Robotics Exhibits for Science Centres. Some Prototypes

NATURAL AND ARTIFICIAL COGNITION LABORATORY - WWW.NAC.UNINA.IT
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Introduction

Robots are attractive for public as they represent a clear and ambitious scientific challenge: an artificial being creation similar to natural ones by man. The popular enthusiasm grows up in parallel with huge scientific research progress in this field. On this success wave many Science Centers, Science Museums and Science Festivals propose spaces and moments to spread theoretic, methodological and technical issues of this discipline. In this poster we describe some of our exhibits prototypes that were designed and carried out to communicate main approaches of modern robotics (telerobotics, cognitive robotics, autonomous and evolutionary robotics and collective robotics).

These exhibits have been conceived as laboratories where a visitor can experiment and put the hands on various kinds of robot.
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Telerobotics

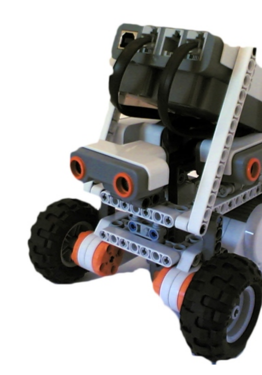
The first step of the tour we propose is characterized by a very high degree of technological sophistication but it's quite simple on a theoretical level: visitors will be introduced to Telerobotics (Niemeyer and Slotine, 1990), the area of Robotics that is concerned with the control of robots from a distance. The robot expands perceptual and motor capabilities of man, becoming hands, legs and eyes of the humans where they cannot go. This kind of robot has no intelligence or autonomy, it is just a prolongation of humans, one of the other sensors-effectors he/she can use. In the exhibit the visitor can control RoboBug, a small mobile robot that explores an environment that is not directly accessible. The user can use a console to control the robot, while another user that controls a mechanic adjustable arm helps him/her in reaching fixed goals. The available information is provided by 3 monitors that show scenes in real time from the environment RoboBug must explore. It is constituted by a rectangular arena with hills, valleys, harshness of land. In particular the images are retaken by 3 camera posed respectively on the robot itself, on the arm and on the ceiling of the room. This arrangement of the cameras supplies different points of view: allocentric and egocentric.The difficulty of solving the task becomes then to put together these different frames of reference of the world to have a reliable representation of it that permits to reach the target.

Programming a Robot:Cognitive Robotics

The first step to provide a robot of a certain degree of autonomy is to program its behaviour, just like normally traditional personal computers are programmed. The programmer defines in detail a particular behaviour and writes the code to implement it using traditional programming languages. In this case the intelligence of the programmer is transferred in the robot that is released in the environment and can act according to the instructions it has received by the programmer. These instructions are usually expression of a "human-like" way of facing a problem, referable to high-level cognitive abilities. To do this the programmer has to describe, in the language of programming, the properties of the robot, its ability, its representation of the environment to endow the robot of a high-level controller. In this exhibit the visitors will have the possibility to program Lego robots, built with the kit Lego Mindstorms , Robotic Invention System. The visitor, with the help of a guide, can build the robot, create a programs for his/her robot using Lego's own visual programming environment on a desktop computer, download it on the robot and check if the behaviours he/she has programmed are suitable for a certain goal.

Training/Breeding an Artificial Organism (Adaptive Robotics)

Living beings are not programmed, they adapt to the environment they live in or, under some circumstances, they can be bred or trained by other living beings. This establishment has given the start to a wide field of research: Adaptive Robotics. The robots are endowed with the capacity of learning from their experience and their learning processes are often supervised or canalized by a human being. The exhibit allows the visitor to train a population of robots, awarding the individuals that prove to be the best in solving a spatial orientation task. In particular users are introduced to a setting consisting of some mobile robots, an arena and an associated software, in a word, they will interact with Breedbot. Breedbot is an integrated hardware/software system that is suitable for users with no technical or computer experience using which it is possible to breed a small population of robots in a software environment that simulates a process of artificial evolution, based on Darwinian selection. The visitors are aided by two guides that introduce to the use of the simulator and to the physical robot. The exhibit merges then two key techniques used in Artificial Life: User Guided Evolutionary Design (UGED) and Evolutionary Robotics (ER). UGED (Bentley,1999) allows users to "evolve" software and hardware objects, using a computer simulation system. Breedbot is designed to be easy to use for breeders of small robots and to be highly interactive: visitors can use the system's graphical interface, conduct their artificial evolution and if they want, they can select the individuals which will be allowed to reproduce. They can stop the program at any time, choose what they consider to be an interesting robot and use the infrared port to upload its control system to the physical robot. .



Swarm Robotics

Living beings live in community and the behaviour of an individual influences other individuals. Often the sum of several simple individual behaviour produces a complex collective behaviour. This is, for example, the case of ants: every single ant has just simple abilities, but, thanks to the interaction with other simple agents, can display a complex and emergent behaviour, as cooperating for transporting objects. At this step of the tour the behaviour of robots is determined by taking inspiration from this natural phenomenon. The exhibit proposes an experience of collective robotics in which the visitor influence the behaviour of two swarm of robots manipulating the environment. Visitors will interact with ARS, Autonomous Robotics Setting, a setting for artificial ethology. ARS is a platform of 2*2m, divided in 10*10 cells and surrounded by a wall 30 cm high. Every cell contains a lamp that can be turned on and off by an external console. This configuration permits to create quite easily mazes, illuminating the opportune cells, of different complexity.The visitors can interact with a team of 4 robots. These robots have 2 infrared sensors (pointed toward the floor to check luminosity of cells) and 3 sensors of distance. Moreover every robot can receive an infrared signal emitted by its "companion". Two robots halt on bright cells and move on the dark ones (group A), while the others (group B) have the opposite behaviour.The visitor can influence the behaviour of these two families, manipulating the console of the arena and creating different paths.The human intervention creates at each manipulation different scenarios in which the 2 teams of robots move in dynamical interaction. This decentralized control leads to a continuously changing situation that produces emergent behaviours.

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