MIRAGE: Model-agnostic Industrial Realistic Anomaly Generation and Evaluation for Visual Anomaly Detection

Supplementary Material

7. Anomaly Generation Results

To demonstrate the generalisation ability and controllability of MIRAGE, Figure 3 presents more generations across different object types and anomaly types; the corresponding descriptions are provided in Table 5.

Table 5. **MVTec AD pixel-level AUC on 1000 ground-truth masks generated by Gemini Image V3.** Results are reported for the *g-dino + yolo* pipeline.

Category	Pixel-level AUC
bottle	0.9650
cable	0.8866
capsule	0.9413
carpet	0.9263
grid	0.8487
hazelnut	0.9718
leather	0.9155
metal_nut	0.9405
pill	0.9596
screw	0.9709
tile	0.8955
toothbrush	0.9633
transistor	0.9643
wood	0.9321
zipper	0.8594
OVERALL	**0.9292**

8. Automatic Defect Prompt Generation

A core component of MIRAGE is the fully automatic generation of defect text prompts, which removes the need for manual prompt engineering or prior knowledge of the defect taxonomy for each product category. For each object category in the dataset, we provide a Vision-Language Model (VLM) with two randomly sampled *normal* (defect-free) reference images and ask it to list 10 realistic defects that could plausibly occur on that object category, each accompanied by a short description suitable as a text prompt for image generation. By conditioning on actual normal images rather than relying solely on the category name, the VLM leverages its visual understanding of the object's material, geometry, and surface properties to propose contextually grounded defect types (e.g., *scratch*, *dent*, *discoloration*, *crack*). This procedure is entirely automated, requires no anomalous examples or domain expertise, and is model-agnostic: as more capable VLMs become available, they can be substituted with no change to the pipeline.

Table 6. **VisA pixel-level AUC on 720 ground-truth masks generated by Gemini Image V3.** Results are reported for the *g-dino + yolo* pipeline.

Category	Pixel-level AUC
candle	0.8967
capsules	0.8836
cashew	0.9459
chewinggum	0.8483
fryum	0.9553
macaroni1	0.9326
macaroni2	0.9206
pcb1	0.9249
pcb2	0.9448
pcb3	0.9480
pcb4	0.9525
pipe_fryum	0.9700
OVERALL	**0.9265**

The prompt used to generate the defect descriptions is as follows:

Prompt for Defect Generation

> You are an expert in manufacturing quality control. Given the following two images of a normal, defect-free {object class}, please list 10 realistic defects that could plausibly occur on this type of object. For each defect, provide a short defect name followed by a description that could be used as a text prompt for image generation. The descriptions should be concise yet specific enough to guide the generation of realistic defect images.

The short name of the defect (called "Defect Type" in Tab. 7) is fundamental to condition Grounding DINO for the semantic change detection pipeline, and CLIP for the image selection procedure.

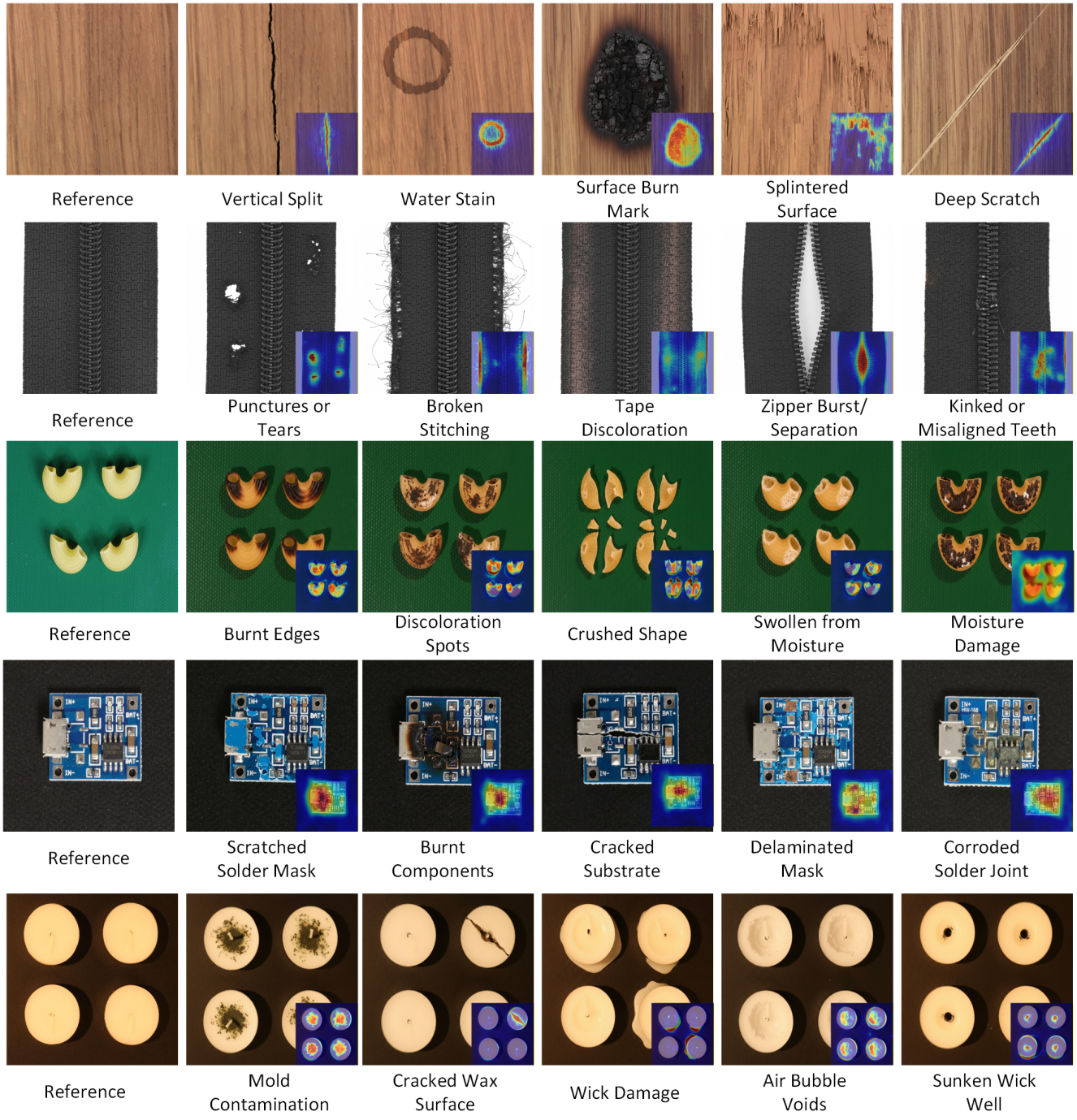

Figure 3. Different types of synthetic anomalous images and corresponding heatmaps generated by MIRAGE.

Table 7. **Corresponding descriptions for anomaly generation** of Fig. 3. ⋆ indicates MVTec AD dataset, while ⋆⋆ indicates VisA classes.

[Class]	[Defect Type]	GPT-Generated Detailed Descriptions
Wood ⋆	Vertical Split	A deep crack runs parallel to the wood grain, showing a physical separation where the material has dried out and pulled apart, creating a dark void.
	Water Stain	An irregular, dark ring or splotch discolors the wood surface, creating a distinct boundary where moisture has penetrated and altered the grain's appearance.
	Surface Burn Mark	A dark, charred patch with blackened, carbonized wood fibers disrupts the natural color, indicating contact with a high-heat source.
	Splintered Surface	The surface fibers are raised and peeling away in jagged, needle-like strips, destroying the smooth finish and creating a rough, hazardous texture.
	Deep Scratch	A distinct, light-colored linear gouge cuts across the vertical grain, interrupting the smooth brown pattern where the surface fibers have been severed.
Zipper ⋆	Punctures or Tears	Visible holes or rips in the woven fabric tape, distinct from the edges.
	Broken Stitching	The specific thread running along the edge of the coil snaps or unravels, causing the plastic coil to detach from the fabric tape.
	Tape Discoloration	The black color of the fabric fades to gray or reddish-brown due to UV (sun) exposure or chemical bleaching.
	Zipper Burst/Separation	The left and right sides of the coil separate and pop open in the middle, even though the slider (not pictured) might be pulled up.
	Kinked or Misaligned Teeth	The smooth, straight line of the center zipper chain looks crooked, bent, or has a distinct 'hump,' preventing the slider from moving past that point.
Macaroni 1 ⋆⋆	Burnt Edges	The rims and tips of the shell appear darkly toasted or charred, turning brown or black from excessive heat during drying or storage.
	Discoloration Spots	Irregular dark brown, black, or white patches mar the uniform yellow-orange color of the pasta, indicating mold, burning, or contamination.
	Crushed Shape	The tubular form is flattened or compressed, losing the round hollow cross-section and characteristic elbow curvature.
	Swollen from Moisture	The pasta appears bloated and soft rather than hard and dry, with the surface losing its smooth finish and becoming sticky or tacky.
	Moisture Damage	The pasta appears swollen, soft, or sticky rather than dry and hard, with a distorted shape and loss of the crisp texture from humidity exposure.
PCB 4 ⋆⋆	Scratched Solder Mask	Deep gouges or scrapes cut through the blue protective coating, exposing the underlying copper or substrate material in irregular patterns.
	Burnt Components	The ultrasonic sensor mesh, resistors, or solder joints show blackened, charred areas with blistered plastic indicating electrical overcurrent or short circuit damage.
	Cracked Substrate	A visible fracture line runs through the blue PCB material, splitting the board and potentially severing internal copper traces beneath the surface.
	Delaminated Mask	The blue solder mask protective coating is peeling, bubbling, or separated from the PCB surface in patches.
	Corroded Solder Joint	The solder connection appears dull, rough, or covered with dark oxidation, indicating poor contact and potential circuit failure.
Candle ⋆⋆	Mold Contamination	Small, dark green or black fuzzy spots appear scattered across the wax surface, indicating fungal growth from moisture exposure in storage.
	Cracked Wax Surface	The smooth cream-colored wax top features a jagged fissure running from the edge toward the center wick hole, exposing a darker interior layer where the material has split under thermal stress.
	Wick Damage	The central fabric wick is frayed, broken off at the base, or completely missing from its anchoring hole, leaving an empty void or torn fiber ends.
	Air Bubble Voids	Large spherical cavities appear trapped beneath the smooth wax surface, visible as bulging domes or collapsed pits that break the uniform flat plane of the candle top.
	Sunken Wick Well	The circular depression surrounding the wick appears excessively deep and irregular, with the wax collapsing inward to create an uneven crater that disrupts the flat top surface.