Sound Sketchbook: Synthetic Synesthesia on a Mobile Platform

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Abstract

The authors present Sound Sketchbook, a mobile phone application featuring real-time sound synthesis based on simple yet evocative cross-modal data mappings. While originally designed as a tool for evaluation of audiovisual correspondences, the application is also appreciated as an enjoyable sound toy and has a strong potential as a multimedia education tool for children. The authors introduce the data mapping strategy of Sound Sketchbook with regard to synesthesia, describe new cross-modal interactions implemented on mobile devices, and discuss the effectiveness of the application based on user survey results.

The unique relationship between image and sound has been explored by both scientists and artists throughout the ages. Study of such relationships, or "audio-visual data mappings," is especially relevant today as multi-modal interfaces emerge and multimedia performances gain popularity. Better knowledge of image-sound relationships could aid the design of audiovisual contents in both usability and appreciation aspects.

As a neurological cross-sensory condition, synesthesia becomes a key to understand and design new audiovisual mappings. Prior works on synesthesia-inspired mappings include those between brightness and amplitude [1], the location, size, and sharpness of shapes and pitch [2] [3], and color and pitch [4]. Cytowic and Eagleman also introduced a variety of synesthetic phenomena between auditory and visual domains [5].

Sound Sketchbook [6] is an iOS multimedia application which enables the user to experience "artificial synesthesiae" between fundamental visual elements and their auditory counterparts on a mobile device. The application features twelve different "sketches" (i.e., user interfaces) – each with its unique cross-modal data mapping scheme: users can draw objects on the touchscreen (or apply physical gestures to the mobile device itself) and listen to their corresponding sonic feedback immediately.

We devised the data mapping schemes of Sound Sketchbook with the aforementioned synesthetic mappings in mind. To make them as intuitive and easy-to-use as possible, we selected basic geometric elements (i.e., point, line, shape/polygon, etc.) as visual objects of the sketches, and their fundamental properties (i.e., position, size, color/texture, etc.) as synesthetic inducers to sound. This "minimalist" approach was most inspired by Kandinsky's theory of point, line, and plane as the basic elements to construct and deconstruct all paintings and images [7]. The potential of these simple, basic elements for forming synesthetic image-sound correspondence has been exemplified by numerous uses of pictorialism in music, including graphic notations of experimental music [8].

Fig. 1 shows the main screen of Sound Sketchbook: users can touch an icon to activate corresponding audiovisual sketch. Here the sketches are grouped into columns by the type of visual objects used, as summarized in Fig. 2: while visual properties correspond to fundamental attributes of sound (e.g., pitch, loudness, and timbre), mapping schemes become more complex in general as the rows descend and columns move to the right.

Interaction on Mobile Devices

The user interfaces for sketches are designed to be simple and intuitive, with various interaction scenarios in mind.

Most sketches offer two modes of operation – drawing and playing. In drawing mode the user can create visual objects to generate sonic events by touching (points), dragging (lines), and long-touching (shapes) on the screen, whereas pre-drawn elements are selected by touch to play sounds in playing mode. This allows the user to "design" a customized layout of objects in drawing mode and use the result as a graphic interface in playing mode. Sketches in the fourth column, on the other hand, feature fixed layouts of grayscale bars (J), noisy texture (K), and a puzzle inspired by Goethe's color triangle [9] to showcase the use of a color-pitch mapping scheme for interactive visualization of harmony (L).

As a step further towards suggesting new cross-sensory metaphors on a mo-

Fig. 1. Main menu screen of Sound Sketchbook. (© Meehei Kim.)

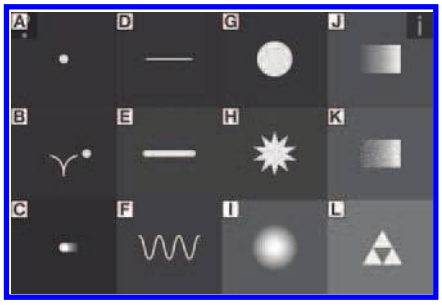
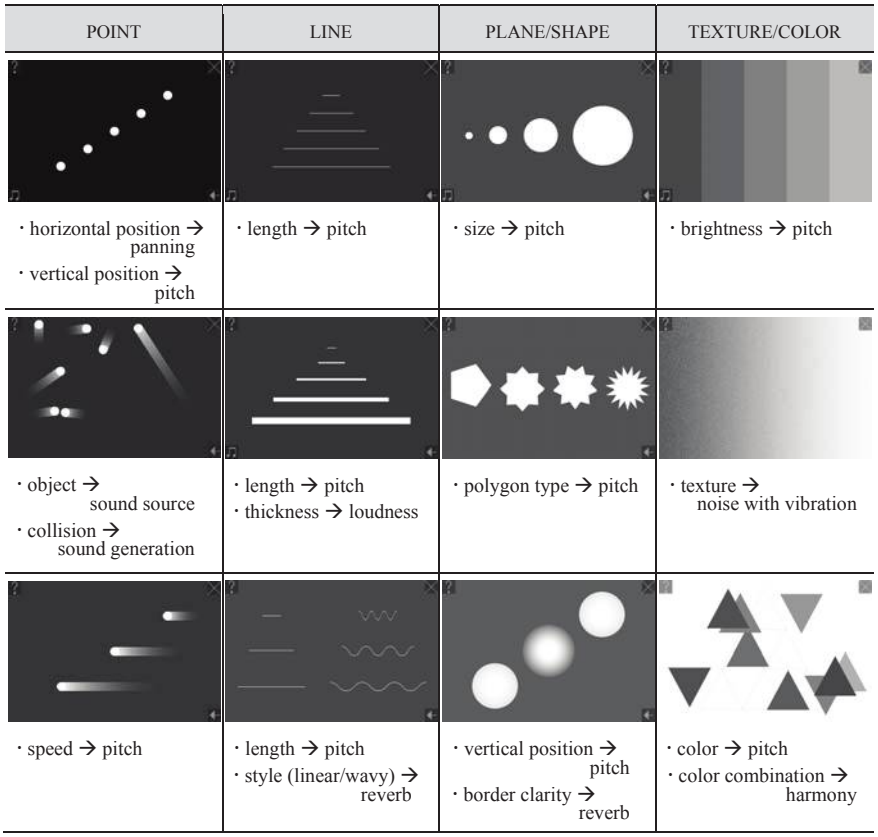


Fig. 2. Sketches of Sound Sketchbook. Sample screenshots are shown with descriptions of mapping schemes. (© Meehei Kim.)



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bile platform, we incorporated some of the interactive features of mobile devices for our interface design: selected sketches provide physical interaction by utilizing the accelerometer for gesture detection or the actuator for haptic feedback (i.e., vibration) as well as the touchscreen interface for drawing: users can shake the device like a maracas (B), slide fingers on the screen to control the speed of an object (thereby the pitch of associated sound) (C), and "rub" the screen to feel subtle vibrations – similar to that of a sandpaper (K) (see Fig. 3).

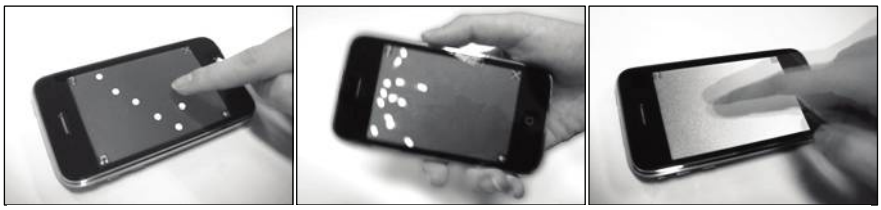

Fig. 3. Pictures of different user interactions: adding objects by touching (left), shaking the device (middle), and rubbing with haptic feedback (right). (Photo © Meehei Kim.)

User Experience

We conducted user surveys [10] on the level of cross-modal perceptual coherence of each sketch (on a scale of 1 to 5).

Results from these surveys are summarized in Table 1. As expected, sketches with simple and intuitive mappings based on well-known synesthetic phenomena not only received high coherence ratings but also were favored in general, as suggested by Ward et al. [11]. It should be noted that sketch H (with deliberately inverted mapping) scored the lowest rating, being the least preferred: many participants clearly noted that they felt the mapping was inverted. This suggests that participants' preferences were strongly affected by the degree of the cross-modal coherence.

In addition, it is noteworthy that interactive sketches were more favored than others with simple touchscreen input. The haptic feedback of sketch K was highly favored, and the familiar physical interaction method of sketch B – in spite of its relatively low coherence ratings mostly due to its over-simplified sound output – was also popular. Most participants instantly related (faster) dot speed to (higher) pitch in sketch C and enjoyed the sliding gesture, too. These show the potential of smartphone-enabled interactions as powerful methods for effective presentation of new and intuitive artificial synesthesia.

Table 1. Cross-modal coherence ratings and preference counts of sketches.

Coherence ratings (1-5 scale)			
A 4.1	D 3.6	G 4.1	J 3.9
B 3.3	E 3.3	H 2.6	K 4.1
C 3.9	F 3.1	I 3.2	L 2.8

Preference counts (most | least)			
A 3 | -	D 3 | -	G - | -	J - | 1
B 4 | 2	E - | -	H - | 7	K 5 | 1
C 1 | -	F - | 1	I - | 3	L 1 | 3

Sound Sketchbook is also promising as a multimedia toy for children. At a public exhibition with eight other musical interfaces [12], we found that Sound Sketchbook was the most popular interface among children: many of them instantly learned how to use the application and played with almost every sketch (Fig. 4).

Fig. 4. Children playing with Sound Sketchbook (Photo © Meehei Kim).

Conclusion

Sound Sketchbook is one of the first attempts to provide synesthetic experience on a mobile platform: the application shows that advanced mobile devices can extend the scope of synesthetic inducers by providing a variety of multimodal interfaces, and hence create new (sometimes unorthodox) but perceptually coherent synesthetic phenomena.

Although Sound Sketchbook was developed for user tests at first, it has been highly appreciated by a number of users as a sound toy and/or an interactive musical instrument. The intuitive, easy-to-use interface made the software highly attractive to children as well.

Future work will include providing upgraded features (e.g., more flexible drawing capabilities, enhanced playability as a musical interface, etc.) as well as introducing new interactive synesthetic mappings. We will also investigate the effects of cross-modal transfers (especially those on a mobile platform) on creativity to verify the effectiveness of Sound Sketchbook for multimedia education.

References and Notes

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6. Sound Sketchbook is available for download on Apple's iTunes App Store.

7. Wassily Kandinksy, *Point and Line to Plane* (New York, USA.: Dover Publications, 1926).

8. Golan Levin, *Painterly Interfaces for Audiovisual Performance*, M.S. Thesis. (Cambridge, USA.: Massachusetts Institute of Technology, 2000).

9. Josef Albers, *Interaction of Color* (New Haven, USA.: Yale University Press, 1975).

10. We had twenty participants, all with previous experience with touchscreen mobile devices. Note that, for this survey, the mapping for sketch H was deliberately inverted for test purpose (as a control condition).

11. Jamie Ward, Samantha Moore, Daisy Thompson-Lake, Shireen Salih, and Brianna Beck, "The Aesthetic Appeal of Auditory-Visual Synaesthetic Perceptions in People without Synaesthesia," *Perception* **37,** No. 8 (August 2008) pp. 1285–1296.

12. Sound Sketchbook was featured at *Studio SEMI*, an exhibition of digital musical interfaces with concerts.