Center for Robotics and Autonomous Systems

https://robotics.fel.cvut.cz

Karel Zimmermann

Department of Cybernetics
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Head: Tomáš Svoboda

Research groups:

- Center for Robotics and Autonomous Systems (CRAS)
- Visual Recognition Group (VGL)
- Machine Learning (ML)
- Biomedical Imaging Algorithms (BIA+AID)
Department of Cybernetics

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https://robotics.fel.cvut.cz/cras/

Tomas Svoboda

Karel Zimmermann

Martin Saská

Jan Faigl

15+ PhD students
Research interests

- Self-driving cars
- Search and Rescue Robotics
Self driving cars

• Longterm cooperation with Valeo
• H2020 EU research projects (Enable S3)
• Shared datasets and students
Active 3D mapping

Lidar with independent steering of depth-measuring rays

S3 principle

Emitted laser beams

Transmitted through Optical Phased Array

Controlling optical properties of OPA elements, allows to steer laser beams in desired directions

Reflected laser beams are captured by SPAD array

Images of S3 Lidar redistributed with permission of Quanergy Systems (http://quanergy.com)
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Active 3D mapping

- SPARSE MEASUREMENT
  - MAKE MEASUREMENTS
  - CNN
  - DENSE OCCUPANCY CONFIDENCE
  - UPDATE GLOBAL MAP

Global map
- PLANNING NEW RAYS
- EXCEPTED TRAJECTORY
- ESTIMATED POSITION
Active 3D mapping

- Sparse measurement
  - Make measurements
  - CNN
  - Dense occupancy confidence
  - Update global map

- Global map
  - Planning new rays
  - Expected trajectory
  - Estimated position

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Active 3D mapping
Active 3D mapping

SPARSE MEASUREMENT → CNN → DENSE OCCUPANCY CONFIDENCE

MAKE MEASUREMENTS

PLANNING NEW RAYS

EXPECTED TRAJECTORY

UPDATE GLOBAL MAP

Global map

ESTIMATED POSITION

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Active 3D mapping

input (320x320x32) sparse voxel map

output (320x320x32) probability of occupation
Active 3D mapping

Experiment: Qualitative evaluation

Sparse measurements

Reconstructed map

Ground truth
Active 3D mapping

[1] Zimmermann, Petricek, Salansky, Svoboda, Learning for Active 3D Mapping, **ICCV oral**, 2017  
https://arxiv.org/abs/1708.02074
Object detection and tracking


Data-driven simulation from GTA

RGB images
Data-driven simulation from GTA

Depth images
Data-driven simulation from GTA

Stencil layer
Data-driven simulation from GTA

Stencil layer - cars
Data-driven simulation from GTA

Stencil layer - humans

pedestrian
driver’s hand
Data-driven simulation from GTA

Stencil layer - vegetation
Data-driven simulation from GTA

Stencil layer - **sky**
Data-driven simulation from GTA

Stencil layer - **artificial light**
Data-driven simulation from GTA

Stencil layer - artificial light
Data-driven simulation from GTA

virtual car in GTA environment

ideal RGBD images
Data-driven simulation from GTA

Input

Geometric simulation of lidar from depth
Data-driven simulation from GTA

Geometric simulation of lidar from depth

Input

Valeo lidar dataset

Data-driven refinement

strong response

weak response
Data-driven simulation from GTA

Learned reflectivity
Data-driven simulation from GTA

Preparing publicly available dataset with Valeo R&D
Research topic outline

- Self-driving cars
- Search and Rescue Robotics
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- Self-driving cars
- Search and Rescue Robotics
DARPA Subterranean challenge

3 Sub-Domains
Tunnel Systems • Urban Underground • Cave Networks

2 Competition Tracks
Systems Track • Virtual Track

1 Revolutionary Vision
Create breakthrough technologies and capabilities for underground operations

https://www.subtchallenge.com
DARPA SubT integration exercise
Motion and compliant control

DARPA SubT integration exercise

• Our team achieved best score in our group
Mohamed bin Zayed International Robotics Challenge

2017 + 2020
The helicopter has to fly up autonomously above the field, where the car is expected to move, and to localize the car using the landing pattern carried on its roof.
Firstly, the helicopters have to scan the entire environment to localize the objects by onboard cameras, then to plan trajectories over the estimated locations of objects to refine these positions and to start with collecting of the individual objects.
MBZIRC – Victory
We search for collaboration opportunities

- PostDocs
- PhD students
- EU project partners

in

- aerial and ground robotics
- self-driving cars
- humanoid robotics and grasping
- computer vision
- machine learning

We are building consortium for the new EU project (besides research organization firefighters and first responders are needed)

https://cyber.felk.cvut.cz
http://robotics.fel.cvut.cz