

Image Classification in the Dark using Quanta Image Sensors

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Results from experiments

The complete results from the synthetic experiments can be found in Table 1. The complete results from the real experiments can be found in Table 2. More visualizations of the real data are provided in Figure 1.

Sensor	Avg. ppp	Restor. Vanilla	Dir. Pix. Net	Dir. Pix. Shallow	Dir. Pix. Deep	Ours Shallow	Ours Deep
Dogs							
QIS	0.25	17.9%	35.6%	42.1%	43.9%	48.6%	52.1%
	0.5	24.7%	40.3%	48.3%	52.2%	56.5%	58.5%
	1.0	28.9%	42.9%	53.9%	56.5%	62.7%	63.4%
	2.0	38.0%	44.9%	59.1%	63.6%	68.4%	69.3%
	4.0	43.3%	50.9%	61.5%	66.1%	72.7%	72.9%
CIS	0.25	12.1%	26.3%	17.4%	28.6%	23.3%	29.0%
	0.5	14.8%	30.4%	22.9%	34.5%	33.9%	36.7%
	1.0	16.4%	34.3%	30.1%	46.6%	48.6%	50.1%
	2.0	25.3%	40.4%	48.4%	53.5%	59.5%	59.8%
	4.0	33.8%	44.6%	58.2%	62.3%	69.7%	69.8%
No. of parameters in denoiser		7.7M	7.7M	3,235	7.7M	3,235	7.7M
Animals							
QIS	0.25	33.4%	43.7%	63.0%	68.0%	68.2%	68.5%
	0.5	43.8%	48.8%	68.5%	74.5%	74.4%	74.5%
	1.0	51.3%	56.4%	77.4%	78.5%	81.9%	82.3%
	2.0	60.1%	62.3%	83.5%	84.9%	86.0%	86.8%
	4.0	66.9%	67.5%	87.4%	88.7%	89.4%	89.8%
CIS	0.25	17.3%	27.8%	28.6%	41.2%	33.1%	41.6%
	0.5	20.8%	38.2%	43.4%	53.4%	45.8%	53.9%
	1.0	28.0%	41.1%	57.8%	62.6%	61.2%	63.0%
	2.0	42.4%	49.7%	69.7%	73.1%	73.3%	73.4%
	4.0	59.7%	62.3%	81.2%	83.2%	83.5%	83.5%
No. of parameters in denoiser		7.7M	7.7M	3,235	7.7M	3,235	7.7M

Table 1. Comparison with state of the art.

Photon Level	Dirty Pixels		Ours	
	QIS	CIS	QIS	CIS
0.25	15 / 30	6 / 30	17 / 30	6 / 30
0.5	17 / 30	8 / 30	19 / 30	9 / 30
1.0	19 / 30	11 / 30	22 / 30	13 / 30
2.0	22 / 30	16 / 30	24 / 30	18 / 30
4.0	25 / 30	21 / 30	25 / 30	21 / 30

Table 2. Real data using the Animal Dataset. The reported numbers are number of images correctly classified among the 30 images considered. The networks are trained using the synthetic data.

Implementation

The proposed network is pre-trained with ImageNet dataset, with fine-tuning using the synthetic datasets simulated from ImageNet. All networks are implemented using Keras [3] with TensorFlow [1] backend. All the networks are learnt using the RMSProp [4] with initial learning rate of 10^{-5} and the learning rate is decayed by a factor of 0.98 at each epoch. The networks are trained for 400 epochs. For a training set containing 9000 training samples, the typical training time is 10 hours.

References

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