

COMMISSION C: SIGNALS AND SYSTEMS

Edited by Masami Akaike

C1. Digital signal processing

Research and development in the field of digital signal processing have been very active in Japan for past three years. Especially, various new methods have been investigated in adaptive signal processing, applications of signal processing, implementations of signal processing systems, nonlinear signal processing, theory and algorithms of signal processing, and so on.

Adaptive signal processing or adaptive filter design is continuous research topic in digital filtering.

Some adaptive algorithms including a gradient type algorithm for blind system [Higa et al., 1999], an algorithm for lattice all-pass filter with minimum multipliers [Okello et al., 1999], Sign-Sign algorithm based on Gaussian distributed tap weights [Koike, 2000], INLMS algorithm [Fujii et al., 2000], and an algorithm for cascaded notch filter [Okello et al., 2001] were investigated. An analysis method for adaptive filters using LMS algorithm [Koike, 1999] was developed.

Some application systems including noise canceller [Ikeda et al., 1999], RLS equalizer [Shimamura et al., 2001], beamformer for microphone arrays [Hoshuyama et al., 1999], wideband beamspace adaptive array [Sekiguchi et al., 2000] and echo canceler [Sugiyama et al., 1998] have been developed.

Some design and implementation techniques such as pipelined LMS adaptive filters [Kimijima et al., 1999], RLS adaptive filters [Nishikawa et al., 2000], multidimensional linear-phase paraunitary filter banks [Muramatsu et al., 1999], universal maximally flat lowpass FIR filter [Samadi et al., 2000], [Samadi et al., 1999] and FIR filters with CSD coefficients [Yamada et al., 2001] were discussed.

In the research area of nonlinear signal processing, a hierarchical Bayesian approach for nonlinear dynamical systems [Matsumoto et al., 2001] was proposed. Nonlinear adaptive filters by using recurrent neural networks [Lu et al., 2001], nonlinear pre-filter for a set-theoretic linear blind deconvolution scheme [Kato et al., 2000], sinusoidal estimator using Kalman filter [Nishiyama, 2000] were proposed.

A complex-valued compact-supported orthonormal symmlets [Zhang et al., 2001] was investigated. Digital differentiators based on Taylor series [Khan et al., 2001] was discussed. Design methods of perfect reconstruction filter banks for FIR [Yan et al., 1999], [Hasegawa et al., 2000] have been proposed. An extended algorithm of split-radix FFT [Takahashi, 2001] was presented.

Blind source separation and identification for various applications [Kagiwada et al., 1998], [Amari, 1999], [Ohno et al., 2001] were developed.

Wavelet signal space was applied to error estimation [Chen et al., 1999] and detection of pulse sequence [Ohsumi et al., 1999].

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C2. Optical Signal Processing

In the field of optical signal processing, optical devices integrated with electrical circuits and optical interconnection technologies have been extensively studied because of recent needs for image processing. Smart pixels with optical I/O connections and electrical circuits have been investigated as a key element for parallel signal processing. An integrated single-chip 8x8 array of processing elements and photodiodes named Optoelectronic Computer Using Laser Arrays with Reconfiguration II (OCULAR-II) was fabricated, and an optically interconnected reconfigurable system was demonstrated by using it [McArdle et al., 2000]. Smart pixels with hybrid integration of vertical cavity surface emitting lasers (VCSEL) as light sources and photodiodes and CMOS circuits were realized [Nakahara et al., 1999]. The pipe lined digital correlator (PDC) for the optoelectronic discrete correlation processor (OEDCP) as OE hybrid computing system, which consists of optical fan-in and fan-out interconnection system, was designed and fabricated [Nitta et al., 2001]. As for an image processing, an artificial retina LSI chip which had a 32x32 array of photodetectors was fabricated for high-accuracy on sensor image projection, and motion detection system was demonstrated [Funatsu et al., 2000]. A novel optical time-to-two-dimensional(2D)-space-to-time-to-2D-space conversion technique for ultrafast image transmission with ultrashort-pulse lasers was proposed and demonstrated [Konishi et al., 1999]. A new design procedure for binary zone-plate array (BZPA) was proposed and applied it to a parallel joint transform correlator for the recognition of the human face [Kodate et al., 1999]. As for an optical communication, time space conversion-based differential processing of optical signals by using a high resolution arrayed-waveguide grating (AWG) and a spatial filter was proposed and demonstrated [Takenouchi et al., 1999].

(H. Sakata)

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C3. Circuits and Systems

In these three years, studies on circuits and systems have been very active in Japan. The most remarkable activity was seen in the field of nonlinear sciences such as chaos, bifurcation, neural networks, etc.

Since Ueda's first systematic observation on chaos, studies on chaos and bifurcation have been very active in Japan. A new concept of spatio-temporal expansion to the time delayed feedback control system was introduced [Hikiyama and Ueda, 1999]. It is a clue to grasp the dynamics in a functional space and has a potential to analyze the stability of the system with delay. Moreover, it was made clear that the heteroclinic intersections between the manifolds of unstable wave solutions are substantial to the onset of wave propagations [Hikiyama, Torii and Ueda, 2001].

A method to calculate bifurcations of periodic solutions in Hodgkin-Huxley neurons coupled by excitatory synapses with a time delay was proposed [Yoshinaga, Sano and Kawakami, 1999], and synchronization phenomena in chaotic oscillators coupled by a transmission line are investigated [Kawata, Nishio and Ushida, 2001]. A chaotic neurodynamical searching method for quadratic assignment problems and an automatic parameter tuning method for robust applications were also proposed [Hasegawa, Ikeguchi and Aihara, 2000].

Studies on neural networks and chaotic neural networks have also been very active in Japan. Synchronous burst firing and global bifurcations in a chaotic neural network model was studied to investigate various temporal patterns of spikes in the brain [Kitajima, Yoshinaga, Aihara and Kawakami, 2001], and a new sufficient condition for cellular neural networks with delay to be completely stable was given [Takahashi, 2000]. It was also proved that chaotic neural networks have a strange attractor [Chen and Aihara, 2000]. Furthermore, information geometry was applied to the manifold of neural networks called multilayer perceptrons [Amari and Ozeki, 2001].

Related to system theory, fluctuation analysis of information-transfer systems with feedback confirmation channels by means of fuzzy-set-valued mapping concept was studied [Horiuchi and Endo, 2001], and a mathematical theory for available operation of network systems extraordinarily complicated and diversified on large-scales was developed [Horiuchi, 2001]. Moreover, it was shown that the solution to a conventional problem of filtering or prediction of a nonstationary time series is reducible to a problem of which solution is given by Kalman-Bucy's theory [Koga, 2001].

Related to circuit simulation, a new algorithm for finding the steady state solution of nonlinear circuits driven by one tone periodic input signal was proposed [Uatrongjit and Fujii, 1998], and an efficient algorithm was proposed to solve communication circuits driven by multi-tone signals which is based on the frequency-domain relaxation method and the multi-dimensional Fourier transformation [Yamagami, Nishio, Ushida, Takahashi and Ogawa, 1999]. A globally convergent algorithm using a homotopy method was proposed for solving modified nodal equations (which are used in SPICE), and it was shown that this algorithm converges to a stable operating point with high possibility from any initial point [Yamamura, Sekiguchi and Inoue, 1999]. Using the homotopy method, bipolar analog integrated circuits with more than 16,000 elements were developed.

Some results on the number of solutions for a class of piecewise-linear (PWL) equations related to transistor circuits were shown [Jitsumatsu and Nishi, 2001], and an efficient algorithm for finding all solutions of PWL resistive circuits was proposed, which could find all solutions of PWL resistive circuits where the number of PWL registers is 300 and the number of linear regions is 10300 in practical computation time [Yamamura and Yomogita, 2000].

Related to graphs and networks, many papers have been published; as for details, see [Watanabe and Shinoda, 1999] and [Mase, Sengoku and Shinoda, 2001]. Furthermore, the problem of obtaining an optimal file transfer on a file transmission is discussed [Kaneko and Shinoda, 2000], and an algorithm for statistical static timing analysis considering correlations between delays was proposed [Tsukiyama, Tanaka and Fukui, 2001].

(K. Yamamura)

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C4. Satellite Communications

<Commercial Services> A S band satellite mobile packet communication system was integrated with N-STAR a and N-Star b, which were launched in 1995 and 1996, respectively [Inoue et al., 2001]. The system has been providing Internet and Intranet access service for those customers, where the terrestrial system is not serving, mainly maritime users, since March 2000. In July 2001, the Aeronautical Mobile Satellite Service was initiated to replace the terrestrial aeronautical telephone system with limited service areas and altitudes [Nitta et al., 2001].

<Satellite Communication Systems> A role of Broadband Satellite Communication System was investigated with respect to the throughput capacity and the size of large antenna reflector [Ueba et al., 2000]. After the proposal of the concept of the gigabit communication satellite which satisfies the demands placed on satellite systems by the future multimedia applications in the optical fiber era, its development status was reported [Kadowaki et al.,1998]. A satellite communication system that enables high-speed communication in a mobile environment was proposed, whose configuration combines a terrestrial mobile network for return link and an existing Ku band satellite system for forward link. The validity of the system was confirmed by using a trial product of tracking antenna system [Nagase et al.,2001]. Based on the concept of Next generation LEO System, satellite constellation for the NELs was designed and four kinds of key technologies are focused and developed [Suzuki et al., 2000]. To reduce the voice delay of the GEO mobile satellite communication systems, in which a communication passes through the GEO satellite twice, single-hop connection methods are investigated with respect to a through repeater satellite and a regenerative satellite [Ebina et al.,

2001]. A new satellite communications system called the direct-multicasting satellite communications system was proposed and its performance evaluation was reported. The proposed system adopts an autonomous decentralized satellite channel assignment control system[Okada et al., 2001].

<Experiments> After the injection into a transfer orbit, several experiments using Communications and Broadcasting Engineering Test Satellite (COMETS), with Ka-band and Millimeter-wave payload, were made and their results were evaluated [Wakana, et al., 2000]. Following the announcement, a plan to make experiments using ETS-VIII (Engineering Test Satellite-VIII) was made public [Homma et al., 2000]. High speed satellite communication experiment of HDTV transmission and IP over ATM transmission, which was agreed between Korea and Japan, was carried out and 35 Mbps throughput with TCP and XTP over IP was confirmed [Nishinaga et al., 2001]. After the proposal of the “figure of eight” satellite system which uses inclined geostationary orbits, the method to evaluate its characteristics of higher elevation angles for land-mobile satellite communications in urban areas with respect to blockage was proposed and confirmed that the new satellite system is more suitable for land-mobile satellite communications in metropolis [Takahashi et al., 1999]. The development of LUCE(Laser Utilizing Communications Equipment) for OICETS(Optical Inter-orbit Communications Engineering Test Satellite) was completed and its test was performed to demonstrate the tracking capabilities[Aoki et al.,2001]. The performance of Bi-directional multimedia satellite communication systems with portable terminals (A4 size) employing superposed transmission was experimentally confirmed [Toshinaga et. al., 2001].

<Key Technologies> On-board components have been developed for new services and future satellite communication systems [Taira et al., 2000], [Taira et al., 2001], [Kadowaki et al.,2001]. A microwave signal processing device has been developed for active phased array beam forming and steering. A large scale beam forming network, comprising 63 power dividers and 32 pairs of phase/amplitude controllers, has been developed and qualified by ground testing [Suzuki et al., 2000]. S band as well as Ka band active phased array antennas have been researched and developed to achieve high EIRP and G/T [Tokunaga et al., 1999], [Kadowaki et al., 1999]. The modular type mesh antenna reflector has been investigated to make mobile terminals smaller. The feature of this reflector is that several nearly identical modules are combined to achieve the required aperture size. The mechanical error for the mesh antenna reflector caused by combining modules was evaluated [Watanabe et al.,1999] and the radiation patten was confirmed to meet the specifications [Senbokuya et al.,2000]. The validity of the proposed scheduling discipline of an adaptive MPEG2-TS Packet for multimedia broadcasting was experimentally confirmed to offer efficient and flexible multiplexing [Teruhi et al., 2001]. High power SSPAs for S band and C-band have been developed [Ishida et al., 2000], [Ogura et al.,2001]. A novel technique to suppress intermodulation distortion was developed and confirmed to be useful [Kaho et al., 2001].

(M. Ueba)

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C5. Mobile radio communications

The third generation mobile communications system based on the Wideband CDMA technology was launched in May 2001, in Japan. To realize the system, a lot of novel technologies have been developed such as 2 Mbps data transmission with multi-code wideband transmission [Okawa, K. et al 2000] and adaptive antenna array diversity [Tanaka, S. et al 2000].

The research interests are shifting from the third generation system to its enhancement and the fourth generation system. One of the important goals for the enhancement of the third generation system is to improve downlink packet transmission throughput by adaptive modulation and coding (AMC). [Ue, T. et al 1998] showed the performance of adaptive symbol rate and modulation level control in TDMA/TDD scheme. Multipath Interference Canceller [Sawahashi, M. et al 2000] can improve throughput of the AMC transmission under fading environment, and a maximum throughput of 8 Mbps is possible with 5 MHz radio bandwidth. "SSDT" site selection diversity transmission power control scheme [Furukawa, H. et al 2000] was also studied to increase link capacity for high-speed down link packet transmission.

Regarding the fourth generation system, "System beyond IMT-2000", system vision and requirements study was done [Yamao, Y. et al 2000]. Mobile radio access schemes with more than 20 Mbps speed, using DS-CDMA [Ikeda, T. et al 2001], Multi-carrier /DS-CDMA and MC-CDMA [Abeta, S. et al 2001] were investigated.

Software Radio [Kohno, R. et al 2001], and dual-band integrated antenna [Amano, T. et al 1999] were the other key technologies for future multi-band and multi-protocol terminals. Basic research on the user mobility characteristics [Kobayashi, T. et al 1999] showed that the cell dwell time of vehicles follows a lognormal distribution, which will influence design of future microcellular systems.

(Y. Yamao)

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C6. Optical Fiber Communications

High-speed, large capacity optical transmission experiments over 1 Tbit/s were reported. A 1.28 Tbit/s TDM transmission [M. Nakazawa et al., 2000], a 3 Tbit/s (160 Gbit/s x 19 channels) TDM/WDM transmission [S. Kawanishi et al., 1999], and a 10.92 Tbit/s (40 Gbit/s x 273channels) TDM/WDM transmission experiment [K. Fukuchi et al., 2001] were successfully demonstrated. Studies on multi-channel optical signal source for WDM systems achieved >1000-channel simultaneous generation using a single source based on supercontinuum in fiber [H. Takara et al., 2000]. A 1010 channel, 10 GHz-spaced WDM demultiplexer was also developed for super-DWDM systems [K. Takada et al., 2001]. Optical signal processing based on all-optical switches are attracting interest and 100 Gbit/s all-optical time-division multiplexing was reported using quasi-phase matched LiNbO₃ waveguide based on cascaded c(2) nonlinear switching [S. Kawanishi et al., 2000]. Loss reduction of a photonic crystal fiber (holey fiber) was realized and 3.2 dB/km was reported [H. Kubota et al., 2001].

A 43 Gb/s x 30-channel high-speed (1.2Tbit/s) WDM transmission experiment over 376 km was successfully performed [Y. Miyamoto et al., 2000]. A various new high-speed optical devices were developed, for instance, 40Gbit/s class LiNbO₃ optical modulator [K. Noguchi,

1999]. A first field trial using OTN-based 43 Gbit/s prototype system was successfully demonstrated [S. Kuwahara et al., 2001]. Moreover, a 40Gbit/s direct modulation using a commercially available 1.3 μ m DFB laser was successfully demonstrated [K. Sato et al. 2002] .

The prototype of Photonic MPLS Router has been developed[F. Kano,et al. 2001 NFOEC]. Setting and removing of the Optical Label Switched Path (OLSP) had been successfully demonstrated following to the constrained-based routed label distribution protocol (CR-LDP) messages [K. Shimano,et al. 2001 ECOC].

(Ken-ichi Sato)

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C7. Broadcasting

A new digital satellite broadcasting service on the 12-GHz band (Integrated Services Digital Broadcasting-Satellite: ISDB-S) started in December 2000. ISDB-S is providing HDTV programs, SDTV programs, independent sound programs, and multimedia data services via high-powered broadcasting satellites. A digital terrestrial broadcasting system has been discussed, and ISDB-T (Terrestrial) was adopted as the standard of the ITU-R for digital terrestrial television and sound broadcasting. Advancements toward next-generation services have been made, including development of a three-dimensional video service and an interactive television service with a home server.

ISDB-S, a new digital multimedia service via broadcasting satellite, has a high-speed transmission rate (maximum: 52.2 Mbps) for transmitting two HDTV programs and several data services within a single 12-GHz broadcasting satellite service channel. The modulation scheme is TC8PSK (trellis coding 8PSK), and the video/audio-coding scheme is MPEG2 [Nakada and Omura, 2000].

Research into a future 21-GHz-band satellite broadcasting system is now underway. A major technical difficulty with satellite broadcasting using frequency bands above 20 GHz is the large rain attenuation. Using the adaptive pattern synthesis technique of phased array antennas would make it possible to reconfigure the radiation pattern for a service according to the distribution of rainfall [Tanaka et al., 2001].

ISDB-T service is scheduled to start in 2003 in three major metropolitan areas in Japan (Tokyo, Osaka, and Nagoya). Pilot broadcast stations have been set up to conduct transmission experiments. Field trials in the Tokyo area showed that the required minimum field strength in the UHF band for stationary reception is about 57 dB μ V/m, assuming the carrier modulation scheme is 64 QAM. They also showed that time interleaving is effective for mobile reception [Tsuchida et al., 2000].

A single-frequency network (SFN) is needed to achieve efficient channel use with digital terrestrial broadcasting. To overcome the distortions caused by coupling between transmitting and receiving antennas at the relay stations, a coupling loop interference canceller that can electrically eliminate such degradation was developed. Field trials in March 2000 of an experimental relay transmitter with a prototype canceller showed that operation was stable under the severe condition where the power of the coupling loop interference was almost equal to that of the desired signal [Hamazumi et al., 2001].

A prototype home server that can automatically record a viewer's favorite programs for subsequent viewing at any time has been developed. It can play back digitally recorded HDTV programs while recording another one, and it can record over four hours of HDTV programs

and play them back without having to wait for the programs to finish being recorded [Kurioka et al., 1999].

Three-dimensional TV service should be an attractive next-generation. A real-time three-dimensional video system based on integral photography will provide an auto stereoscopic image from any desired viewpoint without the use of viewing glasses [Okano et al., 1999].

A broadcast transcription system using a speech-recognition algorithm has been developed and has been used for automatic closed-captioning service on news programs since March 2000. A speech-recognition system automatically converts the announcer's speech into textual data. This barrier-free system is helping hearing-impaired viewers enjoy TV programs [Ando et al., 2000].

TV broadcast centers must handle high-speed digital video signals, as well as many signal formats (SDTV, HDTV, MPEG, and so on). The routing networks in TV broadcast centers should therefore have a large capacity and flexible operation. To cope with this requirement, a wavelength-division and time-division hybrid multiplexed (WD/TD) optical network has been applied to TV broadcast centers [Shiozawa et al., 1999].

An ultrahigh-sensitivity "New Super-HARP (high-gain avalanche rushing amorphous photoconductor)" handheld camera was developed. Its sensitivity is about 100 times that of a CCD camera, making it a powerful tool for reporting breaking news at night and in other low-light conditions [Tanioka et al., 2001].

Research on flat panel displays continues to progress. The plasma display panel (PDP) is a promising candidate for use as a high-quality-picture flat panel display for wall-hanging television sets. The deterioration in the areas with moving pictures, called a false contour artifact and a big problem of PDPs, has been mostly overcome with the use of "time-compression of emission". A digital HDTV receiver with a 50-in-diagonal plasma display panel has been developed and put on the market. [Yamamoto et al., 2001].

TVML (TV Program Making Language), a text-based language, has been developed for making complete TV programs on a PC. A TVML player on a PC generates a TV program in real time, using real-time computer graphics, synthesized voice, and other multimedia functions. TVML substantially reduces both the time and cost of program production [Hayashi et al. 2001].

(T. Nomoto)

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Editor

Masami Akaike

Faculty of Engineering

Tokyo University of Science

Contributors

S. Hangai

Faculty of Engineering

Tokyo University of Science

Takayuki Hamamoto

Faculty of Engineering

Tokyo University of Science

Yuichi Matsushima

KDDI R&D Laboratories, Inc.

Haruhisa Sakata

KDDI R&D Laboratories, Inc.

Kiyotaka Yamamura
Faculty of Science and Engineering
Chuo University

Masazumi Ueba
NTT Network Innovation Labs.
Wireless Systems Innovation Laboratory

Yasushi Yamao
Wireless Systems Laboratories
NTTDoCoMo

Ken-ichi Sato
NTT Network Innovation Labs.
Photonic Transport Network Laboratory

Toshiyuki Nomoto
Digital Satellite Broadcasting Systems
NHK Science and Technical Research Laboratories