Multimedia and Music

MusiKalscope: A Graphical Musical Instrument

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Imagine a system where a performer creates art by playing a trumpet with one hand and painting with the other simultaneously. Intuitively, creating art this way, while possible, seems fairly impractical when it comes to controllability and mastery for effective expression. However, we believe that most multimedia art-generating systems urge performers to do just such things. We contend that for an artist to create good artwork with individual media such as paint or music proves difficult enough. To create them simultaneously without adequate support is nearly impossible.

We believe that using several support mechanisms to reduce the performer’s cognitive load proves essential for simultaneous production in a multimedia computer-supported art system (though excessive support should be avoided). The supporting method shouldn’t obstruct performers’ creativity and should leave enough room for their expression. In this sense, we believe that multimedia art systems—which automatically control several media completely—don’t suit artists very well. To create a good multimedia art-generating system, we suggest supporting a minimum “good enough” quality as well as allowing room for performers’ creativity in all media. In this article, we introduce MusiKalscope, which represents such a system.

To use MusiKalscope, you enter a dark space and pick up the virtual drumsticks. You see a beautiful kaleidoscopic image of yourself on the huge video screen in front of you while jazz music starts to play in the background. As you strike the virtual drum pads in front of you, different tones are selected by the Rhyme subsystem accompanying the background music. At the same time, the kaleidoscopic image on screen responds to you. When you play tension-like sounds, the image turns bluer. It returns to its original state (with no additional color mixed in) when you play chord tones. As you move and play, a beautiful mixture of imagery and music engulfs you. Figure 1 shows an example of the MusiKalscope system.

In MusiKalscope, each action the performer executes controls all media. Thus, even if one of the actions targets a specific media, such as producing music, the other media will follow according to the action’s function for the specified medium. MusiKalscope does this by defining a mechanism for the performer’s actions to adjust a piece of music’s “color” rather than the melody while a song plays. It also assigns the same action to control the “color” of the computer graphics image. At the same time, the performer’s movement and dance and the music’s rhythm during performance translate directly to the aesthetic feeling provided by the visual imagery.

Other systems such as Brush de Samba, Cindy, DanceSpace, and Muse relate to MusiKalscope. Brush de Samba relates most closely to our work—it generates music and computer graphics simultaneously. In Brush de Samba, the performer draws a picture using a drawing pad. Music generates automatically based on the position data. The performers generally focus on the image they’re drawing rather than the music being generated. Hence the system is biased for graphical input, making it difficult to control the music quality in the system.

In contrast, Cindy is musically biased. In this system, performers play music, and an animated character named Cindy dances along to the music played. The music style controls the dance style by changing musical parameters such as the number of notes played, playing a single tone or chord, and the beat.

In DanceSpace, a video camera captures the performer’s dance. The performer’s movement is mapped so that the dancer’s hands and feet con
control virtual musical instruments, and the dancer’s head height controls the music’s pitch. At the same time, the dancer’s motion creates and controls computer graphics. A colored outline of the dancer’s body is represented successively. With DanceSpace, various music styles can be played. However, the sounds generated continuously ascend or descend, significantly impacting the music’s quality.

Finally, Muse provides a musical interface to control a computer-generated character. Muse interprets the music played as an emotional context displayed by the Muse character. Tosa and Nakatsu describe the musical grammar elsewhere. Interestingly, the computer graphics coordinates with the musical sounds. However, the grammar limits the musical scope when using Muse.

In creating Musikalscope, we hoped to achieve three main goals as follows:

1. Maintain a good balance between the quality of computer graphics and music generated.

2. Let novices easily achieve a reasonable quality of music and imagery.

3. Impose no performance ceiling so that with more training, enhanced expression becomes possible.

**Overview of Musikalscope**

Musikalscope consists of three subsystems: the Graphical Musical Instrument Interface (GMII), RhyMe, and the lamascope as shown in Figure 2. The GMII provides the input interface between the performer and the two other subsystems. The GMII uses two main input devices: a video camera and a Polhemus Fastrak. The video camera input feeds directly to the lamascope for the imagery. The lamascope’s output displays on a large video screen (170 inches) in front of the performers so that they can see the imagery they’re producing.

The Polhemus Fastrak data is analyzed to implement a virtual drum interface to RhyMe and the lamascope. The name of the virtual drum pad the user strikes passes to RhyMe (see the section on the RhyMe subsystem). RhyMe then plays the particular note appropriate for that drum pad at that moment during the song (according to jazz analysis of the song being performed). The output from RhyMe plays on speakers mounted on the sides of the large video screen.

RhyMe also dictates whether the virtual drum pad struck corresponds to a chord tone or a tension tone. Currently, RhyMe determines this mapping a priori and embeds it in the GMII, which sends the appropriate signal to change the lamascope’s appearance. When the performer plays a tension note the lamascope image becomes bluer. When the performer plays a chord note, the lamascope returns to its normal color. The faster a user plays the virtual drum pad, the brighter the lamascope image becomes. All changes in color and brightness to the lamascope image will gradually return to the “normal” state if the user stops playing.

![Figure 1. Captured image of a person having fun in Musikalscope. The video camera is at the bottom of the 170-inch screen.](image)

![Figure 2. Block diagram of Musikalscope. The video camera and position sensors capture the performer’s (shown on the right) motions. The video image serves as input to an electronic kaleidoscope, which outputs a kaleidoscopic image on the large screen in front the performer. The position sensors create a virtual drum. Striking the virtual drum pads produces different notes that accompany the jazz background music. The RhyMe subsystem selects which notes to play—according to jazz theory—when a performer plays the virtual drums.](image)

**The lamascope subsystem**

Kaleidoscopes have captured imaginations all over the world since Sir David Brewster first invented them in 1816. The lamascope, an interactive kaleidoscope, uses computer video and graphics technology. In the lamascope, the performer becomes the object inside the kaleidoscope and sees the kaleidoscopic image on a large (170-inch) screen in real time. The lamascope offers an...
How a Kaleidoscope Works

You can make a simple kaleidoscope from two mirrors, some black paper, and objects to view with the kaleidoscope. Place the two mirrors on edge and use the black paper to form the other side of the long triangle as shown in Figure A. The two mirrors will reflect whatever you put at the other end, forming an image of a circle of reflected copies of the objects in it. If you adjust the mirrors so that they're an even fraction of 360 degrees, say 30 degrees, the reflections made with the two mirrors will line up to give a beautiful symmetric image as shown in Figure B. For a 30-degree mirror angle, you get 12-fold symmetry. Other angles give other symmetries. If you use three mirrors, the image appears to spread out forever. Depending on the relative angles of the mirrors to each other, you can see different symmetries. The simplest arrangement is an equilateral triangle. Thousands of variations of kaleidoscopes exist, many of which Baker discusses in the book Kaleidoscope Renaissance.

Figure A. How to make a simple two-mirror kaleidoscope.

Figure B. Example image from a two-mirror kaleidoscope using 12-fold symmetry.

Figure 3. Snapshot of an image created with the two-mirror kaleidoscope.

Figure 4. Snapshot of the three-mirror kaleidoscope image. Notice the performer's hand in the image.

Figure 5. Snapshot of the three-mirror kaleidoscope wrapped around a sphere. The sphere's revolutions per minute can be adjusted.

example of using computer technology to develop art forms. As such, it doesn't enhance another device's functionality. Rather, it provides a rich, aesthetic visual experience for the performer using it and for people watching the performance.

The lamascope is more than a mirror-based kaleidoscope (see the sidebar "How a Kaleidoscope Works") put in front of a video camera, since a computer can generate more extensive reflections such as asymmetric reflections and different tiling patterns than mirrors. Figures 3, 4, and 5 show some of the possible images the lamascope can produce. In Figure 3, the lamascope image uses two mirrors, while three mirrors are simulated in Figure 4. Figure 5 shows a visually interesting pattern. Here the three-mirror version wraps around a spinning sphere. While visually appealing, the sphere image isn't as easy to control compared to the nonmoving surfaces in the two- and three-mirror lamascope versions.

From the perspective of balanced, lower bound quality multimedia, the lamascope possesses an
Important quality—for the most part, anything placed inside it will look beautiful. The symmetries of the mirror reflections appeal to many people. Thus, as part of a multimedia system, the lamascope provides a reasonable minimum level of aesthetic quality even when used by novices. However, as performers learn to move their bodies to manipulate the kaleidoscopic image, they can achieve greater forms of expression. Hence the lamascope provides an upward pathway for achieving highly skilled forms of expression through visual imagery.

Figure 6 shows a block diagram of the lamascope. For input, the lamascope uses a single video camera connected to a video board with a gain to texture memory. Output appears on a video monitor. In our current implementation, the video image from the camera goes into texture memory. Then, the subsystem selects the appropriate part of the video image (currently a “pie” slice but also referred to as a segment) to form the original image (O). The subsystem reflects the original image, creating the desired reflections (O’). In the two-mirrored version, the subsystem draws a multipolygonal circle and applies the appropriate textures (original or reflected) alternately. The necessary reflections are simulated with texture hardware providing frame rates of 30 frames per second. This frame rate provides low-latency, high-bandwidth control of the kaleidoscopic image, supporting a sense of intimacy with the lamascope.

The lamascope used in MusiKalscope is based on the reflections found in a two-mirrored kaleidoscope. However, we used a pie slice (segment) from the original video image instead of a triangular slice typical of two-mirror kaleidoscopes. Thus, if the slice’s arc angle represents an even integer divisor of 360 degrees, a circular image forms using the alternation of the original image and its mirrored reflection (as shown in Figure 6). The even integer multiple arc angle is required so that alternating the original image with its reflection will fill the circle exactly. For example, if we use a 30-degree pie slice, then 12 segments will make up the circular image. The odd segments will have the original image, and the even ones will contain the mirror reflection. Three aspects of this method provide a beautiful effect:

1. Because the segments fill the circle exactly and a reflected image is always paired with the original slice, the boundaries of each segment will line up without perceivable discontinuity.

2. Since we use a pie slice as the original, a singularity exists at the image’s center. This singularity lets viewers perceive the user’s movement relative to the center and circle’s outside edge.

3. The pie slice permits using different visual scales from the image.

The slice’s outer edge captures a large area of the video image; toward the image’s center it captures only a small area for the reflections. Placing objects close to the slice’s center makes it difficult to recognize them in the kaleidoscope image, allowing for more abstract forms of expression. (Likewise, the user can move closer or farther from the video camera to get different scaling effects.)

The lamascope also features additional controls that MusiKalscope exploits: controls for image background color mixing, image brightness, arc angle, slice angle rotation speed, and so on. MusiKalscope uses the image background color mixing and brightness controls to match the lamascope image’s mood with improvisational sounds the performer makes using RhyMe.
What Goes on During Jazz Improvisation

During improvisational jazz performance, players need to recognize many musical qualities to know which notes to play next to express their mood and feeling. First, as they play the piece, they can figure out the current key as it changes throughout the piece from the musical context. Then, knowing the current key, when they play a chord they can categorize it (and its absolute pitches) as a chord relative to the current tonic (key).

![Diagram showing diatonic scale chords for C major](image)

The relative chords are called diatonic scale chords. For example, if we’re playing and we hear an E-minor 7 chord, we can determine its diatonic scale chord name because we know what key we’re in. If we’re in C major, E is the III note and the diatonic scale chord is III-minor 7 as shown in Figure C. However, if the current key is G major, then E is the VI note and the diatonic scale chord is VI-minor 7. Figure C shows the chords and the name of each chord in the diatonic scale chords in C major.

Determining the key of a piece at any point in time can be difficult because it changes. The problem is that any particular chord can come from different keys. However, the dominant seventh chord is nearly unique, thus we can determine the tonic of the current key when we hear it. However, it doesn’t provide enough information to determine whether the key is major or minor. For this, we need to hear a tonic chord to figure it out. Luckily, the tonic chord usually follows a dominant seventh chord. For the other chords, we can compare more of the surrounding chords to determine the key. For example, we can look for common sequences of chords.

Once we know the diatonic scale chord and key, we need to know the available note scale to choose an appropriate note to play. A note scale represents a sequence of notes such as major and minor. Jazz uses many note scales (some are listed in Figure D). Each chord in the diatonic scale chords has been empirically determined to correspond to a certain note scale or scales. This determination leads to a theoretical analysis of jazz.

Once we know the note scale, we can construct phrases from the available notes. Each note in the chosen note scale imparts a specific feeling on the piece depending on its position in the scale. For example, the sixth note of a scale often gives a sense of tension. Some notes aren’t in the scale—we call these out-of-scale notes—and would sound bad if played. Other notes should be avoided even though they’re in the scale. These notes have no fixed rules. Figure D shows the note scales and the notes of each diatonic scale chord in the key of C major. The notes in parenthesis should be avoided. The feeling (or function) of each note in a note scale is only roughly consistent, and the exceptions must be understood for each note scale.

Continuing our example, we know that Em7 will be played and the key is C major. From this, we determined that the diatonic scale chord is III-minor 7 and know that the scale name is E Phrygian. We can now choose which note to play. The sixth note in this note scale is a tension note. So if we play a C, we’ll produce a tension feeling. Similarly, throughout the rest of the piece we can choose which note to play depending on our mood and the mood of the piece.

The RhyMe subsystem

Typically, in real-time multimedia art creation that uses music, the performer can’t concentrate on playing music only. However, even if a well-trained musician concentrates on only playing music, it’s still difficult to generate good music. Therefore, in many cases of multimedia art creation, the musical medium may not have particularly good quality.

Our strategy to avoid this problem in multimedia artwork is to apply structure to a performance artificially. In MusiKalscope we use...
computer to control the performance's structure, thereby applying our own definition of music. We call this "computer-supported improvisation" and developed a subsystem called RhyMe to provide this support. Working from this philosophy, we restrict the type and structure of music that can be created during a performance. However, we're rewarded by allowing the performer easier access to musically appealing performance within these confines.

In our research we focused on supporting jazz improvisation, in particular "bebop." Improvisation is a critical component of jazz. For unaccustomed listeners, jazz improvisation performances may sound like random compositions. However, if studied, these performances can be analyzed as conforming to some well-defined jazz improvisational theory. Well-trained jazz players often analyze the song playing in their head and compose improvisation pieces by using notes dictated by a particular jazz theory. By applying the theory, the piece can have a jazzy atmosphere and the player can express the "color" of a song derived from its chord progression structure. Of course, this analysis may not be performed consciously.

Playing jazz improvisation based on theory poses two problems. First, it's difficult for people to master the theory. Second, it's also difficult to reflect the knowledge of the piece during a real-time performance even if you've mastered the theory. To overcome the first difficulty, several systems have been developed that analyze songs automatically using a knowledge base of particular jazz theories. These systems can show users theoretically determined notes in a song that correspond to different jazz effects. When referring to the results of the analysis, performers can improvise using theoretically correct notes. However, since jazz music has a complicated structure, it's still difficult for nonprofessionals to improvise even when referring to the analysis' results. To make matters worse, it's even more difficult to use this type of system in a multimedia art performance where attention may need to shift to other media representations in real time.

To overcome the difficulties encountered in these systems during live performance, we employed the following method in RhyMe. First, the subsystem automatically analyzes a song offline based on a particular jazz theory. Then, during performance—based on the analyzed results—the subsystem assigns only notes available in the note scale to playing positions of the musical instrument used in the performance. (See the next section for the mapping between notes and positions in the virtual drum set, and see the sidebar "What Goes on During Jazz Improvisation" for a discussion of note scales.) The jazz piece plays continuously while the performer joins in with improvisation assisted by RhyMe.

Figure 7 shows a block diagram of the RhyMe subsystem. RhyMe consists of a song database, an automatic analysis module, and a note-position mapper. The song database stores chord progression data of several musical pieces. Sample data of a piece looks like

...(Dm7, 2) (G7, 2) (C6, 4)...

Each entry consists of the chord name and the number of beats. The above example corresponds to the following score: D minor 7th for 2 beats, G dominant 7th for 2 beats, and then C 6th for 4 beats. RhyMe uses data from the currently selected song as input to the analysis module.

The automatic analysis module has a musical theory knowledge base. Currently, this knowledge base builds on the Berklee theory, a well-known jazz theory (mainly bebop style jazz). Based on
this knowledge, this module analyzes the chord progression (from the input data) and determines what kinds of scales are available at each chord given the “context” of the chord progression. The whole analysis process is complex, but the idea can be illustrated by using the example above. First the analysis module looks for a dominant 7th chord and assumes that it’s a V7 diatonic scale chord. As a result, the tonic—the note corresponding to I—can be assigned. In this example, G7 is a dominant 7th chord, hence note C is assigned as the tonic. Second, the module interprets and relabels the absolute chord progression data in relative terms (using diatonic scale chords) using the assigned tonic. In this example, the chord progression is interpreted as IIIm7-V7-I6. Third, the module matches the interpreted chord progression with one of the chord-progression patterns stored a priori in the module. In this example, this chord progression matches with the major II-V-I chord progression, a typical chord-progression pattern. Fourth, if the module can find a matching chord-progression pattern, the module decides the assigned tonic is correct and outputs available note scales for each chord by looking up the chord-scale map. In this example, the following correspondent scales are output: II (dorian), V (mixolydian, altered 7th, whole tone, and so on), and I (ionian). Finally, the subsystem reinterprets the relative note name as an absolute note. From these results, the available note scales of the example are determined as shown in Figure 7—that is, D dorian, G mixolydian or G altered 7th or G whole tone scale, and C ionian.

The subsystem enters these analyzed results into the note-position mapper. This module maps a scale’s notes at each time point in the song onto the musical instrument’s playing positions. The mapping changes while notes synchronize with the song’s progression. The instrument used in MusiKalscope is a virtual drum machine (see the section “A simple virtual drum”), which has seven active zones. Notice that the root zone corresponds to the root note of the currently available note scale (for example, a G note in Figure 7), while the II and III active zones correspond to the II and III notes of the currently available note scale (in Figure 7, the A and B note, respectively). In our example, G mixolydian is the available note scale. If the performer plays the VII zone, the actual note played is an F as shown in Figure 7. However, when the available note scale changes to D dorian by the song’s progression, the note played by striking the VII zone becomes C.

The whole RhyMe subsystem uses the Musical Instrument Digital Interface (MIDI), thus, the MIDI timing clock data handles the synchronization. Using this scheme, either chord tone zones (root, III, V, VII) can be played or tension note zones (II, IV and VI) corresponding to the note’s relative position in the currently available note scale. The key point to remember, though, is that RhyMe dictates the actual note played.

When using conventional musical instruments, performers must always judge which notes are theoretically correct and which note has which color by thinking about the song’s chord progression and their own theoretical knowledge. However, using RhyMe, performers don’t have to determine notes while playing a song. Since only theoretically correct notes are mapped onto the musical instrument at any time in the song, the performer doesn’t need to know the chord progression and theory. Furthermore, notes are mapped onto adequately classified zones (that is, chord tone or tension note).

We call this mapping method a “fixed-function” mapping: a note always has a certain function depending on the context of the current chord and chord progression. For example, the third note from the root has a function to decide whether the current chord is major or minor. In RhyMe, the third note is always mapped onto the III position. Therefore, performers can easily play the third note whenever they need the sound that emphasizes the major or minor mood in the performance. This method allows easy access for performers to express color throughout the song.

The main result of this is that performers’ cognitive loads can be reduced drastically when creating music, and at the same time they can easily maintain a reasonable quality of music throughout the piece. Further, the RhyMe subsystem gives performers room for free composition. From this reasoning, RhyMe proves a suitable subsystem for generating music in a real-time multimedia art performance system such as MusiKalscope.

The music generating methods used in DanceSpace and Brush de Samba also theoretically analyze songs similar to the technique used in RhyMe. As such, in these systems, performers can play theoretically correct notes without paying conscious attention during each moment in the song. However, these systems don’t offer obvious discrete playing positions to performers to control the music. In particular, in these systems, performers control only successive ascending or descending phrases. Therefore, it’s very difficult
for performers to compose phrases they want to play. The RhyMe subsystem provides discrete playing positions that can be played using instruments like keyboards, virtual drums, or other MIDI instruments. Thus, performers can easily choose notes with specific functions and compose phrases freely by combining the functions.

**GMII: Bringing the pieces together**

The GMII in MusiKalscope links the two sub-systems RhyMe and the lamascpe. The GMII provides a set of virtual drums (see the next section) the performer uses to play with RhyMe and control some parameters of the lamascpe image. With RhyMe, a song’s chord progression determines its global color. However, the performer can play different tones with different velocities to control local (in time) color—for example, playing a chord tone, playing a tension tone, or playing strongly or weakly. For MusiKalscope, we mapped the available scale’s chord tone and tension notes onto different virtual drum pad zones. Therefore, players can easily choose to play a chord tone or a tension tone to control the song’s local color. The virtual drum set provided by the GMII provides seven customizable active zones corresponding to either chord tone or tension notes (each corresponding to an offset from the root tone note).

Figure 8 shows the default configuration of the active zones. The functions associated with each zone are activated when performers make a down-up motion of their hands in the zone.

We mapped the lamascpe’s control according to the functions that RhyMe uses for the active zones. We chose the mapping a priori based on artistic license. Thus, for zones that produce tension notes according to RhyMe, the lamascpe image provides a more visual tension. For this effect, we would make the background mixing color bluer for a sense of foreboding. The more tension zones struck, the bluer the lamascpe image looks. If the performer strikes a chord zone, then the lamascpe image immediately returns to its normal, nonblue state to provide a sense of resolution. If the performer doesn’t strike any key, the lamascpe image gradually returns to its normal state over time. The velocity with which the performer strikes the virtual drum controls the lamascpe image’s brightness. For fast strikes, the lamascpe image lights up strongly in a flash and gradually returns to its normal brightness.

A simple virtual drum. Many different instruments can control RhyMe—any instrument with seven or more keys can be used. For MusiKalscope, performers’ hands and arms must be unencumbered so that they can move freely in front of the lamascpe while simultaneously playing with RhyMe (to control the visual imagery). To do this, we used a virtual drum set along with a Polhemus 3-space Fastrak system that measures performers’ hand and arm motions. The magnetically based trackers measure a receiver’s six degrees of freedom (position and orientation) relative to a source. In MusiKalscope, we used two receivers—one for each hand. Performers attach the receivers to their arms using straps, allowing them to move their arms and hands freely. Down-up movements of their arms strike the virtual drum pads according to the mapping shown in Figure 8. The active zones currently lie horizontally (parallel to the floor) in front of the fixed source. We plan to attach an additional receiver to the performer’s body so that the active zones are relative to the performer and not a stationary point in front of the lamascpe.

To implement the virtual drums, we must measure the velocity of the performers’ arms.

Figure 9 shows an idealized speed profile of a performer moving a hand down and then up. Notice that as the performer’s hand moves down from a stationary position, the speed increases. Then as the performer prepares to turn the hand around, the speed decreases. As the hand rises again, the speed reaches its minimum (ideally, it should reach 0). As soon as our virtual drum system detects a change in hand direction, the zone becomes activated. (The performer must also have exceeded a minimum downward speed threshold before the change in hand direction can activate a zone.) The particular name of the zone that becomes activated passes to RhyMe and the lamascpe controls.
Adjusting the metaphor. One subtle point about this virtual drum scheme is that the change in direction doesn’t correspond exactly to the drum metaphor. Often, performers strike a real drum using a ballistic downward hand motion. Contact with the drum changes the direction of the performer’s hand. However, the virtual drum doesn’t have any surfaces to contact. Instead, the performer’s own muscles have to change the direction. Using a drum metaphor, users expect the system to respond during the ballistic downward stroke of their arm. However, with the virtual drum, activation occurs when their hand changes direction—this happens somewhat later than the ballistic stroke. This introduces a perceptual lag in the system stemming from the wrong metaphor. A closer metaphor might be a conductor’s baton. We’re currently investigating other sensors (such as accelerometers, infrared batons, and vision systems) and techniques that match the perceptual striking position of the virtual drum metaphor.

Discussion of MusiKalscope

We displayed an earlier version of MusiKalscope in Kyoto, Japan. During this display several hundred people used MusiKalscope, providing an opportunity to observe both performers and audiences. We observed two important points. First, novice performers tended to focus either on producing music or producing visual imagery but not both. Second, audiences often enjoyed the combined visual and musical performance, but had difficulty appreciating and understanding the relationship between the performer and the performance they were hearing and seeing.

The fact that performers attended either to producing music or playing with visual imagery didn’t surprise us. In particular, MusiKalscope’s main point is to let performers focus only on one aspect at a time. The complimentary medium always maintains a reasonably good quality level even if it’s ignored or played poorly. However, either system responds appropriately to allow improved expression as the performer becomes skilled. From this point of view, the system succeeded.

Unfortunately, the kaleidoscopic images bear little resemblance to the performer, since only a small slice of the whole image is used in the reflections. Thus, on the one hand, the movement and changes in the image aren’t obviously attributed to the performer. Once an audience member becomes a performer by stepping into MusiKalscope, the relationship is obvious and lasting. Perhaps we need to familiarize the audience with this novel and perform or explain it to them better. On the other hand, the imagery is dynamic and beautiful, so the connection between performer and imagery isn’t critical for appreciation. For the musical performance, identifying the relationship between the performer’s actions and the music proves difficult because background music always plays and doesn’t change with the performer’s actions. Further, lag introduced by the virtual drums exacerbated the problem (both for the audience and performer). Improving the lag situation will help. However, an inherent trade-off exists between providing a minimum quality level of music and letting the performer control the music, establishing a strong link between actions and sounds.

Finally, one frequent comment from performers was that too much lag existed between the virtual drum strike and the sound produced. As discussed previously, this is probably due to the incorrect metaphor for the sensor system we used. We’re working to improve this situation.

Future directions

As mentioned earlier, we had the following three goals in mind when we developed MusiKalscope:

1. Obtain good balance between the quality of computer graphics and the music generated.

2. Let novices achieve a reasonable quality of music and imagery easily.

3. Allow an upward path for skill acquisition so experts can become more expressive with MusiKalscope.

We achieved these goals mostly by combining two systems that each have a reasonable minimum quality even if completely ignored. The RhyMe subsystem will continue to play pleasant music regardless of user input. It can never play particularly bad sounding music (in its genre), but with user input can sound even better. Likewise, the lamascpe, like a standard kaleidoscope, generally produces beautiful images no matter what goes into it. However, the lamascpe allows performers the freedom to express themselves by moving inside it. Through movement and imagination, the performers control the image’s expressiveness. Thus, both subsystems are balanced with respect to quality.

We’re improving three main areas to further
accomplish the goals set out. First, we want to make the system easier to use skillfully. Currently, even though novice users produce reasonable quality music and images, the progression to express themselves well is not as fast as we would like. The main difficulty stems from the awkward input device of the virtual drum set. We plan to modify this device either by using different sensors or improving the recognition techniques. Second, we currently have only a small selection of songs analyzed for use in RhyMe. Some songs suit accompaniment with visual imagery better than others. We're planning on increasing the available selections. Third, it's an iterative process determining which aspects of the lamascope best fit a particular music genre. We're investigating different ways to control the lamascope to enhance the feeling it provides along with matching the particular "color" of the music performed.

References


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