# Foreword

Industrial robotics must address the changing needs of future production systems. Improving productivity and flexibility will remain the major challenge for prospective production systems with reduced energy consumption. The enabling key factors to achieve these goals are novel robotic design principles combined with advanced control concepts. An innovative design principle that is being introduced for industrial robots is the kinematic redundancy, i.e. to use a robotic manipulator that has more degrees of freedom than required to accomplish the intended manipulation tasks. Advanced control concepts shall ensure that a given manipulation task is accomplished efficiently. Time-optimal control schemes are such advanced concepts that allow for task execution in shortest possible time. A seamless combination of these innovative concepts – kinematic redundancy and time-optimal control – does not yet exist.

This master thesis addresses exactly this problem. It presents an original approach to the redundancy resolution that facilitates the numerical solution of the time-optimal control problem. The basis is a non-linear dynamical model for the serial robotic manipulator. Emphasis is always given to a generally applicable approach to the dynamics modeling that allows application of the results to other robotic systems. The presented approach is applicable to any robotic manipulator with a single degree of redundancy, i.e. such that have one more degree of freedom as the task space. The results reported in this thesis represent a progress beyond the state of the art. The reader will get introduced to the basic concepts and to the specific modeling approach.

Optimal control is one of the main research directions of the Institute of Robotics at the Johannes Kepler University Linz, and this master thesis an excellent example for the holistic approach pursued at the institute. In various applications, non-linear, model-predictive, and flatness-based control are also used to derive tailored problem specific solutions. The mathematical basis is always a non-linear dynamical model. This is in particular important for the control of elastic robotic systems. The latter is a research topic that is becoming increasingly important with the advent of light-weight robots. Mobile robotic platforms and humanoids are other topics at the institute that build upon the mathematical modeling.

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http://www.springer.com/978-3-658-12700-8

Time-Optimal Trajectory Planning for Redundant Robots
Joint Space Decomposition for Redundancy Resolution
in Non-Linear Optimization
Reiter, A.
2016, XV, 90 p. 35 illus., Softcover
ISBN: 978-3-658-12700-8