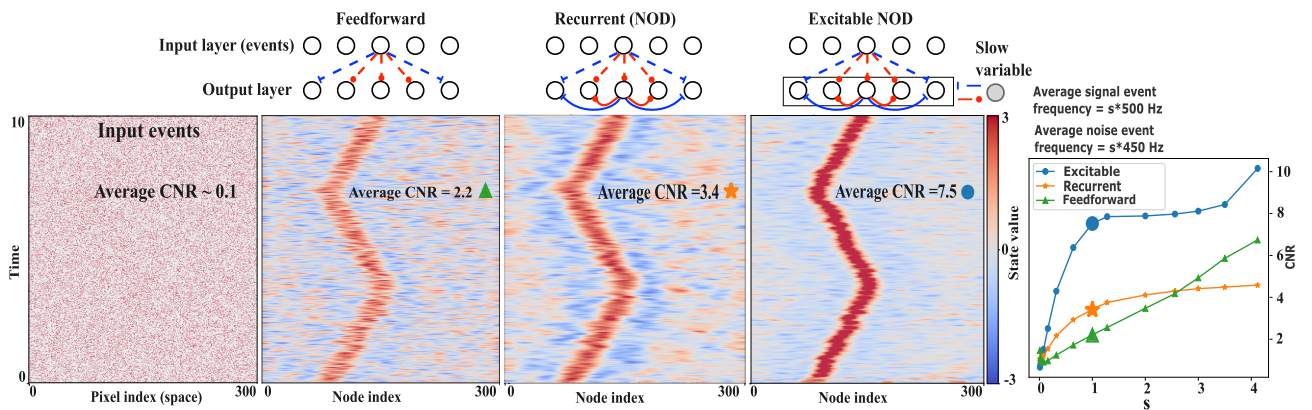


Spatiotemporal Excitability Strongly Improves Event-Based Signal Contrast

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Event-based camera have become increasingly popular thanks to their high dynamic range and temporal resolution, paving the way to efficient machine vision in very adverse condition [1]. The sensitivity of event-based camera comes at the price of of generating large quantity of noise- or ego-motion driven visual events, to the point discerning signal from noise and background in the millions of events generated per second has become a research question on its own [2]. Here we show that the noise-reducing, contrast-enhancing properties of spatiotemporal event filtering based on center-surround architectures can be improved manyfold by making the filter excitable. The resulting nonlinear filter has the structure of a nonlinear opinion dynamics (NOD) [3] with center-surround feedforward and recurrent network interactions augmented with slow negative feedback on its attention parameter. Opinion state is large where a signal is detected. Recurrent interactions create positive feedback and bifurcations to excited opinion states. Slow negative feedback resets the decision to the neutral state, effectively generating an excitable opinion spike. We stress that the excitable model is *not* a spiking neural network. Rather, it is equivalent to a local-excitation lateral-inhibition neural field with a global adaptation variable. The performance of feedforward, recurrent (NOD), and excitable NOD filtering are shown in the next figure for a 1D event-based sensor. In the figure, CNR = Contrast to Noise Ratio.



The input event stream is mostly noise but also contains an imperceptible signal, e.g., an object moving in front of an event camera in extremely low luminosity conditions. When the sizes of the center-surround kernel are well matched to the characteristic spatial scale, e.g, the object size, of the signal, all filtering schemes manage to amplify its CNR. This improvement in the detectability of the signal is particularly dramatic for the excitable filter and particularly at low event-frequency ($s = 1$). Furthermore, the excitable filter performance is more insensitive to event frequency by rapidly reaching, as s increases, a relatively large region ($1 \lesssim s \lesssim 3.5$) where the obtained CNR amplification is not affected by event-rate. We suggest that the dynamic threshold of the excitable model is the key determinant of the superior and robust performance of the excitable filter. As in simple spiking models, this threshold is modulable, which enables the tunability of the filter to changing context.

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