Hands-on Lab: LiDAR

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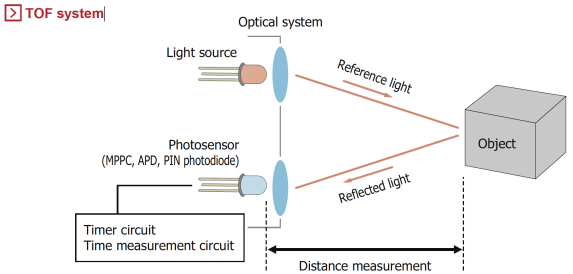
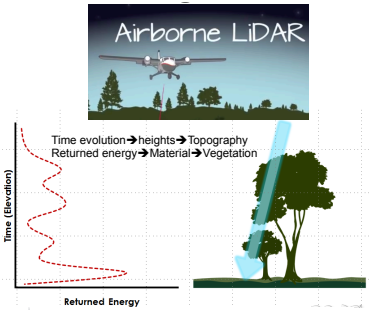
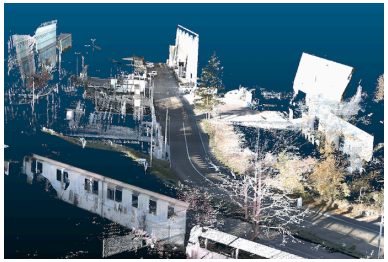
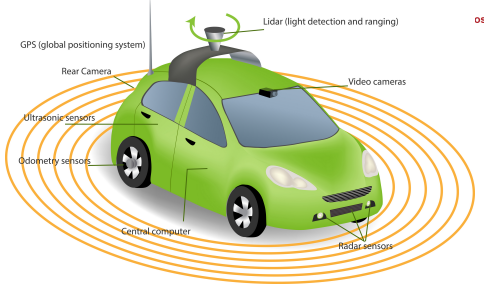
- LiDAR (Light Detection and Ranging) is a technology to measure the distance, by using a laser light and its reflection from the object.
- It is used widely for ranging in medium range (m to km) such as, air-borne remote sensing (~km), 3D mapping, and even in a household appliance, a laser distance meter (~100 m).
- The latest and rapidly developing application is the automotive driving assistance system (ADAS) (~100-500 m).
- For the light-detection, solid-state device (Silicon) is the key for miniaturization:
  - Photodiode (Si-PD) for short-range (<1 m)
  - Avalanche photodiode (Si-APD) for medium range
  - Photomultiplier (Si-PM or MPPC@(HPK) for long-range (~100 – 500 m)

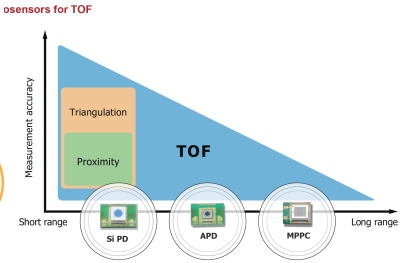
  according to their sensitivity.











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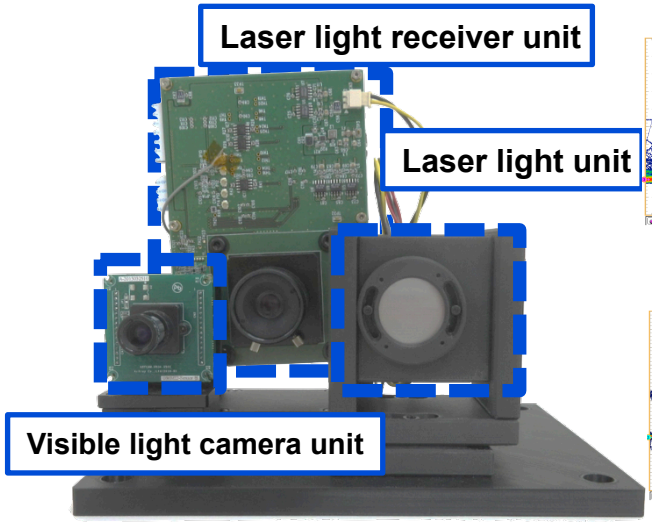
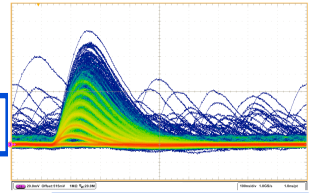
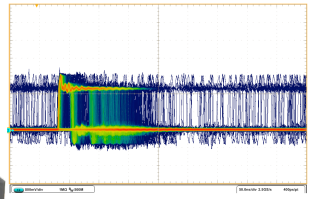
- We use a simple desktop/lab setup, using Time-of-Flight (TOF) technique, with a viewing angle of 30 degrees.
- The setup is made of cutting-edge semiconductor/solid-state devices:
  - Light emitter: Pulsed laser diode (PLD, infra-red 905 nm)
  - Light receiver: 16-ch linear-array MPPC@ (Si-PM)
  - Visible-light camera (yet sensitive to infra-red light)
  - Data acquisition: FPGA-PC chain
- The hands-on experience is made of two sections: (1) Lectures on the LiDAR principle and key devices, and (2) Operation of the device.
- Operations of the device are
  - Operation with
    - Verification of image of laser light,
    - Cross-correlation of visual imaging and ranging (distance and viewing angle), and
    - Visualization of ranging (distance, cross-passing person, ...)
  - Observation of signal processing with oscilloscope
    - Time-of-Flight (TOF) and
    - Energy (Pulse height by Time-Over-Threshold (TOT))

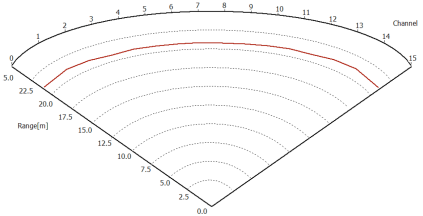




Debug signals



Visual image



Range display

Space, Equipments

- **Space**
  - **One desk (1.8 x 0.9 m^2)**
  - **Open space (5x 5 m^2 to wall)**
    - **Clear is the best, but some obstacles are acceptable**
- **Hardware to bring in**
  - **1x LiDAR setup (Laser: 905 nm Class1) (20x15x10 cm^3)**
  - **1x USB hub**
    - **Bus-powered, optionally self-powered 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 to be available at hosting campus**
  - **1x Desktop/laptop PC & Display (Windows 10)**
  - **1x Oscilloscope with accessary**
    - **1x or 2x oscilloscope probes,**
    - **2x BNC-LEMO adaptors,**
    - **1x LEMO T-connector**
    - **1x 1m LEMO cable**
    - **1x LEMO 50Ω terminator**
  - **Optional: 1x AC power cable tap/adaptor (100-240 V) for 2-prong plug (A type)**