

LiDAR Hands-on Lab

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LiDAR Hands-on Lab

- **The lab is made of two parts:**
 - **Introduction to LiDAR**
 - We will learn technologies and devices being used
 - **Operation and monitoring of a setup**
 - using a **TOF-LiDAR** demonstration machine of HPK
 - We will get hands-on to the setup, learn how it is working,
 - and learn the issues relevant to the LiDAR

Remote Sensing



- **LiDAR** is **one type of** remote sensing method that can be used to **map structure** including **vegetation height, density** and **other** characteristics across a region.

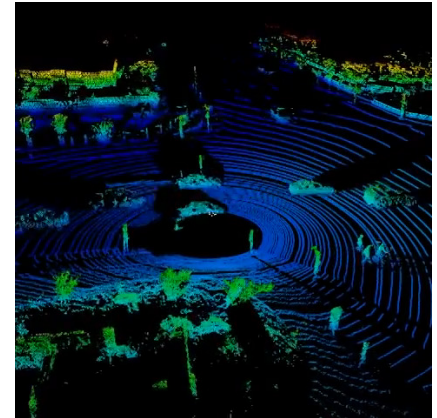
Automotive LiDAR

 Level 0	 Level 1	 Level 2	 Level 3	 Level 4	 Level 5
No Automation: The driver is in complete control of the vehicle at all times.	Driver Assistance: The vehicle can assist the driver or take control of either the vehicle's speed, through cruise control, or its lane position, through lane guidance.	Occasional Self-Driving: The vehicle can take control of both the vehicle's speed and lane position in some situations, for example on limited-access freeways.	Limited Self-Driving: The vehicle is in full control in some situations, monitors the road and traffic, and will inform the driver when he or she must take control.	Full Self-Driving Under Certain Conditions: The vehicle is in full control for the entire trip in these conditions, such as urban ride-sharing.	Full Self-Driving Under All Conditions: The vehicle can operate without a human driver or occupants.

- **Autonomous driving**, as defined by the **Society of Automotive Engineers (SAE)**.
- **LiDAR** is seen as critical for **L4/L5** operation (but even **L1** as **ADAS**)
- Active and fast-growing market
- Anywhere from 80 to 100 companies working in the automotive LiDAR.

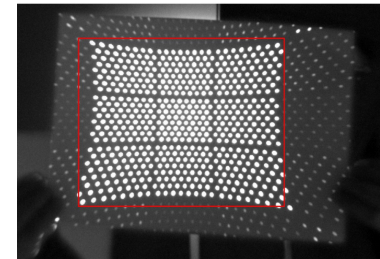
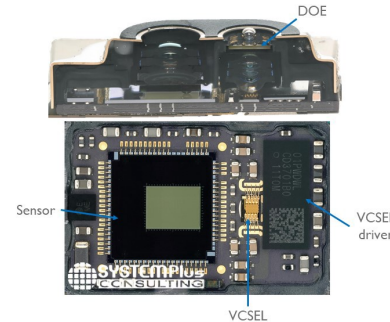
Field of View (FOV)

- Mechanical, Solid-state, and Hybrid.
- **Mechanical** (360°)
 - Spinning, Galvo mirrors, Polygons, or MEMS
 - mounts lasers onto a rotating gimbal (*1).
 - Galvos, polygons, and MEMS all use moving optical elements to scan a scene.
- **Solid-state** LiDAR
 - Flash or optoelectronic pulse amplifiers
 - uses no moving parts to paint a scene, offering high reliability but typically limited range or resolution (*2)
- **Hybrid** systems
 - include a combination of scanning methods.



(*) Velodyne HDL-64_9G

Apple iPad Pro LiDAR opening and cross-section



(*2) Array of lasers (VCSEL)

Abstract: Hands-on Lab - LiDAR

- **Light Detection And Ranging (LiDAR)**

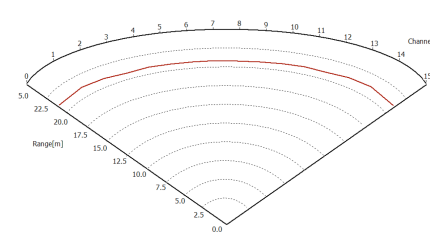
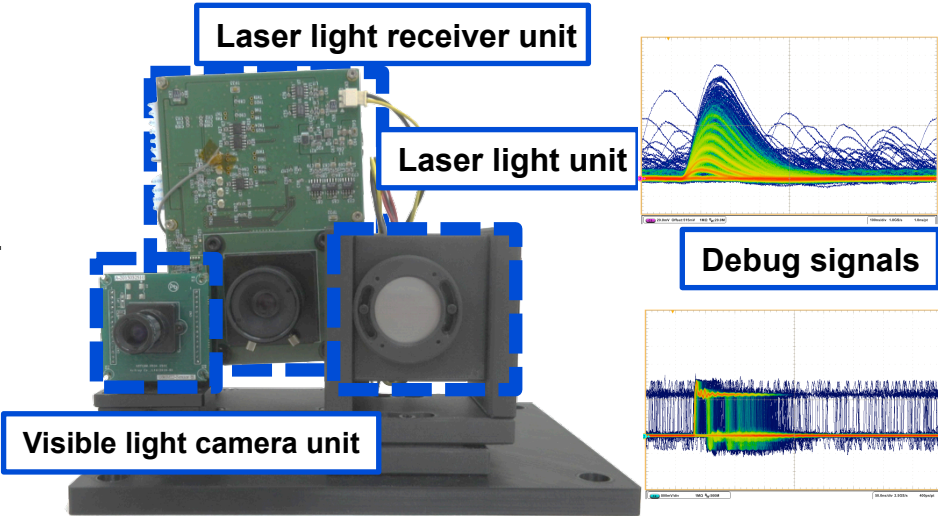
- A simple desktop/lab setup
- measuring distance (especially a long-range, up to 100 m (?) in real time with a viewing angle of 30 degrees, using Time-of-Flight technique
- possible application in automotive world in mind

- **The setup is made of cutting-edge semiconductor/solid-state devices:**

- Light emitter: Pulsed solid-state laser (infra-red 905 nm)
- Light receiver: Linear-array MPPC (solid-state photomultiplier)
- Visual imager: Visible-light camera (yet sensitive to infra-red light)
- Data acquisition: FPGA-PC chain

- **The hands-on experience includes**

- Lectures on the setup and the devices
- Verification of image of laser light
- Cross-correlation of visual imaging and laser ranging (viewing angle)
- Visualization of ranging (distance, cross-passing person, ...)
- Observation of electrical signals with oscilloscope
- Optimization of signal-to-noise ratio with aperture of receiver lens



Visual image

Range display

Space, Equipment

- **Space**

- One desk (1.8 x 0.9 m²)
- Open space (5-10 x 5-10 m² to wall)
 - Clear is the best, but some obstacles are acceptable

- **Hardware to bring in**

- 1x LiDAR setup (see Abstract; Laser 905 nm Class1) (20x15x10 cm³)
- 1x USB hub (with AC power adaptor (100-240V, 2-prong plug (A type)))
- USB cables (1x USB2 TypeA-TypeB, 1x USB3 TypeA-MicroB)
- Import/export paperwork: (hopefully) Not Applicable

- **Software to bring in**

- LiDAR control
 - HPK C15122-1005 Ver1.00/AsicController.exe)
 - HPK MPPC ASIC driver software (DriverSetup_64bit.exe)
 - Microsoft VisualStudio2015 (mfc140u.dll)
- Visual camera
 - Artray VisualCameraVer1.00/Bin/Viewer.exe
 - Artray Camera driver software (ARTCAM-036MI2-WOM-DRV-V2021)

- **Hardware available at hosting campus**

- 1x Desktop/laptop PC & Display (Windows 8.1 or Windows 10)
- 1x Oscilloscope
- 1x AC power cable tap/adaptor (100-240 V) for 2-prong plug (A type)

