Distributed Control of Axonal Conduction: a Proposal

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Abstract

In this note, the authors propose to investigate stimulation and external control of an axon so as to ameliorate its information-bearing capacity, degraded due to demyelination. The problem is broken down into three steps.

Control theory enables the guidance and modulation of trajectories of machines and other objects. Axons are neural processes which carry information to distant brain cells. If we could apply control signals to an axon, what stimulation on a tract would improve communication capacity? To pursue this investigation the following three step program is recommended:

1. Find the capacity of a healthy tract. Steps in this direction were taken by Abeles [1] as well as the author and others in [2].

2. Find the capacity of a demyelinated tract. Initial simulations of demyelination were carried out and reported by the author and others in [3].

3. Introduce control variables at strategic locations along the axon, and study the impact of control on the capacity.

Extending the single axon case to multiple interlinked axons can be considered next [4, 5, 6]. If multiple input locations along an axon are considered for control purposes, it can lead to a distributed control problem [7]. This would be a novel integration of control, communication and neuroscientific theories with implications for implantable neurological interventions and neuroprostheses. As a warning, the parameter space in an axon is large and parameters are many and therefore judicious parameter selection for modeling becomes imperative.

References

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