Lavina: Sound Engine based on Swarm Behaviour for Novel 3D Audio Composition Techniques

Jonas Ohland and Henning Schaar, University Of Applied Sciences Darmstadt

2020, April

Abstract

The motion of a flock of bird is a common phenomenon in nature, which can be seen in other organisms such as schools of fish or herds of land animals. A flock can be understood as a particle system which operates under certain rules which result in complex behaviour. One way to model this behaviour in computer sciences is to model the paths of each bird or particle individually. Lavina is a such a model, with the added functionality of sound synthesis for each particle which is then represented in acoustic space. Composers may use Lavina to create a timeline for parameter changes to the flocking behaviour as well as the sound generation to create novel compositions with unexpected outcomes while retaining artistic control over the final performance.

1 Introduction

Music generation is often times a process in which two or more entities interact and draw inspirations from the sounds created by other performers to inform their own behaviour. In the interaction between machine and performer, the machine can be seen as one such entity.

Sound synthesisers are commonly understood as musical instruments, but with sound generating devices gaining complexity through technological advancement, they can also gain autonomy in their function as performing entities in the music generation process.

In musical improvisation this process happens while the music is being generated. However in experimental composition techniques, established through the work of composers of musique concrète, a composition is being informed by the material which is used to create it. The feedback to user input of music generation systems can act as such a material and can inform decisions about the composition in a workflow that could be understood as trial-and-error.

The nature of musical generation through interaction and feedback manifest themselves not only in the workflow with Lavina, but also in the interactions between the individual particles of the flocking system.

2 Background

2.1 Particle System

Particle systems are collections of large numbers of particles, each having its own behaviour. In models of flocking, there are three accelerating forces acting upon any given particle.[1]

1. Collision Avoidance: avoid collisions with nearby flockmates.
2. Velocity Matching: attempt to match velocity with nearby flockmates.
3. Flock Centering: attempt to stay close to nearby flockmates.

In the particle system Lavina uses, the finite sized birds are replaced by point objects and the velocity matching is omitted. Collision Avoidance is realised by giving the particles a charge. Similiar to charged particles in physics, there is a negative attractive force at close distances which allows the particles to avoid each other and objects in the environment. Flock Centering works via an attractive force to all other particles in the the perception radius of each particle, which scales with distance similar to gravity.[2]

To allow for more chaotic behaviour and expand artistic expression the option to add random acceleration to the particles was added. A greater sense of space is achieved by the addition of the wind parameter, which allows to apply a directed acceleration to all particles.

2.2 Swarm Intelligence

2.3 Experimental Composition

In the tradition of European classical music the creative process starts in the imagination of the composer. The idea is committed to notation and then performed by performers to reach its final auditory form. In the early days of electronic music in Germany, notably in the cologne studios for electronic music, this tradition of idea, notation and performance in this order was preserved. In France however, a new form of composition was being developed. The composers of *Musique Concrète* used recorded sound materials as their starting point, and tried to derive the

[1] Craig Reynolds 1987

[2] T. M. Blackwell & Peter J. Bentley 2002

musical essence of these materials by manipulating them, while being guided by their musical tastes and intuitions.[3]

Working with partially autonomous sound generating systems can be seen as an extension of this french tradition. The Composer might start with an idea in mind, but the hard to predict audio engine, gives a reaction, that then requires the composer to react accordingly and find a way to adapt their composition based on their intuition and vision.

3 Design

3.1 Sonification

3.2 Animation

4 Composition

4.1 Sound Material

4.2 Timeline

5 Conclusion

References

Brindle, R. S. (1987): *The new music: the avant-garde since 1945*. Oxford University Press

Craig Reynolds (1987): Flocks, Herds, and Schools: A Distributed Behavioral Model. In: *Computer Graphics* (S. 25–34). 21 Online verfügbar unter: URL: https://www.red3d.com/cwr/papers/1987/boids.html [19.04.2020]

T. M. Blackwell, Peter J. Bentley (2002): Swarm Music: Improvised Music with Multi-Swarms. In: (Bd. Volume 2). London, UK: Department of Computer Science, University College London Online verfügbar unter: URL: http://igor.gold.ac.uk/~mas01tb/papers/SwarmMusicImprovisedMusicWithMultiswarms.pdf [19.04.2020]

[3] Brindle 1987, S. 108