The Haptic Wave: A Device For Feeling Sound

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Abstract
We demonstrate the Haptic Wave, a device that allows audio engineers with visual impairments to "feel" the amplitude of sound, gaining salient information that sighted engineers get through visual waveforms. The demo will allow visitors, sighted or visually-impaired, to sweep backwards and forwards through audio recordings (snippets of pop songs and voice recordings), feeling sound amplitude through haptic feedback delivered by a motorized fader. The result of Participatory Design, Workshopping, and Research through Design methods, the Haptic Wave has been previously exhibited at the Research Through Design Conference (RTD), Visually Impaired Musicians' Lives conference, and has been trialed in real world settings in recording studios by users with visual impairments in the UK and USA. A detailed account of the research and design process of the Haptic Wave has been accepted as a full paper at CHI'16.

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Cross modal mapping; Haptic interfaces; Digital audio production

ACM Classification Keywords
H.5.2 User Interfaces: Haptic I/O []

Introduction

Producing and recording audio has become increasingly computer-based and therefore also increasingly visual. Much of the tactility of old recording studios has been replaced by highly visual DAWs (Digital Audio Workstations), which use visual representations of analogue equipment (such as compressors or graphic equalizers) and represent recorded audio as waveforms (a graphic representation of the volume of a recording with time on the x-axis and amplitude on the y-axis as in Figure 1). Through quickly glancing at the computer screen in their studio, a sighted engineer can see where a recording is too loud, where the silences are and the overall dynamics of a song, alongside other pertinent points. Trained eyes can spot the shapes of distinctive sounds such as kick drums and snare drums, or the overall structure of a song.

For this reason, much editing can therefore be done by sighted engineers without even listening to a recording. However, none of this visual information about the waveform is available with the same speed for an audio engineer with visual impairments.

Over the course of 3 years and multiple workshops we developed the Haptic Wave, which we will be demonstrating and which people are encouraged to come and interact with, a device which responds to this by turning the amplitude of a recording directly into feel, using a motorized fader on a movable bed to allow users to interact with sounds and feel the amplitude.

The device is of use and interest to both sighted users, and users with visual impairments. Studio trials undertaken this summer suggested that audio engineers with visual impairments found the device to be of great use, comparing the experience to what they imagined seeing an audio waveform to be like. During exhibitions and demonstrations, sighted users have found the device to be compelling to use.

For an audio software developer, the projects shows that accessibility can entail the translation of audio content to sensory modalities other than sight, and that software and hardware can be designed to accommodate alternate, non-graphical display and input/output devices

Figure 1: The waveform of a section of David Bowie's "Let's Dance".

Haptics in music

There is a history of haptic devices for accesibility or enhanced interactivity in music. One of the earliest examples comes from Sile O'Modhrain who developed the The Moose in 1997 [4]. The Moose functions like a mouse, using force feedback so the user feels icons on the screen as it passes over them. Importantly, O'Modhrain had a background in audio production and The Moose was optimised for use with DAW software. More recently, the D'Groove is a DJ turntable that uses interactive force feedback on turntables [2]. This draws on the well-honed skills of a DJ, augmenting them through multiple haptic modes so users can feel the beat, or creating resistance at certain points so the performer can feel the varying amount of energy in a song. Verplank et al developed The Plank [6, 5], a haptic controller for musical performance, designed to provide expressive feedback for the performer. Our own project utilises technologies developed for The Plank, using the modified

Arduino developed by Verplank with the Copenhagen Institute of Interaction Design, CIID in their Music, Machines, Motors (MMM) project [1].

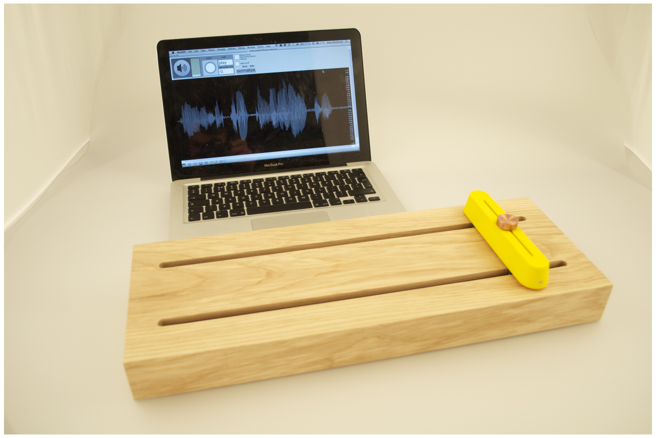

Figure 2: The Haptic Wave set up with our editing software in demo mode.

Development and Design

The Haptic Wave was developed and designed using techniques from Participatory Design, Research Through Design and Design Workbooks. In this way, the end users were involved from the outset in the design process, whilst we were able to draw on our own networks and community of instrument builders to offer the participants prototypes in response to their needs and feedback. From this, a dialogue evolved using using verbal exchanges, exchanging objects, audio diaries and video documentation.

We began by hosting a workshop at Queen Mary University, inviting a number of audio engineers with visual impairments to come along. The workshop was structured into three distinct parts: an initial discussion of commonly encountered problems, a hands-on session with contemporary technologies - ranging from sonification devices to haptic devices such as the Phantom Omni - and finally an open design session, whereby the participants suggested designs for devices that would solve the problems they encountered.

Figure 3: One of our participants uses the Haptic Wave to edit a podcast in her home studio.

Following on from the initial workshop, we hosted several smaller workshops where we introduced participants to a prototype Haptic Wave developed both in response to their struggles and design suggestions, and our own connections with individuals working in interactive music. After gathering feedback, in the form of interviews and video footage, from participants who worked with the initial prototype, we worked with interaction designer David Cameron, who studied the feedback and produced a Design Workbook, a technique developed by Bill Gaver [3]. Using this Cameron worked with an engineer to develop the second prototype of the Haptic Wave, that which we will be demonstrating.

Three copies of this prototype were built and deployed in studio trials over the summer. Users worked with them for an extended period of time and gave us feedback through audio or video diaries and questionnaires.

Figure 4: The Haptic Wave is demostrated at the Nesta SoundLab demo.

Hardware and Software

The device uses a motorised fader connected to a modified Arduino board, developed by Bill Verplank and CIID (the Copenhagen Institute of Interaction Design). This is mounted upon runners, and a digital counter monitors its position. The device is connected to a computer which runs software written in Max MSP. This is cross platform and can either run as a standalone audio editor (as it does in the demo), or be launched as an editor from many common DAW environments such as Logic, Ableton or Reaper. The editing software we have developed allows for users to perform a variety of basic but important tasks, including importing a sound, selecting start and end points of a loop, previewing and exporting edits. The demo version is limited, allowing users to "scrub" (move back and forward) through a recording whilst haptically feeling the volume at the point they are at through the motorized fader. After a second of inactivity the device goes silent, so is relatively unobtrusive in an exhibition setting. It can be used with headphones if it is in an environment where silence is important.

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