Spike-timing Based Image Processing: Can we Reproduce Biological Vision in Hardware

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Abstract. In here I present a review of research and technologies using asynchronous spike-based processing strategies as can be observed in biological vision. The research presented includes a general description of the issue [1], the presentation of a silicon retina [2] and a silicon cochlea []. while the common approach to immitate neural networks is simulation on conventional hardware as CPU's and GPU's this review is rather focussed on the efforts being made to reproduce the property of neural structures to work vastly parallel. in special this review will look at the fact that the biological vision system is able to compute relevant information wiith just one spike per neuron, due to the relative timing of spikes.

1 Biological Vision and its spike-timing-based component

The speed of biological vision poses a problem for conventional views of how information is processed in the brain. As wil be demonstrated, the notion of spike-frequency encoding of information contradicts the speed at which neurons at the highest level of the primate vision system can respond selectively to complex stimuli such as faces. Studies have shown that such processes can be accomplished in as much as 100ms, which combined with the fact, that cortical neurons seldomly show fire faster than every 10 ms and that there are about 10 stages of neurons involved between the photo receptors and the high level neurons, leads to the conclusion that each neuron has in average only time to fire once. It is therefore proposed, that rather than the information being only encoded in firing frequencies corresponding to analog values, the relative timing of the spikes is also used to encode such information.[3][4][5] This idea has been demonstrated experimentally using recordings from the salamander retina[6]. It is showed by simulation, that it is possible to do state of the art face recognition using an approach, where every neuron is only allowed to fire at most once. [1]

2 memristive devices

References

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