Convolutional Neural Networks in Logarithmic Gradient Image Sensing

https://youtu.be/BTdAhNPujyk

Qianyun Lu

Electrical Engineering, Stanford University

Stanford | ENGINEERING
Electrical Engineering

Motivation & Introduction

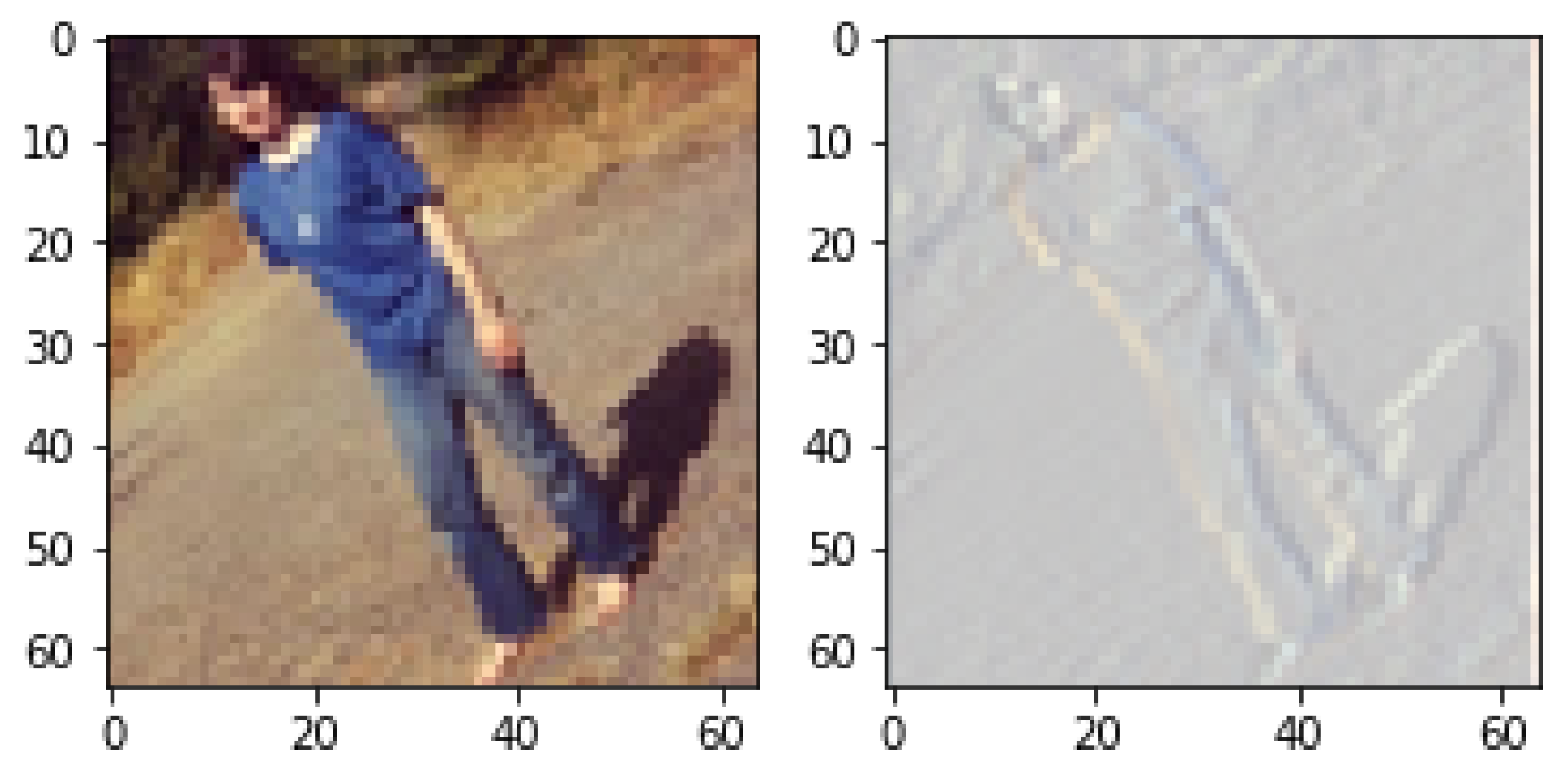


Fig. 1 RGB image and its log-gradient version.

Log-gradient cameras:

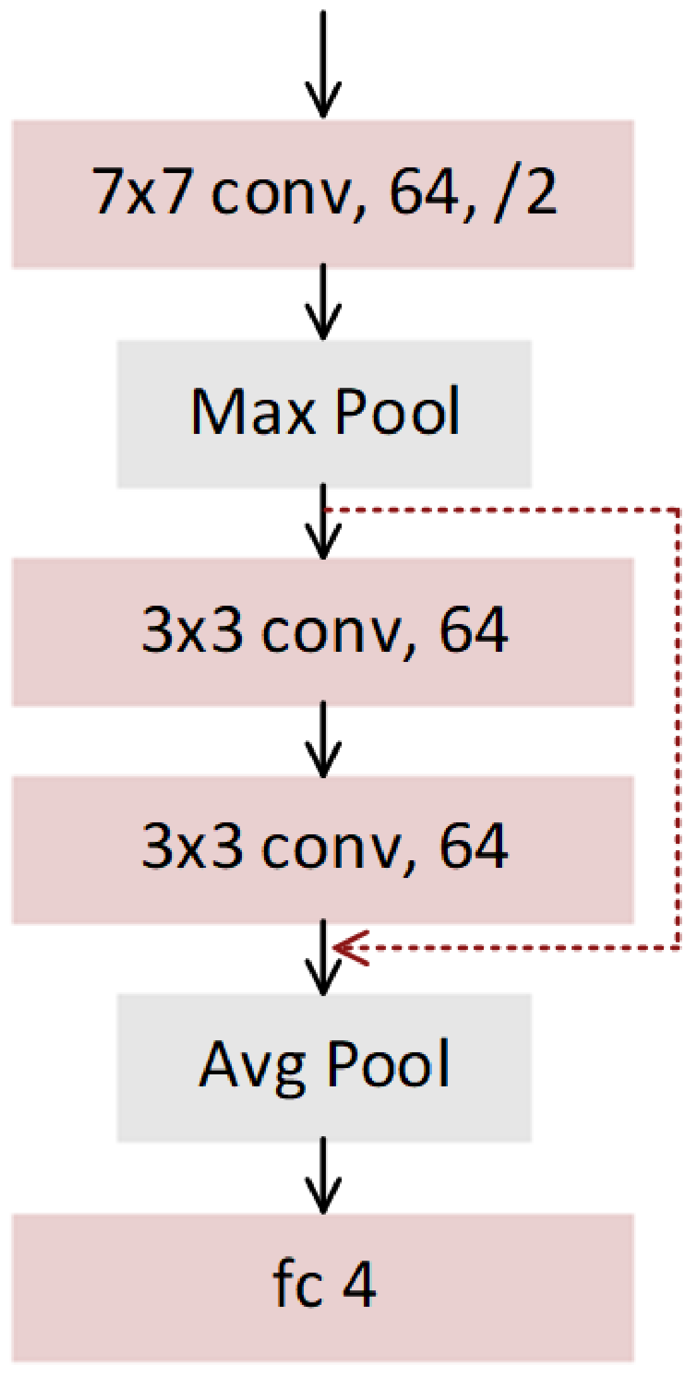
- reject motion
- reduce noises

Image sensing at the edge:

- stringent budget on power
- deep NNs: energy-hungry

Shallow NNs for log-grad images

This project utilizes residual learning and proposes a minimal network: **mResNet**.



7x7 conv, 64, /2

Max Pool

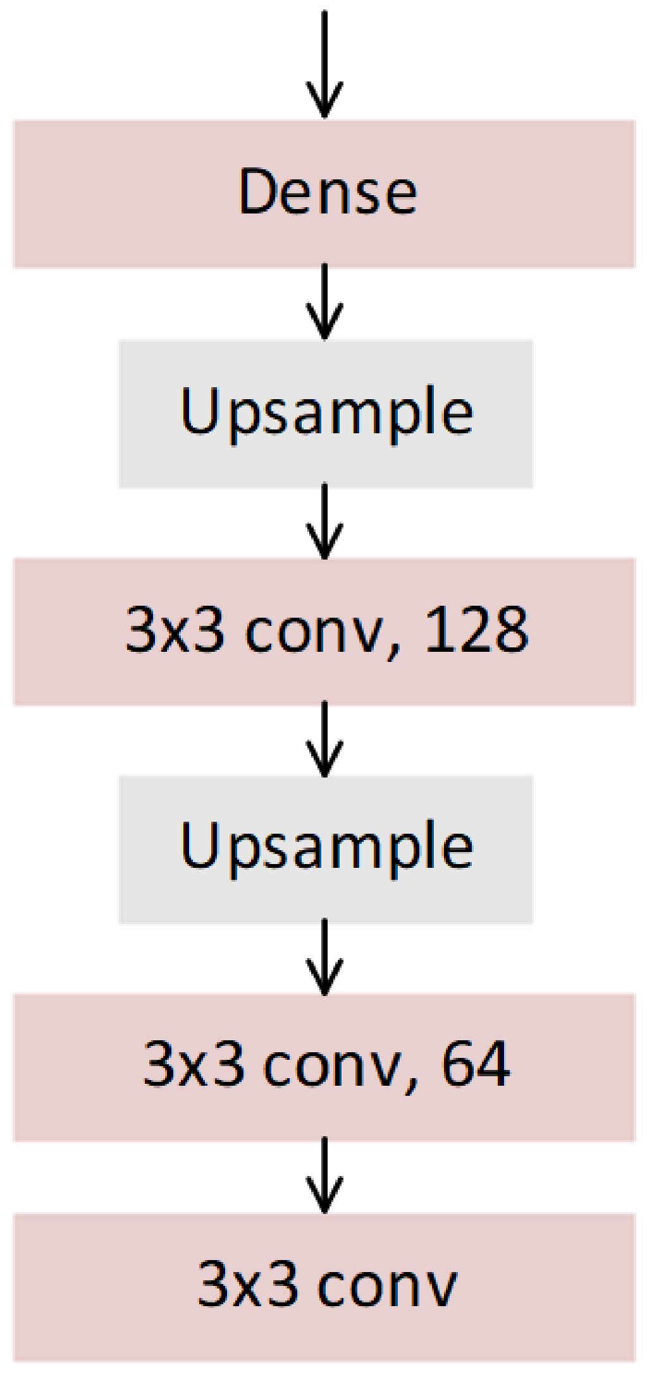
3x3 conv, 64

3x3 conv, 64

Avg Pool

fc 4

Fig. 2 mResNet.



Dense

Upsample

3x3 conv, 128

Upsample

3x3 conv, 64

3x3 conv

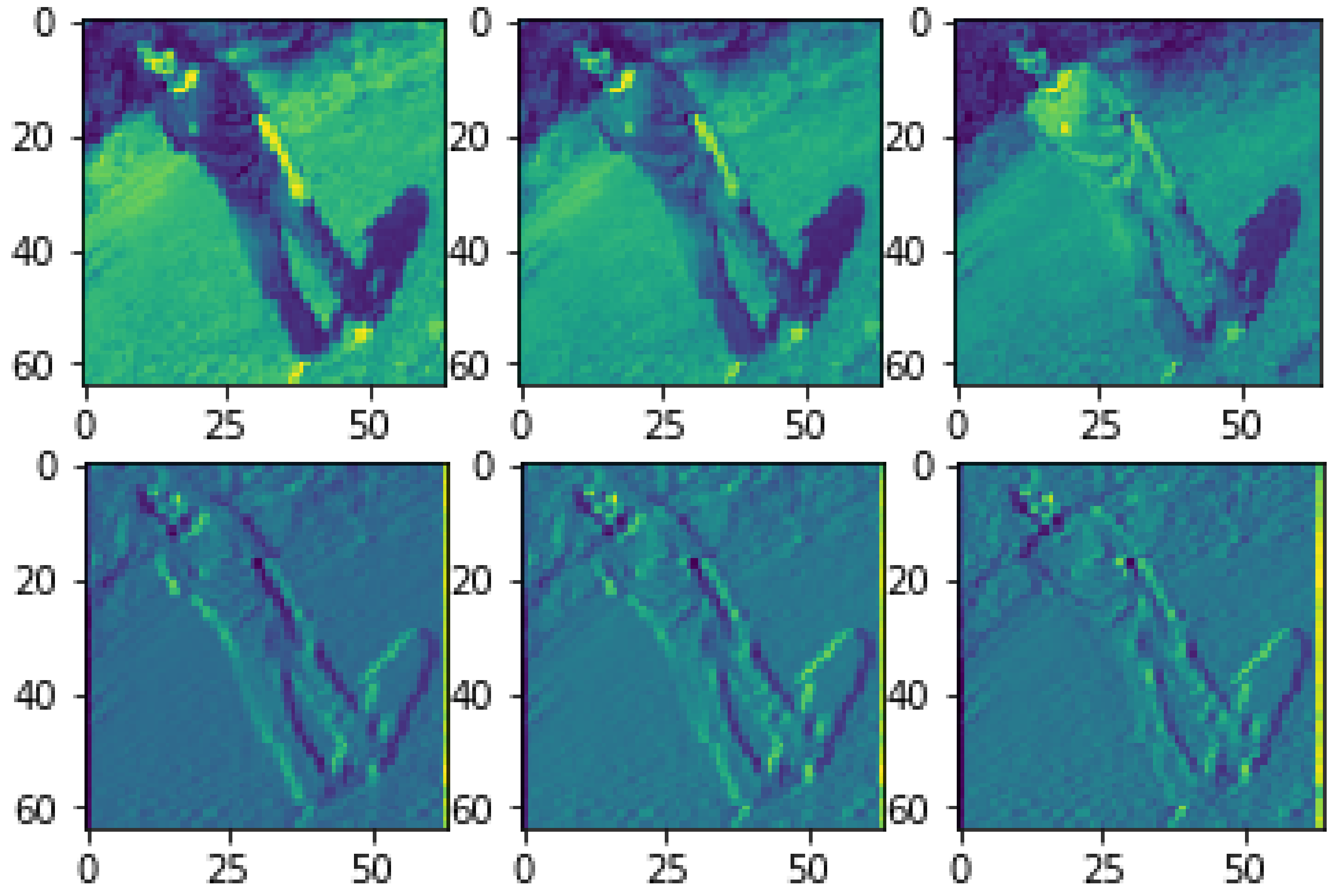
Fig. 3 GAN.

Datasets & Method

	Pascal	Image Distribution				
	Datasets	Person	Car	Bike	Bus	Total
Train	VOC2012	2501	2447	817	668	6433
Test	VOC2007	1001	972	260	155	2388

Log-gradient image generation:

- calculate log $P' = \log P$
- take gradient $G = P' * f$
- $f = h$ or $v, h^T = v = [-1\ 0\ 1]$
- rescale



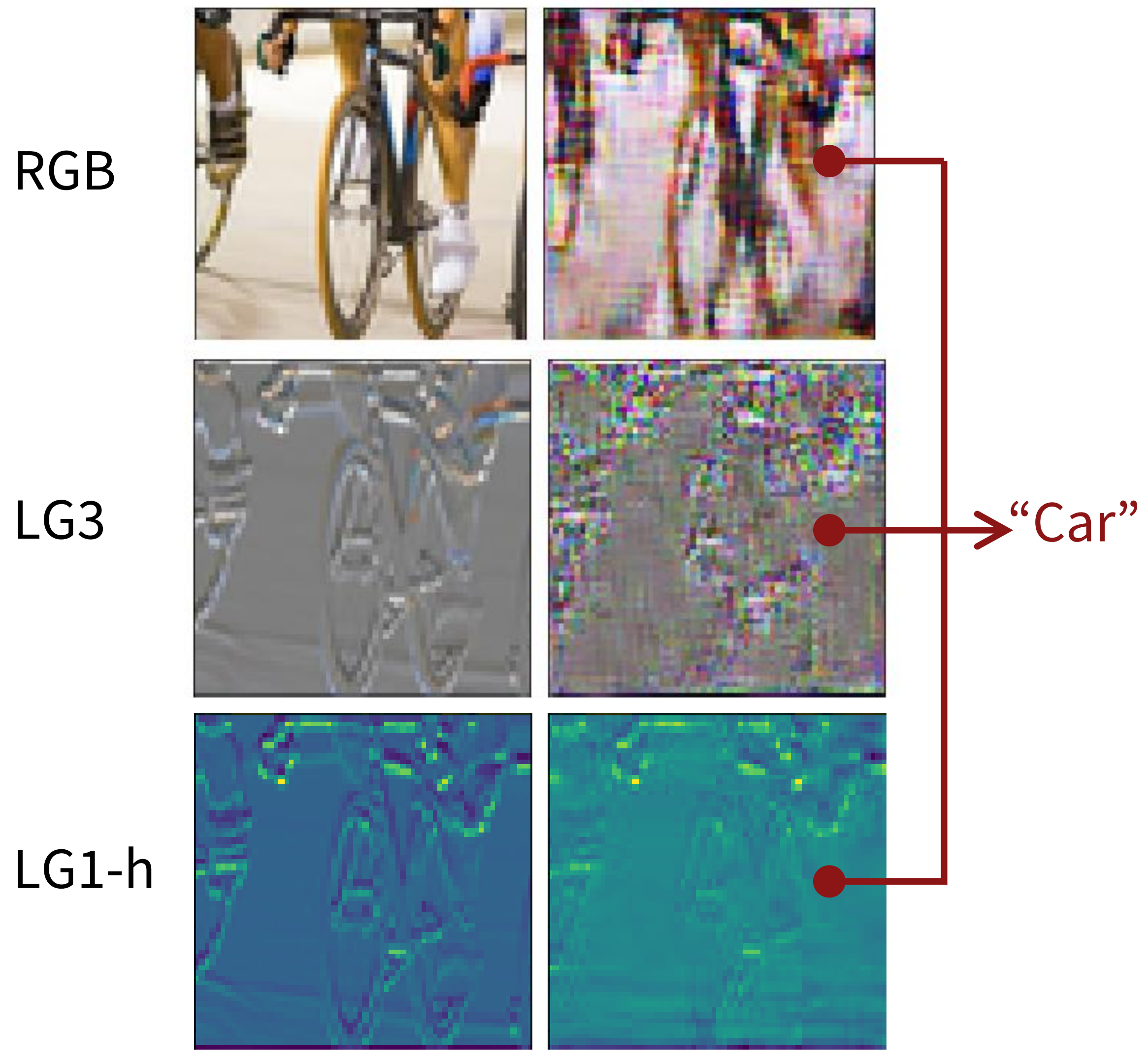
Further reduction on data volume: **modified datasets**

		Train Set Dim.	Test Set Dim.
3-layer (R, G, B)	Log-grad	(6433, w, h, 3)	(2388, w, h, 3)
	Original	(6433, w, h, 3)	(2388, w, h, 3)
1-layer (R only)	Log-grad	(6433, w, h, 1)	(2388, w, h, 1)
	Original	(6433, w, h, 1)	(2388, w, h, 1)
2-layer (h +v)	Log-grad	(6433, w, h, 2)	(2388, w, h, 2)

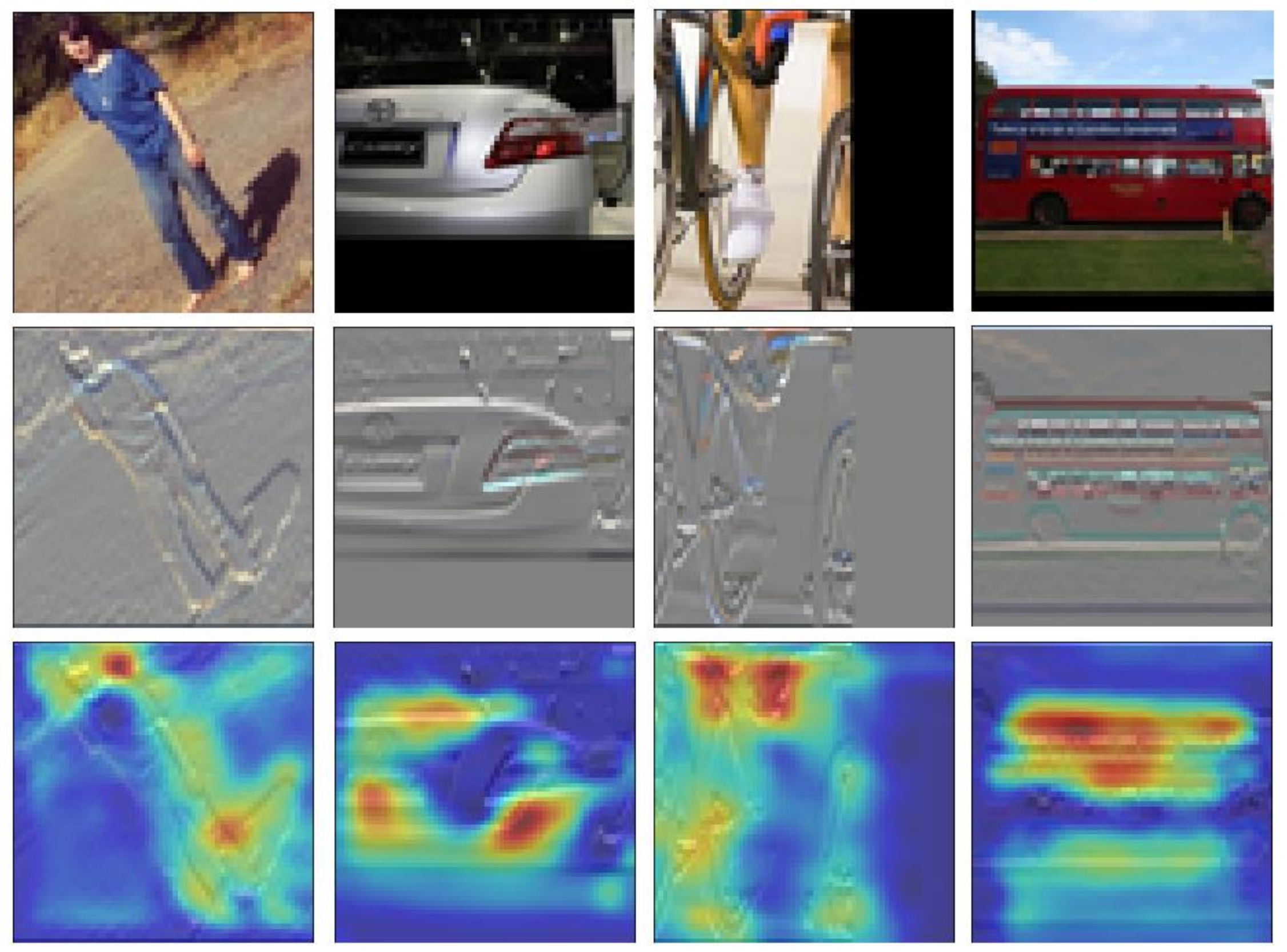
Experimental Results

Datasets (image dim.)	**LG3** (w, h, 3)	**LG1-vh** (w, h, 2)	**LG1-h** (w, h, 1)
ResNet-50	40.67%	47.75%	40.93%
ResNet-34	75.45%	76.07%	71.59%
ResNet-18	61.12%	66.65%	56.59%
ResNet-10	80.10%	81.27%	77.62%
mResNet	84.24%	82.69%	80.47%

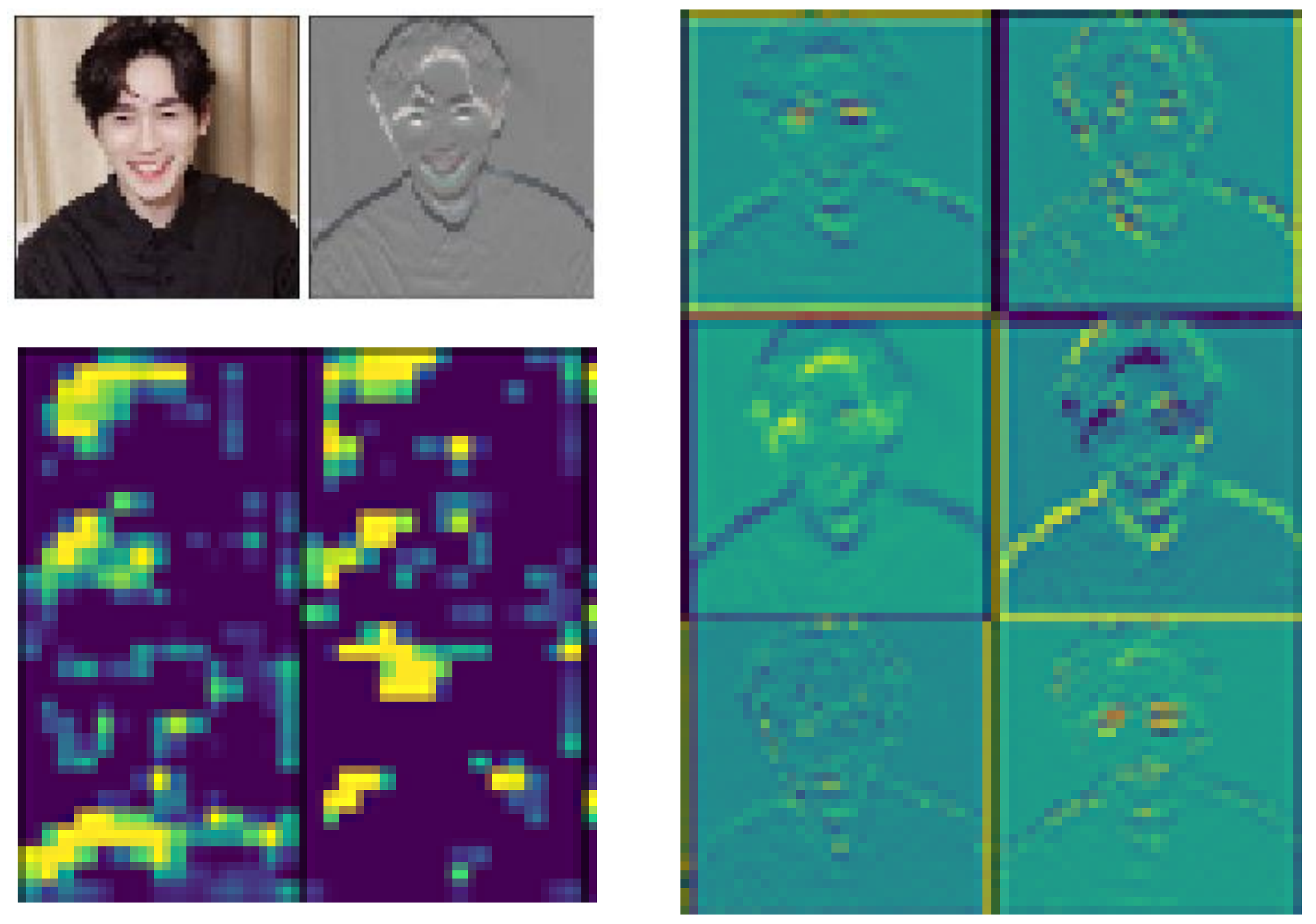
Original images & adversarial examples



Heatmap



Activation maps

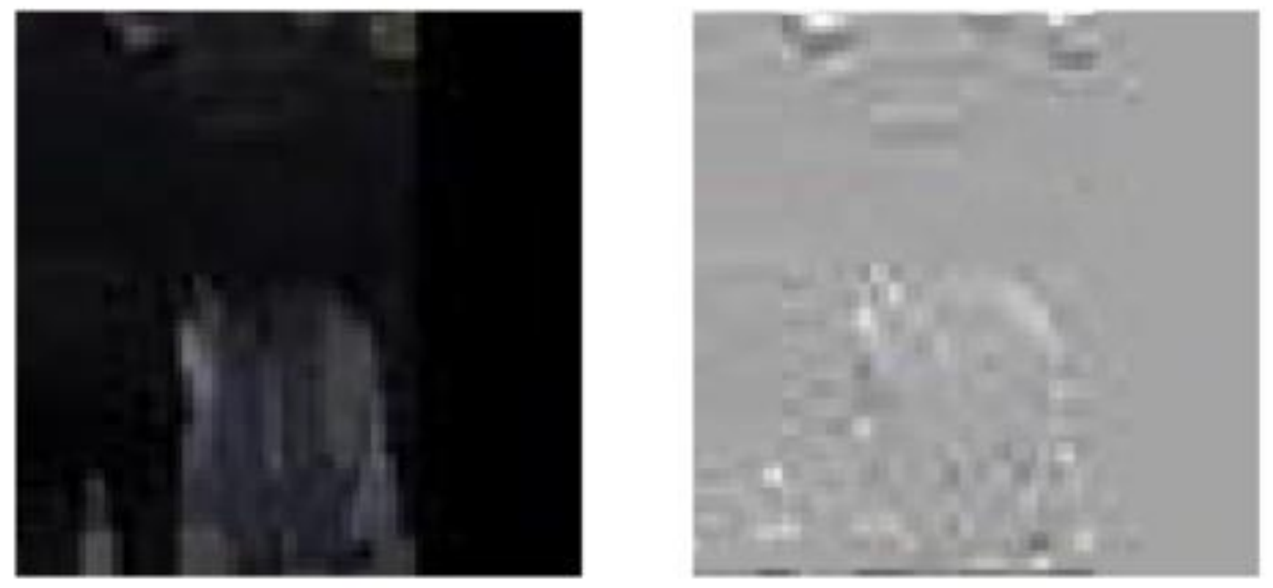


Discussion & Future Work

Class	**#** of error	**e** in test set	**e** in each class
Prsn	70	2.93%	6.99%
Car	130	5.44%	13.37%
Bike	106	4.43%	40.77%
Bus	70	2.93%	45.16%
Total	376	15.75%	/

Error analysis

- High human error
- Black bars
- Image format (.jpg)



Future work

- Improved datasets
- Pascal RAW
- More categories
- Transfer learning
- Object detection