“Eyes” in Sensor Networks

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Biological sensory organs operate at performance levels set by fundamental physical limits, under severe constraints of size, weight and energy resources; same constraints that sensor network devices have to meet. Eyes are specialized sensory structures in biological systems that are employed to *extract information* from the intensity, polarization and spectral content of the light that is reflected or emitted by objects in the natural environments. Reliable and timely answers to the questions: “Is there anything out there?”, “where is it?” and eventually “what is it?” is the goal of processing that follows the photoreceptor mosaics. This is in contrast to CCD or CMOS video and still cameras that have been developed for the precise measurement of the spatial-temporal light intensity and color distribution, often within a fixed time interval, for accurate *communication and reproduction* in electronic or printed media.

In this talk, I discuss bio-inspired image sensor architectures that employ local processing for data reduction and information extraction. I begin with processing at the photon level to extract polarization information at each pixel. I then introduce circuits for analog local pre-processing for spatial and temporal filtering and gain control, addressing issues of noise and device mismatch. I then examine the power/rate/latency tradeoffs of synchronous and asynchronous schemes for accessing the pixel data in the 2D arrays. Anisochronous pulse time modulation and address event representation encoding and processing of data in distributed architectures, is an attractive alternative to traditional synchronous digital signal processing.

Andreas G. Andreou received his Ph.D. in electrical engineering and computer science in 1986 from Johns Hopkins University. Between 1986 and 1989 he held post-doctoral fellow and associate research scientist positions in the electrical and computer engineering department while also a member of the professional staff at the Johns Hopkins Applied Physics Laboratory. Andreou became an assistant professor of electrical and computer engineering in 1989, associate professor in 1993 and professor in 1996. He now holds appointments in computer science and in the Whitaker Biomedical Institute. He is the co-founder of the Johns Hopkins University Center for Language and Speech Processing. In 1996 and 1997 he was a visiting professor of the computation and neural systems program at the California Institute of Technology. In 1989 and 1991 he was awarded the R.W. Hart Prize for his work on mixed analog/digital integrated circuits for space applications. He is the recipient of the 1995 and 1997 Myril B. Reed Best Paper Award and the 2000 IEEE Circuits and Systems Society, Darlington Award. During the summer of 2001 he was a visiting professor in the department of systems engineering and machine intelligence at Tohoku University Andreou's research interests include sensors, micropower electronics, heterogeneous microsystems, and information processing in biological systems. He is a co-editor of the IEEE Press book: *Low-Voltage/Low-Power Integrated Circuits and Systems,* 1998 (translated in Japanese) and the Kluwer Academic Publishers book: *Adaptive Resonance* Theory Microchips, 1998.