slides, form the basis of the natural codes — and of languages based on them — such as "English Deafblind Manual", Australian "Deafblind Tactile Fingerspelling", Italian "Malossi", German"Lorm", reduced forms of Japanese "Finger Braille", and others, the HaptiComm hardware has a broad applicability because the learning curve for its use is short or even inexistant.

3.2 Interface design

The interface has an outer shell that fits the shape of the palm of the hand at rest. This shell has few contact with the skin for the evacuation of the sweat and heat. To avoid interference between actuators, the structure holding the actuators is mechanically decoupled from the shell.

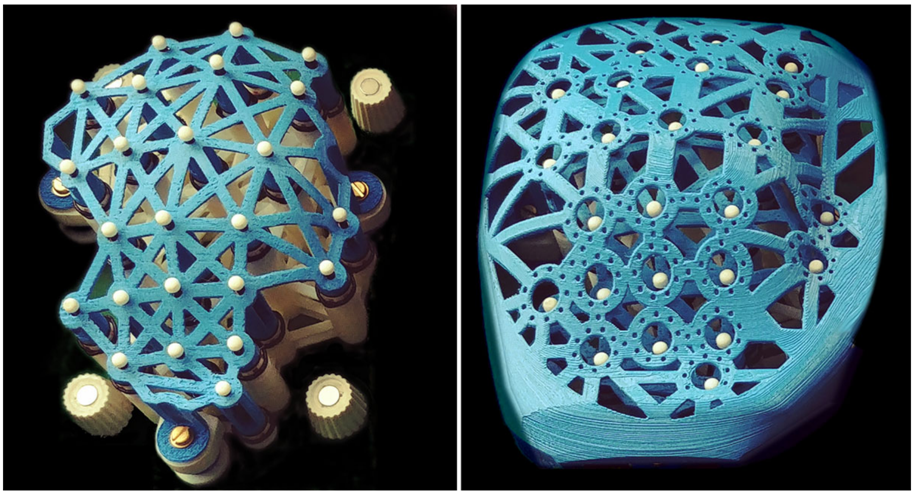

Figure 2: View of the Tactile Communicator

3.3 Software and Tactile motions

The software extracts sentences from speech and translate them into tactile symbols. Creating the sensation of a human hand tapping and swiping is important for the intelligibility of the spelling. The twenty four actuators are strategically placed so that the stimulation regions optimally approximate with the hand regions used during spelling. Swiping sensations are created by producing apparent movement from a carrier signal [1, 2, 6]. Using optimised WAV files in order to create the signals used by the actuator to recreate the symbols, a proper modulation of amplitude and timing provides the sensation of continuous sliding movements.

4 Summary

We created a device of minimal complexity that is easily replicated and low cost. Yet it is capable of a great range of expressiveness thank to the care that was put in its mechanical organization, the distribution of actuators to take advantage of the non-local property of early haptic processing, and the design of actuators that have time constants that are compatible with the basic physics of tactile interaction with the hand.

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