篇名：運用生成 VAE 與主動式學習強化不確定資訊以減少封裝基板瑕疵檢測訓練資料

摘要：Recognizing defects in the manufacturing (MFG) process has become a daily challenge in today's semiconductor industry. This paper introduces an AI-assisted method for inspecting defects in substrates, which are commonly used in packaged IC products. By utilizing Automated Optical Inspection (AOI) equipment and Machine Learning (ML)/Deep Neural Network (DNN) technologies, the manual effort required for substrate defect examination has been significantly reduced. However, as the MFG in-process conditions change, variations in defects may occur. These defect variations may include uncertain scenarios, such as a combination of multiple known defects or even unknown defects, which can lead to a decrease in the confidence score computed by the supervised DNN learning. In this paper, we apply the AL-VAE method, which combines Active Learning (AL) and Variational Autoencoder (VAE) techniques, to improve our field-deployed AOI defect detection flow. The AL utilizes uncertainty information to filter out ambiguous data, accelerate training convergence, and minimize the training dataset, thus reducing the need for human labeling efforts. On the other hand, the VAE can learn the latent distribution of images, enabling it to generate multiple similar image features. By aggregating these reproduced samples, we can significantly increase the uncertainty information, especially for unknown defects. Both the public MS COCO dataset and our ASE substrate defect dataset are used for evaluation. The results show that our method only requires approximately 50% to 75% of the samples from the original training dataset, while maintaining the overall accuracy at the same level. Additionally, the uncertainty information obtained from VAE can help us to distinguish between trained classes and untrained scenarios. The VAE's uncertainty score indicates that 24 % of the defect images exhibit high uncertainty, not requiring no human re-examination. By leveraging the AL-VAE technology, our AI-assisted defect inspection flow can better meet the requirements of smart factories.