Exploring the Container Metaphor for Equalisation Manipulation

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ABSTRACT
This paper presents the first stage in the design and evaluation of a novel container metaphor interface for equalisation control. The prototype system harnesses the Pepper's Ghost illusion to project mid-air a holographic data visualisation of an audio track's long-term average and real-time frequency content as a deformable shape manipulated directly via hand gestures. The system uses HTML 5, JavaScript and the Web Audio API in conjunction with a Leap Motion controller and bespoke low budget projection system. During subjective evaluation users commented that the novel system was simpler and more intuitive to use than commercially established equalisation interface paradigms and most suited to creative, expressive and explorative equalisation tasks.

Author Keywords
Equalisation, user interface, container metaphor

CCS Concepts
• Human-centered computing → Mixed / augmented reality • Human-centered computing → Web-based interaction • Applied computing → Sound and music computing

1. INTRODUCTION
Since the dawn of the Information Age scholars have advocated the "need … not so much for computer oriented people but people oriented computers" [1] with user interfaces that build on transferrable mental models increasingly adopted by designers. Despite this trend, commercial embodiments of the Audio Mixing Interface (AMI) still hark back to their implementation-centric forbears providing interaction via skeuomorphic representations of dials and faders [2]. Over the last decade researchers have proposed an alternative stage-based paradigm that draws on a psychoacoustic mental model visualising audio tracks as objects placed on a metaphorical stage (e.g. [3]). Recently Walter-Hansen [4] has proposed an alternative, as yet unexplored, AMI paradigm termed the container metaphor. This metaphor is grounded in the users embodied sensorimotor experiences representing the mix-space as a deformable three-dimensional object projected mid-air. Whilst the technologies to allow such systems to be realised are very much in their infancy [5], commercial hand gesture controllers (e.g. Leap Motion controller [6]) used in combination with the Pepper's Ghost illusion [7] enable the consideration of alternative augmented reality container metaphor AMIs. This paper presents the first stage in developing a Container (based) EQualisation user Interface (CEQI). The insights gained from this preliminary investigation will be used to inform future iterations of CEQI as more sophisticated technology emerges.

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2. EQ INTERFACES
Traditional EQ interfaces present controls as a suite of aligned knobs. Many Digital Audio Workstation (DAW) implementations have augmented this design style with a graphical visualisation of an EQ curve and real-time spectrogram displayed as overlaid graphs with frequency plotted on the horizontal axis and gain/attenuation/level on the vertical axis. Most DAW style EQ interfaces enable the user to interact directly with the EQ curve to modify multiple parameters simultaneous or use graphical knobs to alter parameters individually. Dewey and Wakefield [8] simplified this interface by removing the EQ curve using a single static plot of a track's average frequency content that could be directly manipulated. In developing a gestural control for EQ, Wilson [9] proposed that the EQ curve could be removed using only a two-dimensional touchpad with finger position to control filter centre frequency and gain according to the DAW style mapping. The pinch gesture was suggested as a possible control for filter Q.

The EQ interface of Gibson's Virtual Mixer [10], which is widely cited as the first alternative to the established AMI, draws on psychoacoustic pitch-height associations presenting EQ controls as a direct manipulation data visualisation. Frequency content is represented as a series of coloured bands which can be pushed away from/towards the user to control each band's relative level. LAMI [11] builds on this pitch-height association offering an alternative three-dimensional stage EQ interface with each track's EQ curve represented as a lathed column visualisation. The adopted interaction style via hand gestures is analogous to moulding or sculpting the spectral components, drawing on, as Walter-Hansen suggests, prior sensorimotor experiences.

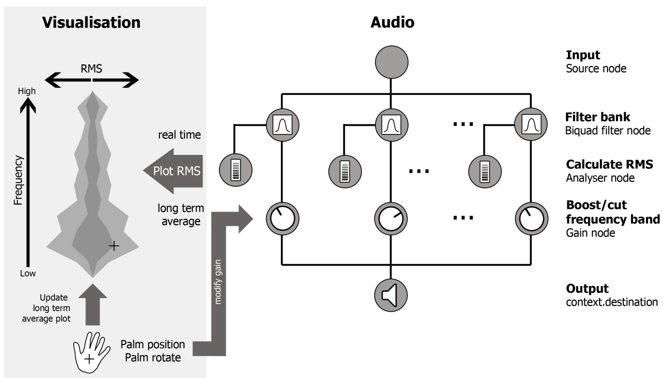

Figure 1: System Overview

3. SYSTEM OVERVIEW
The aforementioned prior work suggests the potential of employing direct manipulation interfaces with pitch-height mapping controlled via hand gestures. In the development of CEQI our design motivation combined the sculpting and shaping metaphor proposed in LAMI with a data visualisation of the average frequency content to enable the direct manipulation of a deformable sound shape representation (see Figure 1). To assess the potential of CEQI a simple implementation

was created using a Leap Motion Controller, web-based application and holographic mid-air projection of the sound shape. Interaction was provided by moving and rotating the palm.

3.1 Software

CEQI was developed in HTML 5 and JavaScript using the Web Audio API to perform spectral analysis and modification. Given the relative restrictions of Web Audio's analyser node for spectral manipulation, a constant Q transform bank of biquad filters spaced at 1/3 octave bands was employed. Each filter was connected to an analyser node to calculate real time and average energy (RMS) and a gain node to alter the relative level of each band. Graphical visualisation was provided via the HTML canvas and easel.js with the real time and average RMS visualisations drawn as overlain opaque shapes. Leap.js controlled interaction by tracking palm position and palm rotation angle. Hand position was displayed as a circular cursor to provide user feedback.

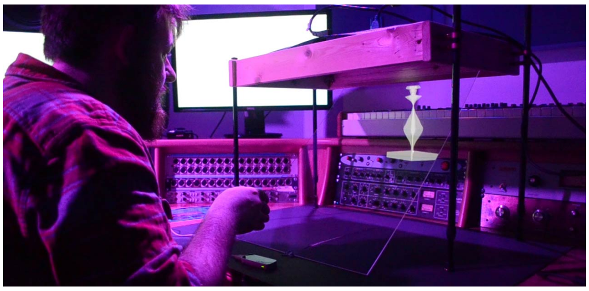

Figure 2: CEQI in use

3.2 Hardware

To create the holographic visualisation a downwards facing 27" computer monitor was used to project the display on to a clear Perspex sheet (see Figure 2). A wooden frame was built to house the monitor with telescopic poles used to raise it to the desired height. To increase the effect of the illusion the frame hid the monitor from the user and the telescopic legs were placed on a sheet of dark, unreflective material with the Perspex sheet angled at precisely 45 degrees. Both sensor and projection were most effective in low light conditions.

4. EVALUATION

CEQI was evaluated subjectively in three separate sessions. The first session involved members of arts focused Music Technology research group, the second, an engineering and the third Undergraduate Music Technology students; totaling 27 intermediate and expert users. Each session began with an explanation of the concept and a demonstration followed by a free exploration task with a variety of audio material. At the end of each session users were asked to complete a questionnaire to capture keywords from a subset of the Microsoft Desirability toolkit and provide suggestions for possible gestures/features. Verbal comments were also recorded.

5. DISCUSSION OF RESULTS

Subjects were generally favourable to the concept of CEQI. This is supported by the range of keywords selected (see Figure 3). Many users commented that CEQI was particularly suited to sonic exploration, facilitating the creation of timbres that varied significantly from the original audio material as indicated by the predominance of the selected keyword *Creative*. It was also commented that the visualisation and interaction method made CEQI suitable for performance. The ability to record and loop interactions was also requested.

The selection of *Approachable*, *Accessible* and *Intuitive* arguably relate to a common theme. Many users commented that when compared with commercial EQ interfaces CEQI was easier to understand and could, for example "easily be explained to someone who's never used a mixing desk before". It was also suggested that this apparent affordance lent the use of CEQI to educational contexts.

Figure 3: Wordcloud of all selected keywords

Whilst only 17% of the keywords selected were negative, many users commented that CEQI's lack of haptic feedback and relatively coarse controls made fine modifications difficult to execute. As fine control was deemed to be a critical component of many EQ tasks users suggested this should be added as a default mode. A range of other modes were suggested including band-pass filter sweep and lowpass and highpass filter mode.

Because the interface only required the use of a single hand users commented that this ergonomic affordance enabled the use of CEQI in combination with a groove box or synthesiser. Most users suggested using the other hand for mode selection, either via a hand gesture or physical buttons.

Subjects suggested having both average and static plots displayed as coloured shapes depending on the task considered. Additionally, they requested the ability to turn visualisations on/off. Some users requested the addition of a pre-modified average frequency plot and the ability to reset the system. It was also suggested that two tracks could be displayed together to facilitate frequency masking tasks. The addition of the cursor was deemed to be a crucial visual aid.

In light of the results of this evaluation, the next stage in CEQI's development will explore more sophisticated interaction styles partnered with a higher resolution of control.

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