Reliability and usability: keys for success in Edutainment Robotics

Andrea Bonarini, Matteo Matteucci

I. Introduction

Reliability and usability are key issues in edutainment robotics. These robots should safely interact with "normal" people, who will accept them only if the interaction is interesting (amusing, useful, ...)[6] and easy. The design approach for edutainment robots (ER) should consider tools to achieve these goals, first defining the ultimate goal of the robot, then its aspect and its behavior, and, finally, its implementation. Design guidelines are far from being defined and will play a crucial role in the rapid diffusion of the technology needed to implement ERs.

In the following, we mention some experiences done in the recent past in this direction. The AI and Robotics Lab has been established at Politecnico di Milano in 1973. In the last years we have produced a number of mobile robots for different applications some of which related to edutainment.

II. Robocup

We are participating to the Robocup initiative with the ART Italian National Team [7]. In addition to the worldwide webcasted world championship matches, we have also participated to one of the largest Italian high-tech fairs (Futurshow 3000 - 500.000 visitors), where our robots were the main attraction for an expositor (the Focus review). We have played two matches per day for five days, displaying our robots also in the rest of time, with an estimated presence of several tenth of thousand people. Probably, it was one of the most followed direct show featuring a set of robots.

The main doubt we had when we accepted to make this show was: "Will we be able to be on stage all the time with two robot teams?" We succeeded thanks to the organization of the ART group: the robots were enough reliable to have a limited number of faults, enough to allow substitutions when needed, each robot was supported by a competent team, able to face problems thanks to the modular implementation of our robots.

Modularity is essential for reliability. At Politecnico di Milano we have oriented our development strategy toward the definition of standard components that can be re-used to implement many different robots.

We have developed HW components such as power cards, control and I/O cards that can be easily interfaced each other and with computers and sensors, and that can be produced at a low cost.

We have implemented a development environment (*BRIAN* [4] [5]) that supports definition and testing of fuzzy behaviors. *BRIAN* is also modular, and can be adapted to different needs, and interfaced to different modules for input and map management, actuators, etc. We have also implemented a simulator used for rapid prototyping and learning. Our *LEARNER* system [1] [3] has been used in many theoretical experiments, and can be adapted to online learning. Another learning module has been already used to tune behaviors to specific situations such as adapting a Robocup player to the strategies of the opponents [4].

We have also modules to manage our sensors systems, namely omnidirectional vision sensors [2] and traditional vision systems. Re-assembled modules can implement different robots, with different abilities, to face different applications. For instance, the same mobile base that we use for Robocup, is also used for an "information robot" that will bring people in the Department to the desired place, with the simple substitution of the HW/SW vision module and the actual behavior modules.

Politecnico di Milano AI and Robotics Project – Dipartimento di Elettronica e Informazione – Politecnico di Milano – Piazza Leonardo da Vinci, 32 – 20133 Milano – Italy – E-mail: bonarini@elet.polimi.it – FAX: +39 02 2399 3411 – http://www.elet.polimi.it/people/bonarini

III. Education, robots and Lego kits

Since the beginning, part of the activities of our lab where devoted to support the AI and Robotics courses and master theses (about 60 per year). The most successful learning situation is when people can concentrate on its own goals without caring too much of non-focal aspects. It is not easy to achieve this situation in a lab, since everything changes quite rapidly (the technology, the goals, the projects, ...) and most of the work is done by students that spend about year of their life in the lab, and then leave it. In some activity lines we succeeded to produce reliable HW and SW support tools which make it possible to capitalize and transmit experiences to newcomers, who can thus start from somebody else's shoulders. Where this has not been done, the robots simply died without leaving nothing, when their technology became obsolete or even when their developers finished their theses. Again, reliability and usability is achieved by modularization: old modules can be substituted with new ones when become unusable or obsolete, and robotic systems may continue to live.

We are also participating to a national project to develop teaching modules for children in secondary schools, where Lego Mindstorm kits are used to teach basic concepts about project development, programming, sensors, feed-back systems and group work. Here, modularization is even more important, since teaching to children technological concepts should consider the time available for each one and its complexity. Teaching modules (and functional modules in the robot implementation) make it possible that also young children supported by non-specialized people develop projects of a certain complexity achieving the teaching goals.

We are also planning to collaborate with the National Museum of Science and Technics in Milan to implement a permanent demonstration room for Robotics concepts, with LEGO Mindstorm, to be used by different types of students, from elementary schools to university. Also in this case a careful modularization of the available material will play an important role both for educational and for maintenance purposes.

IV. Conclusion

We postulate the need of a methodology to develop edutainment robots, which should consider, even more than traditional Robotics, the aspects of usability and reliability. We have mentioned a couple of research lines pursued in our lab, where these key features have been obtained by careful modularization of HW, SW and teaching aspects. Modularization is just one of the many techniques and approaches that can be considered, and there is evidence that it contributes to the success of edutainment applications.

References

[1] A. Bonarini. Evolutionary learning of fuzzy rules: competition and cooperation. In W. Pedrycz, editor, *Fuzzy Modelling: Paradigms and Practice*, pages 265–284. Kluwer Academic Press, Norwell, MA, 1996.

[2] A. Bonarini, P. Aliverti, and M. Lucioni. An omnidirectional vision sensor for fast tracking for mobile robots. *IEEE Transactions on Instrumentation and Measurement*, 3(49):509–512, 2000.

[3] A. Bonarini, C. Bonacina, and M. Matteucci. Learning fuzzy classifier systems. In P. L. Lanzi, W Stolzmann, and S. W. Wilson, editors, *Learning Classifier System: new directions and concepts*, pages 107–124. Springer-Verlag, Berlin, D, 2000.

[4] A. Bonarini and M. Matteucci. Learning context motivation in coordinated behaviors. In *Proceedings of the Sixth Intelligent Autonomous Systems Conference (IAS-6)*, pages 519–526, Amsterdam, NL, 2000. IOS Press.

[5] A. Bonarini, M. Matteucci, G. Invernizzi, and T. H. Labella. Context and motivation in coordinating fuzzy behaviors. In *Proceedings of the Seven Meeting of the Italian Association for Artificial Intelligence (AI*IA 2000)*, Milano, I, 2000. AI*IA.

[6] D. McFarland and T. Bosser. *Intelligent Behavior in Animals and Robots.* MIT Press, Cambridge MA, 1993.

[7] D. Nardi, G. Adorni, A. Bonarini, A. Chella, G. Clemente, E. Pagello, and M. Piaggio. Art – azzurra robot team. In M. Asada M. Veloso, E. Pagello, editor, *RoboCup 98–Robot Soccer World Cup III*, Berlin, D, 2000. Springer Verlag.