Accepted paper with abstract, SoCG'09

Sandor Fekete, Dietmar Fey, Marcus Komann, Alexander Kroeller, Marc Reichenbach and Christiane Schmidt

Distributed Vision with Smart Pixels

We study a problem related to computer vision: How can a field of sensors compute higher-level properties of observed objects deterministically in sublinear time, without accessing a central authority? This issue is not only important for real-time processing of images, but lies at the very heart of understanding how a brain may be able to function.

In particular, we consider a quadratic field of n "smart pixels" on a video chip that observe a B/W image. Each pixel can exchange low-level information with its immediate neighbors. We show that it is possible to compute the centers of gravity along with a principal component analysis of all connected components of the black grid graph in time $O(\sqrt{n})$, by developing appropriate distributed protocols that are modeled after sweepline methods.

Our method is not only interesting from a philosophical and theoretical point of view, it is also useful for actual applications for controling a robot arm that has to seize objects on a moving belt. We describe details of an implementation on an FPGA; the code has also been turned into a hardware design for an application-specific integrated circuit (ASIC).