An evaluation of augmented reality music notation

Zeruo Liu
RS Computer Science, CECS,
The Australian National University
Canberra, ACT, 2600, Australia
Zeruo.Liu@anu.edu.au

Matt Adcock
Data 61
Canberra, ACT, 2600, Australia
Matt.Adcock@csiro.au

Henry Gardner
RS Computer Science, CECS,
The Australian National University
Canberra, ACT, 2600, Australia
Henry.Gardner@anu.edu.au

ABSTRACT

We conducted a focus group study of a prototype application to test the opportunities and limitations of augmented reality music notation for musical performance and rehearsal.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality**; • **Applied computing** → *Performing arts*; Sound and music computing.

KEYWORDS

augmented reality, head mounted display, headset, Hololens, music, musician, musical notation, focus group

ACM Reference Format:
Zeruo Liu, Matt Adcock, and Henry Gardner. 2019. An evaluation of augmented reality music notation. In *The 17th International Conference on Virtual-Reality Continuum and its Applications in Industry (VRCAI '19), November 14–16, 2019, Brisbane, QLD, Australia.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3359997.3365748

1 INTRODUCTION

The hands-free nature of augmented reality (AR) headsets motivates their use for displaying music notation for musical performance. The concept is illustrated by the sketch of the string quartet in Figure 1 where each musician wears a headset that, notionally, displays a personalised musical score that is overlaid on their view of the world. Such a display of music notation in AR headsets worn by musicians in an orchestra could allow them to maintain their attention on other musicians and a conductor.

We report a small focus group evaluation of the prospective use of musical notation in AR headsets. Although there have been video postings of AR-headset apps that include musical notation ([deFranco et al 2016], [Mohan 2016a,b]) these apps have focussed on music education and training (rather than rehearsal and performance) and they do not mention user evaluation. Two recent papers report realisations of new music performances where some or all of the performers wear AR headsets and where the displayed musical notations are innovative and abstract and these studies report anecdotal feedback from performers [Bell and Carey 2019; Kim-Boyle and Carey 2019]. Here, we describe a systematic evaluation of a prototype that displays conventional music notation.

Figure 1: A sketch of the concept of this paper.

2 PROTOTYPE DESIGN

Our principal objective was to facilitate discussion and feedback from musicians. We wanted our prototype to provide options for having the notation at differing distances away from the observer to gauge the impact of visual stress. We also allowed users to locate the notation in different positions in one plane using gestures. We designed two dynamic displays for use in the AR head set: (1) A "bouncing ball" display that moved across the notes of the music and that triggered a page-turn when it reached the end of a line, and (2) a "fading" capability that allowed the music to disappear and then reappear again when desired. The bouncing ball is one way of presenting a real-time musical pointer to musicians. Fading was considered to be a mechanism to enhance memory training. The prototype was implemented in the Microsoft Hololens (1st gen) using Unity 2018.4.3 [Technologies 2019] together with the Windows SDK for Windows 10, Visual Studio 2017, and the MRTK HoloToolkit - 2017.4.2.0.

A small number of images of single lines of music notation were imported into Unity. By changing the image texture the music sheet can change to provide the impression that that the pages of music are being turned over. Several voice-activated commands were implemented in order to conduct the focus group. A "nearby" voice control was used to move the music sheet progressively closer to the observer and the "far-away" voice control was used to move the music sheet progressively further away. Diagnostic labels were overlaid on top of the image to let users know that a voice command had been recognized as shown in Figure 2. The prototype also implemented a dynamic "bouncing ball" to track the musical notation using a timer. We also implemented dynamic fading effects to allow the music to slowly disappear and reappear again following voiced commands. If a user voiced a "fade away" command, a transparency parameter changed continuously.

VRCAI '19, November 14–16, 2019, Brisbane, QLD, Australia

ACM ISBN 978-1-4503-7002-8/19/11…$15.00
https://doi.org/10.1145/3359997.3365748

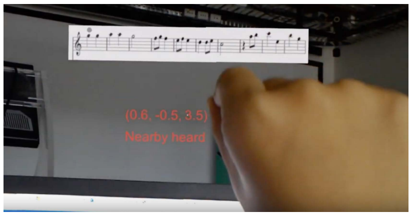

Figure 2: Screen shot where a user has triggered the "nearby" voice command while also dragging the music sheet.

3 FOCUS GROUPS

We recruited two focus groups of experienced musicians with three in each group (five males and one female). Each participant had over 20 years of musical performance experience on a range of musical instruments and three of the participants were closely associated with a university's School of Music. In augmented reality and related fields, focus group interviews are commonly structured about the use of a prototype and participant numbers are often low to enable them to experience the prototype (see for example [Corrêa et al. 2017]). We included two focus group moderators to keep the conversation going and to make notes.

There were three "phases" in each focus group interview. The first phase was to try out the headset and provide initial impressions and then to try out the bouncing-ball effect using voice commands to "start" and "reset" the ball position and to see the page tuning over. The second phase was to show the fading in and fading out effects. The third phase was to position the music sheet by dragging gestures and also to put it "faraway" or "nearby" using the voice commands. The headset was shuffled between participants after each phase with a different participant being the first to use it in each subsequent phase.

Following the focus groups, written notes and audio recordings of both sessions were subjected to a thematic analysis. Some 16 pages of written transcripts were checked against three hours of audio. Core findings and suggestions are summarised in Figure 3.

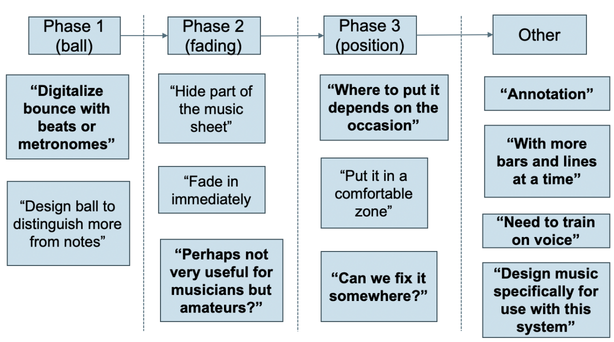

Figure 3: Some of the core findings from the focus groups.

4 THEMES

Three overall themes emerged from our analysis of the focus group discussions: providing musicians with intelligent *assistance* with their engagement with the musical notation, *empowering* musicians to annotate and control the display of musical notation, and how *new musical practices* might take advantage of AR notation.

The first theme, of intelligent assistance, was exemplified by discussions concerning the bouncing ball and page turning. Participants felt that there was considerable opportunity to modify the dynamic displays of notation that included AI agents that were able to listen to music as it is being played. In free improvisation, intelligent agents might provide musicians with feedback on the quality of the music being played (as in [McCormack et al. 2019]) or ideas for new solos or key changes and so on.

The second theme, of empowerment was particularly concerned with respect to being able to annotate individual displays in real time. It was well articulated by a focus group participant with substantial orchestral experience who stressed that orchestral players often have the need to annotate music during rehearsals and, even, during performances.

As the third theme, one of the two focus groups emphasised opportunities for developing new arts practices that incorporate augmented reality with new musical notations. Such practices may move beyond conventional music notation as in the innovative work described in [Bell and Carey 2019; Kim-Boyle and Carey 2019].

5 CONCLUSIONS

This paper has described an evaluation of the concept of displaying musical notation in an augmented reality headset for music performance. By developing a prototype for the Hololens (1st gen) and conducting a focus group study with experienced musicians, we have obtained a large amount of feedback on our prototype and the overall concept. We have identified a number of avenues for further research that we hope will be of interest to researchers interested in augmenting traditional musical performance settings (orchestral, chamber music and jazz) as well as those interested in developing new musical practices that exploit AR music notation.

REFERENCES

Jonathan Bell and Benedict Carey. 2019. Animated Notation, Score Distribution and AR-VR Environments for Spectral Mimetic Transfer in Music Composition. In *Proceedings of the International Conference on Technologies for Music Notation and Representation – TENOR'19*, Cat Hope, Lindsay Vickery, and Nat Grant (Eds.). Monash University, Melbourne, Australia, 7–14.

Ana Grasielle Dionísio Corrêa, Gilda Aparecida de Assis, Marilena do Nascimento, and Roseli de Deus Lopes. 2017. Perceptions of clinical utility of an Augmented Reality musical software among health care professionals. *Disability and Rehabilitation: Assistive Technology* 12, 3 (2017), 205–216.

Adam deFranco et al. 2016. MusicLens. Retrieved July 15, 2019 from https://www.youtube.com/watch?v=4I1RrFp0KWc

David Kim-Boyle and Benedict Carey. 2019. Immersive Scores on the HoloLens. In *Proceedings of the International Conference on Technologies for Music Notation and Representation – TENOR'19*, Cat Hope, Lindsay Vickery, and Nat Grant (Eds.). Monash University, Melbourne, Australia, 1–6.

Jon McCormack, Toby Gifford, Patrick Hutchings, Maria Teresa Llano Rodriguez, Matthew Yee-King, and Mark d'Inverno. 2019. In a Silent Way: Communication Between AI and Improvising Musicians Beyond Sound. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems*. ACM, 38.

Shreyas Mohan. 2016a. Music Instruction in a Virtual/Augmented Environment. Retrieved August 19, 2016 from https://www.youtube.com/watch?v=Tv2SavmbDVg

Shreyas Mohan. 2016b. Music Instruction in a Virtual/Augmented Environment. Retrieved August 19, 2016 from https://www.evl.uic.edu/entry.php?id=2239

Unity Technologies. 2019. Unity3D Manual. Retrieved June 29, 2019 from https://docs.unity3d.com/Manual/index.html