Humanoid Robots Lab

BA-INF 051 Projektgruppe
MA-INF 4213 Seminar
MA-INF 4214 Lab

Prof. Dr. Maren Bennewitz

Supervisors:
Dr. Marcell Missura  Arindam Roychoudhury
Christopher Gebauer  Tobias Zaenker  Nils Dengler
**Courses**

<table>
<thead>
<tr>
<th></th>
<th>Bachelor PG</th>
<th>Master Lab</th>
<th>Master Seminar</th>
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</thead>
<tbody>
<tr>
<td><strong>ECTS points</strong></td>
<td>6 + 3</td>
<td>9</td>
<td>4</td>
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<tr>
<td><strong>Workload</strong></td>
<td>180 h + 90 h</td>
<td>270 h</td>
<td>120 h</td>
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- **Seminar**: Presentation and discussion of relevant scientific work
- **Lab**: Programming project on robot simulation software
- **Project Group**: Lab (2/3) + Seminar (1/3)
- **Due to Covid, experiments can be performed in simulation only.**
Changes due to Covid-19

- All communications will take place electronically until further notice.
- It is possible to visit your supervisor with prior appointment.
- Using simulations instead of actual robot hardware.
- Software requirements on website.
- Presentations over video conference.
MA-INF 4213 Seminar
Seminar Overview

- Presentation and discussion of relevant scientific work (conference/journal papers)
- What is the new contribution of the work? How does the technique work? What are the strengths and the weaknesses of the approach?
- MSc students: Summary and discussion of the work (7 pages not counting figures, LaTeX template provided on web page)
Seminar Overview

- Prepare during the semester (at home)
  - Understand the paper
  - Write summary (MSc)
  - Prepare your presentation
- Seminar Day at the end of the semester
  - Everybody has to present
  - Everybody has to be present
  - It’s a full day event!
  - Present over video conference
Seminar Grade

BSc Students:
- Presentation: 100%

MSc Students:
- Presentation: 70%
- Summary and discussion: 30%
Seminar Papers
Goal: Generation of pushing actions to achieve desired state

Representation as object-centric graph

Learn internal model to predict object pose changes due to pushing actions

For a given scene and goal state, generate possible pushing actions by sampling the parameter space

Evaluate candidates by internal simulation
Affordance-Based Mobile Robot Navigation Among Movable Obstacles
Wang, Luo, Önol, and Padir
IEEE-RAS Int. Conf. on Int. Robots and Systems (IROS), 2020,
Supervisor: Maren Bennewitz

- Framework for navigation among movable obstacles
- Consider affordances of objects (pushing, lifting) to free paths
- Affordance extraction for new obstacles to detect their movability
- Contact-implicit trajectory optimization to interact with movable obstacles
Robot Navigation in Crowded Environments Using Deep Reinforcement Learning
Lucia Liu et al.
IROS 2020, Supervisor: Christopher Gebauer

- Navigation in crowded environments
- Reinforcement Learning based
- Static obstacles avoidance
- Humans explicitly treated to improve navigation quality
Deep Reinforcement Learning for Tactile Robotics: Learning to Type on a Braille Keyboard
Alex Church et al.
RA-L 2020, Supervisor: Christopher Gebauer

- Learning to type on Braille Keyboard
- Compares different reinforcement learning methods
- Observation only based on tactile sensors
Detecting Usable Planar Regions for Legged Robot Locomotion
Sylvain Bertrand, Inho Lee, Bhavyansh Mishra, Duncan Calvert, Jerry Pratt, and Robert Griffin
IROS 2020, Supervisor: Marcell Missura

- Segmentation of a LIDAR point cloud into convex planar regions
- Useful for humanoid walking
Can I lift it? Humanoid robot reasoning about the feasibility of lifting a heavy box with unknown physical properties
Yuanfeng Han, Ruixin Li, and Gregory S. Chirikjian
IROS 2020, Supervisor: Marcell Missura

- Robot reasoning whether it can lift a box
- Weight and joint torque considerations
- Finds a good grip during interaction with the box
Goal: Reconstruct regions of interest (ROIs) in a scene with multiple robotic arms

- Viewpoints are evaluated based on multiple criteria, including visibility of ROIs
- Decentralized Monte Carlo tree search used to coordinate actions
**Coverage Path Planning**

**Jing et al.**

**IROS 2019, Supervisor: Tobias Zaenker**

- **Goal:** Find path for UAV to fully cover target structure at minimal cost.
- **Method:** sample points around targets, generate path primitives for close points.
- **Construct graph from path primitives, find path to minimize travel distance for desired coverage area**
Autonomous Indoor Exploration via Polygon Map Construction and Graph-based SLAM Using Directional Endpoint Features
Gao et al.
IEEE Transactions on Automation Science and Engineering, 2018
Supervisor: Arindam Roychoudhury

- 2D laser based autonomous exploration approach for mobile robots
- Graph-based SLAM using directional endpoint features
- Novel polygon map for navigation
- Autonomous exploration through information gain calculation and collision detection
Three parallel fully convolutional networks are adopted to generate object instance masks, depth map, and edge map of the room layout.

Support relationships inferred in a data-driven manner.

Global-to-local model matching strategy to retrieve the whole indoor scene.

FIGURE 1  Semantic modeling of an indoor scene. With a (a) single indoor photograph, three parallel fully convolutional networks are adopted to extract (b) instance masks, a depth map, and a layout edge map for support inference. Using the support relationships as constraints, (c) a whole semantic indoor scene can be automatically reconstructed. FCN = fully convolutional network.
MA-INF 4214 Lab
Programming Projects

- Small groups of 2-3 people
- Work with robot simulation software at home
- Individual projects involving perception and action generation
- Presentation and written documentation at the end of the semester
- Presentations over video conference.
Soccer

- Detect the goal and the ball, walk up to the ball, and kick the ball into the goal
- Defend with the goalie
Turtlebot

- Program a mobile robot to avoid obstacles and to find an object in a labyrinth
Robot Arm

- Program a robot arm to sort objects into a cup
Lab Grade

- Depends on participation during the semester, performance of the system in the final demonstration, and the final presentation.
- Individual grade for each group member
- Satisfying documentation is a precondition!
BA-INF 051 Projektgruppe
Programming Projects

- Same as MA-INF 4214
- 70% weight
- Small groups of 2-3 people
- Work with robot simulation software at home
- Individual projects involving perception and action generation
- Presentation and written documentation at the end of the semester
- Presentations over video conference.
Seminar Papers

- 30% weight
- Papers decided and assigned by supervisor
- Individual paper assignment
- Presentations over video conference.
Grade

- **Lab:** Depends on participation during the semester, performance of the system in the final demonstration, the final presentation and satisfying documentation.
- **Seminar:** Students are assessed on their understanding of the assigned paper during the final presentation. No written report necessary.
- **Individual grade for each group member.**
Registration
Next Steps

- **Two** separate registrations are necessary!

1. **Registration on our web site** (first-come-first-serve!) until Sunday, 18.04.2021

2. **Notification of topic and group assignment by email** (according to chosen priority): Monday, 19.04.2021

3. **Registration in BASIS until Thursday, 22.04.2021.**

4. **Please wait** for our confirmation mail before registering on BASIS!
22.04.2021, Thursday

13.07.2021, Wednesday

Registration deadline in BASIS

**Registration**

**UPDATE:** Please wait for our confirmation mail before you register on BASIS. We will send you a confirmation mail on 19.04.2021.

Here is the registration link.

### Topics:

1. **Predicting Pushing Action Effects on Spatial Object Relation**
   - Paus, Huang, and Asfour
   - IEEE Int. Conf. on Robotics and Automation (ICRA), 2020
   - Supervisor: Maren Bennewitz
   - [PDF](#)

2. **Affordance-Based Mobile Robot Navigation Among Movable Obstacles**
   - Wang, Luo, Önlö, and Padır
   - IEEE-RAS Int. Conf. on Int. Robots and Systems (IROS), 2020
   - Supervisor: Maren Bennewitz
   - [PDF](#)

3. **Autonomous Indoor Exploration via Polygon Map Construction and Graph-based SLAM Using Directional Endpoint Features**
   - Gao et al.
   - IEEE Transactions on Automation Science and Engineering, 2018
   - Supervisor: Arindam Roychoudhury
   - [PDF](#)
Registration for the Humanoid Robots seminar

Questions marked with (*) are mandatory.

**Name (*)**

**E-Mail address (*)**

**Matriculation Number (*)**

**Study program (*)**
- M.Sc. Computer Science (Uni Bonn)
- M.Sc. Media Informatics (RWTH Aachen)
- M.Sc. Autonomous Systems (Hochschule Bonn-Rhein-Sieg) as “Zweithörer”
- Other: (please specify)

**Topics**
Please choose four topics and rank them from 1 = highest priority to 4 = lowest priority.

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<thead>
<tr>
<th>#</th>
<th>Topic</th>
<th>Priority (1-4)</th>
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<tbody>
<tr>
<td>1</td>
<td>Predicting Pushing Action Effects on Spatial Object Relation</td>
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<tr>
<td>2</td>
<td>Affordance-Based Mobile Robot Navigation Among Movable Obstacles</td>
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<tr>
<td>3</td>
<td>Autonomous Indoor Exploration via Polygon Map Construction and Graph-based SLAM Using Directional Endpoint Features</td>
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<td>4</td>
<td>Semantic modeling of indoor scenes with support inference from a single photograph</td>
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<td>5</td>
<td>Coverage Path Planning using Path Primitive Sampling and Primitive Coverage Graph for Visual Inspection</td>
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Apply for Exam in BASIS

Apply for Exams

Please choose the exam from the structure given below. Click on the identifiers.

Master of Science Computer Science 2007
- 2000 Konto: Algorithmics
- 3000 Konto: Graphics, Vision and Audio
- 4000 Konto: Information and communication Management
  - 612103101 Modul MA MA-INF 3101 High Performance Networking
  - 612203101 Prüfung Modul 3101
    → Date: 08.02.2010, Examiner: Martini, Peter, Date: 01, Room: , Start: Prüfung anmelden
  - 612103102 Modul MA MA-INF 3102 Information Systems Engineering
  - 612103201 Modul MA MA-INF 3201 Network Security
  - 612103202 Modul MA MA-INF 3201 Mobile Communication
  - 612103203 Modul MA MA-INF 3203 Intelligent Information Systems
  - 612103204 Modul MA MA-INF 3204 Distributed and Mobile Information System
# Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>BSc Project Group</th>
<th>MSc Lab Course</th>
<th>MSc Seminar</th>
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<tr>
<td>Sun, 18.04.2021</td>
<td>Registration deadline (HRL Website)</td>
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<tr>
<td>Mon, 19.04.2021</td>
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<td>Confirmation mail</td>
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<tr>
<td>Thu, 22.04.2021</td>
<td></td>
<td>BASIS registration deadline</td>
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<tr>
<td>Mon, 26.04.2021</td>
<td></td>
<td>Notifications by email</td>
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<tr>
<td></td>
<td>Supervised lab course during the whole semester</td>
<td></td>
<td>Individual supervision</td>
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<tr>
<td>Wed, 13.07.2021</td>
<td>▪ Seminar presentation</td>
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<td>▪ Seminar presentation</td>
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<td>▪ Deadline for the summary</td>
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<tr>
<td>Wed, 22.09.2021</td>
<td>▪ Lab demonstration</td>
<td>▪ Lab demonstration</td>
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<td>▪ Deadline for the lab documentation</td>
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Questions?