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Special Session: Nonlinear Waves and Localization. Organised by Yusuke Doi and Masayuki Kimura.

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Soichiro Tanaka (Kyoto University), Masayuki Kimura (Kyoto University), Shinji Doi (Kyoto University)

iors. This was followed by research efforts focused on controlling the behaviors. At the moment, research is geared towards enhancing dynamical systems through the use of chaos. The present study uses the extended time delay feedback control to restore the symmetry of a single-phase AC/AC converter. The converter works in a chaotic regime to reduce harmonics; thus by adding the feature of symmetry recovering, the converter becomes more versatile.

**Keywords:** Symmetry, AC/AC Converter, Extended Delay Feedback Control, PWM

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**C1L-C2] Algorithmic Aspects of a Continuous-Time Dynamical System for Solving SAT Problems**

Hiroshi Yamashita (University of Tokyo), Kazuyuki Aihara (University of Tokyo), Hideyuki Suzuki (Osaka University) ⇒ Proc. pp. 495–498, [Paper ID: 5087]

The CTDS solver is a continuous-time dynamical system designed for solving Boolean satisfiability problems. It uses transient chaos for finding a satisfying truth assignment. In this paper, we propose a modified CTDS solver for the sake of easier analysis. We also investigate the minima of its energy landscape and show that in some sense the CTDS solver behaves like the tabu search. We also present other relations between the CTDS solver and other non-convex optimization algorithms, Lagrange multiplier methods and chaotic neural networks.

**Keywords:** Continuous-time Dynamical System, Boolean Satisfiability Problem, Tabu Search

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**C1L-C3] Analysis of the Inverse Class-E Inverter with the Switch-Voltage Fall Time**

Natsumi Obinata (Chiba Institute of Technology), Xiuqin Wei (Chiba Institute of Technology), Hiroo Sekiya (Chiba University), Tadashi Suetsugu (Fukuoka University) ⇒ Proc. pp. 499–502, [Paper ID: 5096]

This paper presents analytical expressions of the inverse class-E inverter, taking the effects of the switch-voltage fall time into account. By applying the analytical expressions, it is possible to obtain the accurate design values of the inverse class-E inverter. Additionally, a design example is given along with its LTspice simulation. The LTspice-simulation waveforms are in good agreement with the analytical ones. Moreover, all the switch-current waveforms satisfy the class-E zero-current-switching and zero-current-derivative-switching (ZCS/ZCDS) conditions. These results verified that the proposed approach and analytical expressions are available and effective.

**Keywords:** Inverse class-E inverter, zero-current-switching (ZCS), zero-current-derivative-switching (ZCDS), switch-voltage fall time, high efficiency

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**C1L-C4] Robustness of Paralleled Buck Converters with WTA Switching**

Hiroataka Kanzaki (Hosei University), Kaito Ando (Hosei University), Toshimichi Saito (Hosei University) ⇒ Proc. pp. 503–506, [Paper ID: 5100]

This paper studies robustness of a paralleled system of buck converters coupled by winner-take-all switching rule. The switching rule can realize multi-phase synchronization automatically. If an element of the system is broken, the synchronization can be preserved and robust operation can be realized. The synchronization phenomena are suitable for current sharing and ripple reduction for efficient power supply. Using simple piecewise constant model, stability of the synchronization phenomena and robustness of the circuit operation are analyzed precisely.

**Keywords:** Stability, Buck converters

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**C1L-C5] Basic Analysis of Paralleled Boost Converters with Photovoltaic Inputs**

Yusuke Kunii (Hosei University), Toshimichi Saito (Hosei University) ⇒ Proc. pp. 507–510, [Paper ID: 5111]

This paper studies dynamics analysis of paralleled boost converters with photovoltaic inputs. Paralleled system is reducing ripple, current sharing and efficient power supply. Simplifying the system into a piecewise linear model can be analyzed precisely.

**Keywords:** Power electronics

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## C1L-D Special Session: Nonlinear Waves and Localizations 1

DATE: 2018/9/5 08:30–10:30

ROOM: Room 4

Chair: Masayuki Kimura (Kyoto University)

**C1L-D1] Dynamics of Intrinsic Localized Modes in Pairwise Interaction Relative Symmetric Lattices**

Yusuke Doi (Osaka University), Kazuyuki Yoshimura (Tottori University), Akihiro Nakatani (Osaka University) ⇒ Proc. pp. 511–512, [Paper ID: 5138]

Dynamics of traveling intrinsic localized modes (ILMs) in nonlinear lattices is investigated from the viewpoint of symmetry of pairwise interaction between particles. We construct the nonlinear lattices which support more smooth mobility of ILM than the original one by adding

### C2L-C3 Turing Pattern Formation in the Simplest M-CNN

Arturo Buscarino (DIEEI, University of Catania), Claudia Corradino (DIEEI, University of Catania), Luigi Fortuna (DIEEI, University of Catania), Mattia Frasca (DIEEI, University of Catania)

⇒ Proc. pp. 558–560, [Paper ID: 5130]

In the last decades, Turing patterns have been deeply investigated as complex phenomena emerging in spatially-extended systems made of coupled non linear units. In particular, analogue models have been extensively adopted to study the occurrence of this complex phenomena. In this paper, the simplest memristive circuit architecture based on coupled memristor (M)-capacitor (C) basic units able to show Turing pattern formation is proposed. Numerical simulations showing the importance of memristor parameter for Turing Patterns observation will be presented.

**Keywords:** Memristor, turing patterns, cellular nonlinear networks

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### C2L-C4 An Accurate Full Charge Capacity Estimation Algorithm for Primary Batteries of IoT Devices

Hirofumi Shiora (Ritsumeikan University), Shuhei Matsushita (Alps Electric Co., Ltd.), Naoki Yoshida (Ritsumeikan University), Masahiro Fukui (Ritsumeikan University)

⇒ Proc. pp. 561–564, [Paper ID: 5168]

Estimation of state of charge (SOC) is important to schedule internet of things (IoT) devices effectively. However, battery characteristics vary with temperature and initial variation. A dynamic grasp of the battery characteristics is necessary to estimate accurate SOC. Furthermore, because primary batteries can only be charged, accurate measurement of the full charge capacity (FCC) is difficult. This paper describes such an SOC estimation system using FCC compensation method. Furthermore, power saving was performed through current prediction without using an ammeter. The experiment results showed that the SOC estimation error in the proposed method was less than 1.66%.

**Keywords:** battery management of IoT devices, ultra-low-power battery management, full charge capacity estimation

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### C2L-C5 Cryptanalysis of a Chaotic Video Encryption Scheme

Salih Ergün (ERGTECH Research Center)

⇒ Proc. pp. 565–568, [Paper ID: 5198]

This paper presents cryptanalysis of a chaos-based video encryption scheme. An attack system is proposed to discover the security weaknesses of the chaos-based encryption

scheme. Convergence of the attack system is proved using master-slave synchronization. Future evaluation of the chaos-based encryption scheme is obtained from a scalar time series where the only information available are the structure of the encryption system and a scalar time series observed from the chaotic system. Simulation and numerical results verifying the feasibility of the attack system are given.

**Keywords:** cryptanalysis, chaos-based encryption, master-slave synchronization

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## C2L-D Special Session: Nonlinear Waves and Localizations 2

DATE: 2018/9/5 14:15–15:35

ROOM: Room 4

Chair: Yusuke Doi (Osaka University)

### C2L-D1 Bifurcation of Intrinsic Localized Modes in Perturbed Pairwise Interaction Symmetric Lattice

Masayuki Kimura (Kyoto University), Yusuke Doi (Osaka University), Kazuyuki Yoshimura (Tottori University)

⇒ Proc. pp. 569–570, [Paper ID: 5157]

In this paper, bifurcation of ILM in a perturbed PISL is investigated numerically. It will be shown that the stability change of ST mode and P mode occurs when the perturbed PISL corresponds to the PISL.

**Keywords:** Intrinsic localized mode, Discrete breather, Pairwise Interaction Symmetric Lattice(PISL), FPU lattice, Bifurcation

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### C2L-D2 Intersite Resistance Effect on a Saturable Nonlinear Electrical Transmission Line

Kazaki Miyasaka (Kanazawa University), Akane Nishizaki (Kanazawa University), Masayuki Sato (Kanazawa University), Albert J. Sievers (Cornell University)

⇒ Proc. pp. 571–574, [Paper ID: 5148]

In electric transmission lines, there are two kinds of damping due to components in series arm (inter-site) and shunt arm (on-site), respectively. Damping in the shunt arm works the same way as a mechanical oscillator that is proportional to velocity of a mass. Here, we dealt with the effect of a resistance in the series arm on width-spreading/narrowing transitions of an intrinsic localized mode in a saturable nonlinear lattice.

**Keywords:** intrinsic localized mode, nonlinear lattice, saturable nonlinearity

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**C2L-D3 Velocity of Propagating Waves in Weakly Five-Coupled Bistable Oscillators**

Kuniyasu Shimizu (Chiba Institute of Technology), Tetsuro Endo (Meiji University)

⇒ Proc. pp. 575–578, [Paper ID: 5078]

In the coupled bistable oscillators, corresponding to van der Pol oscillators with relatively higher-order nonlinearity, some distinctive propagating wave phenomena coexist. This study investigates velocities of the propagating waves in the weakly five-coupled bistable oscillators by using the approximated theoretical solutions derived from the averaging method.

**Keywords:** Propagating wave, Coupled oscillators, Averaging method, Group velocity

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**C2L-D4 A Numerical Study on Generating Condition of a Train of Moving ILMs by Exciting an Edge of Stretched FPU Chain with an Impurity**

Soichiro Tanaka (Kyoto University), Masayuki Kimura (Kyoto University), Shinji Doi (Kyoto University)

⇒ Proc. pp. 579–582, [Paper ID: 5186]

Intrinsic localized modes (ILMs) are known as energy localized vibrations in nonlinear coupled oscillators. In particular, in the flexible Fermi-Pasta-Ulam (FPU) chain, the existence of various ILMs such as longitudinal, transverse, and rotating ILMs has been numerically shown, and the mobility of the ILMs has also been investigated. We have focused on moving ILM and have been studying a method for generating moving ILMs in the FPU chain for applications in phonon engineering. In the one-dimensional FPU chain, moving ILMs can be excited by driving an edge of the chain. However, amplitude and frequency of the excitation for generating a train of moving ILMs without exciting non-localized waves have not been clarified yet. In this study we introduce the variance of peak values and peak intervals of energy distribution at a certain time for identifying a parameter region in which moving ILMs are generated without exciting non-localized/traveling waves. As a result, the parameter region can be clearly distinguished from the other regions by the smallness of the variance.

**Keywords:** Intrinsic Localized Mode, Supratransmission, Nonlinear

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## D1L-A Special Session: Nonlinear Time Series Analysis

DATE: 2018/9/6 08:30–10:10

ROOM: Room 1

Chair: Takaya Miyano (Ritsumeikan University)

**D1L-A1 Detection of Blowout in a Laboratory-Scale Gas-Turbine Model Combustor**

Tsubasa Kobayashi (Tokyo University of Science), Motoi Funatsu (Tokyo University of Science), Hiroshi Gotoda (Tokyo University of Science)

⇒ Proc. pp. 583–584, [Paper ID: 5171]

We have conducted an experimental study using an online detection method based on complex-network theory to prevent the onset of blowout in a laboratory-scale gas-turbine model combustor with swirl-stabilizer. We introduce the horizontal visibility graph algorithm as a pragmatic online detector. The cluster coefficient of the horizontal visibility graph enables us to detect the onset of blowout

**Keywords:** blowout, detection, horizontal visibility graph

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**D1L-A2 Dynamic Behavior of Flow Velocity Fluctuations During High-Frequency Combustion Oscillations in a Cylindrical Combustor with an Off-Center Installed Coaxial Injector**

Tatsuya Hashimoto (Tokyo University of Science), Hiroshi Gotoda (Tokyo University of Science), Yuya Ohmichi (Japan Aerospace Exploration Agency), Shingo Matsuyama (Japan Aerospace Exploration Agency)

⇒ Proc. pp. 585–588, [Paper ID: 5165]

We have conducted a numerical study on characterization of dynamic behavior of flow velocity fluctuations during high-frequency combustion oscillations in a cylindrical combustor with an off-center installed coaxial injector from the viewpoints of statistical complexity and complex-network-theory. A clear power-law decay in terms of the vertex strength appears in weighted networks between vortices, indicating the presence of scale-free structure. The dynamic behavior mainly consists of noisy-periodic oscillations, stochastic dynamics, and deterministic chaos, which is clearly shown by the multiscale complexity-entropy causality plane.

**Keywords:** Complex-Network Theory, High-frequency Thermoacoustic Combustion Oscillation, Large-eddy Simulation

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**D1L-A3 Feature Pattern Extraction Using Data Synchronization from Time Series of Wind Velocity**

Shinya Takaramoto (Ritsumeikan University), Takaya Miyano (Ritsumeikan University)

⇒ Proc. pp. 589–592, [Paper ID: 5122]

We applied data synchronization as a method of feature extraction from multivariate data to a time series of 2-dimensional wind velocity actually observed at the Biwako-Kusatsu Campus of Ritsumeikan University. Four major patterns were extracted from the time series, which might be