Robotic expression

Developing an applied framework for the integration of artistic approaches and technological competences

by

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Undertaking a research on Robotic Art

The significance of a research conjugating art, science and technology

The separation between art and technology initiated during the Renaissance, when science became codified as a segregated set of processes and worldviews [1].
Since that time, many artists and theorists have challenged this separation, questioning the role of art in society, our perception and awareness of technology and the agendas of cutting-edge research.
Research, today, has become the center of cultural innovation: its results deeply influence life and thought. Just like religion in the Middle-Age unified Europe, and the Enlightenment changed the face of society, at present research, its results and imagery shape both contemporary culture and everyday life [2].

Despite this extensive influence, scientific and technological research is generally interpreted as a specialized and inaccessible technical knowledge. In the same way, contemporary art is often perceived as a segregated niche and it is often arousing suspects in terms of lack of genuineness and quality.
Actually, art – just like research – can explore technological and scientific frontiers and allows us to ask questions about the possibilities of innovation and the agendas of technology.
Today, artist are filling the gap of the lack of understanding and awareness of technology, by working at the intersection of art and science and providing a continue commentary on the possibilities and implications of research and technology.
Artistic creativity and cultural commentary carried out within artistic practices represent the need to rethink the relationship of art to scientific and technological research, exploring also the perspectives for future mutual influence.
While often the approaches towards technology are polarized - from uncritical technophilia to anti-technological Luddism, art is a fertile sector for considering the myths of (anti)technology and explore such issues from a novel point of view.

Difficulties of categorisation

Technological-based art can not be grouped in a vast, indistinct category. Intuitions, social circumstances and technological opportunities set in motion a range of artistic practices into a specific area of techniques, tools and concepts.
Experimentations in a still raw area of technology can last a few years without leaving significant traces, or give birth to a body of artistic work and commentary: if this happens, the artistic choice to work within such a field does not have the same meaning.
On the other hand, at the early stages of an emerging technology, the power of artistic work derives in part from the cultural act of claiming it for cultural commentary and creative production; nevertheless, well-established technological arts, such as videos, with their own well-developed aesthetic and analytic tradition, may lose the possibilities offered by continuous experimentation.
In general, a critical view on techno-art is difficult since these kinds of practices are a moving target: experimental artworks created a few years ago can become obsolescent and archaic, and a complete survey necessarily includes continuous updates about technological and artistic state-of-the arts and new trends.
Without exception, all technological art, since the early developments of photography and cinema, underwent to categorisation problems.

Art practices such as robotic art oscillate between the two poles of continuous experimentation and analytic tradition. As electronic media become more pervasive in today's culture, the role of robotics in contemporary art, along with interactive installations, video, performance, multimedia, telecommunications, needs to be considered.
Like the other fields of technological art, one of the most problematic issues of robotic art is the definition of the medium.

Indeed, robots are an assemblage of mythological and folkloristic traditions, popular science-fiction imagery, often detached by the operational definition of robots as found in scientific research and industrial applications.
Popular imagery and research agendas influence - but do not coincide with - artistic trends.

Chronology and State-of-the-Art of Robotic Art

Robots are deeply embedded in popular culture and, at the same time, raise thought-provoking questions in the research world engaging engineers, artists and philosophers.
The term “robot” was originally coined by the Czech author Karel Capek in his 1917 novel *Opilec*. It comes from the Czech *robota*, meaning obligatory work or slavery. It appears in the play R.U.R by the same author, where a *robot* is defined as an artificial humanoid machine projected as a source of cheap labour.

In the last decades, artists have been exploring robotics and machine-activated motion. Some of the art practices share parallel agendas with the scientific and technological research, for example investigating the limits of “intelligent” machines, the agility of machine motion, the possibilities and progresses of artificial life and emergent behaviour, the implications of telerobotics and telepresence, reactive robots and human/machine interfaces. Others have been commenting images and myths from popular culture.

Other artists track different paths. Robotic art includes robotic/kinetic devices that comment on concerns of control and the relationship with machines to human activity. Other artists, refusing the pragmatic accent of scientific research, explore the qualities of the devices’ motion or appearance, such as beauty, emotional outcomes, interaction illusions or even violence and danger.
Robotic artists explored also the varieties of performance arts, including: theatre and dance, autonomy, extreme performance, body art, music installations.

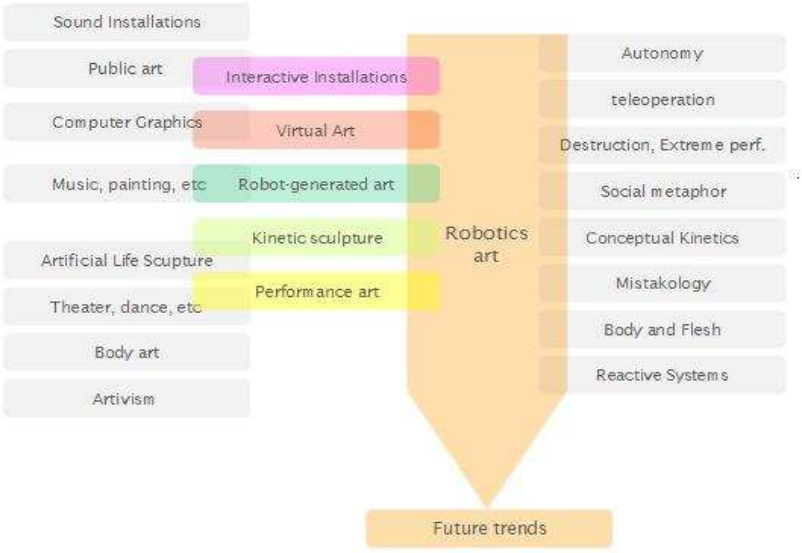
Initial Concepts and Main Issues

What follows is a first, rough categorisation in the field of state-of-the art robotic art., as illustrated in Figure 1. A detailed analysis will be needed in order to understand trends and future development, in order to create a valid framework of analysis.

Kinetic Sculptures

During the '50s, kinetic art contributed to free sculpture from static form and reintroduced the machine at the heart of the artistic debate [3]. Kinetic art is art that moves, by means of the human touch, or natural forces such as wind, or by motor. In his essay *Beyond Modern Sculpture*, the art theorist Jack Burnham suggested that robots were the ultimate extension of sculpture [4]. The seminal work at the origin of the state-of-the art development of kinetic art is probably Nicolas Schöffer's CYSP 1 (Cybernetic Spatiodynamic Sculpture), from 1956 [5]. This interactive work consisted into a pedestal provided with sensors and electronic components, and was designed in order to produce different types of movements in response to the presence of visitors. Schöffer's work represents a link between kinetics and robotics, between sculpture and interaction, and still influences many works that came later.
At present, it seems that two lines of artistic practice has originated from kinetic art: artists that are working with everyday material and with the simplest laws of mechanics, like Norman Tuck [6], Tim Hawkins or Theo Jansen and artists/researchers working with high-technology.
Latter ones provide a bridge between moving sculptures, interaction paradigms and Artificial Intelligence (A.I.) and Artificial Life (A-Life). This appears in the work of Yves Klein on “living sculptures”. These sculptures integrate organic forms with complex interactions guided by neural network programming. The process of creating a “living sculpture” involves developing technologies for gesture, locomotion, sensory input, and behaviour, to achieve a unified sculpture. [7] For instance, *Octofungi* is a eight-sided polyurethane sculpture that uses a neural network to integrate current events via multiple sensors and shape-metal alloy for

silent, nonlinear motion. It belongs to that area in which A-Life meets robotics, just like robotics environments developed by Demers and Vorn, built on biological concepts such as “chain reactions, propagation and aggregation behaviour, herds and swarms” [8].



1 – Categorisation of state-of-the art and related issues in robotic art

A-life Sculptures

Building on an interest in biological behaviours, Ken Rinaldo develops a series of sculptures with complex learning and interactive capabilities and using robotics technology: putting the accent is on Artificial Intelligence and emergent behaviours. Emergence is the coming together of systems with no central controller, allowing the global behaviour to evolve independently out of the local interactions among the systems.

The Flock consists of an assemblage of hanging robotic arms interacting with each other and with viewers, and manifest “flocking” behaviour, which develops from awareness of each other and the environment: “The Flock is a group of cybernetic sound sculpture that exhibit behaviours analogous to the flocking found in natural groups such as bird, schooling fish, or flying bats. Flocking behaviours demonstrate characteristic of supra-organization, of a series of animals or artificial life forms hat act as one. They are complex interdependent interactions which require individual members to be aware of their position in relation to others” [9].

Also Simon Penny creates art derived from artificial-life and A.I. concept. The robotic artwork Petit Mal attempts to explore autonomous behaviour as a probe of interactivity and the research field of A-Life. Penny’s goal is to produce a robotic artwork that senses and explores architectural space and that pursues and reacts to people, that gives the impression of intelligence and has behaviour which is neither anthropomorphic nor zoomorphic, but which is unique to its physical and electronic nature [10]: in other works, a robot which is really autonomous.

Autonomy

One of the major cultural issues of robotics focuses on autonomy, which it is often identified as a distinguishing characteristic both of human beings and humanoid robots. Autonomy is probably the feature that allowed robots being a feature of popular culture in literature and cinema since such a long time.

Nicolas Baginsky creates robots that use chaos theory and sophisticated intelligence to interact with viewers. Built on techniques from neural net research, his robots create complex image or sound events [11]

Within the same conceptual framework, Bill Vorn creates its *Hysterical Machines*, interacting with the passers-by and simulating, even if not by means of an anthropomorphic shape, a personality and emotional reactions to theirs environment.
Another example of commentary on the classic concept of autonomy is *Tree Time* by Bruce Cannon: such an installation reanimates a lightening-struck tree by means of robotics elements. The branches move at an imperceptible vegetal-like speed, and its "autonomy" mimes the Frankenstein myth.

Telerobotics

Artist and engineer Ken Goldberg created a series of Web-based installations in which a remote viewer, connected via the Internet, could introduce tests on an object to try to learn more about it. In *Legal Tender* [12] the remote viewer could view a one-hundred dollar bill and apply various tests to determine if it were counterfeit. Goldberg notes that instrumentation and remoteness complicate issues of epistemology even more than normal. He calls this topic tele-epistemology [13] In 1995, Ken Goldberg created the project *TeleGarden*, a Web telepresence installation. The *TeleGarden* enabled anyone on the Web to plant and water seeds in a real living garden using an industrial robot arm. Participants, who became 'members' of this virtual cooperative could also discuss via an online chat system. Telerobotics artistic experimentation generally consist in a cultural commentary about the technological possibility to perform an action in disjunction from "being there", both if this possibility offers new paradigm of interaction (as in *TeleGarden*) or if it puts into questions issues such as responsibility and other psychological implications of tele-operations: "Remoteness creates a new situation for performance, robotics, and interactive art, one that could be called "drama of distance"[14].
The same concept is valid for the work of Marcel.li Antunez Roca, founder of La Fura dels Baus: in his work *Epizoo*, the audience can directly manipulate the artist' body via a computer mouse: actuators move a variety of corresponding body parts.

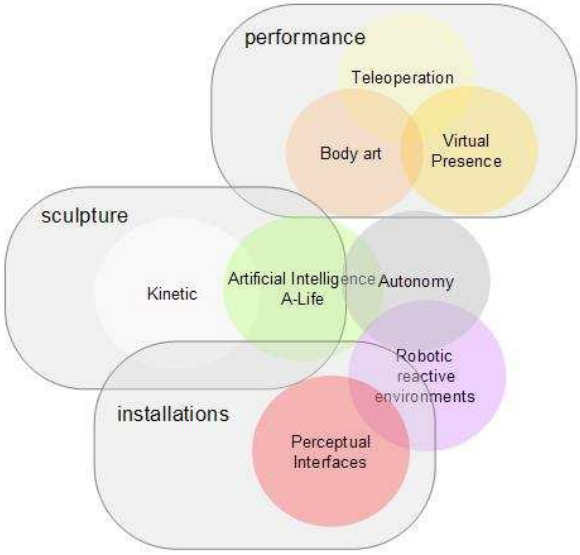
The Body

Science and technology have profoundly affected our abilities to observe, transform, and manipulate bodily functions and our concepts of the body. Artists have long focused on the body in painting and sculpture, just like actors, dancers and performers have used the body as their primary expressive medium. For autonomous robots and for robotic devices, body is a fundamental issue too. On the one hand, generally in Virtual Environment and in condition of teleoperation the normal sense of the body fades away [15]; on the other hand, robotic devices such as haptics interfaces allow creating an interface between the virtual /computational world and the user's perceptions.
Australian artist Stelarc has focused his work on his own body. His work consists in performances in which he amplifies and expands his bodily limits with the aid of electronic devices and telecommunications systems. In the Third Hand piece, he attaches a third (robotic) arm to his right arm [16] and then performs gestures dealing with evolved cyborg and post-human metaphors raising the issue of evolution and adaptation in the technological environment [17].
One of the central concern of robotic art is to seek for an interface that "speak the language of the body and bypasses textual, verbal or iconic signs [10]. The shadow of the organic body, of spatial awareness and enactive knowledge is present in every virtual reality or telecommunication-based experience, as illustrated by A-positive, by Eduardo Kac. The artist set up an exchange of blood between a human and a robot; blood is withdrawn intravenously from the human and passes through an oxygen-extracting apparatus in the robot, which uses the oxygen to maintain a small flame [18]
Robots and cyborgs are demanded to set in motion a process of humanization of machines; paradoxically, metal performances frequently dramatize a return to nature, to flesh and the animal [19].

Robotic environments - beyond installation

Luis-Philippe Demers and Bill Vorn attempt to exploit robot's ambiguity fluctuating between artificial machine and autonomous being, creating dramatic installations inhabited by robotic creatures that can interact with humans by following an emergent behaviour path (e.g. *The Frenchman Lake*) [20].

The machines composing the installations are animated by simple behaviours. Even if they are not anthropomorphic, by producing human-like sounds and movements they create a hybrid world between nature and the artificial in the participants' perceptions.
These kind of robotic environments go beyond the art of interactive installation. Interaction is usually associated to the direct control of the viewers over the systems. These installations can be categorized as reactive rather then interactive. In the reactive model of man/machine interaction, the viewers do not gain complete control over the system (like in interaction). Generally, the user influences the high level events (expressed by robots' behaviour) by means of her simple presence and movement.
This communication scheme is closer to the relationship between living organisms and their environment, if compared to the common interactive model where the system is waiting for an input from the user in order to react; in a reactive context proper to autonomous systems, the objects react at their own "will", between them and without the presence of any viewer.
An extreme example of the lack of control that can characterize reactive systems is represented by Ulrike Gabriel's *Terrain*, an installation in which the viewers brain waves affected the motion of a colony of small robots. The installation consists of mobile robots that have the intelligence to pursue light and avoid each other. The viewer's brain waves affect the lights, illuminating the vehicles.



2 Categories and issues

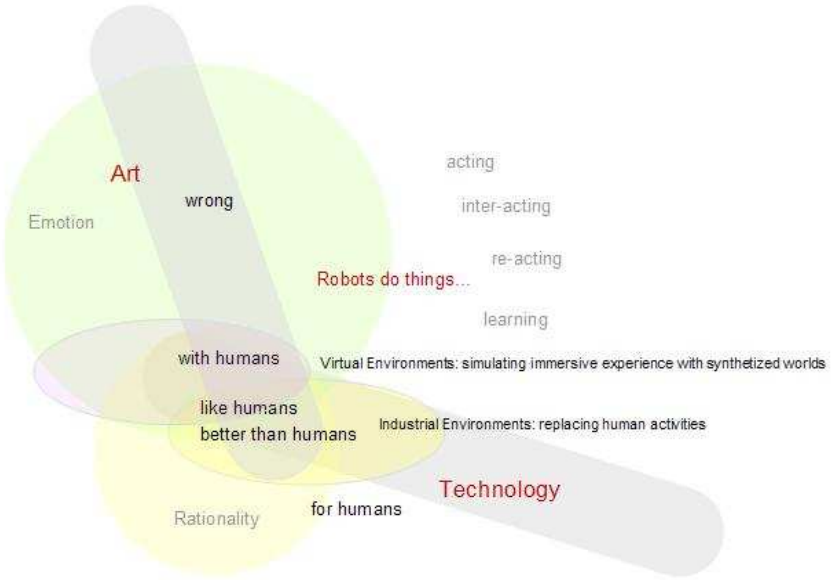
Perceptual Interfaces

Robotics can also act as a vector of computer mediated perception turning abstract data in sensitive experiences, making the remote, invisible or intangible experiencable, just like in the Museum of Pure Form Project, a virtual gallery of 3D artworks digitized and offered to user's touch via haptic interface [22].
Stahl Stenslie and Kirk Woolford have initiated several lines of art research investigating tactile stimulation as a medium. Their projects typically involve participants wearing special sensor/stimulator suits (*Inter_skin*) or exploiting a common medium (*SensoCouch*) that allowing to exchange tactile messages among participants.

Representation, function and deconstruction

"Art is a response to belief and acts as a consolidating force within culture. It gives place, time, image, and sound to myths. But the myths of science are not content to be represented by picture, poems, and symphonies. The scientific revolution threw away the idea that things were connected by appearances and replaced it with the idea that things are connected by how they work" [23]

Artistic experimentation in robotics illustrates an important difference in the ways artists and researcher approach research, as illustrated in Fig. 3. Even though scientists and technologists may give heed to the context of their funding or research agendas, artists are much more likely to deeply explore the cultural



3 Functions in art and technology

context underlying the research activities. What really unifies these heterogeneous practices is the artistic will to change the perspective, give another function and exposing and commenting the cultural underpinning of technology, often in a humorous and troubling way.

Robots as part of the surveillance power structure is deconstructed by Critical Art Ensemble by means of "Contestational Robotics", seeking to develop robots to serve as resistant forces, such as robot pamphleteers that can safely counter the police robots or graffiti robots. In the same way, the artists using kinetics have been creating mechanical installations pursuing cultural agendas unaddressed by mainstream industrial applications, or devices devoted to conceptual explorations rather then utility.
Systematic unpredictability and non-optimization are artistically fertile and scientifically provocative for Simon Penny [24], creator of the autonomous robot *Petit Mal* (an epileptic condition, a lapse of consciousness), whose unpredictable behaviour is not only an artistic exploration of medium's possibility but also an act of humour on the typical conventional idea of control in robotics: the device is "anti-optimized" to induce the maximum of personality [10].
Possible mistakes and "unpredictability" of the machine is one of the main feature of the Survival Research Lab work. the SRL push things far from equilibrium, to that point of unpredictability: "you don't know whether these machines are going to attack the audience; the question in everybody's mind is, "Hey, are these guys really in control"? [25]. Vorn too investigates the same concept area by ideating machines that are not "clean" in the technological way. In Vorn's *Court of Miracles*, a "universe of faked realities loaded with pain and groan (…) induce empathy in the viewer towards these characters which are solely articulated metallic structures"[26].
All these work are conceived on the principle of deconstruction, suggesting dysfunctional, deviant and absurd and through a functional machine.

Trends and new approaches to technological-based art and line of research

Nevertheless, deconstruction of scientific research and technological innovation common places and stereotypes should leave space, in art theory and practice, for genuine innovation or the exploration of new possibilities.
Artistic work is precious also for research agendas, since artists and artisans often discover “subtle properties of matter” before they are even noticed by research scientists [27].
One of the outputs of my research would be that of outlining a schema illustrating the ways in which art and techno scientific-research can be integrated. What I would like to point out here is that artists can be researcher themselves, pursue “unprofitable” lines of inquiry of research outside of disciplinary priorities, integrate disciplines and create events that expose the cultural implications, costs, and possibilities of the new knowledge and technologies.
One of the objectives of my research would be that one of identifying trends and features that underline such a relationship, results and different approaches, in order to clearly define guidelines and good practices allowing a creative and fruitful collaboration between artists and technologists.

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