Time-Slotted Transmission over Molecular Timing Channels[☆]

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Abstract

This work studies time-slotted communication over molecular timing (MT) channels. The transmitter, assumed to be perfectly synchronized in time with the receiver, is required to send K bits to the receiver using K information particles. It *releases a single information particle in each time-slot*, where the information is encoded in the *time of release*. The receiver decodes the transmitted information based on the *random* time of arrivals of the information particles during a *finite-time* observation window. The maximum-likelihood (ML) detector is derived in terms of the permanent of a matrix involving the arrival times, and shown to to have an exponential computational complexity, thus, rendering it impractical. Therefore, two additional (practical) detectors are presented: The first is a symbol-by-symbol detector. The second is a sequence detector which is based on the Viterbi algorithm (VA), yet, the VA is used differently than in its common application in electromagnetic communications where the channels are linear. Numerical simulations indicate that the proposed sequence detection algorithm significantly improves the performance compared to the symbol-by-symbol detector. For a short number of transmitted symbols, the numerical results indicate that the performance of the proposed sequence detector closely approaches the performance of the highly complicated ML detector. Finally, the proposed sequence detector is numerically compared with a one-shot transmission scheme that releases all K particles simultaneously to send a single symbol out of a constellation of size 2^K. It is shown that while for a small number of bits the one-shot scheme is better, when the number of bits is medium to large, the sequence detector achieves significantly better performance.

Keywords: Time-slotted communication, Molecular communications, Timing channels, Maximum likelihood detection, Viterbi algorithm, Permanent

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