

Praktikum/Lab Course - Perception and Learning in Robotics and Augmented Reality

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Introduction

- **Computer Vision**

High-level image understanding

- Object recognition
- Object detection
- Pose estimation
- Depth perception
- Scene understanding

- **Deep Learning**

Learn representations of data

- Learn from examples
- Model features relevant for a given task
- Boost performance in CV problems

- **Application in Robotics**

- Grasping and Manipulation
- Navigation
- Obstacle avoidance



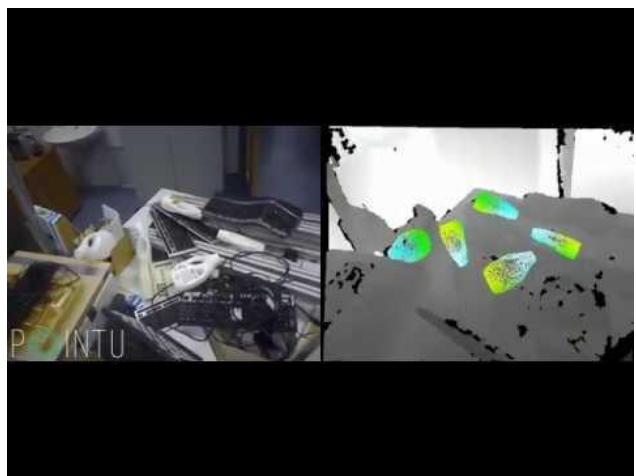
- **Augmented Reality**

- Render virtual/augmented content on real objects of known shape or pose





2D Object Detection



3D Object Detection and tracking



AR



Robotics

Goals

- Be familiar with **practical aspects of computer vision and deep learning** for typical 3D perception tasks such as feature extraction, surface matching, object localization, pose estimation.
- Learn to **develop code with relevant open source libraries** for computer vision, 3D perception and deep learning.
- Learn to **build up an end-to-end framework** within a project related to either robotic perception or augmented reality.

Course structure

- Lectures & Assignments stage:
 - **1 weekly lecture of 1.5 hour** (7 weeks)
 - **Weekly assignments** - to be submitted via GitLab
(**deadline:** Friday morning before every lecture, 11am)
- Project stage:
 - **Project development** based on the selected track
(in parallel + 3 extra weeks)
 - **Final project presentation** and evaluation at the end of the course

Contents - 1st part

- Theory
 - Image matching using keypoints and features
 - 3D data representations
 - Basics of Convolutional Neural Networks (CNNs)
 - Image classification and object detection using deep networks
 - Surface matching via 3D descriptors
 - 3D Object detection and pose estimation
- Assignments/exercises
 - OpenCV (C++, open source)
 - Open3D Library (C++, open source)
 - PyTorch (Python, open source)



Contents - 2nd part

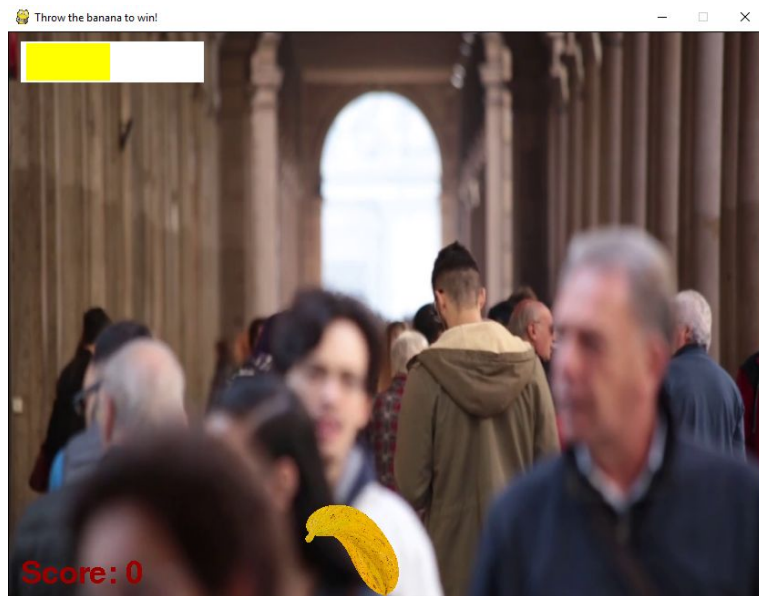
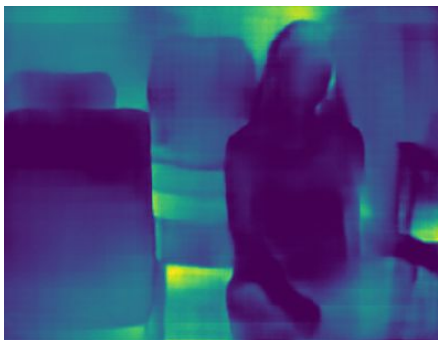
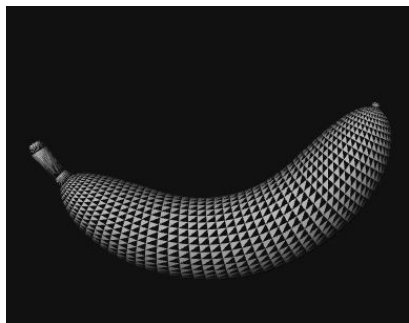
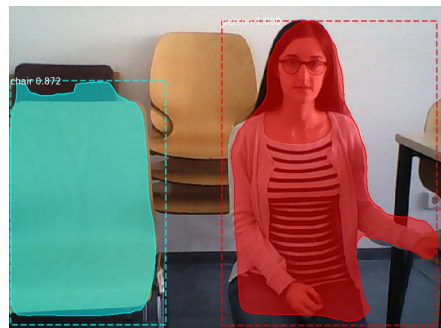
- Final project - tracks:
 - Human-robot interaction
 - AR for video-games
 - Pose estimation for robot manipulation
 - 3D avatar
 - AR via scene understanding

Example projects from previous years



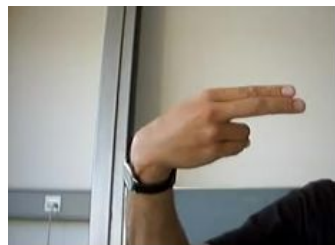
Black Mirror: *Make people disappear from an image*

Example projects from previous years



AR Game: *Hit people with bananas to get points!*

Example projects from previous years



H



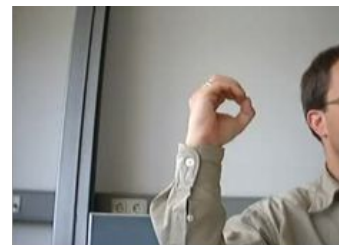
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Human-Robot Interaction: *Sign Language From RGB Images*

Evaluation criteria

- Weekly assignments (60%)
- Final project (40%)

Prerequisites

- Basic knowledge of Python and C++
- (Not mandatory) Basic knowledge of computer vision

TUM Matching System

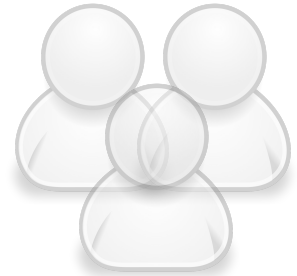
- (Not mandatory, but highly recommended) send a motivation letter to:
plarr-2020@googlegroups.com

Schedule

- Friday afternoon, 3-4.30pm
- Seminarraum 03.13.010

Teams

- Students are grouped **in teams of 3** and evaluated jointly
 - However, we will check for balanced workload in the team
 - Registered students are suggested to team up before the beginning of the semester
 - Unpaired students will be paired randomly after the first class
-
- 7 teams
 - Each team will be **assigned to a tutor**



Tentative schedule

24.04	Introduction and computer vision basics	OpenCV (I)	
01.05	Feiertag		
08.05	Feature description and matching	OpenCV (II)	
15.05	Fundamentals of CNNs and deep feature learning	Pytorch (I)	Weekly assignments
22.05	-		
29.05	Image classification and object detection with CNNs	Pytorch (II)	
05.06	3D sensors and 3D representations	Eigen, OpenNI	
12.06	Surface matching and registration	Open3D (I)	
19.06	3D object detection and pose estimation	Open3D (II)	
26.06	Project building I		
03.07	Intermediate presentations		
10.07	Project building II		
17-24.07 (TBD)	Project presentations		Final Project