New challenges for industrial robotic cell programming

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Industrial technology trends point to the saturation of the classical markets (like automotive and consumer electronics), followed by a huge development in areas like sensor technology, mechatronics, computers, human-machine interfaces, high-level programming, etc. This configures an opportunity to develop robotics and automation solutions adapted to small and medium enterprises (SME): less expensive, safer, easier to install and program, more flexible and agile, capable of interfacing with consumer market electronic and computer products. The focus on SMEs is strategic both because technology manufacturers need to find new markets, and SMEs have a considerable weight in terms of GDP and employment. Stronger SMEs means a stronger economy.

Programming an industrial robot by the typical teaching method is a tedious and time-consuming task that requires a considerable technical expertise. In opposition to the highly intelligent robots described in science fiction, current industrial robots are “non-intelligent” machines that work in a controlled and well known environment. Generally, robots are designed, equipped and programmed to perform specific tasks, and thus, an unskilled worker will not be able to re-program the robot to perform a different task.

We actually operate in the coworker scenario, where humans and robots are supposed to somehow cooperate as their common task unfolds. The future scenario, here briefly introduced, includes cognitive features, allowing humans and robots to safely share the workspace and actively cooperate with the robots, which will then have the capabilities to analyze the working situation, to recommend corrections and solutions to problems and operational deviations, and to communicate using human-like natural interfaces (voice, gestures, etc.). The goal is to develop methodologies that could help users to control and program a robot with a higher level of abstraction from the robot language. In general terms, each robot unit needs to be installed and prepared for the particular application, which makes the introduction of robots an expensive and risky decision, at least for SMEs.

In fact, the demand for new and more natural human-machine interfaces (HMIs) has been increasing in recent years, and the field of robotics has followed this trend. The speech recognition is seen as one of the most promising interfaces between humans and machines, because it is probably the most natural and intuitive way of communication between humans. For this reason, and given the high demand for more natural and intuitive HMIs, the automatic speech recognition (ASR) systems had a great development in the last years. Today, these systems present a good performance and robustness, allowing, for example, the control of industrial robots in an industrial environment (in the presence of surrounding noise).

The adoption of high-level programming (HLP) techniques can overcome the drawbacks of classical approaches since it could help users to program robots easily. The basic idea with HLP systems is to have humans teaching a task solution to a robot using a human-like procedure, which can be done in several ways and at several different levels as already mentioned. Taking for example a PbD (Programming-by-Demonstration) system, the human demonstrates a task solution to a robot, which is observed (using several types of sensors, and not only or necessarily vision), recorded and interpreted. Using the kinematic and dynamic models of a particular robot, the demonstration is mapped into actions that can be downloaded into the selected robot system, in the form of a particular robot programming language, and finally executed.

Even better and most intuitive would be to instruct a robot as you would instruct a human worker how to carry out the work. With skilled workers knowing the applications, devices, processes, and the general requirements on the product to be manufactured, we would only need to say ***what*** to be done. Programming approaches in that direction is often referred to as *task-level programming*. In practice, lacking much of the required background knowledge, we could aim for programming principles that are more close to instructing a (totally) unskilled worker, telling ***how*** things are to be carried out. That means a much more explicit way of instructing, but still human-friendly. More specifically, we would like to teach robots by:

- Manually guiding the robot to the positions of interest, or even along the desired paths or trajectories if human accuracy is enough.
- Having simple ways to make use of CAD data whenever available.
- Using different complementary modalities (paths of communication between the human and the robot), such as speech and gestures.
- Means of expressing the structure of the application, for instance loops and conditions, without requiring programming competence.
- Means of describing acceptable tolerances, e.g. as expected or normal deviations from the nominal path.
- Specification of how external sensing should be used for new types of motions or for handling unknown variation.

These are current and future challenges for SME manufacturing, which constitute a major opportunity for R&D in consortium with SMEs, technology manufacturer companies, system integrators and R&D institutions.

References

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