

## **EXTENDING A LEAKY INTEGRATE AND FIRE MODEL OF THE ELECTRICALLY STIMULATED AUDITORY NERVE FIBER FOR PULSE TRAIN STIMULATION**

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Cochlear implants provide hearing for people suffering from sensorineural deafness by directly stimulating auditory nerve fibers (ANFs). Ideally, the electrical stimulation should evoke a percept that contains the essential information about the auditory scene. However, current stimulation schemes cannot yet achieve this. Computational models of the electrically stimulated ANF could provide a useful tool for the developers, giving them estimates of the peripheral responses that different stimulations evoke.

Here, we present a functional model for the ANF response to biphasic electric pulse sequences able to consider pulse rate and parameters of the biphasic pulse. It is adapted from stochastic leaky integrate-and-fire model by Horne et al. (in review). In that model, the ANF is thought to integrate incoming electrical current and to release an action potential (i.e., to spike) if the cumulative membrane voltage exceeds a stochastic threshold. The latency and jitter of the ANF neuron depend on how greatly the threshold is exceeded. Another underlying assumption is that exceeding the threshold triggers an action potential initiation process and that spiking may only occur after that process has been completed. The spike may still be cancelled if the neuron is hyperpolarized before the initiation process finishes.

We have now extended the model by Horne et al. to simulate the refractory and recovery behavior of the ANF neuron following the approach by Hamacher (PhD thesis, 2003) which dynamically changes the threshold. After a spike, the next action potential may be released only when an absolute refractory period has passed. Further, the gradual recovery of the neuron is simulated with a relative refractory period, during which the threshold is first increased and then gradually restored to the original level.

We show that the model is capable of reproducing ANF response statistics from previous studies. The extended model can account for various pulse train stimulations while preserving the ability of the original model to reproduce physiological data from single pulse stimulations. For instance, the model output reflects the relationship between the pulse rate and the neuron's firing pattern and efficiency. The model output is also in accordance with psychoacoustical data on how polarity orders of two consecutive biphasic pulses and their inter-pulse interval affect the threshold for the latter pulse. Limitations of the model are also identified and discussed.

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