

## Action Potential of Lateral Geniculate Neurons at Low Threshold Currents: Simulation Study

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**Abstract :** Lateral Geniculate Nucleus (LGN) is the relay center in the visual pathway as it receives most of the input information from retinal ganglion cells (RGC) and sends to visual cortex. Low threshold calcium currents (IT) at the membrane are the unique indicator to characterize this firing functionality of the LGN neurons gained by the RGC input. According to the LGN functional requirements such as functional mapping of RGC to LGN, the morphologies of the LGN neurons were developed. During the neurological disorders like glaucoma, the mapping between RGC and LGN is disconnected and hence stimulating LGN electrically using deep brain electrodes can restore the functionalities of LGN. A computational model was developed for simulating the LGN neurons with three predominant morphologies, each representing different functional mapping of RGC to LGN. The firings of action potentials at LGN neuron due to IT were characterized by varying the stimulation parameters, morphological parameters and orientation. A wide range of stimulation parameters (stimulus amplitude, duration and frequency) represents the various strengths of the electrical stimulation with different morphological parameters (soma size, dendrites size and structure). The orientation (0-1800) of LGN neuron with respect to the stimulating electrode represents the angle at which the extracellular deep brain stimulation towards LGN neuron is performed. A reduced dendrite structure was used in the model using Bush-Sejnowski algorithm to decrease the computational time while conserving its input resistance and total surface area. The major finding is that an input potential of 0.4 V is required to produce the action potential in the LGN neuron which is placed at 100  $\mu\text{m}$  distance from the electrode. From this study, it can be concluded that the neuroprostheses under design would need to consider the capability of inducing at least 0.4V to produce action potentials in LGN.

**Keywords :** Lateral Geniculate Nucleus, visual cortex, finite element, glaucoma, neuroprostheses

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