Invited Lecture: **Robot Models in the Age of Machine Learning**

Frank C. Park, IEEE RAS President

Dept. of Mechanical Engineering and Graduate School of Data Science

Seoul National University, Seoul, Korea

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Place: 1st Lecture Room on the 4 Floor of the East Wing Building, BKC

Abstract:

Robot kinodynamic models are needed in traditional applications ranging from robot control and motion optimization to collision detection, and more recently to generate training data for robot learning algorithms via physics-based simulations. Obviously a robot model is only as good as the accuracy of its estimated parameters. While it has been standard practice to estimate kinematic and dynamic model parameters separately and to view the two independent problems as being "solved", in reality this is far from the case, particularly if a robot has high dof and the measurements are noisy. These challenges explain in part the recent trend toward using generic machine learning-based statistical robot models. In this talk we first argue that such models are quite restrictive. We then show that even for complex high-dof robots subject to noisy measurements, accurate robot models can be identified by taking advantage of a robot's underlying geometric properties -- e.g., link masses are positive and inertia tensors are positive-definite -- and by identifying the kinodynamic parameters in a unified fashion rather than decoupling the kinematics and dynamics. We also argue that classical kinodynamic models augmented with machine learning-based methods that capture, e.g., unmodelled dynamics effects like elasticity and friction, are more effective than generic machine learning-based statistical robot models. This point of view is justified with experimental studies of a tendon-driven robot. We conclude with a geometric characterization of a broad class of representation learning problems that are not restricted to robotics, and show that such problems can be formulated as seeking a minimum distortion mapping between two curved spaces, for which tools from Riemannian geomtry are available.

Biography

Frank C. Park received the B.S. degree in electrical engineering from MIT in 1985, and the Ph.D. degree in applied mathematics from Harvard in 1991. After joining the faculty of the University of California Irvine in 1991, since 1995 he has been Professor of Mechanical Engineering at Seoul National University. He is fellow of the IEEE, and has held adjunct faculty positions with the NYU Courant Institute, the Interactive Computing Department at Georgia Tech, and the HKUST Robotics Institute in Hong Kong. His research interests include robot mechanics, planning and control, vision and image processing, mathematical data science, and related areas of applied mathematics. He is a former editor-in-chief of the IEEE Transactions on Robotics, developer of the EDX course Robot Mechanics and Control I-II, and coauthor (with Kevin Lynch) of the textbook Modern Robotics: Mechanics, Planning, and Control (Cambridge University Press, 2017). He is president of the IEEE Robotics and Automation Society for 2022–2023, and founder and CEO of Saige Research, an industrial AI company specializing in inspection and quality control.

Contact Person: Shugen Ma (shugen@se, Ext. 8254)