# INVESTIGATIONS ON ACTIVE SENSORS FOR COMPUTER VISION

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## ABSTRACT

- The perception of 3D information about the local environment is still of great interest. Recent developments show that new types of active sensors allow for a simultaneous capturing of both range and image data, and they are not restricted on the assumption of a static scene. Thus, these active sensors offer new possibilities for applications like surveillance, navigation of autonomous vehicles, object tracking, object recognition, scene reconstruction or scene interpretation.

## 1. INTRODUCTION

- **Current work**
  - → development of concepts and methods for processing active sensor data
  - → e.g. reconstruction and monitoring of dynamic indoor and outdoor scenes
- **Test data for evaluation of basic algorithms**
  - → high point density and high measurement accuracy required
  - → e.g. terrestrial laser scanning (TLS) data
- **Challenges**
  - → fully automatic fusion of range data with the same or different characteristics
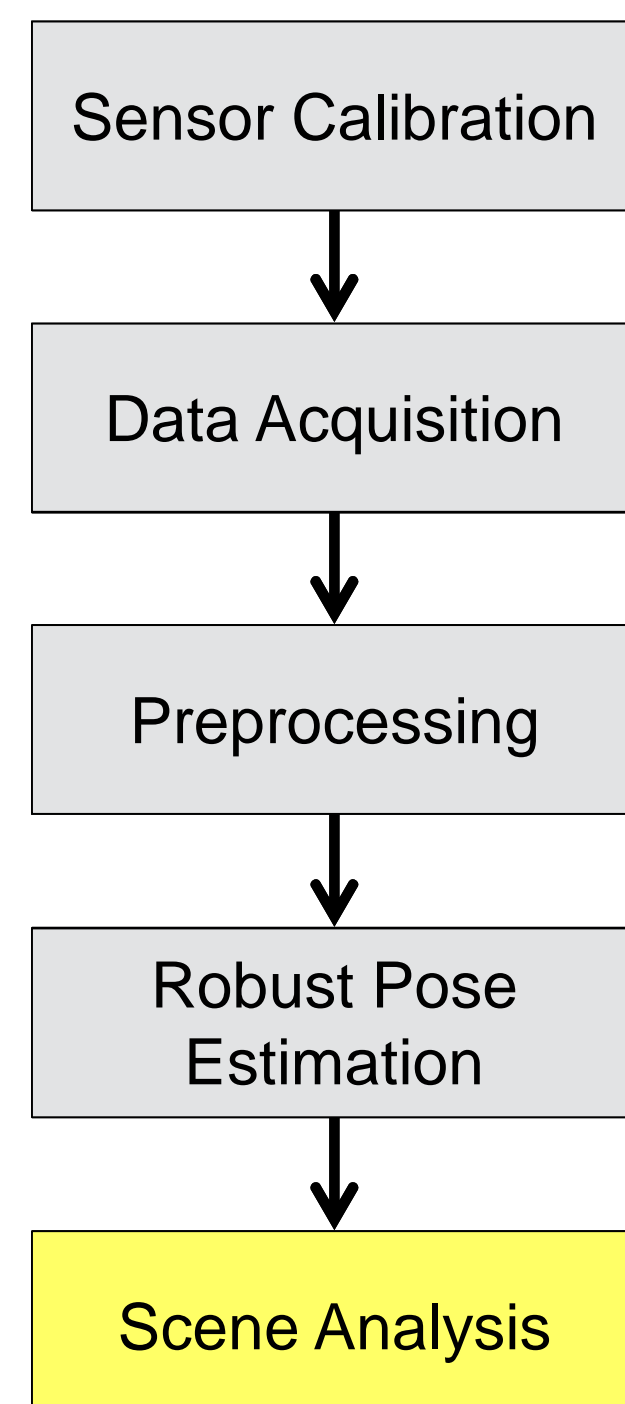  - → design for dynamic and demanding environments without regular surfaces

## 2. ACTIVE SENSORS

- Capturing of both intensity and range data

| | Static scenes | Dynamic scenes |
|---|---|---|
| **Measurement principle** | Terrestrial laser scanning (Leica HDS6000) | Structured light (Microsoft Kinect) Range imaging (PMD [Vision] Camcube 2.0) |



## 3. METHODOLOGY

- Typical processing chain:

Sensor Calibration → Data Acquisition → Preprocessing → Robust Pose Estimation → Scene Analysis

- Geometric calibration
- Radiometric calibration
- Warm-up
- Point cloud data (X, Y, Z, intensity)



- Feature extraction
- Organization
- Consistency check
- 3D point estimation
- Plane projection
- Coarse registration
- Fine registration



- Suitable for both indoor and outdoor scenes
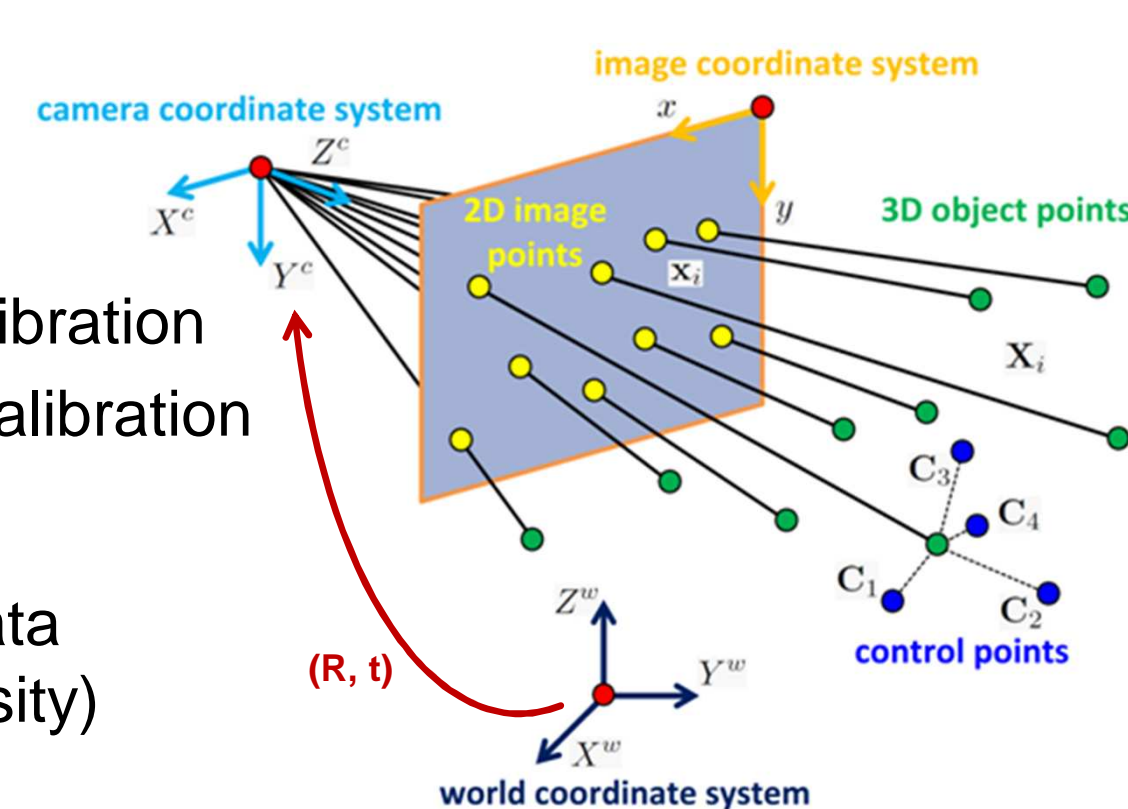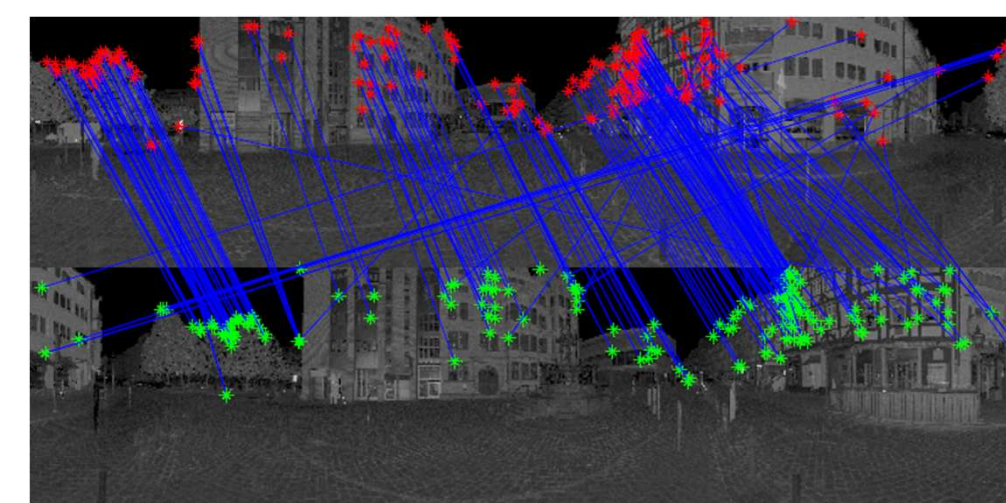
## 4. EXPERIMENTAL RESULTS
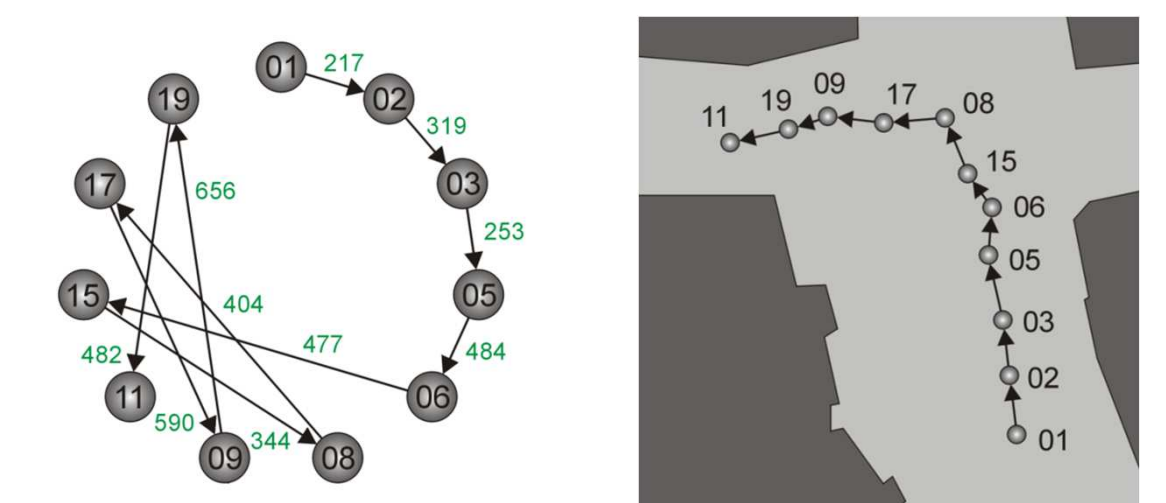
- **Data Acquisition**
  - Terrestrial laser scanner (→ benchmark data set provided by the Institute of Cartography and Geoinformatics, University of Hanover, Germany)
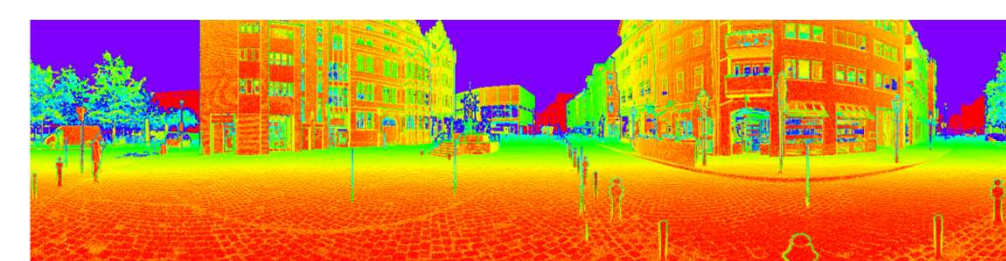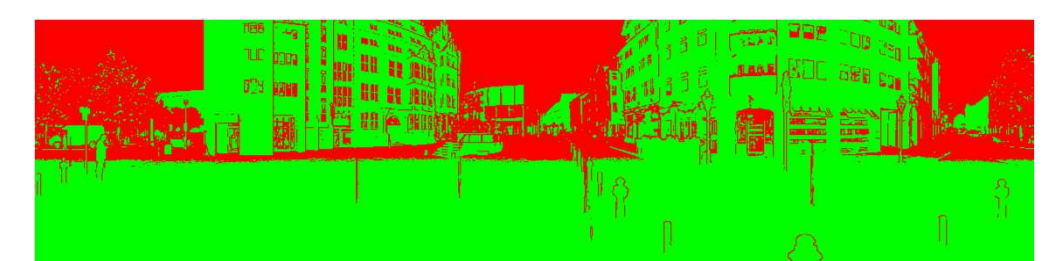


- **Preprocessing 1**
  - Feature extraction and organization of the data by means of similarity (e.g. via SIFT [Lowe 2004] and affinity matrix)
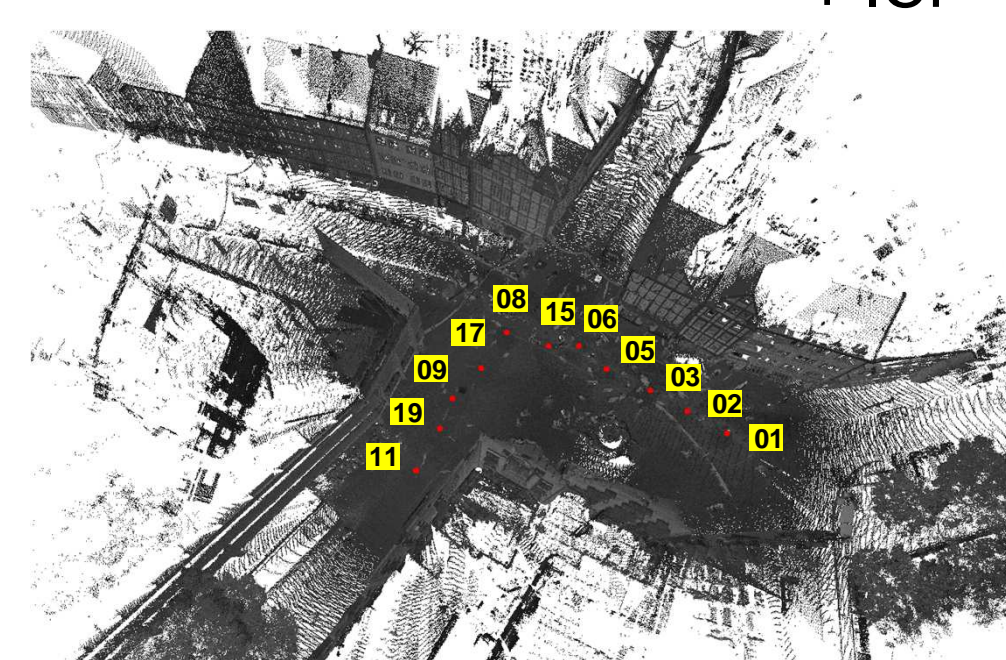
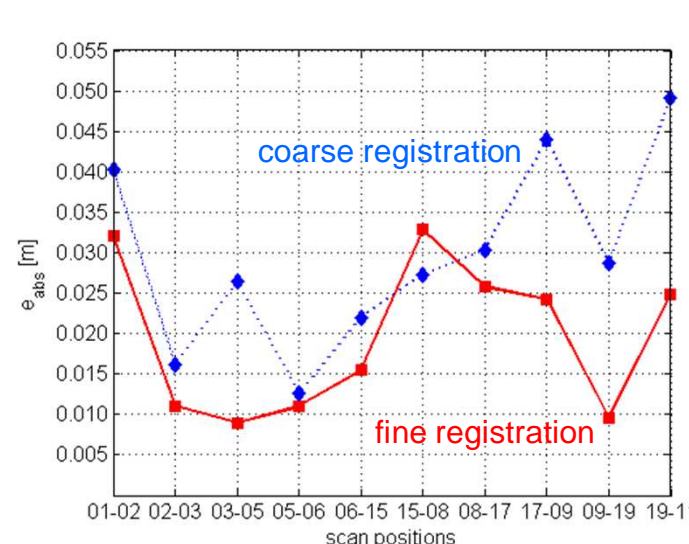

- **Preprocessing 2**
  - Outlier removal via range variance within (3 x 3)-neighborhoods and thresholding



- **Robust Pose Estimation**
  - RANSAC-based EPnP scheme [Lepetit et al. 2009] + geometric outlier removal [Weinmann et al. 2011] + ICP



## 5. CONCLUSION & OUTLOOK

- Active sensors show high potentials for typical computer vision applications.
- A fully automatic approach for registration of range data based on 2D imagery has been established.
- The first experimental results indicate that, concerning reliability, accuracy and performance, an image-based registration of point cloud data yields promising results.
- Even data acquired via different range imaging devices can be co-registered and, consequently, point clouds with differences in density and accuracy.
- Further investigations on scene analysis in dynamic environments are planned as well as fusion with data of INS and GPS.

## REFERENCES

- Lepetit V., Moreno-Noguer F., Fua P., EPnP: An accurate O(n) solution to the PnP problem, *International Journal of Computer Vision 81 (2)*, 2009.
- Lowe D. G., Distinctive image features from scale-invariant keypoints, *International Journal of Computer Vision 60 (2)*, 2004.
- Weinmann Ma., Weinmann Mi., Hinz S., Jutzi B., Fast and automatic image-based registration of TLS data, *ISPRS Journal of Photogrammetry and Remote Sensing*, Submitted, 2011.