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## Preface

In my previous book entitled “Control Theory of Non-linear Mechanical Systems” published in 1996 through Oxford University Press, I mentioned at its preface the difficulties of understanding human motor control and realizing in mechanical robots everyday powers inherent to humans. Regrettably, I could not discuss in that book any control-theoretic problem of dexterity in human or mechanical hands from not only biological but also computational viewpoints. Directly after my move to Ritsumeikan University in 1997, I started a research project on control of multi-fingered hands with the intention of exploring what is the underlying functionality of the human hand in prehension (stable grasping). Indeed, there was a dearth of papers that discussed the derivation of any dynamic model of grasping under rolling constraints.

In this book I attempt to provide a study of robotic prehension (stable grasping and object manipulation) from computational perspectives based upon Newtonian mechanics. The principal approach is grounded on the derivation of a faithful mathematical model of grasping that is a physical interaction between the fingerends and the object through rolling contacts. In the sequel, Lagrange’s equation of motion of the overall fingers/object system is formulated, together with holonomic or non-holonomic constraints of contact and rolling, on the basis of the variational principle developed in analytical mechanics. The most essential functionality of prehension that is referred to for designing a coordinated control signal is the fingers–thumb opposability that distinguishes the mankind from the chimpanzee and other primates, as claimed in anthropology. Stable grasping is regarded in a dynamic sense as a transient behaviour of a solution to the closed-loop equation of system dynamics that should converge to an equilibrium state or manifold satisfying the balance of forces and torques exerted on the object.

I hope that this book will facilitate further indepth research works that unveil the secrets of dexterity and versatility of the human hand and make a contribution to the technological development of dexterous robot hands.

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