

Robotics for small and medium enterprises: control and programming challenges

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Robotics is one of those subjects that leaves nobody indifferent. No matter if they are used in industry or in our homes, mimic human capabilities, or are used to access dangerous environments, launched to space, or simply used to play with, robots are always a source of human interest and admiration. Here the focus is on robots used to work in industrial environments, i.e., robots built to substitute man in certain industrial manufacturing tasks; that is, being a mechatronic co-worker for humans.

In fact, actual manufacturing setups rely increasingly on technology. It is common to have all sources of equipment on the shopfloor commanded by industrial computers or programmable logic controllers connected by an industrial network to other factory resources. Also, the manufacturing systems are becoming more and more autonomous requiring less operator intervention in everyday normal operation. That is a consequence of actual market conditions, characterized by a global competition and a strong pressure for better quality at lower prices, with products defined in part by the end-user customers.

This means producing in small batches, never risking long stocks, and working to satisfy already placed customer orders. Consequently, concepts like flexibility and agility are fundamental in actual manufacturing plants, requiring much more from the systems used in the shopfloor.

A decision for flexibility

Flexible manufacturing systems take advantage of being composed of programmable equipment to implement most of their characteristics, which are supported by reconfigurable mechanical parts. Industrial robots are good examples of flexible manufacturing systems. Using robots in actual manufacturing platforms is, therefore, a decision for flexibility and a way to increase the agility of the manufacturing process. If the manufacturing processes are complex, with low cycle time and have a lot of parameterization owing to the diversity of products, then using robots is the correct decision, although it isn't enough for a complete solution.

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In fact, engineers need to integrate other technologies with the objective of extracting from robots the flexibility they can offer. That means using computers for controlling and supervision of the manufacturing systems, industrial networks and distributed software architectures. It means also designing application software that is really distributed in the shopfloor, taking advantage of the flexibility installed by using programmable equipment. Finally, it means taking special care of the human-machine interfaces (HMI), i.e., the devices, interfaces and systems that enable humans and machines to cooperate on the shopfloor as co-workers taking advantage of each other's capabilities.

Also, the robot and robotic cell programming task would benefit very much from improved and easy-to-use interaction devices. This means that availability of software development kits (SDKs) and/or programming libraries supported under common programming environments is necessary. Application development depends very much on that.

Working on future small and medium enterprises means considering humans and machines as co-workers, on environments where humans have constant access to the manufacturing equipment and related control systems.

User interfacing

Several devices are available for user interfacing (several types of mouse, joysticks, gamepads and controls, digital pens, pocket PCs and personal assistants, cameras, different types of sensors, etc.) that have very nice characteristics making them good candidates for industrial use. Integrating all these devices with current industrial equipment requires the development of a device interface, which exhibits some basic principles in terms of software, hardware and interface to commercial controllers.

This scenario can be optimized in the following concurrent ways:

- Develop user-friendly and highly graphical HMI applications to run on the available interface devices. Those environments tend to hide the complexity of the system from the operators, allowing them to focus on controlling and operating the system.
- Explore the utilization of consumer input/output devices that could be used to facilitate the operator access to the system. In fact, there is a considerable amount of different devices on the market developed to use with personal computers on different input/output tasks. Such devices are usually programmable, with the manufacturers providing suitable SDKs which make those devices suitable for further exploitation with the objective of integrating them with industrial manufacturing systems.
- Explore the functionality of the available software packages commonly used for engineering. Good examples of those packages are the computer-aided design (CAD) packages used by engineers involved in design and project activities, to develop, optimize or improve their designs. Since the vast majority of companies use CAD software packages to design their products, it would be very interesting if the information from CAD files could be used to generate robot programs. That is, the CAD application could be the environment used for specifying the way the robots should execute the required operations on the specified parts. Furthermore, since most engineers are familiar with CAD packages, exploring CAD data for robot programs and parameterization seems to be a nice way to proceed.

These and other challenges are the objectives of the SMEROBOT consortium, an IP project financed by the European 6th Framework R&D programme. For details visit the website: <http://www.smerobot.org>

This article will be appearing in *Industrial Robot* (33/6).

About the author

J. Norberto Pires was born in the “*mui nobre*” city of Guimarães (Portugal). He finished high-school in Guimarães and travelled to Coimbra to graduate in [Engineering Physics](#) in 1991 from the University of Coimbra (Physics Department). He received his MSc degree in 1994 in Technological Physics (Physics Department), and his PhD degree in 1999 in Robotics and Automation (Mechanical Engineering Department), both from the University of Coimbra. Since 1991 he has been with the Mechanical Engineering Department at the University of Coimbra, where currently he is Auxiliary Professor.

His research interests include force control, industrial robotics, object-oriented and distributed programming applied to industrial robotics, flexible manufacturing systems and human-machine interfaces. Dr Pires is currently editor-in-chief of the journal [Robótica](#), the only Portuguese journal on robotics and automation, author of three books in the robotics and automation areas (one in Portuguese edited by LIDEL, with three editions, and two in English edited by Springer) and more than 100 scientific publications. He has organized several workshops and seminars on robotics and automation.

Dr Pires focuses his activities in cooperation with industry, having pursued cooperative projects with several companies in Portugal and abroad (resulting in several prototypes and products), along with scientific projects financed by the Portuguese Science Agency (FCT) and by the European Community. His current main focus is on the project SMEROBOT (<http://www.smerobot.org>) financed by the 6th European Framework (European Union).

He is a member of the IEEE Robotics and Automation, and Industrial Electronics Societies, SPF (Sociedade Portuguesa de Física, Portuguese Physics Society) and APCA (Portuguese Association of Automatic Control).

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For more information about Dr Norberto's research, please visit <http://robotics.dem.uc.pt/norberto/>