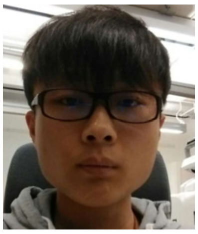
[26] M. Buss, H. Hashimoto, J. Moore, Dextrous hand grasping force optimization, IEEE Trans. Robot. Autom. 12 (3) (1996) 406–418. http://dx.doi.org/10.1109/70.499823.
[27] Y. Zheng, M. Lin, D. Manocha, On computing reliable optimal grasping forces, IEEE Trans. Robot. 28 (3) (2012) 619–633. http://dx.doi.org/10.1109/TRO.2012.2183057.
[28] S.A. Schneider, R.H. Cannon, Object impedance control for cooperative manipulation: theory and experimental results, IEEE Trans. Robot. Autom. 8 (3) (1992) 383–394.
[29] T. Wimbock, C. Ott, G. Hirzinger, Analysis and experimental evaluation of the intrinsically passive controller (IPC) for multifingered hands, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2008.
[30] K. Tahara, K. Maruta, A. Kawamura, M. Yamamoto, Externally sensorless dynamic regrasping and manipulation by a triple-fingered robotic hand with torsional fingertip joints, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2012.
[31] M. Li, H. Yin, K. Tahara, A. Billard, Learning object-level impedance control for robust grasping and dexterous manipulation, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2014.
[32] T. Takahashi, T. Tsuboi, T. Kishida, Y. Kawanami, S. Shimizu, M. Iribe, T. Fukushima, M. Fujita, Adaptive grasping by multi fingered hand with tactile sensor based on robust force and position control, in: IEEE International Conference on Robotics and Automation, 2008. ICRA 2008, 2008, pp. 264–271. http://dx.doi.org/10.1109/ROBOT.2008.4543219.
[33] J. Romano, K. Hsiao, G. Niemeyer, S. Chitta, K. Kuchenbecker, Human-inspired robotic grasp control with tactile sensing, IEEE Trans. Robot. 27 (6) (2011) 1067–1079. http://dx.doi.org/10.1109/TRO.2011.2162271.
[34] B. Siciliano, L. Sciavicco, L. Villani, G. Oriolo, Robotics: Modelling, Planning and Control, first ed., Springer Publishing Company, Incorporated, 2008.
[35] H. Dang, P. Allen, Stable grasping under pose uncertainty using tactile feedback, Auton. Robots (2013) 1–22. http://dx.doi.org/10.1007/s10514-013-9355-y.
[36] K. Hsiao, S. Chitta, M. Ciocarlie, E. Jones, Contact-reactive grasping of objects with partial shape information, in: Proceedings of International Conference on Intelligent Robots and Systems, IROS, 2010. http://dx.doi.org/10.1109/IROS.2010.5649494.
[37] J. Felip, A. Morales, Robust sensor-based grasp primitive for a three-finger robot hand, in: Proceedings of International Conference on Intelligent Robots and Systems, IROS, 2009. http://dx.doi.org/10.1109/IROS.2009.5354760.
[38] Y. Zheng, W.-H. Qian, Coping with the grasping uncertainties in force-closure analysis, Int. J. Robot. Res. 24 (4) (2005) 311–327.
[39] J. Kim, K. Iwamoto, J. Kuffner, Y. Ota, N. Pollard, Physically based grasp quality evaluation under pose uncertainty, IEEE Trans. Robot. 29 (6) (2013) 1424–1439. http://dx.doi.org/10.1109/TRO.2013.2273846.
[40] R.C. Brost, Planning robot grasping motions in the presence of uncertainty, Tech. Rep. CMU-RI-TR-85-12, Robotics Institute, Pittsburgh, PA, 1985.
[41] M. Roa, R. Suarez, Computation of independent contact regions for grasping 3-d objects, IEEE Trans. Robot. 25 (4) (2009) 839–850. http://dx.doi.org/10.1109/TRO.2009.2020351.
[42] V.N. Christopoulos, P.R. Schrater, Handling shape and contact location uncertainty in grasping two-dimensional planar objects, in: IROS, IEEE, 2007, pp. 1557–1563.
[43] J.-P. Saut, S. Ivaldi, A. Sahbani, P. Bidaud, Grasping objects localized from uncertain point cloud data, Robot. Auton. Syst. 62 (12) (2014) 1742–1754. http://dx.doi.org/10.1016/j.robot.2014.07.011.
[44] J. Laaksonen, E. Nikandrova, V. Kyrki, Probabilistic sensor-based grasping, in: Proceedings of International Conference on Intelligent Robots and Systems, IROS, 2012.
[45] S. Dragiev, M. Toussaint, M. Gienger, Uncertainty aware grasping and tactile exploration, in: 2013 IEEE International Conference on Robotics and Automation, ICRA, 2013, pp. 113–119. http://dx.doi.org/10.1109/ICRA.2013.6630564.
[46] N. Sommer, M. Li, A. Billard, Bimanual compliant tactile exploration for grasping unknown objects, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2014.
[47] M. Bjorkman, Y. Bekiroglu, V. Hogman, D. Kragic, Enhancing visual perception of shape through tactile glances, in: Proceedings of International Conference on Intelligent Robots and Systems, IROS, 2013., 2013, pp. 3180–3186. http://dx.doi.org/10.1109/IROS.2013.6696808.
[48] J. Bohg, M. Johnson-Roberson, B. Leon, J. Felip, X. Gratal, N. Bergstrom, D. Kragic, A. Morales, Mind the gap—robotic grasping under incomplete observation, in: 2011 IEEE International Conference on Robotics and Automation, ICRA, 2011, pp. 686–693. http://dx.doi.org/10.1109/ICRA.2011.5980354.
[49] I. Gori, U. Pattacini, V. Tikhanoff, G. Metta, Three-finger precision grasp on incomplete 3d point clouds, in: IEEE International Conference on Robotics and Automation, ICRA, Hong Kong, China, 2014.
[50] C.E. Rasmussen, C.K.I. Williams, Gaussian Processes for Machine Learning, in: Adaptive Computation and Machine Learning, The MIT Press, 2005.
[51] E. Solak, R. Murray-Smith, W.E. Leithead, D. Leith, C.E. Rasmussen, Derivative observations in gaussian process models of dynamic systems, in: S. Thrun, S. Becker, K. Obermayer (Eds.), Advances in Neural Information Processing Systems, Vol. 15, MIT Press, Cambridge, MA, 2003, pp. 1033–1040.
[52] F.L. Bookstein, Principal warps: Thin-plate splines and the decomposition of deformations, IEEE Trans. Pattern Anal. Mach. Intell. 11 (6) (1989) 567–585. http://dx.doi.org/10.1109/34.24792.
[53] S. Dragiev, M. Toussaint, M. Gienger, Gaussian process implicit surfaces for shape estimation and grasping, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2011.
[54] B. Siciliano, O. Khatib, Springer Handbook of Robotics, Springer Science & Business Media, 2008.
[55] R.M. Murray, Z. Li, S.S. Sastry, S.S. Sastry, A Mathematical Introduction to Robotic manipulation, CRC Press, 1994.
[56] A. Wächter, L.T. Biegler, On the implementation of an interior-point filter line-search algorithm for large-scale nonlinear programming, Math. Program. 106 (1) (2006) 25–57. http://dx.doi.org/10.1007/s10107-004-0559-y. URL http://dx.doi.org/10.1007/s10107-004-0559-y.
[57] K. Tahara, S. Arimoto, M. Yoshida, Dynamic object manipulation using a virtual frame by a triple soft-fingered robotic hand, in: Proceedings of International Conference on Robotics and Automation, ICRA, 2010.
[58] R. Diankov, Automated construction of robotic manipulation programs (Ph.D. thesis), Carnegie Mellon University, Robotics Institute, 2010, URL http://www.programmingvision.com/rosen_diankov_thesis.pdf.
[59] G. Mclachlan, D. Peel, Finite Mixture Models, first ed., in: Wiley Series in Probability and Statistics, Wiley-Interscience, 2000.
[60] M. Powell, A direct search optimization method that models the objective and constraint functions by linear interpolation, in: S. Gomez, J.-P. Hennart (Eds.), Advances in Optimization and Numerical Analysis, Kluwer Academic, Dordrecht, 1994, pp. 51–67.

Miao Li has received the Bachelor and Master's degrees both from the School of Mechanical Science and Engineering, Huazhong University of Science and Technology (HUST), China, in 2008 and 2011 respectively. From Sep. 2011, he joined the Department of Mechanical Engineering at École Polytechnique Fédérale Lausanne (EPFL) in Switzerland, as a doctoral assistant. His current research interests mainly focus on robust robotic grasping, impedance control of dexterous manipulation using tactile sensing.



Kaiyu Hang is a Ph.D. student at the Centre for Autonomous Systems and the Computer Vision and Active Perception Lab at KTH Royal Institute of Technology, Stockholm, Sweden. His current research interests include robotic precision/fingertip grasping, object–hand joint representation, adaptable grasping and grasp manifold learning, etc. His interests include robotics, machine learning, AI and computer vision.

Danica Kragic is a Professor at the School of Computer Science and Communication at the Royal Institute of Technology, KTH. She received M.Sc. in Mechanical Engineering from the Technical University of Rijeka, Croatia in 1995 and Ph.D. in Computer Science from KTH in 2001. She has been a visiting researcher at Columbia University, Johns Hopkins University and INRIA Rennes. She is the Director of the Centre for Autonomous Systems. Danica received the 2007 IEEE Robotics and Automation Society Early Academic Career Award. She is a member of the Royal Swedish Academy of Sciences and Young Academy of Sweden. She holds a Honorary Doctorate from the Lappeenranta University of Technology. She chaired IEEE RAS Technical Committee on Computer and Robot Vision and served as an IEEE RAS AdCom member. Her research is in the area of robotics, computer vision and machine learning. In 2012, she received an ERC Starting Grant. Her research is supported by the EU, Knut and Alice Wallenberg Foundation, Swedish Foundation for Strategic Research and Swedish Research Council.

Aude Billard is Professor of Micro and Mechanical Engineering, and the head of the LASA Laboratory at the School of Engineering at the Swiss Federal Institute of Technology in Lausanne. She received an M.Sc. in Physics from EPFL (1995), an M.Sc. in Knowledge-based Systems (1996) and a Ph.D. in Artificial Intelligence (1998) from the University of Edinburgh. She was the recipient of the Intel Corporation Teaching award, the Swiss National Science Foundation career award in 2002, the Outstanding Young Person in Science and Innovation from the Swiss Chamber of Commerce and the IEEE-RAS Best Reviewer award in 2012. Aude Billard served as an elected member of the Administrative Committee of the IEEE Robotics and Automation society (RAS) for two terms (2006–2008 and 2009–2011) and is the chair of the IEEE-RAS Technical Committee on Humanoid Robotics. Her research interests focus on machine learning tools to support robot learning through human guidance. This extends also to research on complementary topics, including machine vision and its use in human–robot interaction and computational neuroscience to develop models of motor learning in humans.