

Novelty Assessment Report

Paper: AnyTouch 2: General Optical Tactile Representation Learning For Dynamic Tactile Perception

PDF URL: <https://openreview.net/pdf?id=ndilONnABZ>

Venue: ICLR 2026 Conference Submission

Year: 2026

Report Generated: 2026-01-01

Abstract

Real-world contact-rich manipulation demands robots to perceive temporal tactile feedback, capture subtle surface deformations, and reason about object properties and force dynamics. Although optical tactile sensors are uniquely capable of providing such rich information, existing tactile datasets and models remain limited. These resources primarily focus on object-level attributes (e.g., material) while largely overlooking fine-grained temporal dynamics. We consider that advancing dynamic tactile perception requires a systematic hierarchy of dynamic perception capabilities to guide both data collection and model design. To address the lack of tactile data with rich dynamic information, we present TouchHD, a large-scale tactile dataset spanning tactile atomic actions, real-world manipulations, and touch-force paired data. Beyond scale, TouchHD establishes a comprehensive dynamic data ecosystem that explicitly supports hierarchical perception capabilities from the data perspective. Building on it, we propose AnyTouch 2, a general tactile representation learning framework for diverse optical tactile sensors that unifies object-level understanding with fine-grained, force-aware dynamic perception. The framework captures both pixel-level and action-specific deformations across frames, while explicitly modeling physical force dynamics, thereby learning multi-level dynamic perception capabilities from the model perspective. We evaluate our model on benchmarks that covers static object properties and dynamic physical attributes, as well as real-world manipulation tasks spanning multiple tiers of dynamic perception capabilities—from basic object-level understanding to force-aware dexterous manipulation. Experimental results demonstrate consistent and strong performance across sensors and tasks, highlighting the framework's effectiveness as a general dynamic tactile perception model.

Disclaimer

This report is **AI-GENERATED** using Large Language Models and WisPaper (a scholar search engine). It analyzes academic papers' tasks and contributions against retrieved prior work. While this system identifies **POTENTIAL** overlaps and novel directions, **ITS COVERAGE IS NOT EXHAUSTIVE AND JUDGMENTS ARE APPROXIMATE**. These results are intended to assist human reviewers and **SHOULD NOT** be relied upon as a definitive verdict on novelty.

Note that some papers exist in multiple, slightly different versions (e.g., with different titles or URLs). The system may retrieve several versions of the same underlying work. The current automated pipeline does not reliably align or distinguish these cases, so human reviewers will need to disambiguate them manually.

If you have any questions, please contact: mingzhang23@m.fudan.edu.cn

Core Task Landscape

This paper addresses: **Tactile Representation Learning for Dynamic Perception**

A total of **50 papers** were analyzed and organized into a taxonomy with **18 categories**.

Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Self-Supervised and Contrastive Tactile Representation Learning**
- **Task-Specific Tactile Learning for Manipulation**
- **Tactile Sensor Hardware and Signal Processing**
- **Neuromorphic and Spiking Tactile Processing**
- **Human Tactile Perception and Psychophysics**
- **Haptic Rendering and Human-Robot Interaction**
- **Non-Tactile and Peripheral Applications**

Complete Taxonomy Tree

- Tactile Representation Learning for Dynamic Perception Survey Taxonomy
- Self-Supervised and Contrastive Tactile Representation Learning
 - Unimodal Tactile Self-Supervised Learning (2 papers)
 - [5] Learn from Incomplete Tactile Data: Tactile Representation Learning with Masked Autoencoders (Guanqun Cao, 2023) [View paper](#)
 - [7] Sparsh: Self-supervised touch representations for vision-based tactile sensing (Carolina Higuera, 2024) [View paper](#)
 - Multimodal Visual-Tactile Contrastive Learning (3 papers)
 - [1] Multimodal visual-tactile representation learning through self-supervised contrastive pre-training (Vedant Dave, 2024) [View paper](#)
 - [9] Touch-Based Manipulation with Multi-Fingered Robot using Off-policy RL and Temporal Contrastive Learning (Naoki Morihira, 2024) [View paper](#)
 - [12] SARL: Spatially-Aware Self-Supervised Representation Learning for Visuo-Tactile Perception (Gurmeher Khurana, 2025) [View paper](#)
 - Cross-Sensor and Transferable Tactile Representations ★ (3 papers)
 - [0] AnyTouch 2: General Optical Tactile Representation Learning For Dynamic Tactile Perception (Anon et al., 2026) [View paper](#)
 - [6] AnyTouch: Learning Unified Static-Dynamic Representation across Multiple Visuo-tactile Sensors (Feng RuoXuan, 2025) [View paper](#)
 - [48] Transferable Tactile Transformers for Representation Learning Across Diverse Sensors and Tasks (Zhao Jialiang, 2024) [View paper](#)
- Task-Specific Tactile Learning for Manipulation
 - Imitation Learning and Teleoperation-Based Tactile Manipulation (3 papers)
 - [2] Simultaneous Tactile-Visual Perception for Learning Multimodal Robot Manipulation (Yuyang Li, 2025) [View paper](#)
 - [10] Grasp like humans: Learning generalizable multi-fingered grasping from human proprioceptive sensorimotor integration (Ce Guo, 2025) [View paper](#)

- [11] ViTaMin: Learning Contact-Rich Tasks Through Robot-Free Visuo-Tactile Manipulation Interface (Liu, 2025) [View paper](#)
- Reinforcement Learning for Tactile-Guided Manipulation (3 papers)
- [4] Human-like Dexterous Grasping Through Reinforcement Learning and Multimodal Perception (Wen Qi, 2025) [View paper](#)
- [34] Tactile-rl for insertion: Generalization to objects of unknown geometry (Siyuan Dong, 2021) [View paper](#)
- [40] Learning Variable Impedance Control for Aerial Sliding on Uneven Heterogeneous Surfaces by Proprioceptive and Tactile Sensing (Zhang, 2022) [View paper](#)
- Object Property Inference and Recognition (3 papers)
- [3] Predictive visuo-tactile interactive perception framework for object properties inference (Anirvan Dutta, 2025) [View paper](#)
- [8] Lifelong visual-tactile spectral clustering for robotic object perception (Yuyang Liu, 2022) [View paper](#)
- [33] Tactile MNIST: Benchmarking Active Tactile Perception (Schneider, 2025) [View paper](#)
- Slip Detection and Force Prediction (2 papers)
- [31] TransForce: Transferable Force Prediction for Vision-Based Tactile Sensors with Sequential Image Translation (Zhuo Chen, 2024) [View paper](#)
- [43] VT-VT: a slip detection model for transformer-based visual-tactile fusion (Jing Yang, 2024) [View paper](#)
- Interaction Prediction and Forward Modeling (2 papers)
- [22] Efficient tactile simulation with differentiability for robotic manipulation (J Xu, 2023) [View paper](#)
- [35] Bridging vision and touch: advancing robotic interaction prediction with self-supervised multimodal learning (Luchen Li, 2024) [View paper](#)
- Tactile Sensor Hardware and Signal Processing
 - Novel Tactile Sensor Design and Fabrication (4 papers)
 - [13] Unlocking Dynamic Subtle Stimuli Tactile Perception: A Deep Learning-Enhanced Super-Resolution Tactile Sensor Array with Rapid Response (Shuyao Zhou, 2025) [View paper](#)
 - [14] Mechano-gated iontronic piezomemristor for temporal-tactile neuromorphic plasticity (Wu Yuchen, 2025) [View paper](#)
 - [26] A wearable tactile sensor array for large area remote vibration sensing in the hand (Shao, 2020) [View paper](#)
 - [30] GTac-hand: A robotic hand with integrated tactile sensing and extrinsic contact sensing capabilities (Zeyu Lu, 2023) [View paper](#)
 - Tactile Signal Processing and Modeling (2 papers)
 - [15] Touching the World from Known to Unknown: Tactile Representation Learning for Robotic Perception (Cao, 2024) [View paper](#)
 - [28] Drift-free latent space representation for soft strain sensors (Thuruthel, 2020) [View paper](#)
- Neuromorphic and Spiking Tactile Processing (2 papers)
 - [45] Bio-Inspired spiking tactile sensing system for robust texture recognition across varying scanning speeds in passive touch. (Fatemeh Yavari, 2025) [View paper](#)
 - [50] SpikeTouch: Optimizing Spike Neural Networks for Tactile Perception (X Zhao, 2025) [View paper](#)
- Human Tactile Perception and Psychophysics
 - Temporal and Cross-Modal Tactile Perception (5 papers)
 - [27] Audiotactile interactions in temporal perception (Valeria Occelli, 2011) [View paper](#)
 - [38] Anisotropy in tactile time perception (Souta Hidaka, 2020) [View paper](#)
 - [39] The development of audiotactile temporal perception (Stanley, 2023) [View paper](#)
 - [41] Auditory clicks elicit equivalent temporal frequency perception to tactile pulses: A cross-modal psychophysical study (Deepak Sharma, 2022) [View paper](#)
 - [44] Perceiving Synchrony: Determining Thermal-Tactile Simultaneity Windows (Takuya Jodai, 2024) [View paper](#)
 - Spatial and Active Tactile Perception (2 papers)
 - [29] Idiosyncratic selection of active touch for shape perception (Neomi Mizrachi, 2022) [View paper](#)
 - [32] Disentangling sensory precision and prior expectation of change in autism during tactile discrimination (Laurie-Anne Sapey-Triomphe, 2023) [View paper](#)
 - Neural Coding and Biomechanical Modeling of Touch (2 papers)
 - [23] From skin mechanics to tactile neural coding: Predicting afferent neural dynamics during active touch and perception (Yuyang Wei, 2022) [View paper](#)
 - [24] Multiplexing intensity and frequency sensations for artificial touch by modulating temporal features of electrical pulse trains (Kevin K. W. Ng, 2024) [View paper](#)
- Haptic Rendering and Human-Robot Interaction
 - Tactile Display and Illusion Rendering (2 papers)
 - [20] Comparing Apparent Haptic Motion and Funneling for the Perception of Tactile Animation Illusions On a Circular Tactile Display (Thomas Pietrzak, 2025) [View paper](#)
 - [47] Deepxpalm: Tilt and position rendering using palm-worn haptic display and cnn-based tactile pattern recognition (Altamirano Cabrera Miguel, 2022) [View paper](#)
 - Teleoperation and Remote Haptic Feedback (2 papers)
 - [21] Audio-Based Roughness Sensing and Tactile Feedback for Haptic Perception in Telepresence (Bastian Pätzold, 2023) [View paper](#)
 - [25] Estimating time-varying delays and parametric uncertainties in teleoperated robots (Rohit Singla, 2025) [View paper](#)
 - Gesture and Emotion Recognition from Touch (2 papers)
 - [36] Multitask touch gesture and emotion recognition using multiscale spatiotemporal convolutions with attention mechanism (Ya-Xin Wang, 2022) [View paper](#)
 - [49] Touch-stroke dynamics authentication using temporal regression forest (Ooi Shih Yin, 2019) [View paper](#)
- Non-Tactile and Peripheral Applications (7 papers)
 - [16] Pushing in the Dark: A Reactive Pushing Strategy for Mobile Robots Using Tactile Feedback (Idil Ozdamar, 2024) [View paper](#)
 - [17] Touch-driven advantages in reaction time but not in performance in a cross-sensory comparison of reinforcement learning (Wenhan Sun, 2025) [View paper](#)
 - [18] Research on the construction of cheerleading technique evaluation and teaching system integrating deep visual recognition and cognitive feedback mechanism (Yao Lu, 2025) [View paper](#)
 - [19] Adding Internal Audio Sensing to Internal Vision Enables Human-Like In-Hand Fabric Recognition with Soft Robotic Fingertips (Iris Andrussow, 2025) [View paper](#)
 - [37] Tactual perception (M Scott, 1986) [View paper](#)
 - [42] Postural representations of the hand in the primate sensorimotor cortex (James M. Goodman, 2019) [View paper](#)

- [46] Spatial Learning by Using Non-Visual Geometry and a Visual 3D Landmark in Zebrafish (Danio rerio) (G. Baratti, 2023) [View paper](#)

Narrative

Core task: tactile representation learning for dynamic perception. The field has organized itself around several complementary directions. Self-supervised and contrastive tactile representation learning explores how to extract generalizable features from raw tactile signals, often drawing on cross-modal alignment or temporal consistency principles (e.g., Multimodal Contrastive Pretraining[1], Temporal Contrastive Learning[9]). Task-specific tactile learning for manipulation focuses on end-to-end policies for grasping and insertion, where tactile feedback directly informs control (e.g., Dexterous Grasping RL[4], Tactile RL Insertion[34]). Meanwhile, tactile sensor hardware and signal processing addresses the physical design and low-level encoding of touch signals, neuromorphic and spiking tactile processing investigates event-driven architectures (Spiking Texture Recognition[45], SpikeTouch Optimization[50]), and human tactile perception and psychophysics examines biological mechanisms. Haptic rendering and human-robot interaction studies how to convey tactile information to users, while non-tactile and peripheral applications extend these ideas to other sensory modalities or domains.

A particularly active line of work concerns cross-sensor and transferable tactile representations, where the goal is to learn encoders that generalize across different sensor types and tasks. AnyTouch Dynamic[0] sits squarely in this branch, emphasizing dynamic perception and the ability to handle temporal sequences from diverse tactile hardware. It shares this transferability emphasis with AnyTouch Unified[6] and Transferable Tactile Transformers[48], both of which also aim to unify representations across sensor modalities. In contrast, works like Incomplete Tactile Autoencoders[5] focus more narrowly on reconstruction under partial observations, and Predictive Visuo Tactile[3] integrates vision and touch through predictive modeling rather than purely tactile transfer. The main open question in this cluster is how to balance sensor-agnostic generality with the fine-grained, sensor-specific details that often matter for downstream manipulation tasks.

Related Works in Same Category

The following **2 sibling papers** share the same taxonomy leaf node with the original paper:

1. AnyTouch: Learning Unified Static-Dynamic Representation across Multiple Visuo-tactile Sensors

Authors: Feng RuoXuan, Hu, Jiangyu, Ruoxuan Feng, Xia, et al. (18 authors total) | **Year/Venue:** 2025 • International Conference on Learning Representations | **URL:** [View paper](#)

Abstract

Visuo-tactile sensors aim to emulate human tactile perception, enabling robots to precisely understand and manipulate objects. Over time, numerous meticulously designed visuo-tactile sensors have been integrated into robotic systems, aiding in completing various tasks. However, the distinct data characteristics of these low-standardized visuo-tactile sensors hinder the establishment of a powerful tactile perception system. We consider that the key to addressing this issue lies in learning unifie...

△ Similarity Notice

These papers appear to be closely related versions or variants of the same research project. Both papers share the 'AnyTouch' naming convention, focus on unified tactile representation learning across multiple optical tactile sensors, and address cross-sensor transferability through similar technical approaches including multi-modal alignment and cross-sensor matching. The original paper (AnyTouch 2) appears to be an extended version that emphasizes dynamic perception and introduces the TouchHD dataset with force prediction capabilities, while the candidate paper (AnyTouch) focuses on static-dynamic representation learning with the TacQuad dataset. Given the substantial overlap in methodology, naming, and core contributions, these are likely different versions or iterations of the same research effort rather than independent works.

2. Transferable Tactile Transformers for Representation Learning Across Diverse Sensors and Tasks

Authors: Zhao Jialiang, Ma Yuxiang, Jialiang Zhao, Wang, Lirui, et al. (10 authors total) | **Year/Venue:** 2024 | **URL:** [View paper](#)

Abstract

This paper presents T3: Transferable Tactile Transformers, a framework for tactile representation learning that scales across multi-sensors and multi-tasks. T3 is designed to overcome the contemporary issue that camera-based tactile sensing is extremely heterogeneous, i.e. sensors are built into different form factors, and existing datasets were collected for disparate tasks. T3 captures the shared latent information across different sensor-task pairings by constructing a shared trunk transforme...

Relationship Analysis

Both papers belong to the Cross-Sensor and Transferable Tactile Representations category, focusing on learning unified representations across heterogeneous optical tactile sensors. They overlap in addressing sensor heterogeneity through cross-sensor matching and multi-sensor pre-training for tactile representation learning. However, AnyTouch 2 emphasizes hierarchical dynamic perception capabilities (from pixel-level deformations to force-aware physical properties) using a novel TouchHD dataset with touch-force pairs and manipulation data, while T3 (Transferable Tactile Transformers) focuses on scaling across 13 sensors and 11 tasks using the FoTa aggregated dataset with sensor-specific encoders and task-specific decoders for zero-shot transferability.

Contributions Analysis

This paper presents **3 main contributions**, each analyzed against relevant prior work:

Contribution 1: Tactile Dynamic Pyramid and TouchHD Dataset

Description: The authors propose a five-tier tactile dynamic pyramid framework that stratifies tactile data by the complexity of dynamic perception capabilities they support, and introduce TouchHD, a large-scale hierarchical dataset spanning simulated atomic actions, real-world manipulations, and touch-force pairs to enrich higher-tier dynamic tactile data.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. AnyTouch: Learning Unified Static-Dynamic Representation across Multiple Visuo-tactile Sensors

URL: [View paper](#)

Brief Assessment

AnyTouch Unified[6] focuses on unified multi-sensor representation learning across different tactile sensors through aligned datasets and cross-sensor transfer, rather than proposing a hierarchical framework for organizing tactile data by dynamic perception complexity or introducing a large-scale dataset spanning simulated actions, real-world manipulations, and touch-force pairs.

2. Spatiotemporal Organization of Touch Information in Tactile Neuron Population Responses

URL: [View paper](#)

Brief Assessment

Spatiotemporal Touch Organization[59] focuses on neural population responses to touch gestures using vibrometry data and computational neuroscience methods, not on hierarchical tactile dataset organization or dynamic perception frameworks for robotic manipulation.

3. Fabric surface characterization: Assessment of deep learning-based texture representations using a challenging dataset

URL: [View paper](#)

Brief Assessment

Fabric Surface Characterization[56] focuses on visual texture classification of fabric surfaces using microscopic images for quality assessment. It does not address tactile sensor data, hierarchical organization of tactile perception capabilities, or dynamic tactile interactions, which are central to the original paper's contribution.

4. Snake Robot with Tactile Perception Navigates on Large-scale Challenging Terrain

URL: [View paper](#)

Brief Assessment

Snake Robot Terrain[57] focuses on hierarchical reinforcement learning for snake robot locomotion with tactile perception in terrain navigation, not on organizing tactile datasets by dynamic perception complexity or creating large-scale hierarchical tactile datasets for representation learning.

5. Emotion recognition using affective touch: A survey

URL: [View paper](#)

Brief Assessment

Affective Touch Survey[52] focuses on emotion recognition through affective touch databases and gesture attributes, not on hierarchical tactile data organization for dynamic perception or robotic manipulation datasets like TouchHD.

6. Reassemble: A multimodal dataset for contact-rich robotic assembly and disassembly

URL: [View paper](#)

Brief Assessment

Reassemble Dataset[51] focuses on contact-rich robotic assembly/disassembly with multi-modal sensors (event cameras, force-torque, microphones, RGB cameras) for industrial manipulation tasks, not on hierarchical tactile data organization or optical tactile sensor representation learning.

7. Haptic codecs for the tactile internet

URL: [View paper](#)

Brief Assessment

Haptic Codecs[53] focuses on haptic data transmission and codec design for the tactile internet, not on hierarchical organization of tactile perception capabilities or large-scale dynamic tactile datasets for robotic manipulation.

8. CoMPAS3D: complex multi-level person-interaction annotated salsa dataset

URL: [View paper](#)

Brief Assessment

CoMPAS3D Dataset[55] focuses on human-human interaction in salsa dance with haptic communication, not on tactile sensor data organization or robotic tactile perception. The domains are fundamentally different: human motion capture versus robotic tactile sensing.

9. Deep multi-model fusion network based real object tactile understanding from haptic data

URL: [View paper](#)

Brief Assessment

Deep Multi Model[54] focuses on haptic data understanding from a multi-model fusion perspective for object recognition, not on hierarchical organization of tactile data by dynamic perception capabilities or large-scale dataset construction spanning simulated actions, manipulations, and touch-force pairs.

10. Multi-Scale Voting System for Robotic Tactile Texture Recognition on Uneven Surfaces

URL: [View paper](#)

Brief Assessment

Multi-Scale Voting System[58] focuses on multi-scale temporal classification for texture recognition on uneven surfaces using a voting ensemble, not on hierarchical organization of tactile data by dynamic perception complexity or large-scale dataset construction across multiple tiers.

Contribution 2: AnyTouch 2 General Tactile Representation Learning Framework

Description: The authors develop AnyTouch 2, a unified representation learning framework that integrates pixel-level deformation modeling, semantic-level tactile feature understanding, and physical-level force dynamics prediction to support hierarchical dynamic tactile perception across multiple sensor types.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Development and evaluation of refreshable Braille display and active touch-reading system for digital reading of the visually impaired

URL: [View paper](#)

Brief Assessment

Refreshable Braille Display[73] focuses on a specialized braille display device for visually impaired users, not on general tactile representation learning for robotic manipulation across multiple sensor types.

2. Tactile Sensor Integrated Fingertip Capable of Detecting Precise Contact Force for Robotic Grippers

URL: [View paper](#)

Brief Assessment

Tactile Sensor Fingertip[70] focuses on hardware design for force measurement in robotic grippers, not on representation learning frameworks for optical tactile sensors across multiple modalities and hierarchical perception capabilities.

3. Towards forceful robotic foundation models: a literature survey

URL: [View paper](#)

Brief Assessment

Forceful Foundation Models[72] is a literature survey reviewing methods for integrating force and tactile sensing in robot manipulation, not a technical framework. It does not present a unified representation learning system combining pixel-level deformation, semantic features, and force dynamics prediction like AnyTouch 2.

4. Can Vision Feel Touch? Tactile-aware Visual Grasping for Transparent Objects

URL: [View paper](#)

Brief Assessment

Vision Feel Touch[71] focuses on visual-tactile fusion for transparent object grasping, not on general tactile representation learning across multiple sensors with hierarchical dynamic perception capabilities.

5. Tactile Robot Programming: Transferring Task Constraints into Constraint-Based Unified Force-Impedance Control

URL: [View paper](#)

Brief Assessment

Tactile Robot Programming[77] focuses on task-based robot programming for manufacturing using constraint-based force-impedance control, not on unified tactile representation learning across multiple sensors or hierarchical dynamic perception capabilities.

6. VibroTouch: Active Tactile Sensor for Contact Detection and Force Sensing via Vibrations

URL: [View paper](#)

Brief Assessment

VibroTouch Active Sensor[76] focuses on vibration-based contact detection and force sensing using eccentric rotating mass motors and accelerometer data analysis. This is fundamentally different from AnyTouch 2's unified representation learning framework that integrates pixel-level deformation modeling from optical tactile sensors with semantic understanding and force dynamics prediction.

7. Multi-sensor data fusion and time series to image encoding for hardness recognition

URL: [View paper](#)

Brief Assessment

Multi Sensor Hardness[75] focuses on hardness recognition using glove sensors with force data fusion and time-series-to-image encoding (GASF/GADF/MTF), not on unified optical tactile representation learning across multiple sensor types with hierarchical dynamic perception capabilities.

8. Investigation of Experimental Devices for Finger Active and Passive Tactile Friction Analysis

URL: [View paper](#)

Brief Assessment

Finger Friction Analysis[78] focuses on human finger tactile friction experiments with active/passive sliding paradigms, not on unified tactile representation learning frameworks for robotic optical sensors across multiple modalities and hierarchical perception tasks.

9. Intrinsic contact sensing and object perception of an adaptive fin-ray gripper integrating compact deflection sensors

URL: [View paper](#)

Brief Assessment

The candidate paper focuses on model-based contact sensing for adaptive fin-ray grippers using strain-gauge sensors, not on general tactile representation learning frameworks that unify pixel-level deformation modeling, semantic understanding, and force dynamics prediction across multiple optical tactile sensor types.

10. Capturing forceful interaction with deformable objects using a deep learning-powered stretchable tactile array

URL: [View paper](#)

Brief Assessment

Forceful Interaction Deformable[74] focuses on capturing forces during manipulation of deformable objects using a stretchable tactile glove with force-sensing channels, not on unified tactile representation learning across multiple sensor types or hierarchical dynamic perception capabilities.

Contribution 3: Multi-Level Dynamic Enhanced Modules

Description: The authors introduce specialized modules including frame-difference reconstruction for capturing fine-grained temporal variations, action matching for semantic-level dynamic understanding, and force prediction tasks to explicitly model physical properties underlying tactile interactions.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. CATCH-FORM-ACter: Compliance-Aware Tactile Control and Hybrid Deformation Regulation-Based Action Transformer for Viscoelastic Object Manipulation

URL: [View paper](#)

Brief Assessment

CATCH FORM ACter[60] focuses on compliance-aware tactile control for viscoelastic object manipulation using admittance control and PDE-stabilized loops, not on temporal deformation modeling, action matching, or force prediction for tactile representation learning.

2. Touch and temporal behavior of grand piano actions.

URL: [View paper](#)

Brief Assessment

Piano Actions Temporal[69] focuses on the temporal behavior of grand piano actions (mechanical components), not tactile perception or robotic manipulation. The domains are entirely different.

3. Deformable Object Manipulation with a Tactile Reactive Gripper

URL: [View paper](#)

Brief Assessment

Deformable Tactile Gripper[62] focuses on cable and cloth manipulation using tactile sensors for pose estimation and control, not on temporal deformation modeling, action matching, or force prediction for general tactile perception as in the original paper.

4. SIMULATING THE TIME-VARYING PARAMETERS OF ROBOTS IN PERFORMING THE COMPLEX SEQUENTIAL TASKS

URL: [View paper](#)

Brief Assessment

Time Varying Parameters[67] focuses on simulating robot parameters (torque, velocity, force) in sequential tasks using kinematic modeling and control algorithms, not on tactile perception or optical sensor representation learning.

5. Robotic tactile sensing: technologies and system

URL: [View paper](#)

Brief Assessment

Robotic Tactile Technologies[63] is a survey paper on tactile sensing technologies and systems. It does not present specific technical methods for temporal deformation modeling, action matching, or force prediction tasks as computational modules for tactile representation learning.

6. The dynamic response of a tactile sensor

URL: [View paper](#)

Brief Assessment

Dynamic Sensor Response[68] focuses on characterizing the frequency response and viscoelastic properties of a thumb-shaped tactile sensor array using Maxwell-Kelvin models for force prediction from strain measurements. This is fundamentally different from the ORIGINAL paper's multi-level modules (frame-difference reconstruction, action matching, force prediction) designed for optical tactile representation learning across diverse sensors and manipulation tasks.

7. An Adaptive Grasping Force Tracking Strategy for Nonlinear and Time-Varying Object Behaviors

URL: [View paper](#)

Brief Assessment

Adaptive Grasping Force[61] focuses on force tracking control for robotic grasping using LSTM-based stiffness estimation, not on tactile representation learning with frame-difference reconstruction, action matching, or force prediction modules for optical tactile sensors.

8. Spatio-temporal deep learning models for tip force estimation during needle insertion.

URL: [View paper](#)

Brief Assessment

Spatio Temporal Tip Force[66] focuses on needle insertion force estimation using spatio-temporal deep learning models, which is a specific medical application domain. The candidate paper does not address general tactile representation learning or the multi-level dynamic perception framework proposed in the original work.

9. Identifying 3-D spatiotemporal skin deformation cues evoked in interacting with compliant elastic surfaces

URL: [View paper](#)

Brief Assessment

Spatiotemporal Skin Deformation[64] focuses on human finger pad skin deformation during passive touch with compliant objects, developing 3-D metrics for penetration depth and surface curvature. The candidate does not address frame-difference reconstruction, action matching, or force prediction tasks in the context of optical tactile sensor representation learning for robotic manipulation.

10. Time-varying changes in median nerve deformation and position in response to quantified pinch and grip forces.

URL: [View paper](#)

Brief Assessment

Median Nerve Deformation[65] focuses on biomechanical analysis of median nerve deformation during pinch and grip forces in human hands, not on tactile sensor representation learning or robotic manipulation tasks.

Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

References

- [0] AnyTouch 2: General Optical Tactile Representation Learning For Dynamic Tactile Perception [View paper](#)
- [1] Multimodal visual-tactile representation learning through self-supervised contrastive pre-training [View paper](#)
- [2] Simultaneous Tactile-Visual Perception for Learning Multimodal Robot Manipulation [View paper](#)
- [3] Predictive visuo-tactile interactive perception framework for object properties inference [View paper](#)
- [4] Human-like Dexterous Grasping Through Reinforcement Learning and Multimodal Perception [View paper](#)
- [5] Learn from Incomplete Tactile Data: Tactile Representation Learning with Masked Autoencoders [View paper](#)
- [6] AnyTouch: Learning Unified Static-Dynamic Representation across Multiple Visuo-tactile Sensors [View paper](#)
- [7] Sparsh: Self-supervised touch representations for vision-based tactile sensing [View paper](#)
- [8] Lifelong visual-tactile spectral clustering for robotic object perception [View paper](#)
- [9] Touch-Based Manipulation with Multi-Fingered Robot using Off-policy RL and Temporal Contrastive Learning [View paper](#)
- [10] Grasp like humans: Learning generalizable multi-fingered grasping from human proprioceptive sensorimotor integration [View paper](#)
- [11] ViTaMin: Learning Contact-Rich Tasks Through Robot-Free Visuo-Tactile Manipulation Interface [View paper](#)
- [12] SARL: Spatially-Aware Self-Supervised Representation Learning for Visuo-Tactile Perception [View paper](#)
- [13] Unlocking Dynamic Subtle Stimuli Tactile Perception: A Deep Learning-Enhanced Super-Resolution Tactile Sensor Array with Rapid Response [View paper](#)

- [14] Mechano-gated iontronic piezomemristor for temporal-tactile neuromorphic plasticity [View paper](#)
- [15] Touching the World from Known to Unknown: Tactile Representation Learning for Robotic Perception [View paper](#)
- [16] Pushing in the Dark: A Reactive Pushing Strategy for Mobile Robots Using Tactile Feedback [View paper](#)
- [17] Touch-driven advantages in reaction time but not in performance in a cross-sensory comparison of reinforcement learning [View paper](#)
- [18] Research on the construction of cheerleading technique evaluation and teaching system integrating deep visual recognition and cognitive feedback mechanism [View paper](#)
- [19] Adding Internal Audio Sensing to Internal Vision Enables Human-Like In-Hand Fabric Recognition with Soft Robotic Fingertips [View paper](#)
- [20] Comparing Apparent Haptic Motion and Funneling for the Perception of Tactile Animation Illusions On a Circular Tactile Display [View paper](#)
- [21] Audio-Based Roughness Sensing and Tactile Feedback for Haptic Perception in Telepresence [View paper](#)
- [22] Efficient tactile simulation with differentiability for robotic manipulation [View paper](#)
- [23] From skin mechanics to tactile neural coding: Predicting afferent neural dynamics during active touch and perception [View paper](#)
- [24] Multiplexing intensity and frequency sensations for artificial touch by modulating temporal features of electrical pulse trains [View paper](#)
- [25] Estimating time-varying delays and parametric uncertainties in teleoperated robots [View paper](#)
- [26] A wearable tactile sensor array for large area remote vibration sensing in the hand [View paper](#)
- [27] Audiotactile interactions in temporal perception [View paper](#)
- [28] Drift-free latent space representation for soft strain sensors [View paper](#)
- [29] Idiosyncratic selection of active touch for shape perception [View paper](#)
- [30] GTac-hand: A robotic hand with integrated tactile sensing and extrinsic contact sensing capabilities [View paper](#)
- [31] TransForce: Transferable Force Prediction for Vision-Based Tactile Sensors with Sequential Image Translation [View paper](#)
- [32] Disentangling sensory precision and prior expectation of change in autism during tactile discrimination [View paper](#)
- [33] Tactile MNIST: Benchmarking Active Tactile Perception [View paper](#)
- [34] Tactile-rl for insertion: Generalization to objects of unknown geometry [View paper](#)
- [35] Bridging vision and touch: advancing robotic interaction prediction with self-supervised multimodal learning [View paper](#)
- [36] Multitask touch gesture and emotion recognition using multiscale spatiotemporal convolutions with attention mechanism [View paper](#)
- [37] Tactual perception [View paper](#)
- [38] Anisotropy in tactile time perception [View paper](#)
- [39] The development of audiotactile temporal perception [View paper](#)
- [40] Learning Variable Impedance Control for Aerial Sliding on Uneven Heterogeneous Surfaces by Proprioceptive and Tactile Sensing [View paper](#)
- [41] Auditory clicks elicit equivalent temporal frequency perception to tactile pulses: A cross-modal psychophysical study [View paper](#)
- [42] Postural representations of the hand in the primate sensorimotor cortex [View paper](#)
- [43] VT-VT: a slip detection model for transformer-based visual-tactile fusion [View paper](#)
- [44] Perceiving Synchrony: Determining Thermal-Tactile Simultaneity Windows [View paper](#)
- [45] Bio-Inspired spiking tactile sensing system for robust texture recognition across varying scanning speeds in passive touch. [View paper](#)
- [46] Spatial Learning by Using Non-Visual Geometry and a Visual 3D Landmark in Zebrafish (*Danio rerio*) [View paper](#)
- [47] Deepxpalm: Tilt and position rendering using palm-worn haptic display and cnn-based tactile pattern recognition [View paper](#)
- [48] Transferable Tactile Transformers for Representation Learning Across Diverse Sensors and Tasks [View paper](#)
- [49] Touch-stroke dynamics authentication using temporal regression forest [View paper](#)
- [50] SpikeTouch: Optimizing Spike Neural Networks for Tactile Perception [View paper](#)
- [51] Reassemble: A multimodal dataset for contact-rich robotic assembly and disassembly [View paper](#)
- [52] Emotion recognition using affective touch: A survey [View paper](#)
- [53] Haptic codecs for the tactile internet [View paper](#)
- [54] Deep multi-model fusion network based real object tactile understanding from haptic data [View paper](#)
- [55] CoMPAS3D: complex multi-level person-interaction annotated salsa dataset [View paper](#)
- [56] Fabric surface characterization: Assessment of deep learning-based texture representations using a challenging dataset [View paper](#)
- [57] Snake Robot with Tactile Perception Navigates on Large-scale Challenging Terrain [View paper](#)
- [58] Multi-Scale Voting System for Robotic Tactile Texture Recognition on Uneven Surfaces [View paper](#)
- [59] Spatiotemporal Organization of Touch Information in Tactile Neuron Population Responses [View paper](#)
- [60] CATCH-FORM-ACter: Compliance-Aware Tactile Control and Hybrid Deformation Regulation-Based Action Transformer for Viscoelastic Object Manipulation [View paper](#)
- [61] An Adaptive Grasping Force Tracking Strategy for Nonlinear and Time-Varying Object Behaviors [View paper](#)
- [62] Deformable Object Manipulation with a Tactile Reactive Gripper [View paper](#)
- [63] Robotic tactile sensing: technologies and system [View paper](#)
- [64] Identifying 3-D spatiotemporal skin deformation cues evoked in interacting with compliant elastic surfaces [View paper](#)
- [65] Time-varying changes in median nerve deformation and position in response to quantified pinch and grip forces. [View paper](#)
- [66] Spatio-temporal deep learning models for tip force estimation during needle insertion. [View paper](#)
- [67] SIMULATING THE TIME-VARYING PARAMETERS OF ROBOTS IN PERFORMING THE COMPLEX SEQUENTIAL TASKS [View paper](#)
- [68] The dynamic response of a tactile sensor [View paper](#)
- [69] Touch and temporal behavior of grand piano actions. [View paper](#)
- [70] Tactile Sensor Integrated Fingertip Capable of Detecting Precise Contact Force for Robotic Grippers [View paper](#)
- [71] Can Vision Feel Touch? Tactile-aware Visual Grasping for Transparent Objects [View paper](#)
- [72] Towards forceful robotic foundation models: a literature survey [View paper](#)
- [73] Development and evaluation of refreshable Braille display and active touch-reading system for digital reading of the visually impaired [View paper](#)
- [74] Capturing forceful interaction with deformable objects using a deep learning-powered stretchable tactile array [View paper](#)

- [75] Multi-sensor data fusion and time series to image encoding for hardness recognition [View paper](#)
- [76] VibroTouch: Active Tactile Sensor for Contact Detection and Force Sensing via Vibrations [View paper](#)
- [77] Tactile Robot Programming: Transferring Task Constraints into Constraint-Based Unified Force-Impedance Control [View paper](#)
- [78] Investigation of Experimental Devices for Finger Active and Passive Tactile Friction Analysis [View paper](#)
- [79] Intrinsic contact sensing and object perception of an adaptive fin-ray gripper integrating compact deflection sensors [View paper](#)