



RITMO

Centre for Interdisciplinary Studies in
Rhythm, Time and Motion



UNIVERSITY
OF OSLO

Human-Swarm Interactive Music Systems

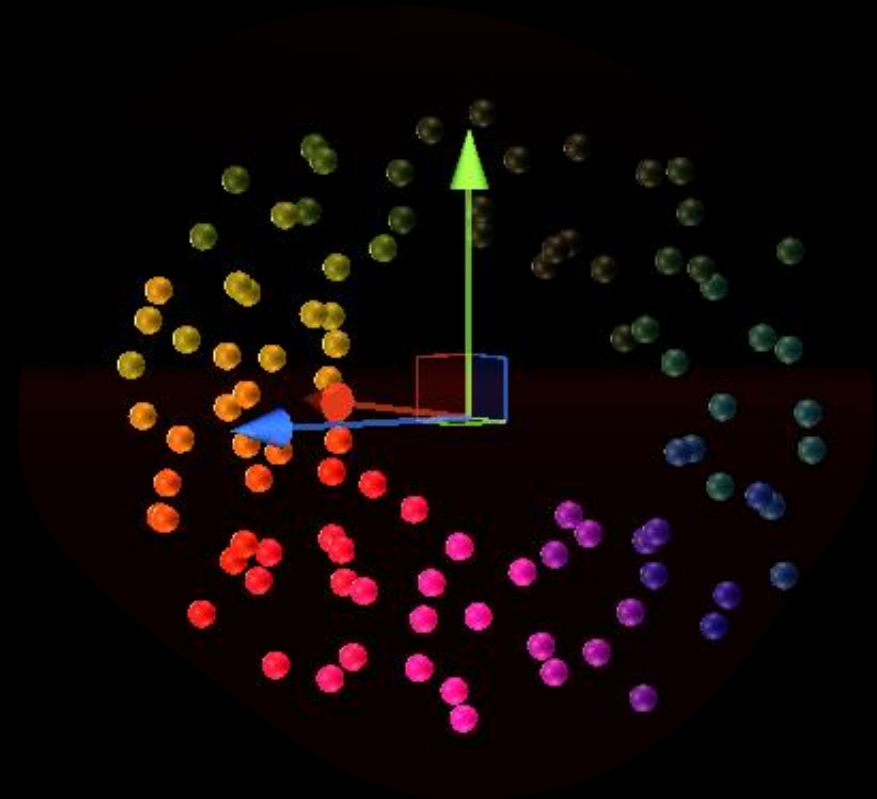


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Agenda

- Definition
- Swarm Models Explorations.
- Systems in Extended Reality (XR)
- Some topics of interest for Human-Swarm IMSs



Definition

Human-Swarm Interactive Music Systems

A Human-Swarm Interactive Music System (IMS) is an improvisational system that allows users to interact with a swarm of **self-organized** artificial agents exhibiting **emergence** in a sound and music context [1].

From an individual perspective, **self-organization** involves interactions among agents that represent various elements of sound and music. As a result of these interactions, the agents collectively produce **emergent** properties that can be used in favor of music performances.

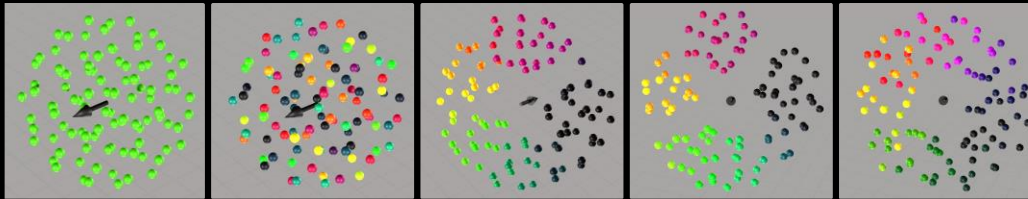


Swarm Models Exploration

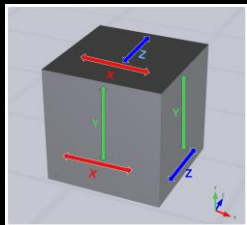
Swarmalators

The term "**Swarmalator**" combines "**swarm**" and "**oscillator**". The Swarmalators are oscillators whose phase and spatial dynamics are coupled [1].

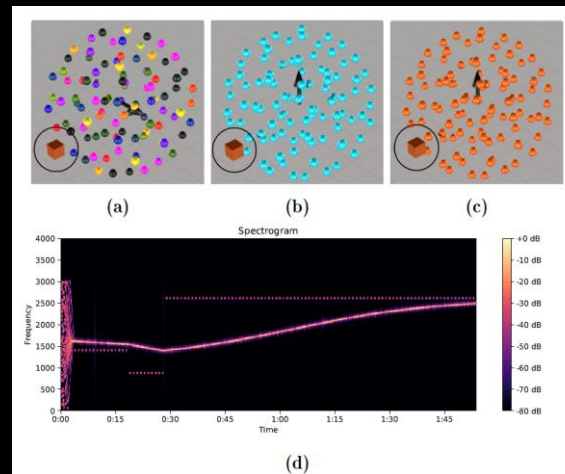
Macro States [1] [2]



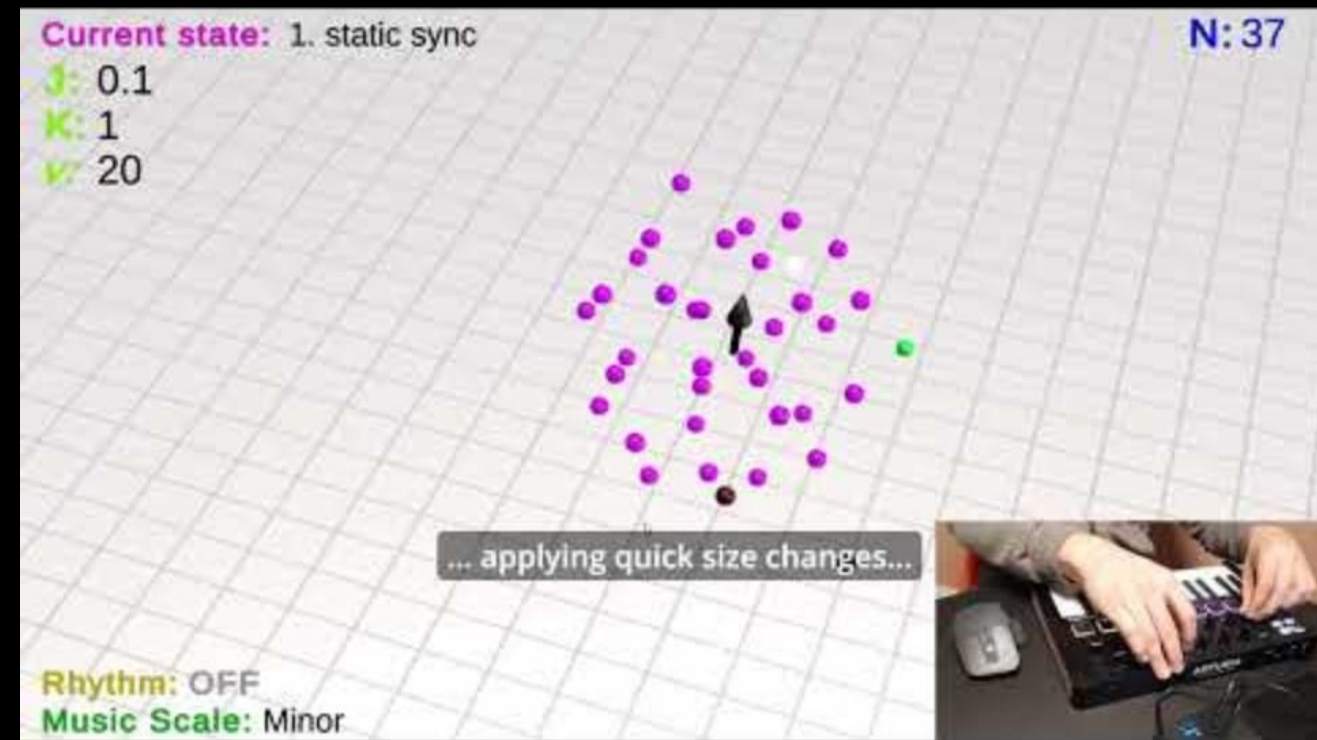
Interactive Swarmalator [2]



Influence of an Interactive Swarmalator [2]



Music Exploration [2]



<https://www.youtube.com/watch?v=rgXaFE6npD8>

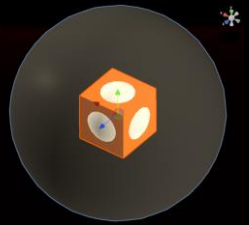
[1] O’Keeffe, K. P., Hong, H., & Strogatz, S. H. (2017). Oscillators that sync and swarm. *Nature Communications*, 8(1), 1–12.

[2] Lucas, P. P., Fasciani, S., Szorkovszky, A., & Glette, K. (2024). Interactive Sonification of 3D Swarmalators. *NIME 2024*

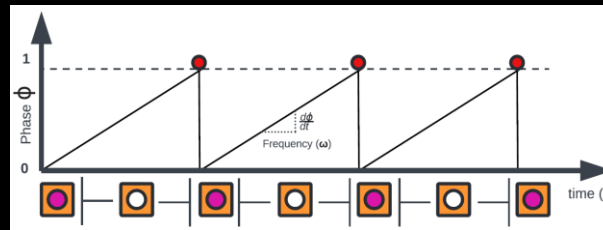
Self-Assembly

"Self-assembly" is a natural growth mechanism that occurs on different scales. It involves components that follow local interaction rules, leading to the formation of patterns or structures without human intervention.

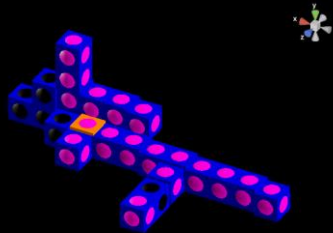
Music Generation Proposal [1]



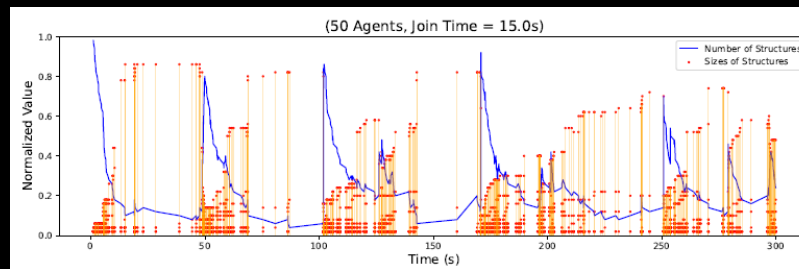
Agent



Internal Oscillator

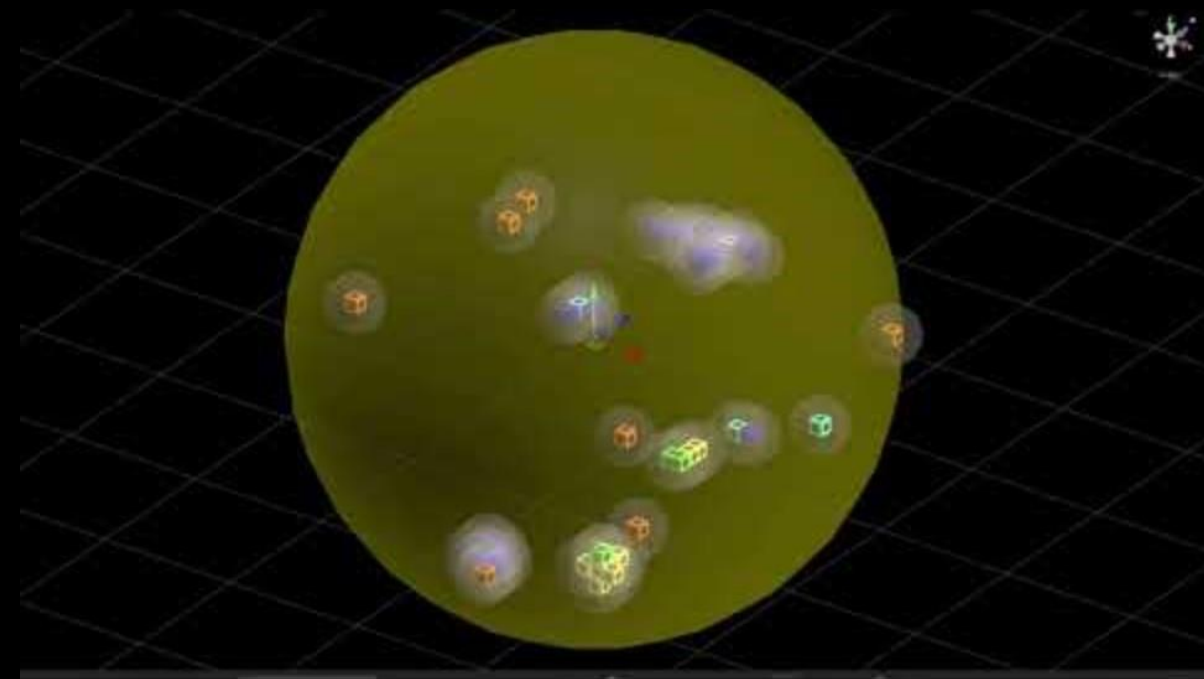


Structure



Discovered Patterns

Realtime Demo [1]



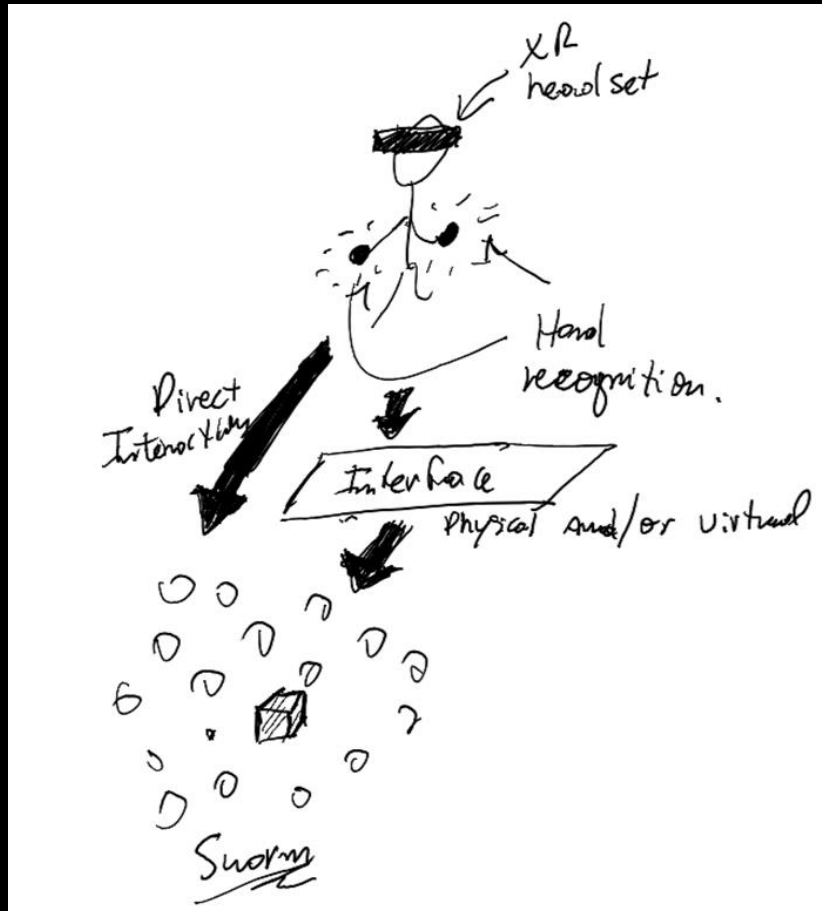
<https://youtu.be/GplsQD09y7Q>

Systems in Extended Reality (XR)

Swarmalators in XR

Use of group-based and individual-based control.

Overall Design



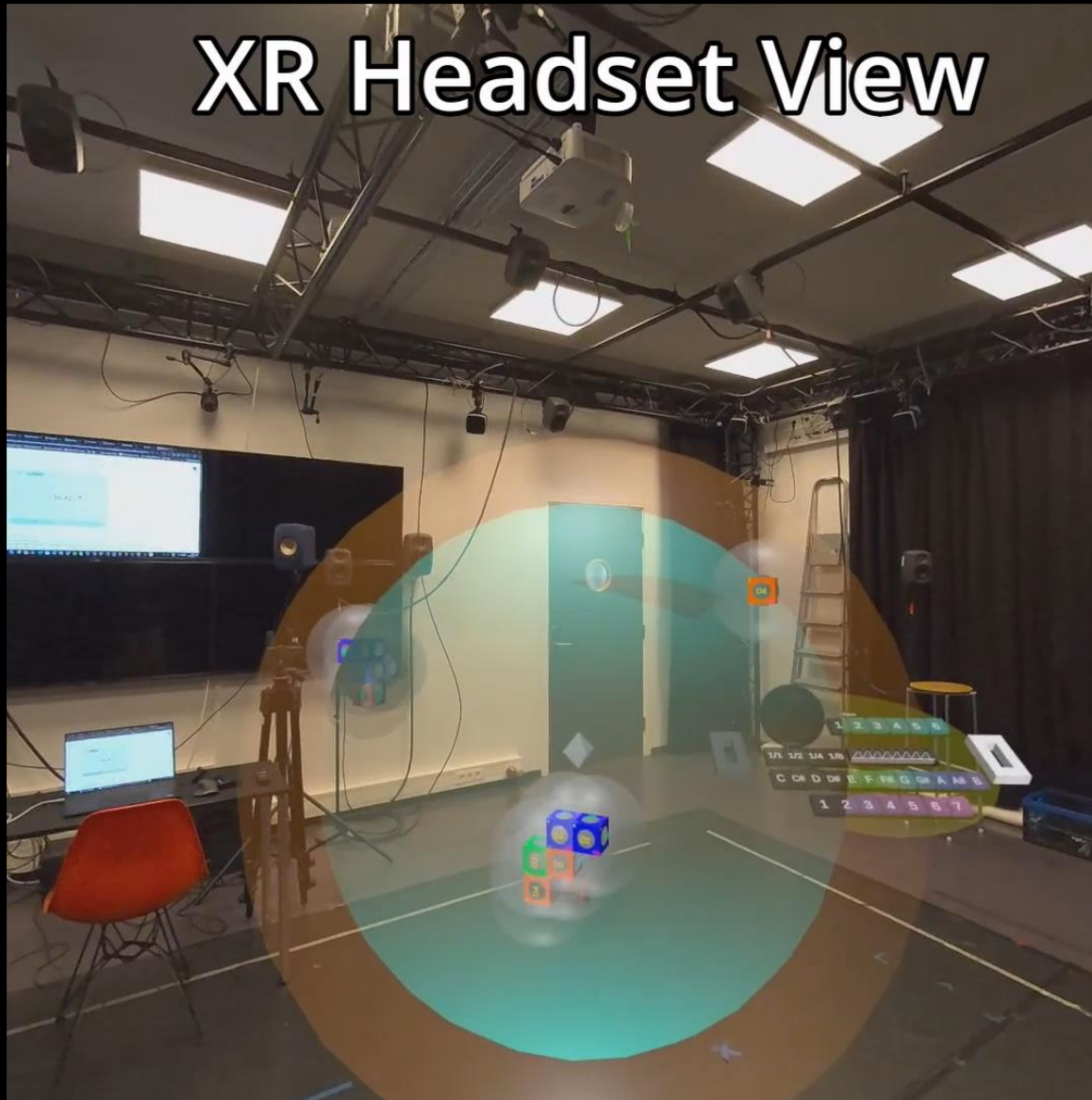
Meta Quest 3: Headset view



https://youtube.com/shorts/xoCbOf9_alc?feature=share

An Interactive Self-Assembly Swarm Music System in XR

XR Headset View



Front View



<https://youtu.be/Y894nOZluLk>

Some topics of interest for Human-Swarm IMS

- Individual Intelligence (ML Perspective)
 - What types of multi-agent solutions can we have if we model individual agents using machine learning techniques?
 - How can such models be kept efficient for real-time learning and inference? (Online machine learning?)
- Estimation of emergent properties.
 - What emergent properties can we discover from swarm models?
 - How can we estimate aspects of emergent macro-states?
 - How can we use these properties and aspects for IMS?
- Machine Listening.
 - How can an autonomous agent listen to multiple sources and differentiate them?
 - How can listening be optimized for a real-time and decentralized solution?

User Study

Human-Swarm Music in XR

- Explore a unique mixed reality experience where you collaborate with autonomous agents to create music together.
- **NO music expertise is required!**
Everyone is welcome!
- You get a **200 Kr gift card** valid at several stores.

Join us for a fun user study featuring an XR system!
Everyone is welcome to participate.



Reserve a spot in the lab that is most convenient for you:

RITMO (Department of Psychology)	ROBIN (Department of Informatics)
	



Questions?

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