

Call for Papers: Spatial Computing special issue of ACM TAAS

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Submission Deadline: August 1st, 2009

Many self-organizing or self-adaptive systems are “spatial computers”—collections of local computational devices distributed through a physical space, in which:

- the difficulty of moving information between any two devices is strongly dependent on the distance between them, and
- the “functional goals” of the system are generally defined in terms of the system’s spatial structure.

Systems that can be viewed as spatial computers are abundant, both natural and man-made. For example, in wireless sensor networks and animal or robot swarms, inter-agent communication network topologies are determined by the distance between devices, while the agent collectives as a whole solve spatially-defined problems like “analyze and react to spatial temperature variance” or “surround and destroy an enemy.” Similarly, in reconfigurable microchip platforms, moving data between adjacent logic blocks is much faster than moving it across the chip, which in turn favors problems with spatial structure like stream processing. In biological embryos, each developing cell’s behavior is controlled only by its local chemical and physical environment, but the eventual structure of the organism is a global property of the cellular arrangement. Moreover, a variety of successful established techniques for self-organization and self-adaptation arise from explicitly spatial metaphors, e.g., self-healing gradients.

On the other hand, not all spatially distributed systems are spatial computers. The Internet and peer-to-peer overlay networks may not in general best be considered as spatial computers, both because their communication graphs have little relation to the Euclidean geometry in which the participating devices are embedded, and because most applications for them are explicitly defined independent of network structure. Spatial computers, in contrast, tend to have more structure, with specific constraints and capabilities that can be used in the design and analysis of algorithms.

Spatial computing has recently been investigated at a number of meetings and workshops, namely Computing Media and Languages for Space-Oriented Computation (Dagstuhl, 2006), French Workshop on Amorphous Computing (Paris, 2007), From Amorphous to Spatial Computing Workshop (Paris, 2008), and Spatial Computing Workshop at IEEE SASO (Venice, 2008). The goal of this special issue is to investigate the idea of “spatial computing” as systems exhibiting emergent and adaptive behavior in order to develop the study of spatial computation as a subject in its own right. We believe that an in-depth treatment of common principles, techniques, and research directions - consolidating the substantial progress that is currently being made - will benefit all of the fields in which spatial computing takes place. As the impact of spatial computing is recognized in many areas, we hope to set up well-founded frameworks to ensure portability and cross-fertilization between solutions in the various domains.

We are soliciting submissions on any aspect of spatial computing. Examples of topics of interest include, but are by no means limited to:

- Languages for programming spatial computers and describing spatial tasks and patterns
- Methods for compiling global programs to local rules that produce the desired global effect
- Characterization of spatial self-organization phenomena as algorithmic building blocks
- Characterization of error in spatial computers (e.g., error from approximating continuous space with networks of devices)
- Analysis of tradeoffs between system parameters (e.g., communication radius vs. device memory consumption)
- Studies of the relationship between time, propagation of information through the spatial computer, and computational complexity
- Application of spatial computing principles to novel areas, or generalization of area-specific techniques
- Device motion in spatial computing algorithms (e.g. the relationship between robot speed and gradient accuracy in multi-robot swarms)

For more information on spatial computing, see: <http://www.spatial-computing.org>

Submission: Submitted papers must be written in English and describe original research not published nor currently under review by other journals or conferences. Parallel submissions will not be accepted. If an earlier version of the manuscript was published/accepted in conferences, authors should state so in the cover letter. The manuscript must be a substantial extension to the previously published/accepted work and a summary of changes and a copy of the previous conference paper must be submitted together with the submission to the special issue. Manuscripts should be formatted according to the ACM TAAS guidelines available from the journal homepage (<http://taas.acm.org/>) and submitted to the guest editors through email to spatial-computing-submissions@spatial-computing.org

