

## Computer Organization Laboratory



Toshiaki Miyazaki  
Professor



Hiroshi Saito  
Associate Professor

The following researches are progressed in Computer Organization Laboratory:

Toshiaki Miyazaki:  
has mainly two topics as follows:

- *Die-hard sensor network* is a wireless sensor network that has an autonomous function alternation mechanism among sensor nodes as well as ordinary wireless sensor network capabilities such as automatic network establishment. With this mechanism, we can realized self-organized and maintenance-free sensor network systems. Its applications include surveillance of disaster-hit region, and river and forest monitoring. We are developing not only sensor-node hardware but also protocols equipped to the sensor node.
- *Custom Computing* is a research field to realize a dedicated hardware using programmable logic devices such as FPGAs (Field Programmable Gate Arrays) in order to solve a give problem effectively. We focused on two applications; BLAST accelerator.
  - BLAST accelerator: Basic Local Alignment Search Tool (BLAST) is one of the most popular sequence alignment tools. Sequence alignment is used to extract similar parts of the input protein (or DNA) sequence from protein (or DNA) databases, in order to investigate biological evolution and genomic genealogy. It is a very important and difficult task in bioinformatics. Although BLAST is well tuned to effective sequence alignment, the performance is still not enough to deal with the rapid growing of the databases. BLAST consists of three steps: query words

and neighborhood word list creation (step 1), word-hit search and un-gapped extension (step 2), and gapped extension (step 3). We are developing a hardware accelerator that performs abovementioned all processing steps of for BLAST.

Hiroshi Saito:

Our research interests are design of asynchronous circuits and its automation. Asynchronous circuits are circuits where circuit components are controlled by pairs of local handshake signals instead of a global clock signal. Because of the absence of a global clock signal, asynchronous circuits are low power and low electromagnetic interference compared to synchronous counter parts which use global clock signals. Our research topics are as follows.

- Synthesis of asynchronous circuits from a behavioral model specified by C language
- Design of low power and low energy asynchronous circuits
- Synthesis of networks-on-chip architecture from a behavioral model such as Mathworks Simulink

## Summary of Achievement

### Refereed Journal Papers

- [hiroshis-01:2012] N. Hamada and H. Saito. Integration of Behavioral Synthesis and Floorplanning for Asynchronous Circuits with Bundled-Data Implementation. *IEICE Transaction*, E95-C(4):506–515, 2012.

In this paper, we propose a synthesis method .....

- [miyazaki-01:2012] T. Miyazaki. Dynamic Function Alternation to Realize Robust Wireless Sensor Network. *International Journal of Handheld Computing Research (IJHCR)*, 3(3):17–34, 2012.

In this paper, a distributed algorithm to realize a dynamic function alternation is proposed. The algorithm enables sensor nodes to take over the damaged functions of their neighboring sensor nodes automatically in a wireless sensor network. After describing the concept of the function alternation, the algorithm is explained in detail with some evaluation results. Comparing the results obtained using the proposed algorithm with those obtained using non-function alternation methods shows that the proposed algorithm makes the initial functionality of each sensor function sustainable even if some sensor nodes are damaged. A wireless sensor network system dedicated to disaster monitoring is also introduced, as an application of the proposed function alternation algorithm.

### Refereed Proceeding Papers

- [hiroshis-02:2012] Y. Nakamura H. Saito, T. Yoneda. An ILP-based Multiple Task Allocation Method for Fault Tolerance in Networks-on-Chip. In *Proc. IEEE International Symposium on Embedded Multicore SoCs*, pages 100–106, 2012.

This paper proposes a multiple task allocation .....

- [miyazaki-02:2012] Y. Kasama and T. Miyazaki. Simultaneous Estimation of the Number of Humans and their Movement Loci in a Room using Infrared Sensors. In *Proc. 2012 IEEE Workshops of International Conference on Advanced Information Networking and Applications (AINA2012 Workshop, HWISE2012)*, pages 508–513, March 2012.

When creating a ubiquitous service environment for humans, it is very important to be able to determine their location and movement. In this paper, we propose an algorithm that simultaneously estimates the number of humans

and the movement locus for each human in a room, using only the binary sensing data obtained from infrared sensors attached to the ceiling. Compared to other camera-based systems, the estimation results of our algorithm can be used directly in application systems without violating anyone's privacy. After describing the proposed algorithm in detail, we then describe our evaluation results.

- [miyazaki-03:2012] T. Miyazaki and Y. Kasama. Estimation of the Number of Humans and their Movement Paths in a Room using Binary Infrared Sensors. In *Proc. ACM International Conference on Ubiquitous Information Management and Communication (ICUIMC2012)*, page DOI:10.1145/2184751.2184858, February 2012.

It is very important to be able to determine humans' locations and their movement in order to a ubiquitous service environment. In this paper, we propose an algorithm that simultaneously estimates the number of humans and the movement path for each human in a room, using only the binary sensing data obtained from infrared sensors attached to the ceiling. Compared to other camera-based systems, the estimation results of our algorithm can be used directly in application systems without violating anyone's privacy. After describing the proposed algorithm in detail, we then describe our evaluation results.

- [miyazaki-04:2012] T. Miyazaki, D. Shitara, R. Kawano, Y. Endo, Y. Tanno, and H. Igari. Robust Wireless Sensor Network Featuring Automatic Function Alternation. In *Proc. IEEE ICCCN 2011 Workshop on Privacy, Security and Trust in Mobile and Wireless Systems (MobiPST 2011)*, page DOI:10.1109/ICCCN.2011.6005770, July 2011.

A function alternation mechanism is proposed. It enables sensor nodes to take over the damaged functions of their neighboring sensor nodes automatically. By introducing the mechanism in a wireless sensor network (WSN), we can realize a WSN that never stops monitoring, and does not require maintenance after it is deployed, even if some sensor nodes suddenly die. In this paper, after explaining the details of the function alternation mechanism along with some evaluation results, we introduce a mission-critical application that utilizes the proposed function alternation mechanism for monitoring disaster-hit regions.

- [miyazaki-05:2012] T. Hayashi, A. Kara, T. Miyazaki, J. Iwase, H. Fukuhara, T. Saburi, and M. Hisada. Coping with the Complexity of SOA Systems with Message Forensics. In *Proc. 2012 IEEE Workshops of In-*

## Summary of Achievement

*ternational Conference on Advanced Information Networking and Applications (AINA2012 Workshop, SMPE2012)*, pages 732–737, March 2012.

This paper introduces an approach to construct SOA (Service Oriented Architecture) systems using the so called a synchronous messaging network. An asynchronous messaging network (or simply messaging network) refers to an overlay network (over LAN, VPN, Internet, etc.) that allows exchanging well-formatted asynchronous messages (typically in XML) between the service providers and consumers in the system. The proposed approach aims at reducing the operation and maintenance cost of the system by using a messaging network enhanced with the capability to store, inspect and analyze selected portions of the exchanged messages under the strict control of security and privacy. Complexity makes any information system vulnerable to design flaws, operation error, and security problems. The proposed approach facilitates analyzing these problems associated with complex SOA systems through the message-store analysis. We consider that the application of computer forensics to the message store in SOA helps the system administrator to identify and fix various problems. The requirements for the messaging network for SOA systems are also presented.

[miyazaki-06:2012] T. Hayashi, H. Fukuhara, M. Hisada, K. Suzuki, T. Yamada, Y. Watanabe, J. Terazono, T. Suzuki, T. Miyazaki, S. Saito, I. Kosedo, and J. Iwase. A network-centric approach to sensor-data and service integration. In *Proc. SICE Annual Conference 2011*, pages 2037–2042, September 2011.

Sensor net require the information integration of various sensors and related contents and services. The present paper describes an approach to the construction of a sensor network using a content-aware network so called messaging network. A messaging network can be constructed as a structured overlay network. The proposed scheme enables loosely-coupled integration of sensor data and related services. The proposed scheme can be realized by an overlay network over an ordinary IP network. The paper also introduces a policy mediation, which is a kind of message mediation, for over-lay networks having each own policies enables secure overlay networks inter-operation. This paper also introduces a secure data-store grid for sensor network. The data-store grids helps to construct and manage as secure, flexible, elastic, and sustainable loosely coupled integration of sensor data and related services. The application of the proposed scheme to SmartGrid and health-care system are discussed.

## Unrefereed Papers

- [miyazaki-07:2012] H. Iwata and T. Miyazaki. Estimation of Perimeters and Sizes of Multiple Objects Using Binary Sensors. In *IEEE student session in 2012 Tohoku-Section Joint Convention of Institutes of Electrical and Information Engineers, Japan*, volume 1A01, August 2012.
- [miyazaki-08:2012] S. Ishikawa, A. Tanaka, and T. Miyazaki. An approach to accelerating BLAST algorithm using dedicated hardware (BLAST アルゴリズム全体のハードウェア化による高速化の検討). In *IPSSJ 75th National Convention*, volume 3K-3, March 2013.
- [miyazaki-09:2012] K. Kobayashi and T. Miyazaki. An Approach to Multiple Role Assignments for Wireless Sensor Nodes (無線センサノードに対する複数機能の動的割り当て法の検討). In *2013 IEICE General Conference*, volume B-19-22, March 2013.
- [miyazaki-10:2012] H. Igashima and T. Miyazaki. A geometric routing considering network reliability for multisink wireless sensor networks (マルチシンク無線センサネットワークにおける通信の信頼性を考慮したジオメトリックルーティングの提案). In *IPSSJ 75th National Convention*, volume 2Y-7, March 2013.
- [miyazaki-11:2012] Y. Kasama and T. Miyazaki. An Approach to Movement Loci Estimation for Multiple Humans in a Room Using Binary Infrared Sensors (室内における赤外線センサを用いた複数人の移動軌跡推定法の提案). In *IPSSJ 75th National Convention*, volume 4V-1, March 2013.
- [miyazaki-12:2012] S. Yamaguchi and T. Miyazaki. An Approach to Information Management and Shearing among Sensor Nodes (センサノード間の情報管理・共有法の提案). In *IPSSJ 75th National Convention*, volume 1Y-4, March 2013.
- [miyazaki-13:2012] Y. Nishimaki, J. Kitamichi, and T. Miyazaki. A Simulator Visualizing Inside Behaviors of MIPS Processor (内部動作を視覚化した教育用 MIPS プロセッサシミュレータ). In *IPSSJ 75th National Convention*, volume 6ZC-7, March 2013.
- [miyazaki-14:2012] A. Tanaka, S. Ishikawa, and T. Miyazaki. A General Hardware Accelerator for Dynamic Programming (動的計画法向け汎用ハードウェア

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アアクセラレータの提案). In *IPSJ 75th National Convention*, volume 3K-2, March 2013.

[miyazaki-15:2012] H. Iwata and T. Miyazaki. An approach to flexible management method for huge sensor data (大規模センサデータに対する柔軟な管理法の提案). In *IPSJ 75th National Convention*, volume 1Y-3, March 2013.

[miyazaki-16:2012] T. Miyazaki, T. Hayashi, T. Tsukahara, S. Guo, and J. Kitamichi. Demand Addressable Sensor Network: Towards Demand-driven Large-scale Sensor Network. In *IEICE Technical Report (Invited Talk)*, volume –, March 2013.

[miyazaki-17:2012] S. Ishikawa, A. Tanaka, and T. Miyazaki. An FPGA implementation of BLAST Algorithm. In *IPSJ Tohoku Section Workshop*, volume –, February 2013.

The encouragement award of IPSJ-TOHOKU

## Grants

[hiroshis-03:2012] H. Saito. Ministry of Education Scientific Research Fund, 2012-2014.

[hiroshis-04:2012] T. Hanyu H. Saito K. Kise T. Yoneda, M. Imai. Core Research for Evolutional Science and Technology of Japan Science and Technology Corporation, 2008-2013.

[miyazaki-18:2012] T. Miyazaki. JSPS KAKENHI (Grants-in-Aid for Scientific Research), 2011-2013.

[miyazaki-19:2012] T. Miyazaki. MIC Strategic Information and Communications R and D Promotion Programme (SCOPE), 2012–2014.

## Academic Activities

[hiroshis-05:2012] H. Saito, September 2012.

Financial Chair, IEEE MCSoc 2012.

[miyazaki-20:2012] T. Miyazaki, 2012-1013.

IEEE Sendai Section, Executive Committee Member

[miyazaki-21:2012] T. Miyazaki, 2012.

Steering committee member, Technical Group for Function Integrated Information System (FIIS)

[miyazaki-22:2012] T. Miyazaki, 2012.

Steering Committee Member, CIT2012 (11th International Conference on Computer and Information Technology)

[miyazaki-23:2012] T. Miyazaki, 2012.

Program Chair, MCSoc-12 (IEEE 6th International Symposium on Embedded Multicore Systems-on-Chip)

[miyazaki-24:2012] T. Miyazaki, 2012.

Technical Program Committee Member, ISVLSI (IEEE Computer Society Annual Symposium on VLSI)

[miyazaki-25:2012] T. Miyazaki, 2012.

Technical Program Committee Member, MobiPST (International Workshop on Privacy, Security and Trust in Mobile and Wireless Systems)

[miyazaki-26:2012] T. Miyazaki, 1984 – present.

Member

[miyazaki-27:2012] T. Miyazaki, 1986 – present.

Member

[miyazaki-28:2012] T. Miyazaki, 2012 – present.

Senior Member

## Patents

[miyazaki-29:2012] T. Miyazaki. Sensor network system and data auistion method in the sensor network system Pending Patent

特願 2012-204403, September 2012.



## Summary of Achievement

[miyazaki-30:2012] T. Miyazaki. SENSOR DEVICE, SENSING INFORMATION COLLECTION SYSTEM, AND METHOD AND PROGRAM OF ALTERNATIVE TO SENSING FUNCTION PAT. No. P5099777, December 2012.

## Ph.D and Others Theses

[hiroshis-06:2012] M. Iizuka. Master thesis: Development of an ASIC Design Support Tool Set for Non-pipelined Asynchronous Circuits with Bundled-data Implementation, University of Aizu, 2012.

Thesis Advisor: H. Saito

[hiroshis-07:2012] H. Katabami. Master thesis: A GALS-NoC Implementation using Soft-Cores on FPGAs, University of Aizu, 2012.

Thesis Advisor: H. Saito

[hiroshis-08:2012] D. Akihama. Master thesis: A Power Optimization Method using Mobility for Non-pipelined Asynchronous Circuits with Bundled-data Implementation, University of Aizu, 2012.

Thesis Advisor: H. Saito

[hiroshis-09:2012] D. Yoshida. Master thesis: Development of High-level Verification Support Environment for Asynchronous Circuits with Bundled-data Implementation, University of Aizu, 2012.

Thesis Advisor: H. Saito

[hiroshis-10:2012] R. Yasuda. Graduation thesis: A Task Graph Generator for Simulink Models, University of Aizu, 2012.

Thesis Advisor: H. Saito

[miyazaki-31:2012] Naoto Sagami. Graduation Thesis: A General Purpose Toroidally-connected 2D Array Processor, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-32:2012] Taiko Kawasaki. Graduation Thesis: A Software Program Distribution Method Using Attributes of Sensor Nodes for Wireless Sensor Networks, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-33:2012] Ronghua Zhu. Master Thesis: Ring Array Processor Architecture to Perform High-Speed Dynamic Programming, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-34:2012] Asuka Tanaka. Master Thesis: Hardware Accelerator Adaptable to Different Variations of Dynamic Programming Problems, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-35:2012] Shizuka Ishikawa. Master Thesis: Hardware-based Acceleration for BLAST Algorithm, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-36:2012] Hiroshi Igashima. Master Thesis: A Geometric Routing for Multi-sink Wireless Sensor Networks, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki

[miyazaki-37:2012] Yuki Kasama. Master Thesis: Movement Path Estimation for Multiple Humans Based on Their Moving Directions using Binary Infrared Sensors, University of Aizu, 2012.

Thesis Advisor: T. Miyazaki