Articles, Magazines, etc

Paper List

Foundations

Human Manipulation & Human Hands

Evolution of the human hand: approaches to acquiring, analysing and interpreting the anatomical evidence. Journal of anatomy. 2000.

Form, function and evolution of the human hand - Kivell - 2023 - American Journal of Biological Anthropology

The physiology of the joints, volume I, upper limb. American Journal of Physical Medicine & Rehabilitation.1971. (Hand anatomy from a biomechanics perspective)
Patterns of static prehension in normal hands. American Journal of Occupational Therapy. 1980. (Understanding human grasp patterns by studying hand-object contacts)

Hand Modeling and Simulation Using Stabilized Magnetic Resonance Imaging, ACM Transactions on Graphics, SIGGRAPH, 2019.
Modeling of Personalized Anatomy using Plastic Strains, ACM Transaction on Graphics, 2021 (follow-up of the 2019 paper above)

The Complexities of Grasping in the Wild, Humanoids, 2017. (understanding grasping with human studies)
Annotating Everyday Grasps in Action, 2016. (understanding grasping with human studies)

Estimating the Complexity of Animal Behaviour: How Mountain Gorillas Eat Thistles, 2001 (Observed 121 low-level skills for gorilla thistle eating. Human manipulation could be much more complex!)

Manipulation Synergies & Taxonomy

The GRASP Taxonomy of Human Grasp Types. 2016.

The Complexities of Grasping in the Wild, 2017

Postural Hand Synergies for Tool Use. J Neurosci. 1998.

A bimanual manipulation taxonomy. Robotics and Automation Letters, 2022.

A hand-centric classification of human and robot dexterous manipulation.IEEE transactions on Haptics, 2012.

Postures and Movement Patterns of the Human Hand: A Framework for Understanding Hand Activity for Clinicians and Engineers. 2022.

Contact Mechanics & Contact Interactions

Mechanics of Robotic Manipulation, Chapter 6 Friction, Book by Matthew T Mason, 2001.

An implicit time-stepping scheme for rigid body dynamics with Coulomb friction, 2000

On the Similarities and Differences Among Contact Models in Robot Simulation, 2021

Variational Contact-Implicit Trajectory Optimization, 2020

Automatic generation of high-level contact state space. 2001

Contact Transfer: A Direct, User-Driven Method for Human to Robot Transfer of Grasps and Manipulations, 2022.

Hydroelastic contact in Drake, 2022

Efficient Contact Mode Enumeration in 3D, 2020

Contact Interaction for Robot Dexterity, 2024

Grasping

The neuroscience of grasping | Nature Reviews Neuroscience, 2005

Grasping. Springer handbook of robotics, 2016 (a very clear discussion of fundamentals in grasping, including key terms such as Force Closure, Form Closure, Grasp Matrix, and others)

Planning Optimal Grasps. C Ferrari and J Canny. 1992.

Dexterous Grasping via Eigengrasps: A Low-dimensional Approach to a High-complexity Problem, 2007
Hand posture subspaces for dexterous robotic grasping. 2009.

From Caging to Grasping, 2011

Human-Inspired Force Compliant Grasping Primitives, 2014

Physically-based Grasp Quality Evaluation under Pose Uncertainty, 2013. (used a physics simulation to evaluate grasp quality)

Grasp'D: Differentiable Contact-rich Grasp Synthesis for Multi-fingered Hands, 2022

AnyGrasp: Robust and Efficient Grasp Perception in Spatial and Temporal Domains. 2023.

SpringGrasp: An optimization pipeline for robust and compliant dexterous pre-grasp synthesis, 2024

DexGraspNet: A Large-Scale Robotic Dexterous Grasp Dataset for General Objects Based on Simulation, 2024

Non-prehensile Manipulation

(manipulation that is not grasping)

Stable Pushing, in the 90's

A Convex Polynomial Force-Motion Model for Planar Sliding, 2016

Nonprehensile Dynamic Manipulation: A Survey, 2018

Dexterous Manipulation

On dexterity and dexterous manipulation, 2011

Extrinsic Dexterity: In-Hand Manipulation with External Forces. 2014

Learning to Grasp the Ungraspable with Emergent Extrinsic Dexterity. Conference on Robot Learning. 2022.

Synthesizing Dexterous Nonprehensile Pregrasp for Ungraspable Objects. 2023

Contact Mode Guided Planning for Dexterous Manipulation in 2D(2020) or 3D(2021).

Tools and Evaluation

Human Manipulation Benchmarks

Please check these notes from Nancy Pollard for a good overview of human & robotic manipulation benchmarks.

Robotic Manipulation Benchmarks

The Elliott and Connolly Benchmark: A Test for Evaluating the In-Hand Dexterity of Robot Hands, 2021.

NIST benchmark for Robotic Grasping and Manipulation for Assembly

The YCB Object and Model Set: Towards Common Benchmarks for Manipulation Research, 2015

robosuite: A Modular Simulation Framework and Benchmark for Robot Learning

RLBench: The Robot Learning Benchmark & Learning Environment, 2020

Bi-DexHand: Towards Human-Level Bimanual Dexterous Manipulation with Reinforcement Learning, 2023

PerAct2: Benchmarking and Learning for Robotic Bimanual Manipulation Tasks, 2024

FMB: A Functional Manipulation Benchmark for Generalizable Robotic Learning, 2024

HumanoidBench: Simulated Humanoid Benchmark for Whole-Body Locomotion and Manipulation, 2024

LeRobot: an Open-Source Machine Learning Platform for Robotics, HuggingFace, 2024.

Datasets

Ego-Exo4D: A foundational dataset for research on video learning and multimodal perception, 2023

OAKINK2: A Dataset of Bimanual Hands-Object Manipulation in Complex Task Completion, 2024

Open X-Embodiment: Robotic Learning Datasets and RT-X Models, 2024

DROID: A Large-Scale In-the-Wild Robot Manipulation Dataset, 2024

AgiBot World, 2025

Simulation

For simulators, you could check out MuJoCo, Isaac Sim, DART, Drake, Bullet, IPC (large deformation dynamics), Box2D, and Genesis (a newly released simulator that integrates many existing simulators).

Drake: Model-based design and verification for robotics, 2019

Genesis: A Generative and Universal Physics Engine for Robotics and Beyond, 2025

Cosmos World Foundation Model Platform for Physical AI, 2025

Control

Compliance Control / Force Control

Chapter 7 Force Control, Springer Handbook of Robotics, 2007

Real and Artificial Forces in the Control of Manipulators: Theory and Experiments, 1990

Hybrid Position/Force Control of Manipulators, 1981

Robust Execution of Contact-Rich Motion Plans by Hybrid Force-Velocity Control, 2019

Adaptive Compliance Policy: Learning Approximate Compliance for Diffusion Guided Control, 2024

Adaptive and Reactive Control

Learning for Adaptive and Reactive Robot Control - Book, 2022

Online movement adaptation based on previous sensor experiences, 2011

Residual policy learning. 2018.

Iterative Residual Policy for Goal-Conditioned Dynamic Manipulation of Deformable Objects. 2022.

In-Hand Object Rotation via Rapid Motor Adaptation. 2022.

Perception

Interactive Perception: Leveraging Action in Perception and Perception in Action, 2016

3D Perception

BundleSDF: Neural 6-DoF Tracking and 3D Reconstruction of Unknown Objects. 2023.
FoundationPose: Unified 6D Pose Estimation and Tracking of Novel Objects. 2024.

DART: Dense Articulated Real-Time Tracking. 2014.
Probabilistic Articulated Real-Time Tracking for Robot Manipulation. 2017

What's in your hands? 3D Reconstruction of Generic Objects in Hands, 2022

Tactile Sensing

The unstable queen: Uncertainty, mechanics, and tactile feedback, 2021

Tactile sensory control of object manipulation in humans." The Senses: A Comprehensive Reference, 2008.

Review papers:
A Comprehensive Realization of Robot Skin: Sensors, Sensing, Control, and Applications, 2019
A Review of Tactile Information: Perception and Action Through Touch, 2020
Guest Editorial Special Collection on Tactile Robotics, 2025

GelSight: High-Resolution Robot Tactile Sensors for Estimating Geometry and Force. 2017

Neuro-inspired electronic skin for robots, 2022

Bioinspired soft electroreceptors for artificial precontact somatosensation, 2022

AnySkin: Plug-and-play Skin Sensing for Robotic Touch, 2024

Perception with tactile sensing:
NeuralFeels with neural fields: Visuo-tactile perception for in-hand manipulation, 2023

Tactile DreamFusion: Exploiting Tactile Sensing for 3D Generation, 2024

NormalFlow: Fast, Robust, and Accurate Contact-based Object 6DoF Pose Tracking with Vision-based Tactile Sensors, 2024

Sensors

SonicSense: Object Perception from In-Hand Acoustic Vibration, 2024

Multimodal tactile sensor. The Human Hand as an Inspiration for Robot Hand Development, 2014. (The BioTac Sensor)

All the Feels: A dexterous hand with large-area tactile sensing. 2023. (magnetic sensing, ReSkin)

Fully 3D printable Robot Hand and Soft Tactile Sensor based on Air-pressure and Capacitive Proximity Sensing, 2024. (air pressure sensing)

Planning

Manipulation Motion Planning

Manipulation planning on constraint manifolds, 2009

Enhancing Dexterity in Robotic Manipulation via Hierarchical Contact Exploration, 2023

PINSAT: Parallelized Interleaving of Graph Search and Trajectory Optimization for Kinodynamic Motion Planning, 2024

Task planning & Task and Motion Planning (TAMP)

Hierarchical Task and Motion Planning in the Now. 2011.
[2010.01083] Integrated Task and Motion Planning, 2020

Differentiable Physics and Stable Modes for Tool-Use and Manipulation Planning. 2018.

Generalized Planning in PDDL Domains with Pretrained Large Language Models, 2023

Learning Reusable Manipulation Strategies. 2023

Uncertainty and Robustness

Automatic synthesis of fine-motion strategies for robots, 1984. (The origins of having a chain of funnels so that the object motions converge.)
LQR-Trees: Feedback Motion Planning on Sparse Randomized Trees, 2009

Characterizing Manipulation Robustness through Energy Margin and Caging Analysis, 2024

Planning and acting in partially observable stochastic domains. 1998. (POMDP)

Belief space planning assuming maximum likelihood observations, 2010

Pre-image backchaining in belief space for mobile manipulation, 2011

Monte-Carlo Planning in Large POMDPs, 2020

Robust Planning for Multi-stage Forceful Manipulation, 2022

A POMDP-based hierarchical planning framework for manipulation under pose uncertainty, 2024

Learning-focused

Robot Foundation Models & Related

Toward General-Purpose Robots via Foundation Models: A Survey and Meta-Analysis, 2023
Foundation Models in Robotics: Applications, Challenges, and the Future, 2023

Open X-Embodiment: Robotic Learning Datasets and RT-X Models, 2024

LLARVA: Vision-Action Instruction Tuning Enhances Robot Learning, 2024
Octo: An Open-Source Generalist Robot Policy, 2024

OpenVLA: An Open-Source Vision-Language-Action Model, 2024

Hand-Object Interaction Pretraining from Videos, 2024

Manipulation + VLM/LLMs

Code as Policies: Language Model Programs for Embodied Control, 2022

Do As I Can, Not As I Say: Grounding Language in Robotic Affordances. 2022

VoxPoser: Composable 3D Value Maps for Robotic Manipulation with Language Models, 2023

HandsOnVLM: Vision-Language Models for Hand-Object Interaction Prediction, 2024

Human-Object Interaction from Human-Level Instructions, 2024

Eureka: Human-Level Reward Design via Coding Large Language Models, 2023

Reinforcement Learning for Manipulation

End-to-End Training of Deep Visuomotor Policies. 2016.

Learning dexterous in-hand manipulation. 2020

HACMan: Learning Hybrid Actor-Critic Maps for 6D Non-Prehensile Manipulation, 2023

Visual dexterity: In-hand reorientation of novel and complex object shapes. Science Robotics, 2023.

General In-Hand Object Rotation with Vision and Touch, 2023

Lessons from Learning to Spin “Pens”, 2024

Imitation Learning for Manipulation

Handbook of Robotics Chapter 59: Robot Programming by Demonstration, 2008

Generalization of Motor Skills by Learning from Demonstration. 2009

A Reduction of Imitation Learning and Structured Prediction to No-Regret Online Learning. 2011. (DAgger)

Perceiver-Actor: A Multi-Task Transformer for Robotic Manipulation, 2022 (PerAct)

Diffusion policy: Visuomotor policy learning via action diffusion, 2023

Learning Fine-Grained Bimanual Manipulation with Low-Cost Hardware. 2023

MimicPlay: Long-Horizon Imitation Learning by Watching Human Play. 2023.

Diffeomorphic Transforms for Generalised Imitation Learning, 2022

Robot Hands/Manipulators

Some Robot Hands

Hands of the 80's:
Belgrade / USC hand, Stanford / JPL hand, Utah / MIT hand

Commercial Hands:
Barrett hand, Gifu Hand, DLR / HIT hand, SVH Hand

More recent commercial hands:
Shadow hand, Allegro hand, qbRobotics Soft Hand, Inspire robotic hand, …
(one in-class presentation idea is a survey and comparison of the commercial robot hands on the market)

Open-source hand/manipulator projects:

- Yale OpenHand project: https://www.eng.yale.edu/grablab/openhand/
- Soft Robot Hands: https://softroboticstoolkit.com/
- Robot Nano Hands: https://robotnanohand.com/
- Build low-cost robot arms with using the LeRobot (a robot learning platform from HuggingFace): TheRobotStudio/SO-ARM100: Standard Open Arm 100 (~$110), GitHub - jess-moss/koch-v1-1 (~$200)

Prosthetic Hands:
iLimb (Touch Bionics), Cyberhand, COVVI hand, Psyonic Ability Hand, DEKA Luke Hand and JHU MPL Hand
Open-source prosthetic hand: https://enablingthefuture.org/upper-limb-prosthetics/

Robotic Hand Research

Human prehension and dexterous robot hands. The International Journal of Robotics Research, 1997.

Hands for dexterous manipulation and robust grasping: a difficult road toward simplicity, 2000.
Toward dexterous manipulation with augmented adaptive synergies: The pisa/iit softhand 2. IEEE Transactions on Robotics, 2018. (Written by the same author of the paper above, 18 years later)

Generality and Simple Hands, ISRR, 2009.

Lightweight High-Speed Multifingered Hand System, Ishikawa Group, 2002

Mechanisms of the Anatomically Correct Testbed (ACT) Hand, 2011. (An attempt to completely mimic human hand)

Fluid Lubricated Dexterous Finger Mechanism for Human-Like Impact Absorbing Capability," IEEE Robotics and Automation Letters, 2019. (FLLEX Hand V1&V2, an attempt to mimic a human hand. Very impressive design but hard to fabricate and reproduce.)

The Robonaut 2 Hand – Designed To Do Work With Tools, 2011

A Compliant, Underactuated Hand for Robust Manipulation, 2015

A 1-DoF SimpleHand Capable of Complex Manipulation, 2013

Direct Drive Hands: Force-Motion Transparency in Gripper Design. 2019

A Novel Type of Compliant and Underactuated Robotic Hand for Dexterous Grasping. International Journal of Robotics Research 2015. (A completely soft hand)

A robotic hand with a gecko-inspired grip, 2021

Tilde: Teleoperation for Dexterous In-Hand Manipulation Learning with a DeltaHand, 2024. (The DeltaHand is a robotic hand consisting of four delta robots as fingers. This paper introduces a full-stack robot hand system including the hand, teleoperation, and imitation learning.)

LEAP Hand: Low-Cost, Efficient, and Anthropomorphic Hand for Robot Learning, 2023
LEAP Hand V2

The modular prosthetic limb. Wearable robotics, 2020. (Prosthetic hand & arm)

Robot Manipulator Systems for Large-scale Data Collection

DexCap: Scalable and Portable Mocap Data Collection System for Dexterous Manipulation, 2024

Learning Fine-Grained Bimanual Manipulation with Low-Cost Hardware (The ALOHA robot, and here is the mobile version of it: Mobile ALOHA)

Universal Manipulation Interface: In-The-Wild Robot Teaching Without In-The-Wild Robots, 2024 (A gripper that can be hand-held to collect data and then mounted on robot arms).
GELLO: A General, Low-Cost, and Intuitive Teleoperation Framework for Robot Manipulators, 2024

ACE: A Cross-platform Visual-Exoskeletons for Low-Cost Dexterous Teleoperation, 2024

Robot (Hand) Design Optimization

An end-to-end differentiable framework for contact-aware robot design. 2021

Automated design of robotic hands for in-hand manipulation tasks.2020
Automated Design of Simple and Robust Manipulators for Dexterous In-Hand Manipulation Tasks using Evolutionary Strategies. 2019

Learning to Design and Use Tools for Robotic Manipulation, 2023

Dynamics-Guided Diffusion Model for Robot Manipulator Design, 2024

PaperBot: Learning to Design Real-World Tools Using Paper, 2024

Co-Designing Tools and Control Policies for Robust Manipulation, 2024

More Topics

Manipulation in Human Robot Interaction

Human-Robot Interaction for Cooperative Manipulation: Handing Objects to One Another, 2007

Collaborative manipulation: New challenges for robotics and HRI, 2013

Eye-Hand Behavior in Human-Robot Shared Manipulation, 2018

DegustaBot: Zero-Shot Visual Preference Estimation for Personalized Multi-Object Rearrangement, 2024

Conformalized Teleoperation: Confidently Mapping Human Inputs to High-Dimensional Robot Actions, 2024

Locomotion, Manipulation, Humanoids

Humanoid Locomotion and Manipulation: Current Progress and Challenges in Control, Planning, and Learning, 2025

A Hybrid Systems Model for Simple Manipulation and Self-Manipulation Systems, 2015 (math heavy, very good learning material for hybrid systems, legged locomotion, and manipulation with small number of contacts)

Legs as Manipulator: Pushing Quadrupedal Agility Beyond Locomotion, 2023

Grasping Diverse Objects with Simulated Humanoids, 2024

Deformable Object Manipulation

Unfolding the Literature: A Review of Robotic Cloth Manipulation, 2024

Supplementary References

Books

Mechanics of Robotic Manipulation, Matthew T Mason

A Mathematical Introduction to Robotic Manipulation, Richard M. Murray, S. Shankar Sastry, and Zexiang Li

Springer Handbook of Robotics, Siciliano, Bruno, Khatib, Oussama

Modern Robotics: Mechanics, Planning, and Control, Kevin M. Lynch and Frank C. Park

Courses

Mechanics of Manipulation, Carnegie Mellon University
Robotic Manipulation, MIT
Hands: Design and Control for Dexterous Manipulation, Carnegie Mellon University
Topics in advanced robotic manipulation, Stanford
Robotic Manipulation, Northwestern University

Articles, Magazines, etc

Towards robotic manipulation, Matthew T Mason, 2018 & Matt's Robotics Blog

IEEE Robotics & Automation Magazine: Robotic Manipulation --- Seizing the Future, Dec 2024