Publication Overview

2004 – 2020

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https://github.com/jkerdels/pub_overview

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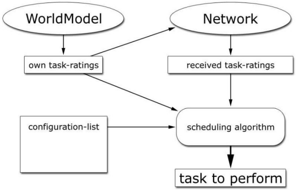
Decentral Control in Robot Teams

We developed a **decentral scheduling algorithm** that allows multiple robots to coordinate their behavior to achieve a common goal in a challenging, dynamic environment where communication might be intermittent and the number of robots might change without prior notice [1, 2].

Characteristics of our approach:

- synchronization free
- low-bandwidth broadcast communication
- graceful degradation in case of
  - communication outages
  - loss of team members
- continuous replanning



Schematic of the proposed scheduler [1].

The scheduling algorithm was successfully used during the RoboCup 2004 competition winning the Standard Platform League Open Challenge [3]. video

[1] J. Ziegler et al. *Virtual Robot - Adaptive Ressource Management in Robot Teams*. Technical Report 0204. presented at International RoboCup Worldchampion, Lissboa, July 2004. University of Dortmund, 2004 PDF bibtex

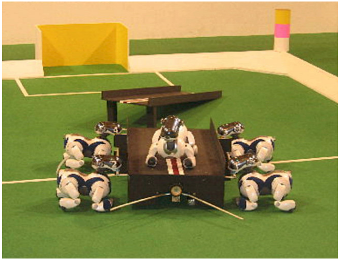
[2] I. Dahm et al. "Decentral control of a robot-swarm". In: *Autonomous Decentralized Systems, 2005. ISADS 2005. Proceedings*. Apr. 2005, pp. 347–351. DOI: 10.1109/ISADS.2005.1452083 PDF bibtex

RoboCup 2004

As an undergraduate I participated in a yearlong **robotics project** in which we programmed ERS-210 and ERS-7 robotic dogs made by Sony to compete in the Standard Platform League (SPL) of the international **RoboCup 2004 competition**.

Our technical report [3] provides an in-depth look into the core challenges of teaching robots to play soccer, the solutions developed by our team, and the involved support infrastructure.

As part of the GermanTeam – a collaboration between the universities of Berlin, Bremen, Darmstadt, and Dortmund – we won the world championship in the SPL as well as the SPL Open Challenge.



Scene from the SPL Open Challenge [3].

[3] Ingo Dahm et al. *Virtual Robot: Automatic Analysis of Situations and Management of Resources in a Team of Soccer Robots.* Tech. rep. PG 442 Final Report. University of Dortmund, 2004 PDF bibtex

Diploma Thesis

My diploma thesis [4] presents a novel approach to **discover objects in unlabeled image data** using a combination of traditional methods including image segmentation, feature extraction, clustering, and dynamic programming.

The key idea consists of using **image segmentation to group features** in an image, and use these feature groups to represent the individual segments in a way that is invariant to rotation, scale, and translation.

Such feature segments can then be related to each other by an appropriate distance measure to **identify segments that occur repeatedly** in different contexts.

Finally, neighborhood relations among segments can be learned in a similar fashion to **discover stable feature segment constellations** that indicate the presence of reoccuring structures, i.e., putative objects in the images.

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[4] Jochen Kerdels. "Dynamisches Lernen von Nachbarschaften zwischen Merkmalsgruppen zum Zwecke der Objekterkennung". Diplomarbeit. Diplom. University of Dortmund, Aug. 31, 2006 **PDF** **bibtex**

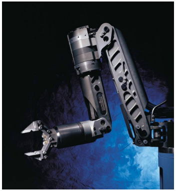
Project C-Manipulator (1/4)

C-Manipulator [5] is a research project that was conducted from 2006 to 2009 at the German Research Center for Artificial Intelligence (DFKI) in Bremen.

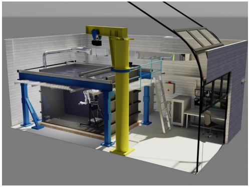
Its main objective was the development of a **manipulator system for deep sea applications** that provides autonomous and assistive functions to the system's operators.

The project used a **hydraulic ORION 7P** by Schilling Robotics as its main robotic arm. As main sensors, the system was equipped with two overhead cameras used for stereo vision and a single camera mounted to the wrist for visual servoing.

The project was finished successfully with an open water test in coastal waters. video



The ORION 7P manipulator
((c) Schilling Robotics)



3D rendering of the underwater testbed
(Jan Albiez, DFKI)

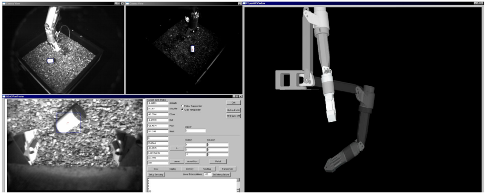
[5] Dirk Spenneberg et al. "C-Manipulator: An Autonomous Dual Manipulator Project for Underwater Inspection and Maintenance". In: *Proceedings of OMAE 2007*. ASME 2007 International Conference on Offshore Mechanics and Arctic Engineering. San Diego, USA, 2007
PDF bibtex

Project C-Manipulator (2/4)

In [6] we report on **early results** of the C-Manipulator project that introduce a number of improvements over the traditional, manual control of underwater robotic arms:

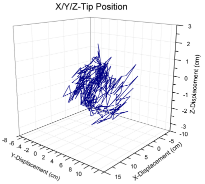
- We developed a **fast inverse kinematic closed form solution** that allows movements in cartesian space and guarantees numerical stability.
- We implemented a two-phase, **semi-autonomous gripping** of objects. video

The Orion 7P in our underwater testbed [6].



View of the control software. The left side contains all three camera images. The right side shows a 3D representation of both the current (solid) and future (transparent) positions of the manipulator [6].

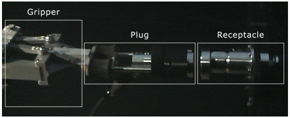
[6] Marc Hildebrandt et al. "Robust Vision-Based Semi-Autonomous Underwater Manipulation". In: *The 10th International Conference on Intelligent Autonomous Systems*. Ed. by Wolfram Burgard et al. IOS Press, 2008, pp. 308–315 PDF bibtex



3d plot of tip displacement during movement compensation [7].

Deep sea robotic arms are usually mounted to remotely operated vehicles (ROV). We developed a **novel algorithm to compensate for disturbances** that does not rely on the station-keeping algorithm of the ROV but compensates vehicle movements directly **via a movement overlay** in the robotic arm [7]. **video**

We **augmented the built-in controller** of the ORION 7P with a multi-layered controller enabling **high precision end-effector control** well beyond the manipulator's original capabilities [8]. We showcased the achievable precision by the automated plugging of an underwater connector. **video**



Automated plugging of a Gisma Series 80 underwater connector [8].

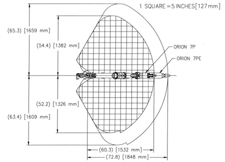
[7] Marc Hildebrandt et al. "Realtime motion compensation for ROV-based teleoperated underwater manipulators". In: *OCEANS 2009 - EUROPE*. 978-1-4244-2523-5. May 2009 **PDF** **bibtex**

[8] Marc Hildebrandt, Jochen Kerdels, and Jan Albiez. "A Multi-Layered Controller Approach for High Precision End-Effector Control of Hydraulic Underwater Manipulator Systems". In: *OCEANS 09 MTS / IEEE Biloxi - Marine Technology for Our Future: Global and Local Challenges. OCEANS MTS/IEEE Conference (OCEANS-09), Marine Technology for our Future: Global and Local Challenges, October 26-29, Biloxi, USA*. o.A., Oct. 2009. ISBN: 978-1-4244-4960-6 **PDF** **bibtex**

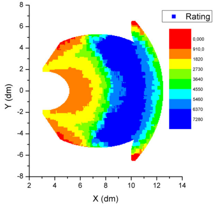
One of the primary tasks of modern ROV deployment is **intervention work**. Intervention in these cases consists of tasks like opening fixtures, or plugging connections.

Robotic operators have to rely solely on visual feedback and their experience to determine if in a given situation a desired position is reachable, and how much dexterity will be available to perform the intended task.

We introduced a **methodology to represent workspace properties** like remaining dexterity with **respect to tele-operation tasks** [9]. The information gained can be used as a signal to an operator or as the basis for motion commands to the ROV carrying the robot arm.



Nominal workspace of the ORION 7P [9].



Dexterous workspace of the ORION 7P for a front-down position of the gripper [9].

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[9] Jan Albiez, Marc Hildebrandt, and Jochen Kerdels. "Automatic Workspace Analysis and Vehicle Adaptation for Hydraulic Underwater Manipulators". In: *OCEANS 2009, MTS/IEEE Biloxi - Marine Technology for Our Future: Global and Local Challenges*. o.A., Oct. 2009
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[9] Jan Albiez, Marc Hildebrandt, and Jochen Kerdels. "Automatic Workspace Analysis and Vehicle Adaptation for Hydraulic Underwater Manipulators". In: *OCEANS 2009, MTS/IEEE Biloxi - Marine Technology for Our Future: Global and Local Challenges*. o.A., Oct. 2009.