A Journey in (Interpolated) Sound: Impact of Different Visualizations in Graphical Interpolators

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ABSTRACT

Graphical interpolation systems provide a simple mechanism for the control of sound synthesis systems by providing a level of abstraction above the parameters of the synthesis engine, allowing users to explore different sounds without awareness of the synthesis details. While a number of graphical interpolator systems have been developed over many years, with a variety of user-interface designs, few have been subject to user-evaluations. We present the testing and evaluation of alternative visualizations for a graphical interpolator in order to establish if the visual feedback provided through the interface, aids the navigation and identification of sounds with the system. The testing took the form of comparing the users' mouse traces, showing the journey they made through the interpolated sound space when different visual interfaces were used. Sixteen participants took part and a summary of the results is presented, showing that the visuals provide users with additional cues that lead to better interaction with the interpolators.

CCS CONCEPTS

• **Human-centered computing~Visualization design and evaluation methods** • Human-centered computing~Usability testing • Human-centered computing~Empirical studies in HCI

KEYWORDS

Sound, synthesizer, interpolation, visualization, interface, sound design

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1 Introduction

The fundamental problem when designing sounds with a synthesizer is how to configure the often large number of synthesizer parameters to create a certain audio output, i.e. how to translate sonic intent to parameter values. Although having direct access to every parameter (*one-to-one* mapping) gives fine control over the sound, it can also result in a very complex sound design process. Alternatively, it is possible to map a smaller number of control parameters to a larger number of synthesizer parameters (*few-to-many* mapping) in order to simplify the process. Particular states of synthesis parameters ("presets") are associated with different control values and then as these control values are changed, new synthesizer parameter values are generated by interpolating between the values of the presets. This provides a mechanism for exploring a defined sound space, constrained by the preset sounds and the changes of the control parameters.

A number of such interpolation systems have been proposed previously and these can be categorized based on whether the control mechanism is via some form of graphical interface or some other medium. Those that are of interest here are those that offer a graphical representation that allows the control of a visual model.

1.1 Graphical Interpolation Mapping

Graphical interpolation systems typically provide a two-dimensional graphical pane where markers that represent presets can be positioned. Interpolation can then be used to generate new parameter values in-between the specified locations by moving an interpolation cursor. Interpolating between presets of parameters can facilitate smooth sonic transitions and the discovery of new settings that blend the characteristics of two or more existing sounds. The sonic outputs are a function of the presets, their location within the interpolation space, the relative position of the interpolation point and the interpolation model used to calculate the influence of each preset [1].

A variety of distinct graphical models have been used for parameter interpolation [1 - 8] which present the user with different levels of visual feedback. A detailed review of these has been undertaken [9], however, from this it is difficult to gauge if the visual information provided actually aids the user in the identification of desirable sounds, given that the goal is to obtain a sonic output, or if the visual elements distract from this intention. Moreover, if the visuals do aid the process, how much they help and what visual cues will best serve the user when using the interface for sound design tasks.

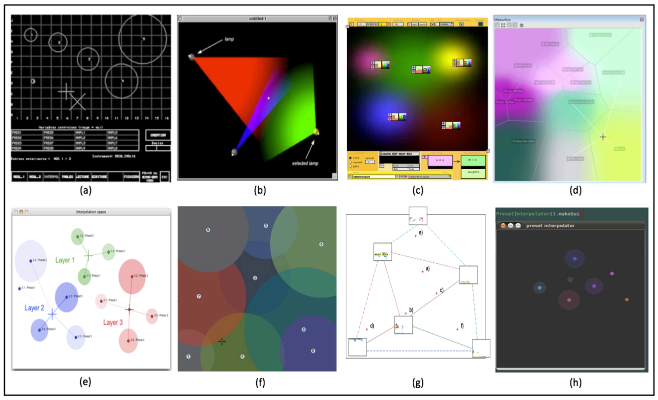

Figure 1: Graphical Interpolator Models: (a) SYTER, (b) Interpolator, (c) Gaussian Kernels, (d) Metasurface, (e) INT.LIB, (f) Nodes, (g) Delaunay Triangulation with Spikes and (f) Intersecting N-Spheres

1.2 Nodes

Andrew Benson created the *nodes* object for Max in 2009 and it proved so popular that it has been included in subsequent distributions [6]. Here each preset is represented as a circular *node* within the interpolation space. The size of each node defines the extent of its influence within the interpolation space (Figure 2). The interpolation weightings are calculated for each node currently under the cursor as the distance from cursor to node center, normalized with respect to the node size. Interpolation is therefore performed where nodes intersect and when the interpolation point is on an area only occupied by a single node, then just that node's preset will be active. For example, in Figure 2, the cursor position shown corresponds to the overlap of nodes 4 and 7 with the relative weights 0.355 and 0.180, giving 66.36% of preset 4 and 33.64% of preset 7. The node weightings are updated in real-time as the interpolation point is moved or if the nodes are resized or repositioned within the space.

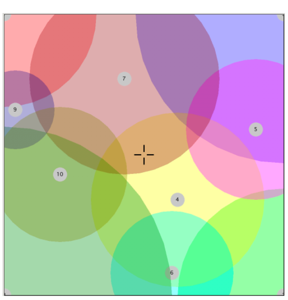

Figure 2: Interpolation Space Created with Max nodes Object

2 Graphical Interpolation Framework

In order to evaluate different visualizations, an interpolation system was needed that permitted the visual representation for the interpolation model to be modified, whilst leaving all other aspects the same. The previously created graphical interpolation framework [9] was used to facilitate comparative user testing, where only the interpolator's visual representation was changed.

2.1 Nodes Reimplementation

Although the *nodes* object is freely available in Max, it needed to be reimplemented in order to be able to customise the visual representation for testing. The *nodes* object within the framework structure [9] was replaced with an interactive user-interface created using OpenGL for the visual representation and JavaScript for the control mechanism and to generate the preset weightings. This allowed the influence of different visualizations using the same nodes interpolation model to be evaluated while also facilitating the future implementation of other interpolator models. The reimplementation of the nodes model was functionally tested by undertaking back-to-back tests between it and the original *nodes* object, ensuring that both implementations gave the same results.

3 Experiment Design

Using the reimplemented nodes interpolator, an experiment was designed to evaluate user behaviour when using the interpolation systems and different levels of visual feedback are provided. To assess the impact that different visualizations had on the usability of the interpolator three interfaces were created, based on the dimensions of a unit square. These were:

1. Interface 1 – no visualizations (i.e. an empty 2D display).
2. Interface 2 – only preset locations displayed.
3. Interface 3 – the original nodes interface.

These are shown in Figure 3, Interface 1-3, left to right.

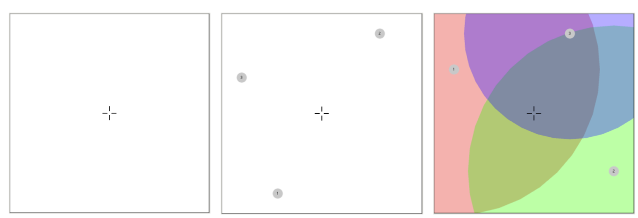

Figure 3: Different Visualizations for Nodes Interpolator

The user testing took the form of a sound design task with a subtractive synthesizer, where the participants were asked to match a given sound which on the interpolator had a fixed, but unknown to the participants, target location. Each interpolator interface was populated with different preset sounds, with all of the presets being created from the same base patch, generating some sonic commonalities between them. However, the starting sounds for each interpolation space interface were different. The layout of the nodes and target location within the interpolation space were same in each case, but so this was not obvious to the participants, the interface was rotated through 90° clockwise for each interpolator.

To simulate a real sound design scenario, the participants were given only three opportunities to hear the target sound before commencing the test and none after that. Participants therefore had to retain an idea of the required sound in their “mind’s ear”. All participants completed the same sound design task with each interface, but each interface produced different sonic outputs from different presets. To minimise bias through learning, the order in which the interfaces were presented was randomised. Each test lasted a maximum of ten minutes with participants able to stop the test early if they felt the task had been completed by pressing a button to register their estimated target location. All of the user’s interactions with the interfaces were recorded for analysis.

4 Analysis and Results

The experiment was undertaken with sixteen participants, all with some degree of sound design experience. For each participant, their mouse movements were recorded allowing comparison of their navigation behaviour with each interface - the journey that each user made through each interpolation space. An example is shown in Figure 4 for participant 1 who had the following interface order – 1, 3 & 2, although they are shown here Interface 1 – 3, left to right.

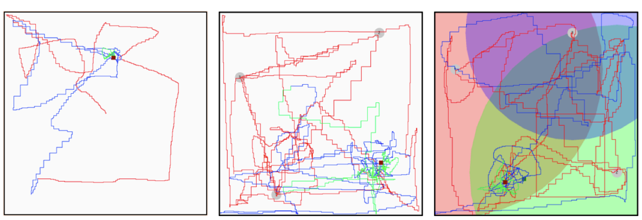

Figure 4: Mouse Traces for Participant 1

It was found that at the start of the test users tended to make large, fast movements. In the middle of the test the movements tended to slow and become more localised, but a few larger, moderately fast movement were often made. Towards the end of the test movements tended to slow and become even more localised towards the intended target location. To visualize these aspects, in Figure 4 the first third of the trace is shown in red, the middle third is shown in blue and the final third is shown in green. This was also corroborated when the mouse movement speed and distance to target were plotted on a graph, using the same colour coding. Figure 5 shows an example for participant 2, with interface 3.

Broadly these trends were seen in fifteen of the sixteen participants, although as might be expected it did not always evenly divide into thirds of the test time. Nonetheless it appears to indicate that there are three distinct phases during the use of a visual interpolation interface:

1. Fast space exploration to identify areas of sonic interest
2. Localise on regions of interest, but occasionally check that other areas do not produce sonically better results
3. Refinement and fine tuning in a localised area to find the ideal result

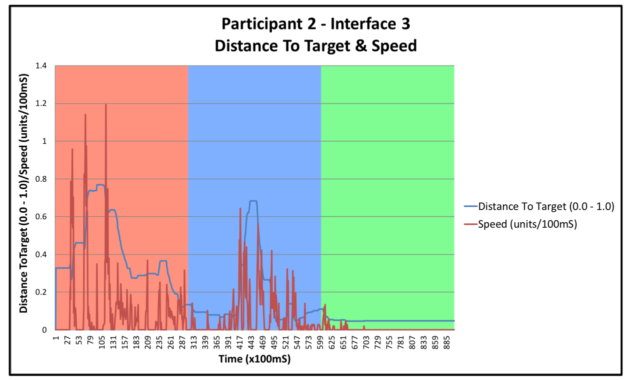

Figure 5: Mouse Distance to Target & Speed for Participant with Interface 3.

These three phases may be summarised as *exploration*, *localisation* and *refinement*. These phases were present regardless of the interface being used, showing that these are associated with exploration of the space and not the detail of the interface used.

From the traces, it was also observed that as the detail of the visual interface increased so did the area of the interpolation space that tended to be explored. This was despite the fact that the participants were given no information with regard to what the visuals represented. It seems that giving the participants additional visual cues encouraged them to explore those locations. To demonstrate this effect, the mean location for each trace was calculated and the deviation in the form of Standard Distance Deviation (SDD) [10], based on the unit square dimensions of the interpolator interfaces. These were then plotted back onto the traces to give a visual representation for each interface. Figure 6 shows this for participant 6 who took the test with interface order – 3, 2 & 1, although they are shown Interface 1 – 3, left to right.

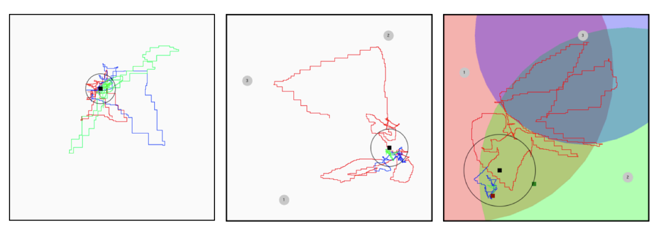

Figure 6: Mouse Trace, Mean Location and Standard Distance Deviation for Participant 6

Thirteen of the sixteen participants showed an increase in the SDD when more visual cues were provided by the interface. The mean SDD was 0.131 units (σ = 0.23) for Interface 1, 0.146 units (σ = 0.19) for Interface 2 and 0.180 units (σ = 0.21), for Interface 3.

Significance was confirmed ($F(1, 15) = 3.132$, $p = 0.05$) with a repeated-measures ANOVA. This indicates that additional visual cues on the interface encourage wider exploration of the interpolation space, even though the output and goal of the test was sonically (not visually) based.

The locations actually selected by participants as their target sounds were also plotted to see if there were any trends resulting from the different interfaces. Figure 7 shows the selected target locations for all the participants, for Interface 1 – 3, left to right.

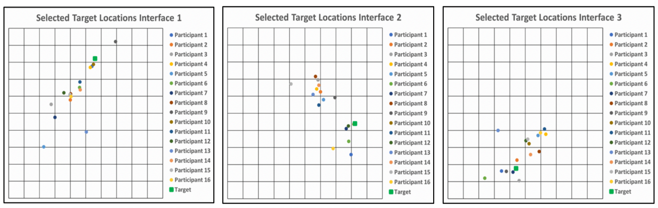

Figure 7: Participants Selected Target Locations by Interface

The results in Figure 7 show that for Interface 1 (no visualization) there is a fairly wide disbursement of locations selected as the target. From the correct target location, the SDD was calculated as 0.300 units for Interface 1. For Interface 2 (locations only), there was a tighter distribution of target locations with SDD of 0.267 units. Finally, for Interface 3 (full nodes) there is an even stronger localisation with the SDD reducing still further to 0.187 units. This indicates that as the interface provides more visual detail it improves the user's ability to identify the intended target.

Comparing by ear the user selected targets with the actual target sounds showed that in all cases there were sonic differences, but as the selected locations got closer to the true location on the interpolator, as expected these became less distinguishable.

5 Discussion

The testing undertaken indicates that users tend to follow three phases when finding a sound with a graphical interpolator system (*exploration*, *localisation* and *refinement*). In the first phase the users make large, fast moves as they explore the space. During the second phase the speed tends to reduce as they localise on specific areas of interest. In this phase, though, confirmatory moves have been observed when the user quickly checks that there are no other areas that may produce better results. These tend to be done at a moderate speed, often in multiple directions. In the final phase the user refines the sound with small, slow movements as they hone-in on a desired location. These phases appear to be present regardless of the visual display that is presented, with similar phases being observed with all three of the interfaces tested.

From examination of the mouse traces, the visual feedback presented by the different interfaces does appear to affect how users interact with the systems. When no visualization is provided, the users were effectively moving "blind" and tended to just make random movements within the space initially. When the preset locations were provided, although the users were not aware of where or how the interpolation was being performed, the provided visual locations encouraged the users to investigate these points and so explore the defining locations. The full interface not only shows the location of the defining sounds, but also indicate to the users' regions of interest (node intersections for this interpolation model), where there may be interesting sounds. This seems to focus users' exploration on these areas of interest and results in the users getting closer to the target location and so "better" sonic results.

6 Conclusions

The identification of three distinct phases of use during the testing of the graphical interpolators is of significant interest as it suggests that users interact with the interfaces differently at different stages during their journey through the interpolation space. Better understanding of the user behaviour with these systems will in future work allow the design of new interfaces that provide users with visuals that will further facilitate the different phases of a sound design task.

A number of different visual models have been previously presented for graphical interpolators [1 - 8], each of these using very different visualizations. Given the suggested importance of the visual feedback provided by each interface, it will be important in future work to evaluate the suitability and relative merits of each through further user testing.

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