

Advanced Tactile Perception for Materials Handling and Collaborative Robotics in Industrial Tasks

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Abstract— Robotic manipulation is often limited not by the finesse achievable by mechanisms employed, but rather by the perceptive capacity of the sensors used for perceiving the environment and the control algorithms employed. At our Next Generation Systems Lab, we are investigating novel methods of integrated perception and control including Robotic Skin and Deep Neural Nets for grasping and manipulation.

Robotic skin is a key type of heteroceptive sensor, inspired by nature, which could eventually enable co-Robots to share their workspace with humans. Despite considerable progress in that last 30 years with this “holy grail” product, numerous fabrication, integration, dynamic performance, reliability, and cost challenges remain in realizing robotic skins, which is why several projects around the world, and the US National Robotics Initiative (NRI) have continued investing in this technology. A leading application of electronic skins is in robotic material handling. In this scenario, industrial robots retrofitted with electronic skins will work collaboratively with humans on the assembly line, to assist with complex tasks such as bin-picking and order fulfillment [1-5].

Grasping is a fundamental problem in materials handling. Although there are various methods for identifying effective solutions for gripping an object, it is often challenging to reliably implement these in an unstructured environment due to reliance on exact object modeling and pose measurement. Deep neural nets hold the potential to significantly improve the flexibility of grasping systems by leveraging visual data to address both problems, treating pose estimation and grasp selection as classification tasks, rather than geometric ones. By representing the task as a decision problem, we can capitalize on the information base of neural networks to enable operation under the constraints imposed by the disorder of real world settings such as the occlusion, misalignment, and restricted spaces encountered in bin-picking [6].

Keywords— Robot skin, Tactile manipulation, Deep Neural Nets, Robotic Grasping and Manipulation, Collaborative Robotics

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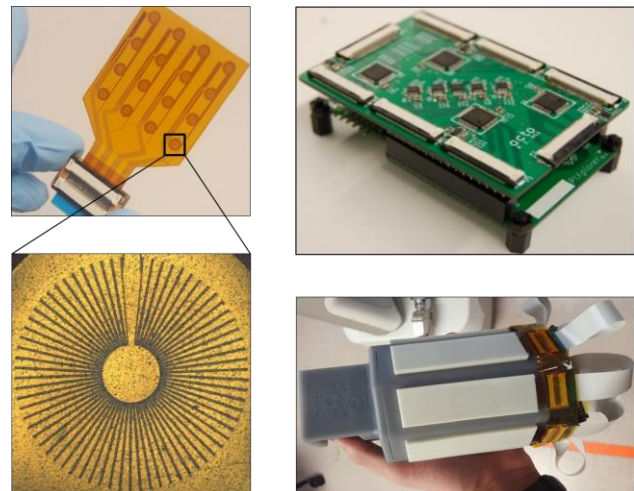


Figure 1. Robotic skin apparatus; sensor array (top left), sensor cell (bottom left), data acquisition board (top right), and multi-faceted can covered with robotic skin patches (bottom right)



Figure 2. Pneumatic gripper augmented with fingertip skin sensor mounted on an industrial arm from Denso