SpikeATac: A Multimodal Tactile Finger with Taxelized Dynamic Sensing for Dexterous Manipulation

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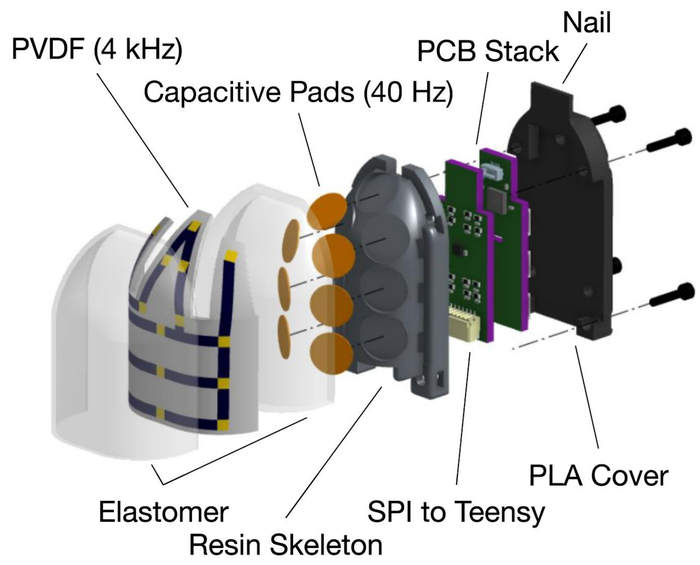
Overview

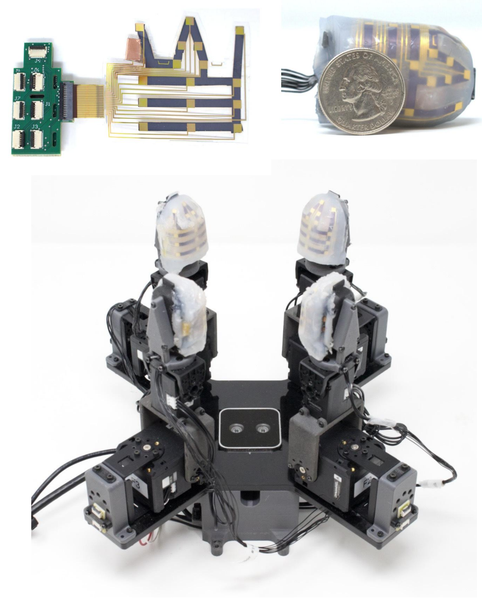
We present SpikeATac, a multimodal tactile finger that combines dynamic and static contact sensing:

- 16 PVDF taxels for *high-frequency* (up to 4 kHz), *dynamic* contact sensing at the finger surface
- 7 capacitive pads for *static pressure information*
- A 3-axis accelerometer embedded within the finger for finger-level *vibration information*

The taxelized PVDF layer provides rich information about the oneset/breaking of contact, extrinsic contacts, and texture. Its distributed, high-frequency design allows the finger to detect contact in any part of its surface—enabling rapid, delicate, and dexterous manipulation.

Hardware Design

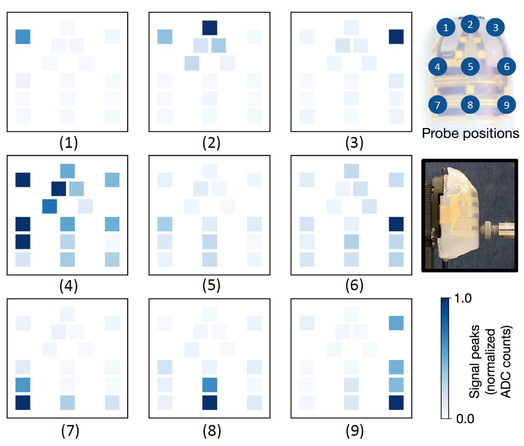




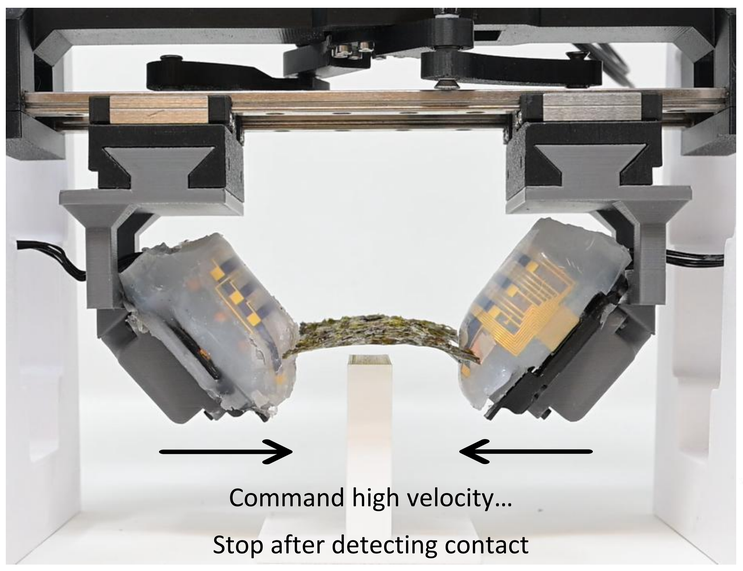
Fast and Delicate Grasping

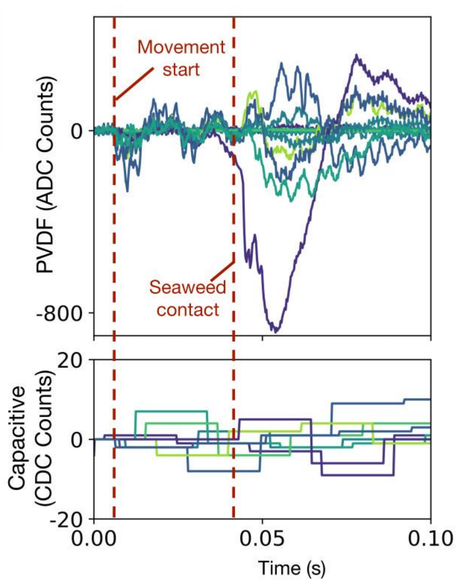
Contact Localization

We visualize PVDF sensor data, by poking different locations on the finger surface

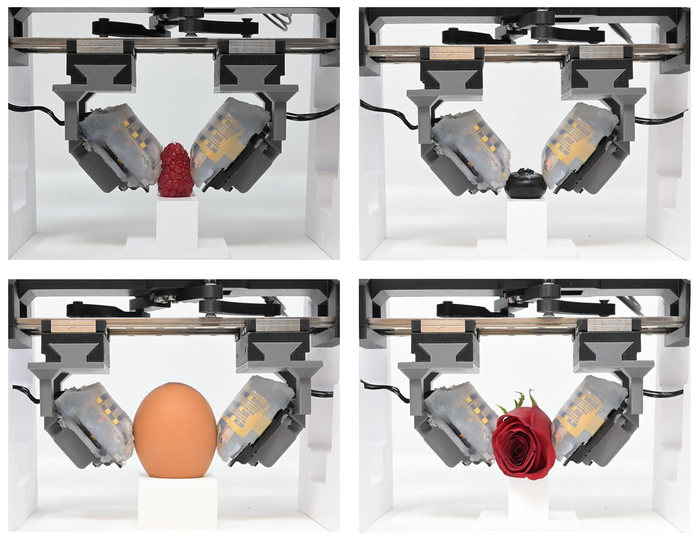


Using PVDF sensors to detect contact and capacitive sensors to apply gentle pressure, we achieve reliable grasping of fragile and deformable objects.





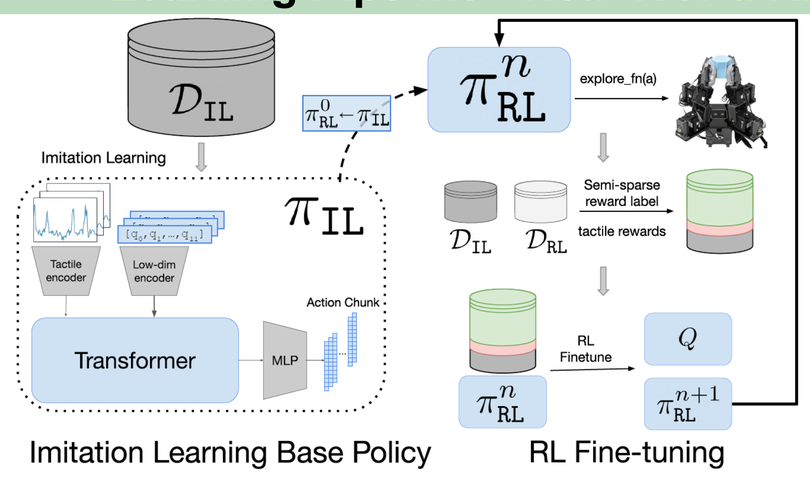
Other Object

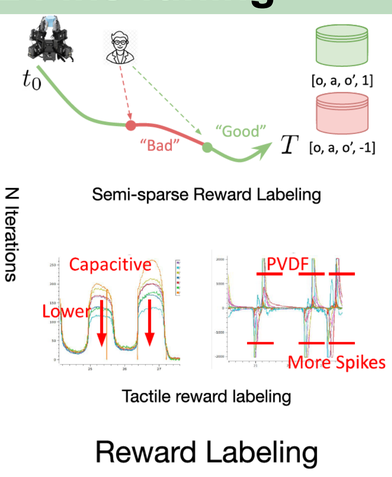


Conclusion: Rapid contact detection from the PVDF sensors enables immediate reaction at touch, while capacitive feedback controls gentle pressure—together achieving fast yet delicate grasping of fragile and deformable objects.

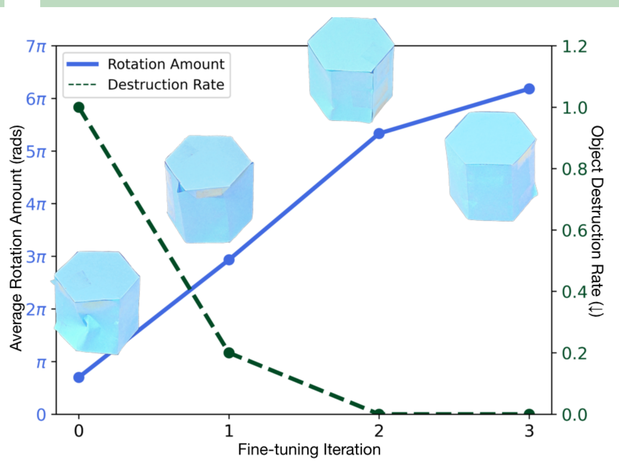
Learning Delicate Object In-hand Rotation via On-Robot RL

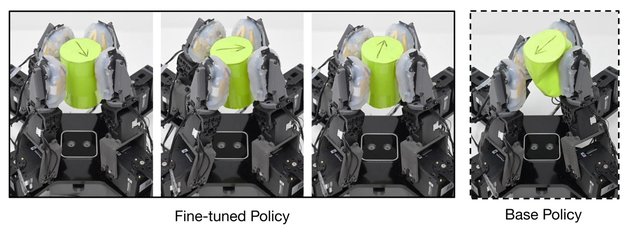
Learning Pipeline - Real World RL Fine-funing





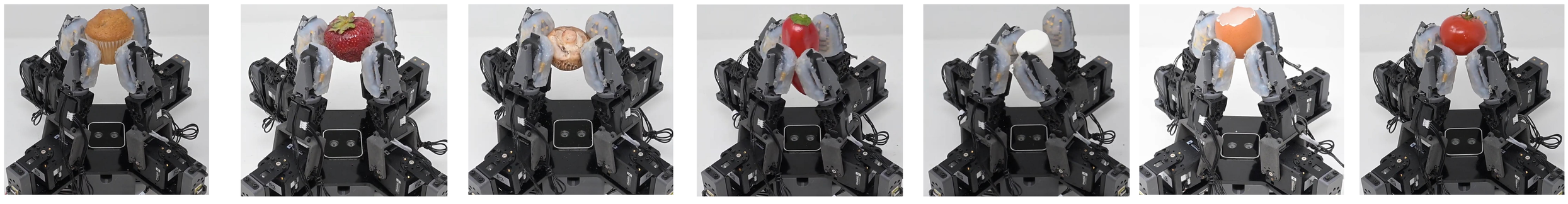
Learning Result





Rollout of the fine-tuned policy at three time points. The base policy $\pi^0_{RL} = \pi_{IL}$ quickly crushes the paper object, while the fine-tuned policy using raw SpikeATac signals is capable of long rollouts without damaging the object.

Rotating Object not in training data



Acknowledgments

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