Robotics and Computer Science:

toward continued collaboration between CCNY and Kyutech

June 18-19, 2018

AV Lecture Room & Learning Agora
Iizuka campus
Kyushu Institute of Technology

Jointly hosted by
School of Computer Science and Systems Engineering
at Kyushu Institute of Technology
and
The Department of Computer Science in the Grove School of Engineering
at the City College of New York

The City College of New York | The Grove School of Engineering

Kyutech
Kyushu Institute of Technology

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Date: June 18-19, 2018 (Day1 9:20am–4:30pm / Day2 10:20am-3:50pm)
Venue: AV Lecture Room (Oral session) & Learning Agora (Poster session)
Iizuka campus, Kyushu Institute of Technology
(680-4 Kawazu, Iizuka-shi, Fukuoka, JAPAN)

Day 1: June 18		
Time	Program	
9:20-9:30	**Welcoming remarks**	Prof. Eiji HAYASHI (Kyutech) Prof. Akira KAWAGUCHI or Prof. Abbe MOWSHOWITZ (CCNY)
9:30-10:00	**Keynote talk** (Kyutech)	Individual Adaptation for Assistive Robotics Using Reinforcement Learning Speaker: Prof. Tomohiro SHIBATA (Kyutech)
10:00-10:30	**Keynote talk** (CCNY)	Query optimization in highly distributed data networks Speaker: Prof. Akira KAWAGUCHI (CCNY)
10:30-10:45	Break	
10:45-11:10	**3 contributed talks** *20 minutes plus 5 minutes for questions and discussion	Session 1 Virtualized Adaptable Computing with Elastic Split-memory Virtual Machines Speaker: Prof. Kenichi KOURAI (Kyutech)
11:10-11:35		Session 2 Learning Algorithms in Artificial Intelligence for Robotics Speaker: Prof. Stephen LUCCI (CCNY)
11:35-12:00		Session 3 ~~Implementation of Vision-based Autonomous Following Robot with Two Spherical Image Cameras~~ ~~Speaker: Prof. Shuichi ENOKIDA (Kyutech)~~ ***Cancelled**
12:00-2:00	Lunch	*Posters on display in Learning Agora
2:00-2:25	**4 contributed talks** *20 minutes plus 5 minutes for questions and discussion	Session 4 Multi-Resource Allocation for Cloudlet-based Mobile Cloud Computing System Speaker: Prof. Myung LEE (CCNY)

2:25-2:50	**4 contributed talks** *20 minutes plus 5 minutes for questions and discussion	Session 5 Computational Illumination for Material Classification and Editing Speaker: Prof. Takahiro OKABE (Kyutech)
2:50-3:15		Session 6 Structural Interpretation of the Roots of Graph Polynomials Speaker: Prof. Abbe MOWSHOWITZ (CCNY)
3:15-3:40		Session 7 Resilient Edge Network for Local Production and Consumption of Spatio-Temporal Data Speaker: Prof. Kazuya TSUKAMOTO (Kyutech)
3:40-3:50	**Remarks from Dean**	Prof. Seiji KAJIHARA (Kyutech)
3:50-4:30	**Poster session**	*Workshop attendees will have an opportunity to view the posters and discuss the work with students.
5:30-7:00	**Welcome Party**	President Yuji OIE (Kyutech)

Day 2: June 19		
Time	Program	
~~10:20-10:45~~	**3 contributed talks** *20 minutes plus 5 minutes for questions and discussion	~~Session 1~~ ~~Visibility assisted indoor navigation — Experiments and Applications~~ ~~Speaker: Prof. Huy VO (CCNY)~~ ***Cancelled**
10:45-11:10		Session 2 Mobile Activity Recognition and Bigdata in Medical and Caregiving Domains Speaker: Prof. Sozo INOUE (Kyutech)
11:10-11:35		Session 3 Smart & Accessible Transportation Hubs and SRGANs For Crowd Analysis Speaker: Mr. Gregory OLMSCHENK (CCNY)
11:35-12:00		Session 4 Artificial Immune System Based Approach to Cyber Attack Detection Speaker: Prof. Tarek SAADAWI (CCNY)

12:00-2:00	Lunch	*Posters on display in Learning Agora
2:00-2:25	**4 contributed talks** *20 minutes plus 5 minutes for questions and discussion	Session 5 Indoor localization based on BLE signal mapping Speaker: Dr. Brahim BENAISSA, Prof. Kaori YOSHIDA (Kyutech)
2:25-2:50		Session 6 Joint Time Synchronization and Localization in Mobile Underwater Sensor Networks Speaker: Prof. Zheng PENG (CCNY)
2:50-3:15		Session 7 Effective Multimodal Computing in Biomedical, Civil, Military and Medical Applications Speaker: Prof. Jie WEI (CCNY)
3:15-3:40		Session 8 Toward development of flying robots like birds flapping high into the blue sky Speaker: Prof. Hiroshi OHTAKE (Kyutech)
3:40-3:50	**Closing remarks**	

Abstract

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Individual Adaptation for Assistive Robotics Using Reinforcement Learning

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Abstract

Recent demographic trend across developed nations shows a dramatic increase in ageing population, fallen fertility rates and shortage of caregivers, which has been the most salient in Japan. Hence, the demand for service robots to assist daily lives is increasing. One of the most important functions in such robots is individual adaptivity, since each individual's cognitive and physical abilities have very different characteristics, which cannot be captured by a user-averaged model. Moreover, these characteristics continue to change over time. Probably the most general framework for robots to adapt to individuals with diversity is reinforcement learning. In this talk will be introduced my studies on adaptive control of human-robot system using reinforcement learning, mainly focusing on assistive robotics.

Query optimization in highly distributed data networks

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Abstract

The main objective of this research is to realize a software layer of query optimization in a highly distributed data environment. A key element in our research is the exploitation of knowledge of the network structure to facilitate query optimization. Suppose the data set to be characterized by a relational model, the challenge is to find an optimal distributed execution plan for the *m*-fold set query involving *m* relations such that the plan guarantees the smallest total amount of data transmission over the network of *n* nodes. For a typical query, the total number *n* of nodes in the network is much larger than the number *m* of the data-hosting. A party of *m*-nodes hosting relations will send their data instances to a so-called central node that can be reached by the smallest total distance from the party. The central node will then execute the query using local optimization for those gathered instances and hold the result. The central node could be one of the party or a certain node that does not host any relation at all. Similarly, the central node is not necessarily the node that generated the query. This talk will present our finding from simulated experiments.

Virtualized Adaptable Computing with Elastic Split-memory Virtual Machines

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Abstract

Recently, clouds provide virtual machines (VMs) with a large amount of memory, e.g., 4 TB in Amazon EC2. Such large-memory VMs are required for big data analysis in artificial intelligence (AI) and Internet of Things (IoT). One of the advantages of using VMs is to migrate a VM to another host without service disruption even on host maintenance. However, large-memory VMs make VM migration difficult because it is costly to reserve large hosts with sufficient memory as the destination of VM migration.

In this talk, the speaker presents split migration of large-memory VMs. Split migration enables a VM to be migrated to multiple small hosts: one main host and one or more sub-hosts. After the migration, the VM runs across hosts as a split-memory VM and exchanges memory data between the hosts. To reduce that data exchange, split migration predicts future memory access of a VM. On the basis of the prediction, it transfers memory data likely to be accessed to the main host. According to our experiments, it was shown that the performance of split migration and application performance after the migration were comparable to that of traditional VM migration with sufficient memory.

Learning Algorithms in Artificial Intelligence for Robotics

Stephen Lucci[1]

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Abstract

This paper describes many of the popular search algorithms in Artificial Intelligence (AI). *Simulated Annealing* is viewed as an improvement to *Hill climbing* as it uses exploration and is not restricted to exploitation alone. *Genetic Algorithms* are presented as an outcome of natural computing, i.e., Darwin's theory of evolution is recast as a search algorithm for the fittest solution to a problem. *Ant Colony-inspired search* can yield solutions for problems that may arise in space exploration. *Tabu search* is shown to be ideal for solving scheduling problems. We delve into *Artificial neural network* approaches in the context of both supervised and unsupervised learning. And finally, *Deep learning networks* and *reinforcement learning* are discussed briefly. All of these approached to learning will be shown to have applications to solutions for problems that arise in *robotics.*

Implementation of Vision-based Autonomous Following Robot with Two Spherical Image Cameras

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Abstract

In this presentation, our vision-based autonomous following robot with two spherical image cameras will be introduced. To realize the capability of following a target person, it is necessary to have a wide viewing angle, and to be able to calculate a relative distance and a relative direction to the target person with high accuracy. To overcome above problems, our robot is equipped with two spherical image cameras. On each spherical image camera uses a virtual pan-tilt-zoom camera to calculate the distance and direction to the target based on a dynamic stereo camera convergence algorithm. In addition, these two cameras have the capability of detecting and tracking a person in the video image sequence. The detection and tracking methods are implemented based on our proposal feature descriptor, named “MRCoHOG”, to extracting a robust feature value for a recognition of a person in an image acquired by a camera in a natural environment. In this presentation, hardware/software architecture is described by focusing on how to design and implement our autonomous following robot based on Robot Operating System (ROS). Then, MRCoHOG, which is our proposal feature description method, will be explained next by using a person detection technique as an example.

Multi-Resource Allocation for Cloudlet-based Mobile Cloud Computing System

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Abstract

Mobile cloud computing utilizing cloudlet is an emerging technology to improve the quality of mobile services. To overcome the major bottlenecks of the computation capability of cloudlet and the wireless bandwidth between mobile devices and cloudlet, we consider the multi-resource allocation problem for the cloudlet environment with resource-intensive and latency-sensitive mobile applications. The proposed multi-resource allocation strategy enhances the quality of mobile cloud service, in terms of the system throughput (the number of admitted mobile applications) and the service latency. We formulate the resource allocation model as a semi-Markov decision process (SMDP) under the average cost criterion, and solve the optimization problem using linear programming technology.

Through maximizing the long-term reward while meeting the system requirements of the request blocking probability and service time latency, an optimal resource allocation policy is calculated. From simulation result, it is indicated that the system adaptively adjusts the allocation policy about how much resource to allocate and whether to utilize the distant cloud according to the traffic of mobile service requests and the availability of the resource in the system. Our algorithm is shown to outperform greedy admission control over a broad range of environments.

Computational Illumination for Material Classification and Editing

Takahiro Okabe

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Abstract

The appearance of an object depends not only on the geometric and photometric properties of the object but also on the light source illuminating it. In particular, the appearance depends on the color, i.e. the spectral intensity as well as the direction of the light source. Therefore, active illumination, also known as computational illumination using multispectral and multidirectional light sources such as a multispectral light stage is important for computer vision and computer graphics applications.

In this talk, we will introduce two topics on computational illumination using our multispectral light stage: one is material classification and the other is material editing. First, we propose an approach to one-shot per-pixel classification of raw materials on the basis of spectral BRDFs. We achieve two-class/multiclass classification from a single color image by jointly optimizing the non-negative coded illumination and the grayscale conversion. Second, we propose a robust method for separating diffuse and specular reflection components in a set of images of an object taken under multispectral and multidirectional light sources. The proposed method makes use of the inherent structure of the set of images: low-rankness and sparseness. We demonstrate that the diffuse-specular separation is useful for image-based material editing.

Structural Interpretation of the Roots of Graph Polynomials

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Abstract

Structural properties of graphs and networks have long been of interest to researchers in mathematics, computer science, and other disciplines. Many entropy based measures have been developed since the 1950s, each one capturing a specific aspect of graph structure. These measures have proven useful in providing effective heuristics for graph isomorphism and serving as easily determined quantitative indices of particular structural features. This talk deals with another proxy for graph structure, namely, the roots of certain polynomials associated with graphs. Two such polynomials will be examined. One is the Hosoya polynomial which is computed for a graph as a whole; a second is the partial Hosoya polynomial which is computed for each vertex in a graph. Subtracting such a polynomial (whose coefficients are all positive integers) from 1 yields another polynomial with a unique positive root between 0 and 1. It turns out that the roots of one are highly correlated with cycle structure, the roots of the other with centrality of a vertex. The usefulness of these polynomial roots as measures of structure will be discussed in relation to statistical studies. In addition, some analytical results will be presented that illustrate the possibility of distinguishing graphs based on polynomial roots.

Resilient Edge Network for Local Production and Consumption of Spatio-Temporal Data

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Abstract:

The traditional centralized architecture cannot accommodate user demands due to massive load on the core network and long latency. Therefore new architectures, which bring network functions and contents such as computing and communications to the edge of the network, are proposed. However, in such case, maintenance of resiliency closely related to reliability of networks when a subset of nodes are inactive, is important. It arises in applications such as service disruption in communication systems, blackout in power systems, or disruption by targeted attacks, or access imbalance congestion or flush crowd, etc.

In this paper, we propose a resilient edge network to minimize not only latency but also computation offload, thereby aiming to provide spatio-temporal applications such as smart city and smart grid efficiently. In particular, we first introduce a distributed data retention system by exploiting the vehicular ad-hoc networks. Finally, we explain a new geographical location-aware edge network architecture, which can be combined with the prior data retention system, and show the preliminary experimental results through real Internet environment.

Visibility assisted indoor navigation — Experiments and Applications

Hui Vo[1]

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Abstract

Indoor navigation has a wide range of applications ranging from POI discoveries and path guiding for human to utility routing for machineries and robotics. However, unlike outdoor environment, where GPS technologies can be leveraged efficiently, it is more challenging to provide accurate position and navigation in indoor environment due to building walls and signal interferences. GPS devices usually get poor penetration and low signal power. Moreover, it is also non-trivial to obtain an accurate indoor mapping. Thus, real-time indoor navigation is hard to achieve without expensive and costly devices. In this talk, we will discuss commodity alternatives that combine Bluetooth beacons with augmented reality devices to tackle this problem. We will illustrate our preliminary results through an indoor guiding system, and a robotic floor-cleaning service.

Mobile Activity Recognition and Bigdata in Medical and Caregiving Domains

Sozo Inoue

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Abstract

In this talk, we introduce activity recognition technology using mobile type sensors including smartphones and applications to medical and nursing fields. Although a lot of activity recognition technology has already been introduced, there are many challenges in collecting realistic datasets and developing algorithms for complicated and long-term activities. To this problem, from our research, we proposed a method [UbiComp2015] that uses prior knowledge of the activity segment of the day, and a method that automatically corrects when the timing of the labels are inaccurate [MobiQuitou2016]. We also proposed a method [MobiQuitous2016] that corrects differences among individuals by transfer learning. Along with these works, we talk about the future prediction of nursing work volume and patient prognosis in combination with medical data in the hospital[UBI16], and talk about the trial of recognizing whole staffs' activities in nursing homes for 4 months [UBI17].

Smart & Accessible Transportation Hubs and SRGANs For Crowd Analysis

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Abstract

The focus of this project is to turn large transportation facilities into Smart and Accessible Transportation Hubs (SAT-Hub), with minimal infrastructure change. The SAT-Hub testbed is leading to project inspired discovery in areas including: (1) Deep-learning-based pedestrian crowd analysis, using semi-supervised regression generative adversarial networks (SRGAN). (2) 3D semantic facility model-based localization with smartphone images, which offers a renovation- or reconstruction-free infrastructure approach for user localization and provides a way of facility model updating. (3) Optimal sensor placement and rapid calibration using 3D semantic model, which will advance our understanding in deploying smart sensors in a complex and large-scale dynamic environment. (4) Human-in-the-loop traveling guidance with multi-facet inputs, including information of physical 3D models, crowd and traffic flows, security alerts, transportation schedules and user preferences. This includes the capability of serving people with transportation challenges, such as passengers with visual impairment, mobility impairment, ASD (Autism Spectrum Disorder) and language barriers. This presentation will provide an overview of the SAT-Hub research, with a focus on the crowd analysis using SRGANs.

Artificial Immune System Based Approach to Cyber Attack Detection

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Abstract

Cyber Attacks have been increaing at an alarming rate. For example, the attack on DYN compnay (which controls many of the Domain Name Servers that service American domains) on October, 2016 have resulted in the cutoff of Internet services in the North East, USA. Advancements in IoT, nanotech computing, wireless, advanced robotics, autonomous systems, intelligent agents, cloud computing and other technologies, as well as reliance on 3rd party software, will also increase the cyber-attack surface in systems and networks.

Given the ability of the human immune system to detect all forms of infections and how the human body can be related to the complex network of interconnected systems that exist today, our proposal takes a biological approach to solving the network intrusion detection problem. Our proposed bio-inspired system for network intrusion detection makes use of the models that exist in immunology which has been abstracted to an area under artificial intelligence known as artificial immune system (AIS). The proposed system will be a combination of the immunology-developed theory of self-nonself (SNS), and danger theory (DT). The proposed system stems from our successful application of SNS and DT respectively to the detection of cyber attacks that originate from external networks.

Indoor localization based on BLE signal mapping

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Abstract

Indoor position of devices and persons is a key information for context-aware devices and human activity recognition. The need of such information grows bigger by the advancement of IoT technologies, and technologies that allows the communication between robots and humans. In this paper, we discuss existing indoor positioning approaches and their applications, give specific interest to the signal strength fingerprint approaches, to which belongs the presented paper. Bluetooth Low Energy Beacons are used as the source of the signal, and the Radial Basis Functions method is employed to create a model that relates to signal strength and position. The proposed approach allows the possibility of making all the computation on a smartphone application, namely, offline data collection and model computation, and online position estimation. Besides, it allows updating the model later.

Index Terms— Indoor localization, Signal fingerprint, BLE Beacon, Mobile computing.

Joint Time Synchronization and Localization in Mobile Underwater Sensor Networks

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Abstract

In recent years, the advances in autonomous underwater vehicles have enhanced the capability of underwater sensor networks and facilitated a wide variety of applications. Time synchronization and localization are some of the fundamental services demanded by many such applications. Although these two services often depend on each other, they are usually tackled independently. In this talk, we present a joint solution for localization and time synchronization, in which the stratification effect of underwater medium is also considered. By combining time synchronization and localization, the accuracy of both can be improved jointly. In addition, the solution can decrease the number of required message exchanges, and thus reduce energy consumption.

Effective Multimodal Computing in Biomedical, Civil, Military and Medical Applications

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Abstract

This talk presents recent research and development efforts made by Professor Wei and students in the City College of New York to achieve effective multimodal computing using cutting-edge techniques in biomedical, civil, military and medical applications. Using dynamical programming procedures and super-resolution approaches the nanoscale brain images were effectively analyzed to yield desirable classifications of tumor cells with different natures. The point and scanning Laser Doppler Vibrometers were harnessed to remotely collect the vibrations of bridges and building facades to achieve significantly improved maintenance efficiency and safety while reducing the cost by orders of magnitudes. Machine learning and deep learning algorithms were exploited to classify surveillance signals collected by remote sensors to identify authentic threats and suspicious vehicles. State-of-the-art statistical signal processing and machine learning methods were utilized to analyze the Cone-Beam Computational Tomography and optic human lung images that can achieve performance in par with human experts. All these are the results by combining the advanced algorithmic methods in computer science with deep insights made available by domain experts in Biomedical engineering and civil engineering in CCNY and NYU, military engineers in Air Force Research Lab and military contractors in BAE systems, and medical physicians in Mt. Sinai medical center and Memorial Sloan-Kettering Cancer Center, and sponsored by NSF, NIH, Air Force, Army and NIH.

Toward development of flying robots like birds flapping high into the blue sky

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Abstract

Have you ever wished to fly in the shiny blue sky like a bird?
Unlike airplanes and helicopters, birds generate forces to fly in the air by the flapping motion of their wings. They have not only flapping flight, but also excellent flight characteristics such as gliding, turning, hovering flights and so on.
One of the features of flapping motion of birds is the slow flapping frequency compared to airplanes and helicopters. The rotating frequencies of the jet engine of airplanes and the main rotor of helicopters are very fast. It causes great noise. In contrast, the flapping frequency of birds is about 2Hz for large-size birds, even small-size birds excluding hummingbirds are as small as 15 Hz or less. So they do not make so big noise. Therefore, people are not afraid of the flapping motion of birds. In addition, the flapping motion of birds is a swinging motion, not a rotational motion, so there is no risk that objects get caught in rotating blades. In recent years, flapping flight robots have been received attentions due to excellent flight characteristics, safety, and quietness in the research field of flying robots.
In this talk, flight forms of birds, the structure of bird's wing, flight mechanics, and flapping flight robots we have developed are introduced.