KHALIFA UNIVERSITY

Autonomous Grasping
—— Developmental Pathway Towards Autonomy and Dexterity In Robot In-Hand Manipulation

Robotics Institute
Khalifa University of Science, Technology and Research

Introduction

Autonomously handling a large range of different objects and intelligently utilizing human tools are key requirements for robots to carry out accurate and intelligent tasks for people and in collaboration with people. One of the most challenging robotic problems is human like grasping which is essential for autonomous handling. This project aims at understanding how humans perform the manipulation of objects in order to replicate grasping and skilled in-hand movements and thereby move robot grippers from current best practice towards more autonomous, natural and effective articulated hands.
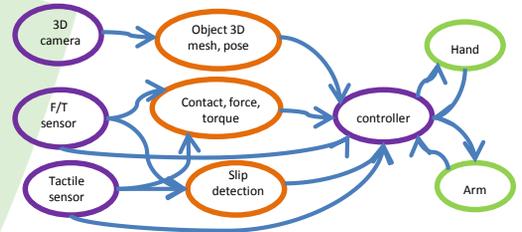

Robonaut

Context and Background

Today's robots supply good performance but are still unable to achieve a high level of dexterous manipulation. They are far from being able to understand and reason about their environments and their own capabilities, to learn skills and improve their performance by what they have been taught and their own experience, or to interact with their environments as humans do.
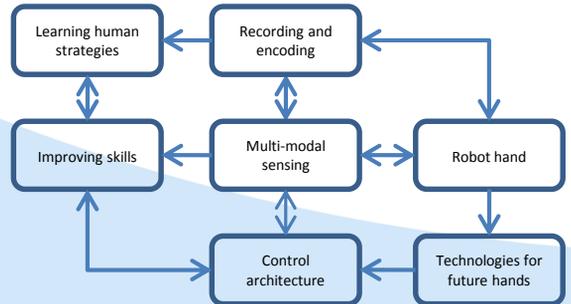

Shadow hand

Research Objectives

Shadow hand

➢ Learning and imitation of human strategies in handling tasks
➢ Algorithms for Autonomous in-hand dexterous manipulation
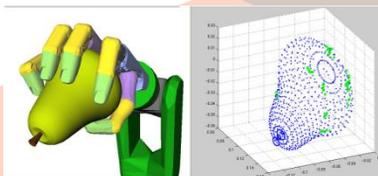➢ Research toward future artificial hands as human-like plug-in devices

Research Challenges and Possible Approaches

❑ Human motion tracking, encoding and representation

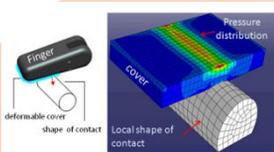CyberGlove II

❑ Imitation of human grasping with robot hand

deformable cover shape of contact Local shape of contact Pressure distribution Finger cover

❑ In-hand object perception based on force/torque and tactile sensors
❑ In-hand grasping control based on sensor information

❑ Data synchronization and system integration

3D camera → Object 3D mesh, pose → Hand
F/T sensor → Contact, force, torque → controller
Tactile sensor → Slip detection → Arm

Work Plan

Learning human strategies ↔ Recording and encoding
Improving skills ↔ Multi-modal sensing ↔ Robot hand
Control architecture ↔ Technologies for future hands

Desirable Outcomes

➢Data base on human grasping for robot hand learning;
➢Imitation modeling for robot hand grasping;
➢In-hand object perception modeling;
➢Robot hand system integration methods;
➢Evaluating criteria for Robot hand performance;
➢PhD: Autonomous Grasping;
➢MSc: Haptic feedback for control and object perception.

International Collaborators

➢ King's College London, University of London
➢ University of Coimbra

KING'S College LONDON

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