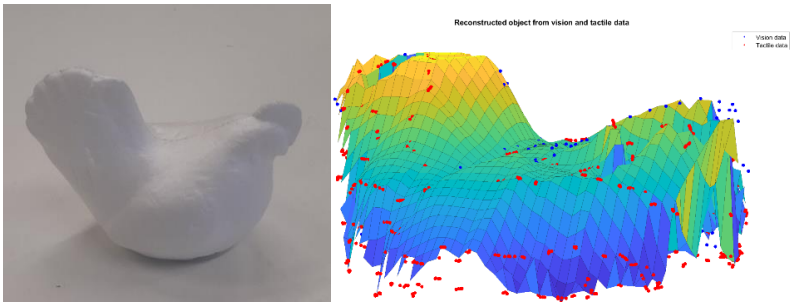
Fusing visual and tactile sensors information to infer object's geometry

Master thesis proposal

Motivation: This project aims to explore a new approach to integrating visual and contact sensors to perceive objects better and faster. Information about the shape, size and pose of the objects in environment is crucial for many simple robotic scenarios, such as reaching, grasping and manipulation tasks. However, obtaining such simple information often require expensive experimental equipment and computationally expensive algorithms. Human beings rely on both visual and tactile information working in tandem while performing day-to-day activities such as grasping objects. Taking a cue from human expertise, we would develop a strategy for robots to efficiently combine the two data from the two different types of sensors. As a matter of fact, tactile exploration algorithm has already been developed in our lab [1] to explore the shape of objects. The algorithm, relying solely on tactile information, is time-consuming. With the aid of information from vision, the exploration strategy can be considerably sped up.

Experimental Setup: The robotic setup would consist of a kuka arm with an allegro hand mounted on it. The phalanges of the hand would be covered with tekscan pressure sensors to obtain information about the contact with the object. To obtain visual information, realsense depth camera would be employed which yields a 3D point cloud of the object in its field of view. As a pilot study, we used the two together to reconstruct a model of toy rooster (see image).



The project will start with preliminary goals of estimating the pose, shape and size of objects. Depending on time, more interesting tasks such as detecting feasible grasp points on the object would be tackled. Ultimately, the output of this work shall be integrated in the shared-control architecture [2] for manipulating objects using robotic hands controlled with muscle signals (EMG). The project offers a lot of scope for creative ideas. Interested students should have adequate programming skills (python, C++, MATLAB, ROS) and background in machine learning and computer vision. Please contact with your CV and a brief statement of your interest/motivation in the project.

Hosting Lab	Learning Algorithms and Systems Laboratory (LASA), EPFL, Switzerland
Period	Six months (flexible)
Earliest start date	February 1, 2020 (flexible)
Required Skills	Programming (C++/Python), Machine Learning
Desired Skills	Reinforcement Learning, ROS, experience with working on robots
Supervision	Saurav Aryan (saurav.aryan@epfl.ch), Aude Billard(aude.billard@epfl.ch)
Funding	At the moment, partial support (900 CHF per month sufficient for lodging)

Bibliography

[1] N. Sommer and A. Billard, "Multi-contact haptic exploration and grasping with tactile sensors," *Robotics and Autonomous Systems,* vol. 85, pp. 48-61, 2016.

[2] K. Z. Zhuang, N. Sommer, V. Mendez, S. Aryan, E. Formento, E. D'Anna, F. Artoni, F. Petrini, G. Granata, G. Cannaviello, W. Raffoul, A. Billard and S. Micera, "Shared human–robot proportional control of a dexterous myoelectric prosthesis," *Nature Machine Intelligence,* vol. 1, no. 9, pp. 400-411, 2019.