

True unmanned art

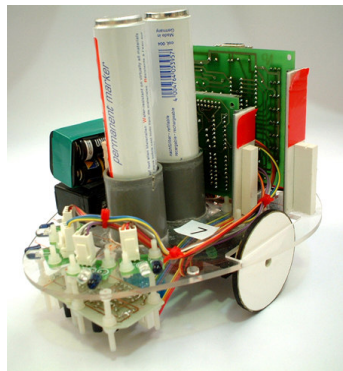
Leonel Moura and Henrique Garcia Pereira

A true unmanned art depends on the capacity to produce mechanical 'organisms' able to create their own art. This can be achieved by building devices with some kind of environmental awareness that run algorithms based on simple rules. The art produced is not predetermined in any manner, resulting rather from randomness and stigmergy, that is, indirect communication between multiple agents through the environment. To witness the construction of a painting by autonomous robots represents for the human viewer an experience of global consciousness.

Keywords: Unmanned art, stigmergy, randomness, complexity, gestalt, global consciousness

The robots and their collective behaviour

Each robot is equipped with two RGB colour detection sensors, four IR obstacle avoidance sensors, a microcontroller and two actuators, one for locomotion and the other for pen manipulation. The microcontroller is an on-board chip, to which the program that contains the rules linking the sensors to the actuators is uploaded, prior to each run, through a PC serial interface. Each robot is 4.9 in tall, composed of an oval 7.8 x 5.9 in chassis, moved by three wheels and carrying 2 marking pens, the sensors, the chip and 8 AA batteries.



General physical view

The algorithm that underlies the program uploaded into each robot's microcontroller induces basically two kinds of behaviour: the random behaviour initialises the process by activating a pen, based on a small probability (usually $2/256$), whenever the colour sensors read white; and the positive feed-back behaviour that reinforces the colour detected by the RGB sensors, activating the corresponding pen (since there are two pens, the colour circle is split into two ranges – "warm" and "cold").

The collective behaviour of the set of robots evolving in a canvas (the *terrarium* that limits the space of the experience), is governed by the gradual increase of the deviation-amplifying feed-

back mechanism, and the progressive decrease of the random action, until the latter is practically completely eliminated. During the process the robots show an evident behaviour change as the result of the “appeal” of colour, triggering a kind of excitement not observed during the initial phase characterized by the random walk.

This is due to the stigmergic interaction between the robots, where one robot in fact reacts to what other robots have done. According to Grassé (1959), stigmergy is the production of certain behaviours in agents as a consequence of the effects produced in the local environment by a previous action of other agents.

Thus, the collective behaviour of the robots is based on randomness and stigmergy.

The emergence of complexity in real time and space

By analysing the above described course of action of the set of robots, it can be stated that from the initial random steps of the procedure, a progressive arrangement of patterns emerges covering the canvas. These autocatalytic patterns are definitively non-random structures that are mainly composed of clusters of ink traces and patches. Hence, this experiment shows *in vivo* (in real time and space) how self-organized complexity emerges from a set of simple rules, provided that stigmergic interaction is effective. The vortices of concentration of ink spots, i.e., the clusters that arise in the canvas, may be looked at as the effect of strange attractors, in terms of non-linear dynamic theory. Also, in the scope of the same theory, the concept of bifurcation is found in this experiment, since the robots may take one direction or another, depending on the intensity and spatial position of the colour detected by their RGB sensors. In fact, this experiment may be understood as the mapping of some sort of deterministic chaos, displayed in practical terms in the canvas and witnessed by the viewer. Actually, in spite of each robot being fed with the same set of rules, its detailed behaviour over time is unpredictable, and each instance of the outcome produced under similar conditions is always a singular event, dissimilar from any other.



Artwork, 156 x 195 in, produced by a group of 10 robots

From a scientific perspective, the proposed experiment illustrates Prigogine’s concept of dissipative structures. While receiving energy from outside, the instabilities and jumps to new forms of organization typical of such structures are the result of fluctuations amplified by positive feed-back loops. Thus, this kind of ‘runaway’ feed-back, which had always been regarded as destructive in cybernetics – as stated by Capra (1996) -, appears as a source of new order and complexity.

The mind/body problem

The dual mind/body problem (that has been floating over Western thought since Descartes) is to be overcome by the ‘horizontal’ synergetic combination of both components, discarding

any type of hierarchy, in particular the Cartesian value system, which privileges the abstract and disembodied over the concrete and embodied. It is fascinating to infer from the possibility that, since computation - a mental operation - is physically embodied, the mind/body duality put forward by Descartes must succumb the way organic/inorganic duality did under Wöhler's achievement in the 1820s, "when he synthesized what everyone would have counted an organic substance - urea - from what everyone would have counted inorganic substances - ammonia and cyanic acid", in the words of Danto (2001).

The approach proposed here follows tightly the interconnectedness of being and its formal embodiment as inseparable parts of *autopoiesis*, in Maturana & Varela's sense. In visual arts, a similar point is made by Sean Cubitt, when he claims that any contemporary artwork must construct its own local, not presume it. In Cubitt's words: "the digital art must be material". This is the paradox that drives all new approaches on the production of 'concrete' artworks by using information technologies.

The first true unmanned art

Modern and contemporary art distinctive features are "magnificence and unusefulness" as stressed by Fernando Pessoa referring to his own masterpiece "The book of disquiet", and confirmed by the main artistic tendencies of the 20th century. In the art of our time the conceptual prevails over the formal, the context over the object manufacture and the process over the outcome.

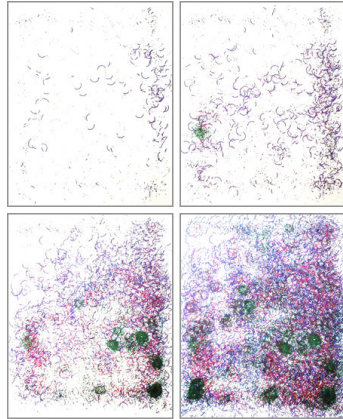
In consequence, if art is to be produced by robots no teleology of any kind may be allowed. Accordingly, all the goal-directed characteristics present in the industrial-military and entertainment domains of robotics must be carefully avoided. Also bio-inspired algorithms that have any flavour of "fitness" in neo-Darwinian terms or any kind of pre-determined aesthetical output must be regarded as of limited and contradictory significance.

To the best of our knowledge, this is the first experiment where robotic art is understood as a true autonomic process. In particular human creators deliberately loose control over their creations and, specifically, concentrate on "making the artists that make the art" (Moura & Pereira, 2004).

Art produced by autonomous robots can not be seen as a mere tool or device for human pre-determined aesthetical purpose, although it may constitute a singular aesthetical experience. The unmanned characteristic of such a kind of art must be translated in the definitive overcoming of the anthropocentric prejudice that still dominates Western thought. In short, a true robotic art must be the matter of robots themselves.

The viewer's perspective

As opposed to "traditional" artworks, the constructing of the painting by the collective set of robots can be followed step-by-step by the viewer. Hence, successive phases of the art-making process can be differentiated.



Painting in progress: 30, 60, 120 and 240 minutes

Instead of trying to “tell a story” by assigning “movement” or “sequence” to a preset spatial image, the proposed approach shows in real time the picture construction, relating each stage of the process with the conditions under which the set of robots is evolving.

Even though the same parameters are given to the program commanding the behaviour of the set of robots, the instances produced are always different from each other, leading to features like novelty and surprise, which are at the core of contemporary art.

From the viewer’s perspective, the main difference from the usual artistic practice is that he/she witnesses the process of making it, following the shift from one chaotic attractor to another. Though finalized paintings are kept as the memory of an exhilarating event, the true aesthetical experience lies in the dynamics of picture construction as shared, distributed and collaborative man/machine creativity. At any given moment, the configuration presented in the canvas fires a certain gestalt in the viewer, in accordance with his/her past experience, background and penchant (a correspondence may be established between the exterior colour pattern and its inner image, as interpreted by the viewer’s brain).

The propensity for pattern recognition, embedded in the human perception apparatus, produces in such a dynamic construction a kind of hypnotic effect that drives the viewer to stay focusing on the picture’s progress. A similar kind of effect is observed when one looks at sea waves or fireplaces. However, a moment comes when the viewer feels that the painting is ‘just right’ and stops the process. Such a gesture can be defined as a moment of aesthetical awareness.

Conclusion

Autonomous robots able to produce their own art based on simple rules, randomness and stigmergy represent for the human viewer the opportunity to understand life and aesthetics beyond the anthropocentric paradigm and the mystifying separations it generates.

If robots can make art, humans can envision a global consciousness based on co-operative and distributed creativity, with no distinction between human beings, life forms and machines.

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