AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

3D Vision

An enabling Technology for Autonomous On- and Offroad Driving

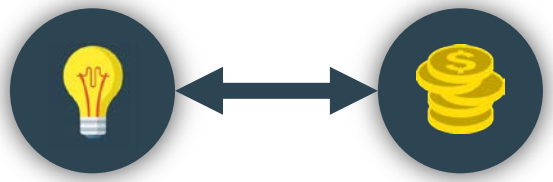
AIT Austrian Institute of Technology

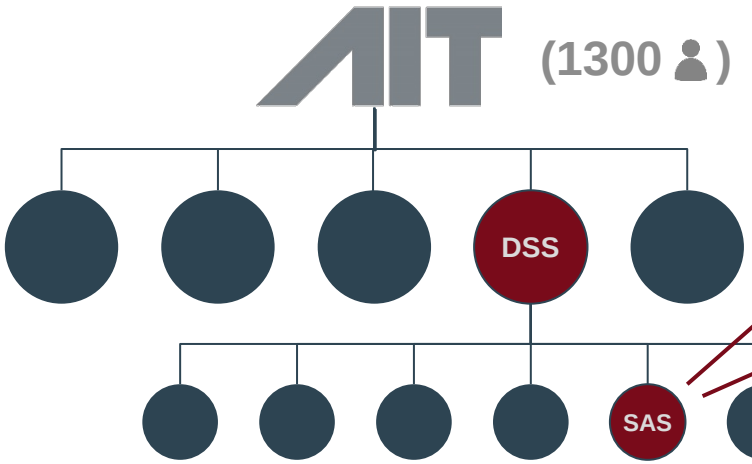
Department Safety & Security

Johannes Pribyl

DI JOHANNES PRIBYL, BSc
Business Development
Digital Safety & Security Department
Safe and Autonomous Systems

AIT Austrian Institute of Technology GmbH
Donau-City-Straße 1 |1220 Wien, Austria
T +43 50550-4144 | M +43 664 8251244 | F +43 50550-4150
johannes.pribyl@ait.ac.at | www.ait.ac.at





Two key areas enable various 3D applications

Verification and Validation

- System Analysis (Safety, Security codedesign)
- Testcase Generation (MoMuT)
- Testdata Generation (VITRO)

3D Vision, Assistance, and Autonomy

- 3D (Stereo) Sensors
- 3D Object and Environment Modelling
- Self Localisation, Path and Motion Planning








Safe and Autonomous Systems

(Industrial) Automation, Surveillance

Three examples of 3D applications in land vehicles

Science Award 2014

Staatspreis Mobilität 2013

AIT has many years of experience in 3D Vision and Modelling

- DARPA Grand Challenge participation

- GC Aavada IOS
- Medical intraoral 3D Scanner
- Vision Award 2011

- Autonomous research truck
- AIT Sensors and drive control

- Extended functions for ADAS and autonomous Vehicles
- Visual self-localization
- Scene understanding

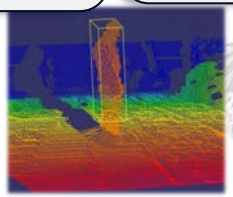
- Highly automated mobile machines
- application-specific assistance systems

2005 **2008** **2011** **2014** **2017** **2020**

- Indoor robotics
- AIT stereo camera

- First autonomous research train
- AIT camera-based obstacle detection

- Tramway use-case
- Conception phase with Bombardier

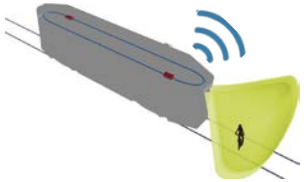


Staatspreis Mobilität 2013

nominee

- ODAS industrialization
- Bombardier, AIT, Mission Embedded

- Transition from ADAS towards driverless rail vehicles

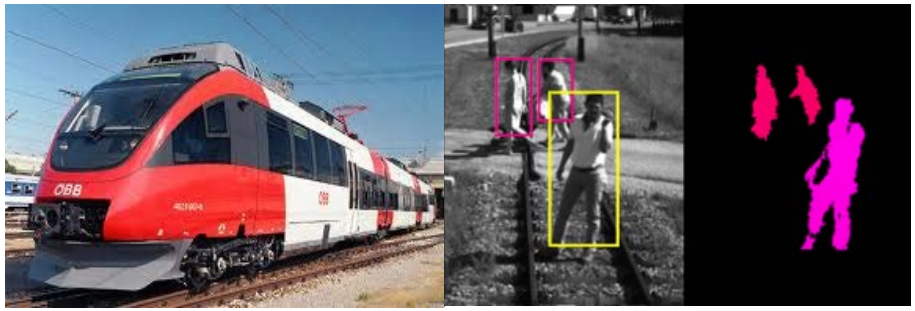


3D environment sensors and methods for land vehicles

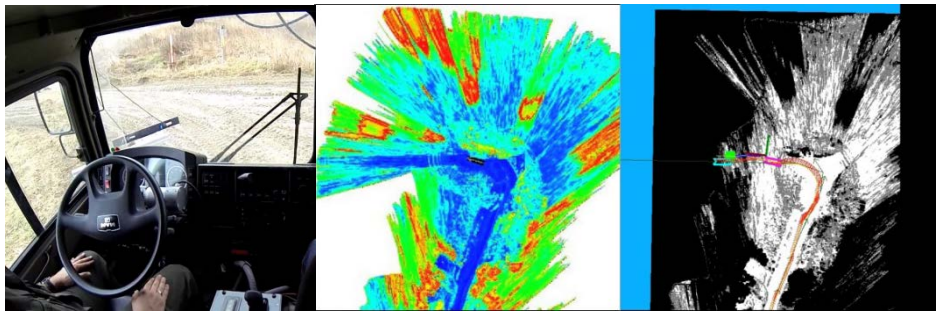
- Real-time stereo vision
- Trinocular and wide baseline stereo
- Dynamic stereo calibration
- Night vision stereo matching
- Visual odometry
- Structure from Motion
- Sensor fusion (IMU, GPS, …)

- 3D point cloud registration
- surface modeling
- object detection, tracking, classification
- obstacle avoidance
- autonomous path planning

Vision based offroad terrain mapping

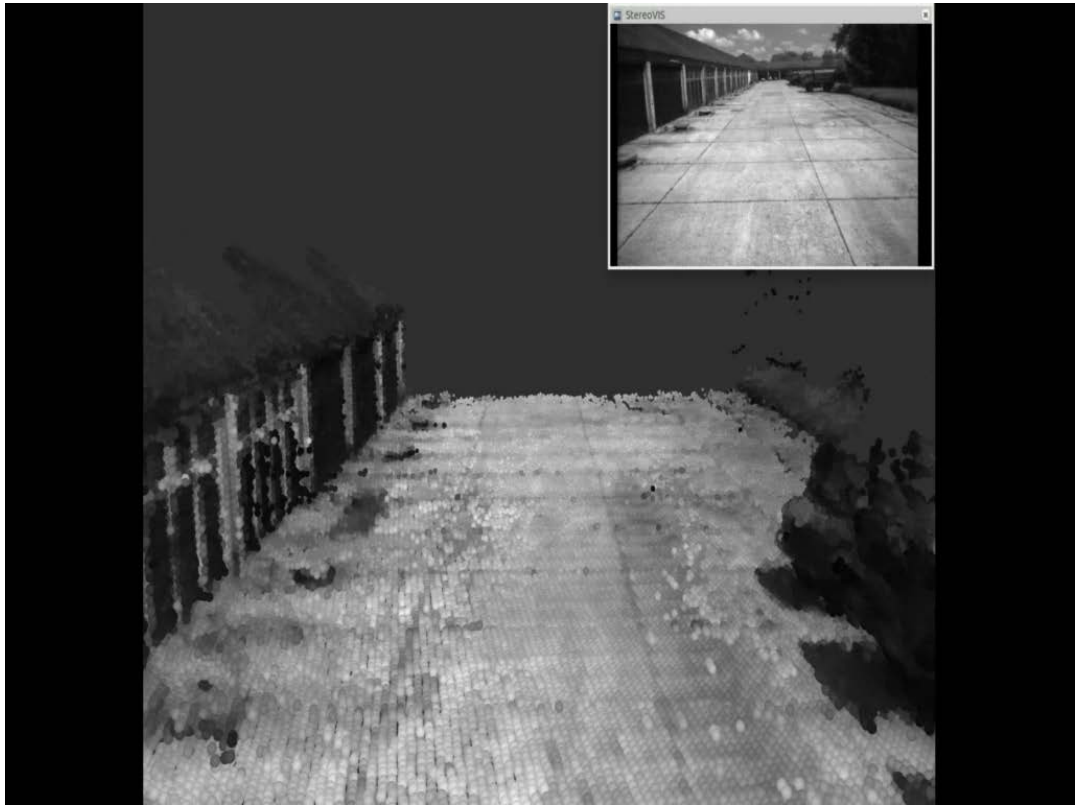


High precision observation of hull volume in front of trains



Autonomous path planning

3D Vision allows driverless missions in „unregulated and unstructured“ environments



- Visual mapping and self-localization
  - Towards GPS-independent navigation
  - 3D-Vision based obstacle avoidance and terrain modelling
  - Solely camera based mode of operation (no need for laser scanners)

Components of Autonomous Vehicles

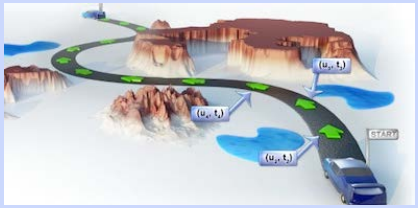
Actuators
- Steering
- Throttle
- Braking
- …

Autopilot and Cruise control

Tracking

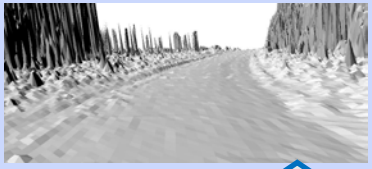
Processing Hardware

Path planning



Mission planning / Route definition

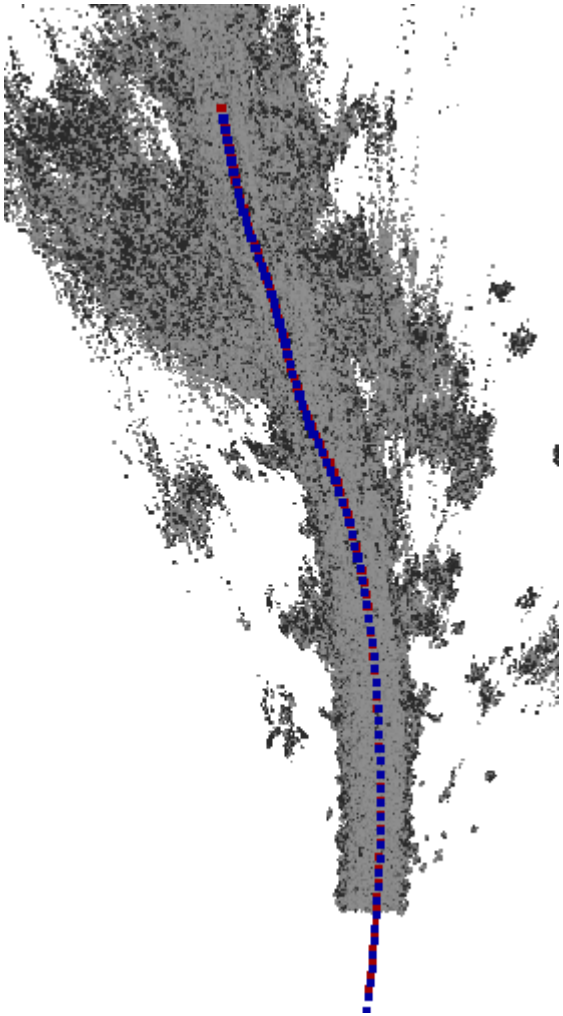
Mapping



3D - Sensors
- Night vision Stereo camera
- Daylight Stereo camera
- Laser scanner

Odometry / Localisation
- Visual Odometry
- Inertial sensor
- Magnetometer
- Wheel speed
- GPS Receiver

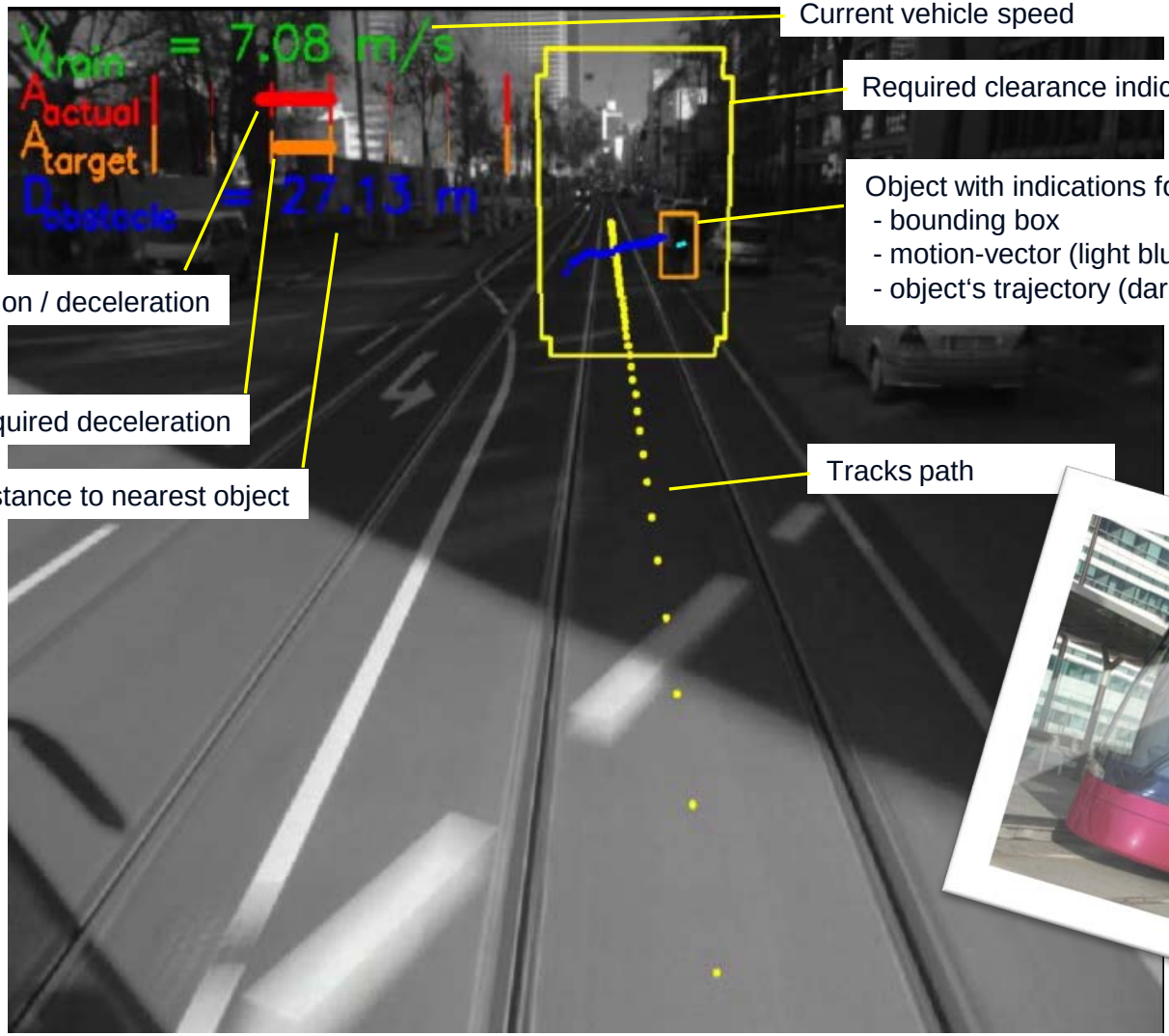
Visual Odometry for determining vehicle movement



- Calculation of vehicle movement
- Tracking of distinctive camera image elements
- Reconstruction of the vehicle movement based on the displacement of image elements

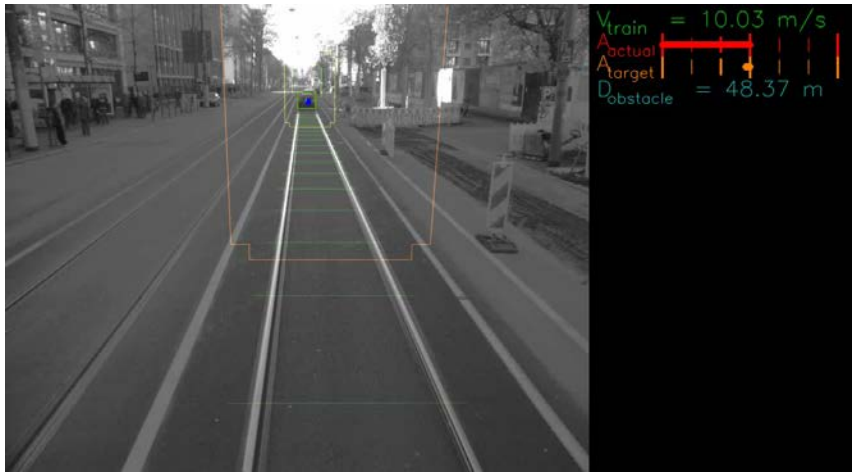
3D4Bombardier

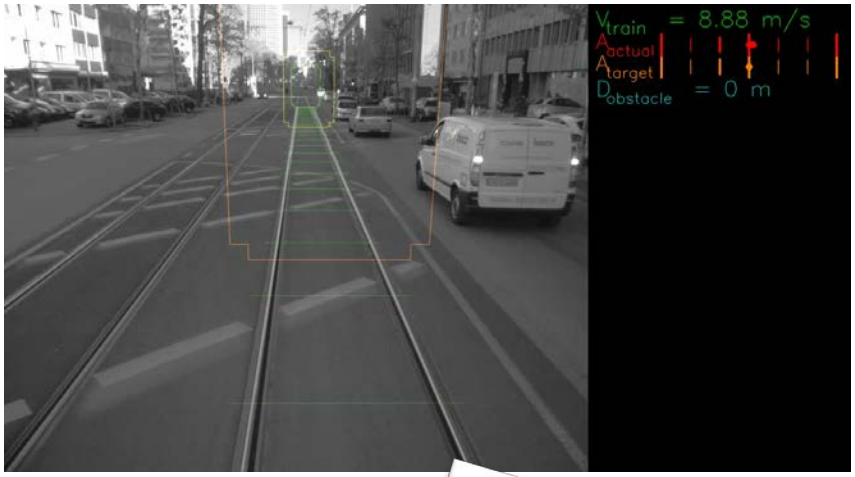
Advanced Driving Assistance System for Trams

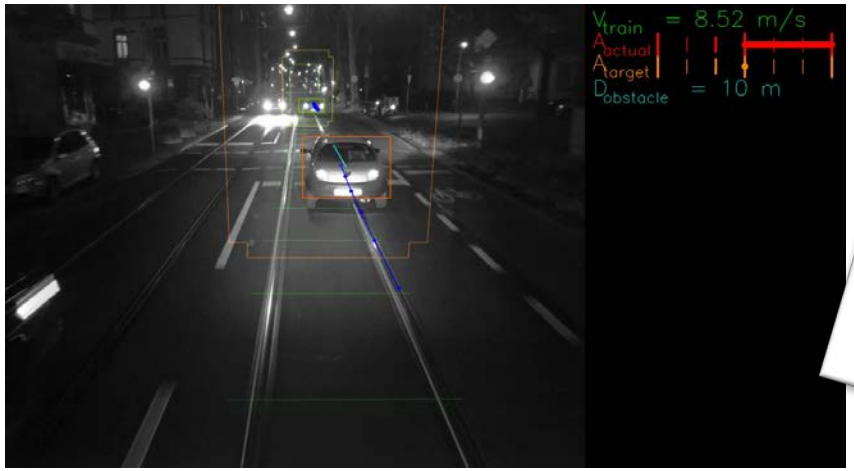


3D4Bombardier

Example Daylight and Night Sequences







AUSTRIAN INSTITUTE OF TECHNOLOGY

DI JOHANNES PRIBYL, BSc
Business Development
Digital Safety & Security Department
Safe and Autonomous Systems

AIT Austrian Institute of Technology GmbH
Donau-City-Straße 1 |1220 Wien, Austria
T +43 50550-4144 | M +43 664 8251244 | F +43 50550-4150
johannes.pribyl@ait.ac.at | www.ait.ac.at

3D Vision

An enabling Technology for Autonomous On- and Offroad Driving

AIT Austrian Institute of Technology

Department Safety & Security