

Spatial Audio Diffusion of Audio Stems with Swarm Simulation

Abstract

We present a novel tool that automates real-time spatial diffusion of multiple audio stems using swarm simulation, while preserving user control. Traditional spatial audio mixing involves static placement or manual animation of sound sources—an increasingly complex task when dealing with many simultaneous sources. Our approach reimagines spatial diffusion by simulating a virtual bird flock, where each bird represents an audio stem. Users can control global motion characteristics by adjusting swarm parameters such as alignment, cohesion, and avoidance, without manipulating each source individually. The system supports dynamic steering and obstacle avoidance, enabling rich and responsive spatial behaviors. We evaluated the tool across eight- and sixteen-speaker configurations, with additional binaural recordings rendered from virtual speaker layouts. To highlight its versatility, we commissioned original compositions in various genres—including baroque, electronic, experimental, and film music—designed specifically for spatial performance.

This tool offers a low-barrier, dynamic solution for real-time and recorded spatial audio applications.