

No.4

# Seminar I on Agricultural Process Engineering 農産加工学演習 I

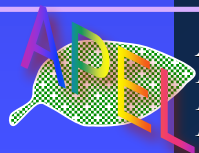
*Naoshi Kondo, Hiroshi Shimizu*

Division of Environmental Science & Technology,  
Graduate School of Agriculture, Kyoto University

農学研究科 地域環境科学専攻

近藤 直・清水 浩

# Camera

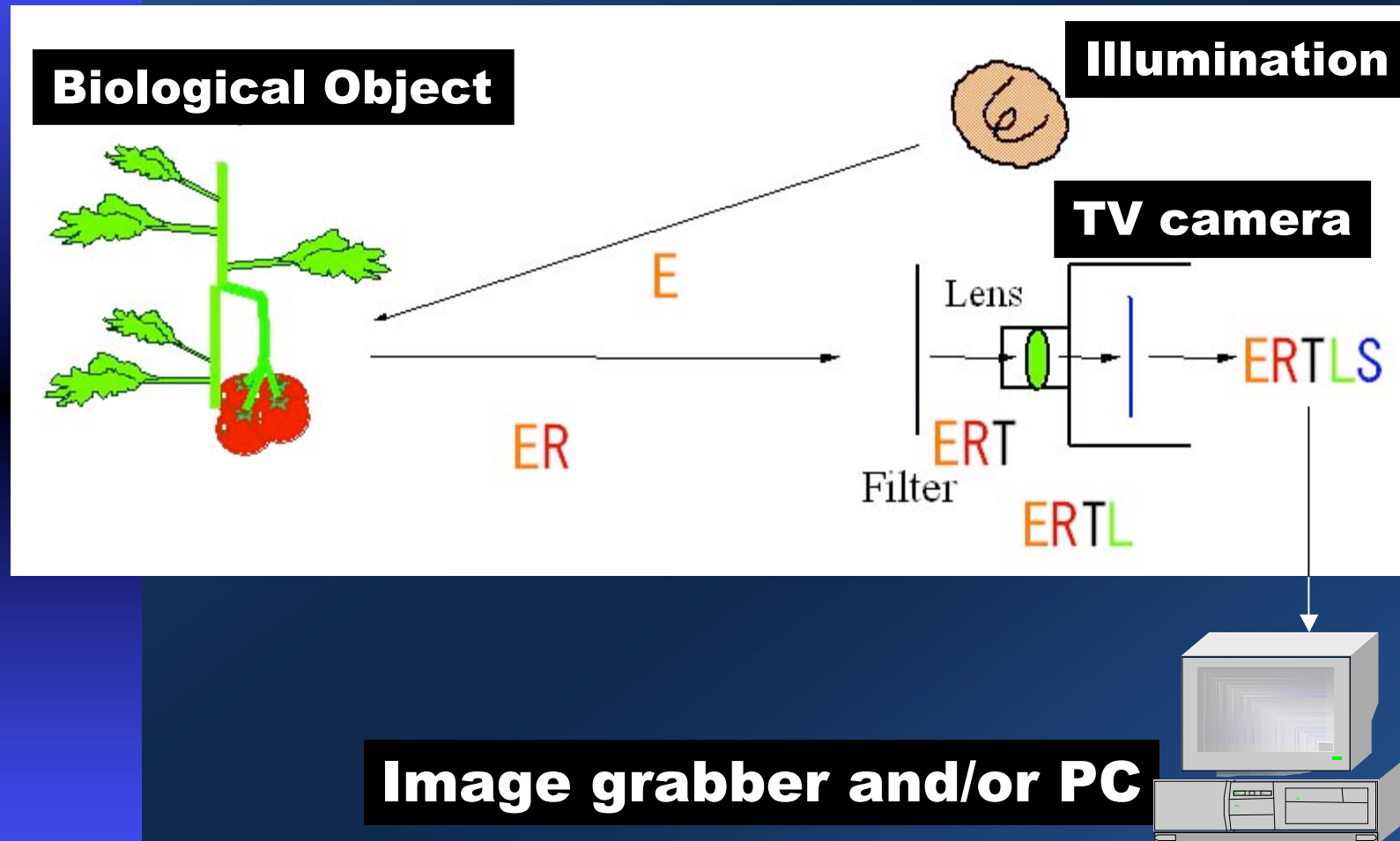


*Agricultural  
Process  
Engineering  
Laboratory*



**KYOTO** 京都大学  
UNIVERSITY

# An energy flow from light source to output of TV camera



# Camera



## Specification

- Single CCD type image sensor
- Flame shutter type  
(non-interlace)
- RGB original color filters
- works under 70°C temp.
- Random trigger shutter
- Variable shutter speed
- Small, simple, light, and cheap

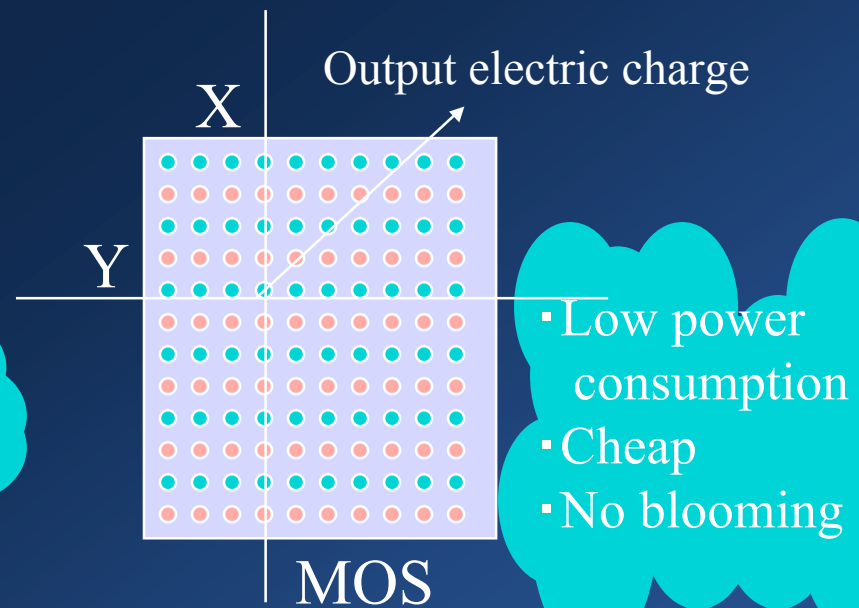
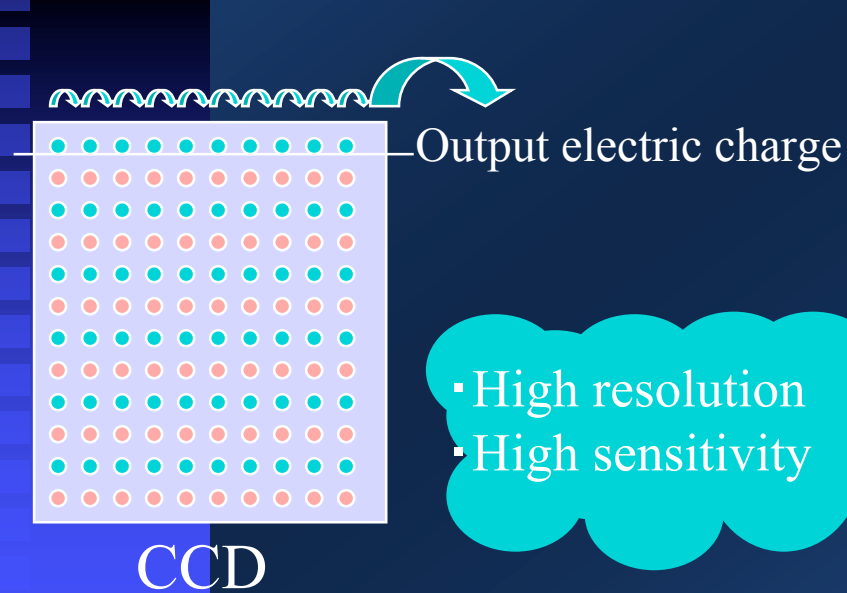
# CCD vs MOS

## (Type of Image sensor)

Image sensor is a sensor of many photo diode arrays (pixels) which accumulate electronic charge according to light intensity.

CCD: Charge Coupled Device, since 1974

MOS: Metal Oxide Semiconductor, since 1973



# Interlace and non-interlace

(Frame shutter and field shutter)

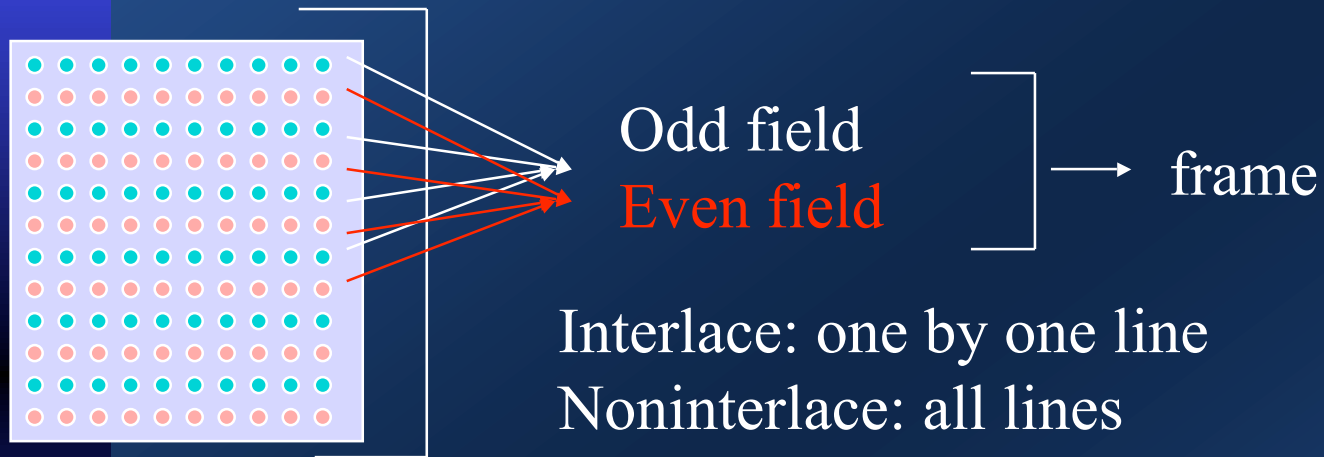


Image sensor

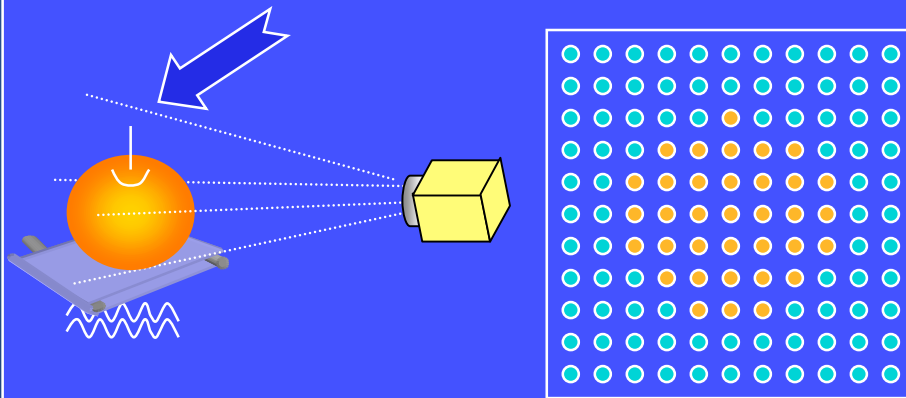
Scanning time

Interlace:  $1/60s + 1/60s = 1/30s$

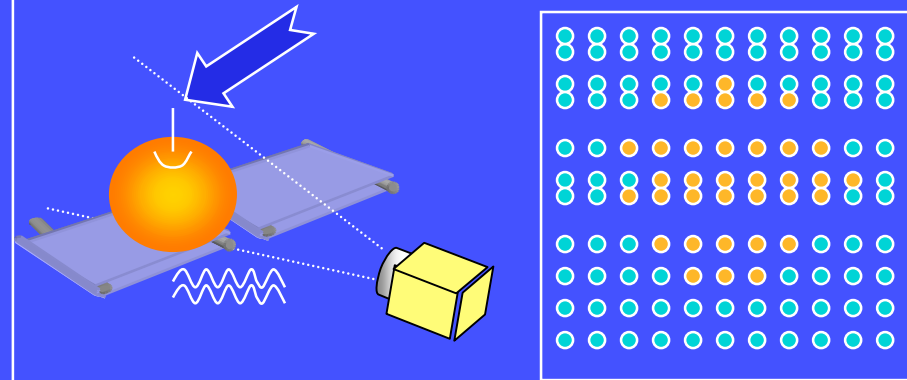
Noninterlace:  $1/30s$

High speed camera:  $1/60s$

## Area sensor



## Line sensor



|                |                                                   |                                                                                             |
|----------------|---------------------------------------------------|---------------------------------------------------------------------------------------------|
| Scanning Time  | <b>33ms</b><br>High speed camera<br><b>16.6ms</b> | Depends on work size and on work speed<br><b>(65ms, when a 65mm fruit moves at 60m/min)</b> |
| Shape analysis | Easy                                              | Not easy due to moving speed and vibration                                                  |
| Resolution     | Depends on camera                                 | Depends on speed                                                                            |

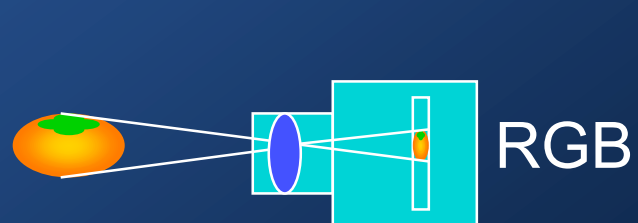
# Resolution

- ✓ VGA (video graphics array: 300,000pix)
- ✓ XGA (extended graphic array: 800,000pix)
- ✓ SXGA (super extended .....: 1,300,000pix)
- ✓ UXGA (ultra extended.....:2,000,000pix)

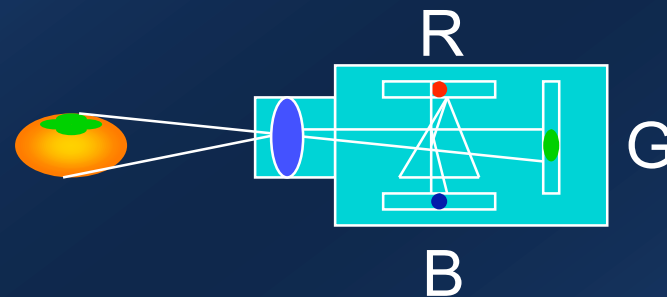
8 bit gray level

10 bit gray level

# Single CCD camera and Three CCD camera

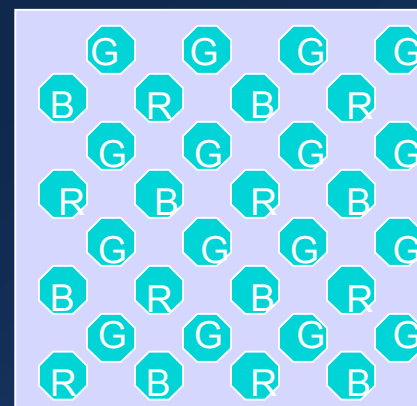


Single CCD



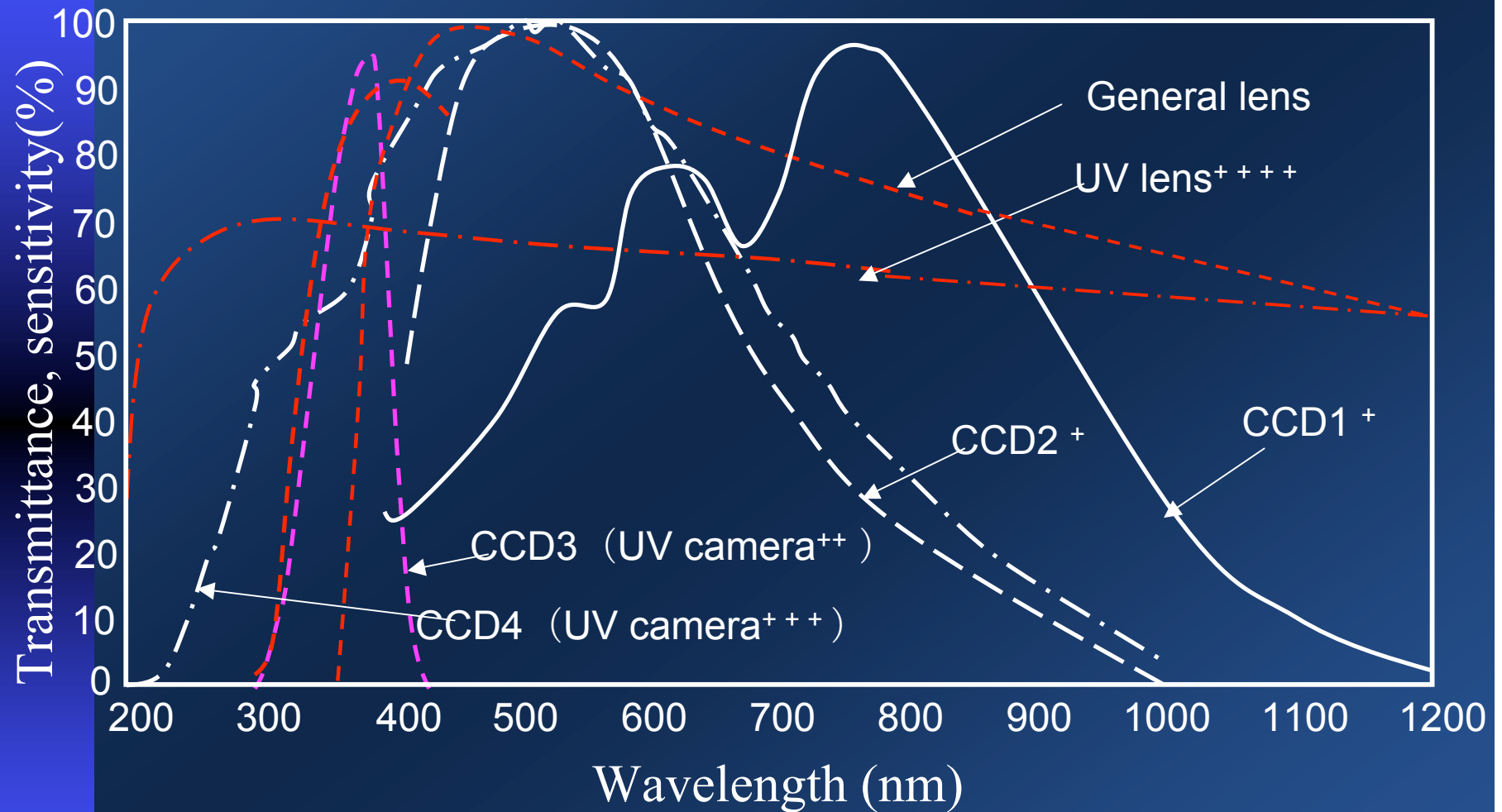
Three CCD

|   |   |   |   |
|---|---|---|---|
| R | G | B | G |
| G | R | G | B |
| R | G | B | G |
| G | B | G | R |



Honeycomb

## Transmittance of lens and camera sensitivity



# Assignment

Describe superior characteristics of camera (conventional color TV camera of VGA class) compared with human eyes.