Figure 1. EmotiSphere on its base.

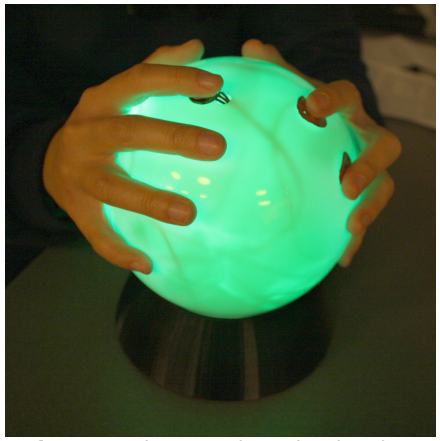

Figure 2. The user places her hands on the sphere so that her fingers rest on the galvanic skin and pulse sensors. Here, the sphere produces green light, indicating the user is relaxed.

EmotiSphere: From Emotion to Music

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Abstract
EmotiSphere is an interactive sensor-based musical instrument that generates music based on a user's current emotional state. Interactions with EmotiSphere draw upon everyday interactions with physical spherical objects, as well as on familiar interactions with music players. EmotiSphere offers a novel way to understand the relationship between emotion and music, and is aimed at people who want to create music and express themselves but do not necessarily possess skills in music composition. We describe the conceptualization and context of EmotiSphere, as well as its technical implementation.

Author Keywords
Tangible interaction; musical instrument; physiological sensors; Arduino

ACM Classification Keywords
H.5.2 [User Interfaces]: Auditory (non-speech) feedback; J.5: [Arts and Humanities]: performing arts; H.5.5: [Sound and Music Computing]: Methodologies and techniques

General Terms
Design, Human Factors, Experimentation

Introduction
Throughout the day, a person experiences a range of ephemeral emotions. Is there a way to utilize the

Figure 3. The left hand is placed on two galvanic skin sensors, and the right hand is placed on a pulse sensor.

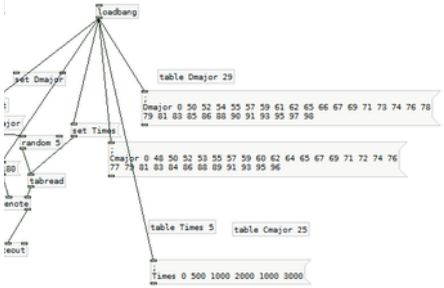

Figure 4. A partial screen shot of Pure Data, the visual programming language used for EmotiSphere's algorithmic music composition.

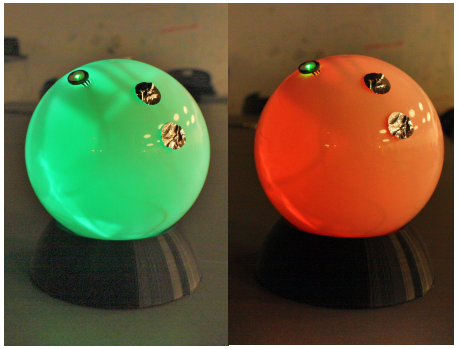

Figure 5. When a relaxed profile is sensed, the sphere glows green. With an angry profile, the sphere glows red.

inherent relationship between music and emotion to create a more tangible translation of emotions felt during the day? EmotiSphere attempts to address this question by translating physiological markers of emotion, gathered through galvanic skin sensors and a pulse sensor, into a composition of sound and light. It can be used in a range of settings, such as at home, at the office, or in a classroom, but is not meant to be portable. Users place their hands on the orb to initiate recording, and can immediately hear the results. Interactions with EmotiSphere draw upon its spherical form, utilizing actions such as shaking, rolling, and rotating.

Related Work

Several projects have examined the relationship between music and emotion, while many others have utilized physiological sensors to measure emotion. Here we describe those most closely related to our work. The "2Hearts" system generates musical compositions from the output of physiological sensors of two people as they interact with one another [6]. "Vocal Vibrations" also utilizes an orb design. When the user holds the Oral Resonant Ball (ORB) and speaks, the ORB reproduces the vibrations created by his or her voice [3]. "ZenTrader" uses a galvanic skin sensor to measure the stress levels of stock traders, and helps prevent them from making risky, emotion-driven decisions [5]. "Inmamusys" is an artificial intelligence system that creates music designed to elicit a certain emotional response [2]. While each of these projects share common elements with EmotiSphere, none of them combine real time computer composition with emotion sensing.

Design and Concept

EmotiSphere allows users to record and store computer-generated music, access previously recorded songs, delete music, navigate in a song database, play and pause songs, and adjust the volume of the music. The orb is connected wirelessly to a computer, where the songs are generated and stored. It rests on a base for stability, and can be removed for certain interactions.

EmotiSphere utilizes its spherical form to guide users through interactions with functionality similar to popular music players. Users activate music generation by placing two fingers of the left hand on the galvanic skin sensors, and one finger of another hand on the pulse sensor, while resting their other fingers naturally on the sphere (Fig. 2, 3). When the user takes his or her hands off the sphere, sensors no longer detect input and recording stops. The song is saved in a database stored in a nearby computer, unless the user deletes the recorded song by immediately shaking the orb (Fig. 6d). To access songs in the database, users can remove the sphere from its base and roll it one full rotation to the left or to the right to navigate between songs (Fig. 6a). The bottom of the sphere is weighted to maintain an upright position after rolling. To play or pause a song, the user can press on the orb in its base (Fig. 6c). To increase or decrease the volume, the user turns the orb clockwise or counterclockwise from above, like a knob (Fig. 6b).

Profiles of emotions are created from skin and pulse sensors, and for each profile a song is generated from an application on the connected computer. Along with a song, LEDs within the sphere will also light up, with color depending on the emotional profile (Fig. 2, 5).

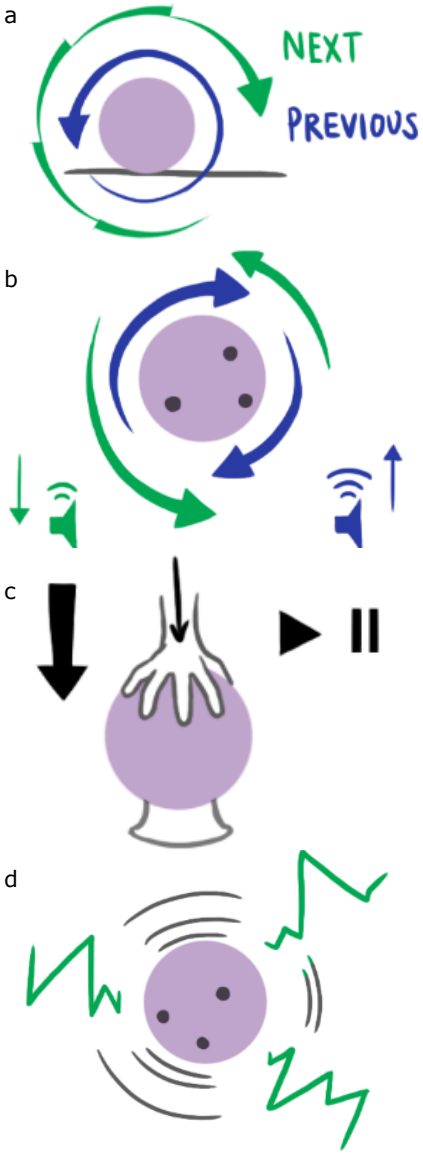

Figure 6. a) Rolling navigates between songs (view from side). **b)** Clockwise rotation increases the volume, while counterclockwise decreases the volume (view from above). **c)** Pushing on the sphere plays and pauses music. **d)** Shaking the sphere deletes the most recent song.

Implementation

EmotiSphere uses Arduino [1] to collect input from galvanic skin sensors and a PulseSensor [8] on the outside of the sphere, as well as a pressure sensor and reed sensors located at the bottom, and an accelerometer. The bottom of the sphere is weighted, and the base contains magnets. Based on the emotional profile of the sensor input, the Arduino also controls RGB LEDs to display different colors associated with different emotions (Fig. 2, 5).

Sensory input is translated into a series of emotional profiles, determined by calculating the change and trend of galvanic skin conductance over ten seconds. According to previous research on physiological signs, frequent fluctuations in skin conductance signify more agitation or arousal and an upward trend of skin conductance indicates relaxation [10]. Combined with heart rate thresholds, skin conductance will be used to generate one of four profiles: relaxed, excited, anxious, or angry. Corresponding LED colors for these profiles are green, yellow, orange, and red, respectively. These colors are chosen in accordance with the findings of a previous study conducted on humans' association of colors to music emotion [7]. Once the emotional profile is determined, the music composition application utilizes the Pure Data [9] programming language to generate a composition utilizing musical parameters such as key, pitch variation, dynamics, and articulation appropriate for the profile. Musical parameters draw upon changing the perceived emotion of computer-generated music [4]. The tempo of the music is mapped to the user's heart rate.

The input from Arduino is sent wirelessly to a connected computer, where the composition program processes it. The resulting composition is played via computer speakers. Interactions with the sphere affect the program running on the computer. For instance, turning the sphere clockwise on the base will increase the volume (Fig. 6b).

Conclusion and Future Work

EmotiSphere is a spherical musical interface that illuminates the relationship between music and the physiological expression of emotion. Interaction is designed to be intuitive to the spherical shape. We plan to improve database interactions, and expand the music production capabilities. The EmotiSphere prototype has been presented in a classroom setting, where it was well accepted. Suggestions included adding the functionality of setting user preferences for algorithmic composition parameters and saving the initial emotional profile reading for successive compositions within a time range, both of which we plan to implement. In the future, we will evaluate EmotiSphere in classroom, office, and home settings.

Acknowledgements

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References

[1] Arduino http://arduino.cc

[2] Delgado, M., Fajardo W., Molina-Solana, M. Inmamusys: Intelligent multiagent music system. *Expert Systems with Applications* 36.3 (2009): 4574-4580.

[3] Holbrow, C., Jessop, E., Kleinberger, Rébecca. Vocal Vibrations: A Multisensory Experience of the Voice. In *Proc. NIME '14,* 2014.

[4] Livingstone, S., Muhlberger, R., Brown, A., Thompson, W. Changing musical emotion: a computational rule

system for modifying score and performance. *Computer Music Journal* 34.1 (2010): 41-64

[5] Luan Dang, T., Kun Liu, S., Fels, Sidney. ZenTrader, an Emotion-Reactive Interface. In *ICEC 2011*, 2011.

[6] McCaig, G., Fels, S. Playing on Heart-Strings: Experiences with the 2Hearts System. In *Proc. NIME 2002,* 2002.

[7] Palmer, S., Schloss, K., Xu, Z., Prado-Léon, L.R. Music-color associations are mediated by emotion. *PNAS* 110.22 (2013)

[8] PulseSensor http://pulsesensor.myshopify.com

[9] Pure Data http://puredata.info

[10]Villarejo, M. V., Zapirain, B. G., Zorrilla, A. M. A Stress Sensor Based on Galvanic Skin Response (GSR) Controlled by ZigBee. *Sensors* 12.5 (2012): 6075-6101