3D Sensing and Sensor Fusion

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- 3D vision is a very important domain within computer engineering/science
  - Tasks are usually very challenging
  - Results are very spectacular
  - Needs both high theoretical and practical skills
- Several sensors can be connected to computers
- Di erent modalities have di erent bene ts/disadvantages
  - Measured data can be fused to exploit the advantages

System Overview of an Autonomous Vehicle

Goal: overview of (i) (advanced) 3D vision and (ii) sensor fusion methods

In modern sensor setups, several devices applied

- Digital cameras
- Depth sensors (structured light, ToF, ...)
- Light Detection and Ranging (LiDAR): 3D and 2D
- Global positioning system (GPS { GPSS)
- Acoustic sensors (ultrasonic)
- Thermal cameras
- Radars
- Inertial Measurement Unit (IMU) { accelerometer, magnetometer, gyroscope
- High-density (HD) Semantic Maps

In this course, we principally concentrate on multi-view images, 2D and 3D LiDAR scans, radars, GNSS/GPS, IMU, ...

Two sensors can be used together if they are
- synchronized in time (usually via timestamps) and
- their 3D pose are know w.r.t. each other

This course principally focuses on 3D pose estimation
- Pose: rigid transformation
- 3D rotation and translation, aka. extrinsic parameters, aka. pose

In human-made environments, bird-eye view is preferred for the data.

Pose can be estimated by calibration

There are two ways for calibration

- O ine
  - ! Calibration object is applied
- Online
  - ! Environment reconstruction carried out

Target object have usually well de ne surfaces/shapes

- 2D: lines, circles, ellipses,...
- 3D: planes, spheres, cylinders, ...

- Introduction to estimation theory
  - Focus: surface/curve fitting
- Robust estimation and the L_1 norm
- Transformations, projections
- Lie algebra
- Optimal point set registration
- LiDAR-camera calibration
  - using planar or spherical objects
- Many surprises by Peter Kozma

Lecture

- Oral exam in examination period
- Topics will be published before exam-period

Practice

- Two assignment in termtime

Combined mark is given: 50-50% from oral exam and assignment

- Satisfactory should be reached for noth assignment and oral exam

Final grade

- 5 (excellent): 85%
- 4 (good): 70 . . . 84 %
- 3 (satisfactory): 55 . . . 69 %
- 2 (pass): 40 . . . 54 %
- 1 (fail): < 40%

- Canvas https://canvas.elte.hu
  - Materials
  - Assignments
- Webpage https://cg.elte.hu
  - Under construction
- Teams
  - It will be created next week.

On Wednesdays,

16.00-17.300

North Building, lab. 0.99

Teacher: Peter Kozma