LiDAR Hands-on Lab

Y. Unno (KEK)
with contribution of
Hamamatsu Photonics K.K.

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

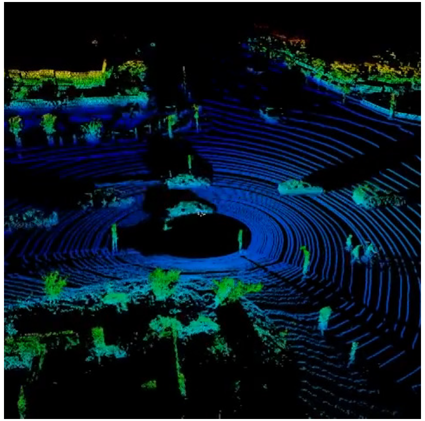
- **LiDAR** is **one type of** remote sensing method that can be used to **map structure** including **vegetation height**, **density** and **other** characteristics across a region.

Automotive LiDAR

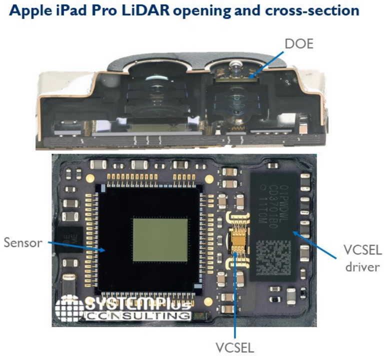
- **Autonomous driving**, as defined by the **S**ociety of **A**utomotive **E**ngineers (**SAE**).
- **LiDAR** is seen as critical for **L4/L5** operation (but even **L1** as **ADAS**)
- Active and fast-growing market
- Anywhere from 80 to 100 companies working in the automotive LiDAR.

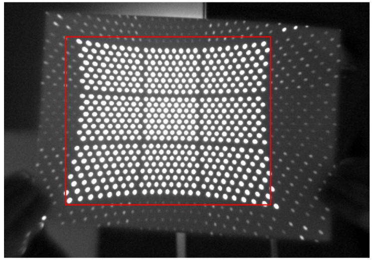
Field of View (FOV)

- 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

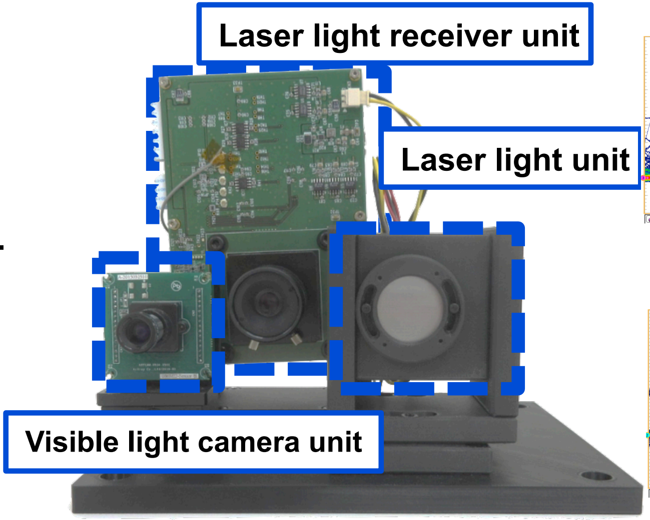


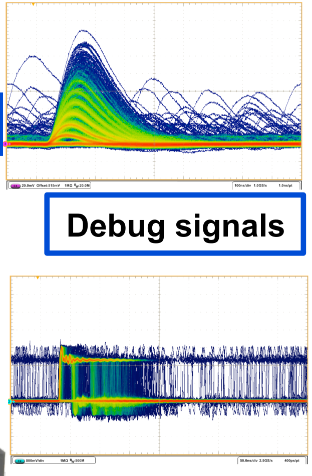


(*2) Array of lasers (VCSEL)

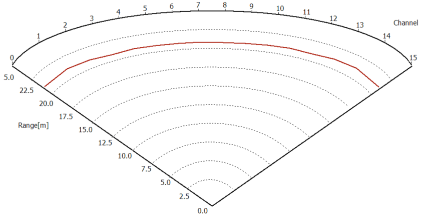
Abstract: Hands-on Lab - LiDAR

- **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 m^2)
  - Open space (5-10 x 5-10 m^2 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 cm^3)
  - 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)