

Machine Vision & Sensors

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Robotic applications

- Machine vision applications have 3 levels of difficulty
- Which depends on – position &/ appearance
- Position control by fixturing
- Lighting techniques for appearance

3 levels of difficulty

1. The object can be controlled in both position and appearance
2. Either position or appearance of the object can be controlled but not both
3. Neither position nor appearance of the object can be controlled

Robotic applications

Categories

1. Inspection
2. Identification
3. Visual servoing and navigation

1. Inspection

- MVS + robot is used here
- Inspection include
- Surface defects, flaws in labeling, verification of presence of components in assembly, measuring for dimensional accuracy, checking of features in parts, etc.
- Prob with manual inspection: human error, only sample is inspected, time taking.

Advantage of machine vision inspection

- Procedure is carried out automatically
- 100 % inspection
- Less time

2. Identification

- Purpose: recognize and classify an object rather than inspect it.
- Determination of part or its position or orientation.
- Applications include sorting, palletizing & depalletizing and picking of parts that are randomly oriented in a conveyor or belt

3. Visual servoing and navigation

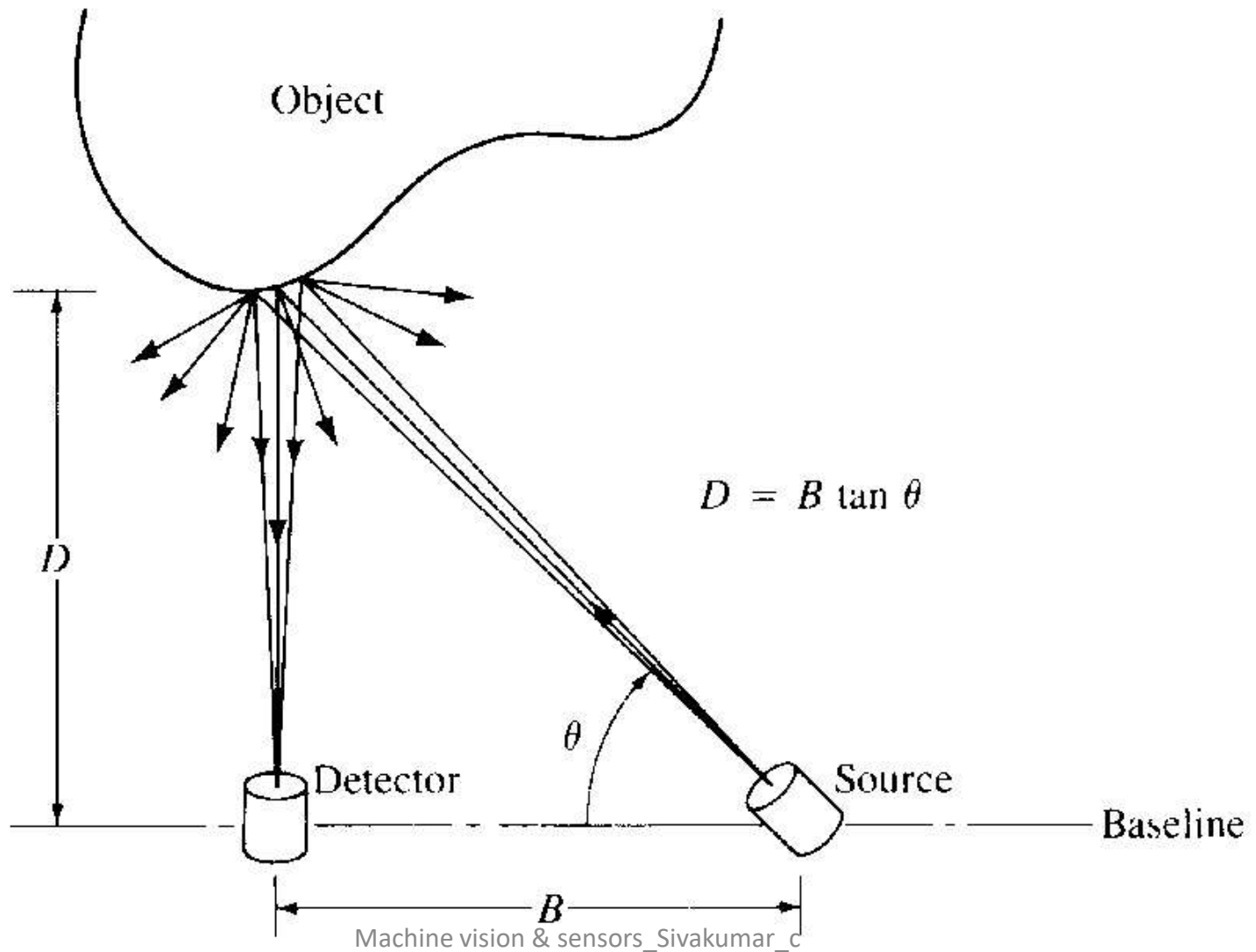
- Purpose: to direct the actions of robot based on visual input
- Ex controlling the trajectory of the end effectors of a robot.
- Part positioning, assembly, bin picking, seam tracking in arc welding, etc

- Ex of navigation control include path planning, and collision avoidance using visual data

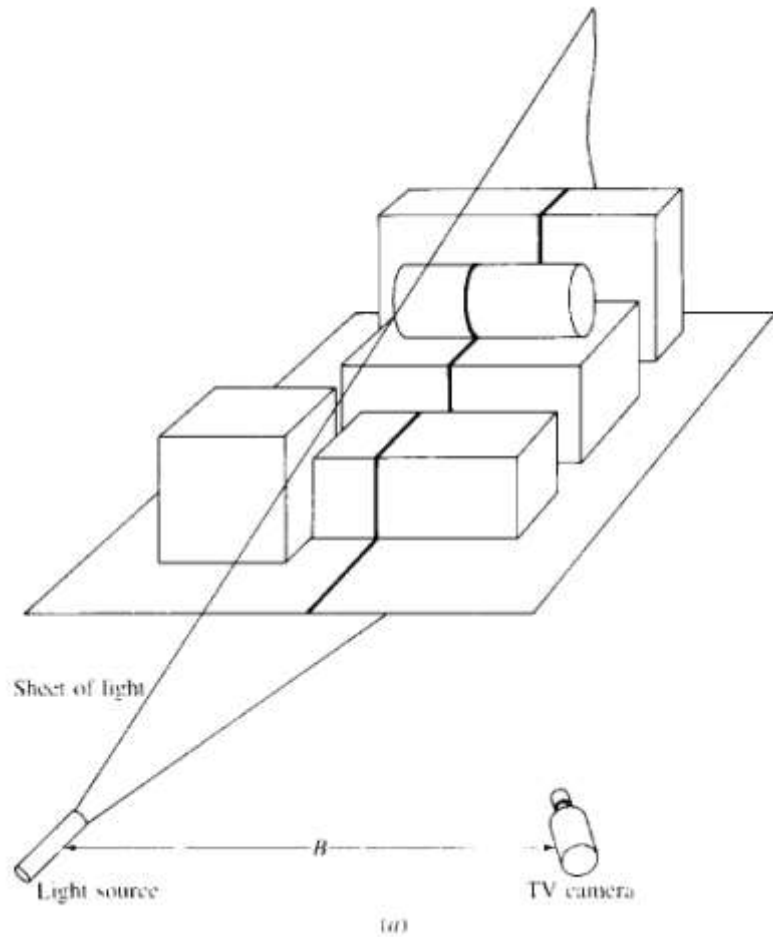
Range Sensing

- Triangulation
- Structured lighting approach
- Time of flight range finders

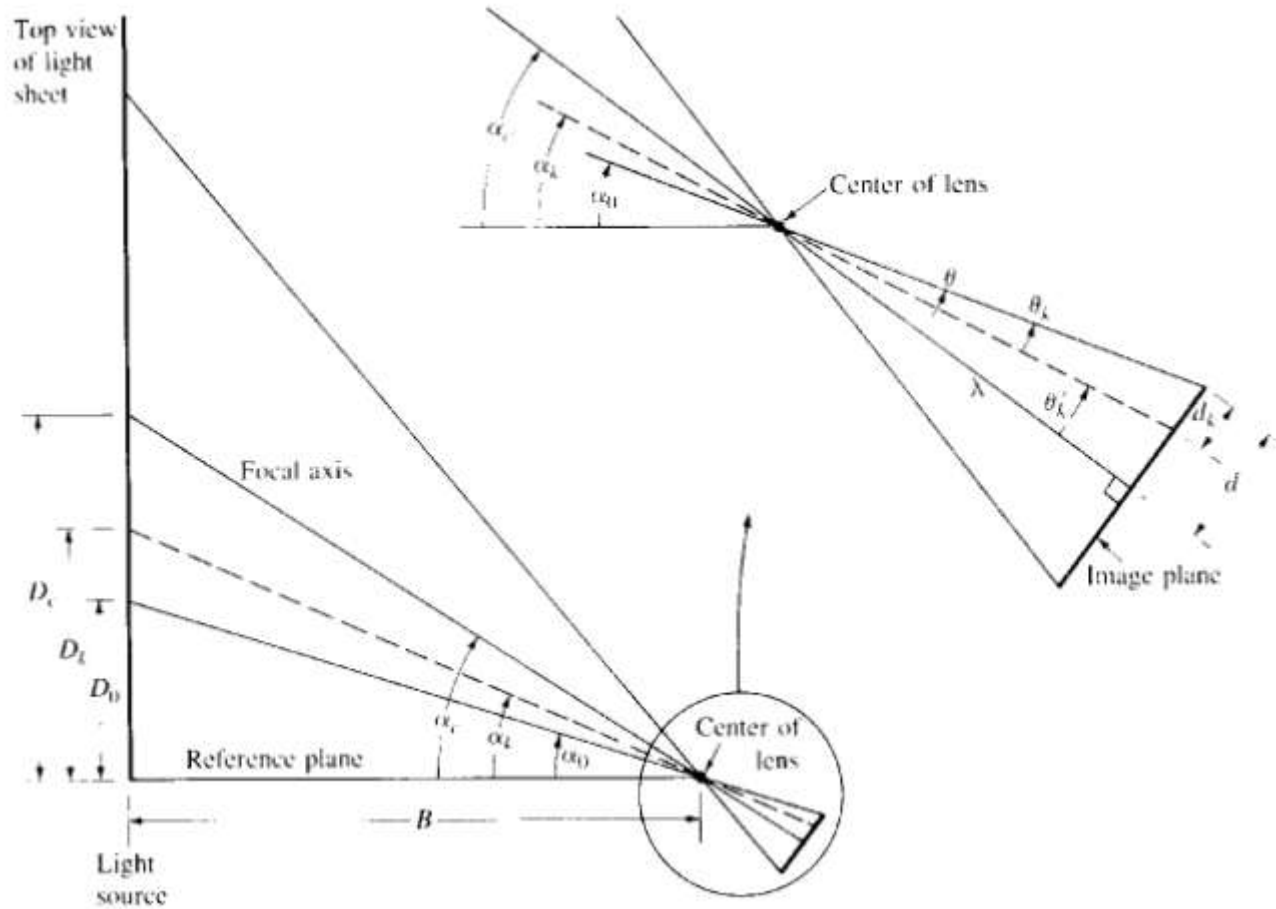
Triangulation



Structured lighting approach



Structured lighting approach



Time of flight range finders

Using LASER

- (a) Pulsed Light
- $D=cT/2$
- T-pulse transit time, c- speed of light

- (c) ultrasonic range finder – same principle
- Using speed of sound which is known

- (b) Continuous beam LASER

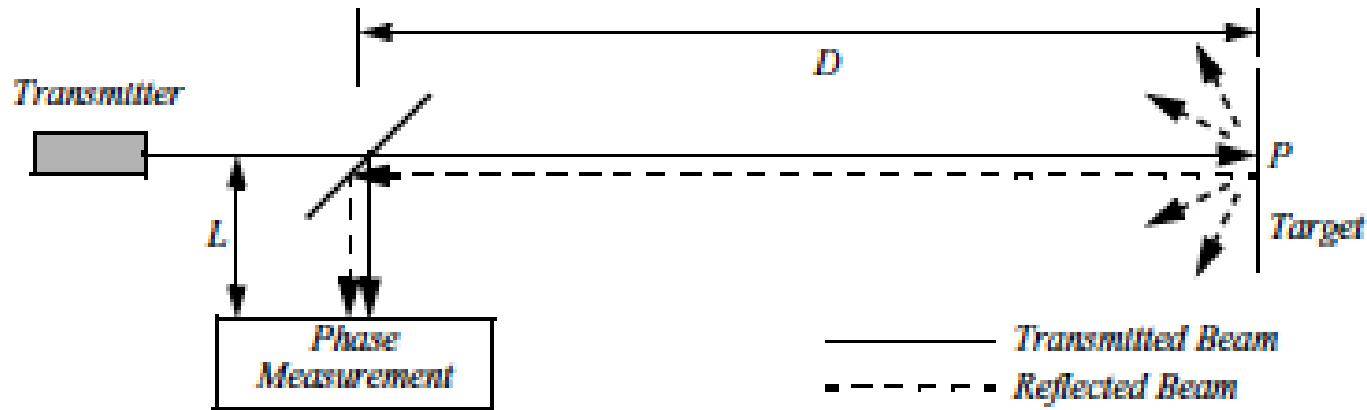
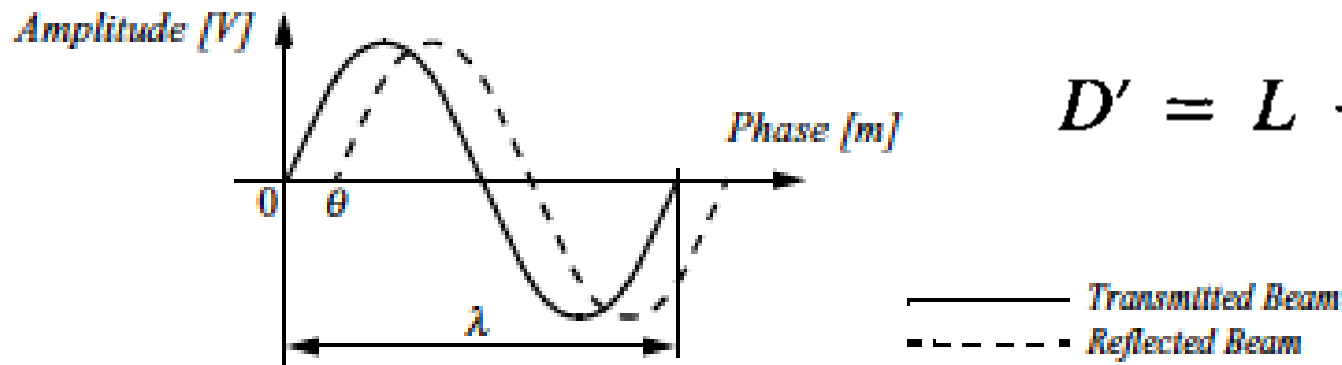


Figure 4.9
Schematic of laser rangefinding by phase-shift measurement.

$$D' = L + 2D,$$




$$D' = L + \frac{\theta}{360} \lambda$$

Figure 4.10
Range estimation by measuring the phase shift between transmitted and received signals.

$$D' = L + 2D,$$

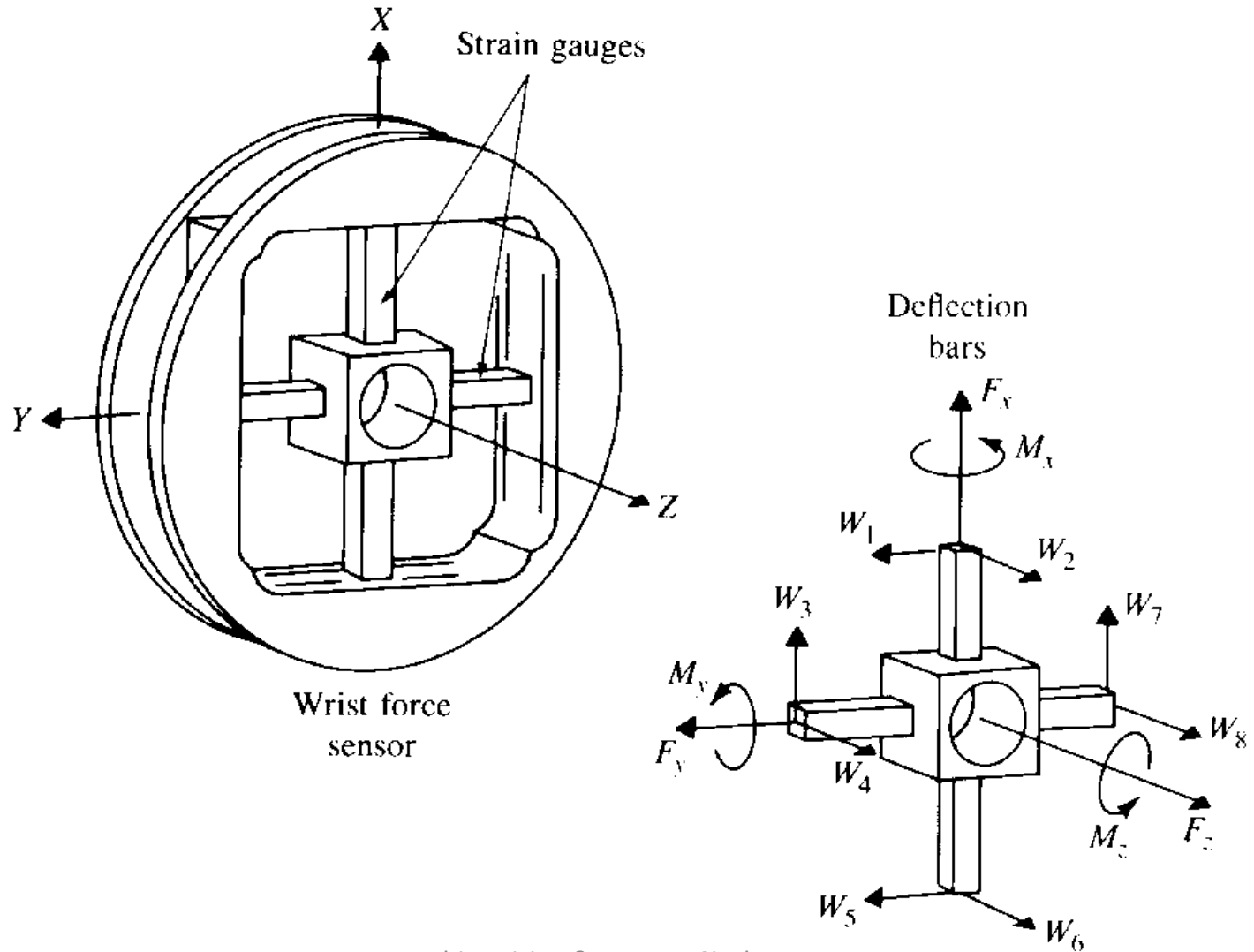
$$D' = L + \frac{\theta}{360} \lambda$$


$$D = \frac{\theta}{360} \left[\frac{\lambda}{2} \right]$$

Force Sensing

- Force sensing wrist
- Torque exerted at joint
- Force sensor array

Force sensing wrist



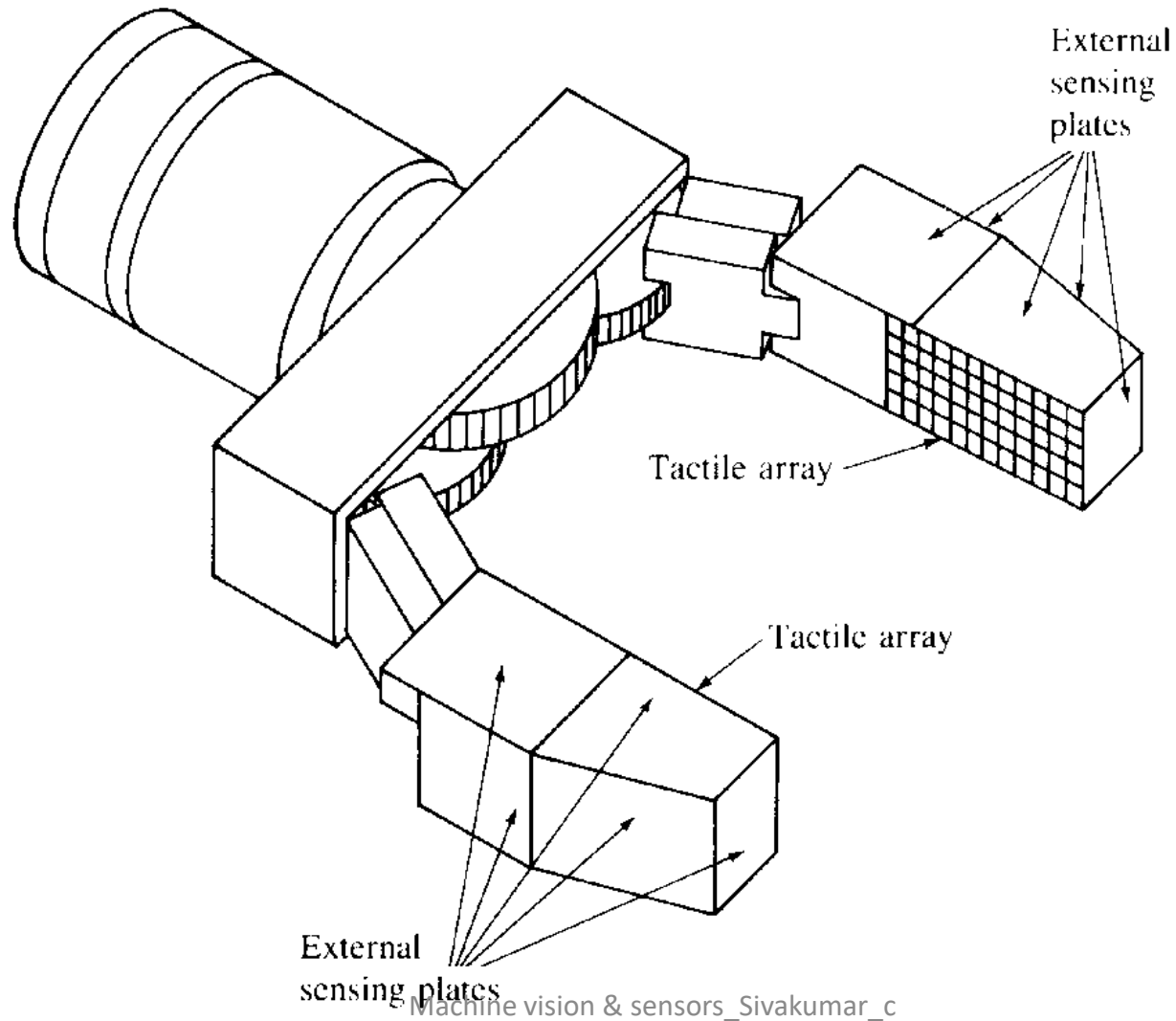
Torque exerted at join

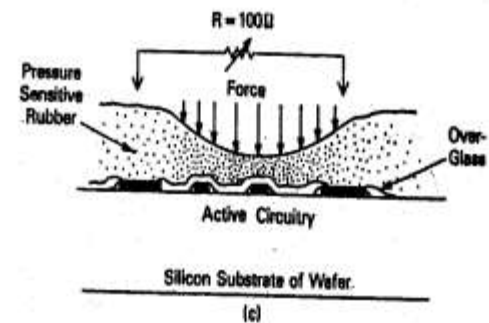
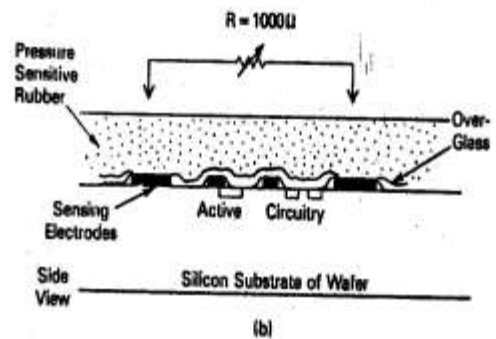
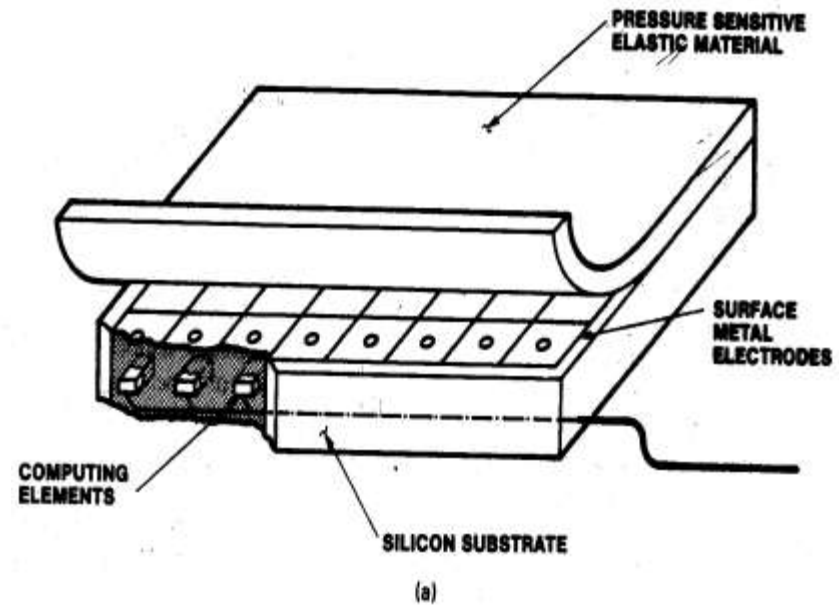
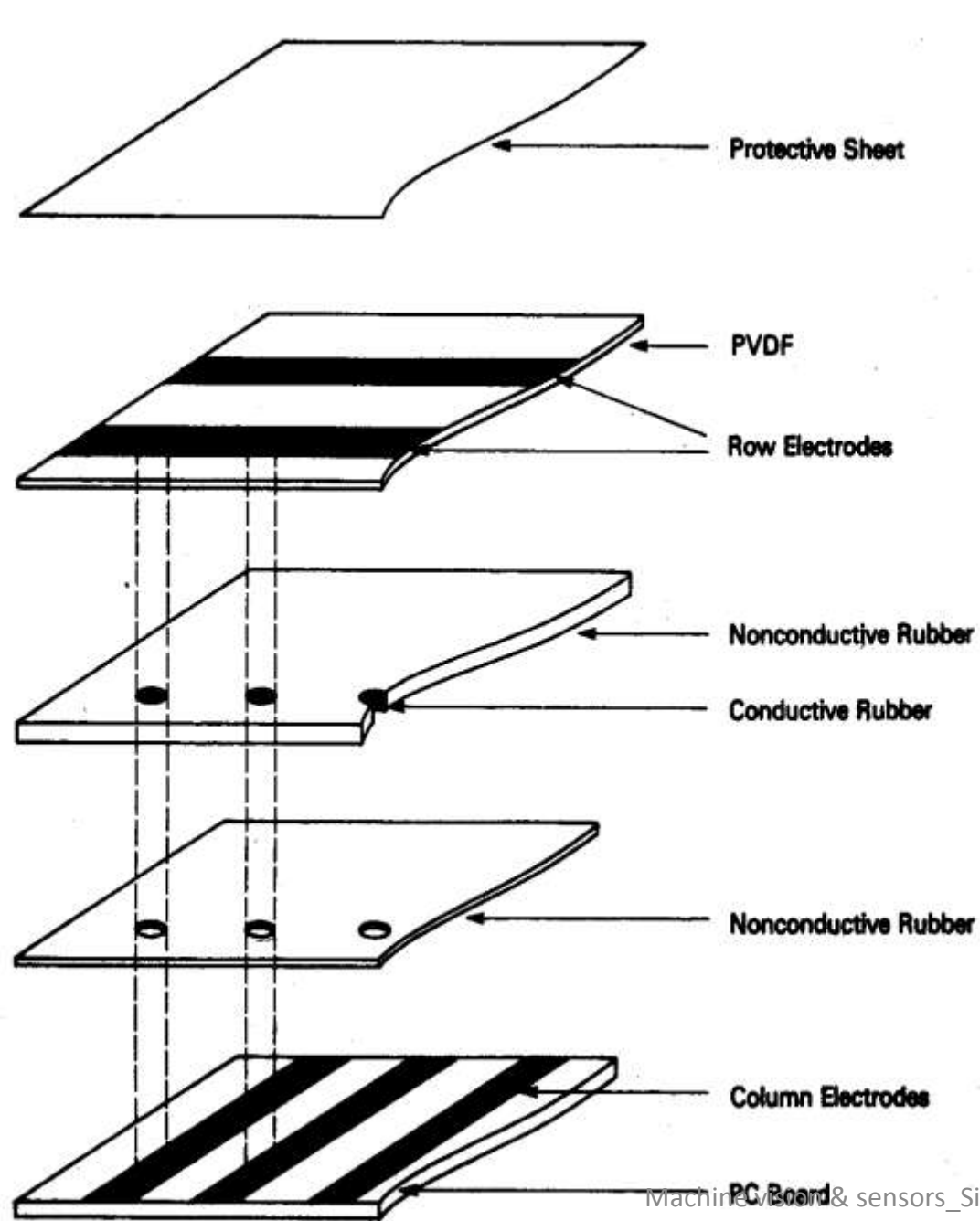
- Torque exerted is proportional to current flowing through motor

Disadvantage

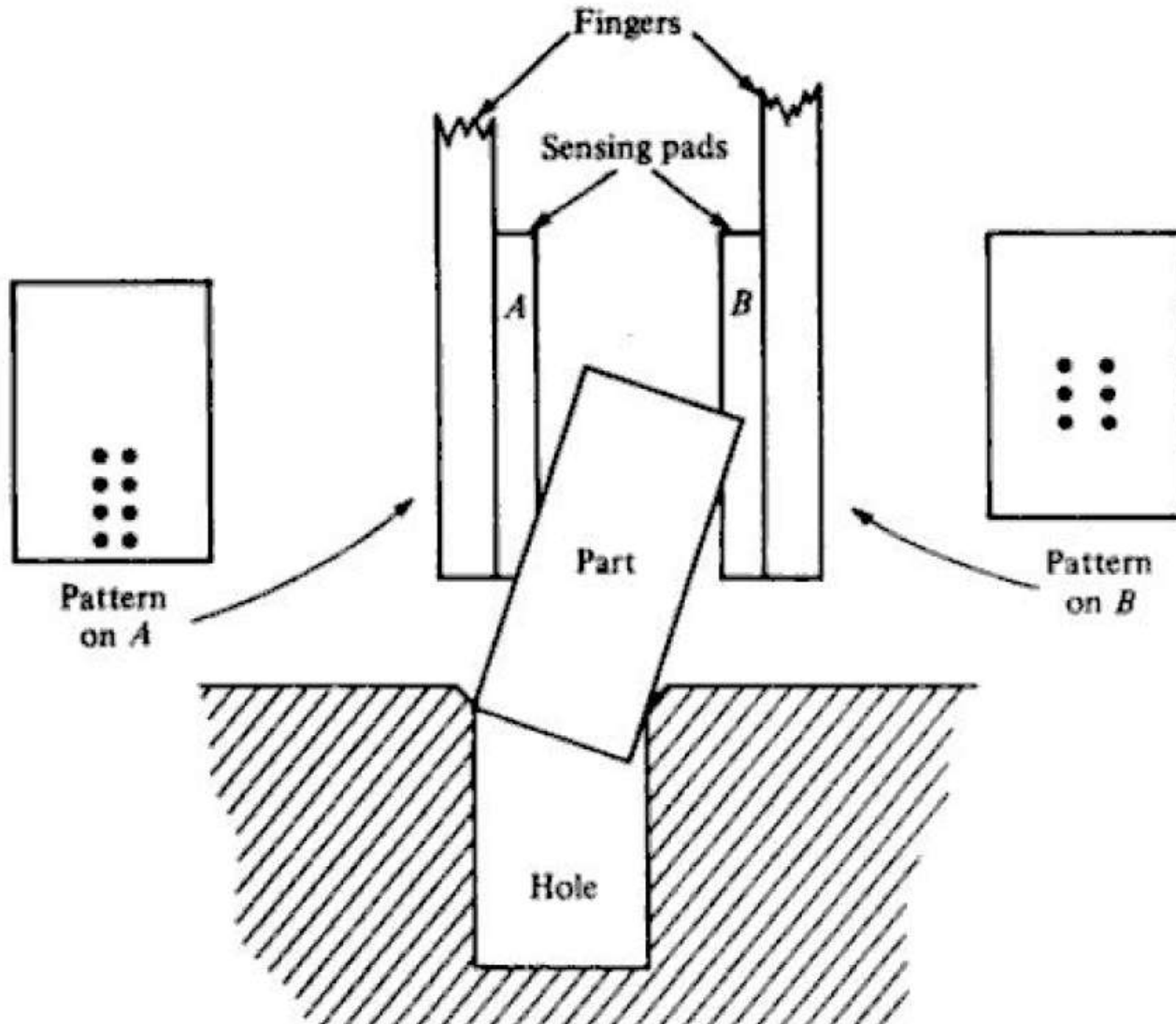
- Measurements done at joint space instead of tool space

Force Sensing Array





Insertion Task



Thank you