

Lichtsuchende: A Society of Cybernetic, Phototropic Sunflowers*

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ABSTRACT

Lichtsuchende is an interactive installation, built using a society of biologically inspired, cybernetic creatures who exchange light as a source of energy and a means of communication. Visitors are invited to engage with the installation using torches to influence and interact with the phototropic robots. The embodied algorithms give rise to emergent behaviours with communicative and emotional resonance, allowing a duet between the humans and the cybernetic beings.

Author Keywords

Cybernetics; Interaction design; Actor Network Theory

INTRODUCTION

Biologically inspired artworks have the potential to feel alive, creating an interplay of needs between the visitors and the system. When people experience digital algorithms associated with the physical structures of artificial creatures, there is a tendency to anthropomorphise, to project ideas of emotion and behaviour, and to empathise with them. There is a vibrant history of swarm behaviour and artificial life within the world of computational art. To highlight some influences on this work: Blackwell's *SwarmMusic* [2] paired a digital swarm with a skilled human improviser to create musical duets and rAndom International's *Audience* piece works with the idea of static robot swarm directing their attention to visitors which they find in some sense 'interesting'¹. Finally, there is a clear relation to Ihnatowicz's seminal *Sound Activated Mobile*², one of the earliest cybernetic kinetic sculptures.

Lichtsuchende engages with the relation between embodied algorithms and emotional responses, the ways in which we may socialise with robots [3]: how the internal state is performed and understood, how activity is organised, and what gives rise to the underlying dynamics of action and response. This draws on Barlow's modal action patterns—recognisable behaviours with clear preconditions underpinning theories

¹<http://www.chrisoshea.org/audience>

²<http://www.senster.com/ihnmatowicz/SAM/sam.htm>

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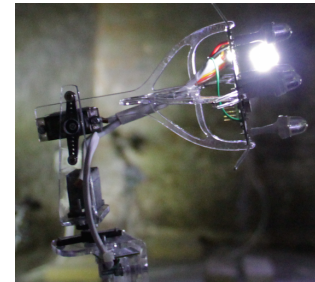


Figure 1. The head of a robot, consisting of a PCB mounted on an armature composed of transparent acrylic and servo motors.

of animal communication such as zones of safety [1], and Maslow's organisation of human needs into a hierarchy of dependance with the requirement to satisfy base needs before more rarefied desires are considered [5].

Another area of interest is the relation between digital creatures and their environment, in particular Uexküll's *Umwelt*—the perceptual life-world which gives rise to the creatures' biosemantic view of their environment: "Every subject spins out, like the spiders threads, its relations to certain qualities of things and weaves them into a solid web, which carries its existence" [6, p. 53]. The environments in which these creatures exist, however, are often created alongside their inhabitants, developed in dialogue with the ways in which the creatures practise and perform their behavioural routines. This creates a symbiotic relation, where the environment and its organisms shape and influence each other [4, p. 20], an ecosystemic network between the emerging lifeforms, their creators, and their visitors.

DESCRIPTION OF THE WORK

Lichtsuchende is an interactive installation, comprising a society of cybernetic creatures. The creatures base their interaction on the exchange of light, using it both as a source of energy and a means of communication. Visitors to the installation can interact with the creatures using torches to influence their behaviour (Figure 2). A video showing an early version of the robots can be found here: <http://bit.ly/1HF0od8>.

The creatures resemble sunflowers to some extent: they are fixed to the floor, and rotate their heads to track light. They have a relatively curtailed set of basic capabilities for sensing and affecting their environment (Figure ??): actuators to angle their heads; 5 ambient light sensors arranged in a cross allow them to sense the intensity and gradient of the light



Figure 2. Lichtsuchende installed in the Hidden Door Festival, Edinburgh, 2014. Photo credit Chris Scott @chrisdonia

field in front of them; and cluster of superbright LEDs emit a strong, narrow beam of light in the direction that they are facing, with variable intensity 1.

This means their *Umwelt* is built on an extremely pared down set of basic inputs: knowing their position, and sensing part of the structure of the light field around them. This allows them to turn their attention towards sources of light, and to project light in the direction of their attention as a means of engaging, connecting their inner world to that of their fellows and any visitors in the installation environment.

As previously noted, the central characteristic of the creatures is their fascination with light, their immediate enrapturement and constant alignment with any source of photons. As well as their fascination with light, the creatures navigate a graph of behavioural states (Figure 3), which are arranged in a rough parallel with Maslow's hierarchy of needs [5]. Taken in increasing priority, the states, their conditions and the associated observable activities are as follows:

Sleeping occurs when a flower lacks energy, looking downwards, pulsing gently and regaining energy.

Searching involves moving by small, random amounts, and then sending out a slow pulse of light in that direction to see if anything responds.

Tracking happens when there is sufficiently bright light source and involves turning towards the sensor giving the highest reading. When tracking, the robot outputs a strong beam of light, to allow itself to be tracked by whatever is producing the light. Tracking consumes a lot of energy, meaning that often the flower will go to sleep if the light source is lost.

Communication is enabled when a robot has seen a bright light, for a certain amount of time, with minimal movement, indicating that it has found a fellow flower. The physical effect is that the robot freezes in place, and flashes rapidly, as a placeholder for exchange of information.

Joy occurs when communication is successfully completed: the flower points at the sky, emits a few bright flashes of light. It then goes back to sleep, exhausted.

Some physical behaviour is unplanned, resulting from their embodiment and situation: if a person reaches out to

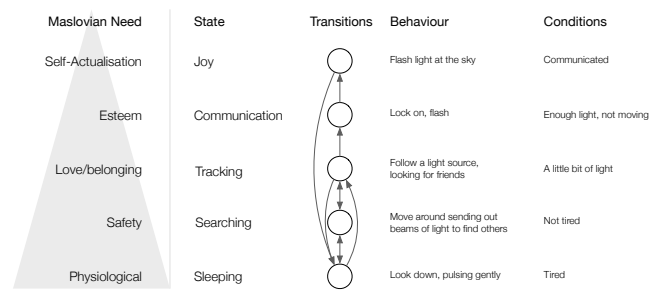


Figure 3. Behavioural states of the robots with their activation conditions, and a relation to the Maslowian hierarchy of needs.

touch a flower which is tracking light, their hand casts a shadow on the sensor, and the robot will turn away. This can happen abruptly, and has been interpreted as shyness, or a nervous reaction. We are interested firstly in how the robots' internal state can be communicated to visitors, the relation between display and interpretation and matching conceptual ideas to anthropomorphic readings. Secondly, how can the network of states be constructed to give rise to pathways of behaviour that are understandable and plausible in the context of creaturehood.

The behaviours above provide a link between the individual and the social, and these interrelationships provide fertile ground for emergent behaviour. At one level, there are the effects of having several autonomous, embodied entities sharing a space: communication may occur or not; if it does, it may be subject to misinterpretation, or interrupted by the actions of others. There is the possibility of cascades of behaviour change throughout the space, a positive feedback as each robot activates others, spreading excitation.

We are interested in the question of what it takes to design an 'interesting' robot society, which exhibits a range of behaviour, which reacts to visitors but has its own internal dynamics, and which doesn't exhibit pathological complete failure modes.

REFERENCES

- Barlow, G. W. Modal action patterns. In *How Animals Communicate*, T. A. Sebeok, Ed. Indiana University Press, 1977, 98–136.
- Blackwell, T. Swarm Music: improvised music with multi-swarms. In *2003 AISB symposium on AI and Creativity in Arts and Science* (2003), 41–49.
- Fong, T., Nourbakhsh, I., and Dautenhahn, K. A survey of socially interactive robots. *Robotics and autonomous systems* 42, 3 (2003), 143–166.
- Ingold, T. *The Perception of the Environment: Essays on livelihood, dwelling and skill*. Routledge, 2000.
- Maslow, A. H. A theory of human motivation. *Psychological Review* 50, 4 (1943), 370–396.
- Von Uexküll, J. *A foray into the worlds of animals and humans*. University of Minnesota Press, 2010.