



Digital Sensors

Distance Sensing

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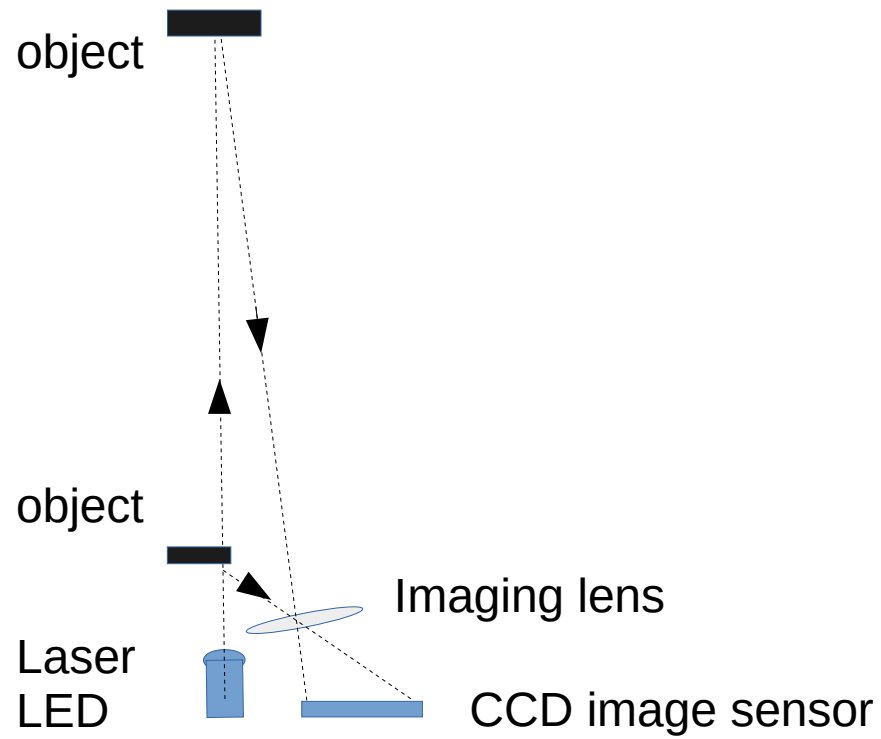
Lecture - Outline

- Distance sensing
- Magnetic sensing

Non-contact Distance Measurement - Optical

- Triangulation method
- Time of Flight (ToF) methods
 - Transit time measurement
 - Phase difference measurement

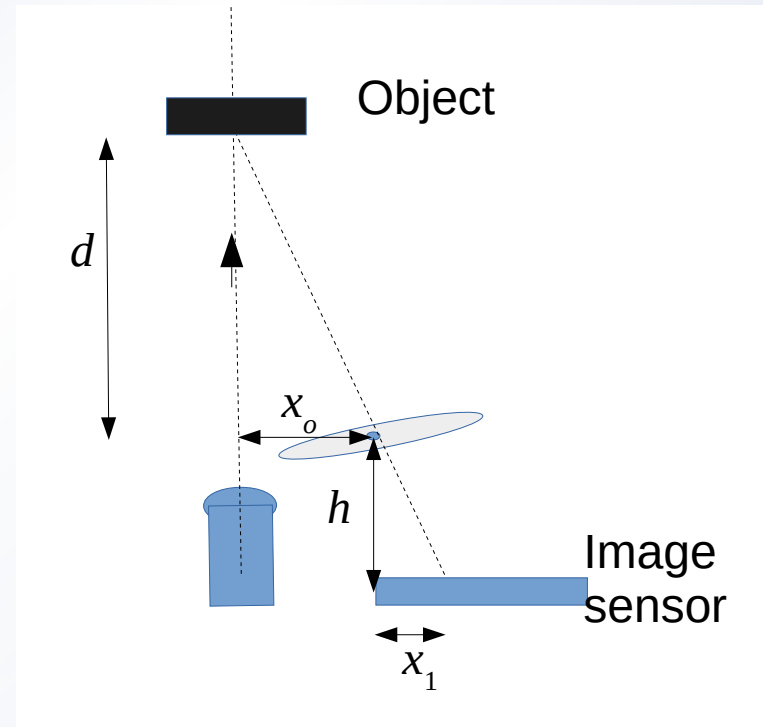
Triangulation method



Triangulation calculation

$$\frac{d}{h} = \frac{x_o}{x_1}$$

$$d = x_o h \cdot \frac{1}{x_1}$$



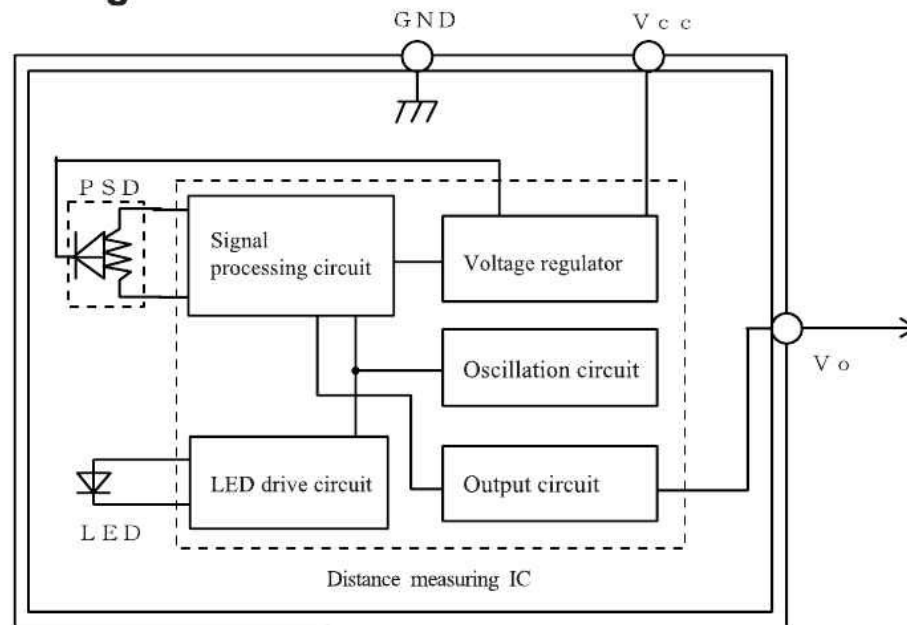
Sharp Sensor GP2Y0A21YK0F

SHARP

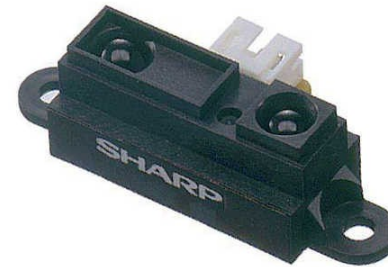
GP2Y0A21YK0F

SHARP

■ Block diagram



GP2Y0A21YK0F



Time of Flight methods

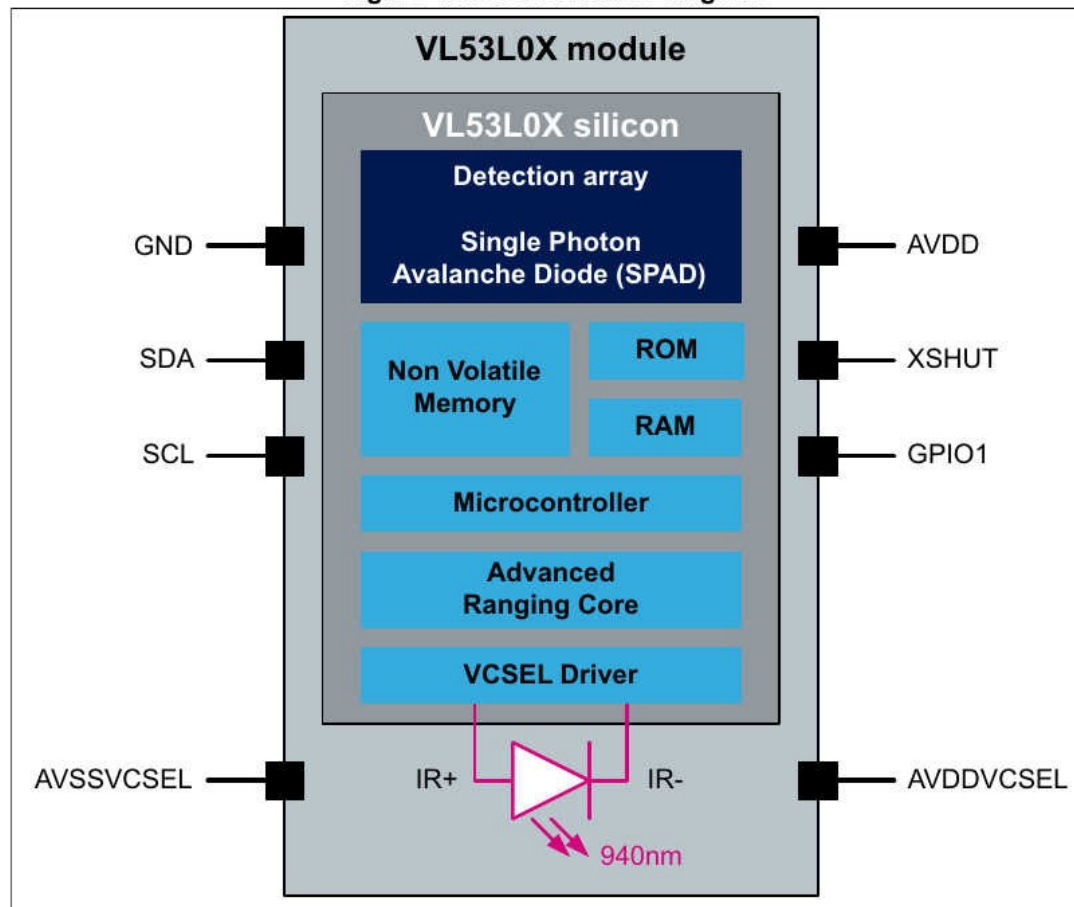
- Time difference between two pulses – transmitted and received
 - Time-to-digital converters (TDC7201)
 - Start and stop signals
 - Resolution 55 ps (0.000055 us)
- Time for light: 33 ps / cm

ToF LiDAR

System block diagram



Figure 1. VL53L0X block diagram



Phase-change measurement

- Modulated light signal
- Phase difference between transmitted and received
- Example:
 - Frequency=60MHz
 - One cycle = 16.6 ns

Computational Delays in Digital Sensors

- Actual delay due to A/D and numerical calculations
- Repetition interval of calculations
 - Clock driven repetition
 - Take measurement
 - Perform calculation
 - Output numerical data
 - Repeat

Note on safety with lasers

- Lasers cause damage by heating
- NOHD=Nominal Ocular Hazard Distance
- Class 1: less than $39\mu\text{W}$ and/or enclosed
- Class 2: 0.99mW NOHD=7m
- Class 2M: safe up to 0.25s
- Class 3R: 4.99mW NOHD=16m
- Class 3B: 499.9mW NOHD=160m
- Class 4: over 500mW
 - 1W NOHD=224m
 - 10W NOHD=710m

Magnetic Sensing

- Hall effect: Potential difference in a current carrying conductor in a magnetic field
 - Electric potential is normal to Current and magnetic field
- Hall sensing is possible in three directions
- Applications
 - Rotation sensing
 - Magnetic field measurement

End of Lecture