Robot Engineering Laboratory

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Refereed academic journal

[yaguchi-301-015-01:2017] W. Chen, Y. Yaguchi, K. Naruse, Y. Watanobe, and K. Nakamura. QoS-aware Robotic Streaming Workflow Allocation in Cloud Robotics Systems. *IEEE Transactions on Services Computing*, PP(99):1–1, 2017.

Current solutions of computation offloading for cloud robotics face challenges: 1) traditional approaches do not consider the characteristics of networked cloud robotics (NCR)(e.g., heterogeneity and robotic cooperation); 2) they fail to capture the characteristics of tasks in a robotic streaming workflow (RSW) (e.g., strict latency requirements and different task semantics); and 3) they do not consider quality-of-service (QoS) issues for cloud robotics. In this paper, we address these issues by proposing a QoS-aware RSW allocation algorithm for NCR with joint optimization of latency, energy efficiency, and cost, while considering the characteristics of RSW and NCR. We first propose a novel framework that combines robot individuals, robot clusters, and a remote cloud for computation offloading. We then formulate the joint QoS optimization problem for RSW allocation in NCR while considering latency, energy consumption, and operating cost, and show that the problem is NP-hard. Next, we construct a data flow graph based on the characteristics of RSW and NCR, and transform the RSW allocation problem into a mixed-integer linear programming problem. To obtain an optimal solution in reasonable time, we also develop a heuristic-based algorithm. Experiments demonstrate significant performance gains, with improved QoS and reduced execution times.

Refereed proceedings of an academic conference

[yaguchi-301-015-02:2017] Y. Yaguchi, M. Omura, and T. Okumura. Geometrical mapping of diseases with calculated similarity measure. In *2017 IEEE International Conference on Bioinformatics and Biomedicine, Workshop on BHI*, pages 1131–1134, November 2017.

Disease similarity is a useful measure that has potential application to various aspects of medicine. One such application is the mapping of diseases in a two-dimensional plane, which can be the foundation of a useful diagnostic reminder method called the "pivot and cluster strategy." However, the mapping of diseases using a similarity measure has yet to be explored. This article investigates such a mapping, and quantifies its basic characteristics. We first

collected mutual similarity data for 1,550 diseases using a machine learning approach. The calculated similarity data were then used to map the diseases using a "multidimensional scaling" algorithm. Quantitative analysis indicated that it is difficult to express all the diseases on the map and yet still show the similarity information between the items. Then, by restricting the input, the algorithm performed well in practice. To our knowledge, this is the first study to investigate the automated mapping of diseases on a plane for use in clinical practice.

[yaguchi-301-015-03:2017] Y. Yaguchi, K. Moriuchi, and K. Amma. Comparison of camera configuration for real-time drone route planning in 3D building maze. In *2017 IEEE 8th International Conference on Awareness Science and Technology (iCAST)*, pages 244–249, November 2017.

In this research, we investigate what camera settings are effective for an indoor automatic search system. We recommend installing RGB cameras with depth sensors like the Kinect and show how they should be installed to facilitate searches in indoor environments such as buildings with multiple floors. To validate camera configurations, the RTA* algorithm is used for automatic searching and we also measured how fast a drone could move to goal points in a simulation of a 3D-building model. We also studied various patterns of restart points because a drone has limited battery life, which restricts the available flight time. In the experiment, we allowed six batteries and each flight could last 600 seconds. This experiment showed that we should use three cameras positioned on the forward, upward, and backward of a drone to conduct a 3D building floor search because drones can easily rotate in the yaw direction, but cannot rotate in the pitch direction. We also showed that once the drone had returned to its start position for a battery replacement, it should restart from that point for effective searching.

[yaguchi-301-015-04:2017] Y. Yaguchi, Y. Nitta, S. Ishizaka, T. Tannai, T. Mamiya, K. Naruse, and S. Nakano. Formation control for different maker drones from a game pad. In *2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, pages 1373–1378, September 2017.

This paper describes a generalized software interface for formation flying by drones from different manufacturers. Conventional research into formation flight assumes that the drones all have the same power and functionality. However, consider a disaster response, where we might assemble a platoon

of drones to sense the environment and to search for survivors by combining the different functions of drones provided by different manufacturers. The difficulties of controlling formation flight by such a variety of drones include both different mechanical specifications and different interfaces from the manufacturers for activating the same command. In this research, we construct a generalized interface for drones from each manufacturer using OpenRTM-aist. We can then assemble these drones and establish formation flight by using a virtual leader-follower system. The leader and the follower positions are calculated by using speed and rotation data from feedback information such as the GPS, velocity and rotation data from each individual machine. We also investigate good features of flight commands that can express the attributes of the representative motion of the drones. From our experiments, we show that we can establish formation flight using drones of different power and from multiple manufacturers.

[yaguchi-301-015-05:2017] I. Otani, Y. Yaguchi, K. Nakamura, and K. Naruse. Quantitative Evaluation of Streaming Image Quality for The Robot Teleoperation. In *2018 23rd International Symposium on Artificial Life and Robotics*, pages 230–235, January 2018.

In this paper, we define a novel measure of streaming video quality for remotely operated robots. Controlling robots remotely is crucial for disaster response, and many attempts have been made to create such systems. Wireless communication, which is used in remote-control systems for unmanned vehicles, change dynamically and the streaming quality also changes to the quality of the network; however, wireless conditions are not typically measured in conventional robot systems. We are developing a quality measure for remote control using video proprieties such as delay and degrading of image quality as Quality of Control (QoC). In this paper, we introduce this QoC measure using delay and degrading of image quality curves in simulation environments, and we discuss the implications for robot system design.

[yaguchi-301-015-06:2017] R. Yamada, Y. Yaguchi, and M. Yoshida. Performances of 3D mapping and odometry tools, and of a visualization system for analyzing accidents of unmanned aerial vehicles. In *2018 23rd International Symposium on Artificial Life and Robotics*, pages 389–394, January 2018.

Our target is to replace the accident conditions of the unmanned aerial vehicles (UAVs) using data obtained from the sensors and flight recorder loaded

on the UAVs to analyze their causes. In this paper, we have first investigated the performances of three types of tools for 3D mapping and odometry to reproduce the surrounding environment and its orbit, and found that the tool using the LIDAR data are more accurate and can reproduce broader areas compared with methods that use monocular and stereo camera images. Second, we applied an optical flow method to images taken by a monocular camera rotating with 4 types of velocities, and found that imaging over 120 fps is required to analyze accurately the velocity field of the rotating and falling UAV. Finally, we have developed a visualization system that displays the reproduced situations of the UAV flights and accidents on a computer screen.

Unrefeered proceedings of an academic conference

[yaguchi-301-015-07:2017] D. Yoshino, Y. Watanobe, Y. Yaguchi, K. Nakamura, J. Ogawa, and K. Naruse. Proposal of MQTT and MQTT-SN Communication Interfaces on RT Middleware for IoR System Construction. In *The 18th Meeting of SICE System Integration Department, SI2018*, 2017.

[yaguchi-301-015-08:2017] Y. Yaguchi and K. Moriuchi. Real-time 3D Maze Searching by A Drone Using The Depth Cameras. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

[yaguchi-301-015-09:2017] D. Yoshino, Y. Watanobe, Y. Yaguchi, K. Nakamura, and K. Naruse. Application possibility of OpenRTM-aist-based integrated robot systems using CORBA interfaces and brokered Pub/Sub messaging interfaces. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

[yaguchi-301-015-10:2017] Y. Yaguchi, Y. Nitta, S. Ishizaka, T. Tannai, T. Mamiya, K. Naruse, and S. Nakano. RT Components for Formation Flight with The Hetero Manufacturer Drones. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

[yaguchi-301-015-11:2017] K. Amma, Y. Yaguchi, Y. Watanobe, and K. Naruse. Constructing Cloud base RTM and automatic deploy to Raspberry Pi. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

[yaguchi-301-015-12:2017] I. Otani and Y. Yaguchi. The Simple Robot Prototyping for RT-Midlleware of the FaBo.inc Sensors. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

[yaguchi-301-015-13:2017] M. Yoshida and Y. Yaguchi. 3D Environment Map Reconstruction with Aerial Camera on A Drone. In *2017 JSME Conference on Robotics and Mechatronics, ROBOMECH2017*, 2017.

Advisor for undergraduate research and graduate research

[yaguchi-301-015-14:2017] Ikumi Otani. Graduation Thesis: Quantitative evaluation of streaming image quality for the robot teleoperation, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-15:2017] Kazutake Suzuki. Graduation Thesis: A Characters Select Recommendation System for League of Legends Beginners, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-16:2017] Masaki Sakuma. Graduation Thesis: Comparison of Cameras and Sensors for 3D Mapping by using mobile robot, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-17:2017] Pham Hung Cuong. Master Thesis: Sensor Fusion of 3D LiDAR and Fish-eye Camera for Landscape Mapping, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-18:2017] Yuta Oshima. Master Thesis: Generation of similar disease map based on disease similarity and sparse network, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-19:2017] Yukinori Inoue. Master Thesis: Collision Avoidance for Drone Fleets using Potential Method, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

[yaguchi-301-015-20:2017] Takaaki Mamiya. Master Thesis: Data Fusion of LIDAR and Stereo Camera for Real Time 3D Dense Mapping, University of Aizu, 2017.

Thesis Advisor: Y. Yaguchi

Contributions related to syllabus preparation

[yaguchi-301-015-21:2017] A undergraduate school course syllabus constructed: [IT03] Digital Image Processing

[yaguchi-301-015-22:2017] A graduate school course syllabus constructed: [ITC05] Pattern Recognition and Machine Learning

[yaguchi-301-015-23:2017] A graduate school course syllabus constructed: [ITA06] Image Rcognition and Understanding

Advisor of a student club or circle

[yaguchi-301-015-24:2017] Circle Advisor: Pokemon Circle

[yaguchi-301-015-25:2017] Circle Advisor: Confort Utopian Orchestra

[yaguchi-301-015-26:2017] Circle Advisor: Soccer Circle

Contribution related to educational planning management

[yaguchi-301-015-27:2017] A member of Curriculum Working Group

Other significant contribution toward university planning, management, or administration

[yaguchi-301-015-28:2017] A member of PC Koshien

[yaguchi-301-015-29:2017] A member of entrance examination working group

Proposal/implementation of a new industry

[yaguchi-301-015-30:2017] A vice chairman of the investigation and review meeting of wireless system related to grasp of flight position of small unmanned aerial vehicles, Tohoku Integrated Communication Bureau

[yaguchi-301-015-31:2017] A member of the bid for UTM to be implemented in Fukushima Robot Test Field

Contribution toward education for employees of regional industries

[yaguchi-301-015-32:2017] A lecturer of the Fukushima Robot Software Study Meeting

Other noteworthy contribution related to regional industries

[yaguchi-301-015-33:2017] A member of the Fukushima Prefecture Industry-Robot Technology Development Support Project

Did you participate in Public Lectures, and/or Open Campus? (Yes or No) If yes, please describe what you did.

[yaguchi-301-015-34:2017] Open Campus: Summer Stage and Autumn Stage

Do you have experience of University-Industry collaboration? If yes, please describe your experience. (for UBIC's information)

[yaguchi-301-015-35:2017] Commissioned research: UAV Security, East-Japan Accounting Center, co.

[yaguchi-301-015-36:2017] Commissioned research: Motion recognition of drive recorder on forklift, Toolmart, co.