TactGen: Tactile Sensory Data Generation via Zero-Shot Sim-to-Real Transfer (Abstract Reprint)

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Abstract

Recent advances in machine learning have driven a step-change in robot perception with modalities such as vision, where large amounts of training data are readily available or cheap to collect. However, in tactile perception, the relatively high cost of data collection still largely impedes the adoption of such data-driven learning solutions. In this article, we introduce TactGen, a novel, cross-modal framework to tackle this challenge. In particular, using a two-step data generation pipeline, we leverage easily accessible vision data to synthesise artificial tactile data for downstream classifier training. Specifically, we use readily collected video data of objects of interest to efficiently learn neural radiance field (NeRF) representations. The NeRF models are then used to render redgreenblue-depth (RGBD) images from any desired vantage points. In the second stage, the RGBD images are translated into corresponding tactile images typically generated by camera-based tactile sensors using a conditional generative adversarial network (cGAN). The cGAN model is itself trained with a large set of visuo-tactile images collected in simulation, and can be transferred into the real world without fine-tuning or additional data collection. We extensively validate this approach in the context of tactile object classification, showing that it effectively reduces data collection time by a factor of 20 while achieving similar performance to training a classifier on manually collected real data.

References

Zhong, S.; Albini, A.; Maiolino, P.; and Posner, I. 2025. TactGen: Tactile Sensory Data Generation via Zero-Shot Sim-to-Real Transfer. *IEEE Transactions on Robotics*, 41: 1316–1328.