IoTBDS 2021
6th International Conference on Internet of Things, Big Data and Security
Online Streaming | 23 - 25 April, 2021

SELFORGANISATIONAL HIGH EFFICIENT STABLE CHAOS PATTERNS

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1 INTRODUCTION

The aim of this paper is to provide a new solution for the problem of a simple application of swarm robots, and here the model and its simulation, which shall be later implemented in these Internet of Things (IoT) devices. For this reason this paper describes how, swarm robots, robot-multirobots, a series of entangled robots or robot-os, as orgitonal units of energy, mass and information [1], form predictable selforganisational room-time patterns, as a function of a binary sensor and a binary actor signal interaction, in a triangular cellular automata fashion. The influence of the outer border compared to the inner border of robot-os is investigated, to answer the question, whether and how they can be distinguished (cf. e.g. [2]). This is methodically demonstrated with Shannon's information entropy measure. Application programs and respective patterns are given in Mathcad and Witness simulations in detail. These prepare for osmotic IoT robot-os applications [3], for future research applications, especially for the open source robot-os [4], that our work refers to and builds upon.

2 TRI INFORMATION PATTERNS

Axiom 1. Information flow is a translational information chain. - The "living" function can be interpreted as a continuous information flow.

Axiom 2. Increasingly nested translational patterns (autoencoders), increase potentially order and allow for increasingly safety or an integrity informational check. When Axiom 2 is true, then this should also be seen in some informational measure. Such a measure could be the Shannon information entropy S_i, which can be calculated by (1): $H_i = S_i = p_i \cdot ln(p_i)$. Here p_i denotes the probability or frequency.

3 SIMULATION

In the following, we give the two simulation programs for the tri-information chaos patterns of the cellular automata. The first simulation is done in Mathcad. A parallelised program for general process simulation is Witness. This has the advantage to be able to simulate each virtual IoT device, which is operating in the IoT swarm, separately. The programs, in Mathcad or Witness itself, can be regarded as information-translation in the sense of Figure 1, and hence the system order is increasing potentially.

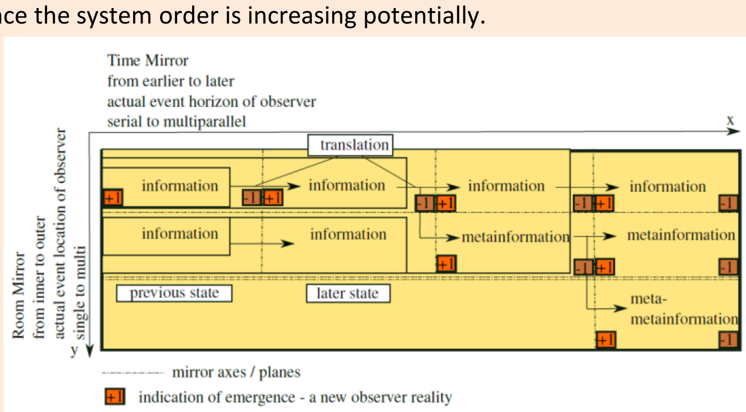


Figure 1: Room-time information multiplication dimension connectivity.

3.1 SIMULATION IN MATHCAD

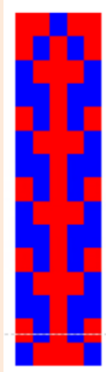
To simulate the triangular process first two programs are made in Mathcad. In Figure 2a we see the cyclic variant. Circular robot-os, can be imagined in a way having one neighbour to the left and one to the right and arranged in a circle. The other variant is to have robot-os with left and right neighbours only, which means that there is an open-end on each side (cf. Figure 2b). In Figure 2c ten (10) variants of open-ended and cycle robot-os patterns can be seen.

[1] Heiden, B. and Tonino-Heiden, B. (2021). Philosophical Studies - Special Orgiton Theory. unpublished.

[2] Heiden, B.; Alieksieiev, V. and Tonino-Heiden, B. (2020). Scalable Logistic Cell RFID Witness Model. In *Proceedings of the 5th International Conference on Internet of Things, Big Data and Security - Volume 1: IoTBDS,*, pp. 420-427. DOI: 10.5220/0009490204200427.

[3] Heiden, B., Volk, M., Alieksieiev, V., and Tonino-Heiden, B. (2020). Framing Artificial Intelligence (AI) Additive Manufacturing (AM). In 14th International Symposium "Intelligent systems" (INTELS'20), Moscow, in Procedia Computer Science, Elsevier B.V., in print.

[4] Elmenreich, W., Heiden, B., Reiner, G., and Zhevzhyk, S. (2015). A low-cost robot for multi-robot experiments. In 12th International Workshop on Intelligent Solutions in Embedded Systems (WISES), pages 127–132. IEEE.



A3c/255 =

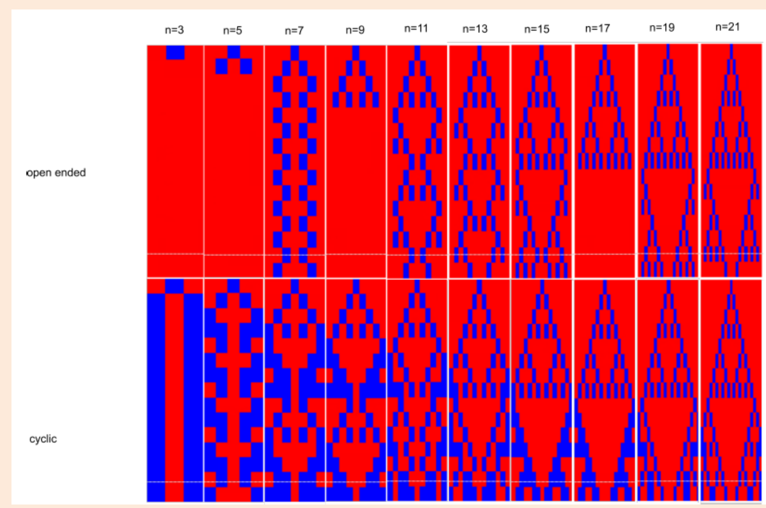
	1	2	3	4	5
1	0	0	1	0	0
2	0	1	0	1	0
3	1	0	0	0	1
4	1	1	0	1	1
5	0	1	0	1	0
6	1	0	0	0	1
7	1	1	0	1	1
8	0	1	0	1	0
9	1	0	0	0	1
10	1	1	0	1	1
11	0	1	0	1	0
12	1	0	0	0	1
13	1	1	0	1	1
14	0	1	0	1	0
15	1	0	0	0	1

a

A3/255 =

	1	2	3	4	5
1	0	0	1	0	0
2	0	1	0	1	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	0	0
15	0	0	0	0	0

b

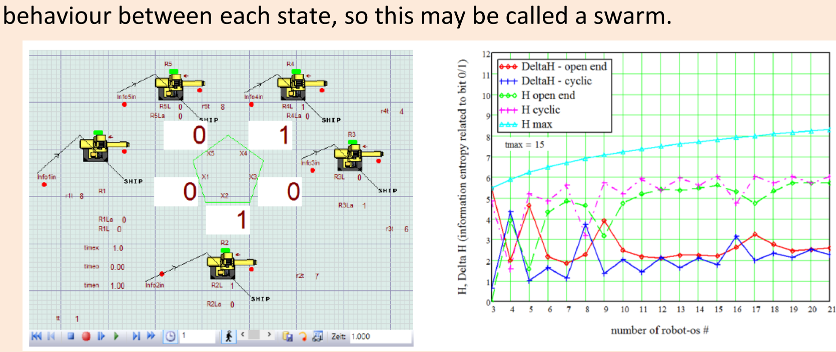


c

Figure 2: Simulation in Mathcad.

3.2 SIMULATION IN WITNESS

In the Witness model (see Figure 3a), the information balance of the 'living' or dynamic cybernetic process is given by ingoing and outgoing information (cf. also [2]). In this context, the ingoing part and outgoing part of every robot-o simulates the event horizon for each time step. In this event horizon then the translation to the next step is calculated inside the robot. The translation is done in this case according to the cellular automaton and is by this a collective behaviour between each state, so this may be called a swarm.



a *b*

Figure 3: (a) Triangularity pattern simulation in Witness with five robot-os and (b) information entropy

3.3 INFORMATION ENTROPY

According to n=3,5,9,17 robot-os, Figure 3b and Figure 2 the open ended case, the information entropy is high, which means, that the room time pattern is instable. In the other cases it is stable.

4 CONCLUSION AND OUTLOOK

- Concept/theory contribution for basic informational system modeling.
- Mathcad/Witness simulation → orgitonal [1] robot-os/cellular automata.
- Information entropy as measure for stable chaos patterns.

Outlook:

- IoT implementation of presented patterns in "spiderin-os".
- New patterns can be investigated with swarm robots or robot-os.