The Scaffolded Sound Beehive

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Abstract

The Scaffolded Sound Beehive is an immersive multi-media installation which provides viewers an artistic visual and audio experience of activities in a beehive. Data were recorded in urban beehives and processed using sophisticated pattern recognition, AI technologies, and sonification and computer graphics software. The installation includes an experiment in using Deep Learning to interpret the activities in the hive based on sound and micro-climate recording.

1 Description of the work

This paper describes an artistic installation, shown in the IJCAI-2015 exhibition, centering around the theme of bee monitoring. The centerpiece of the installation is the top of a Warré beehive constructed using open source digital fabrication and mounted on scaffolds. A Warré hive is a sustainable beehive originally designed by the Warré around 1920. The hive is 2.5 m high so that visitors can put their head inside it and experience a visual and auditory artistic interpretation of hive activity, making this an interactive immersive installation. The Scaffolded Hive will be a very visible beautiful landmark (Figure 1).

Three further components are added:

1. An 8-channel sound installation plays continuously inside the hive. This sound installation is based on recordings of actual bee and environmental sounds in the broodnest of an urban beehive installed on the roof top of the Brussels Urban Bee Laboratory for a complete season (Fig. 2, right). It started with recordings on June 21st 2014, the longest day/shortest night, processed using sophisticated pattern recognition algorithms, and artificial intelligence analysis software, and edited into a 15 minute-piece using Max/MSP by adding swirling electronic sound clusters to sonify the increase and decrease of swarm activity in the hive.

2. A video shows 365 days of activity inside a real observation beehive, played back at higher speed. The images were recorded with an infrared camera inside the hive (Fig. 2, left) and processed using pattern recognition, AI and computer graphics algorithms (Fig. 3). These

Figure 1: Left. Physical Warré-hive. Right: 3d Model (constructed with Blender) of the Scaffolded Warré hive. The Scaffoled Hive will be digitally fabricated based on this design.

images give a stunning visual experience of a colony in action.

3. A second video shows a graphical rendering of AI analysis of colony behavior combining real audio data with measurements of microclimate inside the hive: temperature, CO2 and humidity and using DEEP LEARNING to detect patterns in the data (Fig. 4).

2 Artistic goals and production

The Scaffolded Sound Beehive is part of a series of ecological instrumented beehives leading towards a fully biocompatible intelligent beehive [Maes, 2013]. These beehives allow me to study the tight interaction between city honeybees and urban ecosystems, using artistic research practices and in collaboration with scientists. My preoccupations with bees come partly from a fascination with these amazing insects: Bees exhibit

Figure 2: Field recordings. Left: Cameras connected to Raspberry Pi computers film, process and stream the visual data recorded in the hive. Right: Piezo sensors are inserted into the hive, between the comb frames and in front of the entrance on the landing platform. The piezo's are connected to a small mixing panel with amplification.

very original solutions to the challenges that social insects face, e.g. on the level of communication and collective decision making. They are an endless source of visually stunning images and sounds and their remarkable collective behavior provides inspiration and metaphors for the functioning of human society. But in many industrialised nations, bee colonies are now threatened. So I work also towards an improvement of the environment of bees with the creation of urban gardens and guerilla planting and I use bees as bio-indicators to make citizens aware of the increasingly negative effects of our life styles and methods of industrial production.
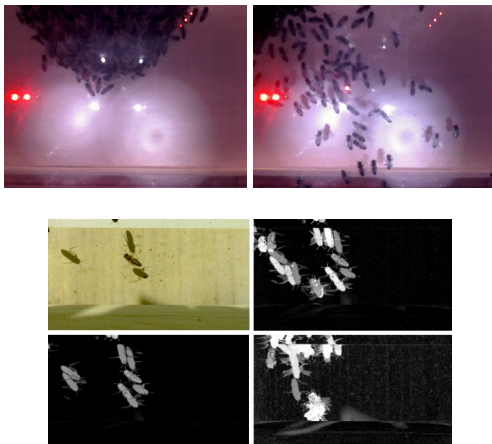

Figure 3: Top. Extract from visually observed bee activity. Bottom: processing and tracking of bee movements.

3 Relationship to AI

The Scaffolded Sound Beehive uses a broad range of pattern recognition and AI techniques. As a special contribution to IJCAI, a project was carried out to use Deep Learning techniques using massive data from sound and microclimate in order to get an interpretation of hive activity. The data were transformed into a multi-dimensional feature space, and presented to a Deep Learning network to extract categories capturing patterns of activity through unsupervised learning. An original visualisation was developed (see Figure 4) which represents categories as attractors in a projected 3d space, with the size of the attractor reflecting the strength of the category.
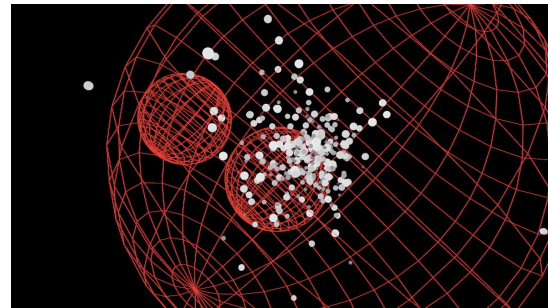

Figure 4: Novel visualisation of results of Deep Learning. The spheres represent learned categories. The white dots are hypothetical bees spatialized for how well they fit with the categories.

4 Context of the work

The Brussels Urban Bee Lab [BUBL] is an independent international collective of artists, scientists, beekeepers, technicians and creative people. It was founded by AnneMarie Maes in 2009. BUBL uses artistic, scientific and technological research approaches to tackle challenges related to sustainability and the monitoring and survival of city honeybees. An extensive rooftop garden in the centre of Brussels hosts the headquarters of the BUBL laboratory. It is giving place to several experimental beehives and instrumentation equipment. From this laboratory, data is continuously being broadcast through streaming technology.

The Brussels Urban Bee Lab operates mainly through artistic installations and workshops. The group has produced several very original beehives and produced art works shown in international exhibitions. The installations explore highly experimental technologies, such as microbial fuel cells, digital and organic fabrication using OpenStructures, biomimicry, spatialised sonification, web-based continuous data streaming, data mining based on Artificial Intelligence, organic electronics, solar energy for powering low-energy computing, etc.

5 Acknowledgement

References

[Maes, 2013] AnneMarie Maes. *The Transparent Beehive*. OKNO Publications, Brussels, 2013.