8th International Workshop on Natural Computing

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Program; 8th IWNC, 18-19 March 2014

Day 1, 18 March

12:45-13:00  Opening

Physics and Bio-Inspired
13:00-13:30  Ayano Yoshida and Shigeru Sakurazawa
Reality of Entrainment Phenomena of Firefly Robots

13:30-14:00  Teturo Itami
Brownian motion applied to macroscopic group robots without mutual communication

14:00-14:30  Erika Shoji, Akane Kawaharada, Hiraku Nishimori, Akinori Awazu,
Shunsuke Izumi, and Makoto Iima
Complex patterns, localized structures, and emanated cellular automata in bioconvection of Euglena gracilis

14:30-15:00  Masataka Iinuma
Measurements of negative joint probabilities in optical quantum system

15:00-15:30  break

Cellular Automata
15:30-16:00  Yasusi Kanada
FDM 3D-printing as Asynchronous Cellular Automata

16:00-16:30  Katsunobu Imai, Hisamichi Ishizaka
On the behaviors of small state rotation-symmetric number-conserving cellular automata

16:30-17:00  Masami Hagiya, Shaoyu Wang, Ibuki Kawamata, Satoshi Murata,
Teijiro Isokawa, Ferdinand Peper, Katsunobu Imai
Invitation to Cellular Automata

18:30- Workshop dinner
Day 2, 19 March

Distributed Systems and Robotics
10:00-10:30  Akihiro Ueyama, Teijiro Isokawa, Haruhiko Nishimura, and Nobuyuki Matsui
*A Comparison of Grouping Behaviors on Rule-based and Learning-based Multi-agent Systems*

10:30-11:00  Kazuhiro Ohkura, Toshiyuki Yasuda and Yoshiyuki Matsumura
*Extracting functional subgroups from an evolutionary robotic swarm by identifying the community structure*

11:00-11:30  Ferdinand Peper, Naoki Wakamiya, Akiifumi Kasamatsu, Shukichi Tanaka, Kenji Leibnitz, Junnosuke Teramae, Tetsuya Shimokawa, Kenichi Takizawa, Akira Otomo
*Concepts for Spiking Wireless Sensor Networks*

11:30-13:00  lunch

Computational Aesthetics and Art
13:00-13:30  Miki Goan, Katsuyoshi Tsujita, Susumu Kihara, & Kenjiro Okazaki
*Drawing as the relative movement between subject and medium*

13:30-14:00  Tatsuo Unemi
*A daily automated evolutionary production of abstract animations*

14:00-14:30  break

Computational Aesthetics
14:30-15:00  Yasuhiro Suzuki
*Tactile Score, a language of describing thinking in our mind from computational aesthetics view*

15:00-15:30  Fuminori Akiba
*Tactile Score: What kind of prescription is it?*

15:30-16:00  Tomohiro Suzuki and Yasuhiro Suzuki
*Computational Aesthetics via Evolutional Computation*

Closing
Entrainment phenomena among nonlinear self-oscillatory systems occur widely in nature. Especially for the biological systems, each substance entrains with others to maintain the structure of our body. The repeated cyclic interaction for conservation of energy in such nonlinear self-oscillatory systems might be one of example of natural computation. In this study, a firefly robot inspired by synchronized flashing of fireflies was designed as one of the example of entrainment interaction. The firefly robot has the blinker light which is controlled by van der Pol equation and synchronizes with the other firefly’s blinker light each other by their entrainment phenomenon. Other than van der Pol equation, various possible algorithms to leads into the synchronized state exist. To investigate the most intimate entrainment phenomenon, some synchronization processes of firefly robots simulated in PC were presented to subjects. The result showed that the synchronization process by van der Pol equation was most intimate one. Usage of the entrainment phenomena is very efficient for intimate interaction between human and Robot.
Brownian motion applied to macroscopic group robots without mutual communication

Teturo Itami
Hiroshima International University

Abstract:
Microscopic Brownian motion is applied to macroscopic transportation systems by group of robots. We feature systems with neither mutual communication among robots nor apparatuses to sense objects to be transported, obstacles, surrounding walls, etc. We develop continuum mechanical picture of group robots that can incorporate energy dissipation of robots under assumption that frictional force on each robot is proportional to velocity. We take "temperature" as a key parameter that describes the system. We show an ordinary time-differential equation to determine development of the temperature in time. After that we give a formula of force acted on the object. Simulation studies are done and we examine comparison of our results based on continuum picture of robots with those by Newtonian mechanics for robots and objects. The results in this article have close relation with those in Cybernetics and Physics Vol.1, No.4, 2012, 258-265 by the author.
Complex patterns, localized structures, and emanated cellular automata in bioconvection of Euglena gracilis

Erika Shoji, Akane Kawaharada, Hiraku Nishimori, Akinori Awazu, Shunsuke Izumi, and Makoto Iima

Abstract:
We study the pattern formation of bioconvection in a suspension of Euglena gracilis in an annular container. E. gracilis is a microorganism with phototaxis; under strong light intensity (>200 W/m²), it escapes from the light source. When the suspension is illuminated from the bottom, a large-scale spatio-temporal pattern is generated as a result of an interaction between E. gracilis and surrounding flow. This system is peculiar because localized convection patterns as well as complex spatio-temporal patterns have been reported. However, the detailed formation process of these patterns has not been analyzed. Part of the reason is that the pattern is distributed within a two-dimensional domain. Further, the boundary of the container blocks moving patterns, which is a barrier for detailed measurements. To overcome this problem, we prepared an annular container of 5mm radial width, which is approximately the same size as a single convection cell. This annular container enables us to achieve periodic boundary condition in the azimuthal direction. We will report various spatio-temporal patterns and dynamics of the localized structures, and some preliminary results of emanated cellular automata rules from experimental data.
Measurements of negative joint probabilities in optical quantum system

Masataka Iinuma
ADSM, Hiroshima University

Abstract:

Quantum information science is based on the superposition principle and the non-local quantum correlation of quantum states. These non-classical properties are still mysterious and inadequately understood as physical phenomena. The biggest reason to un-resolving such problems is that we can directly not get all bare information of the quantum states since an action by any measurement absolutely changes the initial quantum states. Recently, we realized a variable strength measurement of photon polarization, which is capable of controlling the measurement strength from zero (no measurement) to fully projection (completely destructive measurement). This apparatus makes it possible to perform a sequential measurement of two non-commuting observables with an error, which never give fixed values simultaneously, and the back-action effects produced by the measurement. We investigated the role of measurement uncertainties of the first variable strength measurement. The experimentally-obtained joint probabilities can be recognized as statistical mixture obtained by random polarization flips arising the measurement uncertainties from an intrinsic joint probability distribution. This natural assumption provided a removal of the back-action effect from the experimental probabilities and the obtained intrinsic probabilities resulted in negative. This analysis also shows how the negative joint probabilities are converted to observable positive statistics by variable combinations of resolution and back-action uncertainties.
FDM 3D-printing as Asynchronous Cellular Automata

Yasusi Kanada
Dasyn.com

Fused deposition modeling (FDM) is a 3D-printing method that shapes 3D objects by layering melted plastic filament. The process of this type of 3D printing can be regarded as asynchronous cellular-automata because it generates 1D on-off pattern per a head motion. Especially, by a constant head-motion at reduced constant extrusion-velocity, a 3D printer can generate self-organized grids or similar structures, which is much finer than artificial (i.e., program-controlled) patterns. Depending on the parameter values, i.e., layer depth, extrusion velocity, and so on, the generated pattern varies among regular stripes, stripes with crossing waves, and splitting and merging patterns. Some of the patterns can be simulated by a computational model, i.e., asynchronous cellular automata.
On the behaviors of small state rotation-symmetric number-conserving cellular automata

Katsunobu Imai, Hisamichi Ishizaka
Hiroshima University

A number-conserving cellular automaton (NCCA) is a cellular automaton whose states are integers and whose transition function keeps the sum of all cells constant throughout its evolution. It can be thought as a kind of modelization of the physical conservation law of mass or energy. Rotation-symmetry for the rule of a cellular automaton is also considered as a `natural’ condition, so it is frequently employed for the rules of cellular automata based simulations. In this talk, we show that rotation-symmetry can be a very strong constraint for NCCAs. Particularly in the cases of small state number, the rules are extremely limited. We illustrate their behaviors.
Invitation to Gellular Automata

Masami Hagiya, Shaoyu Wang, Ibuki Kawamata, Satoshi Murata, Teijiro Isokawa, Ferdinand Peper, Katsunobu Imai

The notion of gellular automata is introduced. Gellular automata consist of walls made of gels that separate cells containing liquid solutions where chemical reactions produce decomposers and composers of walls. When a wall is dissolved, the solutions of the cells separated by the wall are mixed. They are separated again when the wall is reconstructed. Gellular automata are expected to be used for making a chassis of a gel-type (slime mold) molecular robot. In this talk, possible implementations and mathematical models of gellular automata are briefly explained, and the computational power of gellular automata is touched upon with implementation of rotary elements. Applications and extensions are also discussed.
Akihiro Ueyama (1), Teijiro Isokawa (2), Haruhiko Nishimura (3), and Nobuyuki Matsui (2)
(1) Department of Electrical Engineering and Computer Sciences, University of Hyogo
(2) Graduate School of Engineering, University of Hyogo
(3) Graduate School of Applied Informatics, University of Hyogo

Abstract:
Grouping behavior, such as bird flocking, terrestrial animal herding, and fish schooling, is one of well-known emergent phenomena. Several models have been proposed for describing grouping behaviors, and two types of models can be defined: rule-based model and learning-based model. In rule-based models such as Aoki's model [1], each agent in a group has fixed interaction rules with respect to the other agents. On the other hand, agents in learning-based model [2] acquire these rules by interacting other agents with a learning scheme such as Q-learning. In this paper, we introduce quantities obtained from trails of agents, in order to investigate the properties for grouping behaviors of agents. We evaluate Aoki's model and the model in [2] by using these quantities under the environments with and without predatory agents.

References:
Extracting functional subgroups from an evolutionary robotic swarm by identifying the community structure

Kazuhiro Ohkura, Toshiyuki Yasuda (Hiroshima University) and Yoshiyuki Matsumura (Shinshu University)

Abstract—Robotic swarms solve a given task by developing highly complex adaptive behaviors that exploit their extremely large redundancy. Although a robotic swarm is homogeneous and has the same control architecture, it is not so easy to develop an appropriate collective behavior that poses several challenges. Even when a robotic swarm succeeds in developing a meaningful collective behavior, it still faces difficulty in explaining why it succeeds in performing a given task. In this paper, we aim in providing an explanation of this highly redundant but meaningful behavior by visualizing the emerged autonomous task allocation. We propose a method for analyzing their complex collective behavior that utilizes techniques adopted from the domain of complex networks. First, a robotic swarm is translated into a directed weighted complex network. Next, we define modularity and divide the robotic swarm into subgroups with maximal values. Finally, we demonstrate the emerged allocation of tasks to each subgroup from a macroscopic viewpoint.
Concepts for Spiking Wireless Sensor Networks

Ferdinand Pepe1, Naoki Wakamiya2, Akifumi Kasamatsu2, Shukichi Tanaka3, Kenji Leibnitz1, Junnosuke Teramae4, Tetsuya Shimokawa1, Kenichi Takizawa1, Akira Otomo1

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Abstract

Wireless sensor networks play an increasingly important role in our society. One early proposal to miniaturize them concerns the Smart Dust project [4] at the University of California in Berkeley, which envisioned a vast wireless sensor network consisting of millimeter-scale nodes.

An important problem of wireless sensor networks with tiny nodes is their energy expenditure: since there is little space available in nodes, batteries should be extremely limited. Alternatively, there have been proposals to harvest energy from the environment [3]. Wireless sensor networks typically have nodes containing a primitive CPU to control sensing, communication, and data preprocessing. Energy consumption of nodes tends to be dominated by transmission of data and passive listening for data from other nodes, as well as data processing, but this may already be too much to support a useful model of sensor networks with tiny nodes.

The complexity of computations and communications in wireless sensor networks should thus be decreased as much as possible, to the extent that a node is capable of conducting only the simplest of operations. Unfortunately, the existing wireless networking protocols do not support such a mode of operation [1], since their information encoding and routing is packet-based.

Problems like these necessitate the rethinking of the model for wireless sensor networks. A node in such a network would not need addressing, and it would employ extremely simple signaling and operations. The much decreased complexity of nodes would result in lowered costs, and this would allow the use of nodes in huge numbers. This in turn will change the strategies used for sensing, information processing, and communication.

This presentation explores wireless sensor networks in which the nodes employ a pulse-based protocol for signaling inside nodes, as well as for signaling between nodes. This mode of signaling, inspired by the brain’s use of spiking signals between neurons, has the potential for dramatically simpler hardware requirements of nodes, since all processing and communication takes place in the pulse domain, obviating the need for components like a A/D converter, CPU, etc. This in its turn will allow a drastically reduced power consumption of nodes to the extent that all energy can be harvested from the environment, and no pre-installed battery is necessary.

We discuss how concepts from neuroscience can be useful in this endeavor, as well as the potential of new applications that rely on the availability of a huge number of (albeit simple) sensor nodes. Elements of this paper have been presented before in [2].

References

Drawing as the relative movement between subject and medium

Miki Goan, Katsuyoshi Tsujita, Susumu Kihara, & Kenjiro Okazaki

There are two kinds of consciousness which arise in the creative process of drawing. One is the consciousness that one is trying to draw a picture. The other is the consciousness that one is made to draw a picture facing various material resistances. In this research, drawing experiments were conducted using a parallel link-type robot which played a role of medium combining the two kinds of consciousness. The experimental system was as follows. Participant #1 draws a free line on a tablet computer. The Participant #2 only holds the pen to a moving board on the robot. When the robot moves the drawing board under the pen, the line drawing is recreated on the board. The robot's movements are inversely transformed by the participant’s. Results indicate that even if Participant #2 did not move their own hand they recognize the picture drawn on the robot’s board as their own. Additionally, they could identify who drew the drawings on the tablet by using only haptic information by the robot’s movements. These results show that drawing a picture is regarded as the relative movement between the subject and the medium.
A daily automated evolutionary production of abstract animations

Tatsuo Unemi
Dept. of Info. Sys. Sci., Soka University

abstract:
Evolutionary computing based on an aesthetic measure as fitness criteria is one of the possible methods to let machine makes art. The search space provides an alternative nature of huge scale of diversity constructed with functional expressions as states and mutation and crossover as transitions. The selection takes a similar role of a photographer who captures expressive pictures from the huge variations of scenery in the nature. The author developed and set up a computer system that daily produces ten short animations of a sequence of abstract images and a sound effect. The criteria employed in this system is a combination of a number of statistical measures on both geometrical arrangement and color distribution, such as complexity and the power law. These measures based on image processing techniques are effective to induce viewer’s interest in a perception level of cognitive process. The produced pieces are automatically published on the internet using HTML5 and WebGL technologies. Their digest versions are also uploaded on a popular web service of movie sharing, and the link information is posted on public SNS. It is still in an experimental level but it has often succeeded in attracting the viewers.
Tactile Score, a language of describing thinking in our mind from computational aesthetics view

Yasuhiro Suzuki
Nagoya Univ.

We have been used written and spoken language as the language to describe thinking in our mind. We point out that the tactile sense can be a language to describe thinking in our mind that do not use any written and spoken language. We do have totally different way of describing thinking in our mind via tactile sense so have developed the language for tactile sense, the Tactile Score. In this talk we will show various related works from the tactile score and consider its world from computational aesthetics viewpoint.
Tactile Score: What kind of prescription is it?

Fuminori Akiba,
Graduate School of Information Science,
Nagoya University

Tactile score is a medium invented by Rieko Suzuki and Yasuhiro Suzuki (Suzuki & Suzuki 2014). It instructs us how we should move our hands in order to do beautiful massages. Usually it is compared with five-lines musical score because of the similar appearance. In this presentation, however, I compare it with several prescriptions in artworks. Through the comparison I try to make clear the uniqueness of tactile score as prescription. I take up prescriptions in artworks by Yoko Ono, Sol Lewitt, Masahiro Miwa, and others.
Computational Aesthetics via Evolutinal Computation

Tomohiro Suzuki and Yasuhiro Suzuki
Nagoya Univ.

There have proposed some contributions on creating computer graphics by using Evolutional Computation. In the most of previous works do not include ordinal techniques or rules in conventional paintings. In this talk, we propose a method for creating computer graphics in evolutinal way by using such conventional rules in drawing pictures.