Supplement

In this supplement, we first present the average precision of each kind of defect. Then the detection results of PCB 12000038 and 44000019 are illustrated.

1. The average precision of each kind of defect

The average precision of each kind of defects with IoU of 0.33 and 0.5 are shown in TABLE 1 and TABLE 2, respectively. From the above two tables, we can see that the methods integrated more kinds of pooling can achieve higher accuracy.

TABLE 1 The average precision of each kind of defects with IoU of 0.33

Method	**open**	**short**	**mouse bite**	**spur**	**spurious copper**	**pin hole**	**mAP**
GPP-SSD	98.45%	98.14%	99.19%	98.60%	99.06%	99.76%	98.86%
AP-SSD	98.76%	98.88%	99.70%	98.82%	99.48%	99.79%	99.24%
MP-SSD	98.81%	98.45%	99.70%	99.00%	99.40%	99.97%	99.22%
RP-SSD	**99.50%**	98.49%	99.15%	98.45%	99.55%	99.79%	99.15%
H1P-SSD	99.18%	98.81%	99.69%	98.59%	99.41%	99.79%	99.24%
H2P-SSD	99.37%	98.97%	99.43%	**99.03%**	99.37%	**100.00%**	99.36%
MPCA-SSD	99.07%	**99.29%**	99.25%	98.81%	**99.61%**	99.80%	99.30%
H2PCA-SSD	99.42%	99.24%	**99.72%**	98.78%	99.59%	99.79%	**99.42%**

TABLE 2 The average precision of each kind of defects with IoU of 0.5

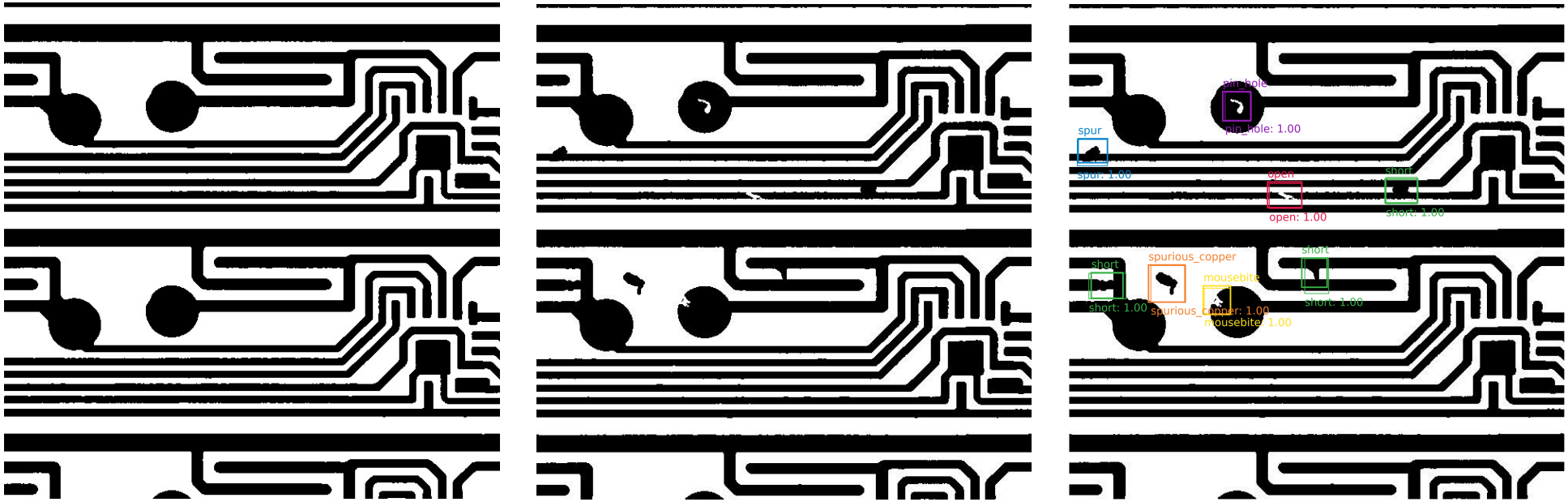
Method	**open**	**short**	**mouse bite**	**spur**	**spurious copper**	**pin hole**	**mAP**
GPP-SSD	97.69%	97.12%	98.66%	98.47%	99.02%	99.75%	98.45%
AP-SSD	97.81%	98.26%	99.21%	98.78%	99.44%	99.79%	98.88%
MP-SSD	98.17%	97.95%	99.48%	98.92%	99.35%	99.85%	98.95%
RP-SSD	98.76%	98.12%	98.96%	98.45%	99.55%	99.77%	98.93%
H1P-SSD	98.50%	98.55%	99.47%	98.58%	99.40%	99.79%	99.05%
H2P-SSD	98.73%	98.73%	99.11%	**99.03%**	99.36%	**99.93%**	99.15%
MPCA-SSD	98.30%	98.96%	99.12%	98.80%	99.58%	99.76%	99.09%
H2PCA-SSD	**98.80%**	**99.19%**	**99.56%**	98.78%	**99.59%**	99.79%	**99.28%**

Several conclusions can be drawn as follows.

a) For **open** defect, mean square root pooling (RP) and our proposed hybrid type 2 pooling (H2P) have higher precision than other pooling methods.
b) For **shot** defect, average pooling (AP) and our proposed hybrid type 2 pooling (H2P) have higher precision than other pooling methods.
c) For **mouse bite** defect, average pooling (AP), max pooling (MP) and our proposed hybrid type 2 pooling (H2P) have higher precision than other pooling methods.
d) For **spur** defect, max pooling (MP) and our proposed hybrid type 2 pooling (H2P) have higher precision than other pooling methods.
e) For **spurious copper** defect, mean square root pooling (RP) and average pooling (AP) have higher precision than other pooling methods.
f) For **pin hole** defect, max pooling (MP) and our proposed hybrid type 2 pooling (H2P) have higher precision than other pooling methods.
g) From the perspective of mean average precision (mAP), the channel attention (CA) mechanism has about 0.1% performance improvement.

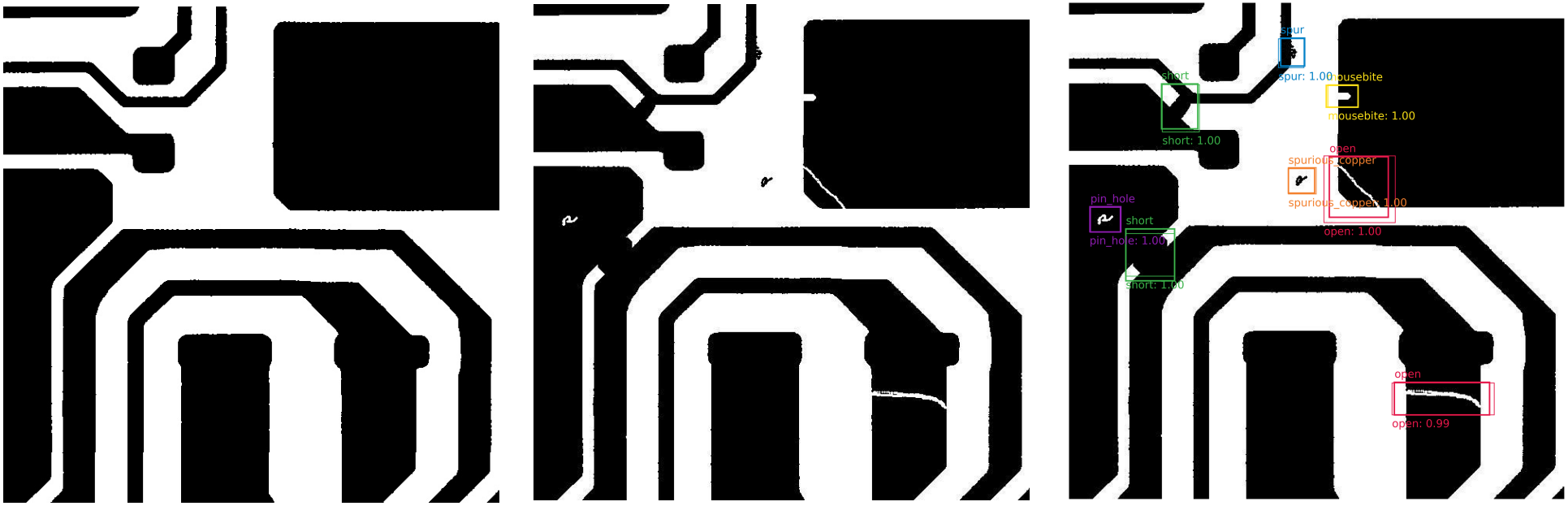
2. Visualization of Detection Results

The detection results of PCB 12000038 and 44000019 are shown in Figure 1 and Figure 2, respectively.



(a) Template image (b) Test image (c) Detection result

Figure 1 Detection results of PCB 12000038 in the test dataset.



(a) Template image (b) Test image (c) Detection result

Figure 2 Detection results of PCB 44000019 in the test dataset.

Figure 1 (a) and Figure 2 (a) are template images, Figure 1 (b) and Figure 2 (b) are test images. The detection results of our proposed H2PCA-SSD method are illustrated in Figure 1 (c) and Figure 2 (c). The ground truth bounding box of each defect is drawn with a bold line, the name of each defect is on the top of the box. The detected bounding box of each defect is drawn with a thin line, the name of each defect and the confidence are on the bottom of the box. We can see that our method can obtain accurate bounding box and high classification confidence.