An Evaluation of the Audiopad

A Tag-based Interface for Musical Performance

Agneya A. Kerure
Georgia Institute of Technology
Atlanta, Georgia, United States of America 30318
kerure.agneya@gatech.edu

ABSTRACT

This paper details the Audiopad which is a table-top interactive musical system which utilizes a touch based user interface. The technologies used by the Audiopad have also been explained. The paper also comments on the interaction design of the Audiopad and it's usability. An evaluation of the system as a whole and a representation of the system in a dimensional plot is presented and reasons for the scoring have been given. The Audiopad is a unique musical interface which warrants a thorough study and critique.

KEYWORDS

Audoipad, Touch User Interface, Table-top music making

ACM Reference format:
Agneya A. Kerure. 2017. An Evaluation of the Audiopad. In *Proceedings of ACM Conference, Washington, DC, USA, July 2017 (Conference'17),* 4 pages.
https://doi.org/10.1145/nnnnnnn.nnnnnnn

Figure 1: The Reactable Musical Interface

1 INTRODUCTION

The Audiopad is a tangible musical interface which combines the modularity of knob based controllers with the expressivity of multi-dimensional tracking interfaces [6]. In order to describe the system , it is important to understand a few basic definitions. TUIO stands for Tangible User Interface Objects which is a simple yet versatile designed to meet the needs of table-top tangible interfaces, where the user is able to manipulate a set of objects which are tracked by a sensor system and can be identified and located in position and orientation on the table [4]. Radio-frequency identification is a method of automatically tracking and identifying objects using electromagnetic fields [8]. This is done by using tags attached to the object which contains electronically stored information about the position and location of the object.

2 BACKGROUND

There have been numerous attempts at building a tangible table-top user interface. The earliest attempt at a table-top interface was Wellner's Digital Desk [9] which projected images down onto a real desk and paper documents. It responded to interactions with pens and bare fingers as well and could read paper documents placed on the desk [9]. This was a prominent milestone in the development of this field. One of the most important attempts at this was the Sensetable [5]. This system offered improvements over existing object tracking approaches like computer vision by reducing the possibility of tracking being affected by occlusion or changes in lighting conditions and hence tracking objects quickly and accurately. It also allowed the objects to have states which could be modified by physical dials and modifiers and be tracked in real time. Computer vision based approaches have problems with robustness due to need for controlled lighting conditions. Magnetic tracker based approaches require the objects to be attached to wires [5]. A more recent tangible table-top interface is the Reactable [3] which is developed specially for music performance. It is a simple and an intuitive interface which turns music into a tangible and a visual experience which enabled users to create music in a unique way. This table is controlled by manipulating tangible acrylic pucks on a translucent luminous surface, rotating them and connecting them to each other to create a unique and flexible composition [3]. The Audiopad is one of the most prominent and unique table-top user interfaces for music performance which paved the way for the further development of such interfaces. Thus a study of it is warranted.

3 SYSTEM

Audiopad determines the position and orientation of "pucks" on a tabletop surface and maps this data into musical cues such as volume and effects parameters. Graphical information is projected

Conference'17, July 2017, Washington, DC, USA

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

Figure 2: The Audiopad

onto the tabletop surface from above, so that information corresponding to a particular puck on the table appears directly on and around the object. This seamless coupling of physical input and graphical output can yield a musical interface that has great flexibility and expressive control [6]. The performer receives haptic feedback while manipulating objects on the table which is an important aspect in musical applications. The objects on the table also behave as persistent representations of the digital system on the table [6]. Objects also allow the performer to physically arrange parts of the song on the table. Audiopad also enables a two stage control using physical objects - one object that corresponds to the desired parameter which is to be manipulated and another one to adjust the parameter. This was not possible in previous systems which controlled one parameter by a single physical object.

3.1 RF Tagging

Audiopad tracks each puck using one or two radio frequency tags, known as an LC tag which consists of a coil of wire and a capacitor [6]. This circuit resonates at a specific frequency depending on its inductance and capacitance. The Audiopad hardware is a result of further development of the Sensetable system which has allowed Audiopad to track objects accurately to within 4mm [6]. The amplitude of the tags is measured by several specially shaped antennas. The amplitude of each tag's resonance varies as a function of the position. By attaching two LC tags to a single object, the position and orientation is determined. The relative positions of the two tags indicate the object's orientation [6]. The tag server also communicates tracking information to the video and audio components of the software which then generate graphical feedback onto the table using a projector. MIDI commands are also sent based on the gestures made using the objects [6].

3.2 Music Making

Audiopad currently uses Ableton's Live [2] software as it's musical back end which arranges a set of sample loops into tracks and allows arbitrary playback of these samples on an arbitrary number of tracks [6]. These samples are always in sync with each other and are triggered with quantization to the bar. Live also allows control of audio effects and parameters [6].

4 INTERACTION DESIGN

In table based interfaces, information is made easily graspable with direct manipulation of simple objects. Such a table can favor nearly unlimited multi-parametric and shared control, interaction and exploration, multi-user collaboration, while contributing to delicate intimate interactions as well. Moreover, the seamless integration of visual feedback and physical control brings forward a richer interaction with music [3]. Patten et al.[7] describe the opportunity to design a set of intuitive interaction techniques for TUI interactions provided by Audiopad. Along with the interactions provided by the Sensetable, Audiopad supported additional interface elements on top of the surface, such as button, dials and interchangeable tokens [7]. Periodic performances and installations gave the development team the opportunity to gauge reactions from the performers and the audience to redesign and improve the interactions afforded by the table. The main motivation which drove the interaction design of Audiopad was the need the allow the audience to begin to see the cause-and-effect relationship between the performer's actions and the changes in music, which stemmed from the visible lack of engagement from the audience in an electronic music performance. It was important to clearly define the motivation to design the interactions as the quality of the performance depends heavily on the ease of interaction with the surface. Another important aspect to consider was the different parameters which were to be manipulated by the performer. These could be both continuous and discrete [7]. A performer begins using Audiopad by mapping pucks on the sensing surface to groups of samples in a piece to be performed [6], where he can select the samples to be played, modify effects, and change sample volumes. The use of several physical objects combined with the display of graphical information on and around them enables a rich set of interaction techniques. One such technique is the ability to dynamically associate pucks with tracks. This allows musicians to perform with numerous tracks using relatively few pucks. Once a track has been associated with a puck, the performer can select from a tree of samples using the selector puck. The performer can rotate a puck to adjust the volume of the corresponding track. The current volume of the track is displayed to the left of the puck. When the performer presses the button on top of the puck, the system displays information about the effect settings of the track, and movement of the puck controls these settings [6].

5 EVALUATION

Birnbaum et al. explored several quantities and configurations of axes to adapt dimensional space to analyze musical devices [1]. There are seven important dimensions to be considered while analyzing a musical instrument or device. This paper has analyzed the Audiopad based on these dimensions and has given a rating out of a possible ten points in each axis.

5.1 Required Expertise

This axis represents the level of practice and familiarity with the system that a user or performer should possess in order to interact

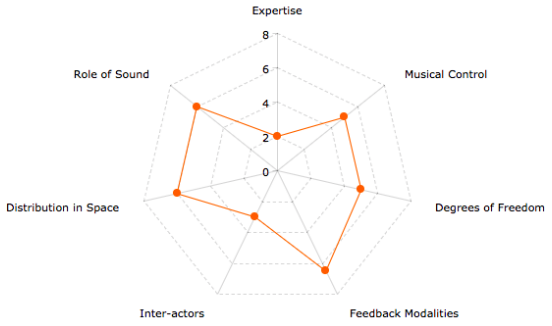

Figure 3: Audiopad Evaluation Chart

Table 1: Audiopad Evaluation Ratings out of 10

Property	Rating
Expertise	2
Musical Control	Control over Musical Process
Degrees of Freedom	5
Feedback Modalities	6.5
Inter-actors	3.5
Distribution in Space	6
Role of Sound	Artistic/Expressive

as intended with the system [1]. The Audiopad does not require the user to be an expert in it's usage to make interesting music. The Audiopad is very easy to learn and start using. This gives it a low floor of approach. This warrants a rating of 2 in difficulty 10 being the most difficult instrument, for example, the trumpet which requires a lot of practice and physical capabilities to produce a musical output.

5.2 Musical Control

This axis specifies the level of control a user exerts over the resulting musical output of the system [1]. The axis is not continuous, rather it contains three discrete points following the characterization of, using three possible levels of control over musical processes: timbral level, note level, and control over a musical process. The Audiopad does not have a lot of control over it's musical output. The music is predefined in the system and the user can only arrange it in a desired way. It does not produce timbral or note level control over the output and hence scores low in this field. The highest score could be given to an acoustic instrument such as a guitar where not only the notes played can be manipulated, but the timbre of the guitar as well.

5.3 Feedback Modalities

This axis indicates the degree to which a system provides real-time feedback to a user [1]. Typical feedback modes include visual, auditory, tactile, and kinesthetic. The Audiopad provides visual, auditory and tactile feedback to the user which warrants a high score in this field. The graphics formed on the pucks are a visual feedback, the sound and music produced is the auditory feedback and the buttons and knobs on the pucks provide tactile feedback.

5.4 Degrees of Freedom

The Degrees of Freedom axis indicates the number of input controls available to a user of a musical system. This axis is continuous, representing devices with few inputs at one extreme and those with many at the other extreme [1]. The Audiopad proved a relatively low number of controls to the user because of the inherent structure of the system which allows control over a musical process. While it may seem that it has a lot of pucks to play with, the overall effect of the pucks does not actually change the musical output to a big extent, thus warranting the score of 5. It only provides a limited number of pucks to control the loops being played and a few of their properties like volume and filter cutoff.

5.5 Inter-Actors

This axis represents the number of people involved in the musical interaction [1]. Typically interactions with traditional musical instruments feature only one inter-actor, but some digital musical instruments and installations are designed as collaborative interfaces, and a large installation may involve hundreds of people interacting with the system at once. The Audiopad is a large instrument if compared to a traditional acoustic instrument such as the flute. But it is a very small system compared to the global reach of instruments built on the internet which can be used by many people sitting in different continents. This warrants the low score of 3.5 out of a possible 10 points.

5.6 Distribution in Space

The Distribution in Space axis represents the total physical area in which the interaction takes place, with values ranging from local to global distribution [1]. This dimension is similar to the inter-actors as if an instrument has a global range, it is as big as the earth and hence the Audiopad is small as compared to global musical systems. On the other hand, most musical instruments and systems are smaller than the Audiopad and hence it gets a 6 out of 10 in this field.

5.7 Role of Sound

The axis ranges between three main possible values: artistic/expressive, environmental, and informational [1]. The Audiopad only has artistic expressiveness and does not produce an environmental or an informational output.

6 CONCLUSIONS

The Audiopad demonstrates that interacting with electromagnetically traced objects on a tabletop surface with a graphical feedback is a powerful tool for musical expression. The current version of the system allows only for one audio effect to be used at a time, which is a limitation in the aspect of musical performance. Also, the number of tags which can be tracked by the system currently is very limited. In addition, it will be interesting to explore the role of this system in the context of musical composition, rather than just performance.

Most importantly, according to the creator of the system [6], "The further evaluation and development of the Audiopad will require road testing in live performance settings. It is perhaps only in this type of environment that we can truly appreciate strengths and weaknesses of this interface for the electronic musician."

ACKNOWLEDGMENTS

The author would like to thanks Dr. Jason Freeman for giving him the opportunity to study the amazing Audiopad and being available to help whenever help was required. The author would also like to thank Mr. Takahiko Tsuchiya for his support and availability throughout the phases of study and research for the paper. A big thanks to everyone who was involved in the conception of this idea and their constant support. The author would like to thanks Dr. Jason Freeman for giving him the opportunity to study the amazing Audiopad and being available to help whenever help was required. The author would also like to thank Mr. Takahiko Tsuchiya for his support and availability throughout the phases of study and research for the paper. A big thanks to everyone who was involved in the conception of this idea and their constant support.

REFERENCES

[1] David Birnbaum, Rebecca Fiebrink, Joseph Malloch, and Marcelo M Wanderley. 2005. Towards a dimension space for musical devices. In *Proceedings of the 2005 conference on New interfaces for musical expression*. National University of Singapore, 192–195.

[2] D DeSantis, I Gallagher, K Haywood, R Knudsen, G Behles, J Rang, R Henke, and T Slama. 2016. Ableton Reference Manual Version 9. (2016).

[3] Sergi JordÃă. 2010. The Reactable: Tangible and Tabletop Music Performance. In *CHI '10 Extended Abstracts on Human Factors in Computing Systems (CHI EA '10)*. ACM, New York, NY, USA, 2989–2994. https://doi.org/10.1145/1753846.1753903

[4] Martin Kaltenbrunner, Till Bovermann, Ross Bencina, and Enrico Costanza. 2005. TUIO: A protocol for table-top tangible user interfaces. In *Proc. of the The 6th IntâĂŹl Workshop on Gesture in Human-Computer Interaction and Simulation*. 1–5.

[5] James Patten, Hiroshi Ishii, Jim Hines, and Gian Pangaro. 2001. Sensetable: A Wireless Object Tracking Platform for Tangible User Interfaces. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '01)*. ACM, New York, NY, USA, 253–260. https://doi.org/10.1145/365024.365112

[6] James Patten, Ben Recht, and Hiroshi Ishii. 2002. Audiopad: A Tag-based Interface for Musical Performance. In *Proceedings of the 2002 Conference on New Interfaces for Musical Expression (NIME '02)*. National University of Singapore, Singapore, Singapore, 1–6. http://dl.acm.org/citation.cfm?id=1085171.1085175

[7] James Patten, Ben Recht, and Hiroshi Ishii. 2006. Interaction Techniques for Musical Performance with Tabletop Tangible Interfaces. In *Proceedings of the 2006 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology (ACE '06)*. ACM, New York, NY, USA. https://doi.org/10.1145/1178823.1178856

[8] R. Want. 2006. An introduction to RFID technology. *IEEE Pervasive Computing* 5, 1 (Jan 2006), 25–33. https://doi.org/10.1109/MPRV.2006.2

[9] Pierre Wellner. 1993. Interacting with Paper on the DigitalDesk. *Commun. ACM* 36, 7 (July 1993), 87–96. https://doi.org/10.1145/159544.159630