Feature Attenuation of Defective Representation Can Resolve Incomplete Masking on Anomaly Detection

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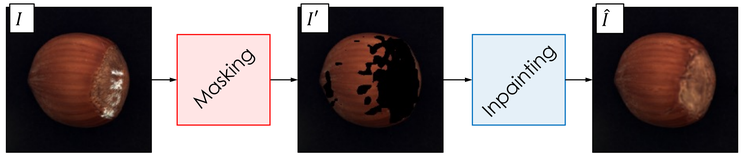
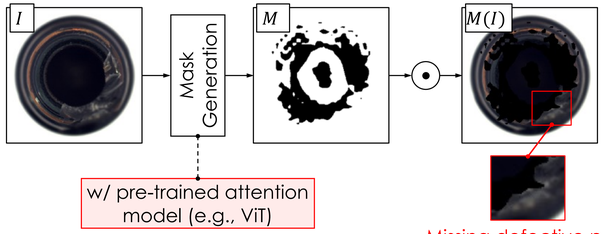
Reconstruction-by-inpainting

- Mask out the suspicious anomalous region
- Determine abnormality based on inpainting error, $\mathcal{L}(I, \hat{I})$

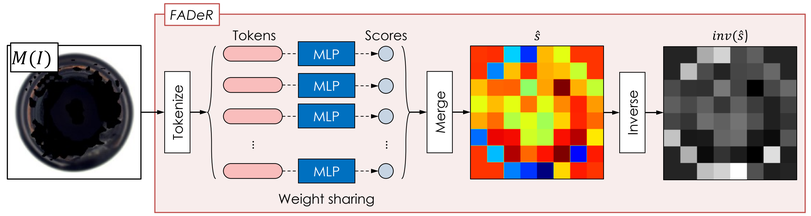


Motivation & Solution

- Challenge to completely cover anomalous regions using existing masking methods without additional training
- The model designed to compensate for mask incompleteness should enable label-free training and scalability

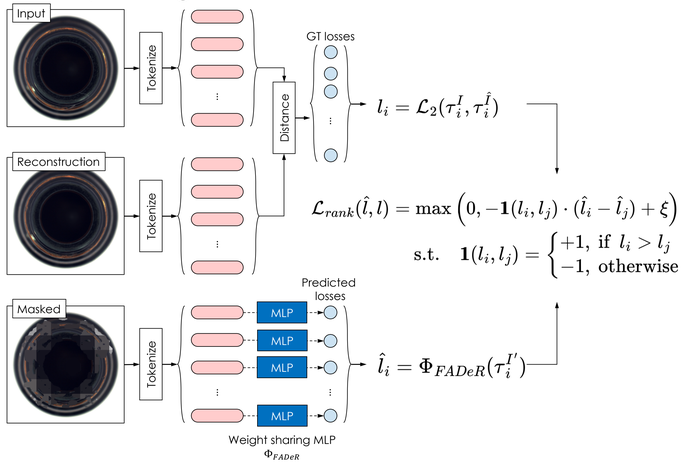


- An MLP component designed to overcome incomplete masking by attenuating defective feature representations

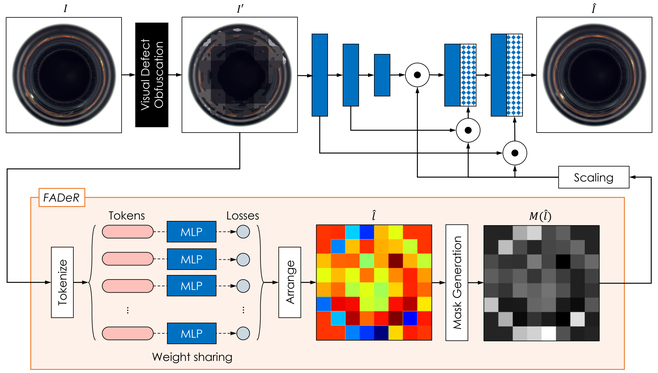


Feature Attenuation of Defective Representation

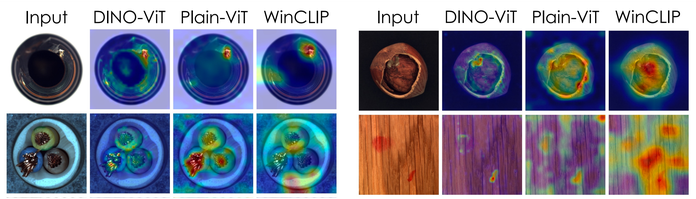
- Enables label-free training by leveraging active learning
- FADeR is trained to predict the rank $\hat{l}$ of path-wise reconstruction errors l by ranking loss



- Generates a soft mask only with a simple two-layered MLP to attenuate defective representations



Results



B

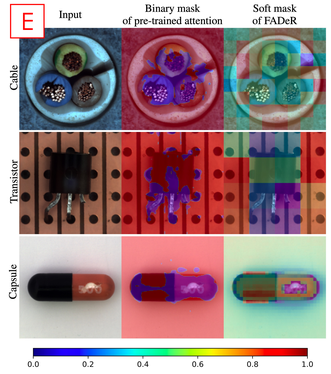
Model	FADeR$_{DINO\text{-}EAR}$	FADeR$_{WT\text{-}EAR}$	FADeR$_{WinCLIP\text{-}EAR}$
Bottle	0.997 / 0.914 → **0.998 / 0.951**	0.983 / 0.930 → **0.993 / 0.950**	**0.992** / 0.939 → **0.992 / 0.936**
Cable	0.870 / 0.775 → **0.887 / 0.856**	0.817 / 0.798 → **0.825 / 0.872**	**0.838** / 0.550 → 0.794 / **0.612**
Capsule	0.870 / 0.944 → **0.947 / 0.980**	0.863 / 0.965 → **0.933 / 0.977**	0.867 / 0.935 → **0.930 / 0.968**
Carpet	0.899 / 0.974 → **0.971 / 0.992**	0.701 / 0.945 → **0.756 / 0.981**	0.679 / 0.909 → **0.746 / 0.955**
Grid	0.959 / 0.974 → **0.983 / 0.986**	0.765 / **0.919** → **0.805** / 0.901	**0.866 / 0.940** → 0.861 / 0.939
Hazelnut	0.997 / 0.957 → **0.988 / 0.976**	0.954 / 0.952 → **0.973 / 0.977**	0.946 / 0.947 → **0.959 / 0.976**
Leather	**1.000** / 0.992 → **1.000 / 0.996**	**1.000** / 0.981 → **1.000 / 0.993**	**1.000** / 0.971 → **1.000 / 0.990**
Metal nut	**0.876** / 0.793 → **0.876 / 0.828**	0.880 / 0.767 → **0.903 / 0.804**	0.775 / 0.780 → **0.821 / 0.779**
Pill	0.922 / 0.875 → **0.976 / 0.945**	0.884 / 0.914 → **0.957 / 0.967**	0.879 / 0.898 → **0.956 / 0.951**
Screw	0.886 / 0.975 → **0.918 / 0.991**	0.883 / 0.977 → **0.905 / 0.993**	0.862 / 0.953 → **0.897 / 0.968**
Tile	0.962 / 0.857 → **1.000 / 0.950**	0.961 / 0.853 → **1.000 / 0.940**	0.960 / 0.816 → **0.986 / 0.921**
Toothbrush	**1.000** / 0.953 → **1.000 / 0.987**	**1.000** / 0.953 → 0.994 / **0.986**	**1.000** / 0.959 → **1.000 / 0.986**
Transistor	**0.947** / 0.745 → 0.933 / **0.825**	0.891 / 0.679 → **0.908 / 0.740**	0.788 / **0.699** → **0.835** / 0.642
Wood	0.985 / **0.875** → 0.996 / **0.818**	0.931 / **0.818** → **0.964** / 0.730	**0.997** / 0.691 → **0.997 / 0.751**
Zipper	0.955 / 0.930 → **0.987 / 0.988**	0.932 / 0.909 → **0.938 / 0.951**	0.924 / 0.895 → **0.975 / 0.967**
Average	0.942 / 0.902 → **0.964 / 0.938**	0.896 / 0.891 → **0.924 / 0.918**	0.892 / 0.859 → **0.917 / 0.889**

C

Model	FADeR$_{DSR\text{-}EAR}$	FADeR$_{MSFlow\text{-}EAR}$	FADeR$_{AMI\text{-}EAR}$
Bottle	**0.991 / 0.953** → 0.984 / 0.938	0.971 / 0.931 → **0.973 / 0.951**	0.886 / 0.910 → **0.987 / 0.978**
Cable	**0.891** / 0.908 → 0.834 / **0.947**	0.920 / 0.898 → **0.939 / 0.943**	**0.879** / 0.794 → 0.856 / **0.928**
Capsule	0.834 / 0.943 → **0.927 / 0.976**	0.861 / 0.957 → **0.938 / 0.976**	**0.911** / 0.773 → 0.902 / **0.970**
Carpet	0.806 / 0.982 → **0.935 / 0.993**	0.983 / 0.970 → **0.984 / 0.982**	**0.983 / 0.932** → 0.785 / 0.903
Grid	0.930 / 0.984 → **0.984 / 0.989**	**0.971** / 0.971 → 0.960 / **0.984**	**0.934** / 0.809 → 0.908 / **0.847**
Hazelnut	**0.989** / 0.954 → 0.975 / **0.964**	**0.903** / 0.946 → 0.901 / **0.963**	0.729 / **0.958** → **0.895** / 0.950
Leather	**1.000** / 0.989 → **1.000 / 0.996**	**1.000** / 0.978 → **1.000 / 0.993**	0.816 / 0.823 → **0.998 / 0.956**
Metal nut	0.817 / 0.804 → **0.851 / 0.893**	0.765 / 0.915 → **0.767 / 0.939**	0.918 / 0.545 → **0.933 / 0.835**
Pill	0.824 / 0.917 → **0.977 / 0.957**	0.855 / 0.924 → **0.974 / 0.963**	**0.995 / 0.938** → 0.903 / 0.936
Screw	**0.752** / 0.987 → 0.751 / **0.993**	0.837 / 0.975 → **0.896 / 0.993**	**0.883 / 0.927** → 0.786 / 0.920
Tile	0.942 / 0.878 → **0.999 / 0.977**	0.937 / 0.875 → **0.999 / 0.980**	0.934 / 0.840 → **0.948 / 0.867**
Toothbrush	0.992 / 0.979 → **1.000 / 0.991**	0.964 / 0.964 → **1.000 / 0.986**	0.770 / 0.883 → **0.919 / 0.957**
Transistor	**0.857** / 0.685 → 0.840 / **0.779**	0.876 / 0.764 → **0.891 / 0.839**	0.821 / **0.950** → **0.915** / 0.884
Wood	0.943 / **0.917** → **0.977** / 0.817	**0.955** / 0.900 → 0.943 / **0.904**	0.875 / **0.856** → **0.887** / 0.715
Zipper	0.939 / 0.965 → **0.993 / 0.989**	**0.947** / 0.929 → **0.947 / 0.982**	**0.970 / 0.967** → 0.902 / 0.934
Average	0.900 / 0.923 → **0.935 / 0.946**	0.916 / 0.926 → **0.941 / 0.959**	0.887 / 0.860 → **0.902 / 0.905**

D

Model	2-stage			1-stage
	DRAEM	JNLD	OmniAL	FADeR$_{EAR}$ (ours)
Candle	0.823	0.891	0.851	**0.927**
Capsules	0.773	0.891	0.879	**0.919**
Cashew	0.942	0.960	**0.971**	0.967
Chewing gum	0.934	**0.985**	0.949	0.926
Fryum	**1.000**	0.932	0.970	0.968
Macaroni1	0.703	0.943	0.969	**0.991**
Macaroni2	0.713	0.865	0.899	**0.965**
PCB1	0.713	0.820	0.966	**0.967**
PCB2	0.897	0.963	**0.994**	0.987
PCB3	0.731	**0.969**	**0.969**	0.974
PCB4	0.913	0.948	0.974	**0.999**
Pipe fryum	0.941	**0.960**	0.914	0.933
Average	0.841	0.930	0.942	**0.960**



A. Attention maps of saliency/defective regions (w/o FADeR)
B. Pre-trained attention-based masking methods on the MVTec AD
C. Latent masking methods on the MVTec AD
D. Comparison with two-stage model on the VisA
E. Original binary mask and soft mask for feature attenuation