論文 / 著書情報
Article / Book Information

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Title(English)	On Architectural Analogy between Passivity-based Robot Control and Distributed Optimization
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種別(和文)	要約
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（博士課程）
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論 文 要 約

THESIS OUTLINE

系・コース： Department of, Graduate major in	システム制御 系 システム制御 コース	申請学位（専攻分野）： Academic Degree Requested	博士 （ 工学 ） Doctor of
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要約
Thesis Outline

This dissertation investigates architectural analogies between continuous-time optimization dynamics and robot control based on passivity.
We first reveal a suitable architectural analogy between a continuous-time distributed optimization algorithm, called primal-dual dynamics, and collective object transport systems. Based on their similar network structure, which consists of a central collector and subsystems, and passivity property, we present a completely distributed solution to the force optimization problem of transporting an object by multiple robots that does not depend on any a priori knowledge of the object, does not require any communication between the robots, and consists of implementing one relatively simple set of dynamics with no unknown parameters. We prove that the present optimization dynamics converge locally, and provide both numerical simulations and real robotics experiments that demonstrate the algorithm's performance.
We next propose a continuous-time version of alternating direction method of multipliers (ADMM), which can be regarded as a variant of the primal-dual dynamics. The continuous-time ADMM has an architectural analogy with bilateral teleoperation systems. In addition to convergence speed, problem decomposability, i.e., network structure of a central collector and subsystems, and passivity property inherent in the primal-dual dynamics, the ADMM has another suitable property such that it can solve non-strictly convex problems. The simple primal-dual dynamics cannot solve them. By virtue of the passivity-based perspective, we prove convergence of the continuous-time ADMM. The effectiveness of the continuous-time ADMM is demonstrated through numerical simulations of a grasping force optimization problem and a multi-robot surveillance problem.
We finally apply a passivity-based robustification technique, namely scattering transformation, against communication delays for the primal-dual dynamics and continuous-time ADMM. From the perspective of passivity, we prove the

convergence of these optimization algorithms with the scattering transformation. The robustness of the present algorithms against delays is demonstrated through numerical simulations of the collective object transportation problem and the grasping force optimization problem.