Image Processing Laboratory

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First and foremost, the Image Processing Laboratory engages in research and development of image-based pattern recognition including some areas of Artificial Intelligence, database organization, retrieval, and robotics.

In image processing area, we research about pattern matching based image processing algorithms such as time-series continuous dynamic programming (TSCDP) for object tracking in two-dimensional image sequence, two-dimensional continuous dynamic programming (2DCDP) for 3D reconstruction and free-viewpoint TV, three-dimensional continuous dynamic programming (3DCDP) for matching boxel-based 3D shape and circle continuous dynamic programming for mining similar pattern in spatio-temporal large-scale one or two-dimensional sequence. Because of dynamic processing approach is able to find matching pattern and segmentation simultaneously, these algorithms are able to quite many applications such as constructing free-viewpoint TV, clothing clustering, customer walking path mining for smart supermarket. Moreover, these algorithms are also able to apply on other area such as data mining, one-dimensional pattern matching.

We also have many application research with business industries: clothes selling system by clothing clustering and pattern mining, lost photo finding system by tsunami disease in Tohoku great earthquake, lamp pattern executive system for sewage plant in rural area and person tracking system using TSCDP.

In the data mining and visualization area, we focused on micro-blog data mining for rumor detection. Especially, we researched how to visualize opin-

ion and emotion of huge dataset by macro and micro viewpoint. For this problem, we plan and construct several visualization tools and finding temporal pattern feature in each topic. We also try to find personal opinion filter from opinion flow in twitter.

In a robotics area, one of our interests is swarm robotics. As we often see in flocks of birds, a flock can be maintained as a whole, while birds control themselves independently by observing neighboring ones. We try to introduce the characteristics of the swarm into a robotic system. In a theory side, we have been attacking to analyze what conditions a swarm comprised of independent robots only with local observation can be maintained, when it breaks, how stable it is. We have got the knowledge of the characteristics of swarms in a small scale such as tens or hundreds. Then we are trying to scale up to thousands and millions.

In an application side, we apply the knowledge to agricultural robots for weeding in a rice fields. The task is for the robots to sweep up the field so that preventing weeds to grow up. We have produced four robots and tested in an actual rice field with manual operation. For the sweeping, the robots need to know their position. We have developed a localization algorithm for the swarm robots, and investigated it with numerical experiments. In addition, we have been developing an image processing method for the robots to know their position, and we will put it into the robot system for automatic operation.

We have another interests of walking control of biped robots, we have set the problem to walk down steep hills, which is known as steps of walking robots fall into chaotic and unstable one. We have developed a control method for the problem, and evaluated it with numerical experiments. The results show it is capable to walk down the steep slopes stably with less control energy consumption is capable to walk down the steep slopes stably with less control energy consumption.

Refereed Journal Papers

[yaguchi-01:2013] Yuichi Yaguchi and Ryuichi Oka. Spherical Visualization of Image Data with Clustering. *JACIII*, 17(4):573–580, 2013.

> This paper proposes to aid the search for images by visualization of the image data on a spherical surface. Many photographs were lost in the Tohoku tsunami, and those that were eventually found are now being scanned. However, the owners of the lost photographs are finding it difficult to search for their images within a large set of scanned images that contain no additional information. In this paper, we apply a spatial clustering technique called the Associated Keyword Space (ASKS) projected from a threedimensional (3D) sphere to a two-dimensional (2D) spherical surface for 2D visualization. ASKS supports clustering, and therefore, we construct an image search system in which similar images are clustered. In this system, similar images are identified by color inspection and by having similar characteristics. In this way, the system is able to support the search for images from within a huge number of images.

Unrefereed Papers

[yaguchi-02:2013] Yaguchi Yuichi Terunuma Naoki Sato Takahiro Wilson Ian Moriya, Shusuke. Normalization and matching routine for comparing first and second language tongue trajectories. *The Journal of the Acoustical Society of America*, 134(5):4244–4244, November. 2013.

Refereed Proceeding Papers

[naruse-01:2013] Ryo Ogata Yutaka Watanobe Keitaro Naruse Ryuichi Oka Shunsuke Wada, Yuichi Yaguchi. Associated Keyword Analysis for Temporal Data with Spatial Visualization. In *Proc. of The 5th IEEE International Conference on Awareness Science and Technology*, page USB, 2013.

> To extract temporal variations in the relation between two or more words in a large time-series script, we propose three procedures for adoption by the existing Associated Keyword Space system, as follows. First, we begin the calculations from a previous state. Second, we add a random

seed if a new object was present in the previous state. Thrid, we forget those object relations from the previous state that have no affinity with the selected term. We have experimented with this improved algorithm using a large time-series of tweets from Twitter. With this approach, it is possible to check on the volatility of topics.

[naruse-02:2013] Shigekazu Fukui and Keitaro Naruse. Swarm Breif-propagation Localization for a Multiple Robot System with Range Measurements. In *Proc. of The 14th International Symposium on Advanced Intelligent System*, page USB, 2013.

Swarm localization, cooperative robot localization in swarm robotics, has a significant role in a swarm robot system and requires much deliberation for its estimation scheme. As such, designing stochastic hidden Markov model, in a way a variety of conditionally dependent, observed random variables such as measurements are effectively chosen and properly integrated into the probability distribution of a belief, is very important. In this paper, we propose swarm EKF localization, a hybrid of two inference algorithms, extended Kalman filter (EKF) and belief propagation (BP), with a capability of choosing how many dependencies of random variables are exploited in inference using the concept of neighborhood. Also, this paper presents a numerical experiment result of swarm EKF localizations. In conclusion, we could confirm that 2nd order neighborhood EKF has an overall better estimation performance compared to conventional 1st order neighborhood EKFs.

[naruse-03:2013] Keitaro Naruse and Shigekazu Fukui. Swarm EKF Localization for a Multiple Robot System with Range-Only Measurements. In *Proc. of 2013 IEEE/SICE International Symposium on System Integration*, pages 796–801, 2013.

Swarm localization is a class of mutual localizations in which each of robots estimates its position by observing its neighboring robots. Since, in the swarm localization, an estimated position by a robot can be different from one by a robot B, infomration propagation among the robots is an important issue. In this paper, mutual localization by EKF works as the information propagation. The method is verified with numerical experiments.

[oka-01:2013] Toshimitsu Suzuki and Ryuichi Oka. Segmentation-free Full Voxel Matching for 3D Image Registration. In *Proceedings of 3DSA2013*, pages P3–4, June 2013.

We propose a new algorithm for 3D registration called three-dimensional continuous dynamic programming (3DCDP). 3DCDP carries out segmentation-free and optimal matching between two 3D voxel patterns. The proposed method realizes matching between not only surfaces of 3D object but also full voxels inside of 3D objects. The matching is carried out between a reference 3D image representing a partial object and an input 3D image including parts which are similar to the reference image. The reference 3D image is segmentation-freely matched with the parts of input 3D image. Segmentation-free property requires no segmentation for two 3D patterns before applying 3DCDP. We conducted some experiments for verifying the ability of matching by obtaining voxel correspondences between two 3D images.

[oka-02:2013] Yuichi Yaguchi Yuki Nitsuma, Syunpei Torii and Ryuichi Oka. Time-segmentation- and position-free recognition from video of air-drawn gestures and characters. In *ICPRAM-2014*, pages 588–599, March 2014.

We report on the recognition from video streams of isolated alphabetic characters and connected cursive textual characters, such as alphabetic, hiragana a kanji characters, drawn in the air. This topic involves a number of dif?cult problems in computer vision, such as the segmentation and recognition of complex motion from video. We utilize an algorithm called time-space continuous dynamic programming (TSCDP) that can realize both time- and location-free (spotting) recognition. Spotting means that prior segmentation of input video is not required. Each of the reference (model) characters used is represented by a single stroke composed of pixels. We conducted two experiments involving the recognition of 26 isolated alphabetic characters and 23 Japanese hiragana and kanji air-drawn characters. Moreover we conducted gesture recognition experiments based on TSCDP and showed that TSCDP was free from many restrictions imposed upon conventional methods.

[yaguchi-03:2013] Kumara, B.T.G.S. and Paik, I. and Ohashi, H. and Yaguchi, Y. Web service filtering and visualization with context aware similarity to bootstrap clustering. In *Awareness Science and Technology and Ubi-Media Computing (iCAST-UMEDIA), 2013 International Joint Conference on*, pages 220–226, Nov 2013.

Web service clustering is an efficient approach to address some challenges in service computing area such as discovering and recommending. To cluster the Web services, we need to filter the similar services. Key oper-

ation of filtering process is measuring the similarity of services. There are several methods used in current similarity calculation approaches such as keyword, information retrieval, ontology and hybrid methods. However, these approaches do not consider the context when measuring the similarity. So these approaches failed to capture the semantic of terms, which exist under a certain domain. In this paper, we propose context aware similarity method, which uses search results from search engines and support vector machine. Then, we apply Associated Keyword Space (ASKS) algorithm which is effective for noisy data and projected results from a three-dimensional (3D) sphere to a two dimensional (2D) spherical surface for 2D visualization to filter the services. Experimental results show our filtering approach is able to filter services based on domain and plot the result on sphere. Also our approach performs better than the existing approaches. Further, our approach aids to search Web services by visualization of the service data on a spherical surface.

[yaguchi-04:2013] Wada, S. and Yaguchi, Y. and Ogata, R. and Wadanobe, Y. and Naruse, K. and Oka, R. Associated Keyword analysis for temporal data with spatial visualization. In *Awareness Science and Technology and Ubi-Media Computing (iCAST-UMEDIA), 2013 International Joint Conference on*, pages 243–249, Nov 2013.

To extract temporal variations in the relation between two or more words in a large time-series script, we propose three procedures for adoption by the existing Associated Keyword Space system, as follows. First, we begin the calculations from a previous state. Second, we add a random seed if a new object was present in the previous state. Thrid, we forget those object relations from the previous state that have no affinity with the selected term. We have experimented with this improved algorithm using a large time-series of tweets from Twitter. With this approach, it is possible to check on the volatility of topics.

[yaguchi-05:2013] Banage T. G. S. Kumara, Yuichi Yaguchi, Incheon Paik, and Wuhui Chen. Clustering and Spherical Visualization of Web Services. In *IEEE SCC*, pages 89–96, 2013.

Web service clustering is one of a very efficient approach to discover Web services efficiently. Current clustering approaches use traditional clustering algorithms such as agglomerative as the clustering algorithm. The algorithms have not provided visualization of service clusters that gives inspiration for a specific domain from visual feedback and failed to achieve higher noise isolation. Furthermore iterative steps of algorithms

consider about the similarity of limited number of services such as similarity of cluster centers. This leads to reduce the cluster performance. In this paper we apply a spatial clustering technique called the Associated Keyword Space(ASKS) which is effective for noisy data and projected clustering result from a three-dimensional (3D) sphere to a two dimensional(2D) spherical surface for 2D visualization. One main issue, which affects to the performance of ASKS algorithm is creating the affinity matrix. We use semantic similarity values between services as the affinity values. Most of the current clustering approaches use similarity distance measurement such as keyword, ontology and information-retrieval-based methods. These approaches have problem of short of high quality ontology and loss of semantic information. In this paper, we calculate the service similarity by using hybrid term similarity method which uses ontology learning and information retrieval. Experimental results show our clustering approach is able to plot similar services into same area and aid to search Web services by visualization of the service data on a spherical surface.

[yaguchi-06:2013] Amma, K. and Yaguchi, Y. and Niitsuma, Y. and Matsuzaki, T. and Oka, R. A comparative study of gesture recognition between RGB and HSV colors using time-space continuous dynamic programming. In *Awareness Science and Technology and Ubi-Media Computing (iCAST-UMEDIA), 2013 International Joint Conference on*, pages 185–191, Nov 2013.

This paper presents a comparative analysis of the color models. It used when identifying human skin in a gesture recognition system. The recognition system was based on time-space continuous dynamic programming (TSCDP). TSCDP performs optimal matching between point trajectories and video images. A point trajectory is a sequential pattern of pixels that can also be a representation of a type of gesture. Human skin can be represented either by RGB-color-based or HSV-color-based imagery. The score for gesture recognition depends on the selection of features used to represent the pixels in the point trajectory. We conducted experiments that compared the two candidate color systems, concluding that HSV-based skin features provide better scores than RGB-based skin features.

Unrefereed Papers

[naruse-04:2013] Masahiro KINOSHITA Tamotsu MITAMURA Keitaro NARUSE Takashi KAWAKAMI Tadaaki NIWA, Keiko YUKAWA. The evaluation of music that considers physiological response for an automatic composition system. In *Proc. of JSME Robomech 2013 conference*, 2013.

[naruse-05:2013] Keitaro Naruse Atsunori Maruyama. Motion Control of Differential Wheels Robot in Paddy Filed Environments. In *Proc. of JSME Robomech 2013 conference*, 2013.

[naruse-06:2013] Keitaro Naruse Yusuke Fukaya. Visualization of Agent Motions in Large Scale Swarms. In *Proc. of JSME Robomech 2013 conference*, 2013.

[naruse-07:2013] Keitaro Naruse Shigekazu Fukui. Sensitivity analysis of swarm EKF localization with range-only measurements. In *Proc. of 2013 JSPE fall conference*, 2013.

[naruse-08:2013] Keitaro Naruse Atsunori Maruyama. Development of Automatic Weeding Robots in Rice Fields. In *Proc. of SICE 14the System Integration division conference*, 2013.

[naruse-09:2013] Masahiro KINOSHITA Tamotsu MITAMURA Keitaro NARUSE Takashi KAWAKAMI Tadaaki NIWA, Keiko YUKAWA. A feature extraction from musical signals using Restricted Boltzmann Machine and automatic composition. In *Proc. of SICE 14the System Integration division conference*, 2013.

[naruse-10:2013] Keitaro Naruse Yusuke Fukaya. Investigation on impression change by different vibrato. In *Proc. of SICE 14the System Integration division conference*, 2013.

[naruse-11:2013] Yuhei Akama, Keitaro Naruse. Development of the Software which Visualizes Large Scale Swarms by Octree. In *Proc. of SICE 14the System Integration division conference*, 2013.

[naruse-12:2013] Akihiro Hayashi Keitaro Naruse Ikuo Suzuki Toshiyuki Suzuki, Toshifumi Satake. Development of ultra redundant robot based on decentralized kinematics calculation method. In *Proc. of JSPE 2014 spring conference,*, 2014.

[naruse-13:2013] Keitaro Naruse Jun Kanno. Stability of passive dynamic walking model with absorption mechanism of kinetic energy. In *Proc. of JSPE 2014 spring conference*, 2014.

[naruse-14:2013] Keitaro Naruse Hiroya Yamamoto. Control and numerical analysis of both side spring stick. In *Proc. of JSPE 2014 spring conference*, 2014.

[naruse-15:2013] Keitaro Naruse Jun Kanno. Stability of passive dynamic walking model with absorption mechanism of kinetic energy. In *Proc. of SICE Tohoku-branch workshop 284*, 2014.

[naruse-16:2013] Keitaro Naruse Hiroya Yamamoto. Control and numerical analysis of both side spring stick. In *Proc. of SICE Tohoku-branch workshop 284*, 2014.

[oka-03:2013] Yuichi YAGUCHI Syunpei TORII, Yuki NITSUMA and Ryuichi Oka. Spotting Recognition of Motions From a Video Captured by a Moving Camera. In *IEICE Technical Report, PRMU2013-31*, pages 71–76. IEICE, June 2013.

In the technology of first person vision, recognition of human motions is an important function as well as recognition of static objects from a video captured by a moving camera. We apply a segmentation-free recognition algorithm called time-space continuous dynamic programming (TSCDP) for recognizing human motions from a video captured by a moving camera with ten typical and different camera motions. The features of camera motions are also extracted by the difference pattern between the point trajectory of a reference pattern and the trajectory extracted by TSCDP from an input video. We report experimental results of motion recognition and feature extraction of camera motions.

[oka-04:2013] Yuki NITSUMA Yuichi YAGUCHI Yuki YOKOKURA, Syunpei TORII and Ryuichi OKA. Spotting recognition of performance motions of figure skating from videos of TV broadcastingt. In *IEICE Technical Report, PRMU2013-106*, pages 159–164. IEICE, January 2014.

We report the result of spotting recognition of sport motions captured by moving cameras of broadcast- ing TV. We focused on recognition of motions of

gure skating. The video includes two kinds of moving objects: one is moving background and the other is moving hands and legs of a skater. We adopt a method called time-space continuous dynamic programming (TSCDP) for spotting recognition of only human motions. The difference pattern between a reference motion (made by hand-drawing as an ideal performance) and a performed motion extracted by TSCDP becomes

a feature pattern for evaluating the performed motion. We showed the experimental results of the spotting recognition of motions and the extraction of a feature pattern used for evaluating performance motions.

[oka-05:2013] Yuichi YAGUCHI Yuki NITSUMA, Syunpei TORII and Ryuichi OKA. Motion Recognition by Time-space Continuous Dynamic Programming Using a Sequence Model of Object Independent Pixels. In *IEICE Technical Report, PRMU2013-30*, pages 65–70. IEICE, June 2013.

In the matching method called time-space continuous dynamic programming (TSCDP) for recognizing motions, a reference pattern is made of a sequence of pixels. The value of pixel is determined depending to moving objects before applying TSCDP to an input video. This gives us a limitation of TSCDP application. This paper proposes to make reference patterns without consideration of pixels depending moving objects. Thus the application range of TSCDP becomes large. Moreover TSCDP is applied to a video captured by a moving camera for extracting scene features from moving and static objects. The paper shows experimental results using the proposed method.

[yaguchi-07:2013] Yutaka Watanobe Ryuichi Oka Yuta Hiroto, Yuichi Yaguchi. ソースコード類似性に基づく Aizu Online Judge の類似アルゴリズムマップの生成. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-08:2013] Kota Furusawa Youhei Hino Yuichi Yaguchi, Tomonori Todoroki. Style Share: 球面上に展開する被服コーディネーションマップの生成. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-09:2013] Yuichi Yaguchi Kyoko Okudaira Yusuke Kiyonaga Satoshi Sasaki Hajime Yano Eiichi Imai Hirohide Demura Akihiko Yamagishi Tanpopo WG Taku Odashima, Takeyuki Matsumoto. 国際宇宙ステーションたんぽぽ計画のためのエアロゲル中の試料貫入孔の認識. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-10:2013] Tomonori Todoroki Youhei Hino, Yuichi Yaguchi. 服の形状や色に基づく類似度を用いた球面マップ生成. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-11:2013] Tomonori Todoroki Kota Furusawa, Yuichi Yaguchi. ユーザの顔画像に類似するアバターの自動生成と花咲け！アバターへの適用. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-12:2013] Yuichi Okuyama Shunichi Idonuma, Yuichi Yaguchi. 2DCDP における累積値ハードウェアの実装. In 平成 *25* 年度 第 *5* 回情報処理学会東北支部研究会, 2014.

[yaguchi-13:2013] Takashi Suzuki Yuki Akamatsu Kanto Nakayama Yuichi Yaguchi Keitaro Naruse Toshiki Hiraide Keigo Anma, Shunsuke Wada. 積層グラフと関係グラフによるツイッター情報の可視化. In 平成 *25* 年度 第 *5* 回情報処理学会東北支部研究会, 2014.

[yaguchi-14:2013] Hideki Washiyama Yuichi Yaguchi. 津波による遺失物写真の返却に資する球面上への画像クラスタリング. In 可視化情報全国講演会 *2013* 会津, 2013.

[yaguchi-15:2013] Naoki Terunuma Takayuki Sato Ian Wilson Shusuke Moriya, Yuichi Yaguchi. 舌特徴空間における言語学習者の違いを比較するための正規化とマッチング手法. In *IEICE Technical report*, volume 113, pages 53–57, 2013.

Chapters in Book

[naruse-17:2013] Keitaro Naruse. *Velocity Correlation in Swarm Robtos with Directional Neighborhood*, pages 843–85. Advances in Intelligent Systems and Computing Volume 194. Springer-Verlag, 2013.

Grants

[naruse-18:2013] Keitaro Naruse. Investigation on phase transition mechanism of a large scale swarm and application to swarm robot control, 2013-2016.

[naruse-19:2013] Keitaro Naruse. Development of weeding robot system for rice field, 2013-2015.

[yaguchi-16:2013] Yuichi Yaguchi. 情報地球儀：球面クラスタリングによるデータの関係の可視化, 2012-2013.

Academic Activities

[naruse-20:2013] Keitaro Naruse, 2013.
General Chair, IEEE iCast 2013.

[naruse-21:2013] Keitaro Naruse, 2013.
General Chair, IEEE UMEDIA 2013.

[naruse-22:2013] Keitaro Naruse, 2013.
Committee member of IPSJ Toohku branch

[naruse-23:2013] Keitaro Naruse, 2013.
Committee member of mockup facility

[yaguchi-17:2013] Yuichi Yaguchi, November 2013.
Publication Chair, IEEE iCAST-UMEDIA 2013

[yaguchi-18:2013] Yuichi Yaguchi, August 2013.
Organizing comittee member, 電気関連学会東北支部連合大会

[yaguchi-19:2013] Yuichi Yaguchi, September 2013.
Organizing comittee member, 可視化情報学会全国講演会 2013 会津

Patents

[naruse-24:2013] Yuki Tsurumi Keitaro Naruse, Kazuhiro Kawashima. Patent application(2013-188978): Development of rice field weeding robots, 2013.

Ph.D and Others Theses

[naruse-25:2013] Yohe Hino. Graduate Thesis: Construction of Spherical Map for clothing Using Shape and Color Pattern, University of Aizu, 2013.
Thesis Advisor: Keitaro Naruse

[naruse-26:2013] Hiroya Yamamoto. Master Thesis: Control and Numerical Analysis of Both Sides Spring Stick, University of Aizu, 2013.
Thesis Advisor: Keitaro Naruse

[naruse-27:2013] Jun Kanno. Master Thesis: Stability of Passive Dynamic Walking Model with Absorption Mechanism of Kinetic Energy, University of Aizu, 2013.
Thesis Advisor: Keitaro Naruse

[naruse-28:2013] Takahiro Hidano. Graduate Thesis: Investigation of Local Feature Amount for the Omnidirectional Image, University of Aizu, 2013.

Thesis Advisor: Keitaro Naruse

[naruse-29:2013] Ryohei Ito. Graduate Thesis: Analysis of Gait Stability on Slip Surface in Passive Dynamic Walking Model, University of Aizu, 2013.

Thesis Advisor: Keitaro Naruse

[naruse-30:2013] Yuhei Akama. Graduate Thesis: The visualizing tool of multiple agents by Octree, University of Aizu, 2013.

Thesis Advisor: Keitaro Naruse

[naruse-31:2013] Satoru Suganuma. Graduate Thesis: Facemark Feelings Classification based on Visual Impression, University of Aizu, 2013.

Thesis Advisor: Keitaro Naruse

[yaguchi-20:2013] Youhei Hino. Spherical Visualization via Shape and Color Clustering of Clothes, Univerisity of Aizu, 2014.

Thesis Advisor: Keitaro Naruse and Yuichi Yaguchi

[yaguchi-21:2013] Yasutaka Kihara. Master Thesis: Detection of multiple lead lines and behaviors of shoppers from multiple videos, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-22:2013] Kota Furusawa. Graduation Thesis: An Automatic Avatar Generation System for Hanasake Avatar!, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-23:2013] Shunpei Torii. Master Thesis: Spotting Recognition of Motions from Video Images Obtained from a Moving Camera, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-24:2013] Sinichi Hasimoto. Graduation Thesis: Aerial 3D Reconstruction using Pixel-wise Matching and Bundle Adjustment, Univerisity of Aizu, 2014.

Thesis Advisor: Incheon Paik and Yuichi Yaguchi

[yaguchi-25:2013] Sota Hoshi. Graduation Thesis: Construction of Tongue Image Database for English Learner, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-26:2013] Yuki Matsumoto. Graduation Thesis: Extraction of emotional expression in tweets, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-27:2013] Eitaro Miyamoto. Graduation Thesis: Creation of a 3D Ultrasound Probe Holder using 3D Scanner and Printer, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-28:2013] Maki Ikeda. Graduation Thesis: A Study of Information Localization - Case Study via Organizing the Internet Movie Broadcasting Group, Univerisity of Aizu, 2014.

Thesis Advisor: Ryuichi Oka and Yuichi Yaguchi

[yaguchi-29:2013] Takahiro Sato. Graduation Thesis: Finding Pronunciation Error from Ultra-Sound Mid-sagittal Tongue Image Using EdgeTrak, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-30:2013] Yuki Yokokura. Master Thesis: Spotting recognition of performance motions Spotting recognition of performance motions Spotting recognition of performance motions Spotting recognition of performance motions, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-31:2013] Shinya Sato. Graduation Thesis: Building a Gesture Recognition Interface Using Particle Filtering and Continuous Dynamic Programming, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi

[yaguchi-32:2013] Toshiki Hiraide. Graduation Thesis: A 3D graph to visualize the transition of Twitter users feelings, Univerisity of Aizu, 2014.

Thesis Advisor: Yuichi Yaguchi