**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 primary somatosensory cortical neurons, 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 (CN). 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 Slowly Adapting-1 (SA-1) and Rapidly Adapting-1 (RA-1) afferents converge, is constructed to emulate the primary somatosensory 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 a distance of 3mm or greater, displaying a capacity akin to human tactile perception. Moreover,, the proposed SNN demonstrated adeptness in identifying the moving direction of a tactile stimulus ranging from 0 to 180 degrees in increments of 10 degrees, which was accomplished by combination of the neural activity patterns of only four groups of the final layer neurons each having receptive kernels oriented to 0, 45, 90 and 180 degrees, respectively. Decoding a stimulus’ orientation among 18 different angles utilizing a Support Vector Machine (SVM) from the neural activity patterns of the final layer resulted in a classification accuracy of 90.1%. In the perceptual dimension of dynamic tactile features, the proposed SNN could recognize the slip of an object within ??? ms. Also, the proposed SNN could discriminate vibration frequency of a stimulus in the range from ??? to ???. 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.