Sketch-Based Musical Composition and Performance

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ABSTRACT

Sketching is a natural way for one person to convey their thoughts and intentions to another. With the recent rise of tablet-based computing, the use of sketching as a control and interaction paradigm is one that deserves exploration.

In this paper we present an interactive sketch-based music composition and performance system called Drawchestra. The aim of the system is to give users an intuitive way to convey their musical ideas to a computer system with the minimum of technical training thus enabling them to focus on the creative tasks of composition and performance.

The system provides the user with a canvas upon which they may create their own instruments by sketching shapes on a touch screen. The system recognises a certain set of shapes which it treats as virtual instruments or effects. Once recognised, these instruments can then be played by the user in real time. The size of a sketched instrument shape is used to control certain parameters of the sound so the user can build complex orchestras containing many different shapes of different sizes. The sketched shapes may also be moved and resized as desired making it possible to customise and edit the virtual orchestra as the user goes along.

The system has been implemented in Python and user tests conducted using an iPad as the control surface. We report the results of the user study at the end of the paper before briefly discussing the outcome and outlining the next steps for the system design.

Keywords

Creativity, Sketch, Design Exploration, Composer

1. INTRODUCTION

A lack of adequate technical literacy can potentially be a barrier between the user and computer-based music creation software systems. Powerful music software may be too complex to learn quickly while simple, easy to learn software may constrain the user in what they can create. To address this issue, we present here a sketch-based composition and performance system, Drawchestra, that is designed from the outset to be intuitive and easy to learn while at the same time allowing the user as much control as possible over what is created.

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The use of sketching as means of communication can be traced all the way back to prehistoric times [13]. It has been shown that sketching positively affects the idea generation process [19], as well as facilitating problem solving [5]. Considered as an efficient way to convey and record physical information, sketching has been explored as means of computer input [17]. It has been used in many areas including design, architecture, user interface creation [6], mechanical engineering [3] and UML(unified modelling language) class diagrams [16]. In the field of music, sketching is also widely used by composers in the creative phase to plan out the wider shape of the work. Indeed, research has found that even highly computer-literate composers tend to begin their creative process by expressing their musical ideas on paper [9].

Systems such as DrawSound [11], Drawdio [14] and Sonic Wire Sculptor [15] have explored the spatial information of sketches for sound creation. Synthesized sounds in these systems are generated by mapping audible frequencies to the position of a drawn element in relation to the origin of a drawing. Graphical scoring programs such as Hyperscore [8] have also used spatial information in a similar fashion, mapping time to one axis and pitch to the other.

Some systems such as Music Sketcher [2, 1] and Tunetrace [10], generate sounds by interpreting the structural information of a drawing. In Music Sketcher, the user can define their own parameters for a two dimensional space where sketches are to be mapped. In Tunetrace the structure of a rasterised image is analysed and turned into a connected graph. This graph is then treated as a program for a simple synthesis process to run; the complexity of the image directly influencing the complexity of the output soundscape.

Other image based music systems such as Monalisa [12] use image and data sonification techniques to generate music. Sonification using sketches has become a popular art form in recent years [20], however we would contend that this technique is not particularly suited to music composition in the strictest sense because the output of a sonified sketch can be difficult for the user to predict.

All the projects mentioned here so far have used sketches or images as input. The input for these systems is usually in the form of rasterised images or wave-like hand-drawn lines. Little attention has been paid to the *meaning* of sketched objects in the images although it is precisely this information that humans take from the images. In the Illusio system [4], players are required to draw objects and associate sounds with those objects. The project explores the connection of shapes and music by associating a sketch with live loops. The sketched objects in Illusio act as marks for storage spaces while the shapes themselves have no direct connection with sound loops and the feature of sound loops can not be inferred from the sketch.

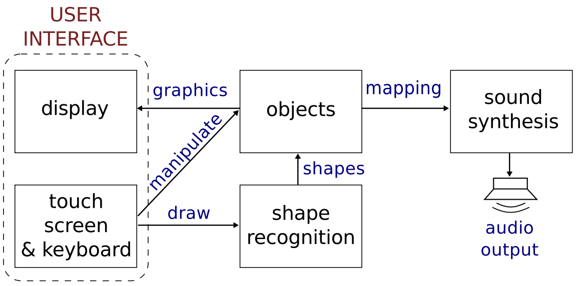

Figure 1: The user interacts with a touch screen display and a keyboard to draw new shapes on to the screen and manipulate existing ones. New shapes are processed by the shape recognition module that identifies what type of instrument or effect the sketch represents. Once an object's type has been decided, it can be played, moved, resized or deleted by the user. The musical synthesis engine generates the sound associated with an object when it is tapped.

An interactive paper space is developed in the InkSplorer project [9], aimed at enhancing and refining composers' computer-based exploration phase of music composition. InkSplorer needs to be integrated to existing tools, OpenMusic and Max/MSP so a level of proficiency with these systems is prerequisite in order to use it.

In terms of interaction with sketched objects, Drawchestra is perhaps most closely related to Freepad [7]. The researchers developed a musical interface using a webcam and computer vision techniques to detect the free hand drawings of a user on paper and transform these into MIDI notes. The system captures the empty paper image and then any shapes drawn subsequently can be detected by calculating a difference page between the empty paper and the new state. A user can draw new shapes with a pen and then interact with the objects they have created by tapping them with their finger or pen, acting like a drum stick. The features of the shape which is drawn do not contribute to the MIDI note output. In the Freepad system, the velocity of the user's finger striking an object can be detected using the frame difference, whereas capturing this type of velocity information is not yet possible with commercially available capacitive touch screen devices. This feature, as well as the immediacy and ease of use of the Freepad system are great advantages but the use of paper and live video also has some potential drawbacks: With a paper and pen based system, the user cannot change the sketched objects they have created. The use of a webcam and video processing software also makes the system computationally expensive since each frame needs to be processed. More importantly, such a system is unable to provide direct visual feedback. Thiebaut et. al. [18] point out that program and paper have different affordance; the action and reaction that a computer program can offer cannot be matched by traditional sketching on paper. For this reason the Freepad system is more like a drawing board with sound feature than a fully interactive musical interface.

2. SYSTEM OVERVIEW

The system is programmed in Python using Pygame and wxPython for the user interface with Mingus and pyFluidSynth modules for sound production.

Figure 1 gives an overview of the system architecture, showing how the touch screen interface works with the shape recognition and sound synthesis modules. The current shape recognition algorithm analyses the size and angle of each turn in a pen stroke. This is a simple and effective way of categorising sketched shapes but it requires that the user finish each shape with a single stroke. After being recognized, a shape can be played when it is tapped by the user. The current system does not sequence objects in time, but it is considered to be employed in future development.

Table 1: Shapes recognised by Drawchestra along with their associated sounds and control parameters.

Shape	Instrument/effect	Size parameter
Circle	Drum	Volume
Triangle	Orchestra Hit	Pitch
Rectangle	Acoustic Piano	Pitch
Straight line	Acoustic Guitar	Pitch
Twist line	Slap Bass	Pitch
Half-Circle	Delay effect	Delay time
Half-Rectangle	Chorus effect	Depth

The system can recognise seven different types of shape which have a defined instrument type or effect associated with them (a list of the shapes and associated sounds is given in Table 1). Although the mappings are arbitrary, the instrument sounds and the shapes were matched where possible to reflect objects in nature that make similar sounds i.e. a straight line represents a string, a circle represents a drum etc. The size of a given shape is also used as a control parameter for the generated sound; the choice of parameter depending on the shape type. For example, pitched sounds from objects such as lines or rectangles derive their pitch parameter from the size; large objects mapping to lower pitches to match the physics of resonant bodies in nature. The sound synthesis module uses MIDI to generate the output sounds with instrument pitches mapped into the pitch range G2 to F5.

When a shape is being drawn, the line colour is black. After a shape is completed and recognised, the system will change the colour of the line to reflect which type of object it is, helping the user to spot any recognition errors. To maximize feedback, the system not only provides an audible response to playing of an instrument but also visual feedback in the form of animation. When a user plays a shape by tapping it, the shape will be animated while the sound output is generated. Again, the animation depends on the type of shape with lines flexing in the middle like a plucked string or a triangle spinning on its centre in the case of the orchestra hit object. When sound effect objects are triggered, blue sparkles appear inside the effect object. In addition, where a sketched object is not a recognised shape, the outline slowly decays and becomes fuzzy to inform a user that this shape is not in the "instrument library".

3. USER STUDY

To validate the usability of the application, a user study was conducted involving 10 participants, half of whom were trained musicians while the rest had no previous music training.

Our prototype system was developed using the python Pygame library to deal with graphics and capture mouse events. For the user study we connected an iPad as a slave touch screen control device; this set up did not support multi-touch, so we used a keyboard to control the mode of user interaction.

Figure 2: The user interface for Drawchestra comprises an iPad and a keyboard. The iPad is employed as a slave touch screen through which user can draw and manipulate shapes. The keyboard, which is labelled for the convenience of the participants, is used to switch between the modes of user interaction due to the current system does not support multi-touch.

3.1 Setup and task design

Since the application is an interactive surface, at this early stage, we are concerned more with the control and usability experience of the interface rather than aesthetic factors of the music that was produced. In this study, all of the participants were required to act as both composer and performer by creating a short piece of music with the system. The complete user interface as seen by the participants is shown in Figure 2, comprised an iPad for display and touch gesture capture along with a keyboard with buttons to select the actions draw, move, resize and remove (the default action when no buttons are pressed is to play the instrument).

Before starting, an information sheet introducing the application and its controls was provided to participants to help them gain a general understanding of the application. The experiment had two main parts: To begin with the participant was given 5-10 mins of unstructured time to familiarise themselves with the interface then they would be given a further 5 minutes to create their short piece of music, performing it at the end.

3.2 Measurement

During the test, the screen and audio output was recorded through video capture software to provide us an overview of how people use the application and sketch in real time. Observing the way people sketch in the context is extremely useful for future improvement of the system. In addition, post-test questionnaires were given to participants to gather their feedback regarding the usability of the application. Information about the musical training and composing history of the participants was collected along with a five-point Likert scale questionnaire to gather general feedback. The questionnaire concluded with some open questions to collect the participants personal thoughts on the experience.

3.3 Results

Overall, the participants found the application is easy to use, but found the building and composition of their piece more easy than performing it. According to the questionnaires, we found musicians thought it was easier to draw a shape at the pitch that they wanted than the novices do.

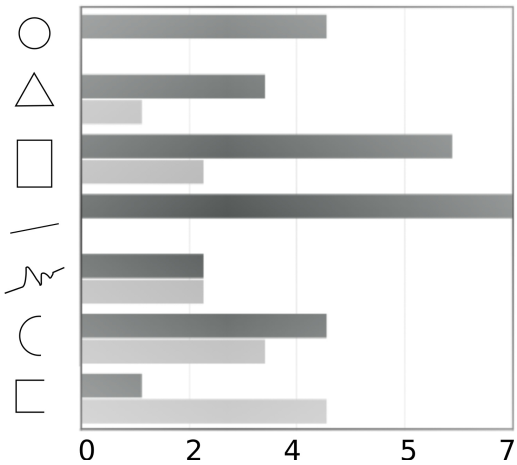

Figure 3: User feedback on the ease of interaction with different shapes. Dark grey bars represent users viewing a shape as intuitive, light grey represents users who reported a shape as being non-intuitive.

The participants voted for the instruments (shapes) that they felt were most or least intuitive to interact with. The summarized votes are illustrated in Figure 3. As shown in the bar graph, 7 out of 10 participants thought that straight lines (a guitar string sound) was very intuitive. The reasons provided included the shape of line being similar to that of a real string, good sound feedback, ease of control and the fact that a shape is easy to draw. Of all of these, the fact the shape is similar to the instrument it represents was mentioned the most frequently. In fact, this same feedback is often the reason for participants giving positive feedbacks on any sound source.

The two resonant elements (delay and chorus) were considered the least intuitive to work with because some users were not sure how to use them. Some participants expected to use them in ways other than the design of the system allowed for. In one case this was due to a miss-understanding of the meaning of the sketch symbol that was chosen because the user thought the half circle and half square shapes looked like parentheses and tried to enclose other shapes between a pair of them.

Looking at the videos of each session, we observed that users interacted with the application vary in different ways. In the exploring phase, some players tended to try all the instruments before they applied sound effects, while some others preferred to draw an instrument then resize and apply sound effects on it to explore the variation of produced sounds. Generally, the second type of users tended to use more sound effects when performing, and the combination of shapes they used was more diverse.

During the preforming phase, users also interacted with the system in different ways. Some used more types of shapes than others; some tried to organise the instruments well before playing. Figure 4 shows six screen shots taken from different user performances. As we can see, players A, B and C arranged their shape in a more organised way. They tend to arrange the same instruments all together. In contrast, the instruments of the other three players are less ordered. We found that players D, E and F were more adventurous in their use of the creative space.

Seven of the ten participants expressed their interest in the application and said they actively forward to trying future versions of it. The freehand drawing was the main reason people they liked the application; quotes from par-

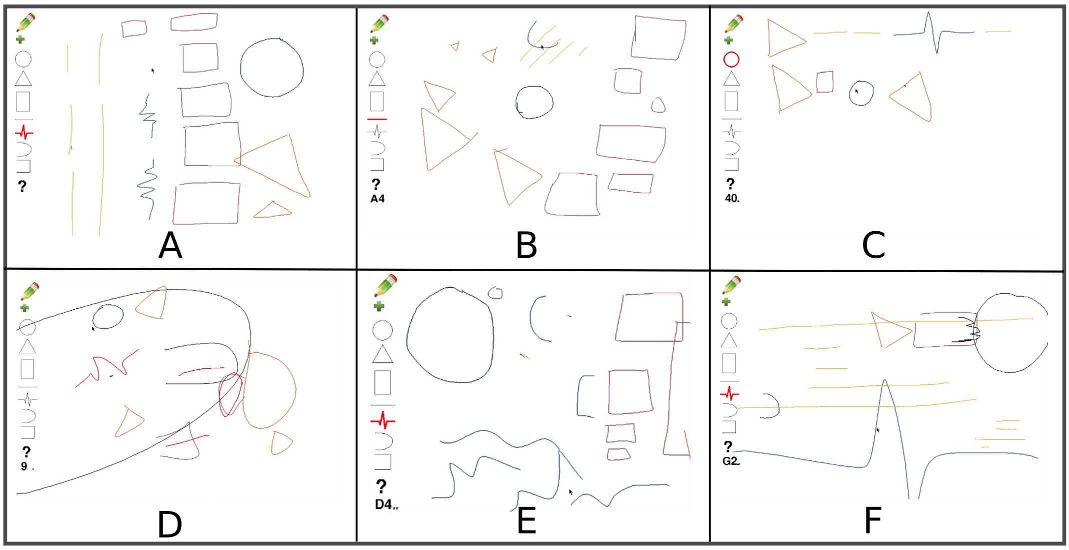

Figure 4: Captured screen shots from users' performances

ticipants included: "It is fun to draw 'instruments' on a canvas and arrange them according to how you want to play them or just for aesthetics purposes.", "Very natural way to compose music.", "Moving the shapes around to organise a piece of music is interesting.". Generally the participants considered the whole application easy to use and facilitated self-learning.

4. DISCUSSION AND CONCLUSIONS

In this paper, we have presented Drawchestra, a novel sketching interface for composing and performing music. A small scale user study has demonstrated that Drawchestra is easy to use and its sketch based features were found compelling by participants. Through the study, we have identified many features of this first prototype system that can be developed further. In the next stage, we intend to add more shapes to support a greater diversity of input and output. The consensus of user feedback prompts us to consider deeper relations between shapes and the sounds that they represent. Users found shapes that related obviously to physical objects that produced a particular sound (e.g. lines representing plucked strings) were most intuitive to use and this relationship between the visual semantics of a sketched shape and a physical object should be investigated further. Due to the similarity of some sounds (for example guitar and bass guitar are both strings) we believe that allowing the specific sound for a particular object to be chosen by the user from a sound family may extend the facility of the system while maintaining the interface's inherent simplicity.

The current system is a single user arrangement but there is no reason why multiple users should not be able to share a common canvas. If several users can join a networked version of the application with a shared canvas this will give the possibility of user interaction and facilitate collaborative composition and performance in real time.

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