

3D Sensing and Sensor Fusion

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Faculty of Informatics

2026 spring (2025-2026-2)

3DSSF Teachers

- Péter Kozma
- Levente Hajder

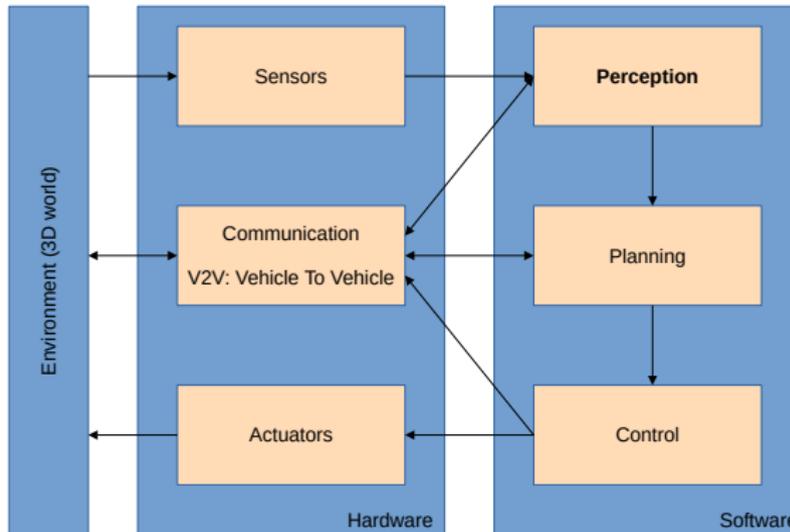


Motivation 1/2

- 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
- Different modalities have different benefits/disadvantages
 - Measured data can be fused to exploit the advantages

Motivation 2/2

System Overview of an Autonomous Vehicle

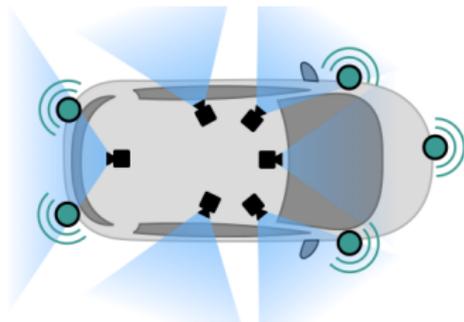


Subject Overview (1/2)

- 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, ...

Subject Overview (2/2)

- 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.



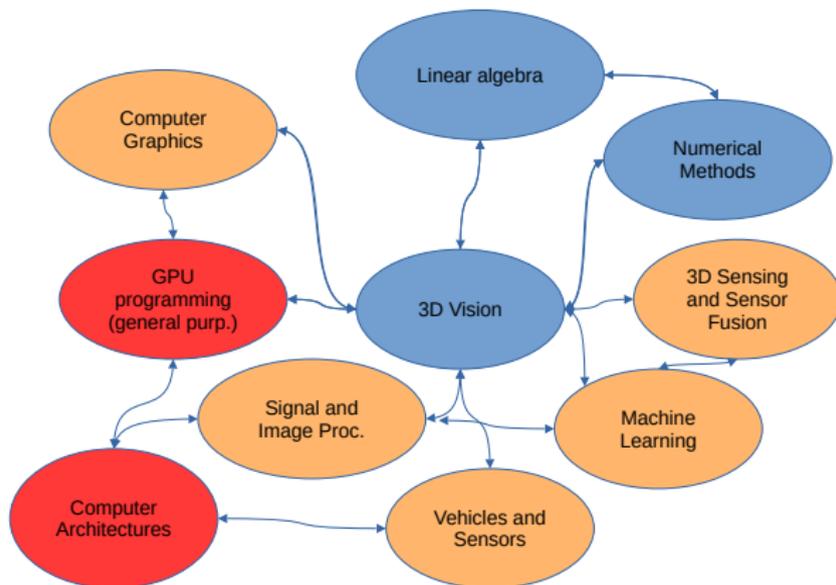
Key Problem

- Pose can be estimated by calibration
- There are two ways for calibration
 - Offline
 - Calibration object is applied
 - Online
 - Environment reconstruction carried out
- Target object have usually well define surfaces/shapes
 - 2D: lines, circles, ellipses,...
 - 3D: planes, spheres, cylinders, ...

3DSSF Content

- Operation of sensors by Péter Kozma
- Introduction to estimation theory
 - Focus: surface/curve fitting
- Robust estimation and the L_1 norm
- Transformations, projections
- Representations of a rotation
- Optimal point set registration
- LiDAR-camera calibration
 - using planar or spherical objects

Related Subjects



3DSSF Requirements

- Lecture
 - Oral exam in examination period. Two topics.
 - 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 both assignment and oral exam
 - Max. 50 per oral/assignments
- Final grade
 - 5 (excellent): $\geq 88\%$
 - 4 (good): 75 ... 87 %
 - 3 (satisfactory): 62 ... 74 %
 - 2 (pass): 50 ... 61 %
 - 1 (fail): $< 50\%$

Our forums

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

Classes

- On Saturdays,
 - 10:15-11:45
 - South Building, 2.219 Graphics Laboratory
 - Teacher: Levente Hahder
- On Saturdays,
 - 14:15-15:45
 - South Building, 0-222
 - Teacher: Péter Kozma

Extra Practice

- Demonstration of our vehicles and sensor-kit
- 20th February,
- Video is also sent after the demo.

