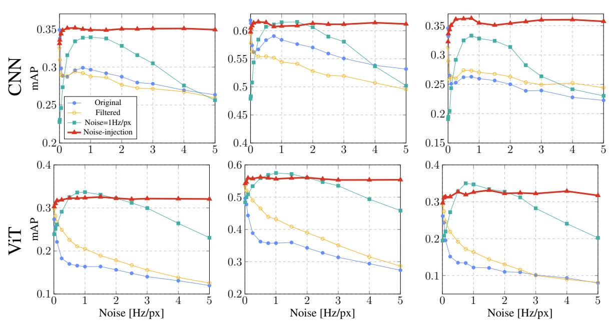
Learning from Noise: Enhancing DNNs for Event-Based Vision through Controlled Noise Injection

Supplementary Material

8. Detection results

In order to examine the impact of our method on another, more complex task, we used the N-Caltech101 dataset for object detection. For this purpose, we employed YOLOX as the detection head and exactly the same CNN and ViT architectures as in the classification study (ResNet18 and MaxViT – detailed information can be found in Table 1 in the main part of the work).



(a) mAP (b) mAP@50 (c) mAP@75

Figure 5. Results of detection on the N-Caltech101 [43] datasets without any filtering, presented across varying noise levels.

We conducted our experiments in the same way as for classification, training the models on four different training sets (*Original*, *Filtrated*, *Noise=1Hz/px*, and *Noise-injection* – see Figure 5). We then evaluated the averaged results across the entire range of noise frequencies using different filters (*NN*, *DIF*, and *EDnCNN* – see Table 3). As the main metric, we employed the mean average precision (mAP).

From the results shown in Figure 5, we can observe that even for the more complex task of detection, our learning method ensures performance stability regardless of the input noise frequency. In the detection setting, the models trained on a single noise frequency (1Hz/px) best results within that particular noise range. Meanwhile, similarly to the classification task, all methods apart from ours gradually degrade as the noise frequency increases.

When evaluating the results with filtering, our method again achieves the best outcomes for both models. The differences amount to 5% mAP with NN filtering between our approach and the *Filtered* for the CNN model, and 5.5% mAP for the ViT model. This demonstrates that our *noise-injection* approach can also be successfully applied to other, more complex tasks such as object detection.

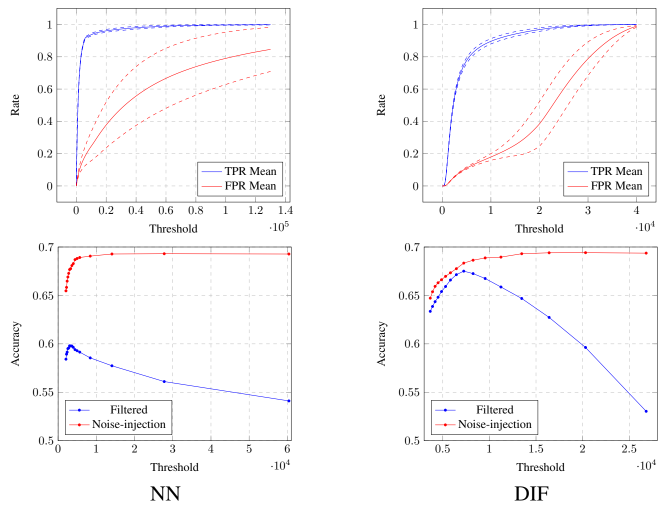


Figure 6. Comparison of true-positive and false-positive rate values together with the accuracy score depending on the NN and DIF filter parameter for the CNN model and the N-Caltech101. In both cases, it can be seen that our method performs better against the filters regardless of the parameters.

9. Ablation over different filter parameters

In order to evaluate the impact of filter parameter settings on denoising effectiveness and overall network performance, an ablation study was conducted for both the NN and DIF methods, using the baseline CNN model and the N-Clatech101 dataset. The results are presented in Figure 6. Due to the fact that the EDnCNN only returns the probability of an event to be noise, which should be set to 50%, it was excluded from this analysis.

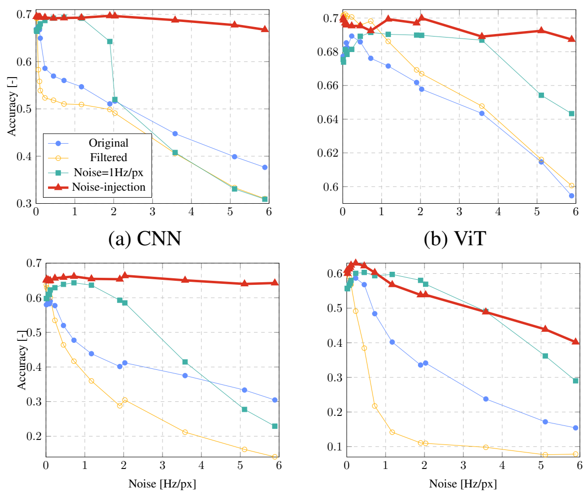
Initially, the True Positive Rate (TPR) and the False Positive Rate (FPR) were evaluated for various filter thresholds. Subsequent to this, representative thresholds were selected, and the average accuracy was assessed on the full test set under different noise intensities.

The TPR and FPR plots provide a clear indication that there is no threshold value at which the filter perfectly removes noise while preserving all true events. The analysis suggests that the optimal filter parameters are 5000 for NN and 7000 for DIF, where the TPR is already relatively high and the FPR remains sufficiently low.

The accuracy plots as a function of the filter parameter demonstrate that models trained on *Filtered* data achieve their highest accuracy at these optimal thresholds, while performance decreases for extreme parameter values. No-

Model	Training Set	NN mAP	NN mAP@50	NN mAP@75	EDnCNN mAP	EDnCNN mAP@50	EDnCNN mAP@75	DIF mAP	DIF mAP@50	DIF mAP@75	w/o mAP	w/o mAP@50	w/o mAP@75
CNN	Original	30.28 ± 2.22	57.57 ± 1.43	27.80 ± 3.89	31.23 ± 1.51	56.42 ± 1.57	30.17 ± 2.44	31.50 ± 1.92	58.04 ± 1.22	30.16 ± 3.53	28.62 ± 1.80	56.56 ± 2.18	24.91 ± 2.66
	Filtered	29.29 ± 1.46	55.62 ± 1.66	27.36 ± 1.79	29.81 ± 1.99	54.91 ± 2.88	28.56 ± 2.75	30.00 ± 1.51	56.18 ± 1.30	27.96 ± 2.17	28.12 ± 1.33	53.66 ± 2.42	26.07 ± 1.22
	Noise=1Hz	27.81 ± 5.06	53.74 ± 6.26	25.13 ± 6.13	24.13 ± 3.29	48.16 ± 4.70	20.71 ± 4.31	24.44 ± 3.84	49.60 ± 5.07	21.13 ± 4.52	30.54 ± 3.85	57.50 ± 4.74	28.18 ± 4.88
	Noise-injection	34.06 ± 1.10	60.40 ± 1.10	34.11 ± 1.95	32.14 ± 0.59	58.20 ± 0.67	30.78 ± 1.07	33.08 ± 1.10	59.48 ± 1.19	32.38 ± 1.79	**34.94 ± 0.43**	**61.17 ± 0.33**	**35.60 ± 0.78**
ViT	Original	20.56 ± 4.25	40.34 ± 5.01	18.22 ± 5.56	17.46 ± 4.08	32.80 ± 6.93	15.55 ± 3.96	22.86 ± 2.84	43.03 ± 3.41	21.20 ± 3.85	16.82 ± 4.66	35.82 ± 6.74	13.30 ± 5.65
	Filtered	25.55 ± 4.21	48.53 ± 4.56	23.57 ± 5.98	22.86 ± 5.48	41.27 ± 9.19	21.94 ± 5.74	27.63 ± 3.18	50.31 ± 3.45	26.71 ± 4.46	19.95 ± 5.51	41.52 ± 7.96	16.07 ± 6.98
	Noise=1Hz	27.15 ± 4.37	50.50 ± 4.62	25.00 ± 6.25	17.65 ± 0.83	34.66 ± 2.58	15.72 ± 0.77	24.57 ± 3.28	47.44 ± 3.96	21.21 ± 4.69	29.67 ± 3.85	54.43 ± 3.78	28.53 ± 5.89
	Noise-injection	31.12 ± 1.26	54.66 ± 1.08	31.01 ± 1.63	23.47 ± 2.22	41.86 ± 4.23	22.74 ± 2.18	30.44 ± 1.11	54.16 ± 1.25	30.04 ± 1.58	**32.06 ± 0.61**	**55.65 ± 0.56**	**32.14 ± 0.92**

Table 3. Quantitative results for CNN and ViT model on the N-Caltech101 datasets in detection problem using NN, EDnCNN, DIF and without filtration. Results represents the mean and standard deviation of mAP (mean average precision). **Bold** indicate the highest values for each model.



(a) CNN (b) ViT (c) SNN (d) GCN

Figure 7. Results of classification on the N-Caltech101 [43] datasets with real camera noises.

tably, regardless of the filtering strategy, models trained with our proposed *Noise-injection* approach consistently outperform those trained on filtered data, even when using the best possible filter parameters. Furthermore, the results indicate that our method performs increasingly well as the filter thresholds rise, i.e. as fewer events are removed. This suggests that aggressive filtering may negatively impact performance by eliminating critical information.

The findings demonstrate that, even under optimal filtering conditions, the proposed method consistently achieves superior results, thereby highlighting its robustness and ability to effectively handle noisy event data.

10. Real Noise Analysis

In order to verify that our method also works with real noise, we employed genuine noise obtained from an event camera. To achieve this, an event stream was recorded from a sensor observing a static scene under constant illumination, thereby ensuring that the recorded data were solely related to noise. The noise intensity was varied by adjusting the sensor's event generation threshold.

For the evaluation, we used the same models as in Section 4.2, trained on the Original, Filtered, Noise=1Hz/px and Noise-injection datasets (based on a Poisson process approximation). The results for the N-Caltech101 dataset, tested on all models, are presented in Fig. 7.

As shown, our method consistently achieves the best and most stable performance across the CNN, ViT, and SNN models. For the GCN model, the results significantly exceed those of the Original and Filtered models, with only the Noise=1Hz/px model achieving higher accuracy under comparable noise levels (around 1Hz/px). For the ViT model, performance at lower noise frequencies is slightly better (by approximately 0.5%) using the Filtered approach; however, at higher noise levels, our method exhibits a clear and substantial advantage.

These findings demonstrate that our approach is also applicable to real noise from an event camera. Crucially, the performance of models trained on artificially generated disturbances successfully translates to real-world noise.

11. Timing results

Filtering, as an additional pre-processing step, requires additional computational resources and increases the overall processing time of the system. Although event reduction through filtering simplifies the generation of representations due to a reduced number of events, in the case of representations such as Event Count Image or Voxel Grid, these operations can be fully parallelised.

We performed an analysis of the average number of events processed for each filtering method, and the results are presented in Table 4. For NN and DIF filtering, we used a single Intel Xeon Platinum 8268 CPU processor core, while EDnCNN filtering was performed on an NVIDIA A100 GPU and used 16 AMD EPYC 7742 processor cores.

As can be seen from the analysis, the use of the EDnCNN network significantly drops the number of events processed compared to other methods, which has a significant impact on system latency in real-time applications. For the remaining methods, although the number of events processed per second is significantly higher, values below 2 million events per second remain relatively low compared to modern event sensors capable of generating hundreds of millions of events per second. The solution to this problem is hardware acceleration of filters using SoC FPGA systems, as demonstrated with the DIF filter. However, it should be noted that each additional pre-processing element implemented on the FPGA increases the memory and computational requirements. In our approach, the absence of filter implementation on FPGA could contribute positively to resource utilisation in embedded systems.

Filtration	Events per second
NN	1412501.03
DIF	1854422.15
EDnCNN	8387.66

Table 4. Number of events processed per second using NN, DIF and EDnCNN filtering.

12. Detail results

Tables 5, 6, 7 and 8 present detailed top-1 and top-3 accuracy results for all versions of the training data: *Original*, *Filtered*, *Noise=1Hz/px* and *Noise-injection*. The average and std values are presented in Table 2.

Figures 8 and 9 illustrate additional GradCAM and GradCAM++ activation map examples for the N-Caltech101 and Mini N-ImageNet datasets, comparing our *Noise-injection* method with no method applied. All examples show consistent patterns: increased input noise results in reduced activation intensity for GradCAM and dispersed activations in background regions for GradCAM++. In contrast, activations remain stable when using our *Noise-injection* method.

	N-Caltech101								N-Cars				N-ImageNet							
	NN		EDnCNN		DIF		w/o		NN	EDnCNN	DIF	w/o	NN		EDnCNN		DIF		w/o	
Noise level	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc.	Acc.	Acc.	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3
CNN																				
0.01	63.84	76.88	59.55	74.16	63.28	76.46	67.18	78.83	88.71	80.47	86.41	77.89	36.74	54.99	14.24	26.01	33.01	49.94	42.91	61.14
0.05	63.73	76.94	59.84	74.16	63.34	76.58	67.25	78.66	88.70	80.61	86.43	56.53	36.94	54.93	14.10	26.21	33.23	49.58	43.55	62.18
0.1	63.73	77.07	59.73	74.27	63.34	76.46	64.75	77.74	88.42	80.81	86.58	56.68	36.88	55.11	14.24	26.01	33.09	50.04	44.09	62.72
0.25	64.01	77.36	60.07	74.04	63.62	76.81	56.77	72.74	84.81	80.27	86.80	61.09	37.20	55.49	14.34	26.01	33.48	50.04	43.67	62.92
0.5	64.30	77.40	60.18	74.56	63.80	76.92	56.83	69.47	63.84	80.71	87.01	69.36	38.26	56.49	14.38	26.21	33.58	50.77	41.85	60.90
0.75	64.75	77.41	60.76	75.02	64.08	77.27	55.28	69.70	56.42	80.99	86.89	67.21	38.94	57.79	14.56	26.56	34.08	51.05	39.50	58.37
1	64.62	77.03	60.93	74.90	64.14	77.27	54.12	68.84	55.34	81.36	85.44	62.25	39.64	59.15	14.81	26.42	34.61	52.25	38.20	56.03
1.5	59.27	75.31	61.39	75.76	64.94	77.73	50.49	66.09	57.34	81.84	73.06	56.39	40.65	60.08	15.15	26.94	35.92	53.88	35.40	51.78
2	56.30	70.63	62.61	76.68	65.46	77.91	46.75	62.69	61.12	82.01	58.82	53.26	39.92	59.35	15.72	27.45	38.27	55.72	32.37	48.06
2.5	56.30	69.43	63.98	76.95	66.79	78.60	43.07	60.74	66.68	82.26	55.30	51.43	38.84	58.39	16.20	27.89	39.73	58.09	29.35	45.11
3	56.09	68.91	64.44	76.87	66.24	78.60	40.82	58.52	68.00	82.76	55.65	50.57	37.84	56.95	16.28	28.58	40.11	58.76	26.96	42.13
4	53.21	67.81	55.80	72.78	58.09	71.71	38.01	56.40	60.97	80.78	62.67	49.71	35.66	53.37	17.33	30.14	39.75	59.04	23.12	37.42
5	48.38	64.41	48.89	63.03	53.95	68.55	35.42	52.49	55.22	64.22	62.24	49.33	32.97	50.16	18.04	31.25	37.82	56.07	20.11	33.51
ViT																				
0.01	66.24	77.64	57.63	72.32	65.75	76.80	67.94	78.74	87.82	76.99	86.76	89.53	37.17	51.40	17.38	28.86	34.77	47.63	41.60	57.37
0.05	66.25	77.64	57.58	72.08	65.96	76.68	68.40	79.26	87.89	77.16	86.87	79.71	37.13	51.50	17.42	28.72	34.77	47.65	42.02	57.93
0.1	66.29	77.64	57.58	72.32	65.79	76.87	68.74	79.73	87.96	77.08	87.02	75.95	37.33	51.60	17.42	28.64	34.99	47.69	42.82	58.65
0.25	66.35	77.58	57.52	72.38	65.69	76.85	68.63	79.43	88.13	77.23	87.07	73.29	37.47	51.72	17.46	28.88	34.89	47.98	42.92	58.85
0.5	66.41	77.36	57.92	71.97	66.09	76.91	67.63	79.62	84.23	77.37	87.21	72.20	37.90	52.22	17.56	28.88	35.11	48.18	41.62	57.09
0.75	66.81	78.04	57.63	72.77	66.03	77.04	67.71	79.68	78.87	77.90	87.79	70.31	38.30	52.88	17.44	28.78	35.26	48.44	39.58	54.18
1	66.81	78.39	58.04	72.49	66.19	77.27	66.91	79.98	75.95	77.69	87.85	68.75	38.76	53.52	17.61	28.84	35.46	48.85	37.27	51.46
1.5	67.21	78.50	57.69	72.55	66.49	77.44	66.32	79.62	73.24	78.53	85.79	65.73	40.18	54.34	17.89	29.22	35.70	49.72	33.49	46.77
2	67.04	79.23	57.46	72.35	66.92	77.78	65.68	79.16	71.89	78.89	79.90	63.08	40.28	54.52	17.81	29.42	36.55	50.65	31.10	43.04
2.5	67.50	79.02	56.72	70.82	67.97	78.76	64.47	78.63	71.16	79.18	75.55	60.78	39.38	53.44	18.01	29.69	37.20	52.53	29.18	40.72
3	66.58	78.67	56.04	69.41	67.93	79.33	64.36	77.83	70.37	79.94	73.25	58.59	37.21	51.46	18.09	29.85	38.47	53.34	27.48	38.24
4	65.88	78.83	48.60	63.59	67.94	79.60	61.66	76.11	67.72	80.21	70.96	55.25	33.87	46.51	18.56	29.97	37.08	52.14	26.26	35.23
5	65.83	78.72	38.11	50.97	66.65	79.43	59.71	74.67	64.64	77.89	67.08	52.72	30.98	42.52	18.88	30.88	32.48	45.81	25.03	33.59
SNN																				
0.01	50.50	63.28	48.83	62.09	46.45	59.06	58.39	70.65	84.86	75.29	82.89	89.19	29.31	45.67	10.21	19.84	27.00	42.17	36.38	54.27
0.05	50.71	63.45	48.77	62.50	46.86	60.40	58.62	70.65	84.97	75.09	83.18	80.69	29.71	45.27	9.87	19.30	26.96	42.05	37.22	54.97
0.1	50.57	62.94	49.12	62.09	47.44	60.00	59.32	71.45	84.92	75.25	82.79	70.07	29.53	45.33	10.23	19.19	26.98	42.56	37.24	56.13
0.25	51.14	63.80	49.12	62.36	47.54	59.67	57.26	69.95	85.16	75.04	83.16	69.10	30.21	45.73	9.99	19.26	27.12	42.68	37.82	56.45
0.5	52.47	64.54	49.16	63.52	48.70	60.74	51.01	66.10	84.36	75.63	83.29	79.40	30.39	45.49	10.40	19.56	27.67	42.60	37.44	55.63
0.75	52.76	65.23	49.81	63.87	48.53	61.12	47.24	63.52	80.49	75.60	83.77	81.90	30.63	46.92	10.19	19.70	28.13	42.92	36.02	54.97
1	53.09	66.26	50.21	63.68	49.39	60.92	45.06	61.90	73.27	75.89	83.61	82.32	30.99	47.58	10.72	19.90	28.28	43.59	34.76	52.84
1.5	54.83	66.79	51.64	64.10	51.34	63.12	42.89	58.75	65.73	76.39	83.33	74.93	31.93	48.18	10.42	19.78	28.86	45.31	32.51	49.84
2	50.50	65.42	52.10	65.82	52.14	63.77	39.69	57.50	65.79	75.94	81.12	65.31	31.55	48.24	10.86	20.71	29.85	46.32	29.97	46.69
2.5	48.54	64.13	53.36	66.86	53.63	66.56	38.87	56.66	69.08	76.70	72.48	58.16	31.95	48.40	10.86	20.27	30.50	47.29	27.96	44.29
3	45.62	61.56	53.37	67.09	55.76	68.53	38.17	56.20	73.53	77.27	67.41	52.51	31.55	47.68	11.21	21.38	31.82	48.42	26.96	41.97
4	42.92	59.80	54.39	68.34	53.02	68.40	35.69	51.95	76.75	78.01	71.32	49.16	29.43	44.83	11.85	21.74	31.72	47.65	23.50	37.92
5	40.75	58.48	50.55	65.53	47.20	62.72	31.63	47.20	72.60	78.53	75.48	48.94	27.62	41.97	12.64	22.78	29.17	43.28	21.11	34.58
GCN																				
0.01	53.30	66.58	44.91	61.30	53.90	66.17	55.28	68.47	75.91	66.52	76.38	78.03	37.85	45.52	15.23	26.05	37.23	44.74	40.16	55.29
0.05	53.06	66.58	44.87	60.91	53.67	66.52	56.89	71.76	76.05	66.18	76.24	78.15	37.79	45.54	15.35	26.29	37.71	44.62	39.90	55.13
0.1	52.63	66.17	44.95	60.38	53.44	66.46	58.16	72.39	75.74	66.56	76.28	77.95	38.19	46.67	15.21	26.27	37.47	45.10	39.58	54.59
0.25	53.43	66.46	45.66	61.36	53.96	66.23	58.52	72.12	75.02	66.19	76.25	77.07	38.47	46.77	15.43	26.21	37.71	45.22	39.62	53.75
0.5	54.62	67.95	45.88	61.14	53.26	66.75	54.06	69.10	74.56	66.03	76.48	75.28	38.67	47.55	15.21	26.05	37.59	46.01	38.35	52.35
0.75	54.69	68.18	45.22	60.44	53.79	66.86	46.21	65.66	74.25	66.54	76.31	72.02	38.83	48.29	15.35	26.01	37.93	45.83	37.15	49.96
1	55.98	70.44	45.86	60.97	54.25	67.89	43.74	61.14	74.87	66.74	76.01	69.74	38.99	48.95	15.41	26.45	37.69	45.67	36.47	49.20
1.5	57.13	71.36	46.89	63.52	54.55	67.12	37.94	56.84	74.77	66.33	75.36	63.82	38.93	48.37	15.51	26.39	38.93	47.55	35.43	46.04
2	56.21	71.49	49.26	65.14	56.07	69.58	30.80	49.26	75.04	67.35	75.51	58.78	38.35	48.29	15.77	26.31	39.42	48.01	34.21	45.04
2.5	55.31	70.30	52.00	66.82	56.53	70.10	29.09	44.39	74.26	67.27	75.06	55.24	37.65	46.65	15.65	26.51	39.52	48.93	33.91	43.69
3	51.41	67.93	52.71	67.35	56.60	70.17	26.29	41.68	73.20	66.63	74.74	53.46	37.35	45.16	15.57	26.61	39.62	48.49	33.25	42.35
4	40.63	60.37	52.08	67.83	56.47	71.83	20.57	35.34	70.44	65.30	72.20	48.74	35.65	42.46	15.21	26.05	37.35	45.81	32.10	40.71
5	34.71	53.92	38.41	56.85	46.99	64.51	16.02	29.11	67.09	65.30	68.55	46.94	34.83	40.78	16.35	27.50	35.43	41.36	31.84	40.51

Table 5. Detail quantitative results of different models trained on *Original* data verions on the N-Caltech101 [43], N-Cars [52] and Mini N-ImageNet [30] datasets, using NN [10], EDnCNN [2], DIF [31] and without filtration.

	N-Caltech101								N-Cars				N-ImageNet							
	NN		EDnCNN		DIF		w/o		NN	EDnCNN	DIF	w/o	NN		EDnCNN		DIF		w/o	
Noise level	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc.	Acc.	Acc.	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3
CNN																				
0.01	68.73	80.99	67.09	79.79	68.45	80.24	68.80	81.57	88.43	80.86	86.72	88.60	42.97	61.50	19.70	33.52	39.97	58.72	45.83	64.94
0.05	68.73	81.11	67.26	79.62	68.45	80.08	57.10	75.89	88.53	80.97	86.80	86.10	43.01	61.46	19.56	33.84	40.11	58.64	45.47	64.42
0.1	68.62	81.11	67.26	79.73	68.28	80.41	53.72	69.41	88.17	80.90	86.73	85.83	42.91	61.52	19.44	33.72	40.09	58.86	44.25	63.18
0.25	68.78	80.76	67.32	79.90	68.40	80.48	51.63	67.51	86.45	80.81	86.81	74.46	42.89	62.10	19.52	33.80	40.49	58.94	42.93	61.58
0.5	66.78	80.29	67.55	80.01	68.23	80.36	51.40	66.30	82.98	81.13	86.76	64.55	43.35	62.84	19.86	34.10	40.64	59.71	41.35	60.12
0.75	58.23	76.38	68.12	79.90	68.45	80.29	50.54	65.60	82.48	81.08	86.44	60.64	43.49	63.20	20.25	34.41	40.88	60.09	39.94	58.49
1	54.67	71.38	68.18	79.96	68.34	80.54	50.19	65.54	82.40	81.27	85.85	58.68	42.73	62.46	20.04	34.77	41.67	60.28	38.04	56.67
1.5	52.09	67.44	68.07	80.01	68.63	80.46	49.56	63.71	79.74	81.81	83.70	56.44	41.77	60.42	20.53	34.85	42.46	61.93	35.02	53.02
2	51.12	66.52	68.18	79.79	66.91	80.06	48.82	62.96	71.42	82.13	82.33	55.16	40.95	59.60	20.97	35.96	43.31	62.64	32.77	49.36
2.5	51.01	66.46	67.95	80.08	58.36	75.94	46.58	61.87	65.42	81.82	81.19	54.21	39.50	58.51	21.60	35.80	43.67	63.07	30.07	46.31
3	50.63	66.12	62.16	77.15	54.12	69.57	44.75	60.38	61.31	82.63	81.95	53.49	38.66	57.07	21.97	36.77	43.61	61.85	27.78	43.03
4	49.94	64.97	46.81	62.53	50.82	66.65	40.62	55.62	56.99	80.71	69.70	52.48	36.50	54.51	23.64	38.81	41.46	60.40	23.46	37.64
5	49.25	63.92	43.03	57.06	50.25	65.01	37.98	51.71	54.54	75.75	57.86	52.01	33.69	50.94	25.36	40.57	39.24	57.32	19.95	32.63
ViT																				
0.01	69.89	81.29	62.25	74.48	69.46	80.43	69.82	81.81	89.04	81.79	87.92	89.16	44.65	59.87	22.38	36.40	43.04	56.80	48.09	65.14
0.05	69.83	81.41	61.96	74.19	69.52	80.32	70.05	81.47	89.00	81.56	88.14	87.28	44.77	59.81	22.54	36.48	43.04	56.80	47.65	64.76
0.1	70.00	81.41	62.42	74.65	69.35	80.38	70.05	81.81	88.81	81.57	88.11	86.56	44.87	60.13	22.66	36.73	42.94	56.90	47.23	64.38
0.25	69.95	81.58	62.31	74.43	69.46	80.55	70.29	81.47	87.67	81.76	88.00	85.66	44.99	60.19	22.58	37.03	43.18	57.06	46.59	63.28
0.5	69.83	81.47	61.96	74.13	69.52	80.61	69.82	81.24	84.08	82.21	88.22	83.38	44.95	60.37	22.58	37.13	43.31	57.46	43.44	59.67
0.75	69.77	81.64	62.36	74.59	69.57	80.55	68.89	80.99	82.90	82.55	87.81	76.42	44.83	60.33	22.88	37.03	43.61	58.19	39.88	56.26
1	69.66	81.47	62.02	73.91	69.63	81.12	69.23	80.52	82.69	82.25	86.87	72.54	44.47	60.31	22.46	37.49	43.57	58.15	37.37	52.48
1.5	69.89	81.24	61.56	73.51	69.52	81.12	68.03	79.85	81.29	83.29	83.36	68.09	43.90	59.73	22.95	37.35	44.01	58.80	34.15	47.75
2	69.83	81.12	61.27	73.05	69.52	81.24	66.54	78.23	82.64	83.40	81.97	65.23	42.58	58.23	23.21	37.96	43.99	59.41	31.06	44.00
2.5	69.54	80.94	59.54	72.49	69.69	81.24	65.27	76.97	82.58	83.72	82.82	63.42	40.84	55.54	23.69	38.26	43.71	59.55	29.36	41.38
3	69.87	80.99	57.71	70.07	69.82	81.29	64.01	76.34	77.17	84.15	83.27	62.21	38.28	53.62	24.00	38.87	42.66	58.23	27.70	39.20
4	68.15	79.69	51.51	64.45	68.94	81.01	62.29	73.63	69.89	83.41	82.90	60.04	34.77	47.95	24.73	39.23	38.41	52.93	25.58	35.47
5	67.27	79.22	42.96	56.01	67.41	79.72	59.88	72.09	65.66	78.08	70.82	58.30	31.06	43.06	25.33	40.06	32.93	45.96	23.95	32.25
SNN																				
0.01	61.22	74.67	58.06	71.55	58.55	71.95	63.15	76.50	87.57	77.55	85.63	89.32	38.06	56.75	14.93	25.63	36.02	53.48	42.53	62.68
0.05	61.26	74.79	57.55	71.49	58.78	71.72	62.42	76.21	87.34	77.55	86.01	85.69	38.00	56.93	15.25	26.54	35.68	53.34	42.47	62.96
0.1	61.10	75.07	57.89	71.32	58.09	71.62	60.23	74.37	87.31	77.43	85.66	82.74	38.28	57.39	14.70	26.50	36.47	53.80	42.95	61.92
0.25	61.40	74.46	57.62	71.38	58.74	72.01	51.66	68.00	86.94	77.59	86.14	77.94	39.06	57.19	14.99	26.38	36.02	54.29	42.19	61.34
0.5	61.96	74.70	57.43	71.65	59.81	71.95	44.89	59.61	85.16	77.49	85.86	64.29	39.28	57.31	15.05	26.54	36.51	55.08	41.37	60.40
0.75	60.76	75.30	57.50	71.22	59.02	72.12	41.39	54.88	82.10	77.27	85.78	57.44	39.10	58.29	15.09	26.74	36.53	55.24	40.85	58.75
1	58.79	73.07	57.90	70.81	60.56	73.50	37.39	51.16	79.76	77.72	85.65	54.44	39.14	57.33	15.17	26.34	37.50	55.80	38.48	56.77
1.5	54.42	69.56	57.78	71.55	60.23	72.01	32.67	46.86	78.91	78.12	83.84	51.63	39.80	57.63	15.55	27.25	38.05	55.97	34.27	52.20
2	48.76	64.47	58.68	73.27	60.34	73.57	28.31	41.34	76.44	78.61	82.20	50.36	39.12	58.21	15.68	27.51	39.56	57.46	30.29	47.64
2.5	44.63	60.43	58.15	72.75	59.70	73.39	25.08	38.43	70.86	78.47	79.96	49.85	39.20	57.93	16.26	28.42	39.02	57.54	26.64	43.41
3	41.85	56.62	57.43	71.72	57.42	71.74	22.09	35.72	65.07	78.61	77.46	49.55	38.38	56.81	16.14	27.97	39.58	57.89	24.18	39.58
4	35.81	49.71	50.22	66.92	45.95	60.01	18.09	30.13	55.92	79.52	72.85	49.24	35.40	52.90	17.13	29.75	38.17	55.76	20.15	34.09
5	31.29	46.49	34.97	50.12	37.27	51.10	14.52	24.70	51.75	78.34	58.64	49.08	31.69	48.22	17.52	30.50	33.80	50.26	15.63	28.79
GCN																				
0.01	59.08	72.32	54.12	68.62	60.05	72.95	60.91	74.11	77.48	68.13	77.87	79.65	40.00	56.21	15.71	27.72	38.77	54.21	42.04	59.18
0.05	59.82	72.49	53.50	68.28	60.28	73.07	59.43	73.78	77.48	68.08	77.97	80.14	40.22	56.07	15.75	27.82	39.29	54.13	40.88	56.77
0.1	59.42	71.69	54.58	68.14	60.57	73.13	56.04	69.65	77.65	68.30	77.97	79.63	40.98	56.73	15.85	27.54	39.07	54.63	39.44	54.91
0.25	58.96	71.93	54.25	69.01	60.68	72.92	44.90	59.10	77.16	67.64	77.32	76.40	41.30	57.62	15.83	27.58	39.68	55.27	37.85	51.53
0.5	59.71	73.30	53.79	67.93	60.63	73.21	32.00	45.55	77.05	68.06	77.98	73.17	40.90	57.72	15.55	27.17	39.84	55.13	35.79	47.90
0.75	59.19	72.04	52.44	66.62	60.74	74.06	21.59	34.01	77.15	68.35	77.68	67.72	41.16	56.59	15.71	27.54	40.34	56.05	35.01	46.02
1	58.16	71.02	52.10	67.48	61.43	73.77	15.97	26.16	76.95	68.43	77.76	64.41	40.26	56.45	15.93	27.76	40.34	55.85	33.99	44.94
1.5	54.09	68.44	53.66	68.68	61.33	74.48	11.07	20.88	77.16	68.69	77.97	59.69	38.55	53.77	16.01	27.60	41.32	58.16	33.53	43.21
2	46.16	61.00	55.57	69.77	61.50	74.77	10.67	17.67	75.93	69.00	77.15	54.52	37.83	51.19	16.07	27.88	41.34	58.12	33.04	42.29
2.5	36.58	52.06	55.71	70.62	59.72	73.34	10.39	18.20	74.15	68.08	76.80	51.96	36.91	48.94	16.49	28.24	40.90	57.04	32.62	41.81
3	29.02	43.78	54.27	69.14	58.85	72.31	9.63	17.60	71.83	68.97	75.00	51.74	35.67	47.72	15.83	28.02	38.77	53.67	32.08	40.57
4	16.09	28.43	42.39	59.03	48.20	63.86	9.23	17.34	68.12	67.06	70.33	51.39	34.25	44.58	16.01	28.42	35.87	47.90	31.66	39.83
5	11.38	20.21	22.55	36.99	22.61	35.55	8.20	15.60	63.82	67.11	66.78	51.41	33.33	43.17	16.79	29.16	33.75	44.42	31.14	38.59

Table 6. Detail quantitative results of different models trained on *Filtered* data verions on the N-Caltech101 [43], N-Cars [52] and Mini N-ImageNet [30] datasets, using NN [10], EDnCNN [2], DIF [31] and without filtration.

	N-Caltech101								N-Cars				N-ImageNet							
	NN		EDnCNN		DIF		w/o		NN	EDnCNN	DIF	w/o	NN		EDnCNN		DIF		w/o	
Noise level	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc.	Acc.	Acc.	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3	Acc.	Acc. top-3
CNN																				
0.01	65.24	77.97	63.11	77.55	64.89	77.87	66.84	79.59	86.31	76.46	85.47	89.64	35.04	51.74	15.76	26.92	32.77	49.70	40.20	58.29
0.05	65.24	78.03	62.99	77.50	64.89	77.81	67.52	79.82	86.34	76.47	85.47	89.80	35.20	51.84	15.82	26.98	32.85	49.62	41.03	59.13
0.1	65.24	78.03	63.28	77.21	65.23	77.87	68.21	80.34	86.43	76.64	85.66	90.10	35.10	51.90	15.88	27.00	32.81	49.86	41.11	59.29
0.25	65.36	78.33	63.05	77.55	65.23	77.99	69.19	81.25	86.34	76.78	85.74	90.58	35.32	52.28	15.90	27.06	33.21	49.98	41.97	60.10
0.5	65.99	78.26	63.57	77.61	65.52	78.16	69.49	81.43	86.55	76.96	85.88	90.94	35.64	52.80	15.98	27.04	33.84	50.40	43.25	61.02
0.75	66.50	79.03	63.57	77.44	65.86	78.16	69.60	81.77	87.07	77.31	86.13	91.40	36.58	53.71	15.98	27.37	34.26	50.81	44.19	62.48
1	67.02	79.83	64.08	77.55	65.80	78.44	69.93	82.06	87.25	77.40	86.43	91.60	37.36	54.47	15.84	27.27	34.65	51.23	45.01	62.36
1.5	68.57	79.66	64.20	77.55	65.63	78.04	69.42	81.13	88.32	77.79	86.73	90.69	38.04	55.19	16.59	27.91	35.23	52.83	44.13	61.24
2	68.81	80.81	64.83	77.90	66.61	78.73	62.98	78.09	88.68	78.05	87.48	75.83	38.84	56.45	16.50	28.16	37.12	54.09	41.11	58.35
2.5	69.03	81.15	65.17	78.01	67.41	79.48	52.77	69.53	89.02	78.78	87.92	62.47	39.78	56.99	16.75	28.24	38.21	55.32	37.24	53.97
3	69.43	81.34	65.86	78.36	68.04	79.88	49.85	65.80	89.57	79.13	88.51	57.53	40.69	58.39	16.71	28.76	38.84	56.53	34.13	50.38
4	69.66	81.44	65.39	77.96	69.13	80.62	46.64	63.38	89.87	80.53	89.08	53.32	41.43	58.53	17.50	29.77	40.35	58.13	29.05	44.05
5	66.85	79.96	63.17	74.66	68.67	80.15	45.21	61.33	85.16	80.91	86.59	51.85	39.22	56.43	18.77	30.54	40.35	58.66	24.52	38.72
ViT																				
0.01	66.25	78.37	60.27	74.23	66.02	78.41	67.79	79.57	85.73	79.32	86.05	89.50	34.01	47.31	15.78	25.99	32.55	44.88	40.14	55.58
0.05	66.36	78.49	60.15	74.11	66.07	78.36	68.19	79.85	85.78	79.46	86.04	89.59	34.11	47.51	15.81	25.92	32.53	45.07	40.58	56.52
0.1	66.36	78.55	60.10	74.06	66.24	78.30	68.08	79.79	85.75	79.44	86.23	89.52	34.35	47.69	15.78	26.09	32.53	45.19	41.18	57.39
0.25	66.25	78.73	59.92	73.77	66.24	78.36	68.25	80.36	86.02	79.29	86.10	89.90	34.63	47.91	15.78	25.86	32.63	45.61	42.90	59.51
0.5	66.71	78.67	59.35	74.00	66.24	78.24	68.88	80.19	86.02	79.44	86.38	91.07	35.35	48.21	15.87	26.03	32.99	45.91	44.53	61.77
0.75	67.05	78.86	59.18	73.77	66.42	78.14	69.05	80.55	86.13	79.93	86.73	91.52	35.61	49.39	15.95	26.19	33.54	46.68	45.95	62.69
1	66.59	79.38	59.75	73.60	66.59	78.30	69.05	80.84	86.40	80.12	86.94	91.24	36.35	50.25	15.87	26.41	33.72	47.21	46.05	63.50
1.5	67.51	79.65	58.49	73.50	66.53	78.70	69.17	81.02	87.56	80.42	87.26	90.96	37.73	52.26	16.23	26.63	34.83	48.48	45.67	62.59
2	68.19	79.64	57.29	72.85	67.39	79.22	68.14	81.02	88.15	80.49	87.48	81.30	39.78	54.84	16.31	27.16	35.90	49.66	42.92	59.57
2.5	68.01	80.11	56.01	71.71	67.33	79.40	68.41	80.79	89.01	81.15	88.10	62.46	41.50	56.60	16.57	27.73	36.79	51.70	40.24	56.20
3	68.77	80.45	54.42	69.54	67.68	79.79	67.84	80.56	89.17	81.04	88.44	58.23	41.88	57.75	17.06	27.36	38.80	53.44	37.29	52.44
4	68.64	80.73	48.51	64.78	68.65	80.66	67.66	79.59	89.04	82.09	89.56	56.14	43.32	59.37	17.38	28.39	40.29	57.36	33.01	46.55
5	68.76	80.95	40.56	57.17	68.18	81.14	65.83	78.78	83.05	82.05	86.81	56.17	41.28	56.85	17.89	29.26	39.26	55.75	29.94	42.56
SNN																				
0.01	56.64	70.67	53.86	68.90	54.83	68.64	60.16	73.58	82.31	71.80	81.50	86.17	27.64	42.29	9.85	19.86	25.67	38.71	33.73	50.72
0.05	56.27	70.97	53.97	69.12	54.77	68.30	60.90	73.80	82.22	71.92	81.39	86.70	28.37	42.03	9.89	19.54	25.65	39.06	34.05	51.32
0.1	56.36	71.02	53.46	68.79	54.25	68.13	62.05	73.59	82.18	71.52	81.60	86.94	28.08	41.81	10.09	19.68	25.55	39.79	35.14	51.68
0.25	56.97	70.74	53.98	69.75	56.09	69.22	62.92	75.65	82.36	71.81	81.48	88.35	27.50	41.59	9.77	19.01	25.87	40.05	35.28	53.08
0.5	57.17	71.32	54.28	69.70	55.34	69.45	64.47	76.84	83.13	72.12	81.89	89.47	28.81	43.03	9.99	19.17	26.05	40.37	38.24	55.73
0.75	58.25	71.60	54.34	70.33	55.86	69.05	65.17	77.40	83.26	71.96	82.50	90.12	28.99	43.73	10.40	19.86	26.23	39.95	38.76	56.13
1	58.99	72.23	54.54	70.45	56.43	69.50	64.30	77.17	84.07	72.14	82.68	90.53	29.51	43.41	9.89	19.30	26.54	40.88	39.32	57.91
1.5	61.70	74.01	55.60	69.99	56.89	70.02	63.28	76.55	84.99	72.65	83.62	90.94	30.53	45.71	10.42	19.80	27.57	42.66	39.38	58.35
2	61.46	74.70	55.07	69.99	56.89	70.48	58.68	72.42	86.02	72.98	83.94	87.82	31.89	47.42	10.50	20.19	28.56	43.91	36.68	55.03
2.5	62.47	76.13	54.88	70.10	58.61	71.93	53.11	69.09	86.78	73.51	84.73	80.05	33.41	49.00	10.48	20.45	30.02	44.78	34.35	51.68
3	63.77	76.36	55.01	70.16	60.16	72.77	46.78	62.11	87.74	73.81	85.72	70.69	34.44	50.08	10.90	21.02	31.35	45.85	30.89	47.94
4	63.29	76.26	55.64	70.91	61.89	74.85	34.27	49.32	88.86	74.97	87.59	57.86	35.72	52.92	10.82	20.59	34.14	50.04	24.40	40.34
5	61.12	73.73	53.00	67.05	61.43	75.05	22.26	35.66	87.56	75.84	88.30	52.46	35.22	51.66	11.65	21.62	34.73	51.40	20.43	35.00
GCN																				
0.01	52.69	67.31	45.66	59.90	52.50	67.05	56.20	70.20	72.86	64.85	74.12	75.72	36.67	48.54	14.48	24.25	36.21	47.74	38.91	52.97
0.05	52.92	67.49	45.54	59.62	52.57	67.33	57.23	70.67	72.92	65.17	74.28	76.80	36.67	48.84	14.22	24.21	36.21	47.82	39.72	54.53
0.1	53.32	67.78	44.68	60.77	52.57	66.99	59.59	72.39	72.93	65.06	74.35	77.24	36.43	49.12	14.22	24.13	35.95	47.68	40.30	55.43
0.25	54.65	67.49	45.51	60.61	53.20	67.23	59.98	73.08	72.98	64.55	73.90	77.61	36.95	49.44	14.46	24.05	35.81	47.96	41.10	57.06
0.5	55.44	68.94	43.99	60.04	53.03	67.16	61.50	73.04	73.52	64.46	74.21	78.46	37.51	51.23	14.30	23.93	35.91	47.94	42.42	59.00
0.75	56.23	69.33	44.06	59.85	53.49	68.02	61.36	73.53	73.53	64.61	73.86	77.60	38.31	52.65	14.48	24.09	36.63	48.48	42.20	59.34
1	57.13	70.66	44.12	60.67	55.28	68.77	59.36	71.42	74.04	65.91	74.28	77.06	38.77	53.15	14.22	24.39	36.13	48.86	42.56	59.92
1.5	58.73	71.99	46.28	61.34	55.12	68.14	59.12	72.48	74.73	65.24	74.09	74.92	39.56	53.97	14.52	24.31	37.65	50.62	40.76	56.75
2	59.61	72.18	49.22	64.05	56.47	69.74	58.26	71.18	75.31	65.77	75.11	69.08	39.92	55.75	14.54	25.03	37.99	51.33	37.71	52.01
2.5	60.52	73.22	51.10	65.79	57.75	70.67	55.98	69.76	75.45	65.15	74.03	64.87	40.46	56.45	14.26	24.89	39.37	54.13	36.29	48.54
3	61.56	73.60	52.50	66.12	57.45	70.43	52.41	67.13	75.65	64.61	73.60	61.27	40.94	57.78	14.40	24.93	40.24	55.79	34.87	46.06
4	60.22	74.03	53.26	67.36	59.18	73.04	46.46	62.27	75.91	63.75	71.36	56.98	41.20	58.70	14.64	25.19	41.36	57.68	33.77	43.73
5	58.96	72.16	52.28	67.07	59.13	72.68	37.39	52.73	75.61	63.90	71.06	55.76	39.84	54.83	14.54	25.19	40.54	56.53	33.63	42.57

Table 7. Detail quantitative results of different models trained on *Noise=1Hz/px* data verions on the N-Caltech101 [43], N-Cars [52] and Mini N-ImageNet [30] datasets, using NN [10], EDnCNN [2], DIF [31] and without filtration.

Noise level	N-Caltech101 NN Acc.	N-Caltech101 NN Acc. top-3	N-Caltech101 EDnCNN Acc.	N-Caltech101 EDnCNN Acc. top-3	N-Caltech101 DIF Acc.	N-Caltech101 DIF Acc. top-3	N-Caltech101 w/o Acc.	N-Caltech101 w/o Acc. top-3	N-Cars NN Acc.	N-Cars EDnCNN Acc.	N-Cars DIF Acc.	N-Cars w/o Acc.	N-ImageNet NN Acc.	N-ImageNet NN Acc. top-3	N-ImageNet EDnCNN Acc.	N-ImageNet EDnCNN Acc. top-3	N-ImageNet DIF Acc.	N-ImageNet DIF Acc. top-3	N-ImageNet w/o Acc.	N-ImageNet w/o Acc. top-3
CNN																				
0.01	68.83	80.48	67.88	80.31	69.14	80.31	69.54	80.65	89.01	82.12	87.77	91.50	42.83	61.46	21.54	34.73	42.19	60.48	45.65	64.54
0.05	68.89	80.48	67.82	80.25	69.37	80.48	69.49	80.99	89.09	82.14	87.77	91.59	42.93	61.44	21.54	34.79	42.29	60.48	45.63	64.76
0.1	68.83	80.42	67.59	80.31	69.31	80.42	69.72	80.99	89.13	81.98	88.03	91.79	42.99	61.46	21.74	34.71	42.31	60.56	45.85	64.76
0.25	68.96	80.42	67.71	80.19	69.03	80.25	69.43	80.59	89.12	82.05	87.94	91.90	43.21	61.86	21.82	34.87	42.37	60.68	46.01	64.70
0.5	68.90	80.36	67.37	80.48	69.43	80.25	69.60	80.71	89.33	82.26	88.27	92.03	43.37	62.18	21.82	35.21	42.31	61.02	45.93	64.94
0.75	69.54	80.42	67.42	80.08	69.49	80.43	69.54	81.11	89.36	82.11	88.14	92.06	43.71	62.18	21.56	35.09	43.16	61.14	45.73	64.64
1	69.07	80.65	67.48	79.90	69.31	80.72	69.14	80.94	89.54	82.07	88.31	92.08	43.99	62.22	21.60	35.34	43.18	61.33	45.55	64.54
1.5	69.31	80.25	67.59	80.08	69.49	80.65	69.37	80.76	89.69	82.65	88.76	91.82	43.97	62.80	22.21	35.52	44.11	62.36	45.49	65.00
2	69.53	80.48	68.40	80.01	69.54	80.69	69.60	81.11	89.44	82.99	89.10	91.82	44.37	62.86	22.53	36.12	44.36	62.95	45.89	64.90
2.5	68.84	81.05	68.05	80.12	69.54	80.71	69.49	81.28	89.86	83.07	89.14	91.60	44.07	63.04	22.86	36.79	44.74	62.90	45.43	64.66
3	68.94	80.54	67.54	80.12	69.37	80.18	69.54	80.42	89.82	83.18	88.83	91.42	43.61	63.06	22.80	36.93	45.08	63.19	45.43	64.68
4	69.06	80.08	67.25	79.38	69.77	80.65	69.43	80.20	89.86	83.88	89.52	91.16	43.85	62.20	23.46	38.29	45.27	63.51	45.09	64.36
5	69.17	80.71	66.73	78.00	69.77	80.41	69.43	80.46	89.87	84.66	89.28	90.73	43.01	61.74	24.41	38.73	44.26	62.46	44.87	63.66
ViT																				
0.01	69.47	80.98	64.70	77.69	69.21	80.94	70.02	81.11	89.51	81.19	89.15	91.93	45.27	61.25	23.37	36.77	44.07	59.47	47.99	64.88
0.05	69.36	80.92	64.64	77.57	69.39	80.94	70.02	81.11	89.45	81.24	89.15	91.88	45.31	61.29	23.43	36.97	43.97	59.33	48.01	64.88
0.1	69.47	80.92	64.89	77.69	69.21	80.94	69.96	81.22	89.50	81.12	89.06	91.82	45.25	61.33	23.59	36.56	43.97	59.26	47.95	65.12
0.25	69.36	81.03	64.64	77.46	69.21	81.11	69.56	81.17	89.57	81.47	89.16	91.91	45.33	61.37	23.21	37.05	44.05	59.31	48.05	65.18
0.5	69.36	81.05	64.24	77.34	69.44	80.99	69.44	80.99	89.65	81.50	89.35	91.72	45.41	61.85	23.63	37.03	44.20	59.63	48.11	65.36
0.75	69.30	80.80	63.67	77.17	69.44	81.11	69.61	81.05	89.72	81.97	89.52	91.43	45.59	61.53	23.71	37.35	44.40	59.65	48.37	65.06
1	69.59	81.10	63.44	76.83	69.61	80.88	69.61	81.05	89.73	82.03	89.59	91.46	45.65	61.69	23.71	37.27	44.34	59.85	47.89	65.30
1.5	69.82	81.18	62.98	76.83	69.56	81.22	69.44	81.40	89.71	82.25	89.52	90.90	45.91	62.29	23.98	37.80	44.94	60.24	48.47	64.80
2	69.53	81.10	62.45	76.25	69.33	81.05	69.61	81.05	89.60	82.60	89.92	91.02	45.57	61.93	24.26	37.92	44.66	60.52	48.37	64.44
2.5	69.76	80.82	61.55	75.91	69.73	81.40	69.56	81.34	89.68	82.72	89.71	90.78	45.77	62.59	24.08	38.04	45.47	60.50	47.95	64.48
3	69.70	81.51	59.54	74.13	69.96	81.17	69.44	81.34	89.26	83.65	89.66	90.36	45.85	62.29	24.50	38.42	45.71	61.06	48.09	64.36
4	69.36	81.17	53.92	68.80	69.61	81.45	69.04	81.40	89.29	84.01	89.36	90.25	45.27	62.07	24.85	39.48	45.19	60.96	47.65	64.44
5	69.53	81.34	47.30	63.41	69.33	81.62	69.10	81.28	89.18	84.13	88.87	90.07	45.35	61.75	25.31	40.37	44.48	60.78	47.59	64.52
SNN																				
0.01	64.48	76.38	61.04	74.02	64.38	76.34	65.89	78.92	87.09	76.76	86.56	89.82	36.44	53.53	15.11	26.74	33.86	50.34	40.18	58.89
0.05	64.31	76.77	61.50	73.72	63.87	75.94	66.06	78.18	87.20	76.69	86.70	89.73	36.60	53.91	14.91	26.50	34.00	50.77	40.54	59.50
0.1	64.64	76.61	60.87	73.96	64.10	76.51	65.54	78.23	87.35	77.30	86.27	89.66	36.32	54.15	15.19	26.21	33.98	51.15	41.23	59.35
0.25	64.71	76.65	61.33	73.77	63.92	76.16	65.66	78.57	87.62	77.00	86.59	89.55	36.98	54.17	15.01	26.82	34.14	51.13	40.87	59.88
0.5	64.77	76.60	60.87	73.10	63.98	75.71	65.07	78.52	87.45	77.48	86.79	89.31	37.16	54.09	15.03	26.82	34.34	51.48	41.33	60.06
0.75	65.08	76.41	61.45	74.09	64.33	76.39	65.83	78.69	87.57	77.64	87.36	89.17	36.86	54.27	15.09	26.42	34.61	51.98	41.01	60.38
1	64.38	77.64	61.16	73.73	64.04	76.72	66.28	78.52	87.98	77.60	87.41	88.95	36.94	54.57	15.78	26.70	34.97	52.41	40.99	59.94
1.5	65.00	76.77	61.04	74.26	64.94	76.78	66.35	78.23	87.66	77.94	87.46	88.92	37.52	55.43	15.19	26.62	35.34	52.65	40.87	59.62
2	65.01	78.27	61.10	73.03	64.73	77.14	66.00	78.74	87.86	78.04	87.94	89.39	36.74	54.51	15.39	27.04	35.54	52.91	39.92	58.71
2.5	65.83	77.94	60.83	72.47	64.84	76.68	65.77	78.11	87.90	79.25	88.15	89.50	38.26	55.59	15.90	27.47	35.62	53.68	39.64	58.83
3	65.98	78.44	59.44	72.68	65.07	77.63	65.43	78.63	87.87	79.25	88.16	89.42	37.66	55.65	15.96	27.91	36.14	53.96	39.80	58.59
4	65.57	78.16	57.37	71.21	65.01	77.66	65.01	78.74	87.87	80.39	88.03	89.32	36.86	54.89	16.44	27.57	36.04	53.38	38.72	57.63
5	66.07	77.83	53.98	69.10	66.00	77.54	66.16	78.06	87.78	81.13	87.24	89.13	36.68	53.85	16.24	28.82	36.00	53.48	39.04	57.41
GCN																				
0.01	58.56	72.01	51.25	65.40	58.79	72.51	61.37	74.16	75.05	66.57	75.79	77.74	40.10	55.81	15.55	27.23	39.09	53.87	41.60	58.88
0.05	58.62	72.41	51.24	64.88	58.85	72.62	62.06	75.62	75.17	66.54	76.05	77.98	39.82	55.37	15.35	27.15	39.01	54.13	41.74	59.24
0.1	58.62	72.46	51.42	64.71	59.32	72.45	62.98	75.72	75.52	66.54	75.91	78.11	39.74	55.37	15.61	27.05	39.11	54.03	41.98	59.76
0.25	58.85	72.68	51.67	64.60	59.02	73.08	62.40	75.43	75.90	66.05	76.06	78.34	40.98	56.85	15.89	27.21	39.80	54.05	41.86	59.18
0.5	60.24	72.97	49.92	64.77	59.75	72.62	61.64	75.43	76.14	66.40	76.60	77.99	41.12	57.36	15.79	26.95	40.26	54.41	42.64	59.60
0.75	60.28	73.48	49.02	63.55	59.92	73.02	59.25	72.85	75.80	66.82	76.85	77.65	41.24	57.80	15.69	27.52	40.24	55.39	42.10	59.58
1	61.10	74.74	49.27	64.60	59.82	74.69	58.50	72.75	75.95	66.97	77.28	76.88	41.22	58.18	16.27	27.40	39.94	55.07	42.42	59.20
1.5	62.29	75.03	50.94	65.05	59.94	73.38	55.19	70.34	76.81	66.71	77.48	74.81	41.66	58.26	16.35	27.35	40.44	56.45	42.46	59.14
2	62.43	75.45	54.15	67.78	61.43	74.18	52.90	67.99	77.05	67.01	77.88	68.72	41.82	58.50	16.09	27.70	40.74	57.16	42.18	58.32
2.5	62.72	74.76	55.91	69.64	61.37	74.60	51.58	67.20	77.45	66.93	77.53	65.03	41.36	58.54	16.35	28.08	41.02	58.08	42.08	58.40
3	61.56	75.32	56.38	69.76	62.37	74.81	49.10	64.54	77.50	66.97	77.69	62.02	41.98	58.50	16.23	28.04	41.14	58.08	41.50	57.60
4	59.91	73.50	55.72	71.72	62.59	76.29	48.27	64.67	77.22	65.68	76.68	57.42	41.46	58.16	16.19	27.90	41.26	58.72	40.50	55.79
5	54.75	70.34	53.64	68.78	61.79	75.34	45.95	62.49	77.01	66.39	76.81	55.66	41.42	57.98	16.83	29.20	41.56	57.40	39.72	54.63

Table 8. Detail quantitative results of different models trained on *Noise-injection* data verions on the N-Caltech101 [43], N-Cars [52] and Mini N-ImageNet [30] datasets, using NN [10], EDnCNN [2], DIF [31] and without filtration.

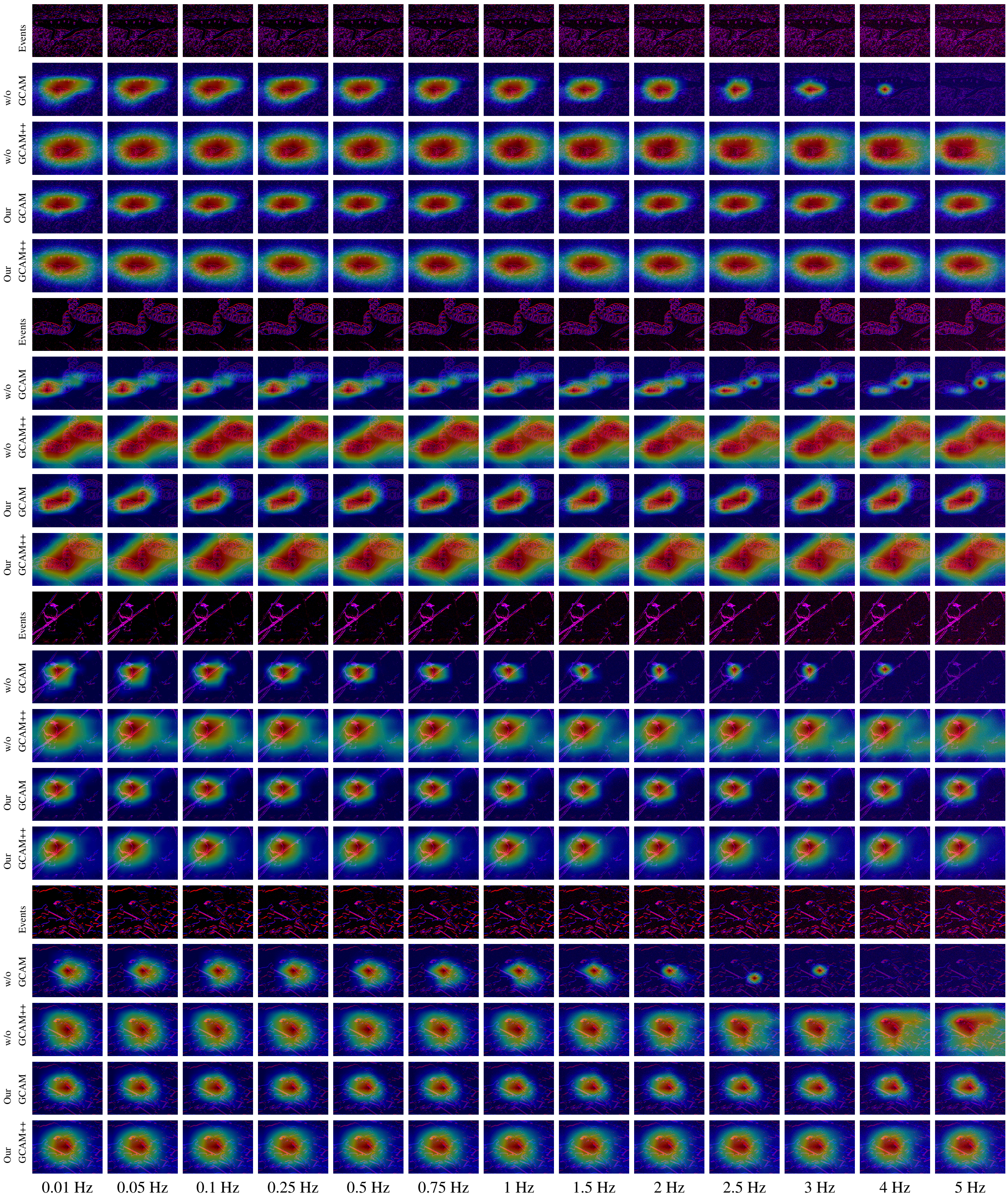


Figure 8. Qualitative comparison using GradCAM and GradCam++ between trained CNN model on Mini N-ImageNet with and without our Noise-injection method for different noise levels.

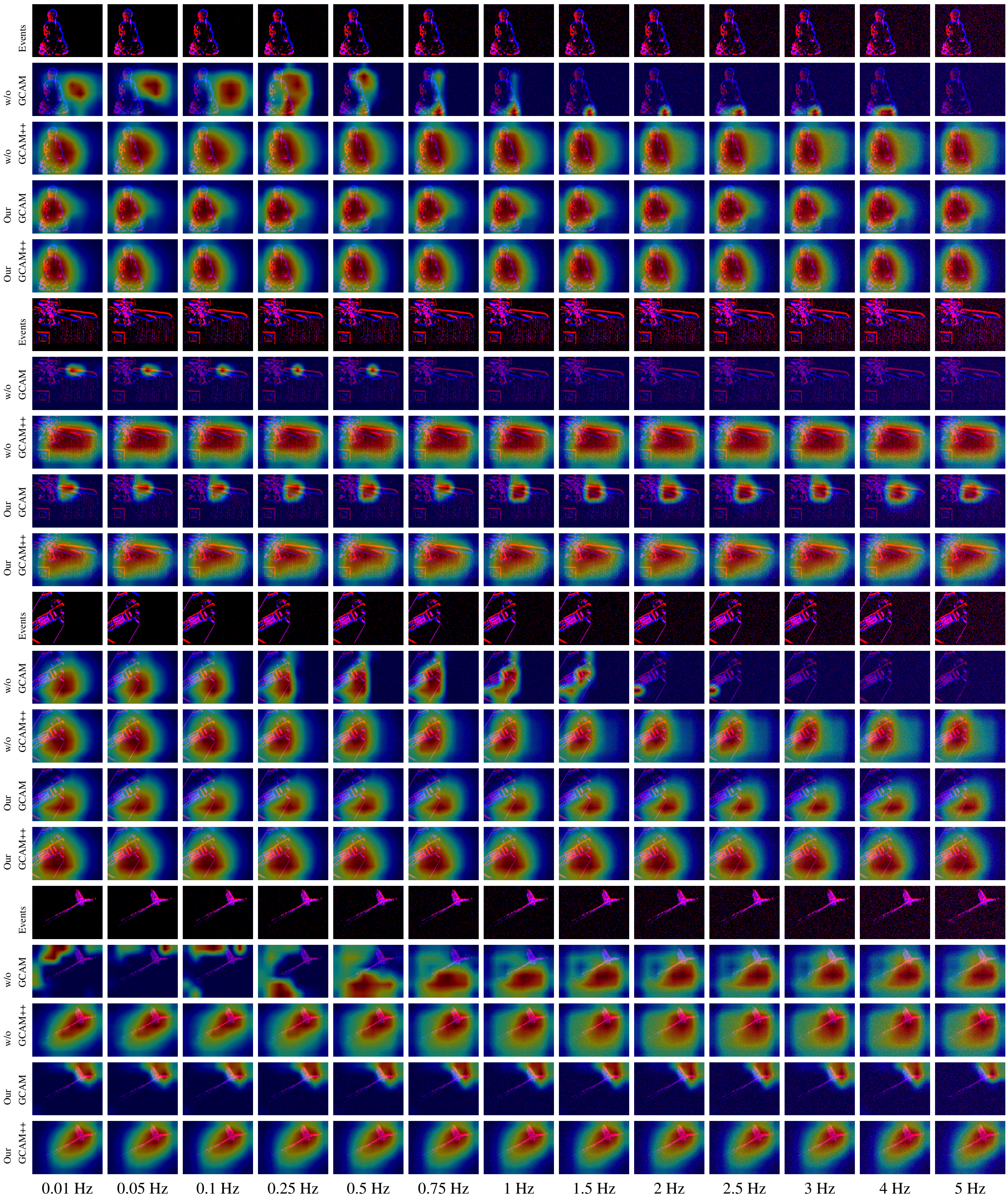


Figure 9. Qualitative comparison using GradCAM and GradCam++ between trained CNN model on N-Caltech101 with and without our Noise-injection method for different noise levels.