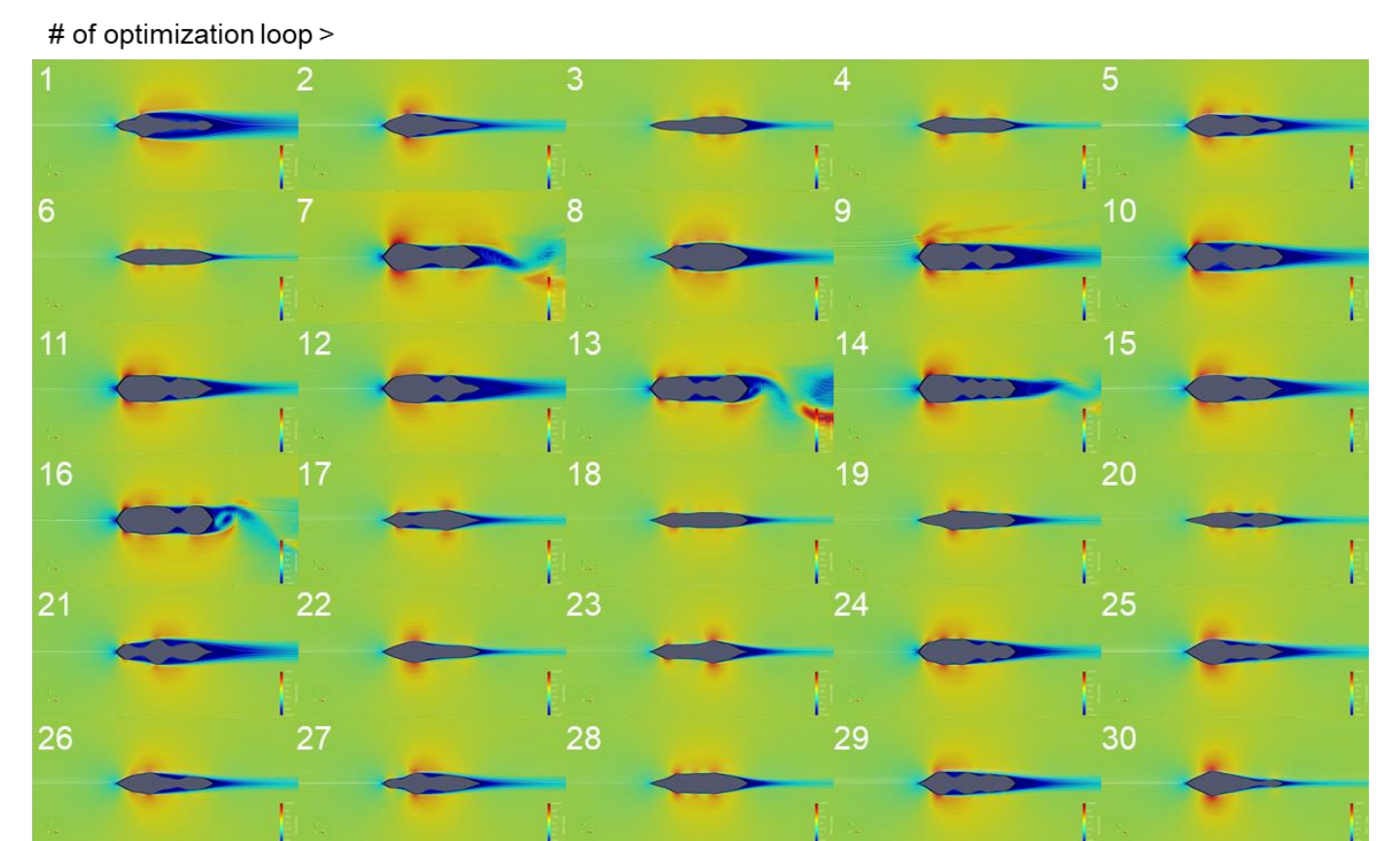


The Information Initiative Center conducts its own joint research program with a central role in grand challenge-type work based on information infrastructure and academic joint research for the promotion of such challenges. Selected research projects are currently under way in collaboration with teachers and researchers from research institutes in Japan and elsewhere.

Efficient Method for Integrated Optimization of Flow Control Devices and Body Geometries (PI: Takashi Matsuno, Tottori University)

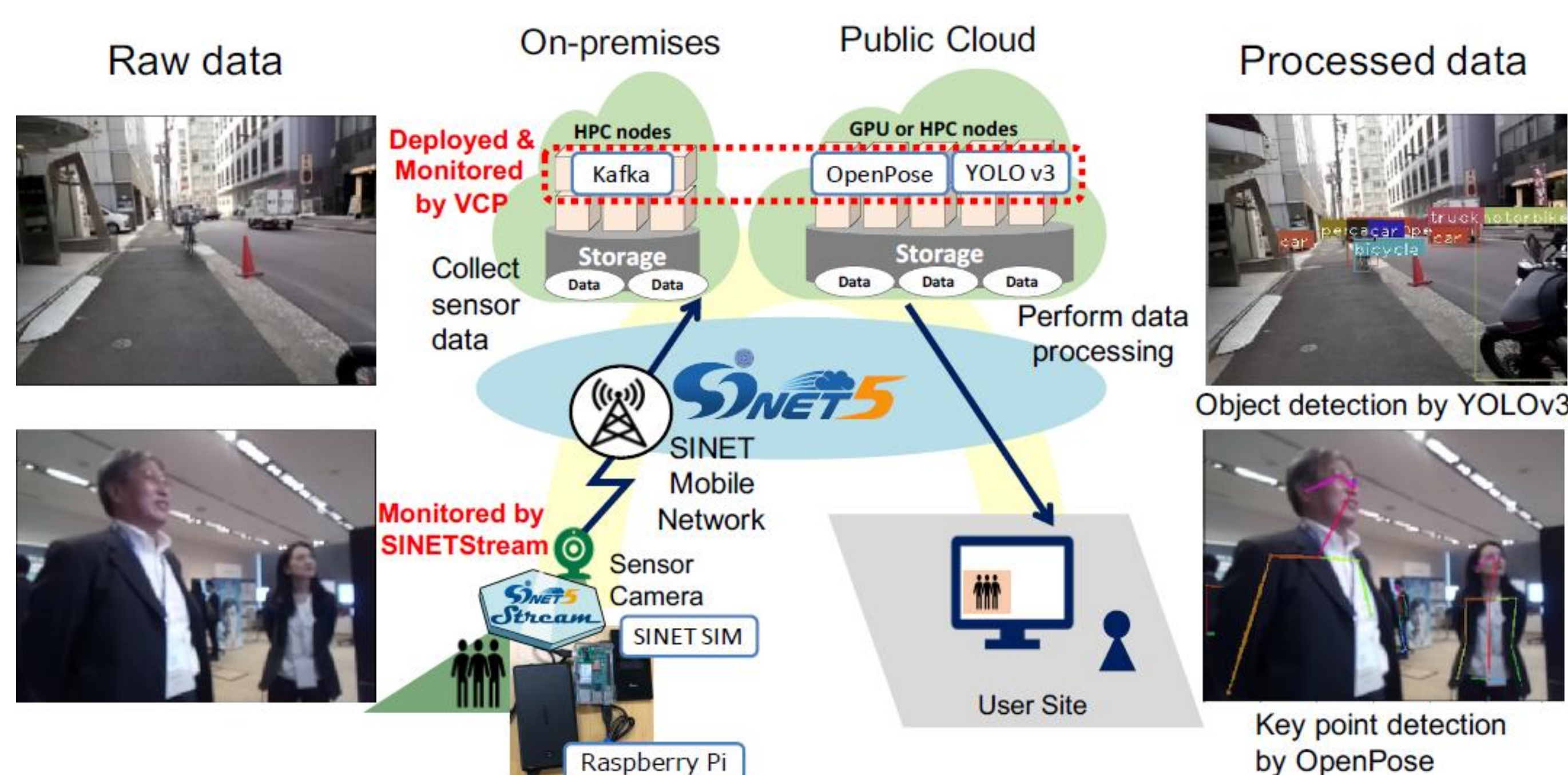
The objective of this research is to demonstrate the concept of aerodynamic optimization by integrating the physical geometry of an object and distributed flow control devices for high performance aerodynamics. Currently, we are implementing a highly efficient and robust evolutionary calculation method, such as the introduction of EHVI, and performing multi-objective optimization tests of geometry in order to evaluate them.



Mach number distributions for the samples explored by Multi-objective design optimization for Drag minimization/volume maximization.

Study of a Monitoring Scheme for an IoT Application Environment (PI: Atsuko Takefusa, National Institute of Informatics)

We have been developing the VCP middleware [1] that enables easy construction of application server environments over cloud resources and the SINETStream software library [2] to support development of IoT applications. In this study, we propose a monitoring scheme for IoT applications using VCP and SINETStream and investigate the behaviors of IoT application workloads. The details are presented at our SC20 site [3].



Reference:

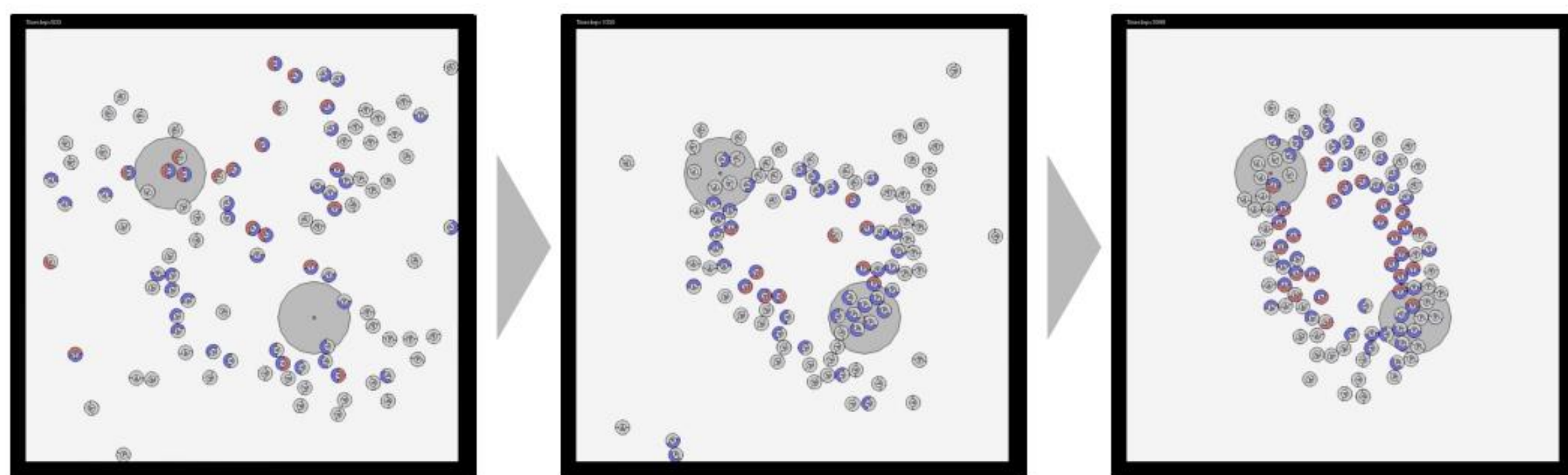
1. A. Takefusa et al., "Virtual Cloud Service System for Building Effective Inter-Cloud Applications", Proc. IEEE CloudCom 2017, pp. 296-303, Dec. 2017.
2. SINETStream, <https://www.sinetstream.net/index.en.html>
3. SC20 Exhibition, National Institute of Informatics, <https://ccrd.nii.ac.jp/sc20/>

Monitoring of an online video processing application deployed over an end-to-end IoT and cloud environment.

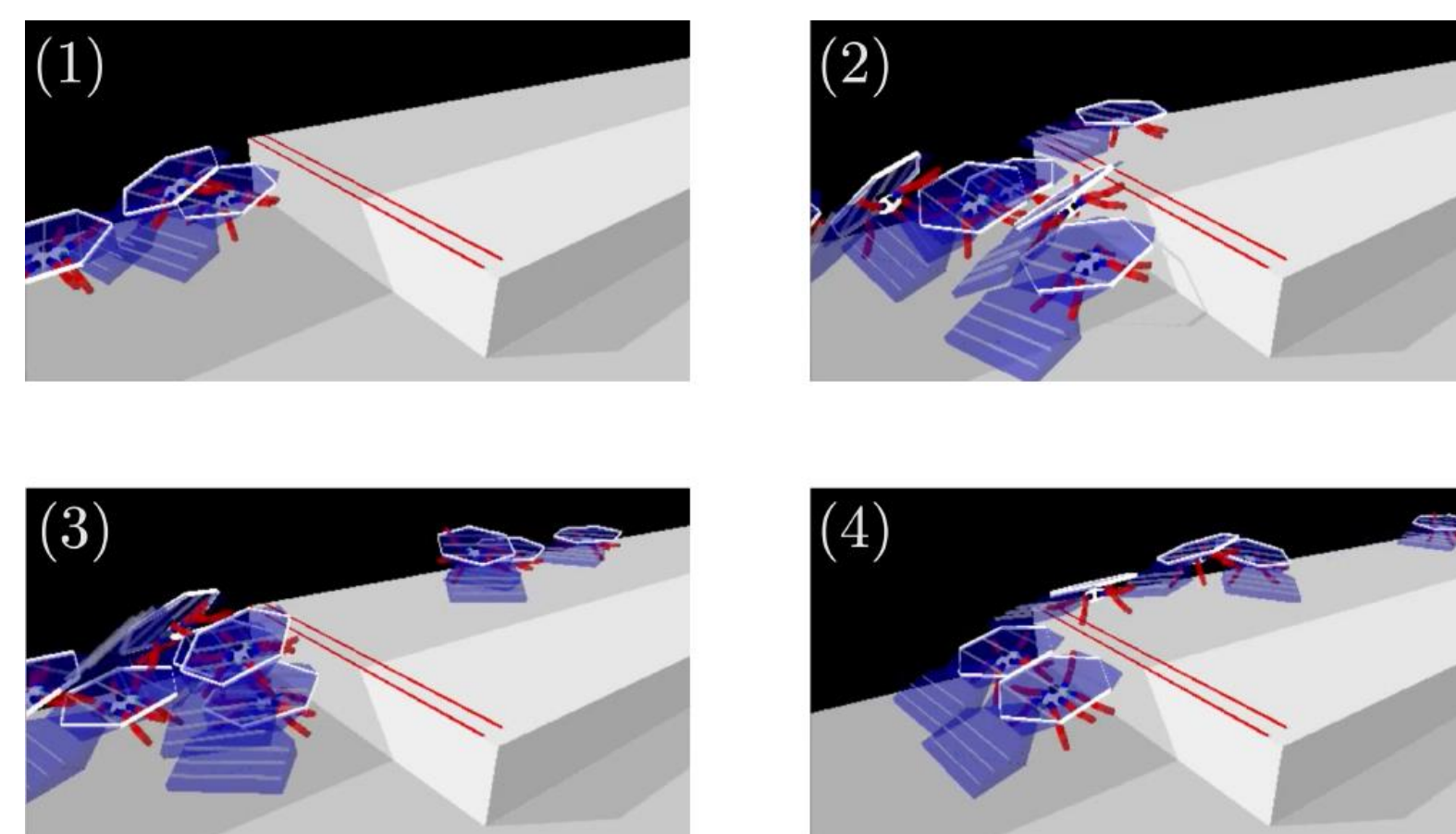


Evolutionary emergence of collectively intelligent behavior for a large-scaled robotic swarm (PI: Kazuhiro Ohkura, Hiroshima University)

This project focuses on the field of swarm robotics where a large group of autonomous robots develops collectively intelligent behavior without relying on any form of centralized control. An evolutionary approach is adopted to design a robot controller in the form of a deep convolutional network.



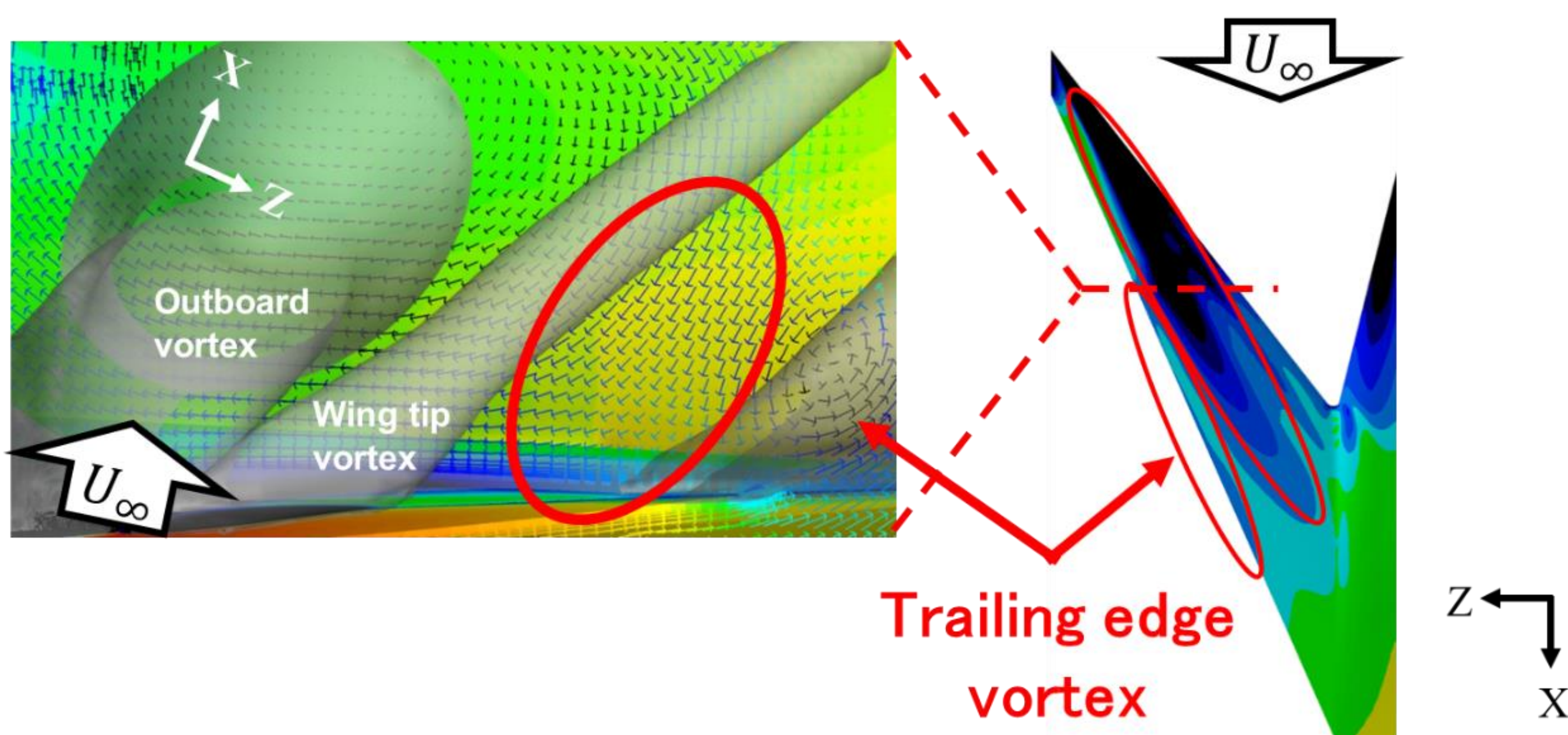
Evolutionary Robotics Approach to Chain Formation Task



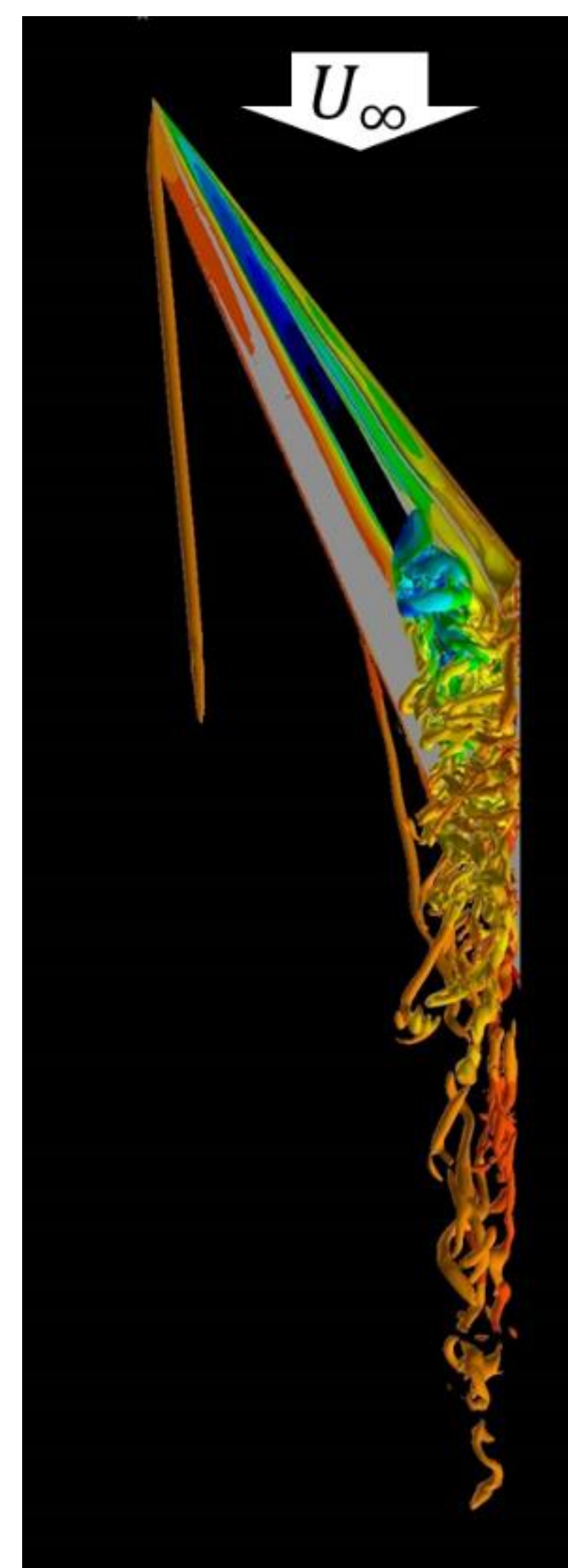
Step-climbing Task of Multi-legged Robotic Swarm

Numerical Study on Flowfield Around Forward-Swept Wing at High-Angle of Attack/Low-Speed (PI: Masahiro Kanazaki, Tokyo Metropolitan University)

To evaluate the characteristics of the forward swept wing, fluid dynamics simulations were performed by employing the Reynolds averaged Navier-Stokes and detached eddy simulation. We visualized the flowfield and computed the aerodynamic forces. Our results suggest that the trailing edge vortex affected to the aerodynamic characteristics of the forward swept wing.



Visualization of the vortex by detached eddy simulation



Schematic illustration of the trailing edge vortex by Reynolds averaged Navier-Stokes



Large-scale electromagnetic field analysis of antennas and propagation for 5G / IoT applications and solving regional issues (PI: Tamami Maruyama, National Institute of Technology, Hakodate College)

In this study, we develop novel supercomputer code for optimal design of antenna and propagation analysis to solve recent new problems in this field [1], [2], [4]. The one is to achieve high efficiency wireless power transmission for energy harvesting to solve power shortage due to the spread of IoT (Fig.1 and Fig.2)[3], [5]. The second is to realize of improvement of propagation environment for utilization of high frequency (28GHz) in 5G (5th generation mobile communication). The third issue is the solution of regional issues peculiar to cold regions [6]. We proposed novel dielectric cover for millimeter-wave band waveguide slot array antenna for the millimeter-wave radar system to improve the gain (Fig.3 and Fig.4)[1], [2].

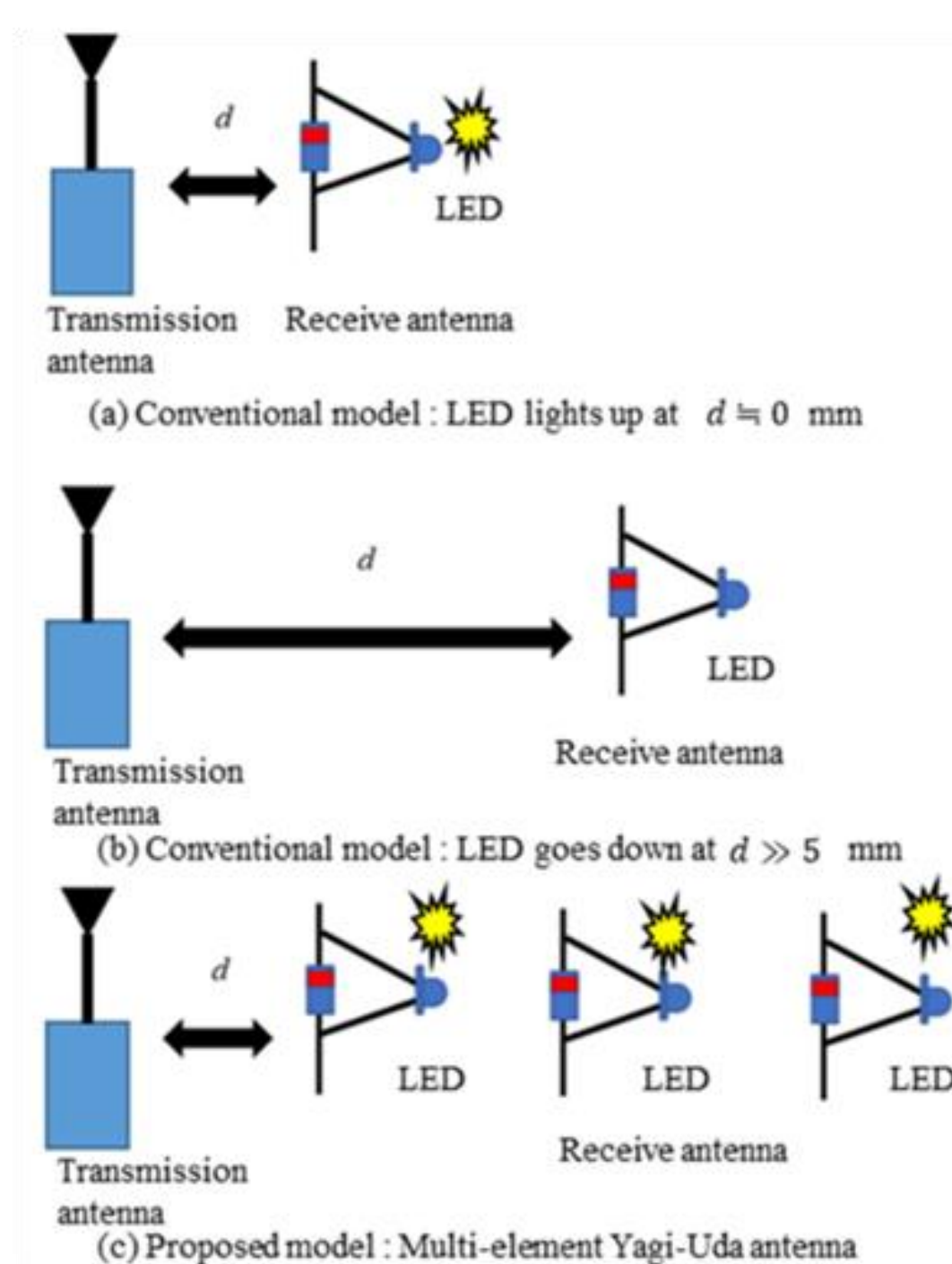


Fig.1 Proposed Yagi-Uda Rectenna for energy harvesting

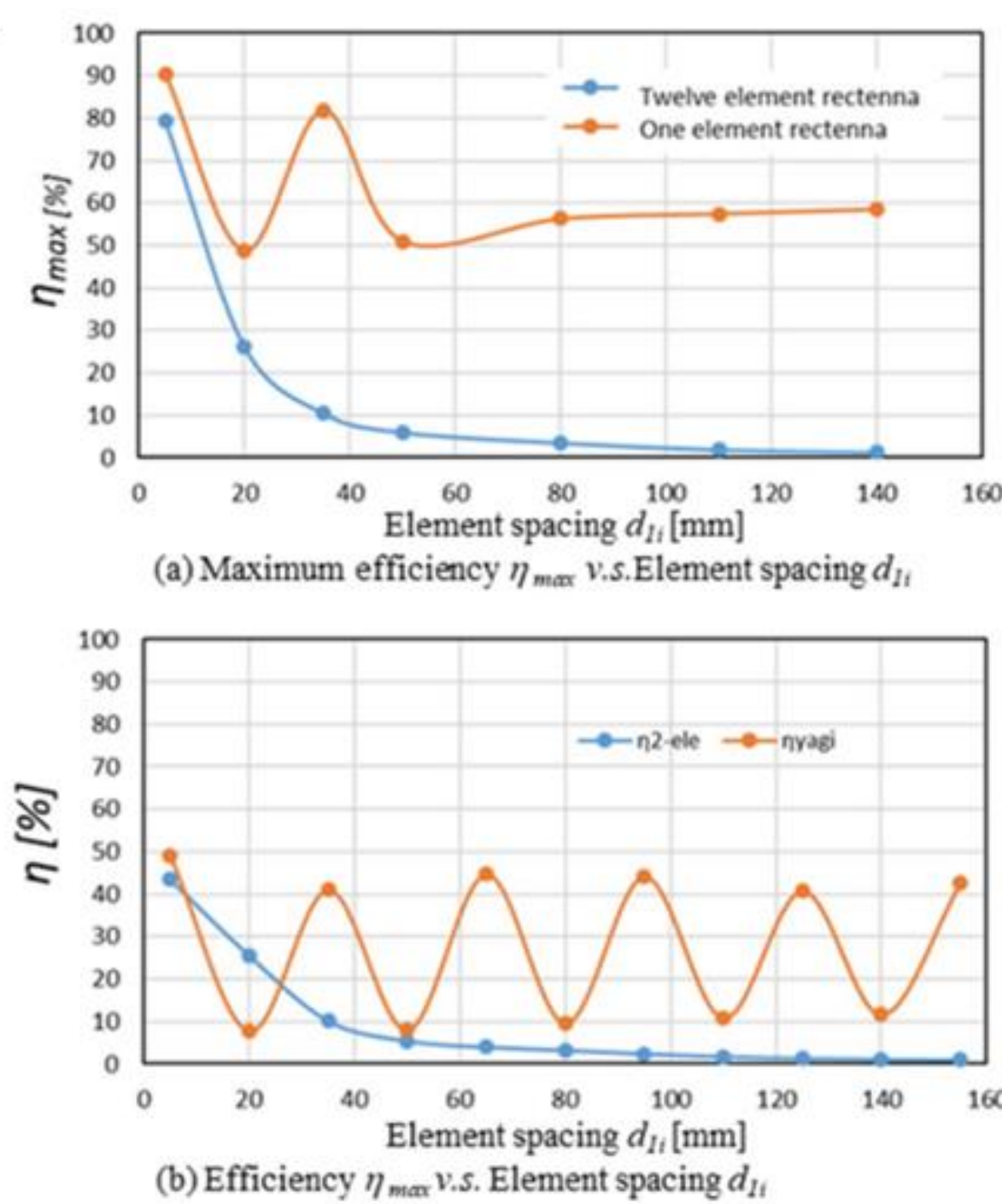


Fig.2 Wireless power transmission efficiency vs. Frequency

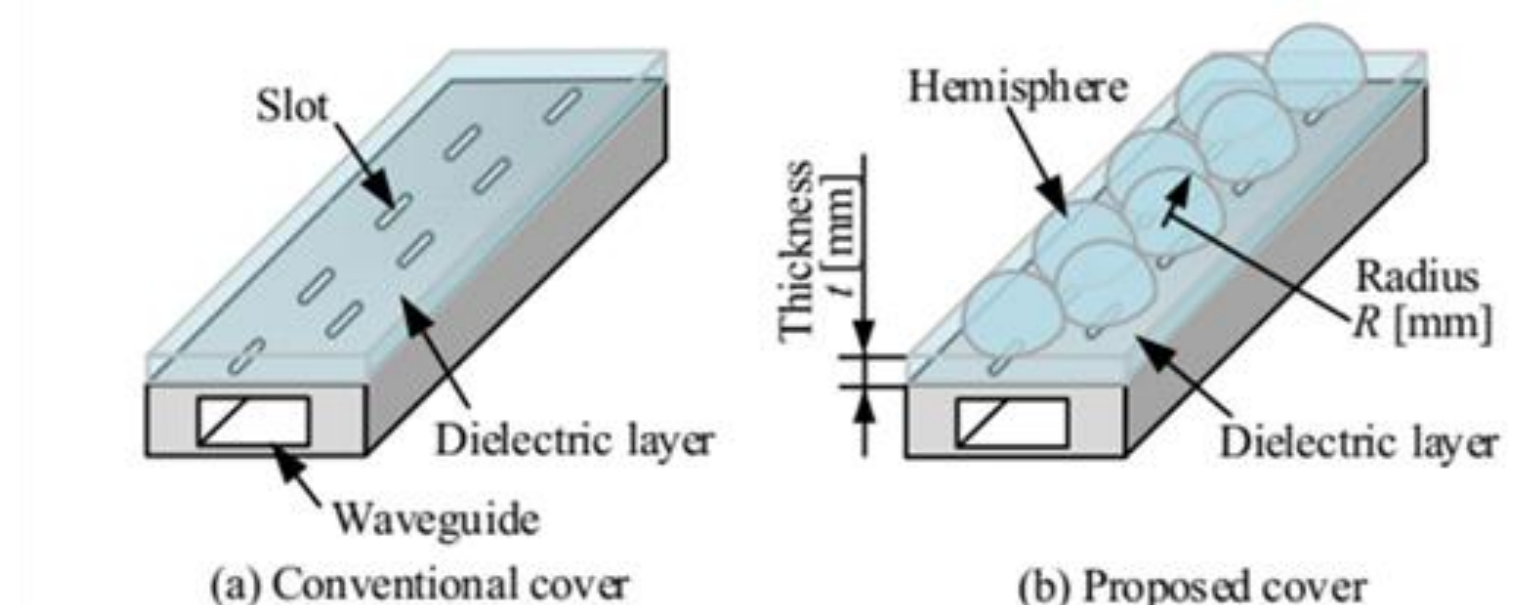


Fig.3 Image of dielectric cover.

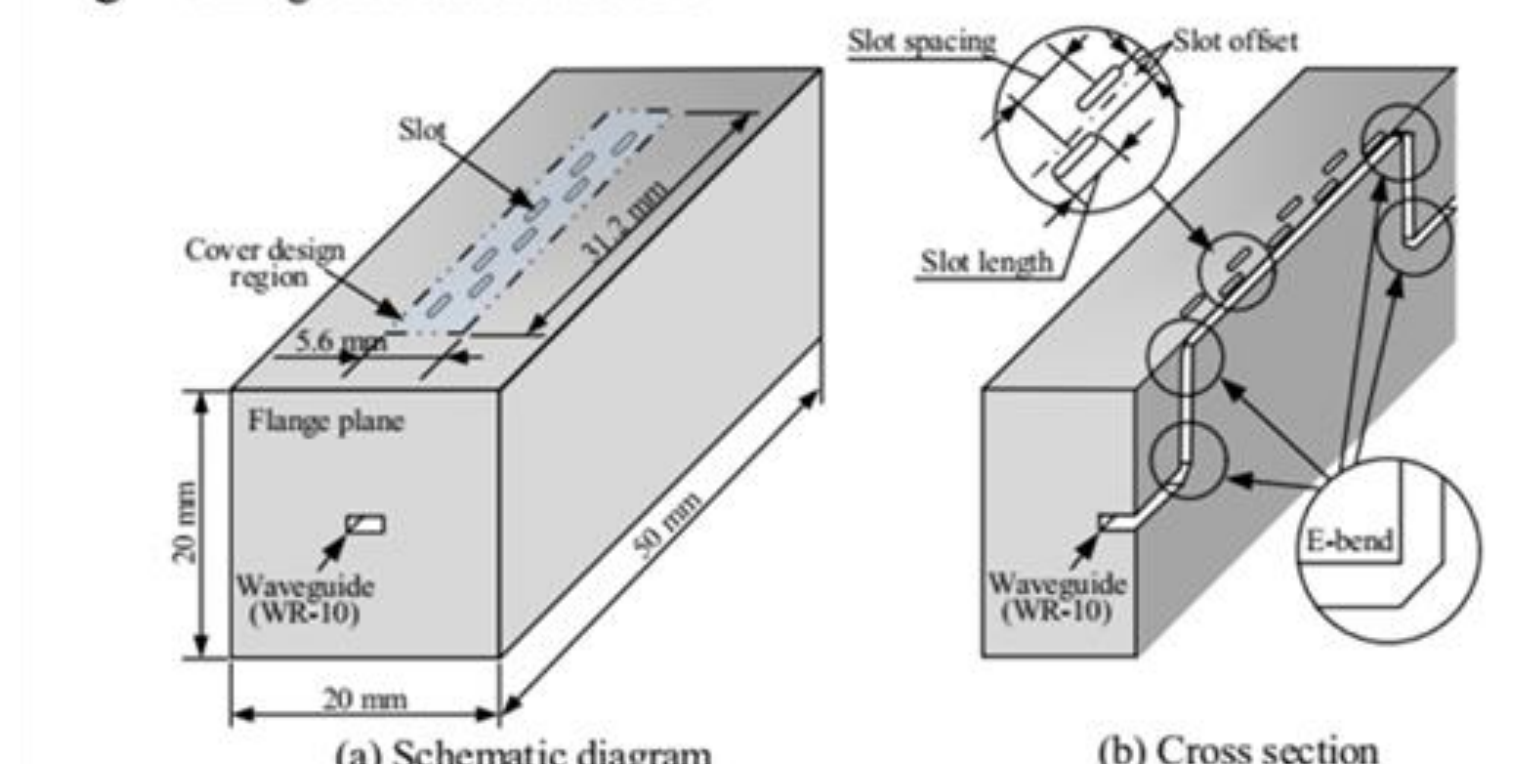


Fig.4 Schematic diagram of waveguide slot array antenna.

Reference:

1. Keiichi Itoh, Kazuma Takita, Masaya Kumata, Hideaki Matsuda, Masaki Tanaka, and Hajime Igarashi, "Development of Novel Dielectric Cover for Millimeter-wave Band Waveguide Slot Array Antenna", 22nd International Conference on the Computation of Electromagnetic Fields (Compumag2019), Paris, PD-M4-13(2019-7).
2. Keiichi Itoh, Kohei Shida, and Hajime Igarashi, "Study on performance improvement of waveguide power divider using evolutionary method", 38th JSST Annual International Conference on Simulation Technology (JSST2019), pp.264-266(2019-11).
3. Tamami Maruyama : "Energy Harvesting Rectenna Applying the theory of Yagi-Uda Antenna," the International Symposium on Antennas and Propagation, ISAP 2019 . vol.1, No. 607, 2019.
4. Tamami Maruyama, Kosei Ozeki, Noriharu Suematsu, Hiroyasu Sato, Mizuki Motoyoshi and Manabu Omiya : "Analysis and Measurement of Diode Mounting Meta-surface for Reflection Beam Control," ICEAA IEEE AWPC, No.720, pp.349-352, 2019.
5. Tamami Maruyama, Q. Chen, and N. Suematsu : "Applied Reflectarray based on Metasurface for Wireless Power Transmission Efficiencies," IEEE ICECOM 2019, s_34_3,.
6. Tamami Maruyama and Yuji Koita : "Design and analysis of EV running using WPT on microwave guide with slot for snow melting," AWPT2019, 2019 Asian Wireless Power Transfer Workshop, FP-13, 2019.



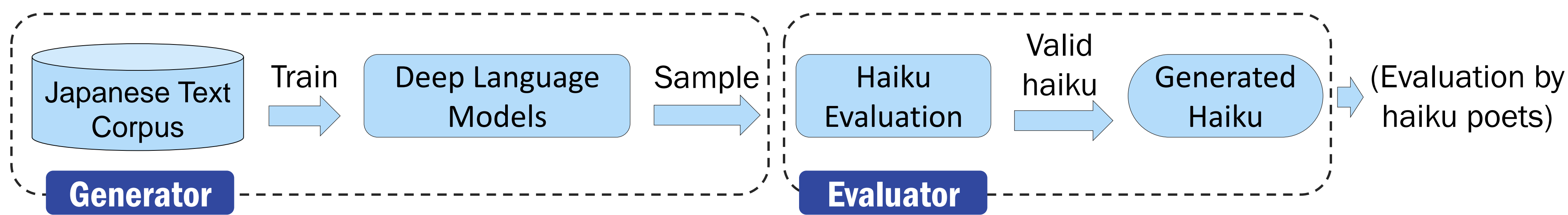
2020 Joint Research Projects with AI-Compliant Advanced Computer system

Japanese Haiku Poems Generation by Deep Language Models (PI: Hidenori Kawamura, Faculty of Information Science and Technology, Hokkaido University)

- ◆ Haiku is a fixed form of Japanese verse with 17 syllables and a season word. The complex scenes and emotions felt by haiku poets are captured in the 17 syllables and conveyed to other haiku poets.
- ◆ Through our attempts to create haiku by computer, We would like to contribute to how computers should handle the human knowledge and emotions.

Haiku Generation Overview

- ✓ Deep language models that are trained on haiku corpus are sampled, which are then evaluated and filtered.
- ✓ The deep models are trained on the AI-Compliant Advanced Computer System, Information Initiative Center, Hokkaido University.



● Training Corpus

1. Aozora bunko: Text data of Japanese copyright expired book of about 600MB in total. Used for pre-training language models.
2. Haiku corpus: Collected from public dataset of famous haiku poets like Basho Matsuo and privately run websites which contains various haiku works. Consists of about 400, 000 haiku in total.

● Deep Language Models

- So far, GPT-2 model which is pretrained on Aozora bunko and then fine-tuned on haiku corpus with early-stopping obtained the best result.
- Takes about 5 days to learn with 4 x NVIDIA V100

● Requirement of the fixed form verse must be met

- Perform morphological analysis on the samples by MeCab to count number of syllables, season words and so on to check if they are in valid haiku form.

● Evaluate the samples numerically

- Refer to log-likelihood of the deep language model.
- Train a haiku classifier to discriminate a haiku whose words are randomly selected and exchanged and perform inference on the samples. Samples of less likely to have been exchanged are considered to be better.

● Ensures that generated haiku are different from ones in training corpus

- Calculate the minimum Levenshtein distance of each generated haiku from the haiku in the corpus.

Generated Haiku Examples

- ✓ Most of generated haiku do not make sense. However, a very few of them are admitted for their quality by poets.
- ✓ The following is a selection from thousands of computer-generated haiku, which is selected and commented by Japanese haiku poet Gai Otsuka. (Generated haiku and comments are originally in Japanese)

なかなかの母の声を聴く山道の春

*A mother's voice
Clear, and rather lovely
And the butterbur's sprouts*

The concise description of "a mother's voice" as "rather lovely" has a good feeling about it. The meaning behind this phrase is "a mother's voice that is clear in sound and quite pleasing to the ears", but the use of the word "rather" (as opposed to a stronger or more meaningful adverb) in the haiku is interesting. A "clear voice" brings a bright, serene space to mind, and the insertion of "butterbur's sprouts" is so clever it is maddening. The growth of these sprouts on an open mountain path in spring may be momentary, but it acts as none other than a hymn to this world.

雲ふくゆくは帰らずとて焼く

*Clouds pass,
Never to return again,
Caterpillars burn*

Once gone, the same cloud never comes back again. This is a phrase that captures an absolute truth. Beneath the bright sky in summer, where clouds go by, moving further and further away, caterpillars are burnt up and wiped clean from existence. The truth is, many caterpillars perish by fire. The contrast of the lively clouds floating along freely and the hell fire of the caterpillars burning on the earth is vivid, and one gets the feeling that caterpillars also become distant, heading further and further away from us in the end, just as clouds do.

For details, please visit <http://harmo-lab.jp/>

