Introduction

This special issue is dedicated to the memory of Tony Bejczy, in celebration of his life and in recognition of his scientific achievements in robotics. In the early years of the field, when the concept of a robot was still forming, the creation of an intelligent machine in the appearance of a human was an exciting aspiration for many researchers and engineers.

For the two of us, the journey into the emerging field auspiciously began with a privileged encounter with Tony Bejczy. Our first meetings with Tony took place long before we actually started to interact with him professionally, encounters which have made lasting impacts on us both.

For Paolo, the first meeting with Tony came during his visit to NASA Jet Propulsion Laboratory in 1981, during the Saturn encounter with Voyager 2. On that occasion, the Laboratory was open to the public, and Tony was presenting his work on teleoperated robots. Paolo, as a consequence of that meeting, decided that robotics would be the topic of his Master's Thesis. Several years later, in 1985, when Paolo applied for a position at JPL, Tony recalled to have seen Paolo's thesis work at one of the earliest robotics conferences in 1983. In the years after, Tony and Paolo became colleagues at JPL, and their collaboration and interaction continued later, when Paolo moved back to Verona.

The encounter of Oussama with Tony took place in Toulouse in 1978. Tony was invited together with Dan Whitney by Georges Giralt for a special Colloquium at LAAS/CNRS. Oussama, who at the time was a PhD student at SupAero, attended what was actually his very first Colloquium in robotics, which turned out to be his most memorable. Several years later, Oussama moved from Toulouse to Stanford. In the mid-eighties came the birth of the IEEE-RA Council, which later became the IEEE-RAS Society. These developments in the field afforded Oussama and Tony the opportunity to work together both on technical and professional activities. They also eventually collaborated on the organization of conferences, notably ICAR 1997 in Monterey, California, and have jointly participated as speaker or panelist in numerous events.

It has been a great privilege to have known Tony throughout our time in the field. For me, Tony was an inspiring colleague, and a wonderful friend. This special issue contains a compilation of fourteen contributions that explore the interaction and impact of Tony's work on the development of robotics, from its early years to today's most recent achievements.

The first four papers address Tony's specific contribution to robotic surgery, sensorized robotic hands and robotic intelligence. The paper by Takács, Nagy, Rudas and Haidegger describes the history of robotic surgery, tracing its origins to the initial NASA desire of giving astronauts remote medical assistance during long duration missions. Tony had the key role in the development of NASA-JPL's RAMS system, the first surgical robot with haptic feedback used in animal

experiments, and in building a relation between NASA and Computer Motion Co., the developer of the Zeus robotic surgical system. Some of the key advances in robotic surgery are also the subject of the paper by Kronreif that addresses some challenges of developing new applications in surgical robotics. In spite of the difficulties, new systems were developed by Austrian companies for very simple but widespread procedures, such as biopsies. The paper by Rudas, Gáti, Szakál and Némethy summarizes the career of Tony Bejczy, as the developer of "Smart Hands" and of dynamical models of robots. These two technologies were combined in the advanced teleoperation systems at JPL, demonstrating their applicability of these technologies to space exploration. The paper by Kovács, Petunin, Ivanko, and Yusupova addresses the relation that exists between Robotics and Artificial Intelligence, as demonstrated in the chess playing machine "the Turk", the computer chess Deep Blue and the Mars rover Pathfinder. They all shared the common aim of reasoning about the data from the environment and acting upon this reasoning.

The impact of Tony's research on control theory is very widespread and is addressed in the following six papers. The paper by Roman, Radac, Precup and Petriu proposes a new tuning approach by which the parameters of data-driven Model-Free Adaptive Control (MFAC) algorithm are automatically determined using nonlinear Virtual Reference Feedback Tuning (VRFT) algorithm. This algorithm uses a model free approach that is computationally simple and could replace the knowledge of the dynamical model of the controlled systems, as proposed in Tony's research. The paper by Tar, Bitó and Rudas introduces a control method that can be used as an alternative to the computation expensive Model Predictive Approach. The method described in this paper is based on a fixed point transformation that changes the problem of computing the control signal into the task of finding an appropriate fixed point of a contractive map. The paper by Kowalczyk and Kozlowsky addresses the issues related to the motion planning of non-holonomic mobile robots, such as, cars of planetary rovers. The approach presented relies on a potential field, which is adapted to account for the constraints imposed by the turning radius of the robots. The paper by Lantos and Max describe an algorithm for the hierarchical formation control of a group of unmanned vehicles. The approach presented consists of the generalization of the multi-body method for underactuated car-like vehicles, developed originally for fully-actuated surface ships. The control system consists of the high level centralized formation control of the UGVs and the low level decentralized PID type suspension, speed and steering control of the different vehicles. The paper by Takács, Dóczi, Sütő, Kalló, Várkonyi, Haidegger and Kozlovszky describes the challenges of developing an autonomous underwater vehicle suitable for search and rescue missions. Standard tests have been developed by NIST to validate the capabilities of such robotic devices and the paper describes the enhancements made to a research robot to perform the NIST tests. The paper by Eigner, Tar, Rudas and Kovács describes a novel approach to the modeling of pathological situation, such as diabetes. The authors propose to use the Linear Parameter

Varying (LPV) methodology, which is based on the parameter vectors and is a satisfactory model of the disease.

The next three papers address the human–robot interaction in the context of teleoperation and of collaborative robots. The paper by Muradore and Fiorini describes some of the algorithms that are currently used to control a remote robot by a human located in a safe place. These algorithms can trace their origin to the seminal work of Tony's in his Advanced Teleoperation Laboratory at JPL in the 1980s, where force feedback was proven to be essential to guarantee a safe interaction with the remote environment. The paper by Kinugawa, Sugahara and Kosuge presents a new concept of robotic co-worker, called PaDY. This prototype is an example of Physical Human Robot Interaction that is one of the most important achievements of today's robotics: i.e., developing robots that will not hurt humans. This concept is also related to haptics and robot operator interaction, and it nicely extends the work on telerobotics and robotic teleoperation with strict safety constraints. These concepts are also addressed by the paper by Ficuciello, Villani and Siciliano that deals with safety in human–robot interaction, where contacts between the human and his robotic co-worker should be always injury free. The paper presents solutions for the cases of accidental contacts and co-manipulation, which is a very peculiar case of robotic teleoperation.

The last paper of this special issue addresses the research area that summarizes all the technologies described above, which was the main focus of Tony's work, i.e., space telerobotics and force feedback teleoperation. The paper by Artigas and Hirzinger summarizes the development of these two technologies at the German Space Agency DLR, starting with ROTEX, the first space telerobotics mission in history, and continuing with demonstrations of on-orbit servicing space force-reflection teleoperation.

The contributions presented in this special issue cover a wide range of robotics areas. These contributions are a testimony to the impact Tony's work has made in robotics. We would like to extend our appreciations and thanks to all the authors who contributed to this memorial special issue.

Tony's vision of robotics, the impact his work has made in many research areas, the energy and enthusiasm he always demonstrated in pursuing his research and communicating it to the robotics community, all showed him as an influential leader and a major contributor to the field. This special issue represents a tribute to a dear friend and a great colleague to many in our community.

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