A Generative Remixing of Music Tracks based on an Interactive Swarm

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Premise

"Identity SA" is an interactive and generative installation that combines a swarm-based simulation with real time camera based interaction that we presented at GA conference 2007. We extended it by embedding two methods to generate sounds and music from pre-recorded sampled sounds. One is to let agent trigger sounds at intervals that are synchronized to a particular musical rhythm. The other one is to generate sounds whose transposition and timing is purely related to the agent's properties. The probability that an agent triggers a sound is proportional to the square of its angular velocity for both cases. By mixture of these two methods, it generates a rich variety of attractive sounds that react with the visitor's motion.

1. Introduction

Swarm simulation is one of the algorithms that automatically produce complex dynamic patterns. It was originally inspired from collective behaviour of a variety of animals, such as school of fish and flock of birds, and imitates such behaviour by simple mathematical model of local interaction. That means each agent, a member of swarm, determines its own movement according to the information gathered from the local environment. This is useful for scientific research for emergent properties of animal behaviour, but also for artistic creation in the context of generative art. Some artists employed this type of method for their artworks on both visuals and sounds such as [1-3]. The authors' former work named "Flocking Orchestra" [4] used visually interactive swarm that flocks in a three dimensional virtual space and composes a music by selecting timing and note following the virtual physical state of each agent. Each sound element is generated as a MIDI note managed by the computer. This is one of the methods to generate music. Another type of generative music generation presented here is reorganization of a set of pre-recorded musical sounds.

"Identity SA" [5] is an authors' work that employed more than two thousands of agents flocking in not 3D but 2D virtual space to cover whole of screen. It draws an abstract painting that dynamically changes according to the position and orientation of the agents. It also reacts to a visitor's motion through a motion-detection mechanism utilising a live camera. The original implementation included only one method to generate reactive sounds. In our first experimental exhibition, most of the visitors gave us positive comments that they enjoyed it, but at the same time, some of them told us that the sound was scary. This comment is not so bad from our artistic point of view, but we considered it would also be nice if it could have more variety of sounds acceptable for as many persons as possible. Then we added two new methods as described in the following sections.

2. Sound generation

Three types of sound effects were implemented, synthesized sound, modified sampled sound, and remixed music. Sound synthesis for all of these types also depends on the movement of agents and visitors. Only a subset of all agents is involved in the generation of sound. The probability that an agent creates a sound is proportional to the square of its angular velocity so as to make it easy for the visitor to recognize the reaction. Our current sound synthesis implementation doesn't rely on any synthesis libraries but is based on relatively simple routines that calculate samples at a fixed frame rate of 44.1 kHz. Agents that are allowed to generate sounds are organized in a queue of fixed length. In the current implementation, the queue can hold 12 agents. If a new agent is selected for sound synthesis and the queue is already full, the new agent replaces the agent that has been in the queue for the longest time.

In each case, the length of the sound is scaled so that it is proportional to $1-\sqrt{F}$ within the range of 0.01 to 1, where F represents the agent's force of attraction towards detected motion. Accordingly, strongly attracted agents tend to produce short sounds whereas agents that don't respond to interaction create long sounds. Therefore, many different types of short sounds are generated in short time when the camera detects any type of very active motions.

Finally, white noise is mixed together with the audible output. The volume of the noise is proportional to the amount of motion captured by the camera. The stereo panning of the noise is controlled by the position of the centre of gravity of the detected motion. This noise is very effective for the visitors to become aware of the reaction of the system to their motion.

The following part of this section describes the generation of sampled sound and remixed music. The creation of synthesized sound has already been described elsewhere [5].

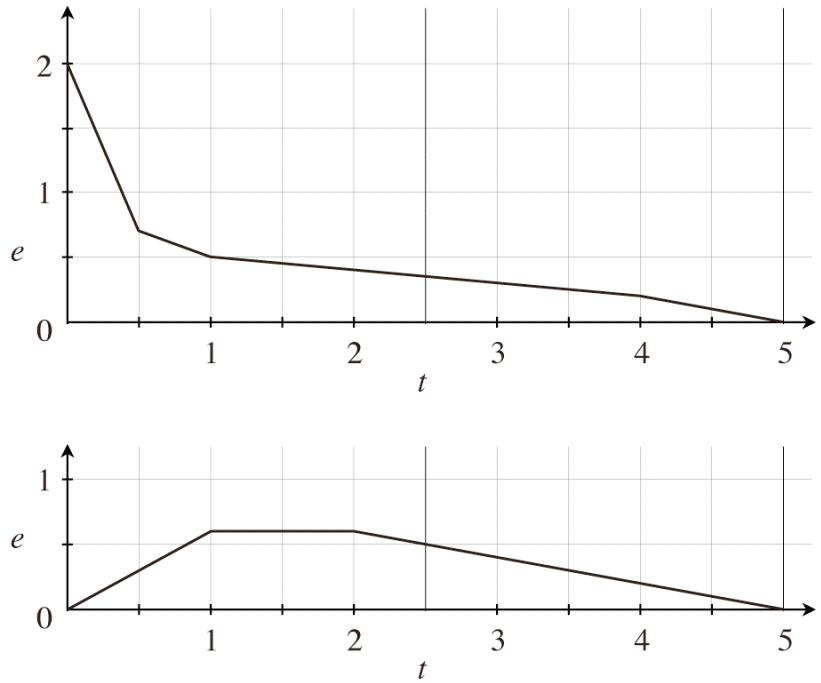

Figure 1. Two predefined envelope shapes.
The upper envelope possesses a strong and fast attack, the lower one starts slowly.

2.1 Modulated Sampled Sound

This method employs pre-recorded sounds that are imported from audio files stored in an assignable folder. The audio data can be stored in any format that is supported by the Audio Toolbox of Macintosh OS X, such as AIFF, MP3, and AAC. Each agent plays back its own allocated audio file. As in the case of synthesized sound, audio panning is controlled by an agent's horizontal position and playback speed depends on its vertical position. The Horizontal position is mapped to the balance of loudness between left and right channels as it is heard in natural, and the vertical position is mapped so that the higher position makes higher pitch and shorter duration. According to this playback speed, an amplitude envelope is generated and this envelope is applied in the same way as for the synthesized sound. Basic shapes of the envelopes were designed in two types, strong attack and slow starter, as shown in Figure 1. A sound track is created by repeating the sampled audio data as many times as is needed to reach the required playback duration.

2.2 Remixed Music

This method remixes pre-recorded sounds according to a uniform rhythm and loop interval. Usually, these tracks correspond to recordings of individual musical instruments such as a drum set, bass, piano and so on. Unlike the modulated sampled sound version, the playback of the selected tracks is synchronized to a global clock. In case the selected tracks differ in length, shorter tracks are iterated in order to match the length of the longest track. Accordingly, all tracks restart at exactly the same time. We tried two types of different methods to allocate tracks for agents. The first one is as same as the case of modulated sampled sound described in previous sub-section, that is, each agent has its own track. The other one is to place tracks in a grid on the space. In the current implementation, the screen space is evenly divided into consecutive vertical regions and each track is assigned to one of these regions. Tracks are selected for playback depending on the agent's horizontal position at the time the agent starts singing. For this method, the agents' vertical position is not taken into account. A playback sounds of a track come from any positions depending on the agents horizontal position in the former method, but the same track is always from the same position in the later method. Therefore, it is possible for the visitors to control the track selection a little by moving left and right.

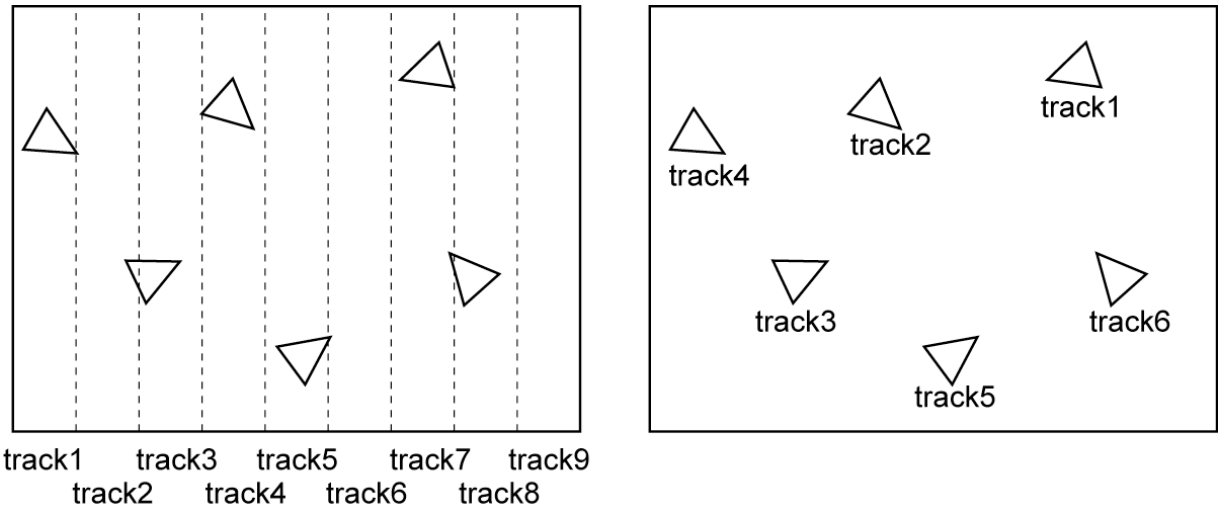

Figure 2. Two methods for track assignment.

2.3 Method selection

The swarm of Identity SA is consists of two species of agents. By changing the relation among the species in terms of physical interaction in collective behaviour, it produces a rich variety of dynamic motion pattern. For each species, one of the methods of sound generation described above can be assigned, but only a single set of sampled files is loadable at any moment, in the current implementation, that is, the same set of sound samples are used to generate each sound even if one species uses modulated sampled sound and another one uses remixed music. However, this style of combination produces effective sounds enough to entertain the visitors.

3. Experimental exhibition

We organized an experimental exhibition at Soka University's campus festival in October 2008. It could receive more positive feedback from the visitors than previous occasion in aspects of both visuals and sounds. For this exhibition, we prepared three sets of sound samples each of which includes a number of sampled files in same rhythm, same tempo, and same keynote. First one is house music of 135 beats per minute, second one is rock music of 120 beats per minute, and third one is hip-hop of 80 beats per minute. These tracks were picked up from a set of free samples accompanied to Apple's music sequence software "GarageBand". Some visitors were dancing at the front of the screen since all of them are danceable.

Concerning the difference between two methods of track assignment, it did not seem effective because it is difficult for the visitors to recognize the positioning of the sound without an explanation by a staff.

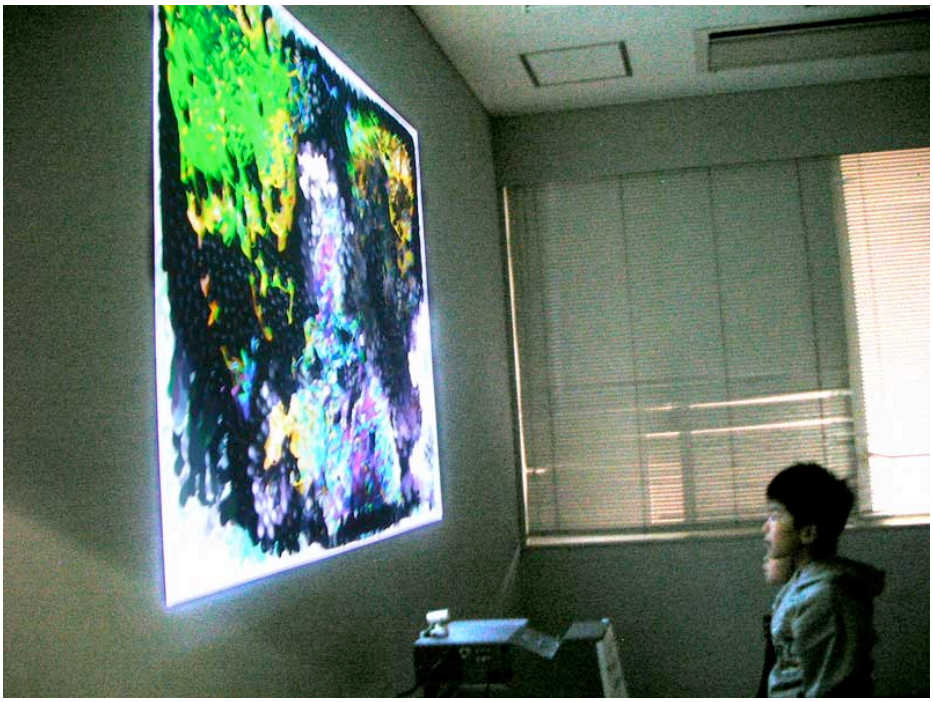

Figure 3. Photograph at experimental exhibition in the campus festival, October 2008.

4. Concluding remarks

A generative remixing of music tracks embedded in Identity SA was effective to engage people in wide range of ages and preferences in the experimental exhibition. Further possible extension includes assignment of more than one set of sample files for different method of sound generation, and introduction of generative music composition by the same method as “Flocking Orchestra” does.

“Identity SA 1.6” is a freeware downloadable from the following URL:

http://www.intlab.soka.ac.jp/~unemi/1/DT4/

We hope as many persons as possible will enjoy it.

References

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