**Title:** Development of a Biomimetic Spiking Neural Network Model for Multidimensional Tactile Perception

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**Abstract**: Implementing an artificial tactile system that approaches the human perception level has proven to be a formidable challenge. This work proposes a biomimetic tactile perception model based on a Spiking Neural Network (SNN) to addresses this challenge. Designed to mimic the tactile pathway from cutaneous mechanoreceptors to S1 cortex, the proposed model utilizes a multi-layered SNN architecture, with each layer representing a distinct component in the tactile pathway. The first layer comprises Slowly Adapting-1 (SA-1) and Rapidly Adapting-1 (RA-1) afferent neurons, which receive tactile stimuli from mechanoreceptors stochastically. The second layer processes the information derived from SA-1 and RA-1 afferents in separate streams, simulating the functions of the cuneate nucleus. This layer follows the neuronal circuit mechanisms intrinsic to the cuneate nucleus, particularly the dynamic interaction between excitatory and inhibitory neurons that facilitates lateral inhibition for minimizing noise accumulation and maintaining the fidelity of spatial information. The final layer, wherein inputs from SA-1 and RA-1 afferents converge, is constructed to emulate the S1 cortex. This layer utilizes a diverse combination of excitatory and inhibitory fields for the encoding of various stimulus properties. The layered organization of the proposed SNN is capable of the processing of multidimensional tactile features, thereby enhancing the efficiency of information processing. In the perceptual dimension of static tactile features, the proposed SNN could distinguish two separate points of pressure stimulation at 3mm or greater. Moreover, the proposed SNN accurately identified a tactile stimulus's direction, ranging from 0 to 170 degrees in 5-degree increments. This was achieved using final layer neurons oriented to 0, 45, 90, and 180 degrees. An SVM decoded the stimulus' orientation, resulting in a 90.1% classification accuracy. In the perceptual dimension of dynamic tactile features, the proposed SNN demonstrated the ability to detect the slip of an object within a time frame of 5 ms. Furthermore, the model could estimate the speed of the object with a resolution of 1 mm/s. Also, the proposed SNN could discriminate vibration frequency of a stimulus in the range from 1 to 100 Hz. These results not only reinforce the proposed model's competency in mimicking biological tactile systems but also provide substantial implications for prospective enhancements in the architecture and functions of tactile intelligence systems.