

“It will discourse most eloquent music”: Sonifying variants of Hamlet

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Sonification is a complementary technique to visualization that uses sound to describe data. Kramer defines sonification as “the use of nonspeech audio to convey information. More specifically, sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation.” [13] While providing new opportunities for communicating through the human perceptual and cognitive apparatus, sonification poses challenges with presenting the exploratory patterns in data to the user as it is a less familiar medium for this purpose.

We describe work to sonify variants of Hamlet to aid exploratory textual analysis. The sonification presented focuses on using pitch and tones to help the user listen to differences in the structure between variations of a text or texts encoded in Text Encoding Initiative (TEI) XML. Our approach is inspired by the Hinman Collator, an opto-mechanical device originally used to highlight print variants in Shakespeare texts, whereby visual differences between two texts literally stood out through a stereoscopic effect [5]. Using an audio stream for each text, this project aims to produce a stereo audio image of the text, so creating an audio version of the stereoscopic illusion used in collating machines. The timing and frequencies are extracted for storage and transformation into alternate formats or to repeat the analysis.

We present initial work on XML variants of Shakespeare’s Hamlet using the Bodleian Libraries’ First Folio XML and their earlier work on the Quartos. We extracted document entities such as act, scenes, lines, and stage directions for the analysis. These are viewed as hyperstructures that may be separated from the text for sonification and comparison with other variants. Analytical perceptions can be altered through the presentation of the tones, pitches and icons. Audio displays demand the creator to rethink how structural data is presented to the user, and about the hyperstructures extracted to give potential for conversion of the analysis into hypermedia using visualization as well as sonification. Early results show promise for the auditory comparison.

We look at related work and present the case study. We then consider the use of audio beacons to help the user locate within the document, and discuss the integration with visualization. Finally we look at future work and conclude the paper.

Related Work

Sonification on exploratory data patterns has been explored in several projects. For example, work on stock market data [3,10] discusses the use of volume and pitch to alert to changes in the data, rather than relying on purely visual stimuli. It demonstrates the use of auditory displays for pattern analysis in exploratory data using a rule system, and is closely associated with visualization.

The *Listening to Wikipedia* project¹ presents an audio and visual display of edits made to Wikipedia pages. Using circles and rule-based sounds, it presents the recent changes feed to the user including new users and the type of user making the edit. This work provides an elegant interface to the user data but it is limited to one stream.

The TEI-Comparator² was developed to compare paragraphs and visualize the changes [9, 14] for the Holinshed Chronicles³ project, illustrating a collation approach applied to TEI. This visualization work does not render the text into audio signals, and it was designed for a particular text. It focuses on the text rather than the editorial structures.

Sonification of hyperstructures is explored in [11], where an authored hypertextual structure is sonified using the techniques of algorithmic composition. In contrast, we present work that develops the notion of sonifying the hyperstructure, or hyperstructures, extracted and transformed from the editorial matter.

Sonifying versions of Hamlet

We present work on creating an auditory display from Shakespeare's Hamlet. This began with the Bodleian's work on the First Folio [5] and their earlier work on the Quartos with the British Library.

Initially we convert a selection of TEI XML elements, relating to acts, scenes, stage directions, lines and speaker, into a series of numbers. The process uses the XPointers for the characters to match the speaker to the line. These are read by the sonification software and mapped to relevant tones and sounds before being recorded as a music file, played to the user, or both actions. The different versions of TEI encodings pose challenges to ensure that each play has the same characters encoded and that the encodings can be mapped to the same number via a rule.

¹ <http://listen.hatnote.com/>

² <http://tei-comparator.sourceforge.net/>

³ <http://www.cems.ox.ac.uk/holinshed/about.shtml>



Figure 1: Example transform of TEI XML structure into sound

This work focuses on an alternative presentation to Hinman's Collator where two texts are transposed in stereoscope to show the differences between them. Our eyes use variations between images to interpret depth in 3D vision; similarly, our ears use subtle timing and phase variations to establish a stereo stage. Using an audio stream for each text, the project aims to produce a stereo audio image of the text with auditory beacons to guide the user within the stream. Playing a synchronized audio stream per text in each ear helps the listener's brain to hear any subtle differences between two versions.

Displaying the hyperstructures of the texts such as the speakers of a line element allows the listener to hear whether editorial changes have been made to the textual structure and to hint at variations of the same text.

By way of example, in the 1603 Quarto edition [7] the first stage direction and first lines are:

```
<stage rend="italic, centred" type="entrance">Enter two Centinels.
  <add place="margin-right" type="note" hand="#ab" resp="#bli">
  <figure>
    <figDesc>Brace.</figDesc>
  </figure>now call&#x0027;d

  <name type="character" ref="#bar">Bernardo</name> <lb/>&#x0026;
  <name type="character" ref="#fra">Francisco</name> &#x2014;
  </add>
</stage>
<sp who="#sen">
  <speaker>1.</speaker>
  <l><c rend="droppedCapital">S</c>Tand: who is that?</l>
</sp>
<sp who="#bar">
  <speaker>2.</speaker>
  <l>Tis I.</l>
</sp>
```

In the 1605 Quarto edition [8], the stage direction and first lines are:

```
<stage rend="italic, centred" type="entrance">Enter
  <name type="character" ref="#bar">Barnardo</name>, and
  <name type="character" ref="#fra">Francisco</name>, two Centinels.
</stage>
<sp who="#bar">
  <speaker rend="italic">Bar.</speaker>
```

```
<l><c rend="droppedCapital">VV</c>Hose there?</l>
</sp>
<sp who="#fra">
  <speaker rend="italic">Fran.</speaker>
  <l>Nay answe re me. Stand and vnfolde your selfe.</l>
</sp>
```

Although the sentinels are identified as Barnardo and Francisco in the stage direction, the text and markup specify different characters. In our software, this would create separate sounds for the first line but not the second. The latter line would create the stereoscopic illusion where the first line breaks it.

Auditory Beacons

Acts and scenes provide useful beacons for the listener to understand which section of the text is being presented. As audio is an unfamiliar medium for this work, there is a need to help the listener identify their position within the document structure. Simple auditory icons are used to aid the listener in understanding the presented event, and research is ongoing to improve these.

In early versions of the sonification, the acts and scenes were produced with different instruments and pitches to allow the user to identify them as this element. This means that the user has to be taught what the sound means and how to associate events within the display. The present version of the software uses simple tones. We are considering the development of auditory icons to help identify the type of element event being presented. In [12], the author discusses the debates in musicology about the use of period and modern instruments in the playing of period music. This sets up a tension in the use of sound. As the text may not be modern, what sound should be represented: one that is contemporary to the text or to the user?

The stage element provides greater detail to use within the display. The ‘type’ and ‘who’ attributes help to design the type of sound. The sounds associated with the ‘who’ attribute can be linked to the speakers but present a different issue. The speaker attribute is associated with one person but the stage directions may have more than one person interacting with the direction. This changes the note from being a single note to a chord or progression. The volume for each speaker is slightly raised as they continue speaking, helping the user identify that the speaker has not changed. When comparing two streams, the listeners will identify any textual changes when both tone and volume alter. Using the two parameters of note and volume provides the user with two axes to understand the data.

Visualization

We created an early prototype visualization showing symbolic representations of the events, using the *Processing* language used for coding in the visual arts⁴. The note data was sent to the visualization server to show an abstract image or text based on the note received, displayed in near real-time to the sound. It did

⁴ <https://processing.org/>

aid comprehension of the audio display, but the use of abstract symbols like the circles for speakers, poses the same challenge as the sonification where the symbol must be understood.



Figure 2: Early visualisations to aid the sonification

User feedback suggests that further refinement is required to help make the displays more useful. This may include the use of text and being developed for the Web.

Future Work and Conclusion

We have demonstrated the potential of sonification as a tool to help the user identify differences between textual variants. Auditory displays are known in exploring data though new for analytical tools. The medium allows the designer to use multiple parameters simultaneously to add meaning to an event by changing tone, pitch, sound or volume. This presents challenges in finding ways of making the technique understandable.

The use of stereo playback indicates that further work with spatial displays is possible to aid the comprehension of the data with a richer display. The timing data is being written out with the frequencies are the sounds being created. This provides the potential for integration of the TEI data with SMIL duration markup and transformation into HTML Media Fragments so that the text can be displayed in the browser with links to the sound or converted into Music Encoding Initiative⁵ to be visualized in a novel fashion.

Words and lines may be auralized using the tone associated with the speaker. The sonification would then render the associated tones. This does pose the issue of how a word is sonified: is it by length or some other metric? The choice element from the Text Encoding Initiative provides the options for an original element and a variation. The sonification would then have to associate a similar tone with the choices. It may be that the original text would be the expected tone given the word change but that the variation is a sharp or minor tone played as a chord.

Further work is needed to create better auditory icons that work across streams and to integrate audio and visual displays. We have not explored this area fully. Contextual questions include the type of sound that would be typical in a dramatic context or physical one, such as the construction of places of performance. It also demands knowledge of the practices of staging. We intend

⁵ <http://music-encoding.org/>

to research the use of the sex attribute of the person element, contemporary auditory icons and conduct user testing.

We believe that the use of sound provides an exciting way of exploring textual structures to determine differences between them as an alternative workflow. The novelty in this area is a major challenge but we strongly believe that it has relevance in the exploration of variants between texts marked up with TEI.

References

[1] Gregory Kramer. 1993. *Auditory Display: Sonification, Audification, and Auditory Interfaces*. Perseus Publishing.

[2] `The Search for the "Killer Application": Drawing the Boundaries around the Sonification of Scientific Data`, Supper, Alexandra in *The Oxford Handbook of Sound Studies*, Pinch, Trevor, and Bijsterveld, Karin 2012. New York: Oxford University Press, New York, p253

[3] Keith V. Nesbitt and Stephen Barrass, Finding Trading Patterns in Stock Market Data, *IEEE Computer Graphics and Applications* 24:5, IEEE Computer Society, pp 45-55, 2004

[4] Digital facsimile of the Bodleian First Folio of Shakespeare's plays, Arch. G c.7, First Folio home page, <http://firstfolio.bodleian.ox.ac.uk/>

[5] C Hinman, Mechanized collation; a preliminary report., *Papers of the Bibliographical Society of America* 41 (1947): 99-106.

[6] Smith, Steven Escar. 2000. "'The Eternal Verities Verified': Charlton Hinman and the Roots of Mechanical Collation." *Studies in Bibliography* 53. 129-62.

[7] The tragedy of Hamlet Prince of Denmarke: an electronic edition, Hamlet, First Quarto, 1603. British Library Shelfmark: C.34.k.1, http://www.quartos.org/XML_Orig/ham-1603-22275x-bli-c01_orig.xml

[8] The tragedy of Hamlet Prince of Denmarke: an electronic edition Hamlet, Second Quarto Variant, 1605. British Library Shelfmark: C.34.k.2, http://www.quartos.org/XML_Orig/ham-1605-22276a-bli-c01_orig.xml

[9] The Holinshed Project: Comparing and linking two editions of Holinshed's Chronicle, James Cummings and Arno Mittelbach, *International Journal of Humanities and Arts Computing*. Volume 4, Issue 1-2, Page 39-53, ISSN 1753-8548, Available Online October 2010, <http://dx.doi.org/10.3366/ijhac.2011.0006>

[10] Keith V. Nesbitt and Stephen Barrass, of a Multimodal Sonification and Visualisation of Depth of Market Stock Data., Nakatsu and H. Kawahara (eds), *International Conference on Auditory Display (ICAD)*, 2002 , pp2—5

[11] De Roure, David C., Cruickshank, Don G., Michaelides, Danius T., Page, Kevin R. and Weal, Mark J. (2002) On Hyperstructure and Musical Structure. The Thirteenth ACM Conference on Hypertext and Hypermedia (Hypertext 2002), Maryland, USA, 11 - 15 Jun 2002. ACM, 95-104.

[12] Holden, Claire 2012. Recreating early 19th- century style in a 21st-century marketplace: An orchestral violinist's perspective. Presented at: *Institute of Musical Research DeNote Seminar*, Senate House, London, 30 January 2012.

[13] Sonification report: Status of the field and research agenda Prepared for the National Science Foundation by members of the International Community for Auditory Display (1997) by G. Kramer, B. Walker, T. Bonebright, et al., <http://sonify.psych.gatech.edu/publications/pdfs/1999-NSF-Report.pdf>

[14] Lehmann, L., Mittelbach, A., Cummings, J., Rensing, C., & Steinmetz, R. 2010. Automatic Detection and Visualisation of Overlap for Tracking of Information Flow. In *Proceedings I-Know*.