

Synchronization in Cellular Automata

Hiroshi Umeo

University of Osaka Electro-Communication,
Neyagawa-shi, Hastu-cho, 18-8, Osaka, 572-8530, Japan
umeo@cyt.osakac.ac.jp

Keywords. Cellular automaton; firing squad synchronization problem.

Synchronization of large-scale networks is an important and fundamental computing primitive in parallel and distributed systems. We study a synchronization problem that gives a finite-state protocol for synchronizing cellular automata. The synchronization in cellular automata has been known as firing squad synchronization problem: FSSP, in which it was originally proposed by J. Myhill in the book edited by Moore [1964] to synchronize all/some parts of self-reproducing cellular automata. The problem has been studied extensively for more than fifty years [1–2]. It is defined as follows: Given a one-dimensional array of n identical cellular automata, including a *general* at one end that is activated at time $t = 0$, we want to design the automata such that, *at some future time*, all the cells will *simultaneously* and, *for the first time*, enter a special *firing* state. The problem has been referred to as achieving a *macro-synchronization* in *micro-synchronization* system and *realizing a global synchronization using only local information exchange*. In this paper, we present a survey on recent advances in designing optimum- and non-optimum-time synchronization algorithms and their implementations for cellular arrays. Several simple, state-efficient mapping schemes are proposed for embedding 1D FSSP algorithms onto 2D, 3D and multi-dimensional arrays.

References

- [1] Moore E. F. (1964) The firing squad synchronization problem. In *Sequential Machines, Selected Papers* (ed. by Moore E. F.), Addison-Wesley, Reading (MA), pp. 213–214.
- [2] Umeo H. (2009) Firing squad synchronization problem in cellular automata. In *Encyclopedia of Complexity and System Science* (ed. by Meyers R. A.), Springer, Vol. 4, pp. 3537–3574.