

# A New Kind of Art: The Robotic Action Painter

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In the context of robotics RAP [Robotic Action Painter] demonstrates that machine creativity can be achieved by means of randomness, stigmergy and chromotaxis.

RAP's action painting is based on two distinct behavior modes, the first being essential random and the second reactive or of positive feedback. The initial random color spots functions as a seed for the reactive mode emergent composition. In this sense the paintings are always distinct and unique.

Mode activation is based on local information gather by the robot itself. RAP uses a set of nine RGB sensors turned to the painting plan in order to determine the presence, shape and intensity of color. If color – with considerable expression (threshold) – is found, RAP changes from Random to Reactive Mode and proceeds to final composition arrangements. In this mode the robot is both attracted by color (chromotaxis) and responds to it (stigmergy).

The nine RGB sensors disposed in a grid of 3x3 make also possible for the robot to decide when the painting is finished. The fact that RAP can read not just single color spots but also local patterns, permits to generate a kind of “sense of rightness” and let the robot determine by itself the end of the process.

RAP is also able to sign its works.

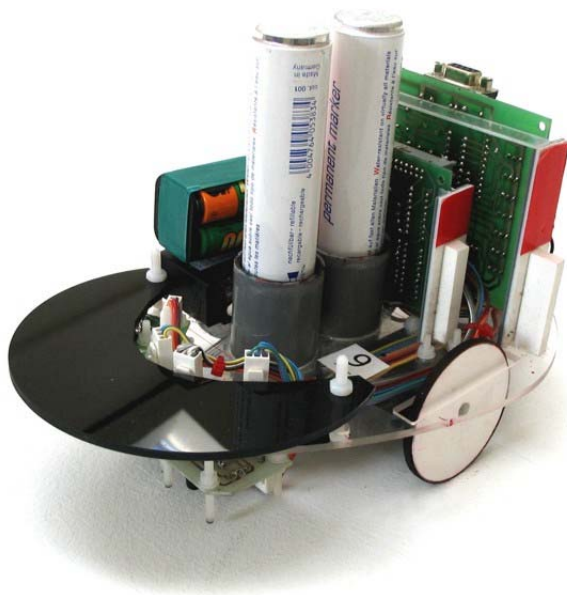
Although thresholds are used, essentially for variation of color sensibility, no use is made of any kind of fitness, other predetermined behavior loops (except for the signature), composition or aesthetical targets. RAP was conceived for the largest robot autonomy and consequently the less human intervention as possible.

RAP's paintings are fairly original to be considered the product of machine creativity. Sensors allow for an effective incorporation of new and non predetermined data which is the base of the creative process. Hence, these artworks are founded on the machine own interpretation of the world and not on its human description.

## Machine creativity

Based on ants and other social insect's studies [1], I have tried to reproduce artificially a similar emergent behavior in a robot swarm. These insects communicate among themselves through chemical messages, the pheromones, based on which they produce certain patterns of collective behavior, like follow a trail, clean up, repair and build nests, defense, attack or territory conquest. Despite pheromone not being the exclusive way of communication among these insects – the touch of antennas in ants or the dance in bees are equally important –, pheromonal language produces complex cognition via bottom-up procedures. Pheromone expression is dynamic, making use of increments and decrements, positive and negative feedbacks. Messages are amplified when pheromone is reinforced, and lose “meaning” when breeze disperses it. It is also an indirect communication, coined stigmergy by Grassé [2], from the Greek stigma/sign and ergon/action. Between the individual who places the message and the one who is stimulated by it, there is no proximity or direct relation.

Following these principles, I have replaced pheromone by color in my first ant-robots (2001). The marks left by one robot triggers a pictorial action on other robots. Through this apparent random mechanism abstract paintings are generated, which reveal well defined shapes and patterns. These robots create abstract paintings that seem at first sight just random doodles, but after some reflexive observation color clusters and patterns become patent. Through the recognition of the color marks left by a robot, the others react to it reinforcing certain color spots. The process is thus everything but arbitrary, stemming from a creative technique analogue to millions of years of evolution. As far as I know, ArtSBot (Art Swarm Robots) [3] was the first project to use emergent organization for developing robot creativity. Every previous experiment focused exclusively on randomness or sometimes on target strategies leading the machines to fulfill a pre-determined program created by the human artist. On the contrary, ArtSBot was ment to put into practice the utmost possible machine autonomy, aimed at producing original paintings. In operational terms, ArtSBot consists of a series of small "turtle" type robots, equipped with two felt pens and a pair of RGB sensors pointing to the painting plan. With these "eyes" the robots seek color (chromotaxis), determine if it is hot or cold, choose the corresponding pen and strengthen it by a constant or variable trace. To begin the process, when the canvas is still blank, the robots leave here and there a small spot of color randomly. Based on these simple rules, unique paintings are produced: from a random background stands out a well defined composition with intense shapes of color. In other words, initial randomness generates "order". The process is emergent and based on the properties of stigmergy.



### **1. A robot of the ArtSBot swarm**

The artistic product of these robots is entirely original. In the same way that somebody who writes a book cannot be considered as a mere instrument of his primary school teacher, robots cannot be seen as simple instruments of the artist that conceived and programmed them. There is an effective incorporation of new and non predetermined information in the process. And that cannot be called anything but creativity. It is true that consciousness is lacking to this creativity. But if we look at the history of modern art, it is obvious that, for example, surrealism tried to produce art works exactly in these same terms. The "pure psychic automatism", the quintessential definition of the movement itself, appeared as a spontaneous, non-conscious and without any aesthetic or moral intention technique. In the first Surrealist

Manifesto André Breton (1924) defined the concept in this way: “Pure psychic automatism by which it is intended to express, either verbally or in writing, the true function of thought. Thought dictated in the absence of all control exerted by reason, and outside all aesthetic or moral preoccupations.” [4]. In the field of the visual arts, Pollock it is who better fulfills this intention by splashing ink onto the canvas with the purpose of representing nothing but the action itself. This was coined Action Painting, as it is well-known. Perhaps, because of that, the first paintings from my robots are, aesthetically, so similar to the ones of Pollock or André Masson, another important automatism based painter. In his surrealist period, this artist tried frequently to prompt a low conscious state by going hungry, not sleeping or taking drugs, so that he could release himself from any rational control and therefore letting emerge what at the time, in the path of Freud, was called the subconscious. The absence of conscience, external control or pre-determination, allow these painting robots to engender creativity in its pure state, without any representational, aesthetic or moral intention.

RAP (Robotic Action Painter), created in 2006 for the Museum of Natural History in New York, is an individualist artist and not a swarm, but makes use of the same composition methods based on stigmergy and emergence. This robot is additionally able to determine, by its own means, the moment in which the painting is finished. Previous versions didn't have this capacity being conditioned by battery discharge or my will to stop the process. RAP's decision is taken based on the information that it gathers directly from the painting, what produces a considerable variation of time and form, since RAP can decide that the work is complete after a relatively short while (entailing accordingly a low pictorial expression) or can extend the picture construction for a quite long period, making it much more dense and complex. The "secret" of this behavior is in the significant change of the sensors, which passed from two to nine "eyes", allowing now the reading of local patterns, in addition to color spots. RAP is also my first robot to sign its works.

ISU, the poet robot also created in 2006, has the ability to write letters and words producing poems and emergent compositions based on the letter, quite similarly to the Lettrism style, artistic movement that followed Surrealism.

These references to 20th century art movements do not seek any kind of historical legitimacy, but are intended simply to show how certain morphogenesis processes produce similar results in human as well as non-human artists. My painting robots generate artworks based on emergence. The essential of those creations is based on the machine own interpretation of the world and not on its human description. No previous plan, fitness, aesthetical taste or artistic model is induced. These robots are machines dedicated to their art. Creativity is not an exclusive ability of human culture and it can be acknowledge in the same way in the physical, biological and artificial world.

## **RAP's behavior**

RAP is equipped with a grid of 3x3 color detection sensors, eight obstacle avoidance sensors, a compass, a microcontroller and a set of actuators for locomotion and pen manipulation. The microcontroller is an onboard chip, to which the program that contains the basic rules is uploaded through a PC serial interface.

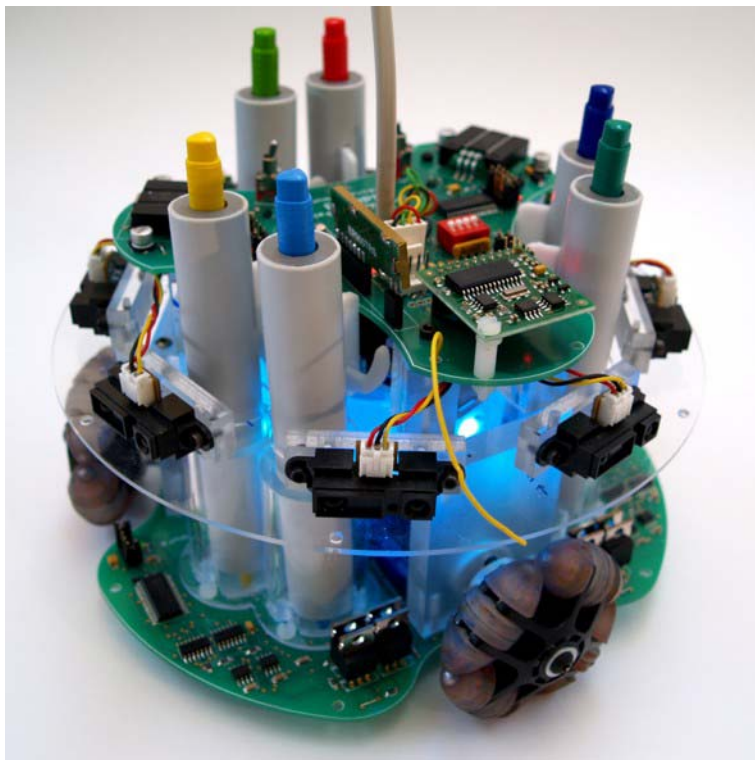
The algorithm that underlies the program uploaded into RAP's microcontroller induces basically two kinds of behavior: the random behavior that initializes the process by activating a pen, based on a small probability, whenever the color sensors read white; and the positive feedback behavior that reinforces the color detected by the sensors, activating the matching color pen. These two distinct behaviors are described as modes, the Random Mode and the Color Mode. In the random mode RAP searches for color (chromotaxis). Until a sufficient amount is not found (threshold) RAP activates here and there, randomly, a pen stroke

choosing also randomly the color and the line configuration. The shape, orientation and extent of these initial lines are determined by the robot based on a random seed acquire from its relative position in the space. This is done with the data retrieved by the onboard compass. In this way RAP's random generator can be described as real random and not pseudorandom.

When a certain amount of color is detected the robot stops the random behavior and changes to color mode. In this phase RAP only reacts to the spots where a certain amount of color is found, reinforcing it with the same tone.

After a while a discrete pattern emerges, where from a general random background a well defined composition can be recognized.

In order to determine when the painting is finished RAP makes use of a grid of 3x3 RGB sensors. If a certain pattern is found the robot "considers" the work to be done, moves to the down right corner and signs.



## **2. RAP (Robotic Action Painter)**

RAP creates artworks based on its own assessment of the world [5]. At any given moment the robot "knows" its situation and acts accordingly. It scans constantly the canvas for data retrieving. It uses its relative position in the space as a real random generator. It builds gradually a composition based on emergent properties. It decides what to do and when to do it. It finishes the process using its particular sense of rightness.

Although the human contribution in building the machine and feeding it with some basic rules is still significant, the essential aspects of RAP's creativity stems from the information that the robot gathers by its own means from the environment. In this sense RAP's art must be seen as an original creation independent of the human artist that was at the origin of the process.

## **A new kind of art**

RAP and the other of my painting robots were created to paint. Not my paintings but their own paintings. Such an objective addresses some of the most critical ideas on art, robotics and artificial intelligence.

Today we understand intelligence as a basic feedback mechanism. If a system, any system, is able to respond to a certain stimulus in a way that it changes itself or its environment we can say that some sort of intelligence is present. ‘Sheer’ intelligence is therefore something that doesn’t need to refer to any kind of purpose, target or quantification. It may plainly be an interactive mechanism of any kind, with no other objective than to process information and to react in accordance to available output capabilities.

Yet this is not what we usually observe in most of the artificial intelligence undertakings. For one part because human intelligence is still seen as the key model to be followed and by which all the experiments should be measured and evaluate. Artificial intelligence is in general a shadow of what we believe to be the human mind and behavior. As opposed to this, my painting robots were built without any previous intelligence model, human or other. Although the starting point was bioinspiration, in particular modeling social insect’s emergent behavior, the idea was to construct machines able to generate a new kind of art with a minimum of fitness constraints, optimization parameters or real life simulation. It is the simple mechanism of feedback and stigmergy that is at work here.

RAP is a singular species, with a particular form of intelligence and a kind of life of its own. It does art works as other species build nests, change habitats or create social affiliations.



### 3. A painting by RAP

If robots would appreciate art RAP’s paintings would probably be the ones they like most. As these artworks expresses true machine creativity. But since we, humans, are for the time being the only pensive observers, the relation between machine art and human aesthetics principles is here the central issue. Many people like the robot paintings, probably because we seem to gladly embrace fractal and chaotic structures. But, more than shapes and colors, what some of us really appreciate in this idea and its associated process, is the fact that it questions some of

our most strong cultural convictions. Actually it was supposed art to be an exclusive matter of mankind. In this sense, the robot paintings are a provocative conceptual art that problematizes the boundaries of art as we know it.

## References

- [1] Wilson, Edward O. (2006) *Nature Revealed, Selected Writings 1949-2006*, The Johns Hopkins University Press, Baltimore
- [2] Grassé, P. P. (1959) *La reconstruction du nid et les coordinations inter-individuelles chez *bellicositermes natalienses* et *cubitermes* sp.* La théorie de la stigmergie: Essai d'interpretation des termites constructeurs, *Insectes Sociaux*, 6, pp. 41-48
- [3] Moura, L. and Pereira, H.G. (2004) *Man and robots: Symbiotic Art*, Institut d'Art Contemporain, Villeurbanne
- [4] Breton, André (1969) *Manifestoes of Surrealism*, University of Michigan Press
- [5] Brooks, R. A. (1991) *Intelligence without Reason*, Ed. Morgan Kauffmann, San Mateo, California