The art of controlling a robot

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Robots are used in many different areas, for instance in factories, in space and in health care. To plan and control the motions of a robot is a challenging task, which Uwe Mettin from Umeĺ University, Sweden, has analyzed in his doctoral thesis.

A typical robot is an electro-mechanical device that consists of several joints, which enable the individual parts of the body structure to move. Actuators, such as electric motors, are used to apply forces, which cause a motion. Sensors give the current state of the robot to a control system. The main problem in planning and controlling robot motion is to shape and eventually apply forces in such a way that a desired movement is achieved despite of external disturbances and uncertainties in the mathematical model description.

Uwe Mettin's thesis provides generic principles for the challenging motion planning and control problem of so-called underactuated mechanical systems. These robots have one or more non-actuated joints, which results in a decreased versatility. On the other hand they can be more efficient and simpler compared with their fully actuated alternatives. In the thesis Uwe Mettin presents dynamic walking robots, ball dribbling and ball pitching robots as application examples. An interesting observation is that typical human movements are also characterized by weakly-actuated or passive joints and Uwe Mettin reveals some insight from a control engineering perspective.

The novelty of the suggested approach is to use a geometric representation of robot motion in a systematic fashion. This helps simplifying the planning of desired motions, gives an analytical insight into characteristics, and allows designing a control algorithm that can be implemented in the real system.

For fully actuated mechanical systems, such as industrial robots, there are standard tools that provide a tractable solution for motion planning and control design. Still, the problem of generating efficient and optimal movements is nontrivial due to actuator limitations and motion-dependent limits on velocities and accelerations. It is especially challenging for robots that possess more joints than those required for a particular task, which enhances dexterity in real-world applications.

Hydraulic cranes on forestry machines serve as an application example in the thesis and the objective is to automate parts of the process to assist the driver, which can save both time and energy consumption in the forest industry.

More information: Read the abstract and/or full dissertation at: urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-30024

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