# Defect detection of IC substrate based on Bi-direction Feature Pyramid Network

Chin Sheng Chen, Professor, National Taipei University of Technology, Taiwan
Hao Wei Lin, National Taipei University of Technology, Taiwan
Tzu Chieh Hung, National Taipei University of Technology, Taiwan

## Abstract

Automatic optical inspection is a typical technology in industrial processes. In recent years, deep learning has been widely used in automated optical inspection (AOI). Deep learning used in AOI brings benefit of defect detection performance. In this paper, the IC substrate is the inspection object. It depends on low-level visual task, which mainly involves the detection of structural features. In contrast, most of the current object detection networks deal with high-level visual tasks, and can't achieve good results in defect detection of IC substrate. In the case of Feature Pyramid Network (FPN) has multi-scale feature map and its architecture transmits features from high-level semantics features to low-level structure features, which lead to the tiny defects in IC substrate could be ignored and missed detection. In this paper, we improved the FPN network architecture, the semantic message transmission from top-down in the original architecture is maintained in the feature pyramid, and a branch line of structural feature message transmission from bottom-up is added. Finally, multi-scale feature superposition is performed, so that the network can obtain structural feature messages from the branch line architecture to improve the problem of missing detection of tiny defects. In this paper, we use 697 training images and 129 testing images for multi-class defect detection, such as broken copper, laser marking, scratch and dust. Finally, the test results show that the proposed Bi-direction Feature Pyramid Network architecture can achieve recall of 92.7%, precision of 77.2% and F2-score of 93.3%, which are superior to the original structure's recall of 89.2%, precision of 75% and F2-score of 85.9%, respectively.

## Image

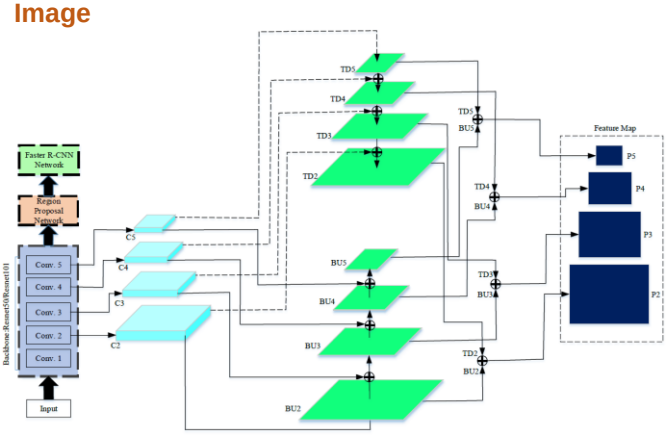



**Figure 1:** Bi-direction Feature Pyramid Network architecture.

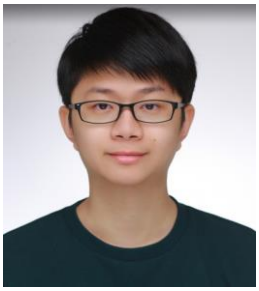
## Recent Publications

1. D. B. Anitha and Mahesh Rao(2017) A survey on defect detection in bare PCB and assembled PCB using image processing techniques. 2017 International Conference on Wireless Communications, Signal Processing and Networking (WiSPNET), pp.39-43.
2. Tsung-Yi Lin, Piotr Dollár, Ross Girshick, Kaiming He, Bharath Hariharan, Serge Belongie (2017) Feature Pyramid Networks for Object Detection. Proceedings of 2017 IEEE Conference on Computer Vision and Pattern Recognotion(CVPR2017)pp.936-944.
3. L. Jiao, F. Zhang, F. Liu, S. Yang, L. Li, Z. Feng, and R. Qu. (2019) A Survey of Deep Learning-based Object Detection. IEEE Access, vol. 7, pp.128837-128868
4. X. Wu, D. Sahoo, and C.H. Hoi (2020) Recent Advances in Deep Learning for Object Detection. Neurocomputing, vol. 396, pp. 39-64.
5. Vishwanath A Sindagi, Vishal M. Patel (2019) Multi-Level Bottom-Top and Top-Bottom Feature Fusion for Crowd Counting, Proceedings of 2019 IEEE/CVF International Conference on Computer Vision (ICCV 2019).
6. Yohei Takada Tokiko Shiina Hiroyasu Usami Yuji Iwahori(2017) Defect Detection and Classification of Electronic Circuit Boards Using Keypoint Extraction and CNN Features. Proceedings of the Ninth International Conference on Pervasive Patterns and Applications (PATTERNS 2017), pp.113-116.



Chin-Sheng Chen received the Ph. D. degrees in mechanical engineering from National Chiao Tung University, Hsinchu, Taiwan, R.O.C., in 1999. He was a researcher of Sintec Technology Co. Ltd. during 1999 to 2000 and a R&D manager of TECO Electric & Machinery Co. Ltd. from 2000 to 2002. In 2002, he joined the Gradulate Institute of Automation Technology, National Taipei University of Technology, Taipei, Taiwan, R.O.C., as an Assistant Professor. He was promoted to be Associated Professor, Full Professor and distinguished professor in 2006, 2012, and 2018, respectively. His research interests include intelligent motion control, mechatronics and machine vision. He received the Outstanding Industry Collaboration Award from Taipei TECH in 2020, and received the Outstanding Research Award from the College of Mechanical and Electrical Engineering, Taipei TECH in 2013 and 2014. Prof. Chen has published over 150 journal and conference papers and book chapters on the research.

Email: saint@mail.ntut.edu.tw



Hao-Wei Lin received the B.S. degree in electrical engineering in 2019 from Tamkang University, Tamsui, Taiwan. He is a master student in the Graduate Institute of Automation Technology at National Taipei University of Technology, Taipei, Taiwan. He mainly researchs machine vision and makes applications in the automation industry. In most of his research time, He spent time researching the application of deep learning in automated optical inspection.



Tzu-Chieh Hung received the B.S. degree in electrical engineering in 2018 from Chung Yuan Christian University, Taoyuan, Taiwan, and the M.S. degree in automation technology in 2020 from National Taipei University of Technology, Taipei, Taiwan. Mr. Hung's expertise is in the fields of digital image processing and deep learning for vision applications

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**Notes/Comments:**