Integrated Technical Cognition Systems
- An Engineering Perspective on Methods, Design, and Applications

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Abstract: Mimicking and even surpassing the information processing capability of natural beings has been the ambition of generations of engineers. Remarkable achievements from pattern recognition to artificial intelligence systems, employing cues of nature, as, e.g., hierarchical information processing, learning, and adaptation principles, can be noted in the wake of the technological evolution, which seems to culminate in the current 'hype' of deep-learning neural networks and their hardware implementation by massively parallel digital processor arrays, e.g., graphics adapters or dedicated chips as IBM's TrueNorth chip & system. These and other powerful computer implementations base on the growth predicted by Moore's law and gave the leverage to realize capable embedded intelligence systems. The ongoing merging of MEMS and micro/nanoelectronics will allow the realization of deeply-embedded/integrated intelligent systems of unprecendented capabilities. However, the main stream of activities in this field seems to have neglected the fact, that Moore's law and related main stream technologies face severe limitations, including degrading device reliability, which render the achieving of dependable and reliable integrated application systems more and more difficult. This encourages the revisiting of natural principles from general Self-X concepts to findings in the lower levels of the information processing, i.e., neural information coding and adaptive spiking neuron models and robust structures for information processing, as commonly also pursued in the context of brain research. In this talk, one particular exemplary approach of our corresponding engineering activities will be presented, that jointly employs bio-inspiration and neuromorphic approaches on the level of sensory signal acquisition, conditioning, and to-digital-conversion by spiking neuron ensembles and their integrated, semi-automatically designed, electronic implementation, which provides a first stepping stone in our research towards the realization of future robust integrated technical cognition systems.