TRAINING DOCUMENT FOR VISUAL INSPECTION

TL IJ - AED

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6.Mar.2015

① General information about Vision processing.

- Typical Usages of Image Sensor
- What is pixel & how to use pixel in image processing.
- Basic Configuration of PC-Based Image Processing

② Hardware training

- Kind of Camera and Lens
- How to use Camera and Lens
- Kinds of light and light system
- How to use light

NEED JOIN TEST AFTER TRAINING No 1-2-3

③ Software training

- Introduce each function in software
- How to use each function.
- How to setting threshold

④ Follow up after training

- Monthly confirm OK points & NG points => Support.

DETAIL SCHEDULE

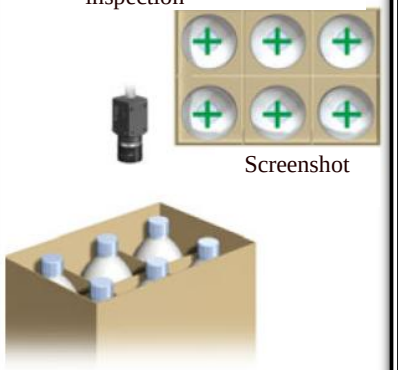
No	JOB List	Time	30.MAR					31.MAR					1.APR					2.APR					3.APR				
			8h	10h	12h	14h	16h	8h	10h	12h	14h	16h	8h	10h	12h	14h	16h	8h	10h	12h	14h	16h	8h	10h	12h	14h	16h
0	**Greatting**	0.5																									
1	**General information**																										
	Typical usages Camera	1																									
	What is pixel	1.5																									
	Basic configuration	1																									
2	**Hardware information**																										
	Kind of Camera	1																									
	How to use Camera & Lens	2.5																									
	Kind of Light	1																									
	How to use Light	3.5																									
3	**Software information**																										
	Introduce software	1.5																									
	How to use each function	1.5																									
	How to setting threshold.	8																									
4	Practice	4																									
	Test	2																									
5	**Follow up**																										
	Report actual theme.																										

① GENERAL INFORMATION ABOUT VISUAL INSPECTION

I. TYPICAL USAGES OF IMAGE SENSOR

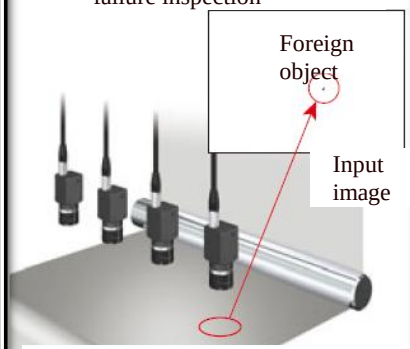
Image processing enables you to two-dimensionally recognize objects.
Therefore, this technique is widely used for automatic inspection replaced with **visual inspection** or **check**.

1 Number and missing part inspection



Counting the number of bottles in the package box
Count the number of bottles in the package box.

2 Foreign object, damage and failure inspection

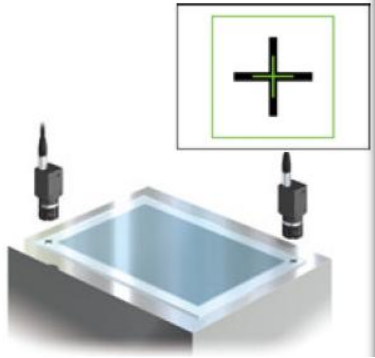


Detecting a pin hole or foreign object attached on the sheet
Detect a foreign object or pin hole on the surface of sheet.

3 Dimension measurement

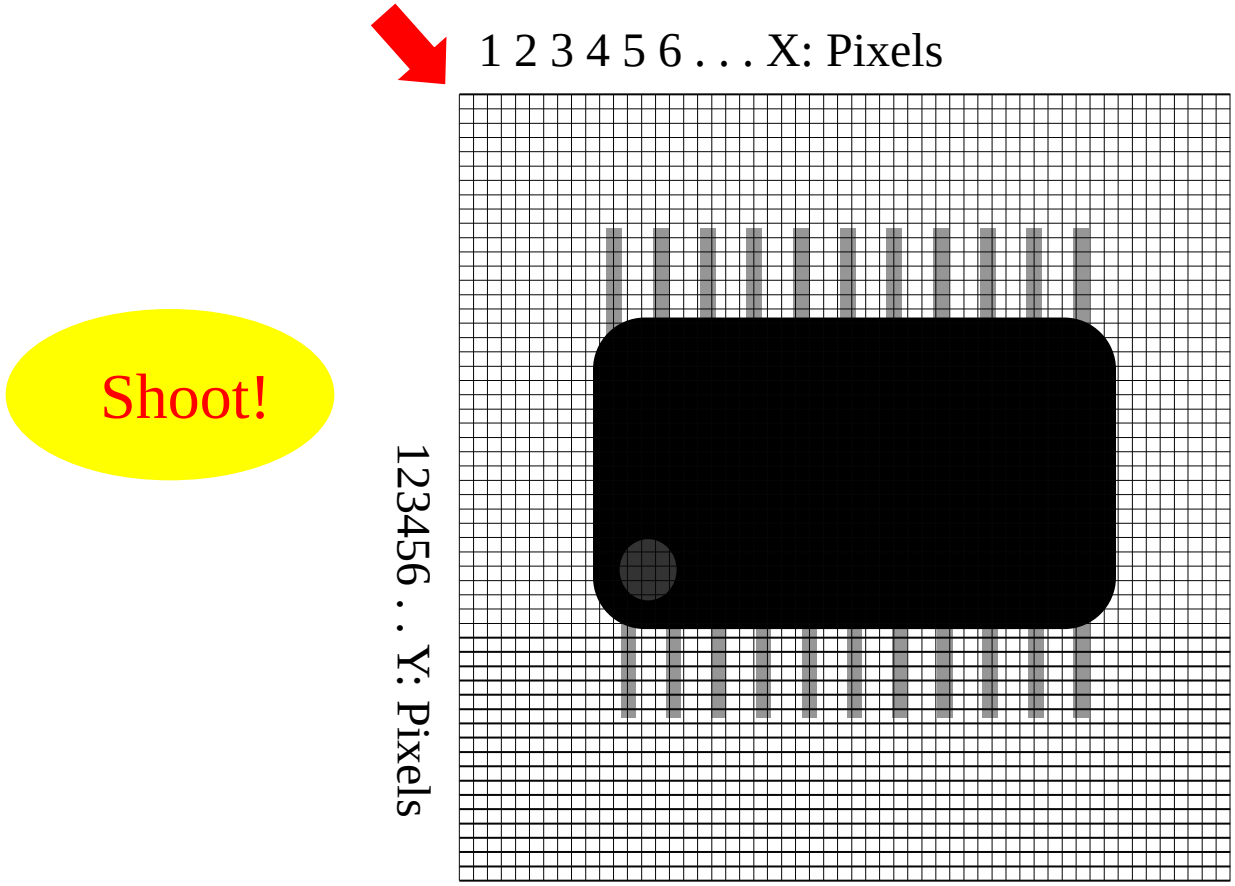
Measuring the co planarity of connector pins
Measure the co planarity of pins in a single window.

4 Position measurement



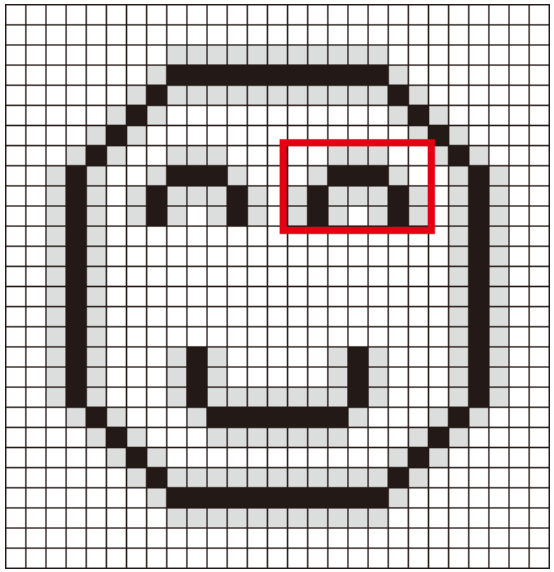
Positioning the liquid crystal glass substrate
Detect the position of alignment mark by search using contour information.

II. WHAT IS A PIXEL?



- ✯ 310,000 pixel camera = 640 (X direction) x 480 (Y direction)
- ✯ 2,000,000 pixel camera = 1600 (X direction) x 1200 (Y direction)
- ✯ 5,000,000 pixel camera = 2432 (X direction) x 2050 (Y direction)

III. USING PIXEL DATA FOR IMAGE PROCESSING



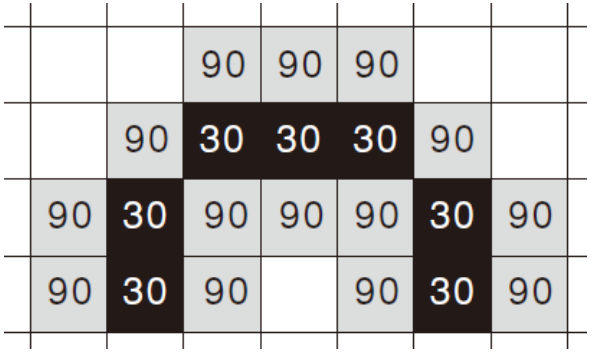
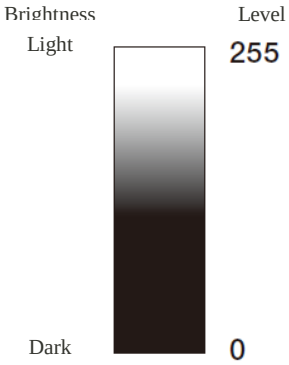
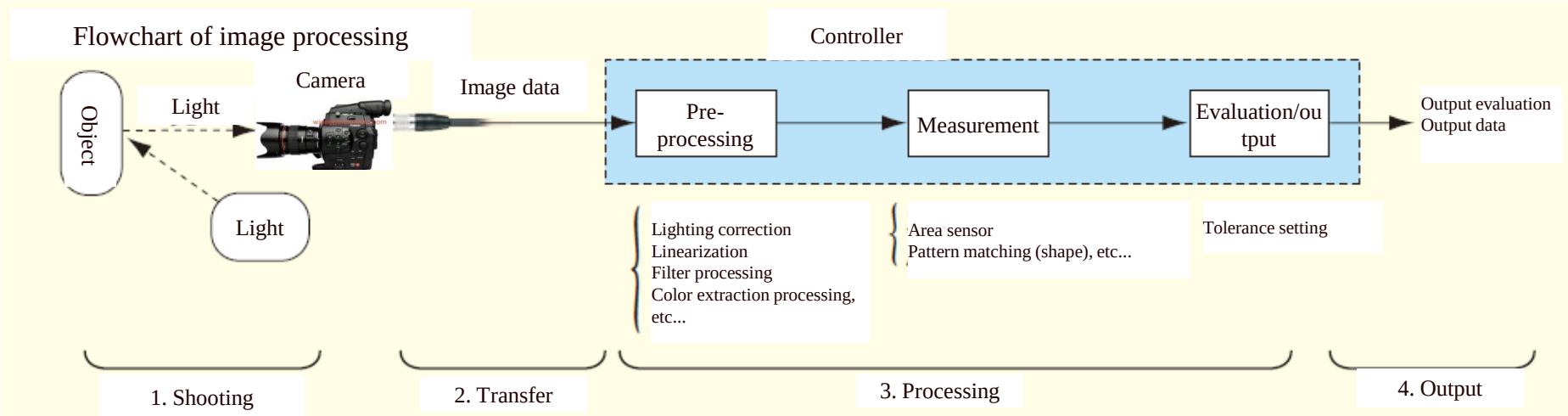


Image of 256 tones



All pixels have concentration data (0 to 255 tones).

IV. STEPS OF IMAGE PROCESSING



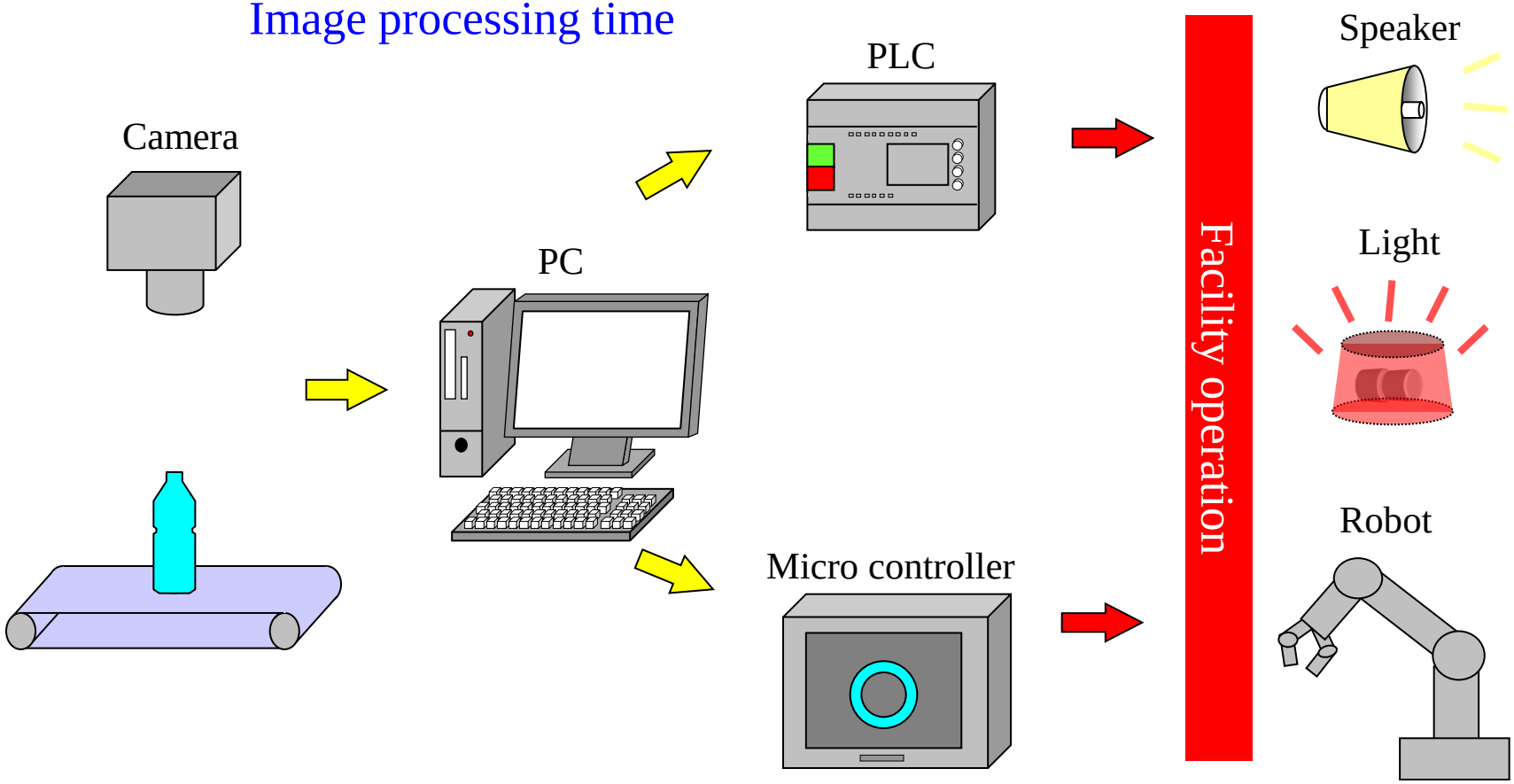
High-performance image processor

1. Shooting: Focused image with a good contrast
2. Transfer: Rapidly transfer data to the controller without degradation.
3. Pre-processing: Process the image for optimal measurement.
   Measurement: Perform processing suited for the inspection objective at a high accuracy or at a high speed.
4. Output: Communication methods to support every control device

V. IMAGE OF USE IN FIELD

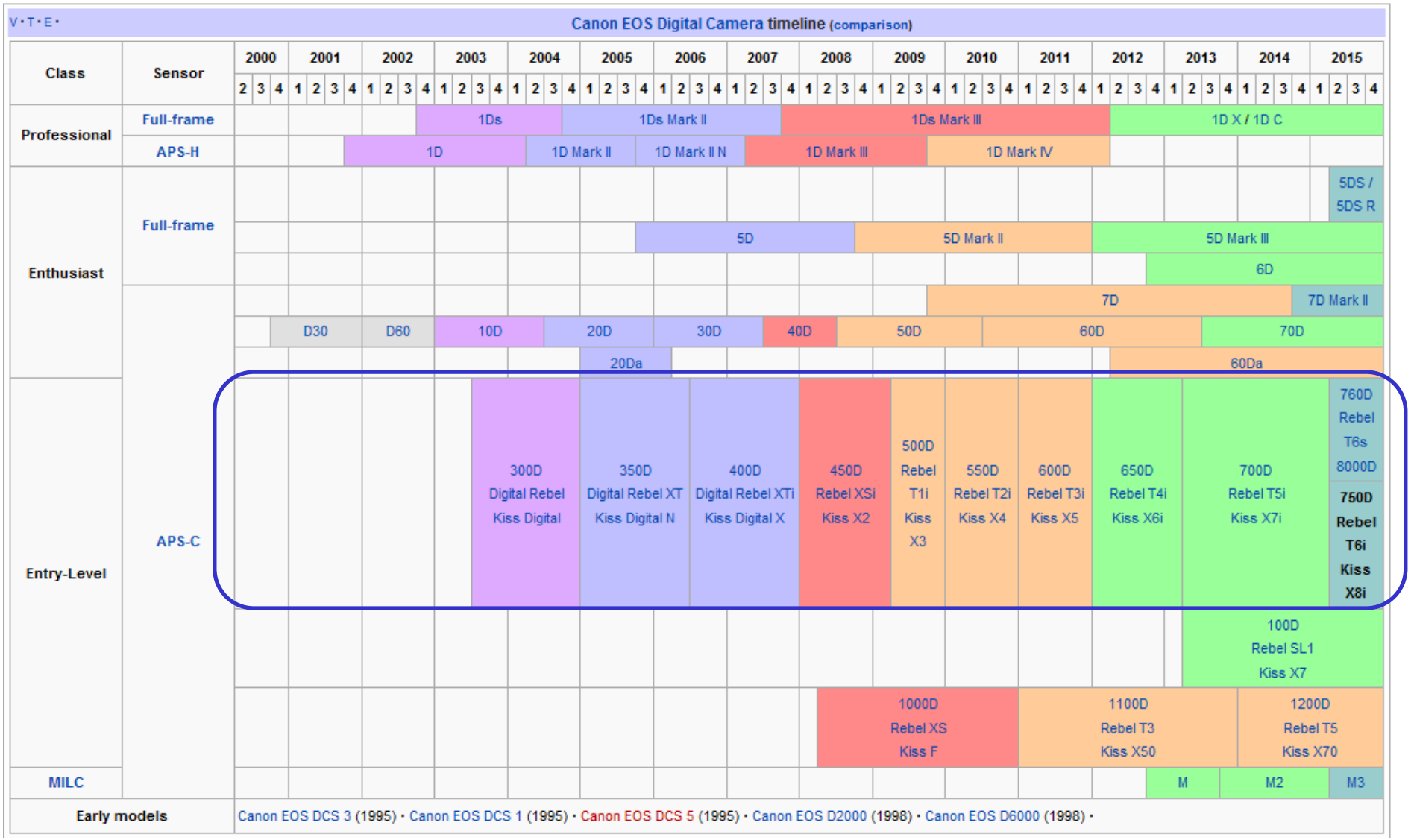
1. Image capturing → 2. Image processing → 3. Input/output signal control → 4. Display processing

Image processing time

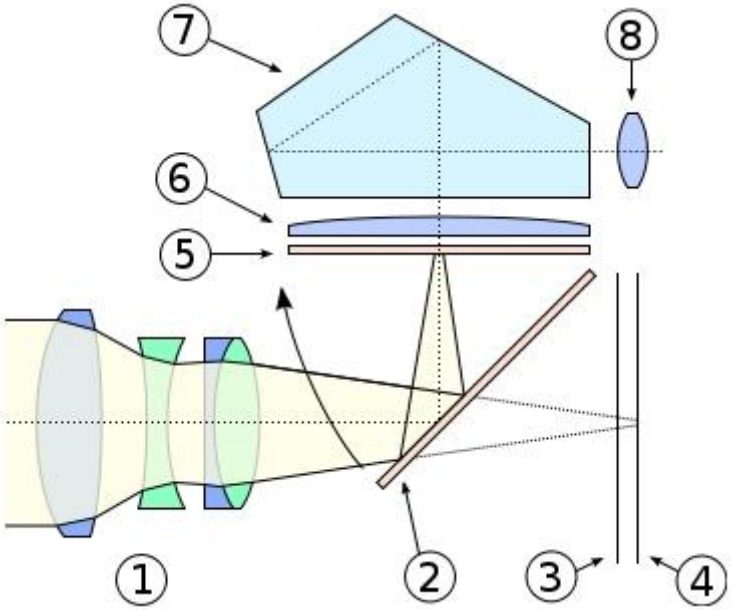


② VISUAL INSPECTION HARDWARE

I. CAMERA TYPE



II. CAMERA STRUCTURE

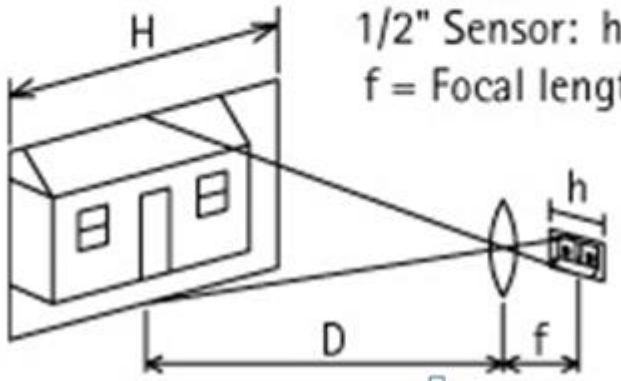


Chú thích:
1 - Hệ thấu kính (ống kính máy ảnh)
2 - Gương phản xạ
3 - Cửa sập mặt phẳng lấy nét, hay còn gọi là màn sập/màn chập (trập)
4 - Sensor (cảm biến)
5 - Màng mờ
6 - Lăng kính condenser
7 - Lăng kính 5 cạnh
8 - Lỗ ngắm

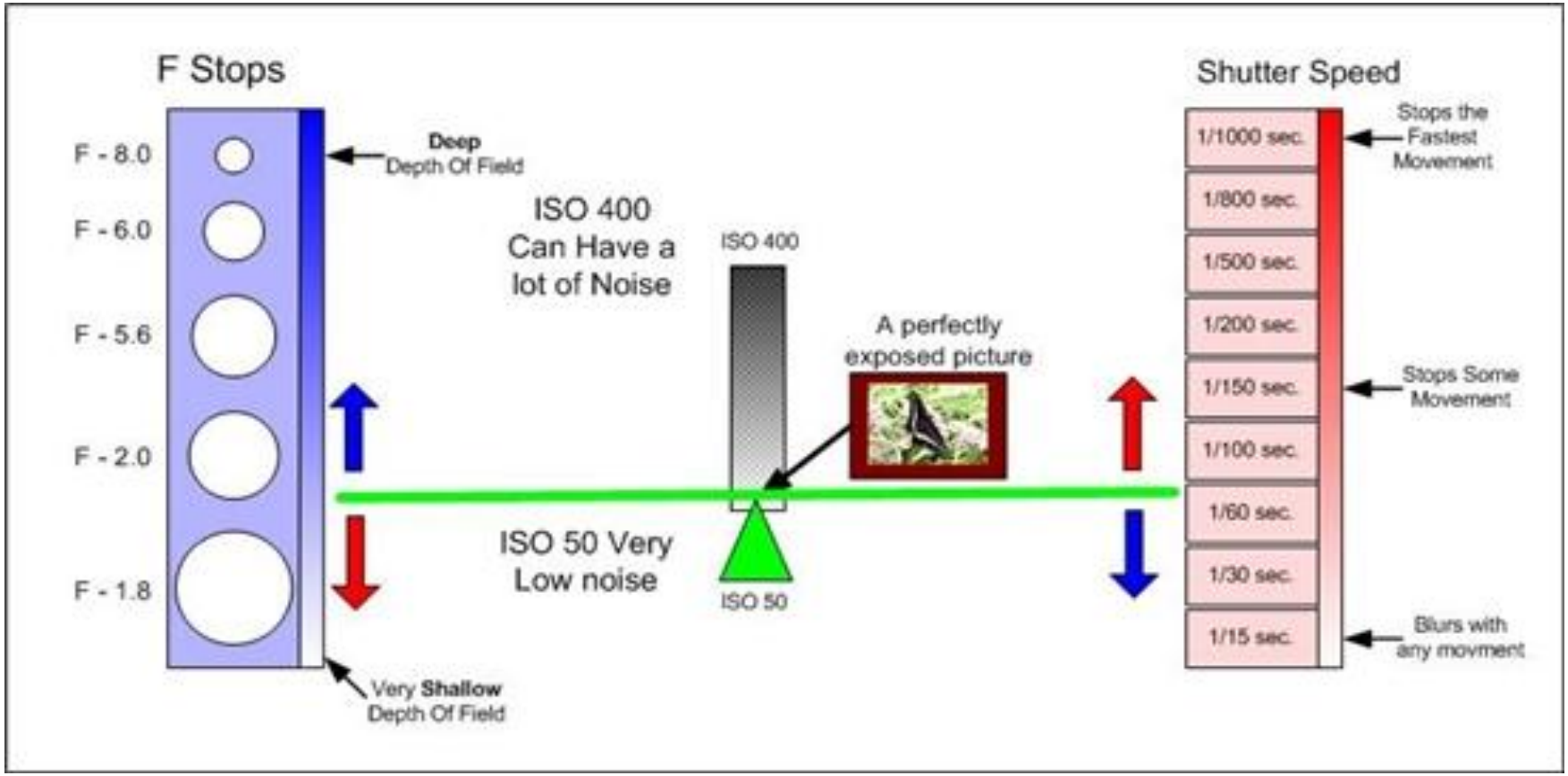
III. TYPE LENS FOR CAMERA

$$f = h \times \frac{D}{H}$$

1/4" Sensor: h=3.6 mm
1/3" Sensor: h=4.8 mm
1/2" Sensor: h=6.4 mm
f = Focal length



IV. HOW TO USE CAMERA ?



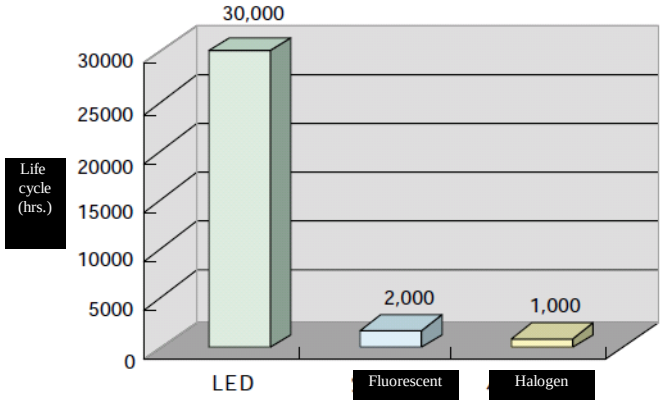
V. HOW TO SELECT PC?

	PC 1	PC 2	PC 3
Canopus sequence	Pentium 2.6GHz DDRAM III : 4 GB Windown7: 32 bit	Core i5 3.5Ghz DDRAM III: 4GB Windown7: 32 bit	Core i7 3.4 GHz DDRAM III: 16GB Windown7: 64 bit
	Win 32 bit	Win 32 bit	Win 64 bit
Datum	62	47	31
Trimming	78	78	31
Gen1	608	500	250
Gen2	2075	1716	1154
Gen3	608	499	265
Gen4	218	188	109
Gen5	296	250	125
Gen6	62	47	32
Total processing	4007	3325	1997
Capture, save picture.....	3193	2575	1503
Total Cycle time(ms)	**7200**	**5900**	**3500**

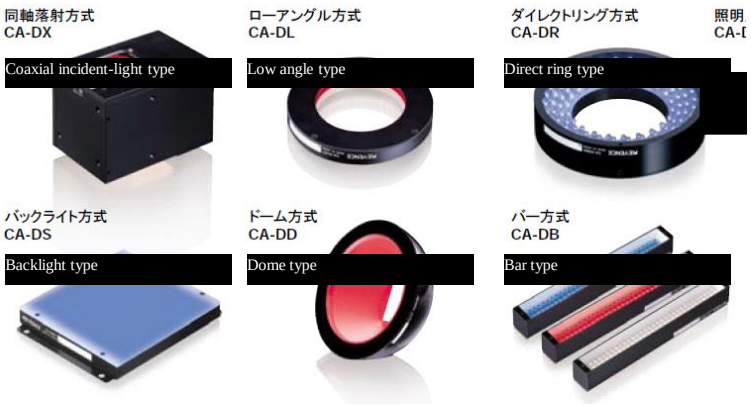
VI. TYPICAL OF LIGHT

- ✯ LED: A variety of illumination shape, size and color
  Good switching characteristic
- ✯ Fluorescent light: Expandable (wide range illumination), relatively reasonable, using a high frequency type (10 kHz or higher)
- ✯ Halogen: High-intensity, light guiding through fiber, glow lighting
- ✯ Metal halide: More similar to sunlight than halogen
  Relatively expensive though the power consumption is small.
- ✯ Xenon: Higher-intensity than halogen, used as strobe, relatively expensive

<Life cycle by light source>



LED type



Fluorescent light type

Halogen type

VII. TYPICAL USAGES OF IMAGE SENSOR

① Determine how to apply light (specula/diffusely-reflected/transmitted light).

- Check the characteristics of detection target (such as scratch, shape, or presence of target).
- Based on whether the surface is plane or curved or whether it is irregular.

② Determine the lighting method and shape.

- Based on the 3D and installation conditions of work piece.

- Is the work piece ring, low angle, coaxial or dome?

③ Determine the lighting color (wavelength).

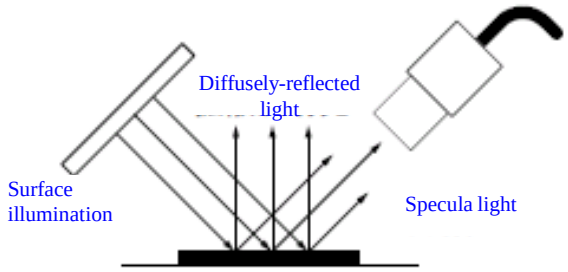
- Based on the material and color of work piece and background.

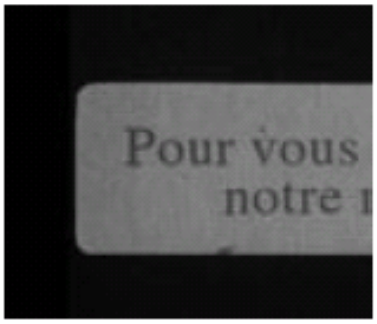
- Are they blue, red or white?

VIII. LIGHTING SYSTEM

Basics of Illumination Method

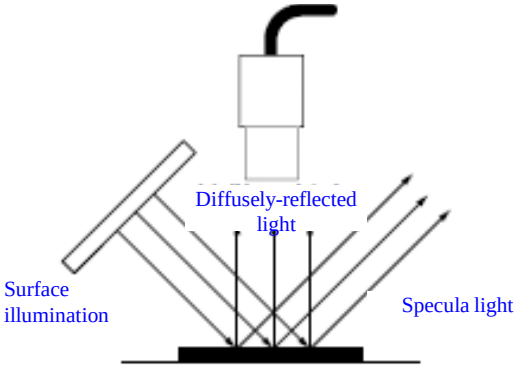
(1) Specula light - Highlights shiny parts.





Shiny parts are bright.

(2) Diffusely-reflected light - Not subject to shine.

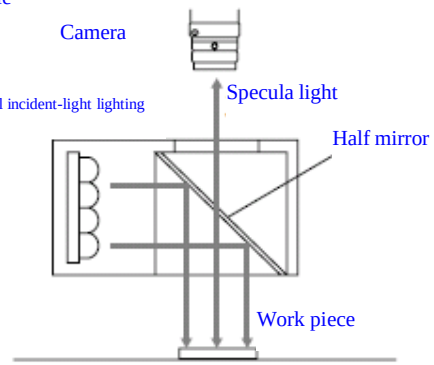


Shiny parts are dark.

VIII. LIGHTING SYSTEM

Specular: Coaxial Incident-Light Lighting System

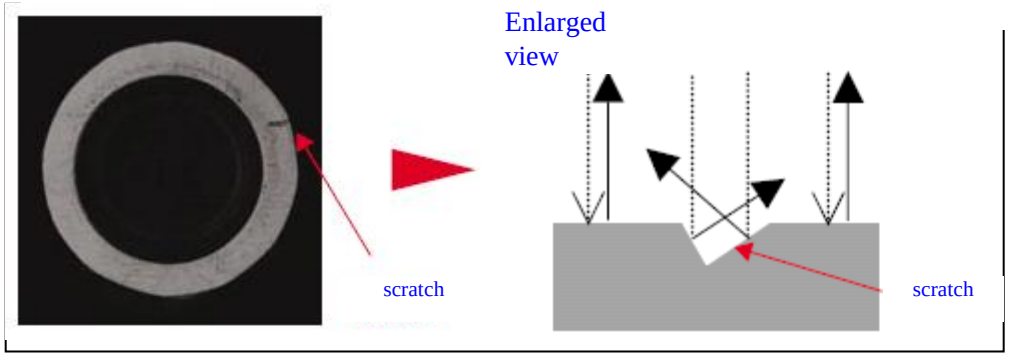
Installation example



The half mirror illuminates even light from the LED to the camera along the same axis as the camera axis.

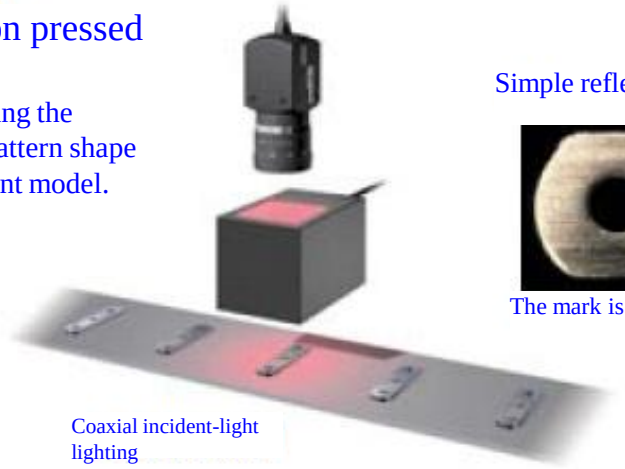
Structure

Have the surface-emitted diffusion light on the half mirror and illuminate light along the same axis as the camera axis.
Effective in emphasizing changes due to irregularity or parallelism.



Detection of engraved mark on pressed parts

Recognize the engraved mark indicating the product number or specifications as pattern shape and detect a missing mark or a different model.



Simple reflected light

Coaxial incident-light illumination

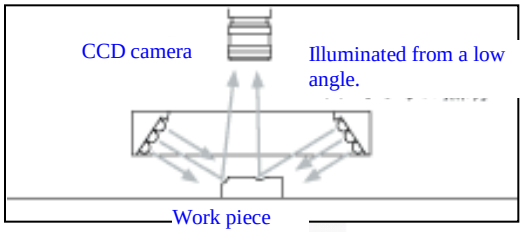
The mark is unclear.

The edge of mark is emphasized.

VIII. LIGHTING SYSTEM

Diffusely-Reflected: Low Angle (Ring) Illumination System

Installation example



Structure

Illuminate the surface and edge of a work piece from a low angle. Irregularities on the edge and surface are difficult to recognize when directly illuminated from above because light is diffused. Illuminating such an irregularity from an angle enables you to shoot the contrast of shade.

Detection of crack of rubber seal

It is difficult to find cracks along the perimeter, surface scratches, and uneven thickness generated during shape forming even by visual inspection because they have the same color, and therefore, less contrast. This system enables you to evaluate such defects.

Simple reflected light

The crack along the perimeter cannot be recognized.

Low angle lighting

The crack on the edge is highlighted in white.

VIII. LIGHTING SYSTEM

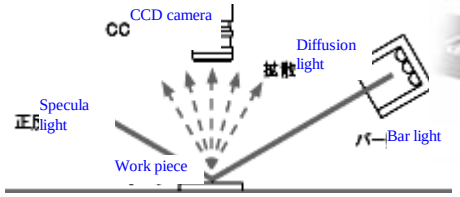
Diffusely-reflected: Low Angle (Bar)

Structure

Can evenly illuminate shiny surfaces.
Maximizes the contrast ratio of specula - reflected surface and diffusely-reflected surface by illuminating light from the angle appropriate to the detection target.

Detection of faulty coat on terminal

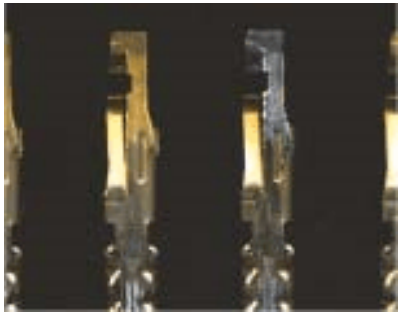
Detect faulty coat at the tip of terminal. Color processing distinguishes the silver color of bare metal and the gold color of coated part, which are difficult to distinguish in monochrome.



Simple reflected light

Color difference is small and lighting is not even due to shine.

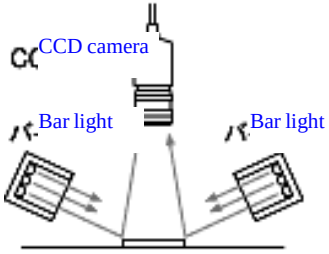
Bar lighting

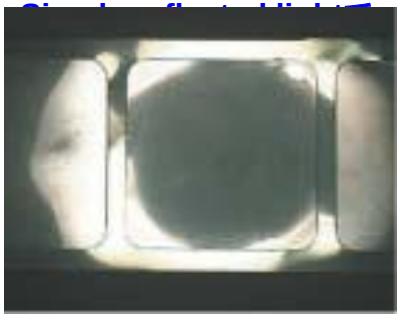


The difference between gold and silver colors is visible and unevenness due to shine is reduced.

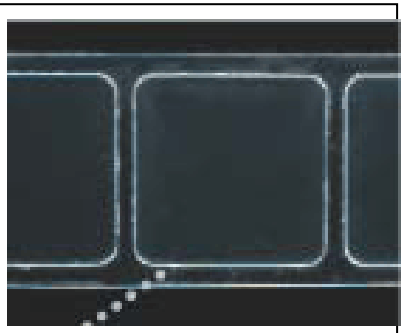
Transparent sheet width inspection

Inspect the width of thin transparent glass or resin sheet.





Color difference is small and lighting is not even due to shine.



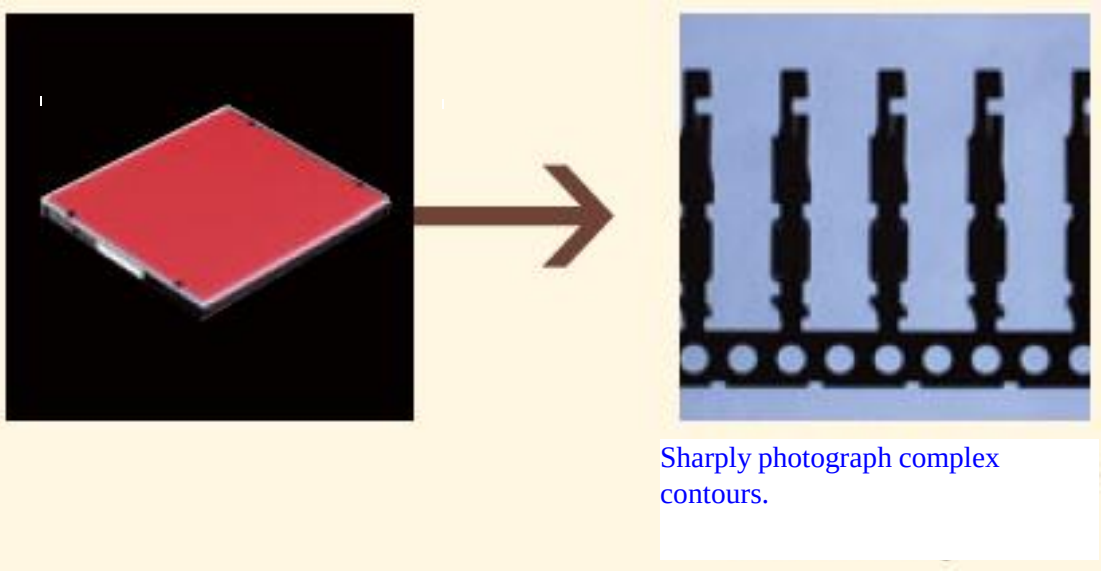
The difference between gold and silver colors is visible and unevenness due to shine is reduced.

VIII. LIGHTING SYSTEM

Transmitted: Backlight Illumination System

Structure

Illuminate the work piece from backward with surface lighting to photograph the silhouette of work piece.
The backlight illumination system enables stable inspection when measuring the width and other dimensions.

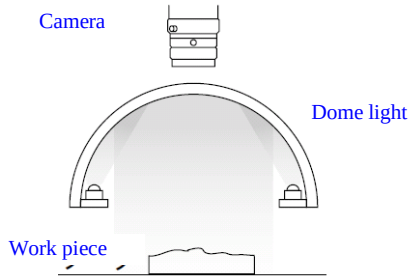


Sharply photograph complex contours.

VIII. LIGHTING SYSTEM

Dome (Shadowless) Illumination System

Installation example



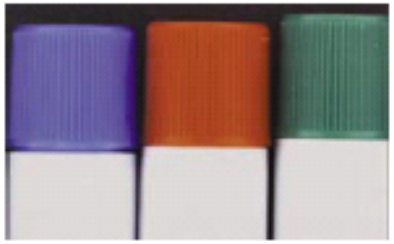
Indirect light within the dome evenly illuminates a curved work piece.

Structure

Have light diffusely-reflected on the inner wall of dome to evenly illuminate the work piece from all directions.
The shadow less effect is more effective when the system is used closer to the work piece.

Normal light

Dome light



Detection of printing on the aluminum package

Evaluate the printing on the aluminum package, which is difficult to detect due to shade of irregularity and film halation, through a transparent film.

Dome light

Simple reflected light

Printing is invisible due to irregular reflection.

Dome light

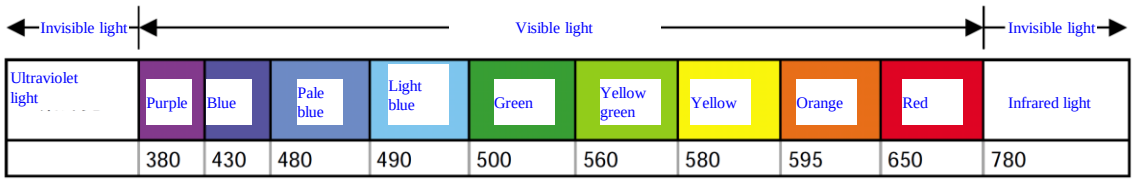
The shades of background disappear and only the printing is displayed.

VIII. LIGHTING SYSTEM

Shooting Technique (Wavelength)

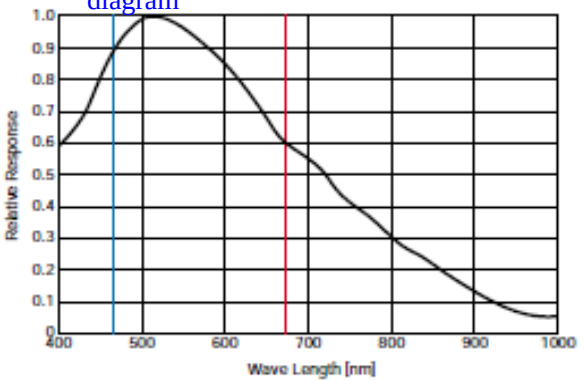
Relationship between the wavelength and the CCD sensitivity

Relationship between colors and wavelengths



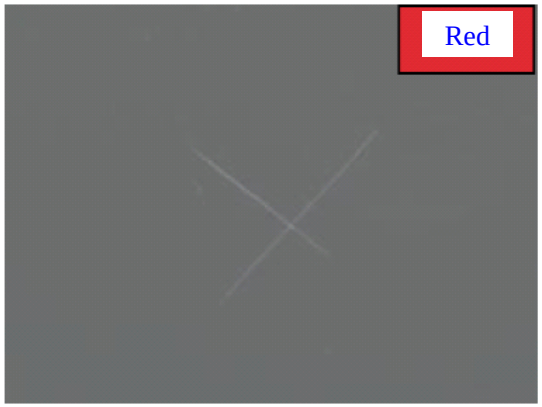
Best sensitivity for human eyes = CCD sensitivity characteristic (around 500 nm)

CCD spectral sensitivity characteristic diagram

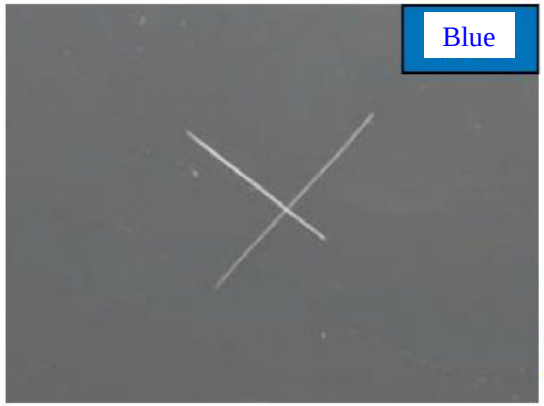


Blue: 460 nm/spectral sensitivity of about 90%
Red: 660 nm/spectral sensitivity of about 60%
Blue is brighter than red by 1.5 time.

Scattering rate and transmittance



Scratch level 86



Scratch level 725

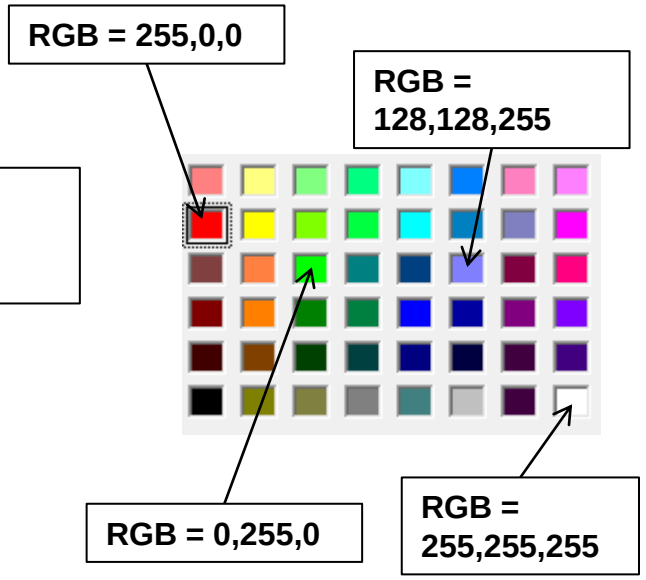
Blue with a shorter wavelength has a high scattering rate while red with a longer wavelength is difficult to scatter and has a higher transmittance.

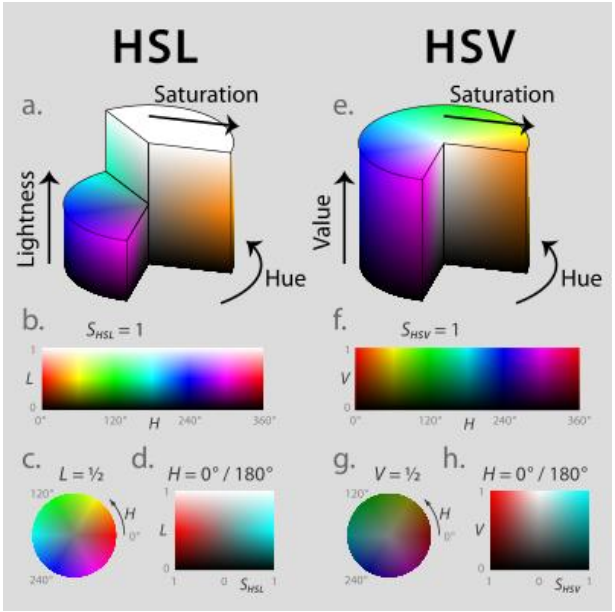
③ SOFTWARE TRAINING

I. COLOR KNOWLEDGE

A color of pixels can separate to:

- RGB value: Red, Green, Blue
- HSL value: Hue, Saturation, Value
- HSL value: Hue, Saturation, Luminous (lightness)





Binary:

Mô tả: Dùng để nhị phân, biến ảnh màu thành đen trắng

3 Thông số: Color (0,1,2,3), Threshold (0-255), Reverse

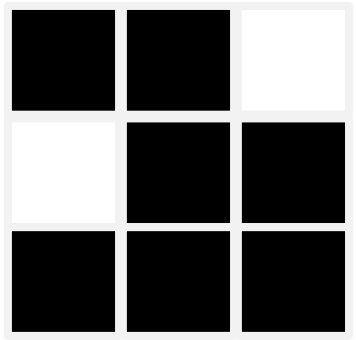
Nguyên tắc:

Giả sửcolor = 1-Red, Threshold = 110, reverse = 0

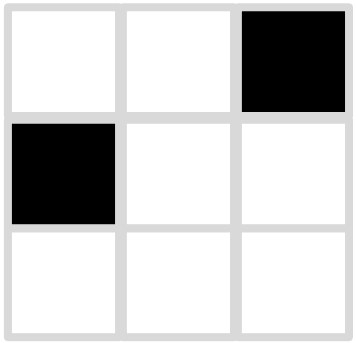
Đây là 1 ảnh có giá trị R trong RGB như sau:

70	75	120
200	20	20
100	25	30

B3: Tất cả những pixel có giá trị R < 110 sẽ biến thành màu đen và ngược lại.



Nếu reverse = 1 thì ngược lai



Chương trình sẽ thực hiện với các ô 3x3 liên tiếp, các ô 3x3 có thể chờm lên nhau.

Erosion(Chỉ dùng cho ảnh đen trắng):

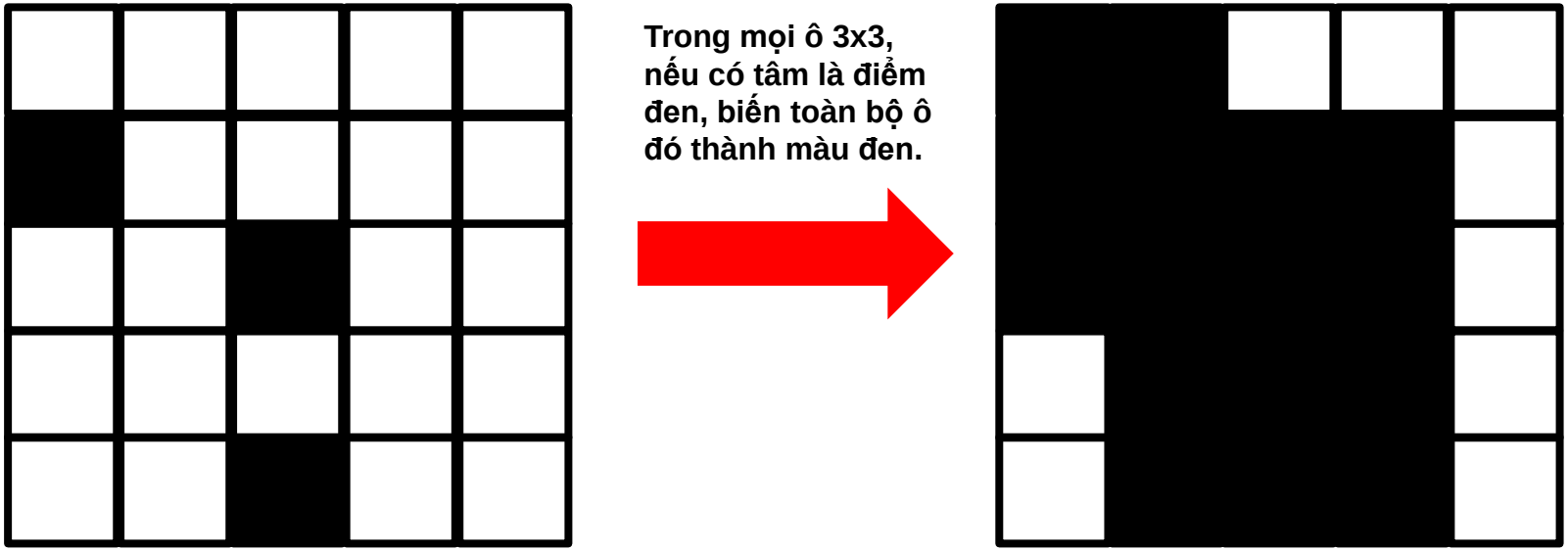
Mô tả: Dùng để loại bỏ nhiễu trắng.

2 Thông số: Windowareatype (0,1,2,3~3x3,5x5,9x9,15x15), Repeat times:

Nguyên tắc:

Giả sử Windowareatype = 1(3x3), Repeat times = 1

Đây là 1 ảnh đen trắng như sau:



Dilation(Chỉ dùng cho ảnh đen trắng):

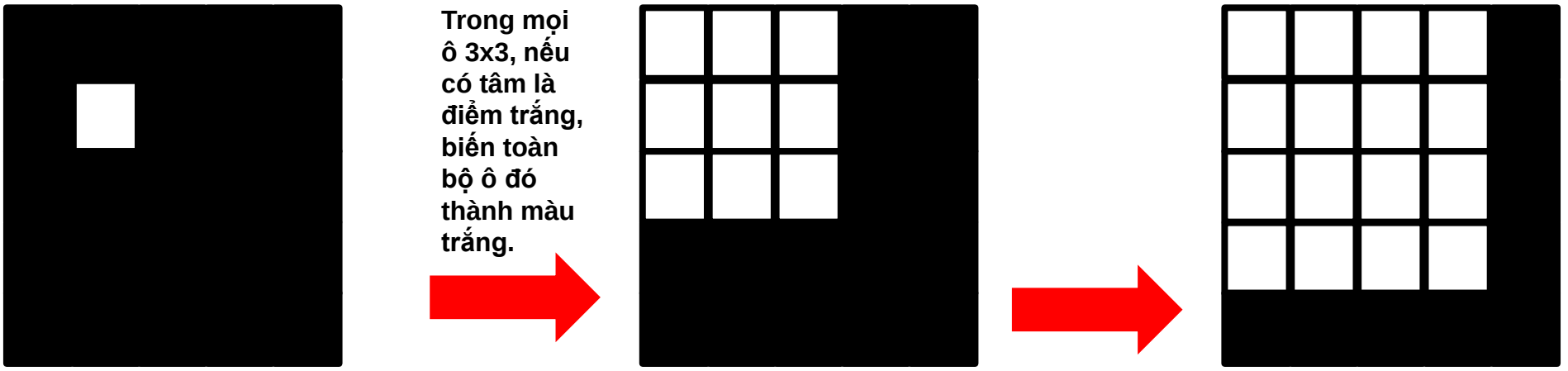
Mô tả: Dùng để loại bỏ nhiễu đen.

2 Thông số: Windowareatype (0,1,2,3~3x3,5x5,9x9,15x15), Repeat times:

Nguyên tắc:

Giả sử Windowareatype = 1(3x3), Repeat times = 2

Đây là 1 ảnh đen trắng như sau:



Time 1 Time 2

Median:

Mô tả: Dùng để khử nhiễu

3 Thông số: Window area type (0,1,2,3), Color (0,1,2,3), times

Nguyên tắc:

Giả sử: window area type = 1 (window = 3x3), color = 1-Red, times = 1(1 lần)

Đây là 1 hình vuông 3x3 trong ảnh có giá trị R trong RGB như sau:

70	75	120
200	20	20
100	25	30

B1: Sắp xếp các giá trị R(G,B) theo giá trị tăng dần

20	20	25	30	70	75	100	120	200

B2: Chọn giá trị nằm ở vị trí giữa

B3: Lấy giá trị giữa đó thay vào ô nằm chính giữa.

70	75	120
200	70	20
100	25	30

Chương trình sẽ thực hiện với các ô 3x3 liên tiếp, các ô 3x3 có thể chờm lên nhau.

Mean(average):

Mô tả: Dùng để khử nhiễu

3 Thông số: Window area type (0,1,2,3), Color (0,1,2,3), times

Nguyên tắc:

Giả sử: window area type = 1 (window = 3x3), color = 1-Red, times = 1(1 lần)

Đây là 1 hình vuông 3x3 trong ảnh có giá trị R trong RGB như sau:

70	75	120
200	20	20
100	25	30

B1: Tính trung bình giá trị độ sáng trong ô vuông

B2: Lấy giá trị đó thay vào ô nằm chính giữa.

70	75	120
200	73	20
100	25	30

(20+20+25+30+70+75+100+120+200)/9 = 73.333 = 73

Chương trình sẽ thực hiện với các ô 3x3 liên tiếp, các ô 3x3 có thể chờm lên nhau.

Outline:

Mô tả: Dùng để tìm đường biên

3 Thông số: Color (0,1,2,3), Threshold, Type

Nguyên tắc:

Giả sử: color = 1-Red, threshold = 110

70	75	120	120	120
200	20	20	200	200
100	25	30	210	210
100	25	30	210	30
100	25	30	30	30

Type = 0

Tất cả các pixel có giá trị R >= 110 và ở bên cạnh nó có một pixel có giá trị R<110 sẽ trở thành R = 255

70	75	255	255	120
255	20	20	255	200
100	25	30	255	255
100	25	30	255	30
100	25	30	30	30

Type = 1

Tất cả các pixel có giá trị R <= 110 và ở bên cạnh nó có một pixel có giá trị R>110 sẽ trở thành R = 255

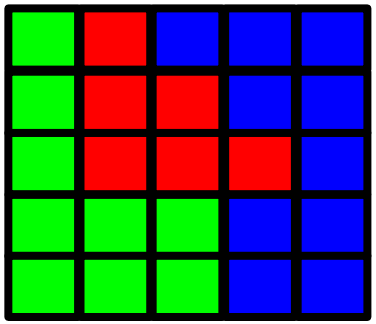
255	255	120	120	120
200	255	255	200	200
255	255	255	210	210
100	25	255	210	255
100	25	255	255	255

Extract Color:

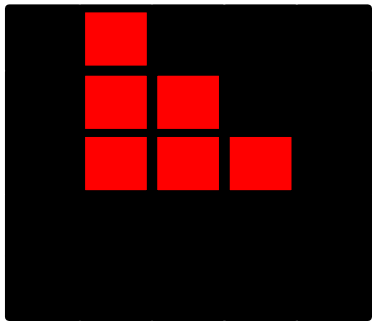
Mô tả: Dùng để chọn lấy những giá trị màu muốn dùng

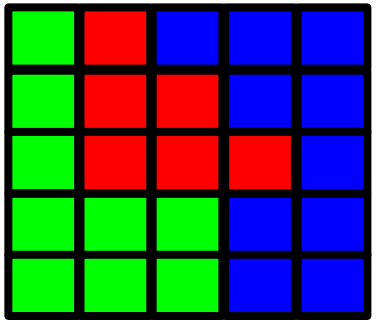
7 thông số: Low R, High R, Low G, High G, Low B, High B, logic

Nguyên tắc: Chọn các điểm ảnh có giá trị R nằm trong khoảng Low R –High R
G nằm trong khoảng Low G – High G
B nằm trong khoảng Low B – High B
Logic = 0 là AND
Logic = 1 là OR

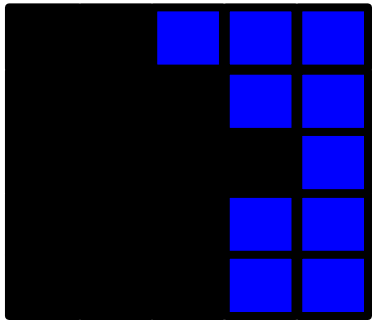


Low R = 100
High R = 255
Low G = 0
High G = 80
Low B = 0
High B = 255
Logic = 0





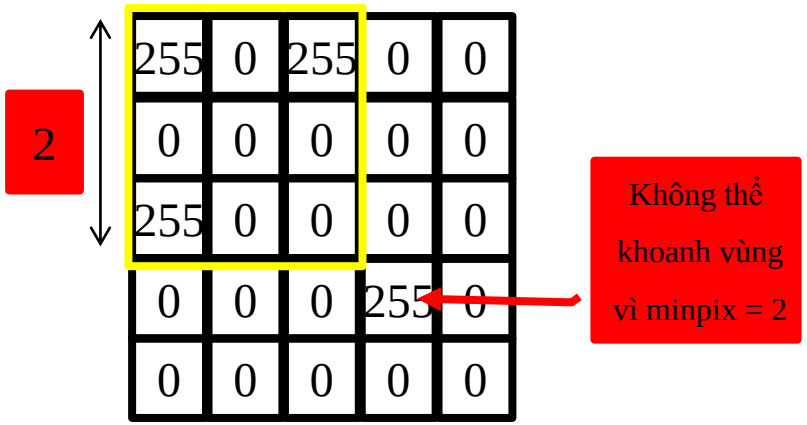
Low R = 0
High R = 1
Low G = 0
High G = 255
Low B = 200
High B = 255
Logic = 0



Label:

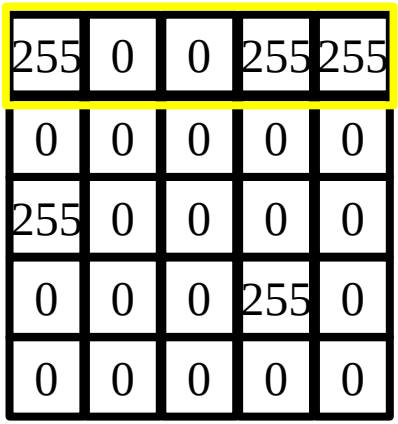
Mô tả: Dùng để khoanh vùng một cụm màu có giá trị R hoặc G hoặc B = 255. Vùng khoanh chỉ có thể là hình chữ nhật hoặc hình vuông

* 2 thông số: Gap, Minpixel



•Gap: Khoảng cách tối đa có thể bỏ qua (ví dụ = 2)
•Min pixel: Số pixel tối thiểu của vùng. (ví dụ = 2)

** 3 thông số: GapX, Khoảng cách tối đa theo chiều x có thể bỏ qua (ví dụ = 3)
GapY, Khoảng cách tối đa theo chiều y có thể bỏ qua (ví dụ = 1)
Minpixel: Số pixel tối thiểu của vùng. (ví dụ = 2)



Particle detect:

Mô tả: Dùng để tìm những điểm bất thường so với xung quanh

3 thông số: Window area, color, threshold

Nguyên tắc:
Giả sử window area = 3 (3x3), color = 1, threshold =

Với một ô 3x3 có giá trị R như sau:

100	95	100
105	100	110
90	100	100

Giá trị trung bình là Average =100

Threshold = 14

100	95	100
105	100	110
90	100	100

R < average – threshold/2

R > average + threshold/2

Threshold = 6

100	95	100
105	100	110
90	100	100

(Average – threshold/2) < R < (Average + threshold/2)

Chương trình sẽ thực hiện với các ô liên tiếp, các ô không thể chờm lên nhau.

Level adjust:

Mô tả: Dùng để tăng độ tương phản của ảnh

3 thông số: Color, Low threshold, high threshold

Nguyên tắc:
Giả sử Color = 1 (Red), Low threshold = 100, high threshold = 200

Tất cả những điểm có R < 100 và R>200 sẽ trở thành màu đen.
Giá trị R của những pixel có 100<R<200 sẽ được tính như sau:

R’ = (R-100)*255/(200-100).

JUDGEMENT FUNCTION

1. Counting Pixel

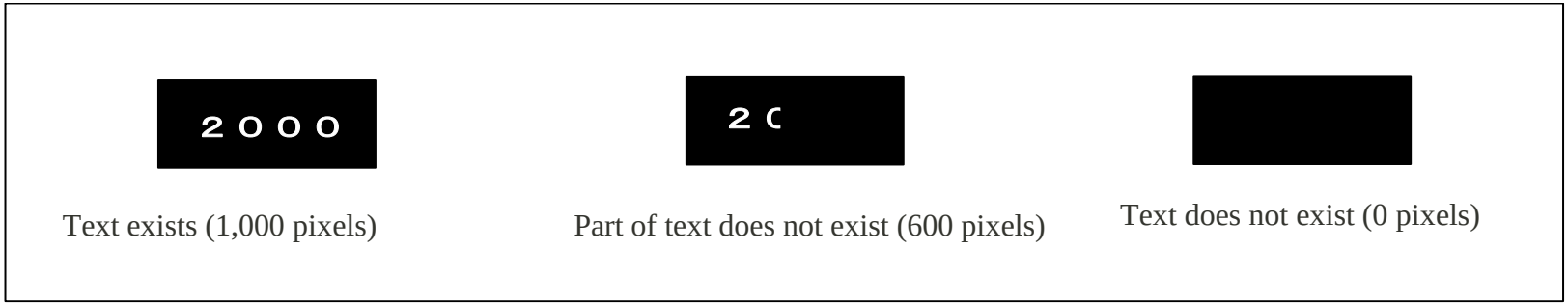
2. Counting Label

3. Pattern matching

4. Measurement height.

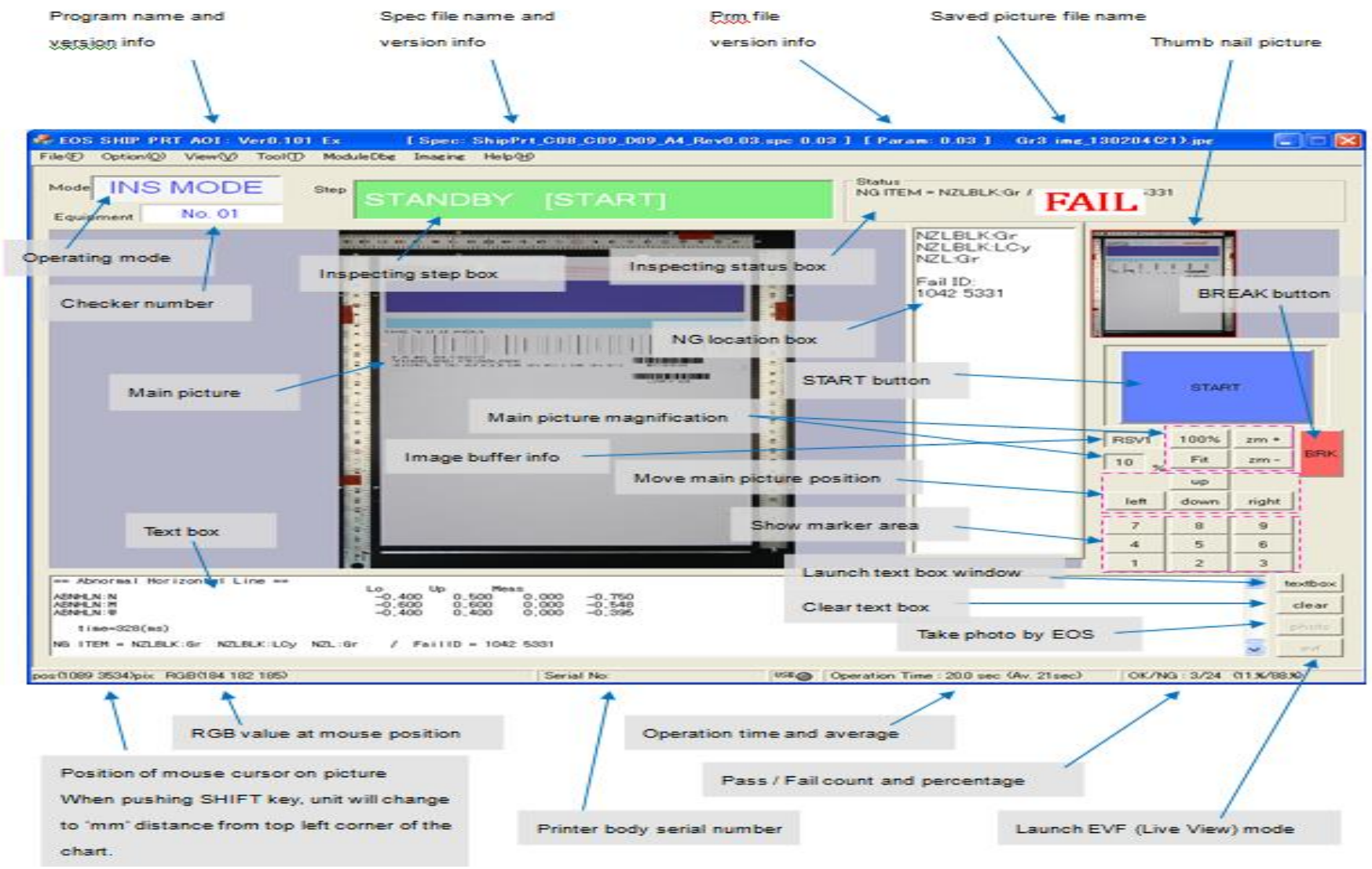
5. Measurement wide.

Example:

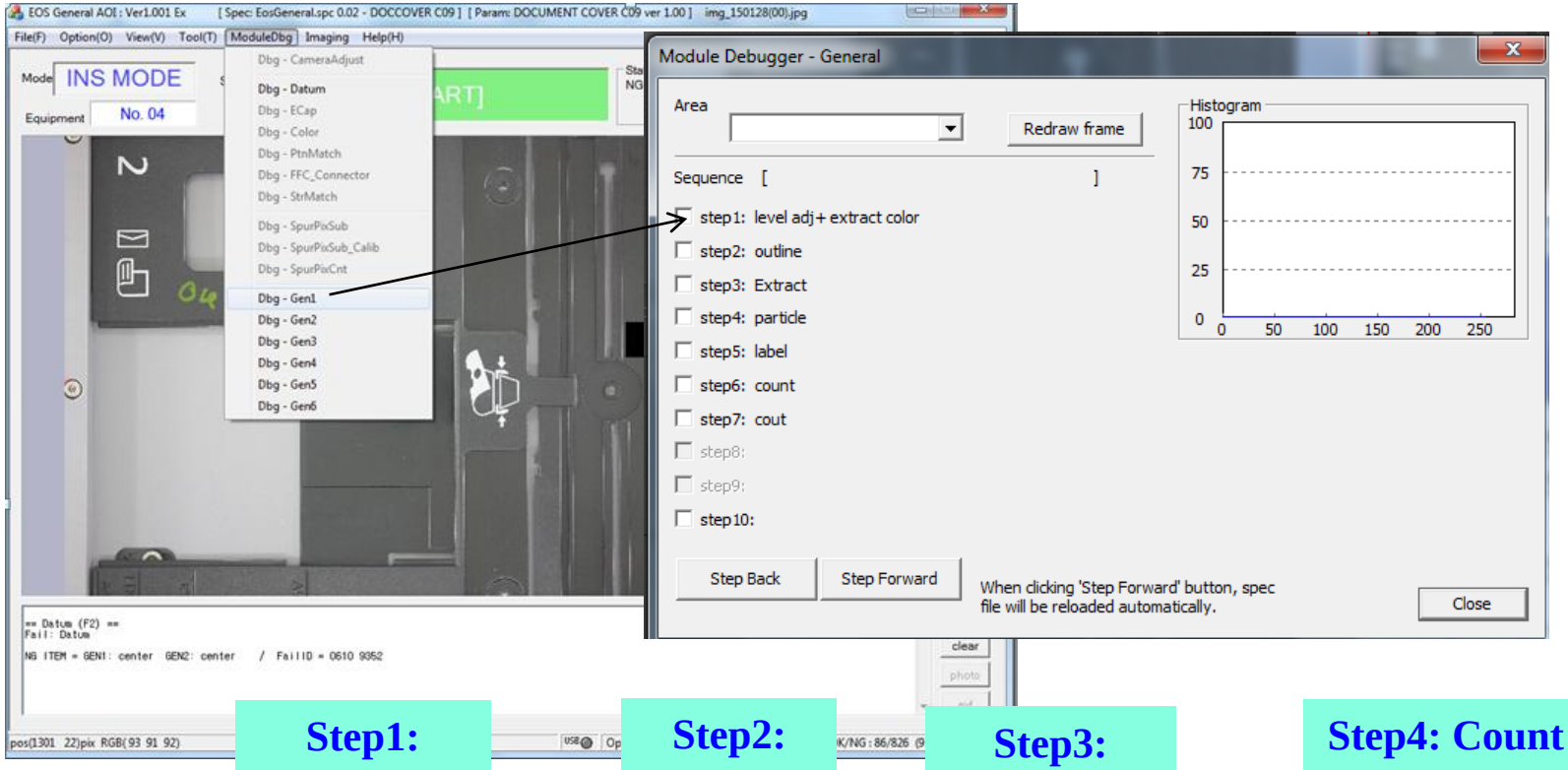


Tolerance: Set to 800 pixels

PROGRAM INTERFACE



SOFTWARE DEBUGING

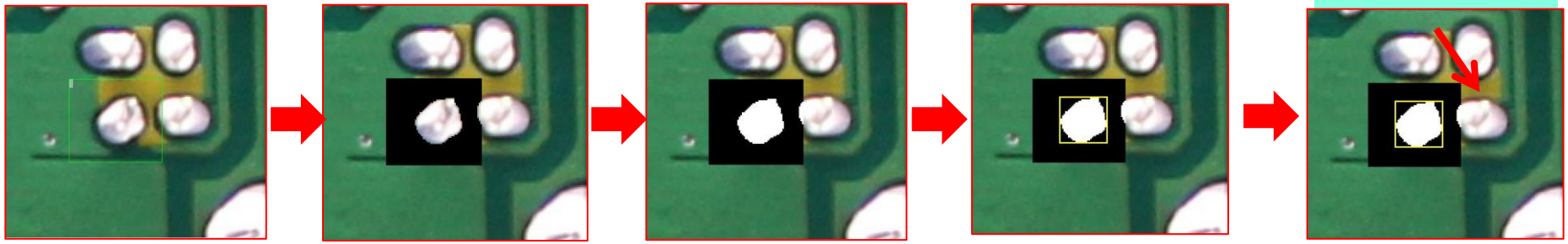


Step1: Extra color

Step2: Binary

Step3: Make label

Step4: Count pixels



PRM AND SPEC FILE SETTING

```
[GEN1]
titlle = "check black dot"

step1 = "level adj+ extract color"
ena1 = 1
prm10 = 150                                ;adjlvlow
prm11 = 230                                ;adjlvHi
prm12 = 255                                ;Red Hi - extract

step2 = "outline"
ena2 = 1
prm20 = 5                                  ;outline times (=1,2,3,4,5)
prm21 = 1                                  ;nth out ine

step3 = "Extract"
ena3 = 1
prm30 = 0                                  ;R low
prm31 = 254                                ;R Hi
prm32 = 0                                  ;G Lo
prm33 = 255                                ;G Hi
prm34 = 0                                  ;B Lo
prm35 = 255                                ;B Hi

step4 = "particle"
ena4 = 1
prm40 = 20                                 ;nWndAreaSize
prm41 = 20                                 ;nth
prm42 = 1                                  ;n color

step5 = "label"
ena5 = 1
prm50 = 5;4                                ;nBoundDist
prm51 = 40;30 ;min pixel = 30              ;nMinDots

step6 = "count"
ena6 = 1

step7 = "cout"
ena7 = 1
```

Default spec

```
[GEN1: center]
area_pix = 2095, 1139, 2919, 2602
ena1 = 0                                   ;
ena2 = 0                                   ;
prm41 = 30                                 ;nth parical
prm51 = 20;10                              ;nMinDots label
spec = 0,0
```

Individual spec

MEANING OF PRM FILE

Open program to see…

MEANING OF SPC FILE

Open program to see…

MEANING OF SCRIPT FILE

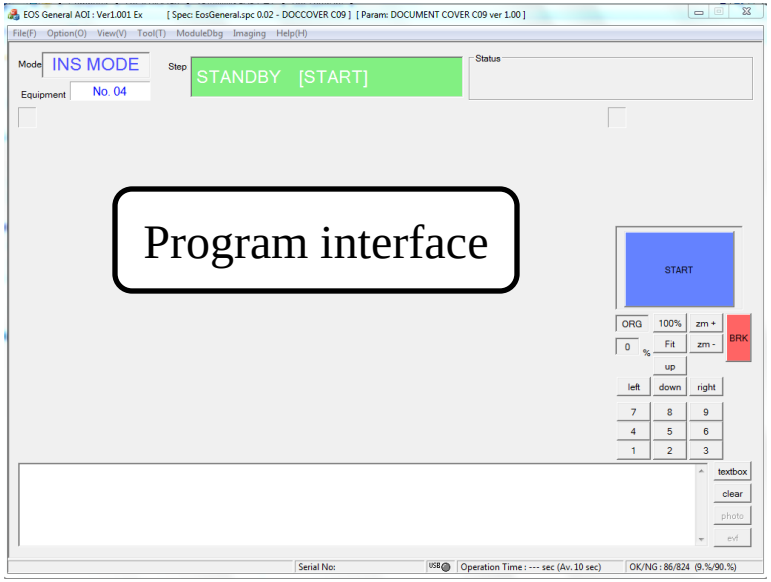
Open program to see…

Testing with actual samples

Using Mold program to detect:

1. Short mold

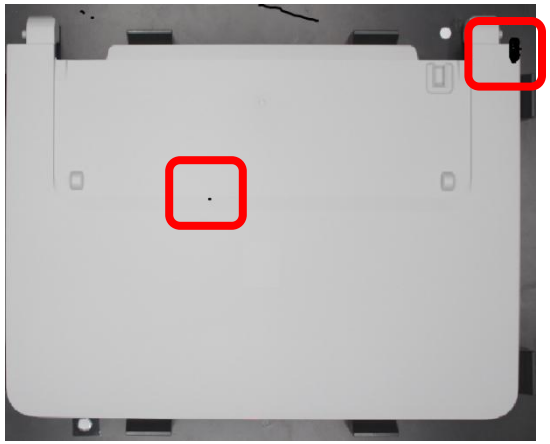
2. Black dot (abnormal point on the surface of part)



Program interface

OK SAMPLE

NG SAMPLE



THANKS YOU FOR YOUR LISTENSNING