PCB板缺陷覆判

光寶AOI_Team2_Group17

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Agenda
專題步驟

定義問題

整理資料

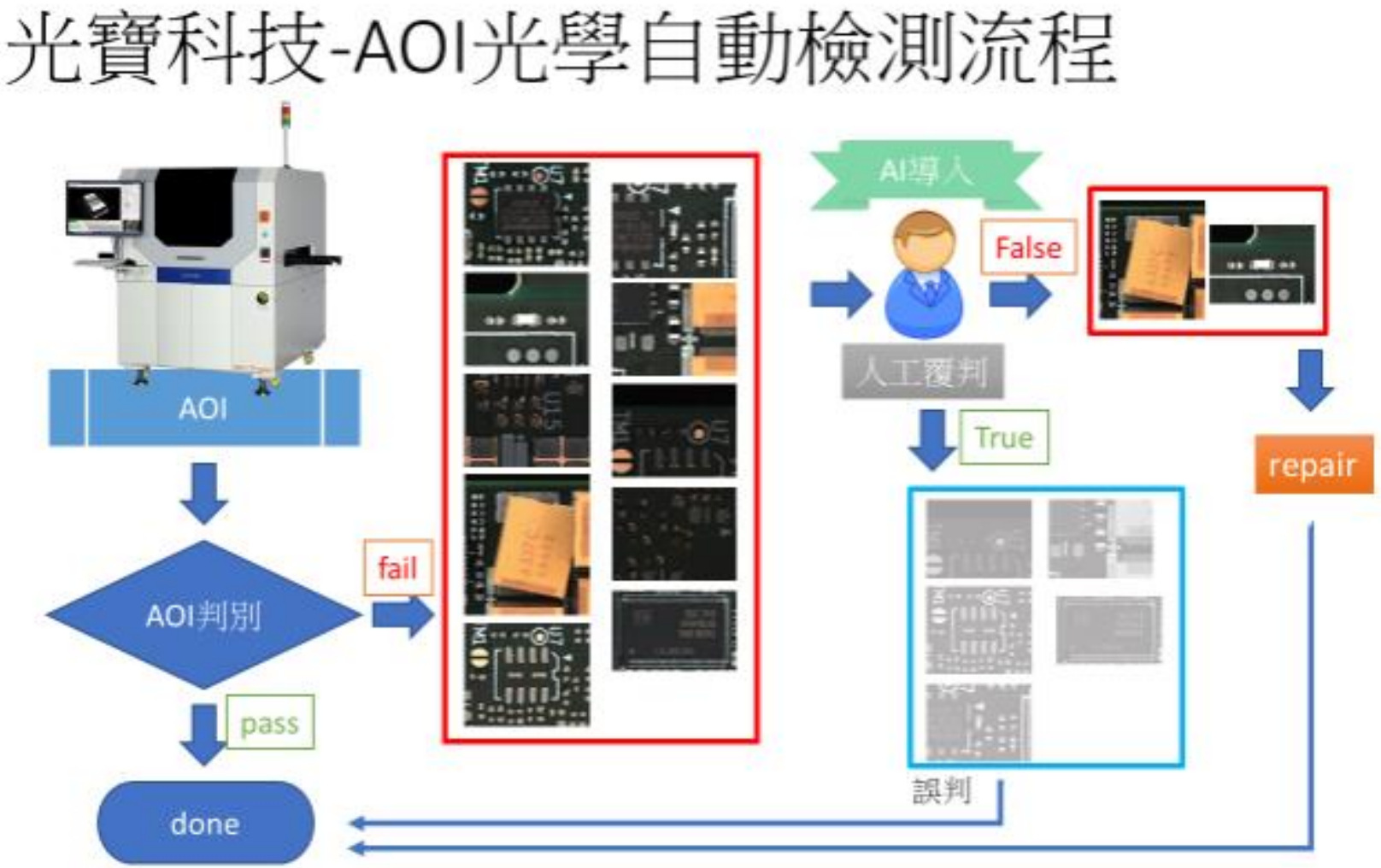
影像處理

訓練模型

定義問題

定義問題

AOI機台只有吐出NG圖片，PASS是不會儲存的，AI主要做覆判的功能，協助人員判斷



整理資料

AOI瑕疵檢測覆判:錯誤分類

0,pass

1,missing

2,MissAlignment

3,Tombstone_SideStanding

4,PartsReversed

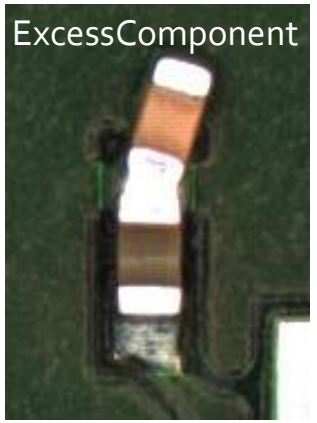
5,ExcessComponent

6,other_Damage

7,voidSolder_Short

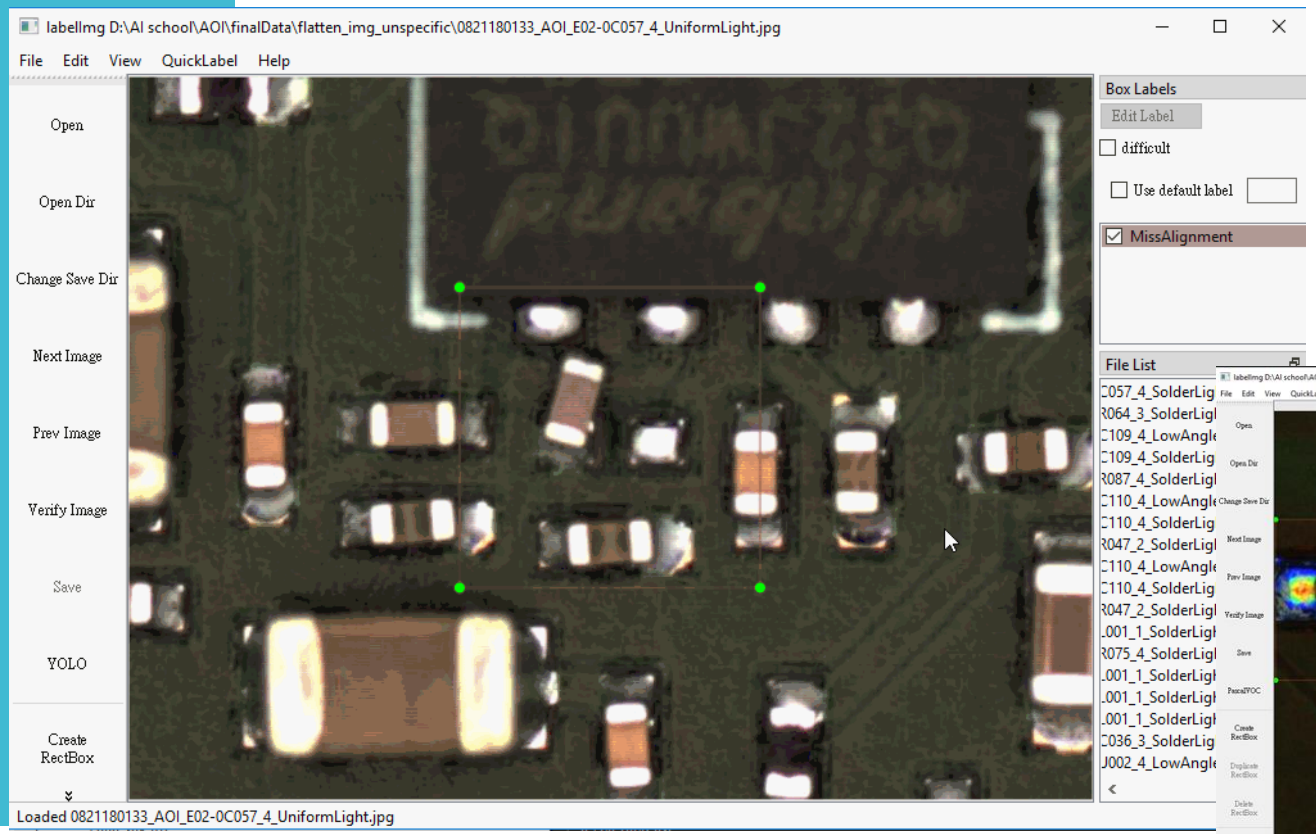
8,TextMissing

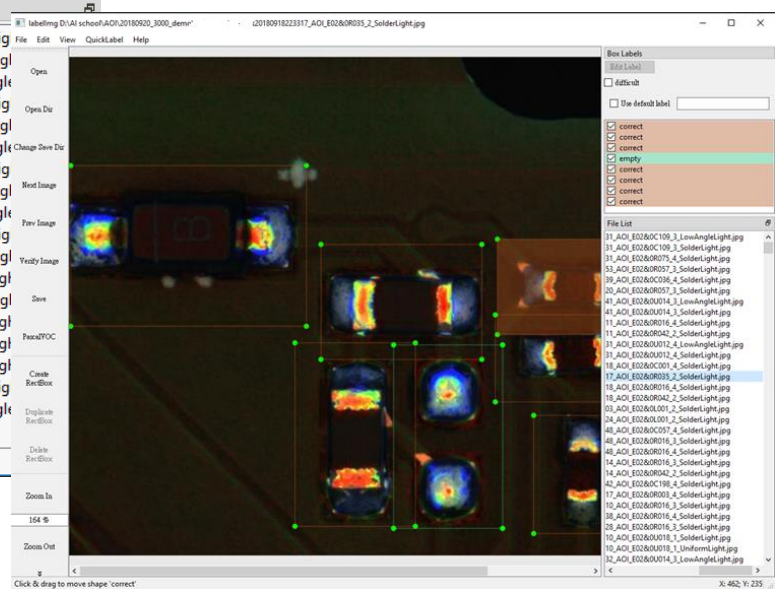
9,tag

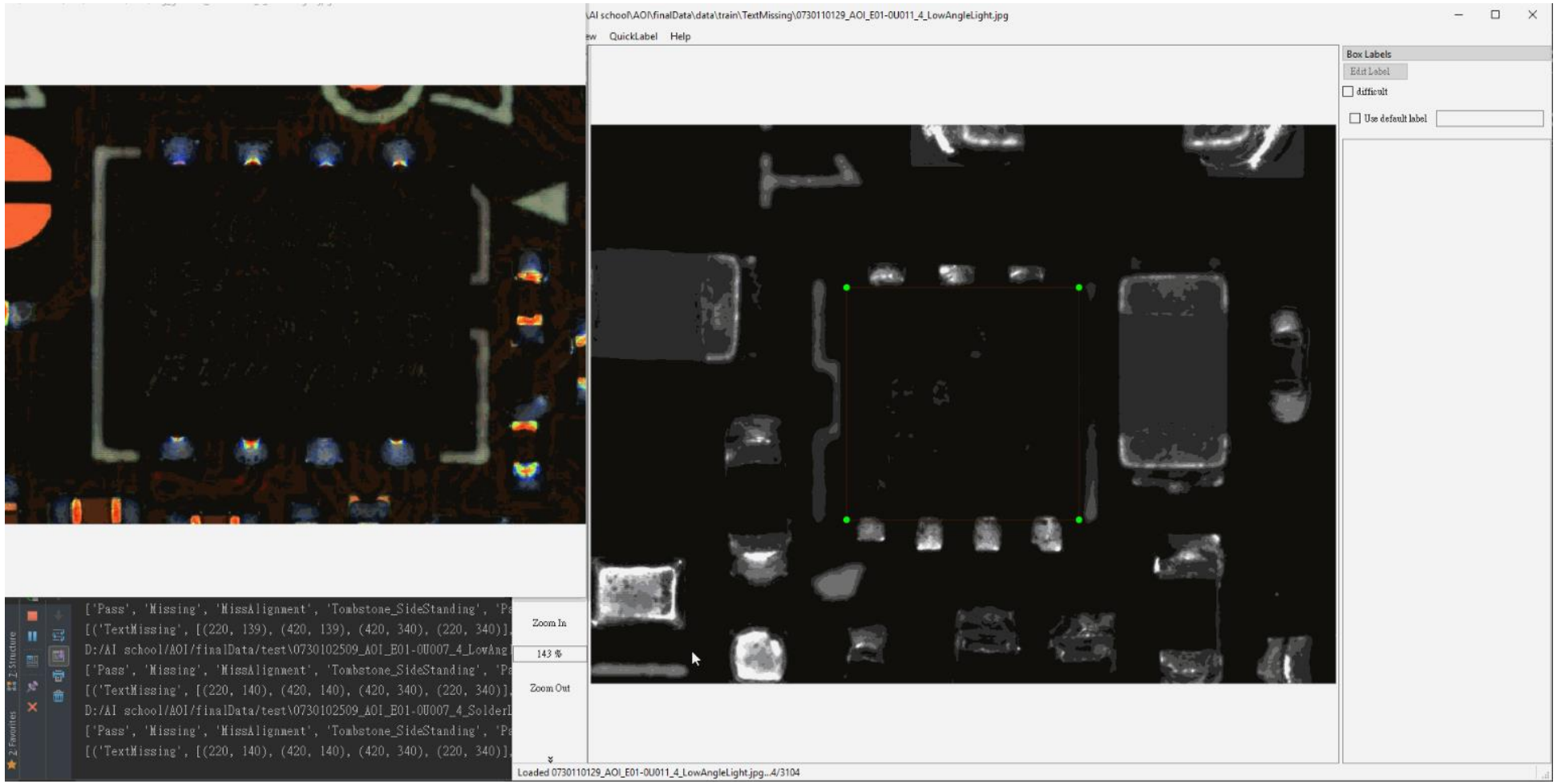


Labeling

先自行 label 35,000張image，並請專業人員覆判
Label tool: https://github.com/tzutalin/labelImg





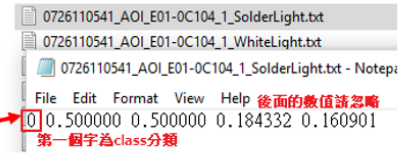


修改image label tool

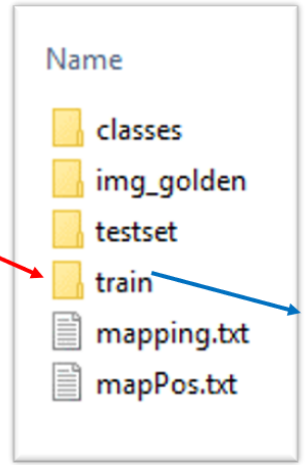
新增同步檢閱golden image功能

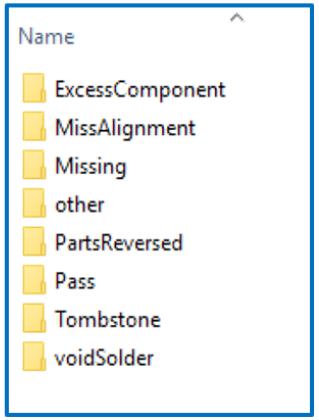
資料集說明

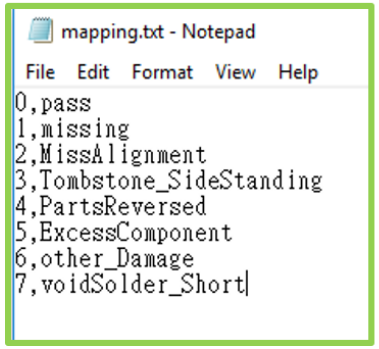
- Classes:每張圖片的class分類，請讀第一個字即可
- Img_golden:正確Demo圖片，可用來對照
- Testset:使用919開頭的圖片
- Train:資料夾名稱即為class
- Mapping.txt:class數字對說明
- mapPos.txt:每個位置的boundingBox四點座標



Dataset內容







Dataset improve

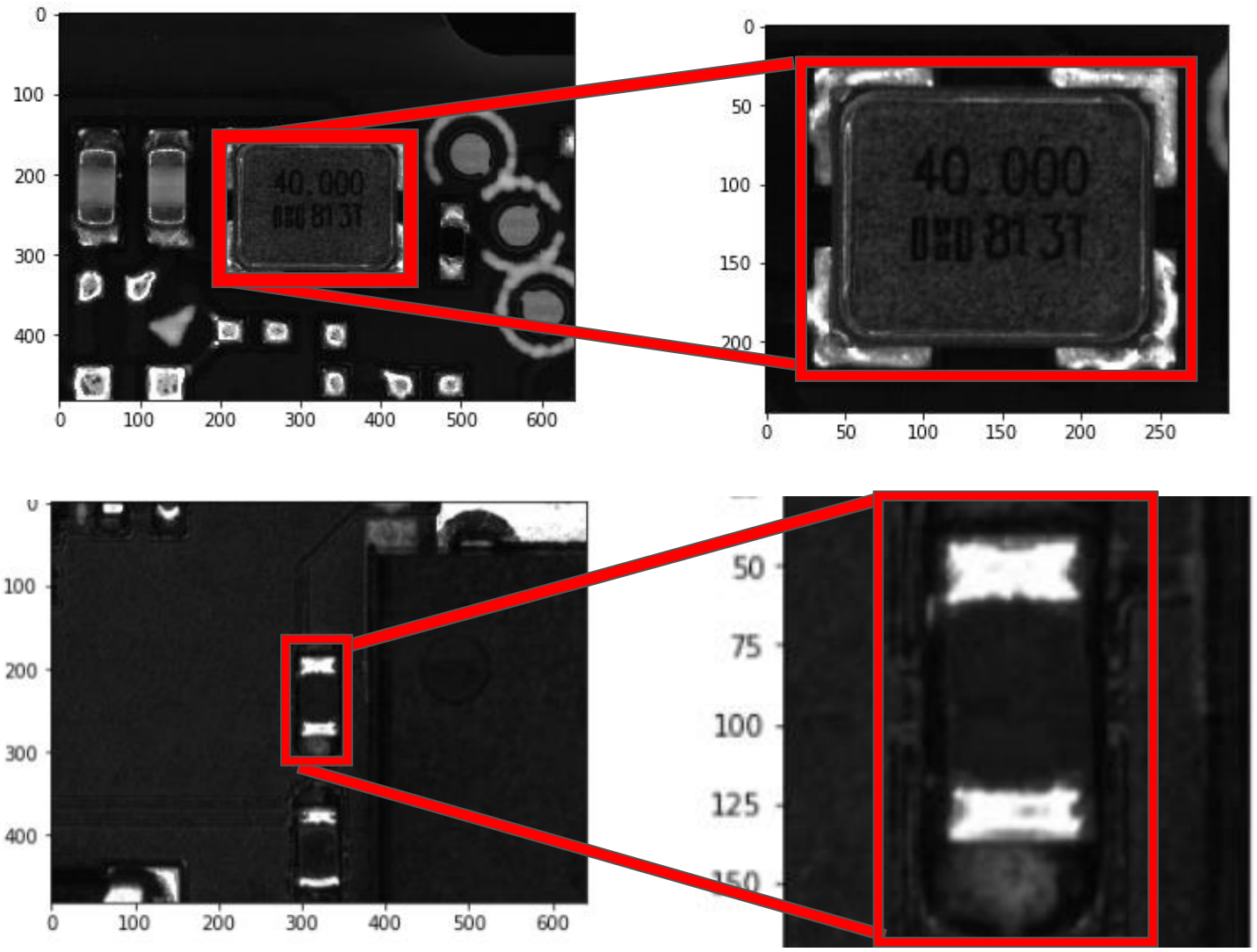
V1	1.釋出未label的約3萬五千筆影像檔 2.檔名去識別化，將model name改掉			
V2	1.釋出已label的所有image檔 2.依照class分類放資料夾 3.抽取一千多張image當作testset			
V3	將train資料夾內的class改成新的8類 2.將所有classes資料夾內所有txt檔，對錯誤代碼的編號重編，由14類改成8類 3.將testset資料夾內改為50張pass，50張error	2018/10/3	0:Pass:26971 times:1 1:Missing:5643 times:4 2:MissAlignment:136 times:198 3:Tombstone_SideStanding:74 times:364 4:PartsReversed:225 times:119 5:ExcessComponent:387 times:69 6:Other_Damage:1525 times:17 7:VoidSolder_Short:408 times:66	Pass:0 Missing:18 MissAlignment:11 Tombstone_SideStanding:2 PartsReversed:2 ExcessComponent:52 Other_Damage:12 VoidSolder_Short:3
V4	1.testset忘記放pass，改為100張pass、100張error 2018/10/6 V4-1 1.更新mapPos.txt，置放在zip外，請自行下載更新 2018/10/9 V4-2 1.增加component.csv，內容為元件位置，對應元件名稱，可以用來削減pass數量 說明: Designator元件位置 Part元件料號 Rotation旋轉角度	2018/10/4	0:Pass:26871 times:1 1:Missing:5643 times:4 2:MissAlignment:136 times:197 3:Tombstone_SideStanding:74 times:363 4:PartsReversed:225 times:119 5:ExcessComponent:387 times:69 6:Other_Damage:1525 times:17 7:VoidSolder_Short:408 times:65	Pass:100 Missing:18 MissAlignment:11 Tombstone_SideStanding:2 PartsReversed:2 ExcessComponent:52 Other_Damage:12 VoidSolder_Short:3
V5	1.因難以判斷黑色元件上的字缺陷，新增第8類，斷字TextMissing 0,Pass 1,Missing 2,MissAlignment 3,Tombstone_SideStanding 4,PartsReversed 5,ExcessComponent 6,Other_Damage 7,VoidSolder_Short 8,TextMissing 2.移除與gold_img不相符之樣本，可能原因為元件供應商不同所導致元件外觀差異太大 3.review所有label，發現錯誤重新分類	201810/19	0:Pass:17059 times:1 1:Missing:5170 times:3 2:MissAlignment:173 times:98 3:Tombstone_SideStanding:83 times:205 4:PartsReversed:230 times:74 5:ExcessComponent:393 times:43 6:Other_Damage:357 times:47 7:VoidSolder_Short:535 times:31 8:TextMissing:3092 times:5	Pass:100 Missing:18 MissAlignment:11 Tombstone_SideStanding:2 PartsReversed:2 ExcessComponent:52 Other_Damage:0 VoidSolder_Short:3 TextMissing:12
V6	1.因多標籤難以判斷，故新增第9類，標籤tag，目前共10類。 2.重作testset， 共893張 2018/10/24 V6-2 1.新增PCB板原貌以供參考 (BigMap_unspecific.jpg)	2018/10/23	0:Pass:16536 times:1 1:Missing:5068 times:3 2:MissAlignment:167 times:99 3:Tombstone_SideStanding:81 times:204 4:PartsReversed:224 times:73 5:ExcessComponent:362 times:45 6:Other_Damage:346 times:47 7:VoidSolder_Short:518 times:31 8:TextMissing:3006 times:5 9:tag:63 times:262	Pass:599 Missing:120 MissAlignment:12 Tombstone_SideStanding:4 PartsReversed:8 ExcessComponent:17 Other_Damage:11 VoidSolder_Short:20 TextMissing:100 tag:2

影像處理

Crop / rotate / pass_new / package

影像切割

使用mapPos.txt
準確率會上升



Augmentation

少量類別擴增與最大類別相似

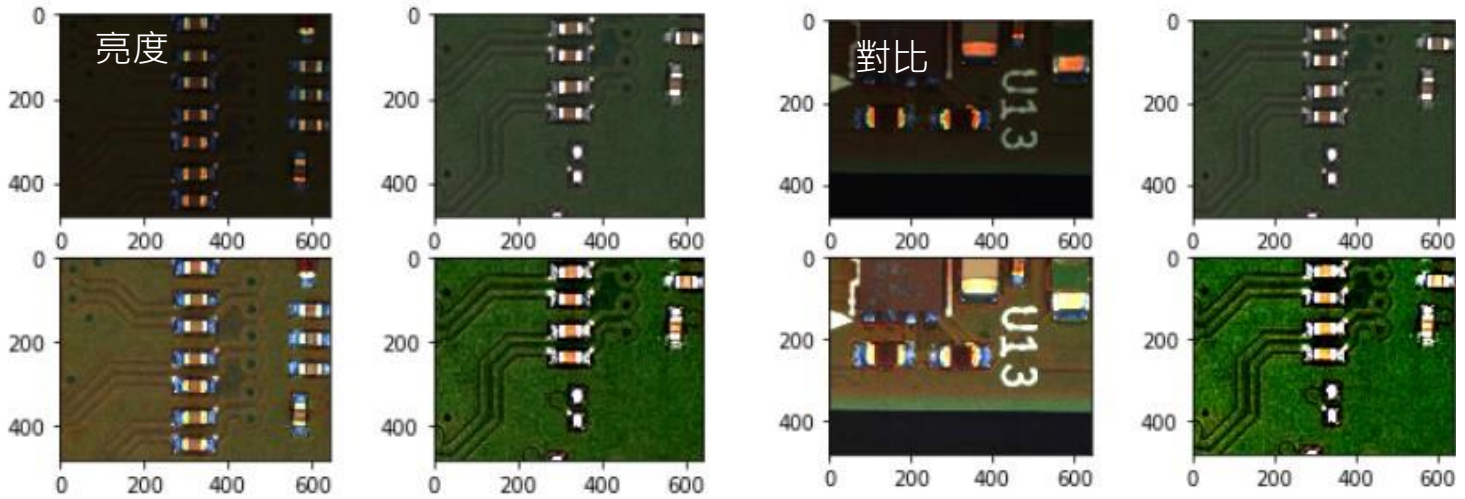
每個小類別都乘上一個倍數，與pass數量相當

些微轉角度

- 隨機+-3角度旋轉

亮度與對比調整

- 調整後讓錯誤特徵更清晰

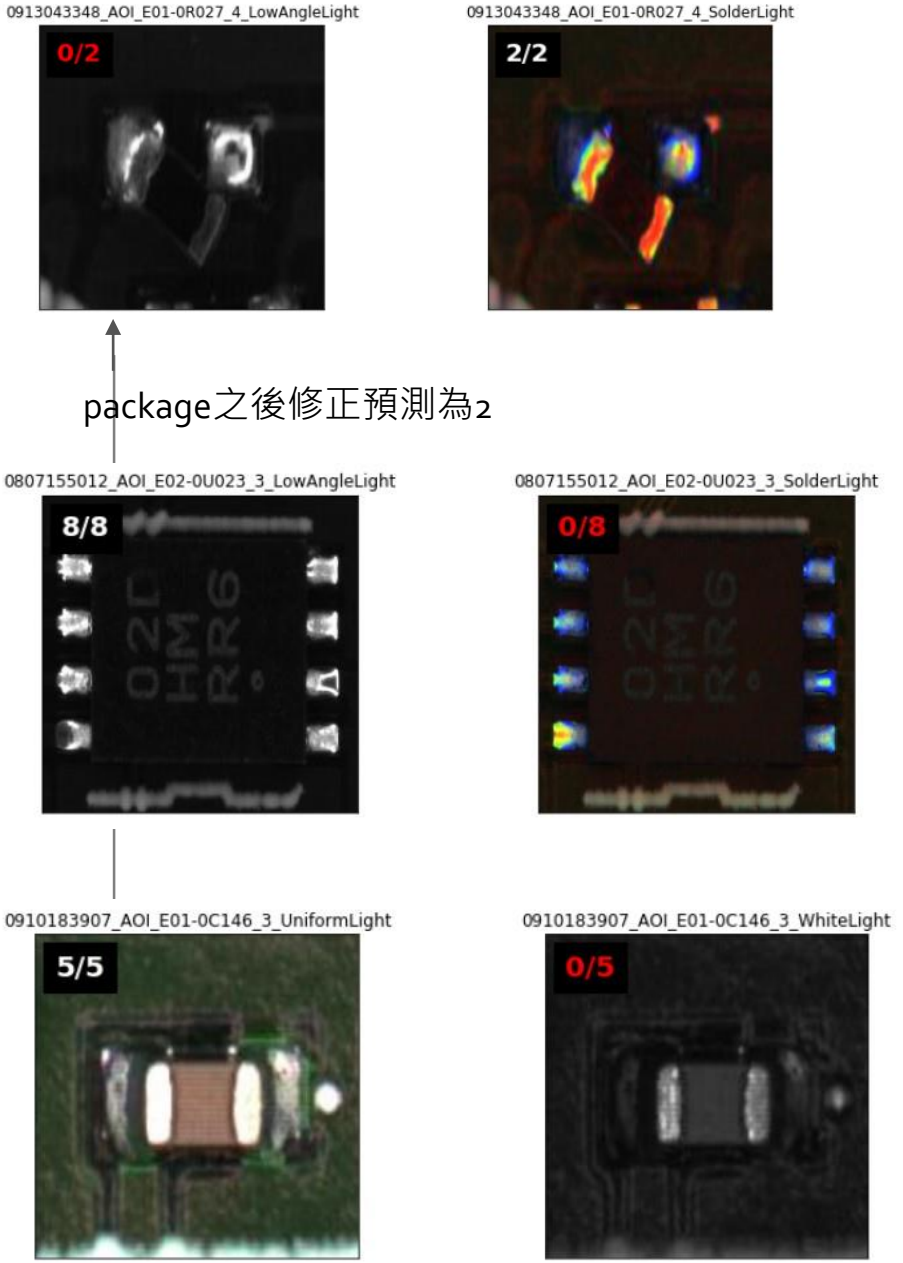


修正資料
減少pass量
(Pass New)

- Pass 的圖片
  - 1.原Pass分類後圖片有近27,000張
  - 2.圖片數量超過與其它7種分類總合3倍以上
  - 3.Pass中同一料號不同時間的圖片的幾乎一樣, 重覆性很高
  - 4.在做model training 時花很多時間
- 處理 Pass 圖片
  - 1.依據的 component.csv中料號列表
  - 2.每個料號依流水號至少留2種圖片(每種有4個光源)
  - 3. 加入golden image圖片

Package

- 機台拍攝照片時共有4種光源：
  - UniformLight
  - LowAngleLight
  - WhiteLight
  - SolderLight。
- 會使用不同光源是因為某些缺陷在特定光源才容易被發現，而此缺陷在其他光源下與pass較難分辨。
- 藉由Package可將此類特定光源下的缺陷挑出，並給予同組照片相同的預測。



混淆矩陣
Confusion Matrix

將預測之分類結果與真實答案比對，可製成混淆矩陣(Confusion Matrix)。

每一欄代表一個類的預測，
每一列表示一個類的實例。

藉由矩陣求值用以計算：
準確率accuracy、
精準度precision、
召回率recall等
(誤報率為100% - recall)。

	預測 Pass	預測 Error
實際 Pass	TP array([[91,	0, 0, 0, 0, 0, 7, 2], FN
實際 Error	[8,	9, 0, 0, 0, 0, 0, 1],
	[5,	2, 2, 0, 0, 2, 0, 0],
	[0,	0, 0, 2, 0, 0, 0, 0],
	[0,	0, 0, 0, 2, 0, 0, 0],
	[34,	0, 0, 0, 0, 12, 5, 1],
	[0,	0, 0, 0, 0, 0, 12, 0],
	[1,	0, 0, 0, 0, 0, 1, 1]])
	FP	TN

	預測為是	預測為否
實際為是	True positives，TP 預測下雨，果然下雨	False negatives，FN 預測沒雨，但卻下雨
實際為否	False positives，FP 預測下雨，但卻沒雨	True negatives，TN 預測沒雨，果然沒雨

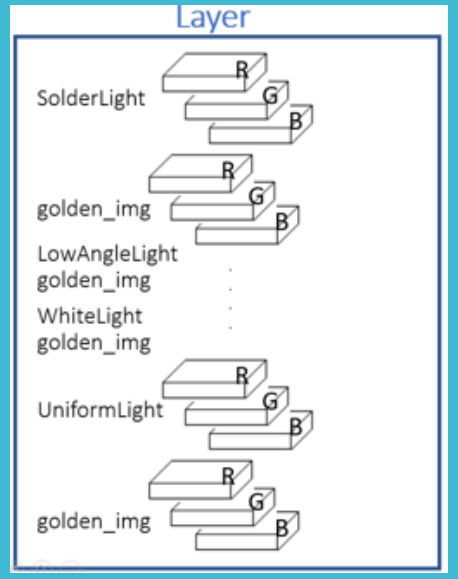
(以降雨預報為例)

ACCURACY = (TP+TN)/Total
PRECISION = TP/(TP+FP)
RECALL = TP/(TP+FN)
F1_SCORE = 2/(1/PRECISION + 1/RECALL)

訓練模型

VGG16 / resNet50 / inceptionv3

VGG16疊圖測試



- Input:各4張不同光源+goldenimg，共8張，每張RGB共24channel
- Output:8 classification
- Result:大部分判為missing，以及excessCompionent
- 結果奇差無比，可能是因為沒光源的就填黑色的關係
- 所以要改用一張一張丟

```
[6 6 6 6 1 1 3 1 1 1 6 6 6 6 1 6 6 6 1 6 6 3 6 6 1 1 6 5 6 6 1 6 6 6 6 6 6
 6 6 1 6 6 6 3 6 1 1 3 1 6 6 6 6 3 6 1 6 6 1 1 6 1 6 6 6 6 6 1 1 6 1 1 6 3
 1 6 1 6 1 6 6 1 6 1 1 6 1 6 1 1 1 6 6 1 6 3 6 1 1 6 1 6 6 1 6 1 6 6 6 6 1
 6 6 1 1 6 6 1 6 6 3 6 1 6 6 1 6 6 1 1 1 6 1 6 6 6 6 6 6 6 6 1 6 3 1 1 6 1 1
 6 1 6 6 4 6 6 1 6 6 1 6 1 6 5 6 1 6 1 6 1 5 6 6 1 1 6 1 6 1 1 6 6 3 6 6 6
 3 6 4 3 6 1 6 6 5 3 6 6 1 6 1]
[0 1 0 5 5 1 5 0 0 0 0 0 0 5 0 2 5 5 0 0 0 1 5 0 0 0 5 5 5 0 0 0 0 0 1 0 5
 0 0 0 5 8 1 0 4 5 2 7 0 0 5 0 0 0 5 0 1 5 1 5 0 0 0 0 1 0 5 0 0 0 1 2 0 1
 5 0 5 5 0 0 0 0 0 2 0 0 0 0 2 0 0 5 5 0 5 1 0 1 5 5 5 0 8 0 2 2 0 5 0 0 8
 0 0 4 0 5 0 5 2 2 5 2 8 0 0 1 0 2 5 0 7 7 1 1 8 0 0 0 5 5 1 0 3 8 5 5 0 0
 0 5 8 5 5 0 8 8 0 0 0 5 0 0 5 0 5 0 0 0 5 5 8 8 5 0 0 5 0 0 5 0 0 3 8 0 5
 1 0 5 0 0 0 0 0 5 0 1 0 5 0 5]
0.06500000000000002
```

Inception_V3

疊圖示意圖

Input
299*299*24

Output
299*299*3

Layer

SolderLight
golden_img
LowAngleLight
golden_img
WhiteLight
golden_img
UniformLight
golden_img

R G B

Input
299*299*3

Output
8

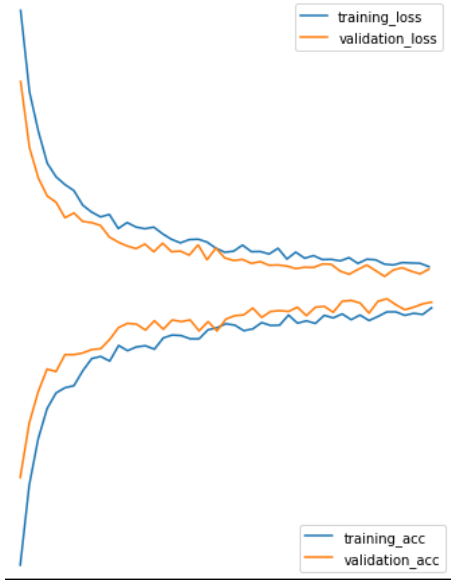
Inception Module

1x1 convolution
3x3 convolution
5x5 convolution
3x3 max-pooling
Previous layer
Filter Concatenate

VGG16

Cutting img
rotate
augment

- ACCURACY: 0.8477
- PRECISION: 0.8297
- RECALL: 0.9360
- F1_SCORE: 0.8796



'0': 'Pass',
'1': 'Missing',
'2': 'MissAlignment',
'3': 'Tombstone_SideStanding
'4': 'PartsReversed',
'5': 'ExcessComponent',
'6': 'Other_Damage',
'7': 'VoidSolder_Short',
'8': 'TextMissing',
'9': 'tag'

```
array([[497,  25,   4,   0,   0,  56,   4,   2,  11,   0],
       [  0, 120,   0,   0,   0,   0,   0,   0,   0,   0],
       [  1,   5,   0,   0,   0,   3,   0,   0,   3,   0],
       [  0,   2,   0,   2,   0,   0,   0,   0,   0,   0],
       [  0,   0,   0,   0,   8,   0,   0,   0,   0,   0],
       [ 14,   2,   0,   0,   0,   1,   0,   0,   0,   0],
       [  4,   0,   0,   0,   0,   0,   5,   0,   2,   0],
       [  4,   3,   0,   0,   0,   1,   1,  11,   0,   0],
       [ 11,  10,   0,   0,   0,   4,  17,   2,  56,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   2]])
```

Inception_V3

Cutting img
Package
Bright:3
Contrast:2

- ACCURACY: 0.9272
- PRECISION: 0.9334
- RECALL: 0.9599
- F1_SCORE: 0.9465

- Pass: 0.9599
- Missing: 1.0
- MissAlignment: 0.0
- Tombstone_SideStanding: 1.0
- PartsReversed: 0.75
- ExcessComponent: 0.0
- Other_Damage: 0.3636
- VoidSolder_Short: 0.75
- TextMissing: 0.74
- tag: 1.0

```
array([[575,   0,   0,   0,   0,   0,   0,   0,  24,   0],
       [  0, 120,   0,   0,   0,   0,   0,   0,   0,   0],
       [  0,   0,   0,   0,   0,   0,   0,   4,   8,   0],
       [  0,   0,   0,   4,   0,   0,   0,   0,   0,   0],
       [  2,   0,   0,   0,   6,   0,   0,   0,   0,   0],
       [ 13,   0,   0,   0,   4,   0,   0,   0,   0,   0],
       [  0,   0,   0,   0,   0,   0,   4,   0,   7,   0],
       [  0,   0,   0,   0,   0,   0,   0,  15,   5,   0],
       [ 26,   0,   0,   0,   0,   0,   0,   0,  74,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   2]])
```

ResNet50

Cutting img
PassNew
└ Package

- ACCURACY： 93.51%
- PRECISION：96.88%
- RECALL：93.32%
- F1_SCORE：95.07%

'0': 'Pass',
'1': 'Missing',
'2': 'MissAlignment',
'3': 'Tombstone_SideStanding',
'4': 'PartsReversed',
'5': 'ExcessComponent',
'6': 'Other_Damage',
'7': 'VoidSolder_Short',
'8': 'TextMissing',
'9': 'tag'

```
array([[559,   0,   0,   0,   0,   8,   0,   0,  32,   0],
       [  0, 120,   0,   0,   0,   0,   0,   0,   0,   0],
       [  0,   0,   4,   0,   0,   0,   0,   0,   8,   0],
       [  0,   0,   0,   4,   0,   0,   0,   0,   0,   0],
       [  1,   0,   0,   0,   7,   0,   0,   0,   0,   0],
       [ 13,   0,   0,   0,   0,   4,   0,   0,   0,   0],
       [  2,   0,   0,   0,   0,   0,   1,   0,   8,   0],
       [  0,   0,   0,   0,   0,   0,   0,  20,   0,   0],
       [  2,   0,   0,   0,   0,   2,   2,   0,  94,   0],
       [  0,   0,   0,   0,   0,   0,   0,   0,   0,   2]])
```

- 增加 同一model 不同條件
- 同一條件 不同model

summary

MODEL	RESNET 50 (v5)			
Pass_new	X	X	V	V
Crop	X	V	X	V
ACCURACY	77.50%	84.00% ▲	66.50%	79.00% ▲
PRECISION	69.78%	75.76% ▲	63.72%	79.00% ▲

MODEL	RESNET 50 (v6 crop)			
Pass_new	X	X	V	V
Package	X	V	X	V
ACCURACY	92.27%	88.91% ▲	93.28%	***93.51%*** ▲
PRECISION	96.17%	97.17% ▲	94.54%	***96.88%*** ▲

summary

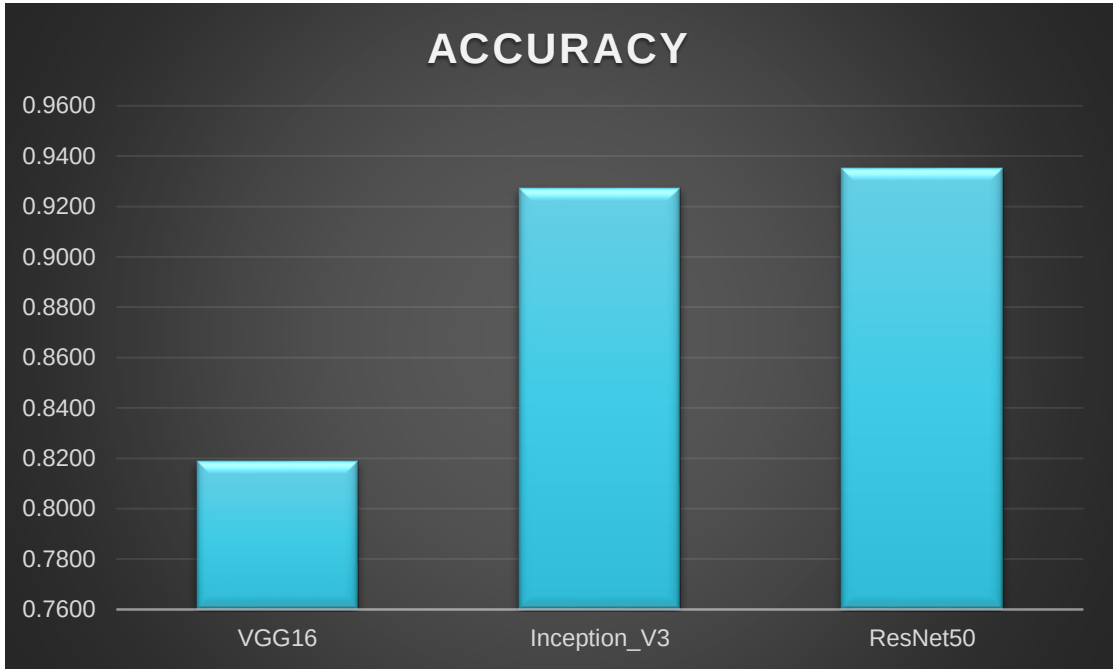
MODEL	Inception_V3 (v5)	
Crop	X	V
ACCURACY	72.50%	80.00% ▲
PRECISION	65.70%	75.49% ▲

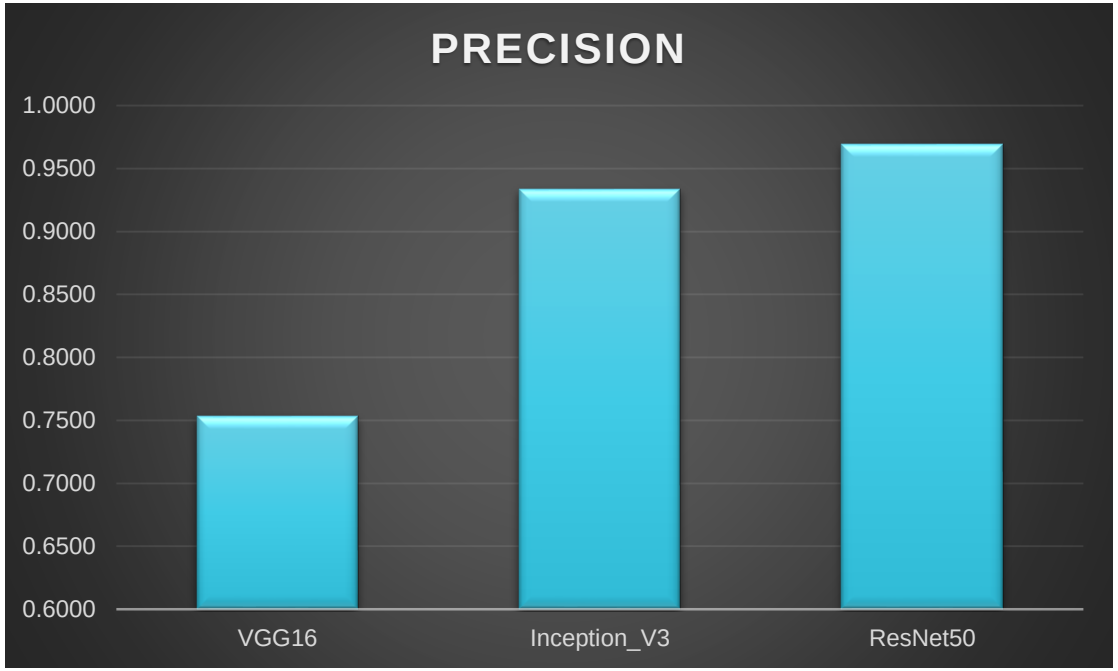
MODEL	Inception_V3 (v6 crop)					
Bright & Contrast	X	Bright=7	Bright=3 UniformLight 不調亮度	Bright=3 UniformLight SolderLight不調亮度	Bright=5 Contrast=2 UniformLight SolderLight不調亮度	Bright=5 Contrast=2 UniformLight SolderLight不調亮度
Package	X	X	X	V	V	V
Pass_new	X	X	X	X	X	V
ACCURACY	91.93%	91.15%	90.36%	92.72%	92.04%	67.63%
PRECISION	96.17%	89.00%	88.45%	93.34%	90.74%	94.79%

summary

MODEL		VGG16		ResNet50		Inception_V3	
		PREDICT					
Crop		V		V		V	
Rotate		V		X		X	
Bright & Contrast		Bright:3 UniformLight不調		X		Bright:5 Contrast:2 UniformLight、 SolderLight不調	
Times		V		V		X	
Package		X		V		V	
train acc	test acc	93.2%	78.6%	99.9%	91.2%	97.6%	91.9%
ACCURACY	PRECISION	84.7%	82.9%	93.5%	96.8%	92.7%	93.3%

result

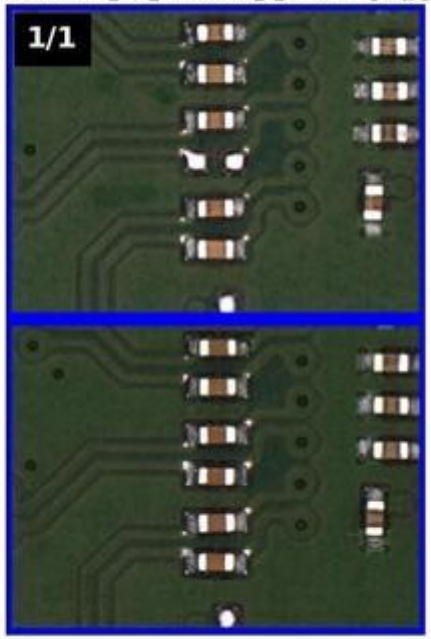

ACCURACY
0.9600
0.9400
0.9200
0.9000
0.8800
0.8600
0.8400
0.8200
0.8000
0.7800
0.7600
VGG16
Inception_V3
ResNet50


PRECISION
1.0000
0.9500
0.9000
0.8500
0.8000
0.7500
0.7000
0.6500
0.6000
VGG16
Inception_V3
ResNet50

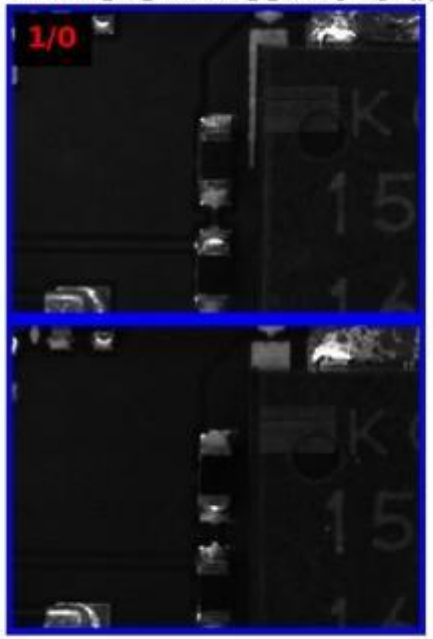
result

0919144541_AOI_E02-0R038_4_LowAngleLight.jpg

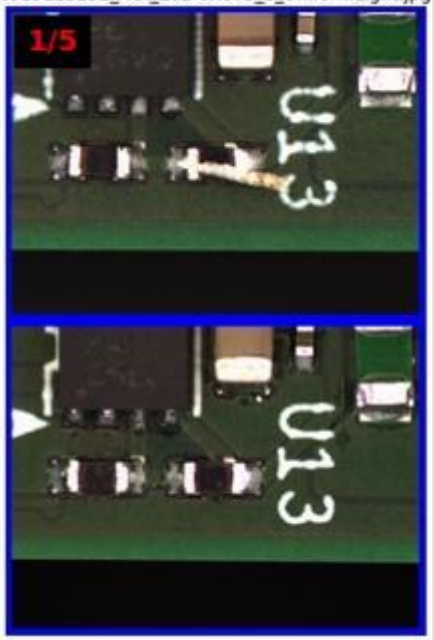
0914143444_AOI_E01-0C003_3_UniformLight.jpg



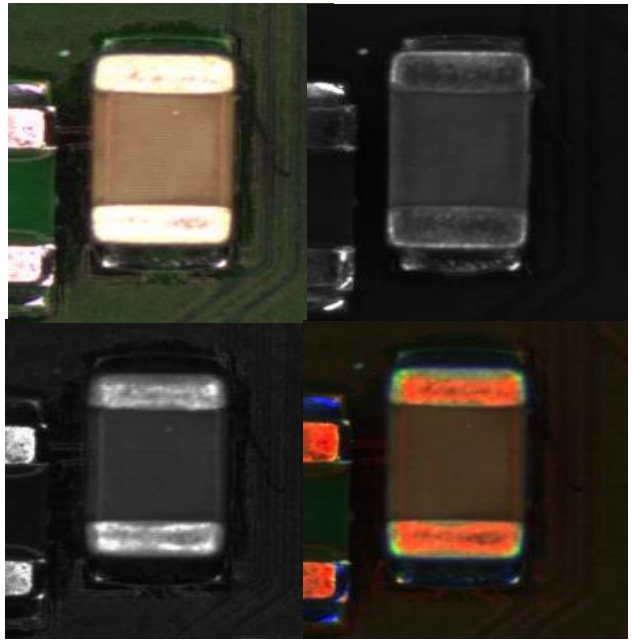
0915202235_AOI_E02-0R038_3_LowAngleLight.jpg



0919123251_AOI_E02-0R075_3_UniformLight.jpg

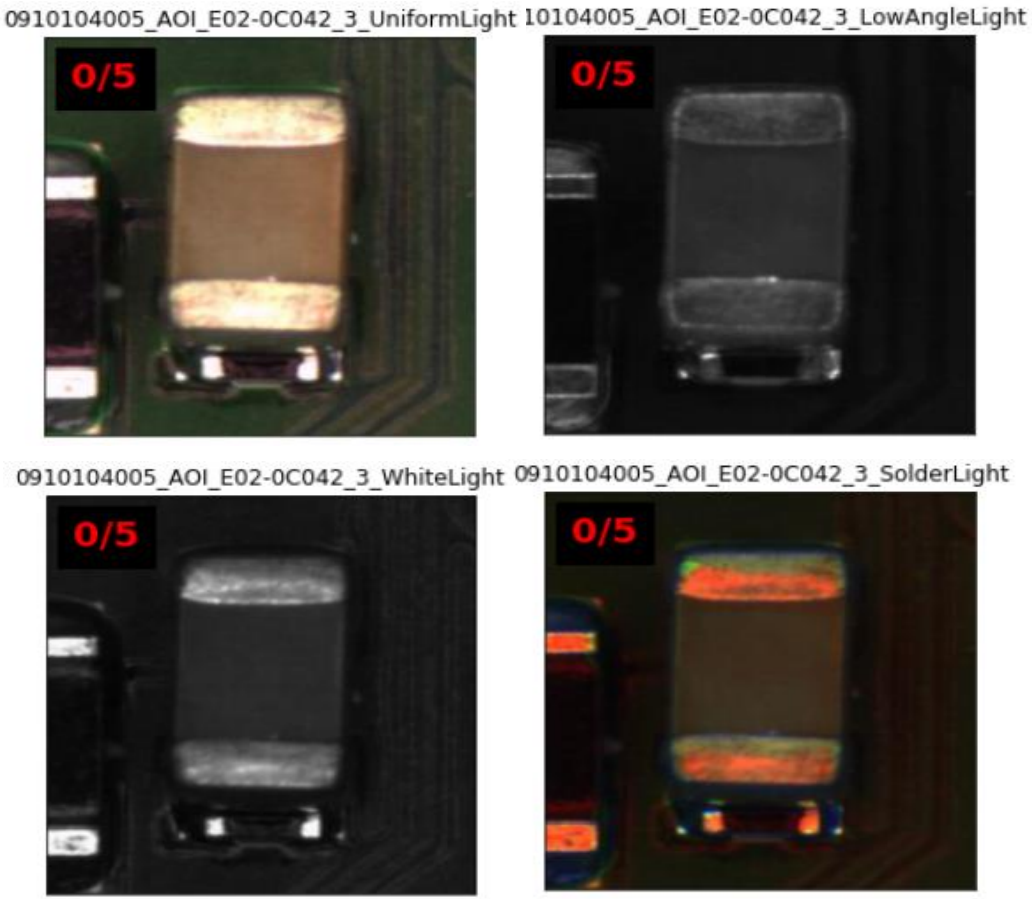


多件誤判 ExcessComponent missing



標記為Pass的圖片

多件誤判的狀況在各模式皆有發生。研判標記為pass的相同圖片數量少，且沒有其他error圖片可供模式學習，導致有類似圖片於測試資料集(Testset)做預測時，無法發揮分類效果。



分類錯誤的圖片
(ExcessComponent預測為Pass)

未來展望

- 用UNet標示出有問題的區塊
  - 挑戰: 要先標好bounding box
  - 專門用來偵測斷字的錯誤
- 使用yolo自動定位
- 使用Ganomaly 半監督式學習自動編碼器瑕疵檢測
- 使用複合型model