香港科技大学(广州) THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY (GUANGZHOU)
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香港科技大學 THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
計算機科學及工程學系 THE DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

Defect Spectrum:

A Granular Look of Large-Scale Defect Datasets with Rich Semantics

Shuai Yang⋆ , Zhifei Chen⋆ , Pengguang Chen, Xi Fang, Yixun Liang, Shu Liu, and Yingcong Chen

Project page

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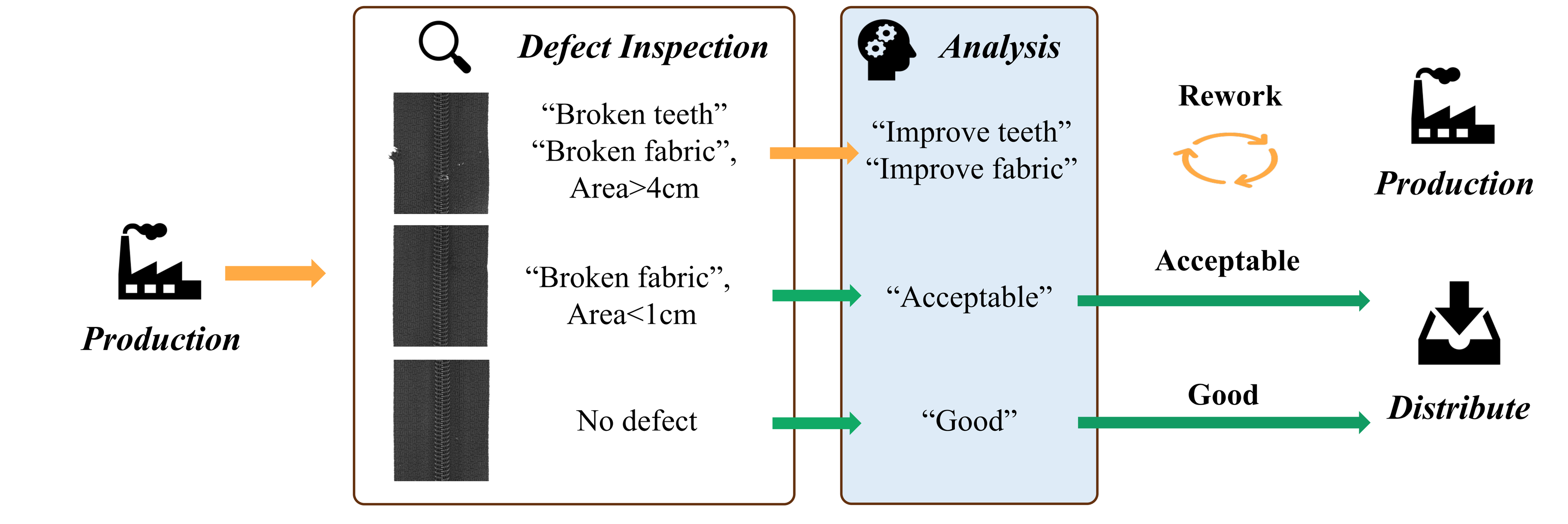
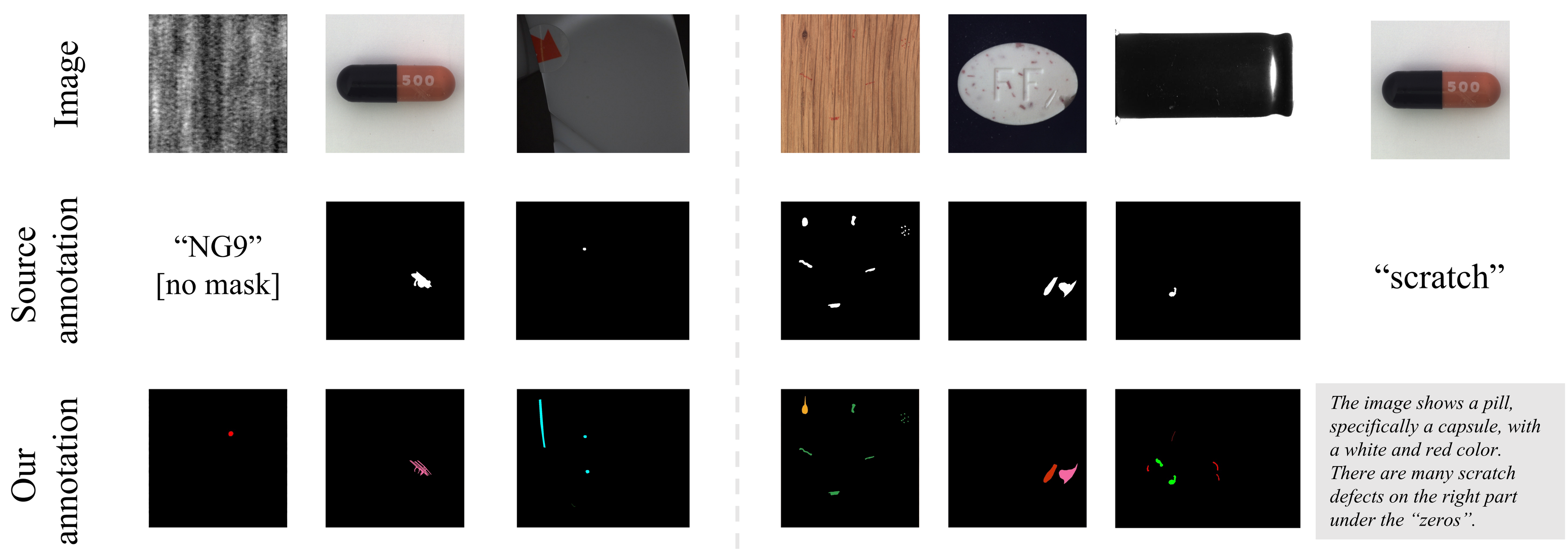
Introduction

- Current datasets fall short in meeting the complex practical requirements of industrial defect inspection. They suffer from poor quality annotations and insufficient sample diversity.
- We introduce the **Defect Spectrum**, a comprehensive industrial defects benchmark offering precise, semantic-rich, and large-scale annotations.
- We introduce **Defect-Gen**, a two-stage diffusion-based generator for creating high-quality synthetic images from limited data.



(a) Manufacturing Loop

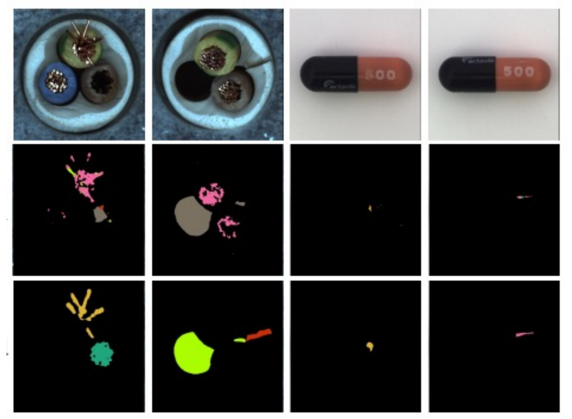


(b) Precision (c) Semantic Abundance

To assess our dataset's superiority, we design a simulation experiment that mirrors real-world manufacturing processes. We reduce the FPR while improving the recall rate.

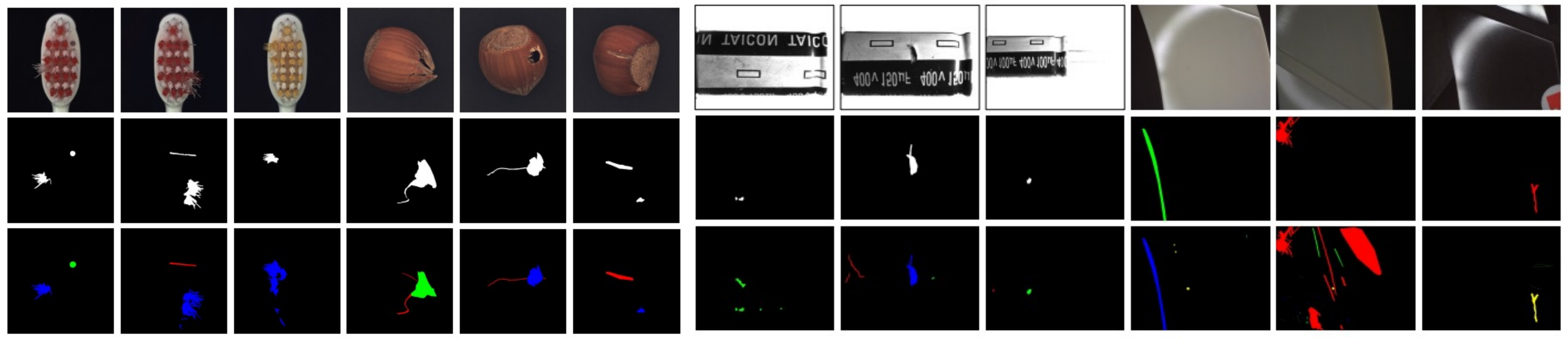
Example classes	Standard For Benign Products
Zipper	No defect on teeth; Fabric defect < 4800 pixels
Pill	No cracks; Contamination < 4000 pixels; Color stains < 300 pixels
Wood	No scratch; No dent; Impurities < 250 pixels; Stain < 1000 pixels

Method	↑ Recall (%)	↓ FPR (%)
Original	85.33	49.60
Defect Spectrum (DS)	**96.07**	**16.50**



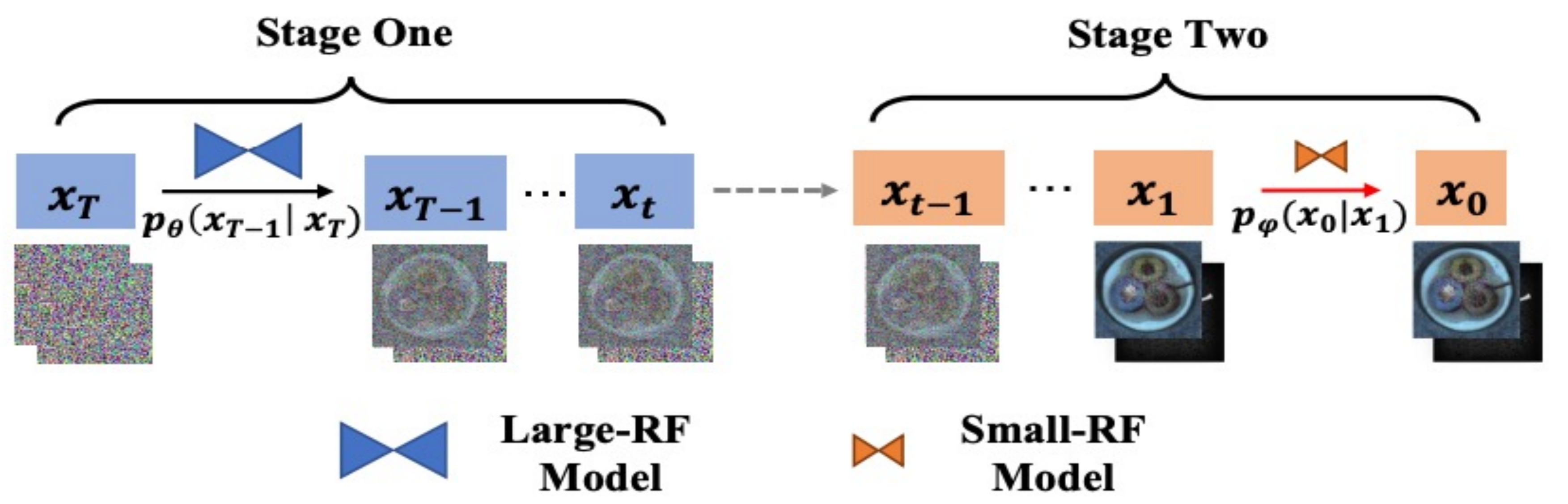
Defect Spectrum Dataset

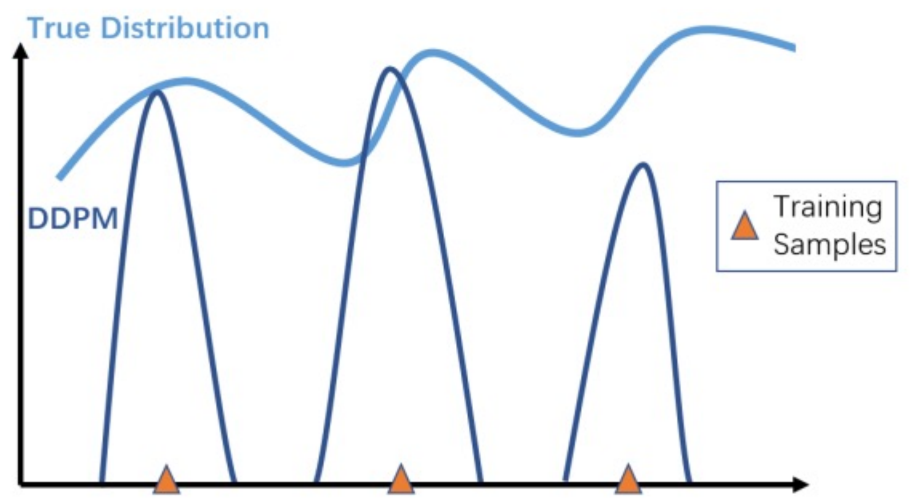
	Annotated Defective Images	Defect Type	Pixel-wise Label	Multiple Defective Label	Detailed Caption
AITEX [36]	105	12	✓		
AeBAD [51]	346	4	✓		
BeanTech [27]	290	3	✓		
Cotton-Fabric [20]	89	1			
DAGM2007 [46]	900	6			
KolektorSDD2 [39]	356	1	✓		
MVTec [3]	1258	69	✓		
VISION V1 [1]	4165	44	✓	✓	
VisA [56]	1200	75	✓		
Defect Spectrum	**3518+1920***	**125**	✓	✓	✓

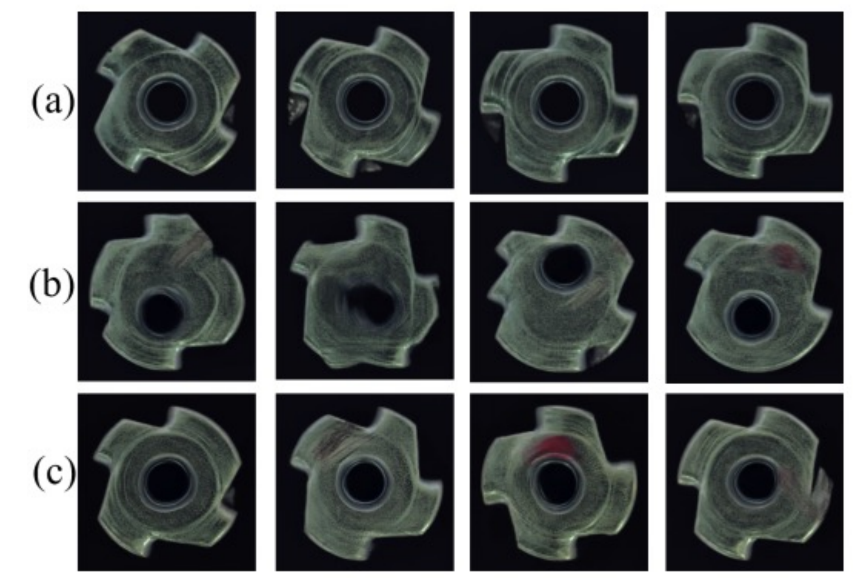


Defect-Gen

By using the limited available data, we propose a two-staged diffusion-based generator, called the **"Defect-Gen"** to generate both defective images and masks.







I. Few-shot Challenge

Due to the scarcity of defect images, models trained on few samples often memorize the training set and fail to capture the true data distribution.

II. Modeling Patch-Level Distribution

To alleviate the above-mentioned problem, we propose to model the patch-level distribution instead of the image-level distribution.

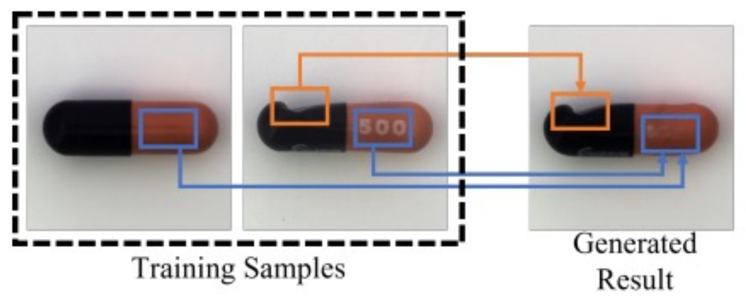
III. Restraining the Receptive Fields

We can naively crop image into patches to achieve patch-level modeling. However, it is hard to use learned patches to reconstruct into a whole image during inference. Alternatively, we reduced number of down-sampling layers to constrain the output receptive fields. This allows the model to only be visible to small patches on the original images.

IV. Handling the Global Distortion

Patch-level modeling is effective in overcoming overfitting, it falls short of representing the global structure of the entire image. Thus, we trained a two-staged diffusion model, one with large RFs and one with small RFs. During inference, we use the large-RF model to capture the geometry structure in the early steps, and then switch to the small-RF model to generate diverse local patches in the remaining steps.

Evaluation of Defect-Gen



	DS-MVTec	DS-VISION	DS-Cotton
DeepLabV3+	51.58/**55.55**	52.33/**53.46**	48.73/**58.58**
Mask2Former	45.70/**50.16**	54.12/**55.47**	64.09/**65.39**
MiT-B0	46.45/**56.21**	49.62/**50.75**	50.52/**55.86**