**Title:** Development of a Biomimetic Multimodal Tactile Perception Model via Spiking Neural Networks for Robot Hand Manipulation

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**Abstract:** It has been challenging to implement an artificial tactile system close to the human perception level. We aim to address this challenge by proposing a biomimetic tactile perception model based on a Spiking Neural Network (SNN), designed to mimic the tactile pathway from fingertip mechanoreceptors to primary somatosensory cortical neurons. The proposed model utilizes a multi-layered SNN architecture, with each layer representing a distinct component of the tactile pathway. The first layer comprises Slowly Adapting-1 (SA-1) and Rapidly Adapting-1 (RA-1) afferent neurons that receive tactile stimuli from mechanoreceptors stochastically. The second layer, representing the cuneate nucleus (CN), integrates and categorizes tactile afferent input. This layer involves lateral inhibition facilitated by central excitatory and peripheral inhibitory connections, enhancing the spatial acuity of tactile information. The final layer, mimicking the primary somatosensory cortex, models the inhibitory receptive fields of cortical neurons, leading to distinct output layers for encoding various properties of stimuli. This stratified configuration allows the SNN to process different tactile information concurrently, thereby improving the efficiency of tactile information processing. We conduct two separate experiments using the proposed model to represent a broad range of static and dynamic tactile stimuli, including pressure, vibration frequency, slip, and shape. Our analysis focuses not only on the classification performance but also on identifying the tactile features recognized by the model's output layer in response to stimuli. The results affirm the model's capacity to effectively emulate the complex nature of biological tactile information processing, demonstrating a comprehensive range of neural representations of diverse tactile features simultaneously, which will advance artificial tactile systems. This advancement holds profound implications for the design and development of future tactile intelligence in robots.