Division of Computer Engineering

Computer Organization Laboratory

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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 acceleration of Time-Space Continuous Dynamic Programing (TSCDP) using FPGAs. TSCDP is a way of recognition of air-drawn gestures and characters from a video stream. It can realize both time- and location-free (spotting) recognition. Spotting means prior segmentation of the input video, and it is not needed to perform TSCDP. However, TSCDP requires computation power. Thus, it is meaningful to accelerate TSCDP using FPGAs.

Hiroshi Saito:
    Our research interests are design automation of asynchronous circuits, design automation of multi/many core systems, and applications of sensor networks.

- 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. We are developing design support environment to implement asynchronous circuits on commercial FPGAs, developing a transformation tool from a synchronous register transfer level (RTL) model to an asynchronous RTL model, and designing a low power asynchronous processor.

- Due to the advance of integration technology, current embedded systems consist of multi/many processing cores. This makes possible parallel execution of multiple applications. However, it makes embedded system design complex. To make system-level design easy, we are developing design support environment to implement a Simulink model into commercial field programmable gate arrays (FPGAs) through task partitioning, scheduling, and allocation.

- Our local area has heavy snow fall in the winter season which results in degradation of economic activities and traffic accidents. To reduce such problems, it is desireble to check snow fall at real time. We are developing a web system which shows snow depth of roads that are measured by a sensor network. The sensor network consists of sensor nodes with open soruce hardware Arduino and XBee module.

Peng Li:

My research interests mainly focus on wireless communication and networking, specifically wireless sensor networks green and energy-efficient mobile networks and cross-layer optimization for wireless networks. I also have interests on cloud computing, big data processing and smart grid. These topics are studied from two aspects. First, new techniques and approaches will be proposed to enhance network system performance. Prototypes are developed to evaluate their feasibility. Second, new algorithms will be designed and evaluated using advanced theoretical methods, like convex optimization, stochastic optimization, game and auction theories.

Refereed Journal Papers

[miyazaki-01:2014] D. Zeng, Peng Li, S. Guo, T. Miyazaki, J. Hu, and Y. Xiang. Energy Minimization in Multi-Task Software-Defined Sensor Networks. *IEEE Transactions on Computers*, PP(99):DOI=10.1109/TC.2015.2389802, 2015.

After a decade of extensive research on application-specific wireless sensor networks (WSNs), the recent development of information and communication technologies makes it practical to realize the software-defined sensor networks (SDSNs), which are able to adapt to various application requirements and to fully explore the resources of WSNs. A sensor node in SDSN is able to conduct multiple tasks with different sensing targets simultaneously. A given sensing task usually involves multiple sensors to achieve a certain quality-of-sensing, e.g., coverage ratio. It is significant to design an energy-efficient sensor scheduling and management strategy with guaranteed quality-of-sensing for all tasks. To this end, three issues are investigated in this paper: 1) the subset of sensor nodes that shall be activated, i.e., sensor activation, 2) the task that each sensor node shall be assigned, i.e., task mapping, and 3) the sampling rate on a sensor for a target, i.e., sensing scheduling. They are jointly considered and formulated as a mixed-integer with quadratic constraints programming (MIQP) problem, which is then reformulated into a mixed-integer linear programming (MILP) formulation with low computation complexity via linearization. To deal with dynamic events such as sensor node participation and vanishment, during SDSN operations, an efficient online algorithm using local optimization is developed. Simulation results show that our proposed online algorithm approaches the globally optimized network energy efficiency with much lower rescheduling time and control overhead.

[miyazaki-02:2014] Z. Tang, S. Guo, P. Li, T. Miyazaki, H. Jin, and X. Liao. Energy-Efficient Transmission Scheduling in Mobile Phones using Machine Learning and Participatory Sensing. *IEEE Transactions on Vehicular Technology*, PP(99):DOI=10.1109/TVT.2014.2350510, 2014.

Energy efficiency is important for smartphones because they are powered by batteries with limited capacity. Existing work has shown that the tail energy of the 3G/4G network interface on a mobile device would lead to low energy efficiency. To solve the tail energy minimization problem, some online scheduling algorithms have been proposed, but with a big gap from the offline algorithms that work depending on the knowledge of future transmissions. In this paper,

we study the tail energy minimization problem by exploiting the techniques of machine learning and participatory sensing. We design a clientserver architecture, in which the training process is conducted in a server, and mobile devices download the constructed predictor from server to make transmission decisions. A system is developed and deployed on real hardware to evaluate the performance of our proposal. The experimental results show that it can significantly improve the energy efficiency of mobile devices while incurring minimum overhead.

[pengli-01:2014] Lin Gu, Deze Zeng, Peng Li, and Song Guo. Cost Minimization for Big Data Processing in Geo-Distributed Data Centers. *IEEE Transactions on Emerging Topics in Computing*, 2(3):314–323, 2014.

We are motivated to study the cost minimization problem via a joint optimization of these three factors for big data services in geo-distributed data centers. To describe the task completion time with the consideration of both data transmission and computation, we propose a 2-D Markov chain and derive the average task completion time in closed-form. Furthermore, we model the problem as a mixed-integer nonlinear programming and propose an efficient solution to linearize it. The high efficiency of our proposal is validated by extensive simulation-based studies.

[pengli-02:2014] He Li, Peng Li, Song Guo, Xiaofei Liao, and Hai Jin. Modeap: Moving Desktop Application to Mobile Cloud Service. *ACM/Springer Mobile Networks and Applications*, 19(4):563–571, 2014.

We propose Modeap, a platform-independent mobile cloud service that can push all desktop applications developed for various operating systems from cloud servers to mobile devices. Modeap follows a design principle of complete detachment and regeneration of desktop user interface, i.e., the essential graphical primitives of the original desktop applications will be intercepted and then translated into standard web-based graphical primitives such that the interactions between users and remote cloud applications become possible via mobile web browsers. In this way, all desktop applications built upon the same set of graphical primitives can be used on mobile devices in great flexibility without installing any new software. We have developed a proof-of-concept prototype that provides Windows applications from cloud server to mobile web browsers. The results of extensive experiments show that the proposed framework can achieve our design goals with low latency and bandwidth consumption.

Summary of Achievement

[pengli-03:2014] Peng Li, Song Guo, Toshiaki Miyazaki, and Weihua Zhuang. Fine-grained Resource Allocation for Cooperative Device-to-Device Communication in Cellular Networks. *IEEE Wireless Communication Magazine*, 21(5):35–40, 2014.

Data traffic in cellular networks has dramatically surged in recent years due to the booming growth of various mobile applications. It is hence crucial to increase network capacity to accommodate new applications and services. In this article, we propose a promising concept of cooperative device-to-device communication to improve resource utilization in cellular networks. Based on a novel fine-grained resource allocation scheme, we study the problem of maximizing the minimum rate among multiple wireless links by jointly considering relay assignment, transmission scheduling, and channel allocation. Simulation results show that our proposed solutions can significantly increase resource utilization in cellular networks.

[pengli-04:2014] Peng Li, Song Guo, Shui Yu, and Athanasios Vasilakos. Reliable Multicast with Pipelined Network Coding using Opportunistic Feeding and Routing. *IEEE Transactions on Parallel and Distributed Systems*, 25(12):3264–3273, 2014.

We propose a reliable multicast protocol, called CodePipe, with energy-efficiency, high throughput and fairness in lossy wireless networks. Building upon opportunistic routing and random linear network coding, CodePipe can not only eliminate coordination between nodes, but also improve the multicast throughput significantly by exploiting both intra-batch and inter-batch coding opportunities. In particular, four key techniques, namely, LP-based opportunistic routing structure, opportunistic feeding, fast batch moving and inter-batch coding, are proposed to offer significant improvement in throughput, energy-efficiency and fairness. Moreover, we design an efficient online extension of CodePipe such that it can work in a dynamic network where nodes join and leave the network as time progresses. We evaluate CodePipe on ns2 simulator by comparing with other two state-of-art multicast protocols, MORE and Pacifier. Simulation results show that CodePipe significantly outperforms both of them.

[pengli-05:2014] He Li, Peng Li, Song Guo, and Amiya Nayak. Byzantine-Resilient Secure Software-Defined Networks with Multiple Controllers in Cloud. *IEEE Transactions on Cloud Computing*, 2(4):436–447, 2014.

We present a secure SDN structure, in which each device is managed by

multiple controllers, not just a single as in a traditional manner, with the dynamic and isolated instance provided by the cloud. It can resist Byzantine attacks on controllers and the communication links between controllers and SDN switches. Furthermore, we study a controller minimization problem with security requirement and propose a cost-efficient controller assignment algorithm with a constant approximation ratio. From the experiment result, the secure SDN structure has little impact on the network latency, provide better security than general distributed controller, and the proposed algorithm performs higher efficiency than random assignment.

[pengli-06:2014] Peng Li, Song Guo, and Weihua Zhuang. Optimal Transmission Scheduling of Cooperative Communications with a Full-duplex Relay. *IEEE Transactions on Parallel and Distributed Systems*, 25(9):2353–2363, 2014.

Motivated by recent successes in hardware implementation of wireless full-duplex transmission, we propose a full-duplex cooperative communication (FDCC) approach to maximize the minimum transmission rate among a set of users to a common destination with the help of a dedicated relay. Under the consideration of hardware cost, only the relay node requires full-duplex wireless equipment in our design. We derive the achievable transmission rate for the proposed FDCC scheme under both amplify-and-forward (AF) and decode-and-forward (DF) modes. Further, as the transmission scheduling of users plays a critical role in determining the achievable transmission rate in FDCC, we formulate the max-min rate scheduling problem as a nonconvex mixed integer nonlinear programming (MINLP) problem. By applying linearization and convex approximation techniques, we propose an optimal algorithm based on a branch-and-bound framework to solve the problem efficiently. Extensive simulation results show that FDCC can significantly improve the transmission rate as compared with direct transmission and half-duplex cooperative communication (HDCC).

Refereed Proceeding Papers

[hiroshis-01:2014] H. Saito T. Hanyu K. Kenji Y. Nakamura T. Yoneda, M. Imai. An NoC-based Evaluation Platform for Safety-Critical Automotive Applications. In *Proc. IEEE APCCAS*, pages 679–682, 2014.

We have been developing an NoC (Network-on-Chip) based platform for a

centralized ECU (Electronic Control Unit), where a many-core system functions as a set of several conventional automotive ECUs.

[hiroshis-02:2014] S. Hosaka K. Takizawa and H. Saito. A Design Support Tool Set for Asynchronous Circuits with Bundled-data Implementation on FPGAs. In *IEEE 24th International Conference on Field Programmable Logic and Applications*, pages 1–4, 2014.

In this paper, we propose a design support tool set for asynchronous circuits with bundled-data implementation to implement them on commercial FPGAs easily considering a latency constraint.

[hiroshis-03:2014] Y. Moriai S. Miyasono and H. Saito. A Code Partitioning Tool for Simulink Models to Implement on FPGA-based Network-on-Chip Architecture. In *Proc. IEEE International Symposium on Embedded Multicore SoCs*, pages 141–148, 2014.

In this paper, we propose a code partitioning tool to implement application C codes generated from a Simulink model into FPGA-based network-on-chip (NoC) architecture.

[hiroshis-04:2014] T. Yoneda H. Saito and Y. Nakamura. A Redundant Task Allocation Method for Reliable Network-on-Chips. In *Proc. SASIMI*, pages 287–292, 2015.

We propose a redundant task allocation method which allocates several copies of tasks to different cores based on multiple task scheduling.

[miyazaki-03:2014] D. Zeng, P. Li, S. Guo, and T. Miyazak. Minimum-Energy Reprogramming with Guaranteed Quality-of-Sensing in Software-Defined Sensor Networks. In *IEEE International Conference on Communications (ICC) 2014*, pages 847–852, June 2014.

After a decade of extensive research on applicationspecific wireless sensor networks (WSNs), the recent development of information and communication technologies make it practical to realize software-defined sensor networks (SDSNs), which are able to adapt to various application requirements and to fully explore the resources of WSNs. In SDSNs, wireless sensor nodes canbe dynamically reprogrammed for different sensing tasks via the over-the-air-programming technique. For a given sensing task, it is usually required to guarantee certain quality-of-sensing, e.g., coverage ratio. Intuitively, the more sensors are deployed with a program, the higher quality-of-sensing of the corresponding task can be achieved. However, this is at the expense of high

reprogramming energy consumption. In this paper, we investigate how to design an energy-efficient reprogramming strategy with guaranteed quality-of-sensing for a sensing task. To this end, two issues will be tackled: 1) the subset of sensors that shall be reprogrammed, i.e., reprogramming sensor selection and 2) the program distribution routing. They are jointly considered and formulated as an integer linear programming (ILP) problem, based on which an algorithm with low computation complexity is then proposed. The high efficiency of our algorithm is validated by extensive simulation studies.

[miyazaki-04:2014] H. Ke, S. Guo, and T. Miyazaki. Towards Latency-Aware Data Acquisition in Wireless Sensor Networks. In *2014 IEEE 8th International Symposium on Embedded Multicore/Manycore SoCs (MC-SoC14)*, pages 82–87, September 2014.

Typically, wireless sensor network (WSN) uses static sinks to gather sensor data. However, it brings not only excessive sink installation cost but also energy-hole problem. In this paper, we consider data acquisition with guaranteeing latency in WSN by multiple mobile sinks. In particular, we optimize the number of sinks as well as the itinerary of each sink for this problem such that the total cost, incurred by these two factors, is minimum. We also conduct extensive simulations to evaluate the performance and efficiency of our proposal.

[miyazaki-05:2014] T. Hayashi, J. Yatabe, S. Demura, Y. Abe, Y. Watanabe, H. Ishikawa, M. Hisada, M. S. Yatabe, D.Yoshino, J. Tsai, Y. Ito, H. Tabata, M. Murasawa, K. Shiozawa, T. Miyazaki, and J. Iwase. A Novel Network-centric Approach to a Secure and Elastic Regional Healthcare System with a Messaging Infrastructure. In *Proc. of SICE Annual Conference 2014*, pages 253–258, September 20143.

This paper introduces an intelligent infrastructure scheme for regional health care systems that uses a messaging network to provide message filtering, routing, and related services via a structured overlay network. The proposed messaging network, which will provide various functions using content/topic-based routing and filtering, also provides the backbone of our proposed regional healthcare system. Additionally, the design of a regional hypertensive patient management system (RHPMS) that uses the proposed scheme is presented, and a sample implementation of an RHPMS under construction in the Aizu region of Fukushima Prefecture in Japan is described. When complete, the design and performance of the system will be evaluated via substantive experiments with an eye towards improvements.

[miyazaki-06:2014] M. Ohta, Y. Watanabe, and T. Miyazaki. Spatiotemporal Analysis of Rambling Activities: Approach to Inferring Visitor Satisfaction. In *The International Federation for Information Technology and Travel & Tourism (IFITT) ENTER2015*, pages 551–563, Feb. 2015.

A method for investigating trajectories of rambling objects is proposed. The goal of this study is to infer peoples satisfaction with their experiences by using their trajectories. Two aspects of rambling activitiesmulti-stop and multi-purpose trips, and trips with unplanned stops at various destinations are examined using mathematical knot theory. A two-dimensional trajectory is transformed into a three-dimensional curve composed of geographical location and dwell time at the visited spots. The aspects of rambling activities are reflected in the shapes of the knots obtained by deforming the curve. An experiment using 135 participant trajectories obtained at a campus festival confirmed: (1) trajectories caused by rambling were effectively detected; and (2) our method reproduced the relation between rambling activities and a participants satisfaction with the festival. Namely, the more satisfied a participant was with the festival, the more likely he was to move around the venue. It is concluded that this method infers visitorssatisfaction with their experiences and is useful for designing ideal spaces to induce rambling activities.

[pengli-07:2014] He Li, Peng Li, Song Guo, and Shui Yu. The joint optimization of rules allocation and traffic engineering in Software Defined Network. In *IEEE International Conference on Communications (ICC)*, pages 695–700. IEEE, June 2014.

[pengli-08:2014] Huan Ke, Peng Li, and Song Guo. Crowdsourcing on mobile cloud: Cost minimization of joint data acquisition and processing. In *IEEE Conference on Computer Communications Workshops (INFO-COM WKSHPS)*, pages 358–362. IEEE, April 2014.

[pengli-09:2014] He Li, Peng Li, and Song Guo. MoRule: optimized rule placement for mobile users in SDN-enabled access networks. In *IEEE Global Communications Conference (GLOBECOM)*, pages 4953–4958. IEEE, Dec. 2014.

[pengli-10:2014] Huawei Huang, Peng Li, Song Guo, and Baoliu Ye. The joint optimization of rules allocation and traffic engineering in Software De-

fined Network. In *IEEE 22nd International Symposium of Quality of Service (IWQoS)*, pages 141–146. IEEE, May 2014.

[pengli-11:2014] Peng Li and Song Guo. Load balancing for privacy-preserving access to big data in cloud. In *IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS)*, pages 524–528. IEEE, April 2014.

[pengli-12:2014] He Li, Peng Li, Song Guo, and Shui Yu. The joint optimization of rules allocation and traffic engineering in Software Defined Network. In *IEEE International Conference on Communications (ICC)*, pages 695–700. IEEE, June 2014.

[pengli-13:2014] Deze Zeng, Peng Li, Song Guo, and Toshiaki Miyazaki. Minimum-energy reprogramming with guaranteed quality-of-sensing in software-defined sensor networks. In *IEEE International Conference on Communications (ICC)*, pages 288–293. IEEE, June 2014.

[pengli-14:2014] He Li, Peng Li, and Song Guo. Efficient privacy-preserving multicast in cloud data centers. In *IEEE International Conference on Communications (ICC)*, pages 810–815. IEEE, June 2014.

[pengli-15:2014] Huawei Huang, Song Guo, Peng Li, and Toshiaki Miyazaki. De-activation controlled epidemic routing in disruption tolerant networks with multiple sinks. In *IEEE Global Communications Conference (GLOBECOM)*, pages 4604–4609. IEEE, Dec. 2014.

Unrefereed Papers

[hiroshis-05:2014] T. Komine and H. Saito. 高位合成ツールからの非同期式回路生成に関する研究. In *VLD2014-165*, pages 73–78, 2015.

[hiroshis-06:2014] S. Hosaka and H. Saito. 演算の移動度を利用した束データ方式による非同期式回路の電力最適化手法の検討. In *VLD2014-104*, pages 215–220, 2014.

[hiroshis-07:2014] T. Komine and H. Saito. SystemC モデルから束データ方式による非同期式回路を合成する合成フローの提案. In *VLD2014-5*, pages 21–26, 2014.

Summary of Achievement

[hiroshis-08:2014] M. Nakajima Y. Kohira S. Hosaka, Y. Moriai and H. Saito. Arduino を用いた積雪量を計測するセンサーネットワークの構築. In *ASN2014-45*, pages 31–36, 2014.

[hiroshis-09:2014] S. Hosaka Y. Kohira Y. Moriai, M. Nakajima and H. Saito. センサーネットワークによる積雪量の可視化. In 電子情報通信学会総合大会, page 587, 2015.

[miyazaki-07:2014] T. Kawasaki, P. Li, and T. Miyazaki. Relay-Node Placement Method for Data Synchronization among Isolated Servers Using Delay Tolerant Network. In *IPSJ 77th National Convention*, volume 6U-07, March 2015.

The student encouragement award

[miyazaki-08:2014] S. Nabeshima and T. Miyazaki. Program Generation Tool for Sensor Nodes. In *IPSJ 77th National Convention*, volume 1U-06, March 2015.

The student encouragement award

[miyazaki-09:2014] D. Baba and T. Miyazaki. Trajectory Pattern Analysis for Rambling Activities in Event Space. In *IPSJ 77th National Convention*, volume 1X-06, March 2015.

[miyazaki-10:2014] S. Yaginuma and T. Miyazaki. User Interface for a Large-scale Sensor Network dedicated to Disaster surveillance. In *IPSJ 77th National Convention*, volume 6U-06, March 2015.

[miyazaki-11:2014] N. Akiyama, Y. Watanabe, M. Ohta, and T. Miyazaki. Extraction and Predicting Singularity in Trajectory Patterns Based on a Pattern Analysis. In *IPSJ 77th National Convention*, volume 1W-06, March 2015.

[miyazaki-12:2014] N. Sagami and T. Miyazaki. Acceleration of Time-Space Continuous Dynamic Programming Algorithm Using an Array Processor. In *IPSJ 77th National Convention*, volume 4J-03, March 2015.

[miyazaki-13:2014] N. Sagami, K. Ishikawa, and T. Miyazaki. An Array Processor for Time-Space Continuous Dynamic Programming Algorithm. In *IEEE student session in 2014 Tohoku-Section Joint Convention of Institutes of Electrical and Information Engineers, Japan*, volume 1A05, Aug. 2014.

[miyazaki-14:2014] S. Nabeshima and T. Miyazaki. Light-weight Role Activation Method for Programmable Wireless Sensor Node,. In *IEEE student session in 2014 Tohoku-Section Joint Convention of Institutes of Electrical and Information Engineers, Japan*, volume 2A02, Aug. 2014.

[miyazaki-15:2014] D. Baba and T. Miyazaki. Light-weight Role Activation Method for Programmable Wireless Sensor Node. In *IEEE student session in 2013 Tohoku-Section Joint Convention of Institutes of Electrical and Information Engineers, Japan*, volume 2A03, Aug. 2014.

[miyazaki-16:2014] N. Suematsu and T. Miyazaki. Database Deployment Strategy for Large-scale Sensor Network. In *IEEE student session in 2014 Tohoku-Section Joint Convention of Institutes of Electrical and Information Engineers, Japan*, volume 2A04, Aug. 2014.

Grants

[hiroshis-10:2014] H. Saito. Ministry of Education Scientific Research Fund, 2012-2014.

[hiroshis-11:2014] H. Saito and Y. Kohira. Strategic Information and Communications R&D Promotion Programme (SCOPE), 2013-2014.

[miyazaki-17:2014] T. Miyazaki. Joint research with NTT innovation laboratories, 2014.

[miyazaki-18:2014] T. Miyazaki. Joint research with ApplyIt Corp., 2014.

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

Academic Activities

[hiroshis-12:2014] H. Saito, March 2015.

Technical Program Committee of SASIMI 2015.

[hiroshis-13:2014] H. Saito, September 2014.

Finance Chair of IEEE MCSoC 2014.

Summary of Achievement

[hiroshis-14:2014] H. Saito, May 2014.

        Technical Program Committee of ASYNC 2014.

[miyazaki-20:2014] T. Miyazaki, 2012-1015.

        IEEE Sendai Section, Executive Committee Member

[miyazaki-21:2014] T. Miyazaki, 2014.

        Steering Committee Member, IEICE Technical Group for Function Integrated Information System (FIIS)

[miyazaki-22:2014] T. Miyazaki, 2014.

        General Chair, MCSoC-14 (IEEE 8th International Symposium on Embedded Multicore Systems-on-Chip)

[miyazaki-23:2014] T. Miyazaki, 1984 – present.

        IEICE Member

[miyazaki-24:2014] T. Miyazaki, 2014 – present.

        IPSJ Senior Member

[miyazaki-25:2014] T. Miyazaki, 2012 – present.

        IEEE Senior Member

[pengli-16:2014] Peng Li, December 2014.

        IEEE Computer Society Japan Chapter Young Author Award.

Ph.D and Others Theses

[hiroshis-15:2014] K. Takizawa. Development and Evaluation of Design Environment for Asynchronous Circuits with Bundled-data Implementation on FPGAs, University of Aizu, 2014.

        Thesis Advisor: H. Saito

[hiroshis-16:2014] T. Komine. Synthesis of Asynchronous Circuits from a High-level Synthesis Tool, University of Aizu, 2014.

        Thesis Advisor: H. Saito

[hiroshis-17:2014] S. Hosaka. A Dynamic Power Optimization Method for Asynchronous Circuits with Bundled-data Implementation using Mobility of Operations, University of Aizu, 2014.

> Thesis Advisor: H. Saito

[hiroshis-18:2014] Y. Moriai. A Simulation Model to Implement Simulink Models into a Network-on-Chip, University of Aizu, 2014.

> Thesis Advisor: H. Saito

[hiroshis-19:2014] M. Nakajima. Debugging of Asynchronous AVR Processor using Simulation, University of Aizu, 2014.

> Thesis Advisor: H. Saito

[miyazaki-26:2014] Kenta Ishikawa. Graduation Thesis: A Hardware Implementation to Accelerate Time-Space Continuous Dynamic Programming, University of Aizu, 2014.

> Thesis Advisor: T. Miyazaki

[miyazaki-27:2014] Shinya Yaginuma. Graduation Thesis: Graphical user interface for a Large-scale Sensor Network Supporting Multiple Users, University of Aizu, 2014.

> Thesis Advisor: T. Miyazaki

[miyazaki-28:2014] Yuta Watanabe. Graduation Thesis: Trajectory Pattern Analysis Using Graph Matching Method, University of Aizu, 2014.

> Thesis Advisor: T. Miyazaki

[miyazaki-29:2014] Taiko Kawasaki. Master Thesis: Efficient Relay-Node Placement Method for Data Synchronization among Isolated Servers in Unstable Communication Environment Using Delay Tolerant Network, University of Aizu, 2014.

> Thesis Advisor: T. Miyazaki

[miyazaki-30:2014] Naoto Sagami. Master Thesis: Acceleration of Time-Space Continuous Dynamic Programming Algorithm using an Array Processor without Complex I/O Operation, University of Aizu, 2014.

> Thesis Advisor: T. Miyazaki