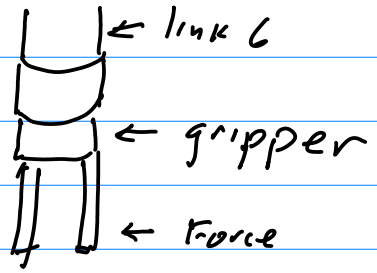
Sensors

sense
- Distance to objects
- Position of robot
- Position of object

- Touch
- Force / torque
- Color
- Vision - camera
- Temperature / smoke / smell
- Sound



- Distance (direction) to target — visual, beacons, landmarks eg. door
  - triangulation
  - LIDAR

Navigation

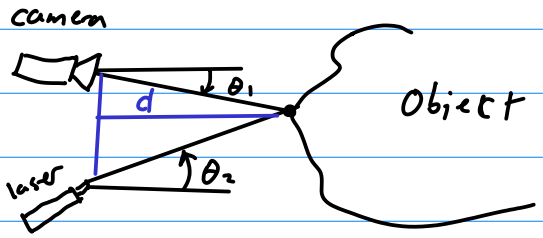
Dead reckoning - calculate position based on a previous position & motion since - errors accumulate

Inertial guidance

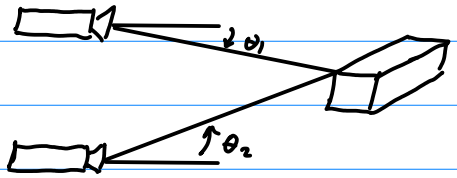
Range Sensing - distance to an object

① Optical

ⓐ Triangulation



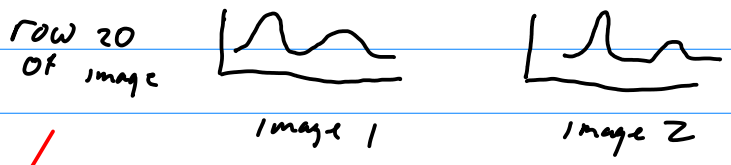
Stereo Vision



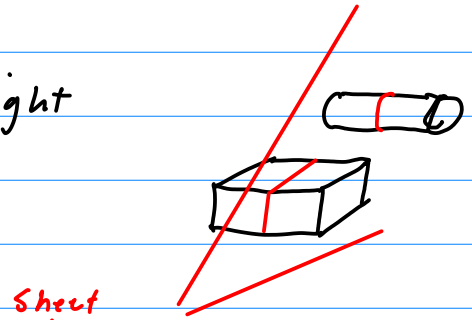
Must find correspondance between images

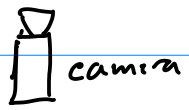
① Correspond features

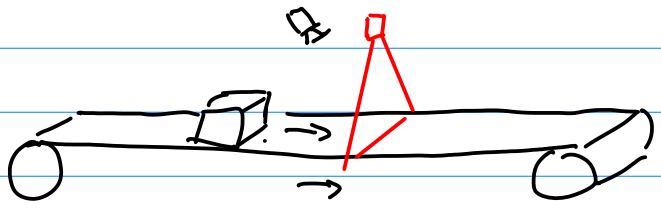
② correspond "raw" image points



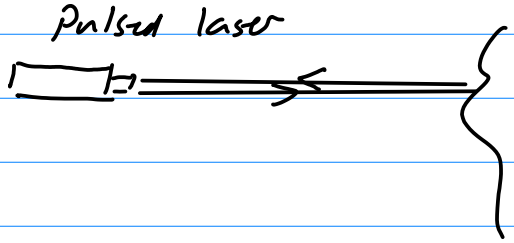
Structured Light





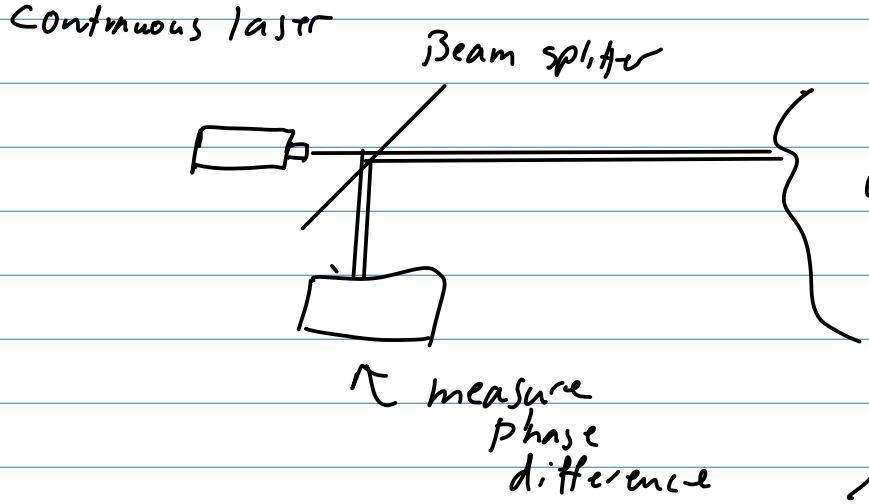


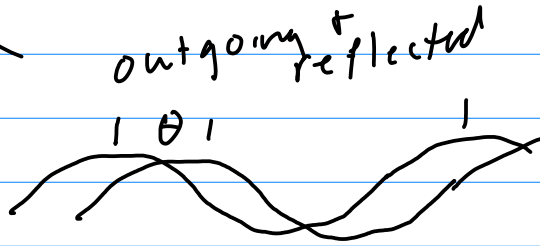
Time of Flight



distance = speed of light × time

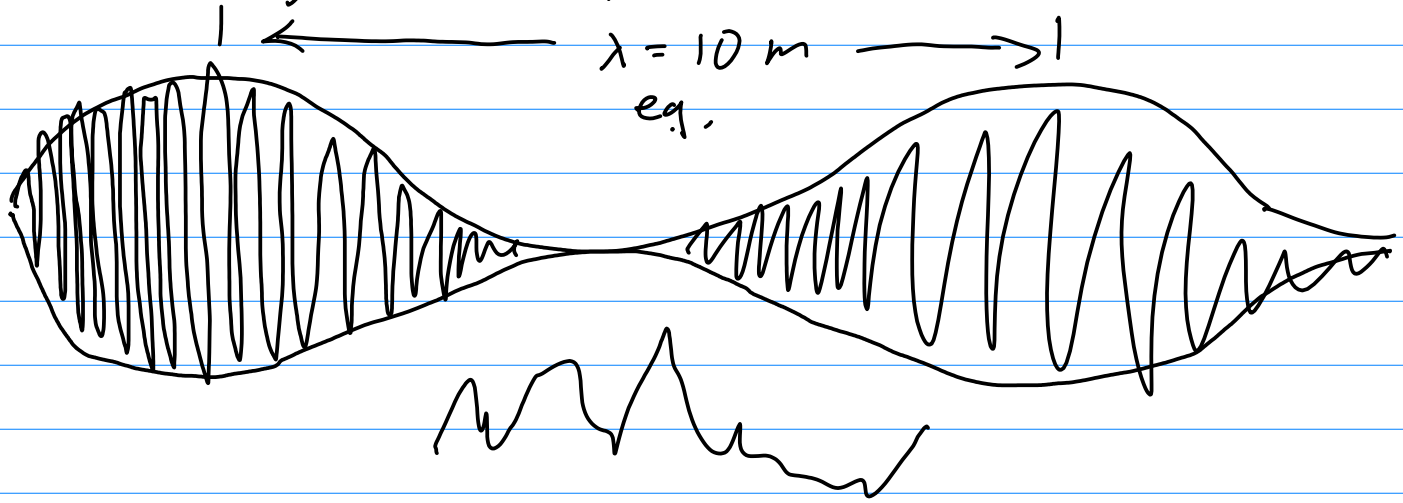
$$D = \frac{cT}{2}$$





$$D = \frac{\theta}{360}\,\frac{\lambda}{2}$$

modulate the beam for longer wavelength



Pulsed ultrasonic

eg, Polaroid version single transducer

Chirp of 50, 53, 57, 60 KHz

Avoids cancellation

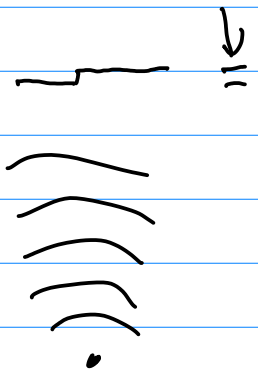
Beam width ~ 30°

Received signal falls by $\frac{1}{d^4}$

- Ramp up gain after ping
- Practical limit on distance 10m

step in object

$\frac{1}{4}\lambda$



Proximity sensors

binary - close to an object or not

(1) Inductive like a metal detector

coil & oscillator - nearby metal changes inductance ⇒ frequency

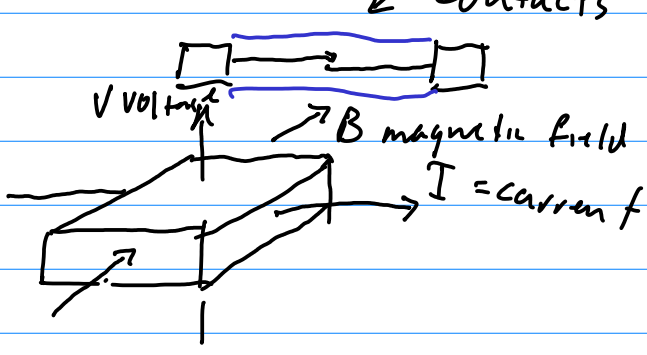
(metals)

(2) Capacitive similar but use "capacitor" plates

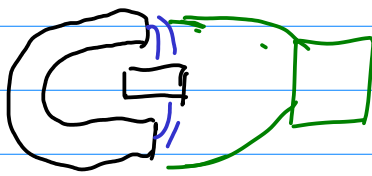
even

other materials liquids & powders

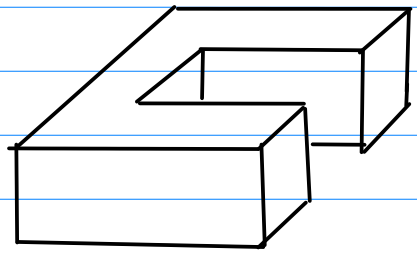
(3) magnetic Reed

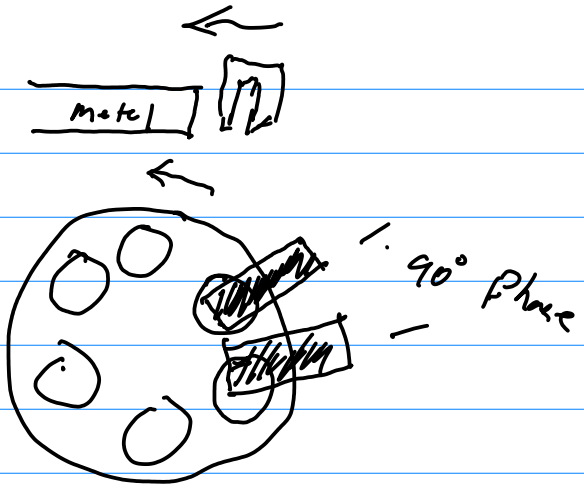


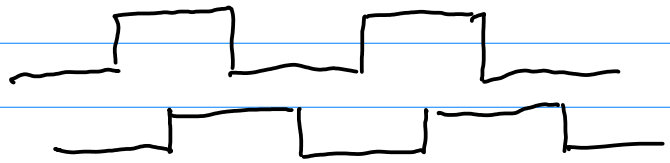
actuated by magnetic field



(4) Hall effect





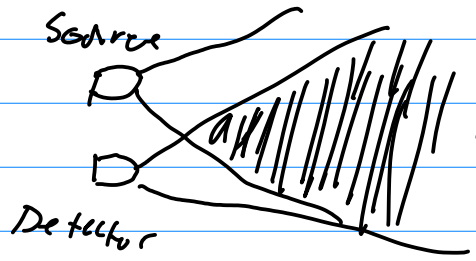


Proximity

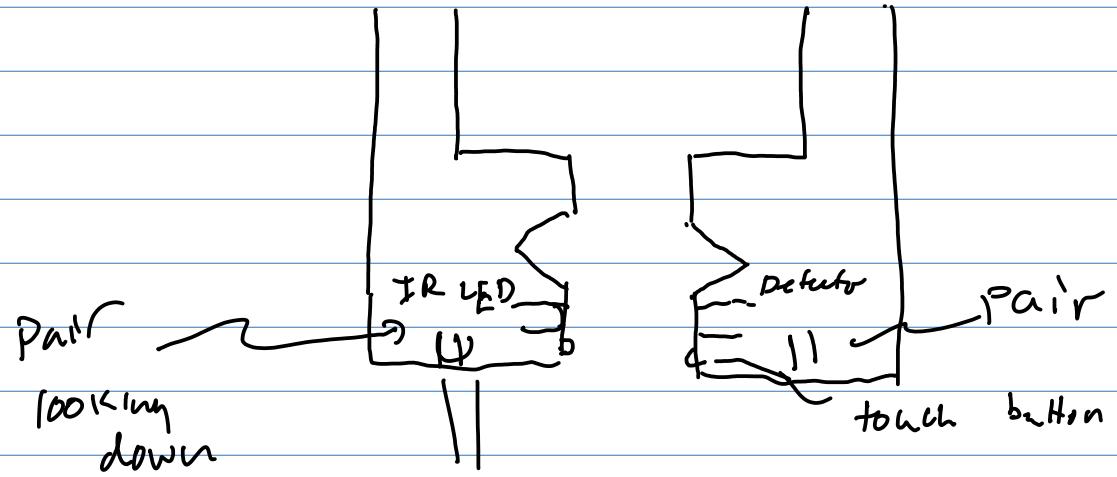
Ultrasonic - small ones possible

Optical

"through beam" 



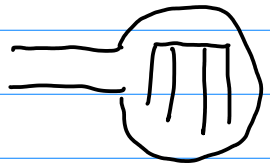
← object in this region will reflect light to the detector

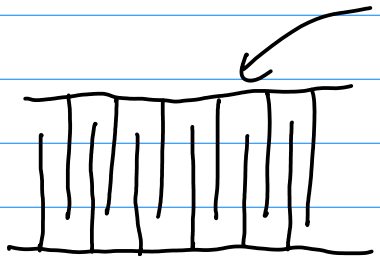


Touch sensors

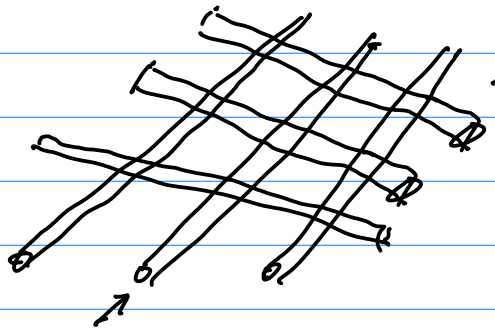
single point
or array

binary
analog — how much displacement
how much "force"



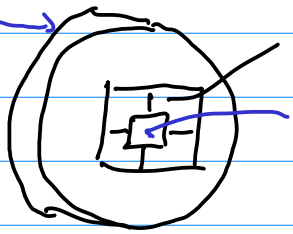


sandwiched with a layer of "conductive foam"



layer of conductive foam between

Force / Torque



Temperature →

Thermocouples
RTD - resistive temperature device
I.C.
etc.

Sensor characteristics

Compact design
Rugged
Linearity
Resolution / accuracy
Hysteresis
Stability time & temperature
Response time