The Bubblegum Sequencer

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Abstract

In this paper we introduce the Bubblegum Sequencer, a physical interface for creating and performing percussive electronic music. Grown out of a course on the Theory and Practice of Tangible Interfaces, the Bubblegum Sequencer is a unique collaborative tool for composing, visualizing, and teaching music through a simple and inviting interaction.

Keywords

Tangible user interfaces, music, MIDI, sequencers, collaborative learning, bubblegum, design, physical computing, computer vision

ACM Classification Keywords

H5.5. Information interfaces and presentation (e.g., HCI): Sound and Music Computing

Introduction

Step sequencers, featured in electronic instruments such as the Roland 808 drumcomputer (see figure 1) have been a popular tool for electronic music composition since the 1980s. Whether implemented in software or hardware, a step sequencer typically consists of a row of 16 positions encoding the placements of a sample in time – typically the 16th-notes in a drumloop. Samples are placed by activating the corresponding grid square, usually by clicking or pressing a button. The sequencer then creates the

drumloop by playing the constructed measure repeatedly. Typical sequencers can be powerful tools for composition, but are also difficult to learn, and are not ideal for performance, given that performers are likely to end up hunched over a computer screen instead of engaging their audience.

Figure 1: The Roland 808 drum computer: The 16 buttons represent points in time in the step sequencer mode.

The Bubblegum Sequencer constitutes an inviting and unintimidating interface that mitigates such barriers to performance. Samples are mapped to objects— gumballs—instead of assigned to tracks, creating what we hypothesize is a more intuitive and fun interaction. A player wanting a kick drum on beat three of the drum loop need only grab and place the appropriate gumball.

Additional visual feedback enriches the interaction, providing an easy way to examine the active pattern in real time. This feedback and ease of interaction not only invite live experimentation and reaction, but also present an intriguing teaching tool. Reactions from

early demonstrations suggest that the Bubblegum Sequencer can be useful for musical novices to explore musical structures and the interactions between different sounds and patterns.

Lastly, the use of brightly colored gumballs as input devices create a fun and easily learned interface, inspiring collaboration and experimentation among users.

Related Work

Mapping sound to physical objects is an established paradigm in tangible user interface research. James Patten and Ben Brecht's AudioPad [3] uses electronically tagged pucks to create "a visual and tactile dialogue between itself, the performer, and the audience." Durrell Bishop's Marble Answering Machine [1] associates voice messages with marbles, which can then be physically selected and played back in any order. The reacTable [2] is a system that maps the traditional components of electronic synthesizers (samplers, oscillators, envelope generators) again onto physical pucks which can be manipulated to create electronic music.

The Bubblegum Sequencer builds on this work, again mapping sounds to physical objects. However, the quality of the objects and the nature of the interaction combine the low barrier to learning of the Marble Answering Machine with the collaborative compositional aspects of the reacTable and AudioPad. Whereas the latter two examples require some preparation of samples and knowledge of electronic music, respectively, the Bubblegum Sequencer works with the standard MIDI software built into most operating

systems,[1] using a familiar and playful object—the gumball. While the Bubblegum Sequencer supports use with more advanced MIDI software, no understanding of MIDI or electronic music is necessary to use it.
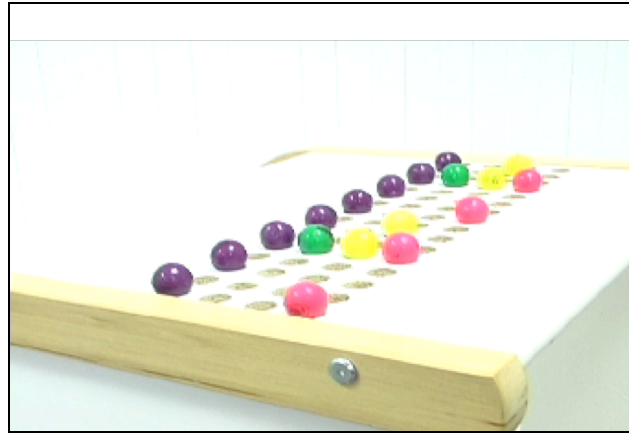
Figure 2: The Interface: a simple grid of holes and gumballs to fill those holes.

Interaction Loop

The Bubblegum Sequencer engages users' tactile, aural, and visual senses to create a rich interactive musical experience. All processing is done in real time, providing users with immediate feedback on their interactions with the gumballs.

Basic Interaction
The interface consists of a 4 x 16 array of holes drilled into a table surface, and gumballs of five different colors that rest in those holes (see figure 2). Each of the 16 columns in the grid represent one sixteenth note

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[1] For example, the Microsoft MidiMapper

in a measure of music. The rows, unlike tracks in traditional step sequencers, are not mapped to a particular musical attribute, but simply allow for the placement of multiple gumballs at any sixteenth note.

As users place gumballs in the grid, the sound samples mapped to each color are played at the appropriate time. As the loop plays, LEDs below the first, fifth, ninth, and thirteenth columns illuminate in sequence to indicate the four quarter notes of the measure. This visual feedback helps anchor users in their compositions and provides a consistent indication of the current tempo.

Visualization
Additional graphical feedback comes in the form of a projected visualization of popping gum-bubbles, which can either be projected on a wall for performance, or directly onto the playing surface (see figure 3). When projected on the wall, the popping pattern mimics the playing surface. When projected on the surface itself, each gumball appears to pop as its sample sounds.
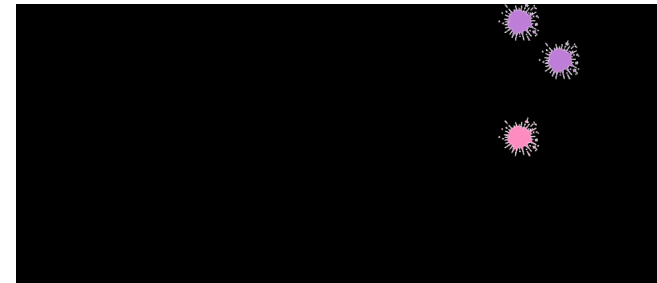
Figure 3: In the visualization, popping bubbles represent the samples currently played. This creates an impression of the beat "sweeping" over the grid.

Tempo change by tapping

A pressure-sensitive area on the side of the playing surface allows users to adjust the tempo of playback in real time as well, by tapping the desired tempo. Tapping three or more times causes the software to compute the average tempo across the taps in beats per minute and adjust playback accordingly.

Note Mode

The default play mode for the Bubblegum Sequencer is drum sounds. However, in note mode, gumballs can be arranged in patterns to play notes using scale-based instrument samples. Here, the vertical position of the gumballs encodes the pitch. In any column, single or double combinations of gumballs are mapped to notes on the blues scale (see figure 4). We chose the blues scale because its constraints limit the number of gumball-combinations to learn and also because of its notes prevalence in bass lines. Sticking only to the notes of the blues scale, any note will sound in tune, reducing the need for musical training and facilitating experimentation. It is possible to play one color gumball in note mode allowing the addition of bass lines or other melodies to drum loops.
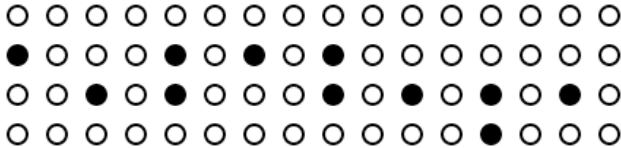
Figure 4: In this pattern, the gumballs encode the bass line of Michael Jackson's "Billie Jean": F – C – E♭ – F – E♭ – C – B♭ – C.

Voice-sample mode

The Bubblegum Sequencer works by sending MIDI messages to the system's MIDI controller. Any MIDI software listening to the controller can be used to control the samples that are played when messages are received. Leveraging this flexibility, we wrote a small program in Processing that listens for MIDI messages and plays back samples that can be voice-recorded in real time by the player. The player selects a color to record, then activates recording (currently by holding the space bar). Whatever is recorded by an attached microphone then immediately replaces the sample for the selected color. In the future we will incorporate this action into the physical playing surface, so that recording can be controlled by physically selecting a gumball.

Use Scenarios

Initial demonstrations have indicated that the Bubblegum Sequencer is an exciting tool for composition, collaboration, performance, and teaching. Players are drawn to the bright, playful, and familiar input, and quickly learn the mapping and begin creating loops.

Collaboration

The discrete and physical mapping of samples to objects invites many hands to participate in musical creation. Rather than limiting composition to a single-user interface, the playing surface is approachable from all directions. At each demonstration, visitors would approach in small groups and begin experimenting together.

Performance

The open nature of the interface can enrich single-player performance, as well. The process of creation of electronic music becomes more transparent by making cause and effect obvious. Rather than hiding behind an effects box or a laptop, performers are free to create using physical, performative gestures. Placing objects in time to create digital compositions narrows the gap between digital composition and playing traditional analog instruments.

Teaching

The real-time visual feedback that the Bubblegum Sequencer provides presents a unique tool for musical exploration and teaching. Feeling, hearing, and seeing are combined to demonstrate basic musical structures. Additionally, the quality of the interaction with the gumballs presents an inviting and fun interface, especially for children. Based on initial reactions, we hypothesize that using the Bubblegum Sequencer will engage users in learning about and exploring music in ways that enrich exploration and improve learning speed.

Implementation

The colors of the gumballs in the grid are detected using a web camera mounted below the surface and custom processing software written in Java utilizing the ImageJ image-processing library. A grid overlaid on the video feed from the camera aligns with the gumballs, with each grid intersection corresponding to the location of a hole in the playing surface (see figure 5). At each hole, a 5 x 5 pixel sample is taken, the average hue is computed, the value quantized and mapped to a note.

A separate thread in the software reads the values from that array to control program output. For each non-zero value, the appropriate MIDI note is sent to the system's MIDI controller, and the popping image of the matching color is displayed on the visualization.
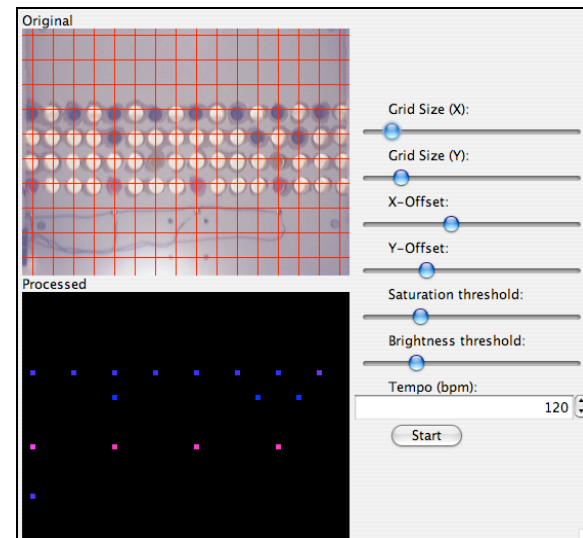
Figure 4: The original and processed video feeds are displayed with a simple GUI for controlling various processing parameters.

Initial Evaluation and Future Work

Based on initial demonstrations, people are quite taken with the Bubblegum Sequencer. For some, it seems to demystify music, and several users expressed delight at the fact that nothing they tried seemed to be "wrong." The most common approach was to remove one gumball and see what happened. One user, upon hearing that samples were mapped to colors and time read left to right, exclaimed "I understand how it works

then—say no more!"[2] This is exactly the kind of exploratory interaction we hoped to elicit.

We will build on this initial evidence in creating testing scenarios for the Bubblegum Sequencer. Our current plan is to conduct a study this summer to evaluate the Bubblegum Sequencer as a tool for musical exploration and teaching. As described above, our hypotheses are that users, especially children, will find it an accessible and fun way to learn musical patterns, and that performers and artists will find it a rich tool for collaboration and playful interactive performance.

Regarding the implementation, the sensitivity of the camera presented the most significant problem. Shadows and other visual noise detected by the camera confused some users (while at the same time exciting some users with the possibility of 'painting sound'). People wondered why what they heard did not exactly match their expectations based on their constructed pattern. We are therefore exploring ways to make the color detection more robust, including using individual detectors for each hole in the grid.

Lastly, while the current prototype meets many of our demands for functionality, we are not satisfied with its appearance. We are therefore brainstorming alternative designs. Some current ideas include frosted glass surface for detection and projection; Apple-style white plastic surfaces; and a carnival-themed cart to enhance the playful creative feel.

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[2] An approximate quotation

Conclusion
We presented the Gumball Sequencer, a tangible interface to create and manipulate digital music. It provides a simple and direct interaction and aims at making the creation and performance of electronic music more spontaneous and transparent. An explicit mapping between physical objects and digital sounds is made to bridge the gap between human performers and software-based instruments.

Acknowledgements

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