Workshop on Cellular and Distributed Computing

29th November 2017, Osaka

Program (tentative)

Morning session chair: **Hiroshi Umeo**

11:00 – 11:50 **Katsunobu Imai** (Hiroshima, Japan)

Homogeneous signal propagations of cellular automata on some quasi-periodic tilings

12:00 – 13:10 **Lunch**

Afternoon session 1 chair: **Ferdinand Peper**

13:10 – 13:50 **GEORGIOS CH. SIRAKOULIS** (Xanthi, Greece)

A Memristor Based Architecture for Cellular Automata and Computing

13:50 - 14:30 **Susumu Adachi** (Hyogo, Japan)

Search for Cellular Automata Rule by Using Duration Distribution

14:30 – 15:10 **Fukuhito Ooshita (Nara, Japan)**

Self-Stabilizing Rendezvous of Synchronous Mobile Agents in Graphs

15:10 – 15:30 **Break**

Afternoon session 2 chair: **Fukuhito Ooshita (Nara, Japan)**

15:30 – 16:10 **Teijiro Isokawa** (Hyogo, Japan)

Computational Universality on Brownian Cellular Automaton with Three States and Two Rules

16:10 – 16:50 **Ferdinand Peper** (Hyogo, Japan)

On Neuromorphic Sensor Networks

17:00 **Closing**

Venue: Univ. of Osaka Electro-Communication, Neyagawa-Campus,
J608 (a room in J Building, 10-15 minutes walk from Station Neyagawa-shi, Keihan Line)

Organizer: **SICE Special Research Group Hypercomputics**
and
Institute of Informatics (Univ. of Osaka Electro-Communication)

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Katsunobu Imai (Hiroshima, Japan)

Homogeneous signal propagations of cellular automata on some quasi-periodic tilings

Signal propagation of cellular automata working on a tiling rely on its homogeneity. We introduced corona limit which naturally visualizes the growth pattern of signal propagation. We calculated the corona limits of 1-regular and 2-regular tilings. We found their corona limit has a variety of shapes of point symmetric convex polygons and they are not so homogeneous in the viewpoint of signal propagation. In this talk, we show some quasi-periodic tilings have more homogeneous properties than the periodic tiling.

GEORGIOS CH. SIRAKOULIS (Xanthi, Greece)

A Memristor Based Architecture for Cellular Automata and Computing

Owing to the dimensional scaling of CMOS technology approaching fundamental physical limits, several new devices and beyond von Neumann computing architectures are being actively explored in an attempt to sustain the IC performance increase. In this context, Cellular Automata (CAs), constitute a powerful, inherently parallel computational model, leading to scalable hardware (HW) architectures consisting of relatively simple, identical, and locally interconnected cells. Moreover, the CA approach is consistent with the modern notion of unified space (memory)-time (processing); in CA HW implementation, memory and processing are inseparably related to the same unit, i.e. CA cell. On the other hand, two-terminal resistive switching devices (memristors) show great promise to be used for in-memory computing where information storage and processing occur in the same device. Since the early discovery of the Hewlett Packard's (HP) version of the Titanium Dioxide (TiO2) substrate memristor, which is considered a generalized memristor device, a lot of research has focused on the properties of these devices. Furthermore, the favorable circuit properties of memristors justify the recent explosive growth of related research efforts which led to several advancements in theory and potential unique applications of memristors including, among others, computing. In this talk taking also inspiration by the pioneering works of L. Chua we will discuss simulations of CAs in networks of memristors. In particular, we deal with the foundations of memristor theory and the fundamental properties of memristors, we describe threshold-type SPICE-compatible device models, on which we based the presented simulations and the research findings and finally, we focus on complex memristor interconnections and

address design strategies for digital logic circuits with memristors, passing from sequential stateful logic to circuit design schemes which allow for parallel processing of the applied inputs. Having all these in mind, we introduce crossbar-based information storage systems, we integrate memristive multi-state switches with the crossbar circuit geometry in a multi-level memristor-based crossbar memory and we finally process with CAs based memristor arrays for the famous shortest path planning problem but also other well-known np-complete problems from computer science like bin packing problem, knapsack problem, and max-clique problem.

Susumu Adachi (Hyogo, Japan)

Search for Cellular Automata Rule by Using Duration Distribution

We would like to discuss duration distributions which is the distribution of time intervals between state changes of a cell. Our suggestion is that the system has long time correlation if its duration distribution exhibits a power law, and in this case, the power spectrum of the system has 1/f fluctuation. The goal is to obtain the rule that the cellular automata exhibit Class-IV behavior, like the Game of Life. The method is obtaining the duration distribution and calculating the exponent which is the difference between its distribution and the power law. The models are 2-d Moore neighborhood outer-totalistic cellular automata. The results are also shown for these models.

Fukuhito Ooshita (Nara, Japan)

Self-Stabilizing Rendezvous of Synchronous Mobile Agents in Graphs

A mobile agent is a software program that can autonomously move from a node to a node in a network. We investigate self-stabilizing rendezvous algorithms for two synchronous mobile agents. That is, our goal is to make two mobile agents meet at a single node, starting from arbitrary initial locations and arbitrary initial states. In this talk, I explain some self-stabilizing rendezvous algorithms for graphs.

Teijiro Isokawa (Hyogo, Japan)

Computational Universality on Brownian Cellular Automaton with Three States and Two Rules

This paper presents a three-state asynchronous cellular automaton that requires merely two transition rules to achieve computational universality. This universality is achieved by implementing Priese's delay-insensitive circuit elements on the cell space of a so-called Brownian cellular automaton, which is an asynchronous cellular automaton with local configurations performing a random walk in the circuit topology.

Ferdinand Peper (Hyogo, Japan)

On Neuromorphic Sensor Networks

A sensor network architecture will be presented that uses impulses for communication. This type of signalling facilitates extremely low power consumption, which potentially allows sensor nodes to operate on energy harvested from the environment. As a result, sensor nodes can be made much smaller and cheaper than usual, resulting in a wide variety of new applications that become possible. Possible implementations of the sensor networks in terms of neuromorphic hardware will be discussed.