Dynamic Motor Primitives for Robot Control and Learning in Time-varying Environments

Degree programme: BSc in Micro- and Medical Technology | Specialisation: Robotics
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Despite the constant growth of robots' use in industry, teaching them to solve tasks is often tedious. Thus, making them work closer to humans and giving them the means to learn how to solve a task, directly by demonstration, is one way to facilitate the robot's learning. Artificial Intelligence algorithms combined with dynamical systems are implemented on a collaborative industrial robot with the purpose of learning to solve complex industrial tasks from line worker demonstration.

State of the art

Industrial robots are mostly used to solve dangerous and/or tedious tasks in a fast and safe way. Usually, every robot task is programmed by an expert. The task consists of sequences of motions and actions, like opening and closing a gripper. Programming a robot is therefore time consuming. Worst of all, the realized program applies to only one task.
These considerations lead to a lack of flexibility, allowing the robot to be deployed only in environments where the position of all objects and obstacles is always well known.

Goals

Improving the collaboration between human and robot is one key to ease the learning process of the robot. Collaborative robots are industrial robots that allow human interaction in a safe and productive way. The robot must no longer be confined inside a safety cage. The aim of this work is to demonstrate how humans can easily teach complex tasks to a robot, hand-guiding it. Artificial intelligence, based on different learning algorithms, can be used to understand how movements have to be structured, how to avoid obstacles and how to react to external stimuli.
In addition, the resulting robotic system must be easy to use, in order to allow an employee without knowledge in robotics and artificial intelligence to use it.

Outlook

Allowing people to easily interact with robots leads to an improvement in efficiency. It can also drastically reduce the time needed to complete certain tasks, such as programming the robot or eliminating dead times in the production.
Furthermore, collaborative learning robots can be employed in dynamic environments where objects' and obstacles' positions vary in time. This would lead to an improvement of the safety and to a continuous collaboration between employees and robots.
Moreover, being able to quickly reprogram the robot allows production chains to directly adapt the products to the clients desires.
Finally, collaboration between employees and robots provides an improvement of the yield, especially for small to medium volumes, enabling Swiss firms to keep production inland instead of outsourcing it.

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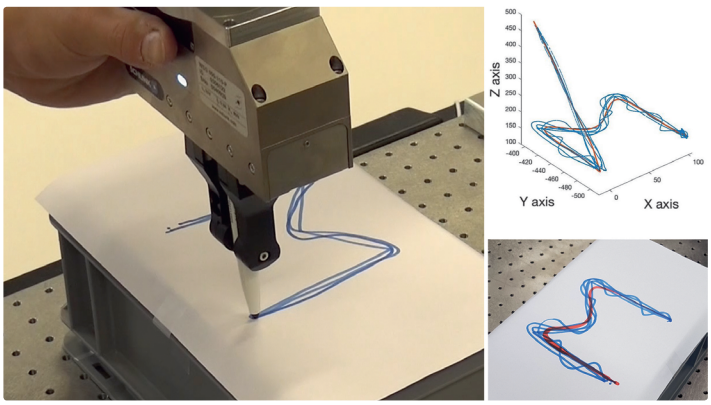
Human-robot team work in an industrial task



Teaching the robot a task:
– Left: Human moves the robot by hand to draw the letter ‹M›;
– Analysis (blue lines: human demonstrations, red line: learned path);
– Bottom right: Robot shows the learned trajectory.
Possible applications include: assembly, welding, grinding, cake decoration, etc.