解 説

Medical Robotics: An Exciting Field

Alicia Casals* *Technical University of Catalonia

1. Background and Professional Career

Industrial Engineering is a degree that provides a wide view of technology. The selection of a degree is usually not easy and my selection of Industrial Engineering was motivated by both, my interest in knowing how machines work, and for the wide range of applications and possible professional options of these studies, either in industry, in the services sector or in education. The launching of a new degree in Computer Science gave me the chance to initiate my professional career as a teacher in the new Faculty of Informatics and to participate in the creation of the research group in Robotics, an emerging area in the seventies. After a first phase working in industrial applications of robotics and computer vision, robotics evolved towards the services sector giving place to applications where vision, and perception in general, is essential to provide robots with more intelligent behaviors, and in this direction has progressed our research.

2. Current Research Areas of the Research Group

The research group on Intelligent Robotics and Systems at UPC, GRINS, works mainly in areas of robotics requiring strong interaction with humans, that is, teleoperation and human robot interaction. This research started in areas as diverse as medical and underwater robotics, which however have many problems in common due to the fact that their applications are too complex for autonomous operation. Therefore, there is a need for human robot cooperation either through teleoperation or human supervision. In teleoperation a human operator guides the robot, which can compen-

sate human limitations, such as increasing precision, reducing tremor, increasing/decreasing the movement or applied forces, etc. In the human supervision of robot tasks, a person can interact with the robot to correct or change the robot actuation or eventually share the control according to the stage of the process. This research, as a real need for today's robotics, motivated the phrase or lemma: "Robots get closer to humans" of the last IEEE International Conference on Robotics and Automation, ICRA'05, which I chaired.

A major part of this research is devoted to the medical field, within the Center of Research on Biomedical Engineering, in its Robotics and Vision division, which I lead. The research in this field started with the development of technological aids for disabled, like an adapted keyboard for tetraplegic and another for blind persons, or a human-machine communication system based on the gaze. The specific requests made by disabled users led us to exploit robotics as a more powerful assistant device, through the building of an assistant robot for severely disabled that can not use their own hands. Now, our current research in the medical field lies in three application areas: Assistive, Rehabilitation and Surgery.

In the field of assistant robots the project going on consists in an adapted robotized kitchen. The adapted kitchen consists of a series of modular systems that can be arranged in such a way so as to cover the needs of the user, that is, a shifting cupboard, a lifting table, a carousel cupboard and a robot. The robot operates from the information of the images taken from cameras located around the kitchen and an interface that facilitates the generation of orders for the robot and other devices. **Fig. 1** shows a view of the prototype. Other projects deal with wheelchairs aids for navigation and safety movement.

In the rehabilitation area the work is manifold, hav-

原稿受付 2006 年 4 月 21 日
 キーワード: Social Impact of Technology, Robotics and Society

*1 Pau Gargallo, n. 5, 08028 Barcelona, Spain

Fig. 1 Prototype of the robotized kitchen

Fig. 2 The robot holding the hummer for repetitive rehabilitation exercises

ing several projects going on: the study of sensing and control of myoelectric prosthetic hands, the modeling and study of the human gait as a means of providing aids to disabled or helping the recovering of the normal walk after stroke or disease, or the study of the behavior of rehabilitation exercises after hummer surgery so as to learn how to improve surgical procedures. A prototype of the later is shown in **Fig. 2**.

In the field of surgery the research is addressed to provide the surgeon with an intelligent support. The research in laparoscopic surgery starts with an assistant robotic arm that holds the camera which is automatically controlled from the analysis of the laparoscopic images, **Fig. 3**, or providing local teleoperation aids using a force sensor on the robot wrist.

In orthopedic surgery the problem tackled is the supervision and assistance to the surgeon in the task of cutting. The registration of the 3D patient reconstructed image (the part undergoing surgery) with the patient itself makes possible to establish some virtual fixtures that are used to guide the planned surgery and supervise the surgeon movements so as to avoid entering in forbidden areas (i.e. cutting a nerve or other struc-

Fig. 3 Vision based controlled robot for assistance in laparoscopic surgery

Fig. 4 Experimental scenario for robot assisted maxillofacial surgery

tures), **Fig. 4**, and thus improving precision and performance.

3. The Studies on Robotics

Frequently future students ask where they can study robotics, sometimes motivated by the attraction of this discipline and the scope of its application fields. The view that robots can become good assistants to humans is increasing more and more, showing their more social aspect. However, being robotics a discipline that involves many different matters such as mechanics, computers, electronics, etc, there are no, or just a few, degrees specialized in robotics. Instead, there are several degrees that include one or a few courses on robotics which provide a background in the field. The robotics career can thus start from the studies on several degrees, such as computer science or electrical and mechanical engineering, which give the technical basis on most of the topics involved in robotics.

Technology is seen sometimes as a hard area, oriented to production or to build and operate machines. However, it is important to see the other effects of technology, which are the increase of quality of life and the availability of assistant devices for daily life or for work.

This face of technology is still not too appreciated and it is important that the society become aware of the potential benefits of robotics. Surprisingly, the number of female students in technology is very low, although they have theoretically the same educational program that their male counterpart. However, in areas more related to biology and medicine the percentage of female students is higher. The difference of professional trends between males and females is evident; the former more oriented to technical themes and the later focusing on more social issues, for instance, medical robotics, technology applied to biology and so. From my experience I feel that female researchers have, in some aspects, higher abilities for research in such fields, for instance men have usually less patience and search for more immediate results. Therefore, these areas of great potential interest for women can hopefully encourage young female students to choose technical studies for which

they can be really well prepared and motivated.

References

- [1] <http://grins.upc.es>

Alícia Casals

Professor since 1990 at UPC. Academic activities both in teaching and research in the Automatic Control and Computer Engineering Dep., at UPC. She has been head of the Department and currently responsible of the Robotics and Vision division of the Centre of Research in Biomedical Engineering of Catalonia. The research is oriented to the incorporation of visual and force perception to robotic systems to reinforce human-robot cooperation, mainly in the area of medical robotics. She participates in the PC of many Int. Conferences, or as General Chair. From 2000, she coordinates the Education and Training Key Area of the European Network on Robotics, EURON. In 2003 launches the Spanish Chapter of the IEEE-RAS and currently has several responsibilities in the IEEE Robotics and Automation Society.