Virtual Holonomic Constraints
from academic to industrial applications

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Akademisk avhandling

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Abstract
Whether it is a car, a mobile phone, or a computer, we are noticing how automation and production with robots plays an important role in the industry of our modern world. We find it in factories, manufacturing products, automotive cruise control, construction equipment, autopilot on airplanes, and countless other industrial applications.

Automation technology can vary greatly depending on the field of application. On one end, we have systems that are operated by the user and rely fully on human ability. Examples of these are heavy-mobile equipment, remote controlled systems, helicopters, and many more. On the other end, we have autonomous systems that are able to make algorithmic decisions independently of the user.

Society has always envisioned robots with the full capabilities of humans. However, we should envision applications that will help us increase productivity and improve our quality of life through human-robot collaboration. The questions we should be asking are: "What tasks should be automated?", and "How can we combine the best of both humans and automation?". This thinking leads to the idea of developing systems with some level of autonomy, where the intelligence is shared between the user and the system. Reasonably, the computerized intelligence and decision making would be designed according to mathematical algorithms and control rules.

This thesis considers these topics and shows the importance of fundamental mathematics and control design to develop automated systems that can execute desired tasks. All of this work is based on some of the most modern concepts in the subjects of robotics and control, which are synthesized by a method known as the Virtual Holonomic Constraints Approach. This method has been useful to tackle some of the most complex problems of nonlinear control, and has enabled the possibility to approach challenging academic and industrial problems. This thesis shows concepts of system modeling, control design, motion analysis, motion planning, and many other interesting subjects, which can be treated effectively through analytical methods. The use of mathematical approaches allows performing computer simulations that also lead to direct practical implementations.

Keywords
Virtual Holonomic Constraints, modeling, control, motion planning, under-actuated systems, forestry cranes, hydraulic manipulators

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