AUSTRIAN INSTITUTE OF TECHNOLOGY

3D VISION AND MODELING

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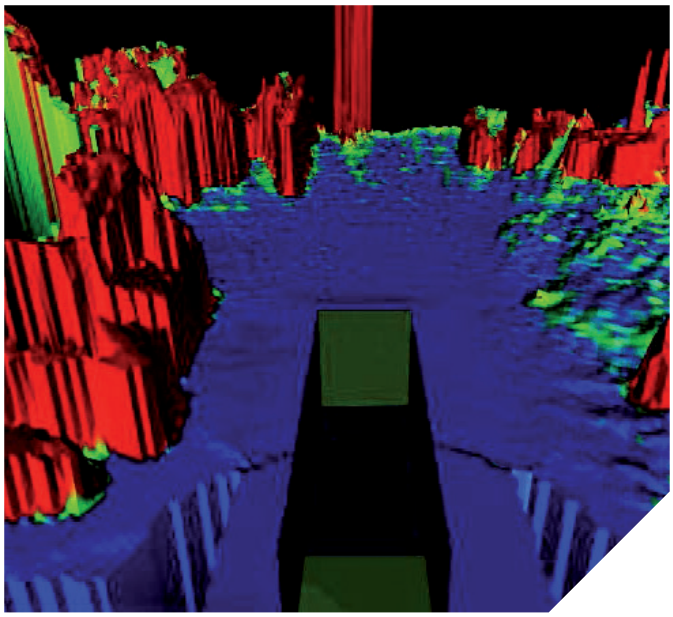


3D VISION AND MODELING

GENERAL

AIT's 3D vision and modeling experts investigate and develop stereovision technologies using advanced image processing methods. Innovative 3D sensor systems open up a wealth of new applications in the areas of transport (assistance systems, autonomous systems), industrial automation, inspection and monitoring. In this connection there is a need to develop reliable, fast and efficient methods for

- **3D reconstruction of the environment**
- **object detection, classification and tracking**
- **precise measurement of objects**
- **self-localisation of the sensor system**
- **path and movement planning**

To meet these needs AIT develops algorithms for stereovision, optical flow, simultaneous localisation and mapping, path and movement planning as well as visual 3D reconstruction and optimises them for efficient performance in real-time environments.

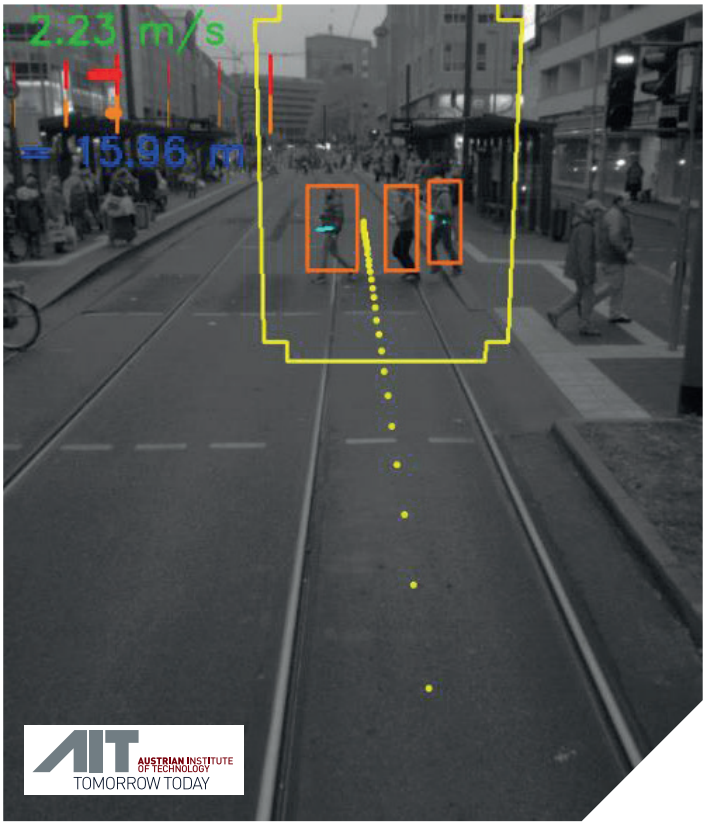
EXPERTISE AND TECHNOLOGY

Successful technology implementation hinges on sound fundamental knowledge, an innovative pool of methods and comprehensive systems expertise. The know-how of the 3D Vision and Modeling group ranges from selection, design and deployment of appropriate sensor systems to algorithm development and optimal implementation in energy efficient embedded systems (CPU, ARM, GPU, FPGA, DSP, mobile) through to application-specific evaluation and integration into complex overall systems.

KEY TOPICS

We focus on the following high-innovation topics:

- **Advanced Driver Assistance Systems**
- **Autonomous Land Vehicles**
- **Airborne Vision**
- **Measuring the World**



3D VISION AND MODELING
ADVANCED DRIVER ASSISTANCE FOR TRAMS

BOMBARDIER "ODAS" OBSTACLE DETECTION ASSISTANCE SYSTEM

The recent growth of cities, the appearance of urban agglomerations and the ever-growing longing of humanity for unrestricted mobility brings about an increased traffic volume in extremely confined spaces. Inevitably, this evolution leads to an increased number of traffic accidents and collisions with light rail vehicles, finally causing important damage, injury and high costs.

INNOVATION PARTNERSHIP

In partnership with Bombardier Transportation, the world market leader for rail vehicles, and Mission Embedded (Member of Frequentis Group), AIT developed a driver assistance system geared to minimising the danger of collision for rail vehicles.

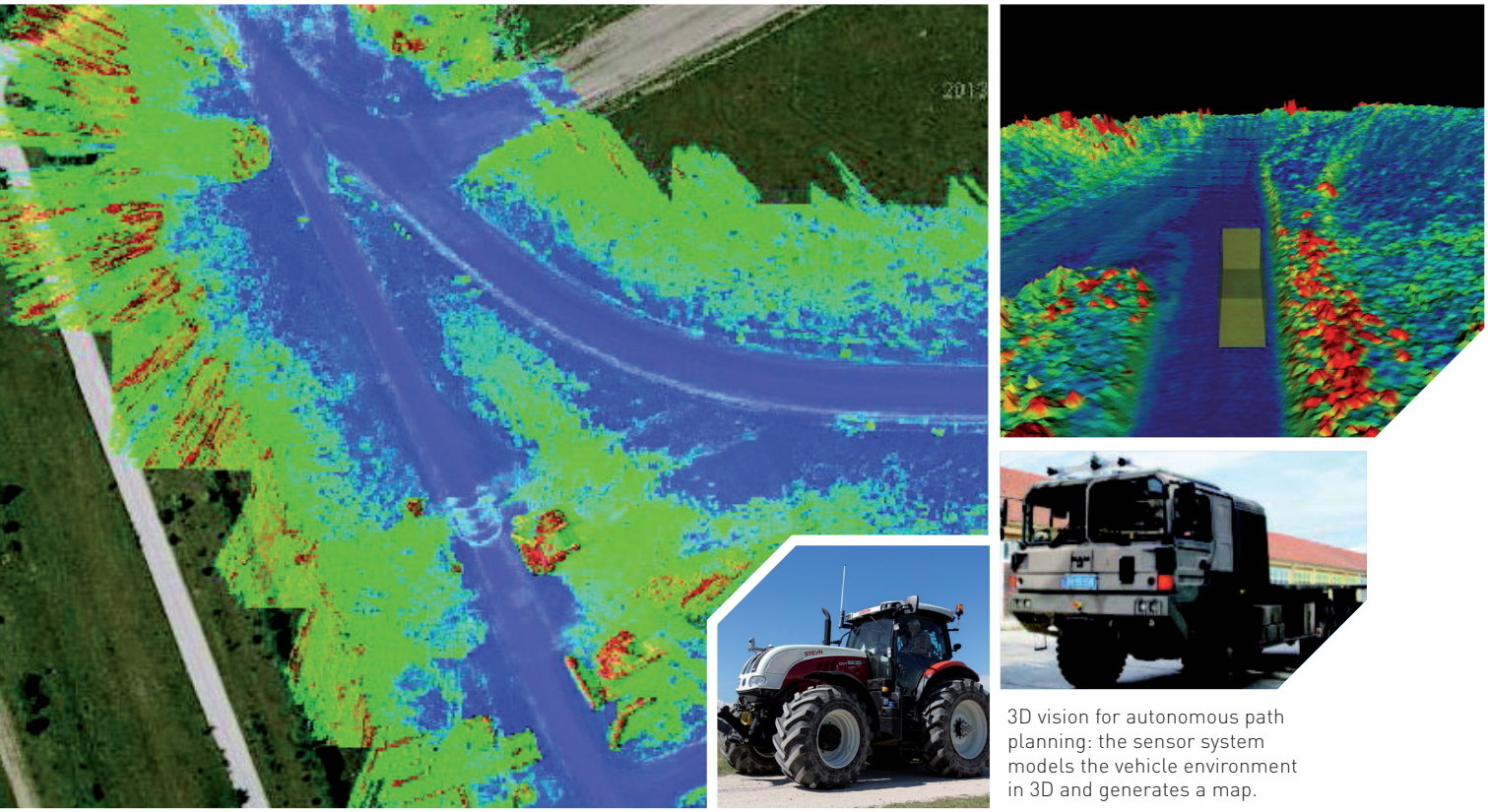
The collaboration with industry builds on several years of AIT research on efficient algorithms for the evaluation of stereo imagery. The result is 3D sensors with very high spatial resolution that make it possible to accurately monitor the route ahead of the rail vehicle. The system can automatically identify objects as obstacles and locate them accurately. The 3D stereo vision technology used is robust, has a long range and a high spatial resolution.

The system automatically detects potential collisions with road users, assists the driver by suitable reactions and, therefore, reduces the risk of collisions and their consequences.

COLLISION WARNING AND BRAKE ASSISTANT

The "ODAS" called Obstacle Detection Assistance System is available as collision warning and brake assistant for new built as well as retrofit system for existing vehicles. It aims increasing the active safety of passengers, drivers, pedestrians and cyclists and thus reducing subsequently costs at collisions.

ODAS is already in commercial service at operator VGF, Frankfurt/Main (Germany) and was ordered for the complete Bombardier FLEXITY Classic fleet. Currently, several ODAS-offers are in preparation for European operators.



3D vision for autonomous path planning: the sensor system models the vehicle environment in 3D and generates a map.

3D VISION AND MODELING
AUTONOMOUS LAND VEHICLES

GENERAL

Sensor systems that capture the environment of a vehicle in 3D enable driver-independent obstacle detection and routing, thus constituting an important element in autonomous driving and assistance systems for vehicles ranging from rail vehicles (trains, trams) to road vehicles (cars, trucks) and vehicles used in the construction and agricultural industries (excavators, tractors etc.).

The overriding goal is to improve safety by supporting the driver while also improving efficiency and reducing operating costs. The technologies available also support the implementation of fully autonomous vehicles.

SEMI-AUTONOMOUS CONVOYING AND SAFE CONTROL OF AUTONOMOUS VEHICLES

AIT is developing technologies for autonomous land vehicles designed to prevent the loss of human life in dangerous environments. The research is carried out under the KIRAS Safety and Security Research Programme (funded by the Federal Ministry of Transport, Innovation and Technology, BMVIT). Potential applications range from safe and reliable navigation of supply and rescue convoys in danger zones to the use of special-purpose vehicles and machines in civil disaster scenarios.

The projects involve a range of technological challenges: a robust yet cost-efficient system of cameras capturing the vehicle environment, the generation of 3D real-time models of the vehicle environment as well as autonomous path and movement planning. The aim is to develop highly innovative solutions for precise navigation in spite of limited GPS availability.

SELF-DRIVING TRACTOR FOR AUTONOMOUS OPERATION

AIT has used its comprehensive expertise in advanced camera technology and intelligent vision systems to develop a modern drive-by-wire tractor. The new development made its debut during the European Land Robot Trial (ELROB 2016), where international research teams showcased their autonomous vehicle concepts. AIT has developed the tractor into a completely autonomous vehicle for use in special off-road scenarios using advances environmental perception technology. The tractor is developed in close collaboration with Austrian partners and receives funding from the Federal Ministry of Transport, Innovation and Technology (BMVIT).

3D VISION AND MODELING
AIRBORNE VISION

GENERAL
Unmanned aerial vehicles are already being used successfully in a wide range of applications and will be increasingly integrated into civilian airspace in the next few years. Future autonomous systems will need to come close to human capabilities when it comes to taking appropriate safety measures, for example to avoid collisions in the air or on the ground during take-off or landing. AIT focuses on measures to safely integrate these autonomous systems into civilian airspace and to ensure appropriate certification. Another core task is to establish official approval procedures for optical systems used in assistance systems including the provision of relevant documentary evidence.

COLLISION AVOIDANCE
Collision avoidance systems are a key technology for future unmanned aerial systems and advanced air traffic services. Experts at AIT Austrian Institute of Technology have developed an innovative vision-based approach, enabling future unmanned aerial systems to observe and understand their environment in real-time. This approach goes beyond state of the art, making use of novel sensing techniques and route planning strategies for avoidance.

ADVANCED NAVIGATION
Robust navigation is crucial for operating any unmanned aerial vehicle. Existing systems are based on global navigation satellite systems, whose functionality can be negatively impacted or even disabled by various influences such as atmospheric disturbances or jamming. Experts at the AIT Austrian Institute of technology have developed an optical on-board navigation system as an alternative or complement to satellite-based systems.

SELECTED APPLICATIONS
The key objective is to increase safety in manned aviation by assisting the pilot and to expand the applications of unmanned systems, e.g. for generating situation maps for crisis and disaster management in the event of fire, floods, avalanches or large events. Important future application scenarios also include the monitoring of critical infrastructure such as power lines, dams or industrial facilities.

3D dental
scanner in use

3D VISION AND MODELING
MEASURING THE WORLD

GENERAL

The stereo-camera based 3D sensor technology developed by AIT as well as the associated methods and algorithms for precise 3D measurement and 3D modelling are already successfully being used in a wide range of applications.

AIT's 3D sensor technology opens up a particularly broad field of applications in precise 3D object measurement. The stereo-camera based measurement principle is ideally suited for 3D measurement and 3D modeling of objects of any volume or geometry. The use of an additional light pattern projector also allows the precise measurement of smooth object surfaces. The measuring accuracy required for the individual application can be adjusted and optimised using a specially adapted stereo camera setup. AIT has already successfully developed and implemented reliable stereo-camera based 3D measurement systems for applications including industrial automation, precise 3D measurement and modeling of workpieces and assemblies, 3D inspection, quality assurance and production process control.

3D DENTAL SCANNER

AIT and a.tron3d have together developed a miniaturised, ergonomically designed handheld 3D dental scanner based on stereo-camera technology for the dental and orthodontics industry. The new dental scanner can be used to replace the unpleasant process of taking dental impressions. The image data recorded by the 3D dental scanner is transmitted via USB to a standard notebook, for example, where it can then be processed in real time to provide the dentist with relevant information on the screen. This immediate generation of 3D denture data also results in time savings and improvements in cost efficiency in the subsequent process to produce dental prostheses such as crowns, inlays and bridges as well as in the planning and implementation of orthodontic treatments.

3D VISION AND MODELING
INTERNATIONAL REFERENCE PROJECTS

INDUSTRIAL REFERENCE PROJECTS

- **Driver Assistance System for Trams**
  Client: Bombardier
- **3D Dental Scanner**
  Client: GC
- **Embedded Stereo Vision on FPGA**
- **Augmented Reality and Indoor Navigation**
- **Human Detection and Obstacle Avoidance for Mobile Machines**

AUTONOMOUS LAND VEHICLES

- **RelCon -** Reliable Control of Semi-Autonomous Platforms
- **SWAMO -** Sensing and Reconstructing the World Around Mobile Machines
- **FarmDrive -** Robust Control of Driverless Farm Machinery
- **AnyView3D -** Combining Multiple Visual Cues for Robust 3D Sensing
- **MoLaFlex -** Highly Flexible Automation Concept for Mobile Loading Machines

AIRBORNE VISION

- **ROPA -** Radar Optical Piloted Aircraft
- **LEAL -** Airborne detection and contextual analysis of dynamic situation reports in crisis scenarios
- **DEMONA -** Demonstration of UAS Integration for VLL Airspace Operations

MEASURING THE WORLD

- **3D-VIP -** 3D Vision for Intelligent Production
- **FlexDetect -** Flexible and Mobile Detection of Intruders into Security Zones
- **InstructMe -** Semi-Automatic Generation of Industrial Process Descriptions using Image Data
- **RoSSATA -** Robust Sensor Systems for Advanced Traffic Applications
- **CONSUS -** Computer Vision Based Weed Detection

AUSTRIAN INSTITUTE OF TECHNOLOGY
TOMORROW TODAY

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