MIOVISION
Smart cities start here

Real-Time, Field-Deployed CV Traffic Analysis System

Justin Eichel

Overview

Miovision Background

Congestion Background

Traffic Analytics Background

GPU based Analytics System

Embedded Deep Neural Network

Miovision

Company

- Founded in 2005
- 40% growth, year over year
- Offices in Kitchener, Canada and Cologne, Germany
- Named one of Canada's fastest growing companies 3 years in a row

Product Innovation

- Developed the first traffic AI
- Leader in the traffic data collection space, serving over 17,000 municipalities worldwide

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Congestion

Congestion Background

Congestion is expensive

$305B in 2017, US

RANK	CITY	PEAK HOURS SPENT IN CONGESTION	INRIX CONGESTION INDEX	AVERAGE CONGESTION RATE	TOTAL COST PER DRIVER	TOTAL COST TO THE CITY
1	Los Angeles; CA	102	18.3	12%	$2,828	$19.2bn
2	New York City; NY	91	17.4	13%	$2,982	$33.7bn
3	San Francisco; CA	79	13.7	12%	$2,250	$10.6bn
4	Atlanta; GA	70	12.3	10%	$2,212	$7.1bn
5	Miami; FL	64	11.8	9%	$2,072	$6.3bn
6	Washington; DC	63	10.8	11%	$2,060	$6.1bn
7	Boston; MA	60	10.6	14%	$2,086	$5.7bn
8	Chicago; IL	57	10.3	10%	$1,994	$5.5bn
9	Seattle; WA	55	9.6	12%	$1,853	$5.0bn
10	Dallas; TX	54	9.3	6%	$1,674	$4.9bn
11	Houston; TX	50	8.4	7%	$1,623	$4.8bn
12	Portland; OR	50	8.1	11%	$1,648	$3.9bn
13	San Diego; CA	48	7.7	10%	$1,583	$3.1bn
14	Austin; TX	43	7.4	11%	$1,627	$2.8bn
15	Stamford; CT	41	7.2	13%	$1,588	$2.8bn
16	Tacoma; WA	41	7.0	11%	$1,485	$2.4bn
17	Minneapolis; MN	41	6.5	7%	$1,332	$2.3bn
18	Philadelphia; PA	37	6.8	8%	$1,427	$2.1bn
19	Santa Cruz; CA	37	6.9	14%	$1,700	$1.9bn
20	Honolulu; HI	37	6.7	11%	$1,701	$1.8bn
21	Denver; CO	36	6.5	8%	$1,394	$1.6bn
22	San Rafael; CA	35	5.7	11%	$1,394	$1.5bn
23	Detroit; MI	35	6.0	6%	$1,256	$1.5bn
24	Santa Barbara; CA	35	6.2	13%	$1,584	$1.4bn
25	Orlando; FL	34	6.4	7%	$1,366	$1.4bn

https://www.citylab.com/transportation/2018/02/traffics-mind-boggling-economic-toll/552488

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Congestion Background

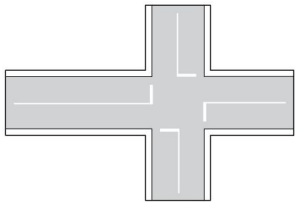
Town of Milton saves hundreds of thousands of dollars and solves traffic problem in just days using Miovision TrafficLink - March 2, 2018

Traffic Analytics

Challenges faced by today's cities

You only improve what you can measure

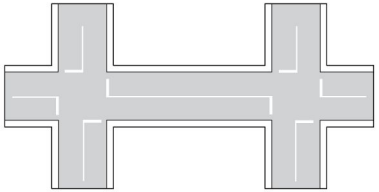
3 Layers of Performance Insights



Layer 1

Intersection View

Tune and optimize individual intersections with signal performance measures



Layer 2

Corridor View

Quantify corridor performance with travel time and congestion metrics

Layer 3

Network View

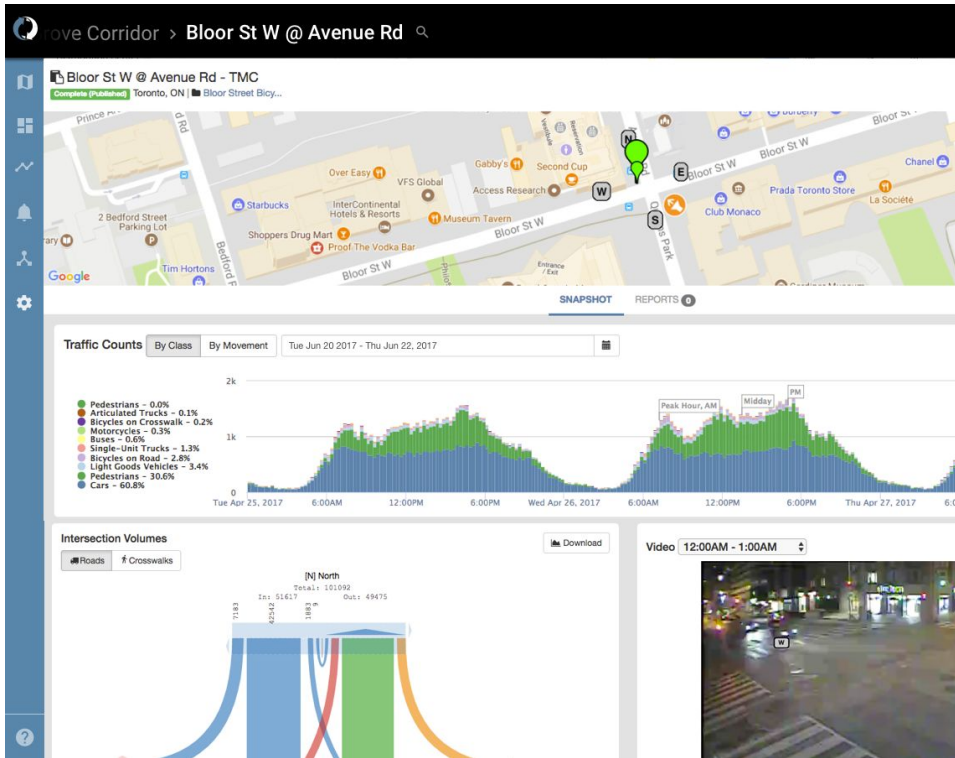
Understand city-wide patterns using maintenance analytics and origin destination analysis

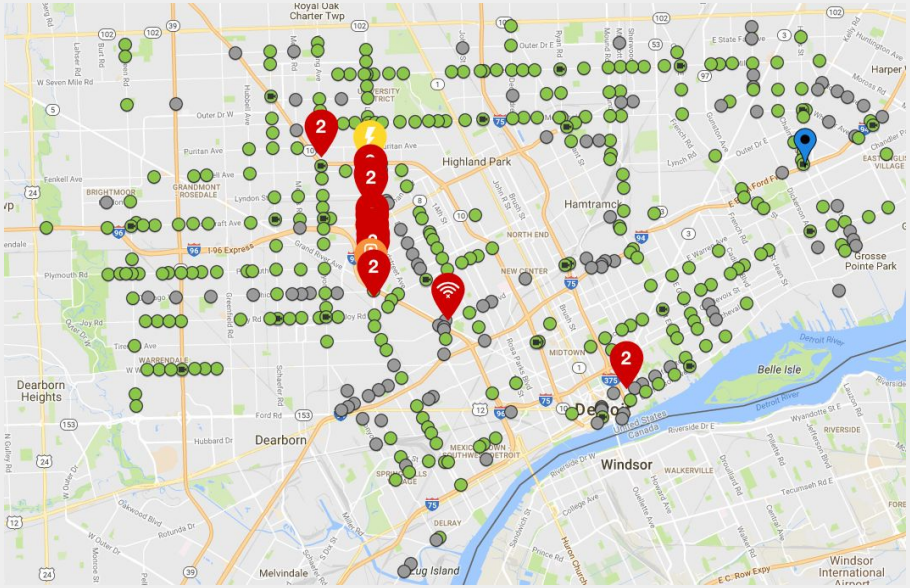
Miovision Scout

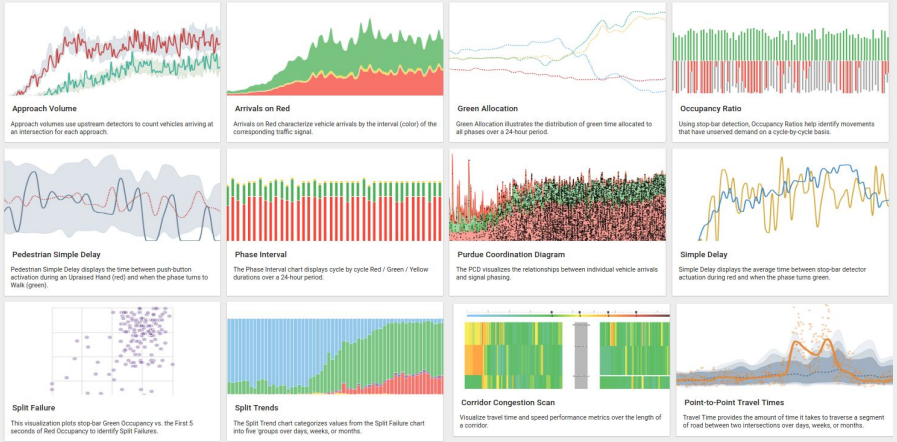
The count data you need to make better decisions.

Easily generate traffic studies to support better planning and design.

- Turning Movement Counts
- Vehicle Classification
  - Light vehicles
  - Motorcycles
  - Buses
  - Pickup trucks
  - Single unit trucks
  - Articulated trucks
- Lane-by-Lane volumes
- Bike/ped studies
- Point-to-Point travel time







Traffic Analytics Background

Network Metrics

Signal Performance Measures

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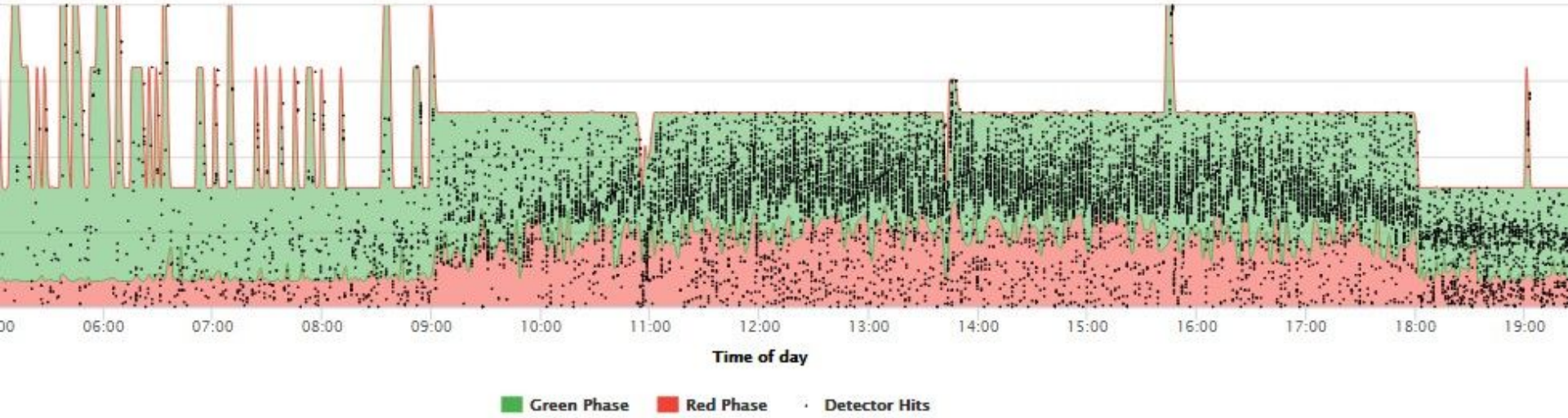
Traffic Analytics Background

Purdue Coordination Diagram

Maximize vehicles arriving at green
Minimize vehicles arriving at red



GPU based Analytics System

GPU based Analytics System

Miovision SmartLink
Remote access to everything in your cabinet via secure wireless communication.

Miovision SmartView 360
Captures an entire intersection from a single camera.
Generates video for monitoring, detection, and analytics.

Miovision SmartSense
Roadside video analysis to produce vehicle detection, traffic counts, and event alerts.

Miovision TrafficLink Portal
Cloud-based software suite for traffic operations.
A full open data API to integrate into all your systems.

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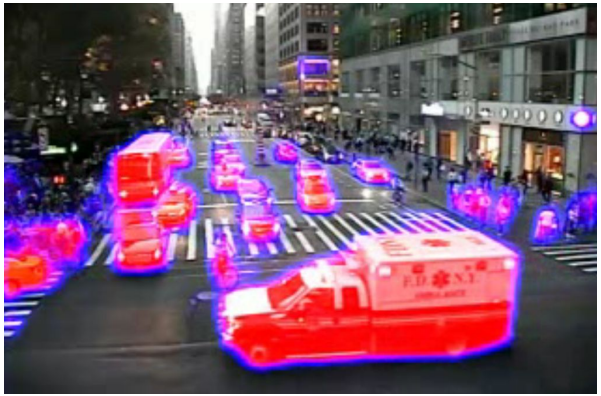
GPU based Analytics System

Classify Vehicles

Locate Vehicles



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Embedded Deep Neural Networks

VGG-16

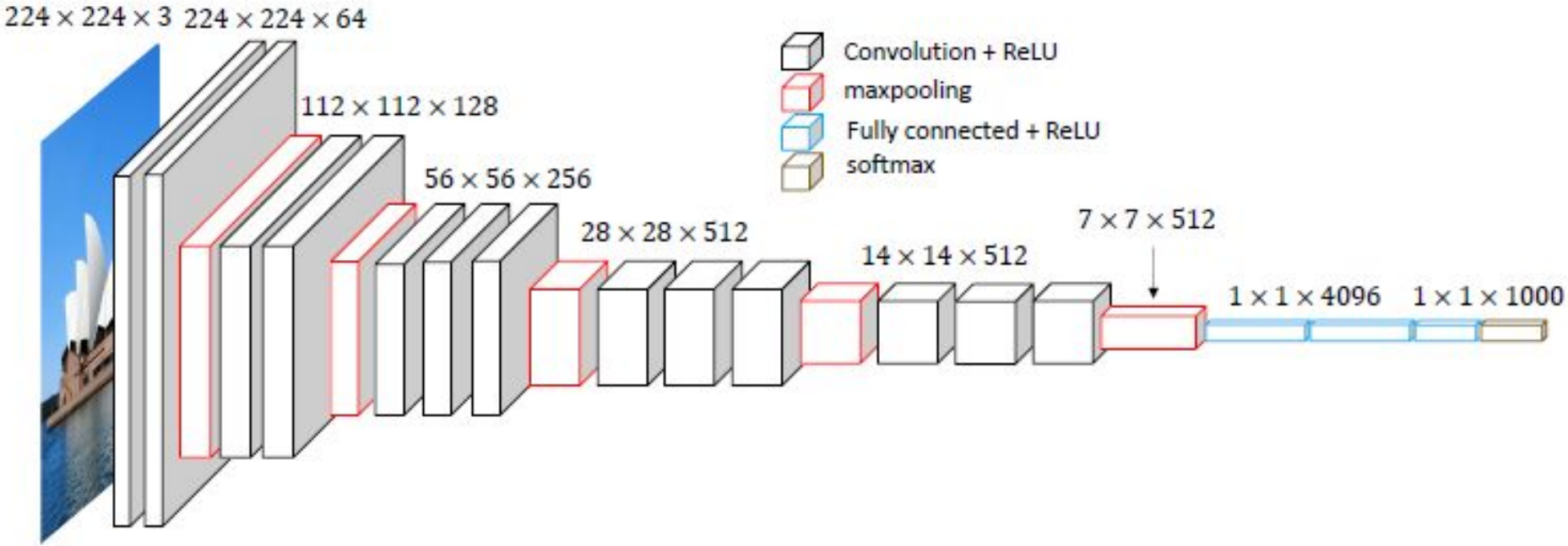
DAC - candidate

DAC

SSD

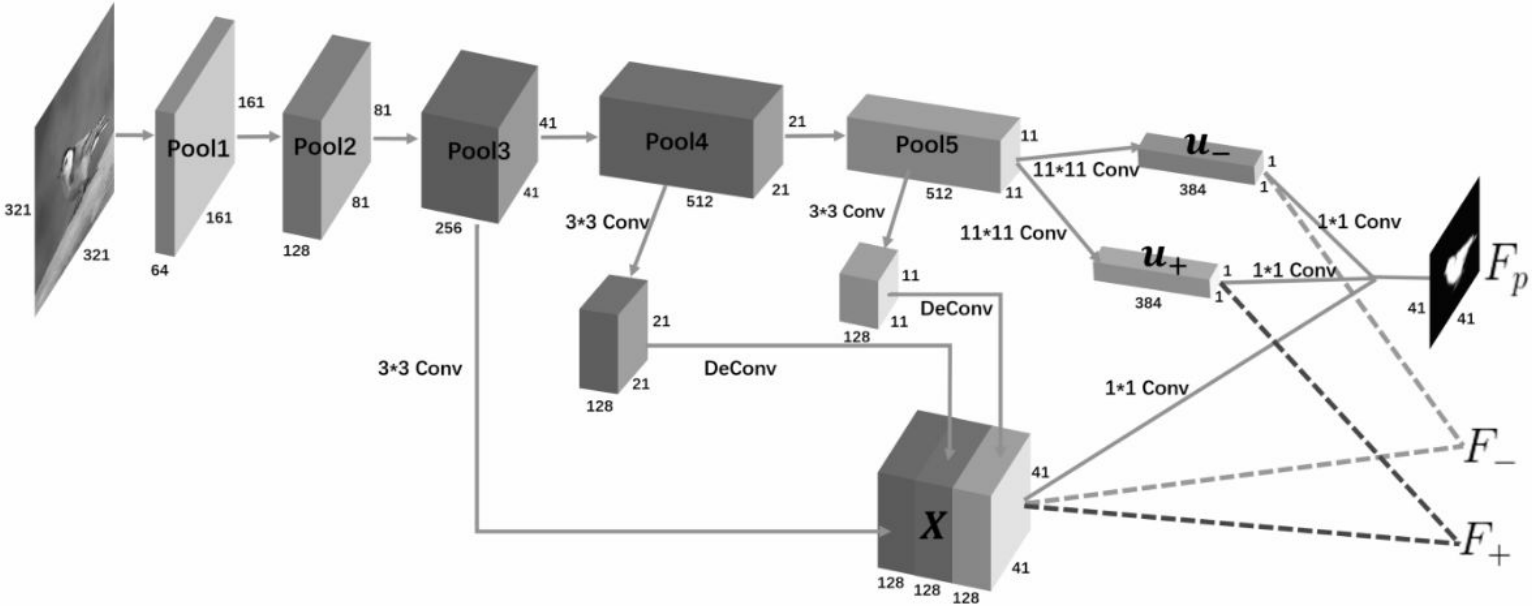
Embedded Deep Neural Network

VGG-16, 2014

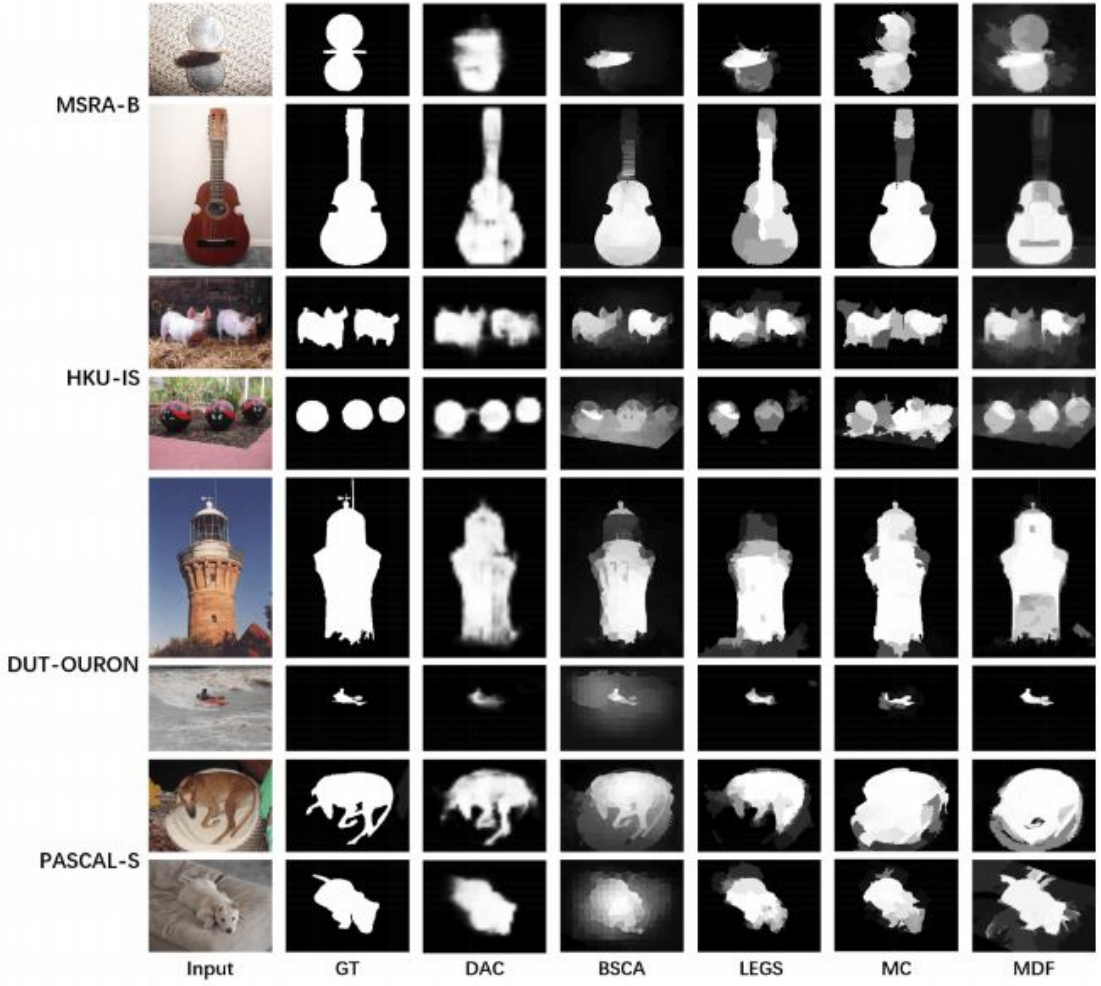


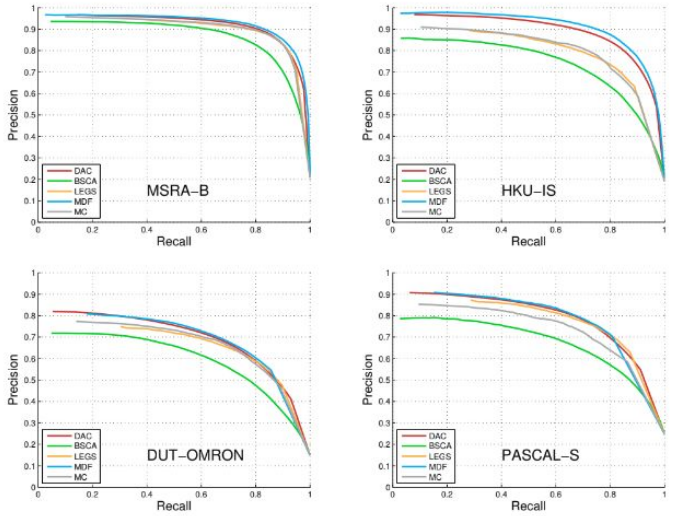
Embedded Deep Neural Network

Deep Active Contours for Saliency Detection (DAC), 2016



CC BY NC SA





Dataset	Metric	BSCA [24]	LEGS[13]	MC[3]	MDF[2]	DAC
MSRA-B	F_β	0.830	0.870	0.872	0.885	0.877
	MAE	0.130	0.081	0.056	0.104	0.074
HKU-IS	F_β	0.723	0.770	0.782	0.861	0.841
	MAE	0.174	0.118	0.097	0.129	0.084
DUT-OMRON	F_β	0.616	0.669	0.678	0.694	0.688
	MAE	0.191	0.133	0.094	0.092	0.105
PASCAL-S	F_β	0.669	0.756	0.728	0.768	0.764
	MAE	0.224	0.157	0.149	0.145	0.145

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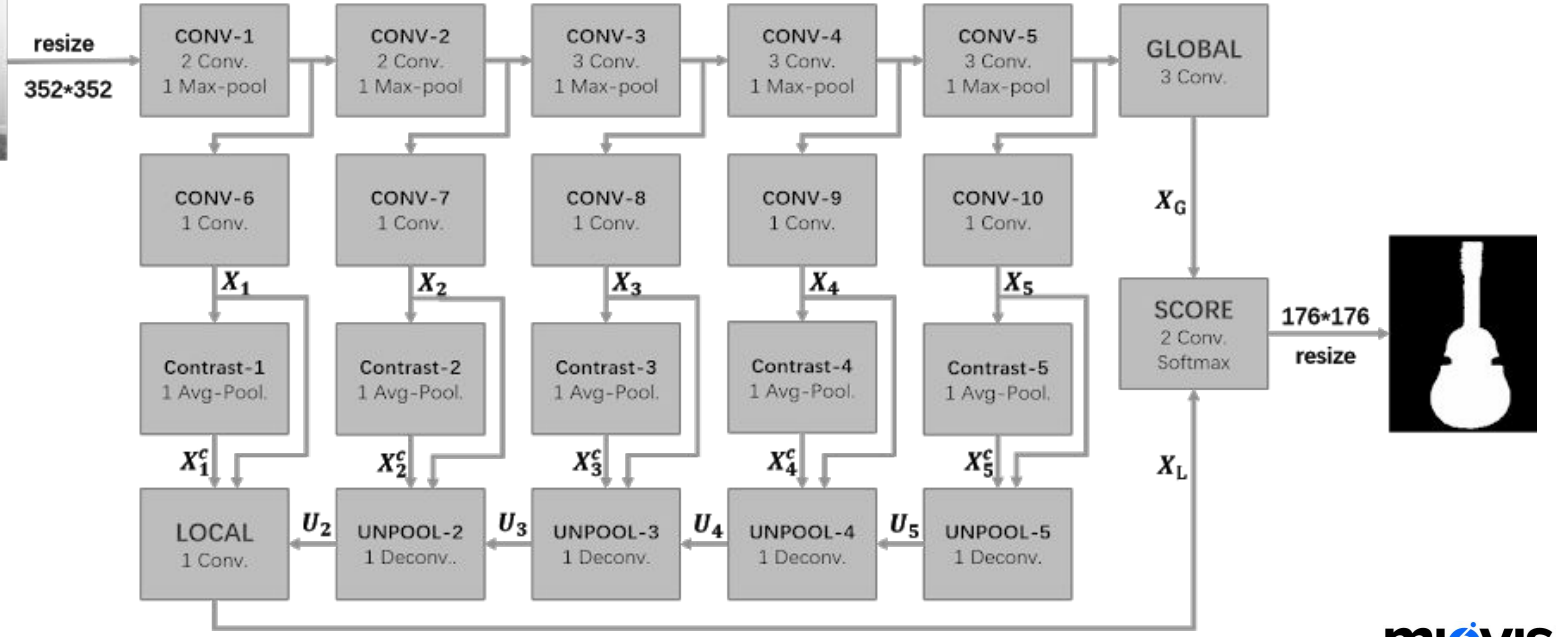
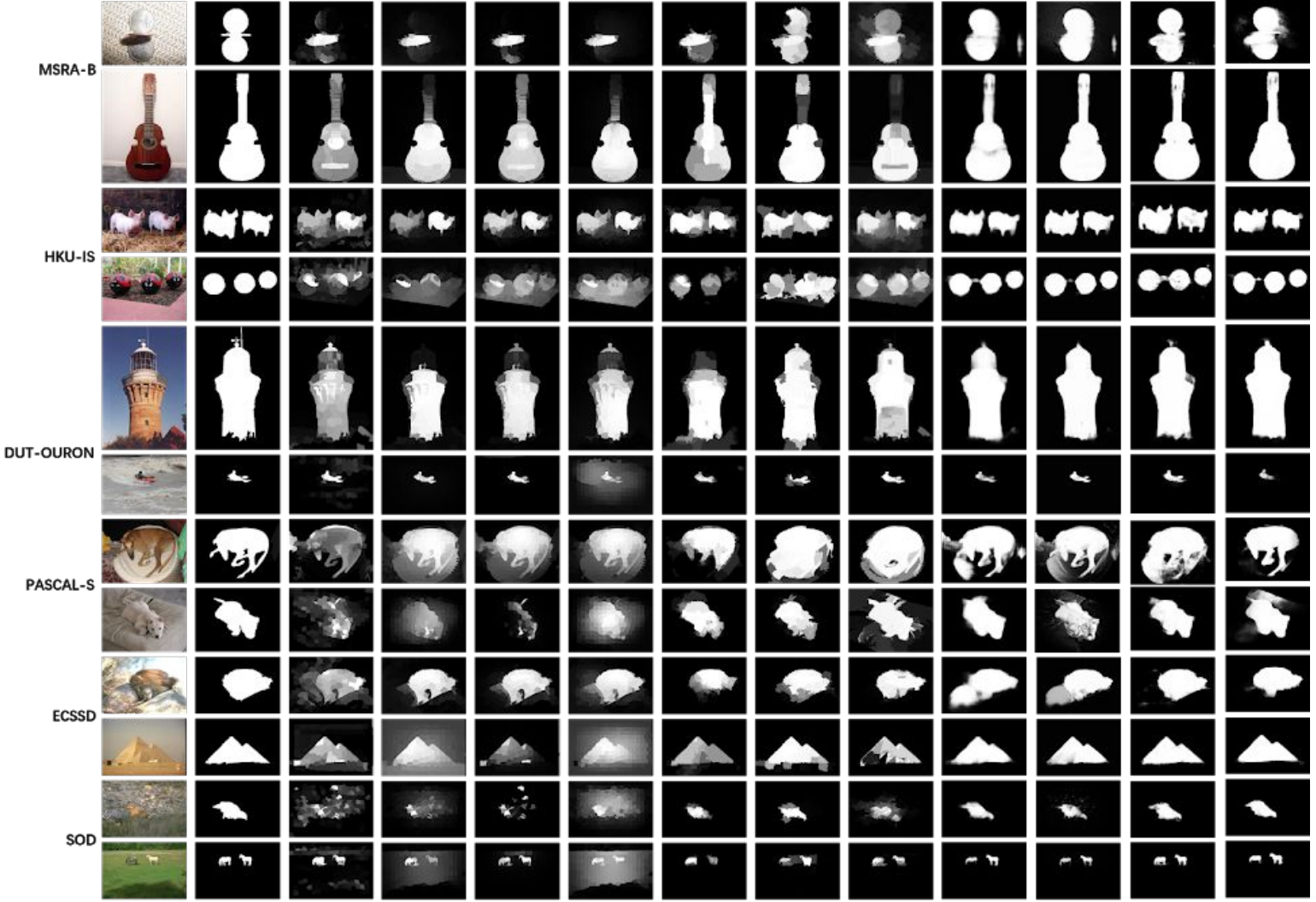
Embedded Deep Neural Network

NLDF, 2017

Luo Z, Mishra A, Achkar A, Eichel J, Li S-Z, Jodoin P-M, "Non-Local Deep Features for Salient Object Detection", IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2017)




MSRA-B
HKU-IS
DUT-OURON
PASCAL-S
ECSSD
SOD
Input
GT
GS
MR
wCtr*
BSCA
LEGS
MC
MDF
DCL
DCL+
NLDF-
NLDF

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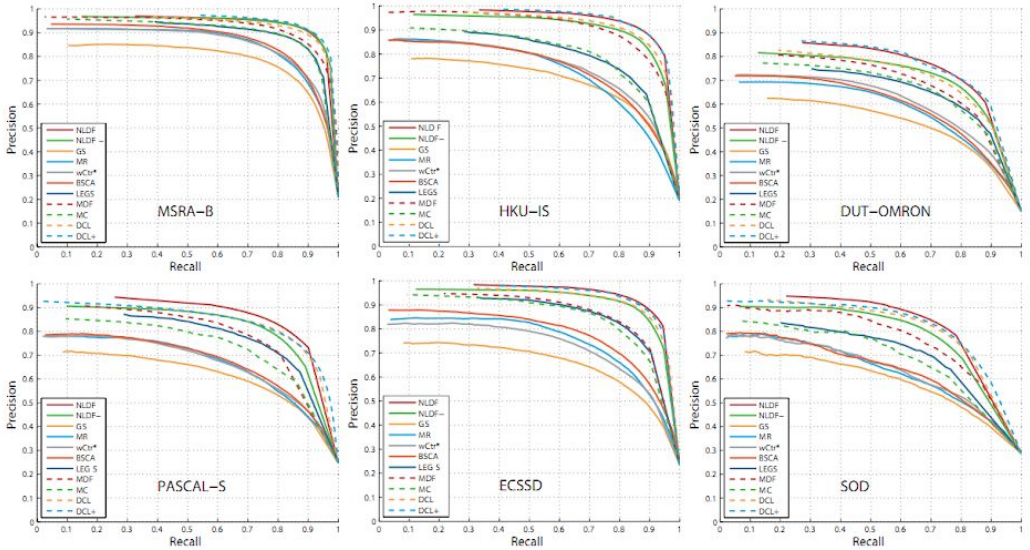
Dataset	Metric	GS	MR	wCtr*	BSCA	LEGS	MC	MDF	DCL	DCL+	**NLDF-**	**NLDF**
MSRA-B	max F_β	0.777	0.824	0.820	0.830	0.870	0.894	0.885	0.905	**0.916**	0.912	0.911
	MAE	0.144	0.127	0.110	0.130	0.081	0.054	0.066	0.052	**0.047**	0.048	0.048
HKU-IS	max F_β	0.682	0.715	0.726	0.723	0.770	0.798	0.861	0.892	**0.904**	0.874	0.902
	MAE	0.167	0.174	0.141	0.174	0.118	0.102	0.076	0.054	0.049	0.060	**0.048**
DUT-OMRON	max F_β	0.557	0.610	0.630	0.616	0.669	0.703	0.694	0.733	**0.757**	0.724	0.753
	MAE	0.173	0.187	0.144	0.191	0.133	0.088	0.092	0.084	**0.080**	0.085	**0.080**
PASCAL-S	max F_β	0.624	0.666	0.659	0.666	0.756	0.740	0.764	0.815	0.822	0.804	**0.831**
	MAE	0.224	0.223	0.201	0.224	0.157	0.145	0.145	0.113	0.108	0.116	**0.099**
ECSSD	max F_β	0.661	0.736	0.716	0.758	0.827	0.822	0.832	0.887	0.901	0.886	**0.905**
	MAE	0.206	0.189	0.171	0.183	0.118	0.106	0.105	0.072	0.075	0.075	**0.063**
SOD	max F_β	0.601	0.619	0.632	0.634	0.707	0.688	0.745	0.795	0.801	0.776	**0.810**
	MAE	0.266	0.273	0.245	0.266	0.215	0.197	0.192	**0.142**	0.153	0.161	0.143



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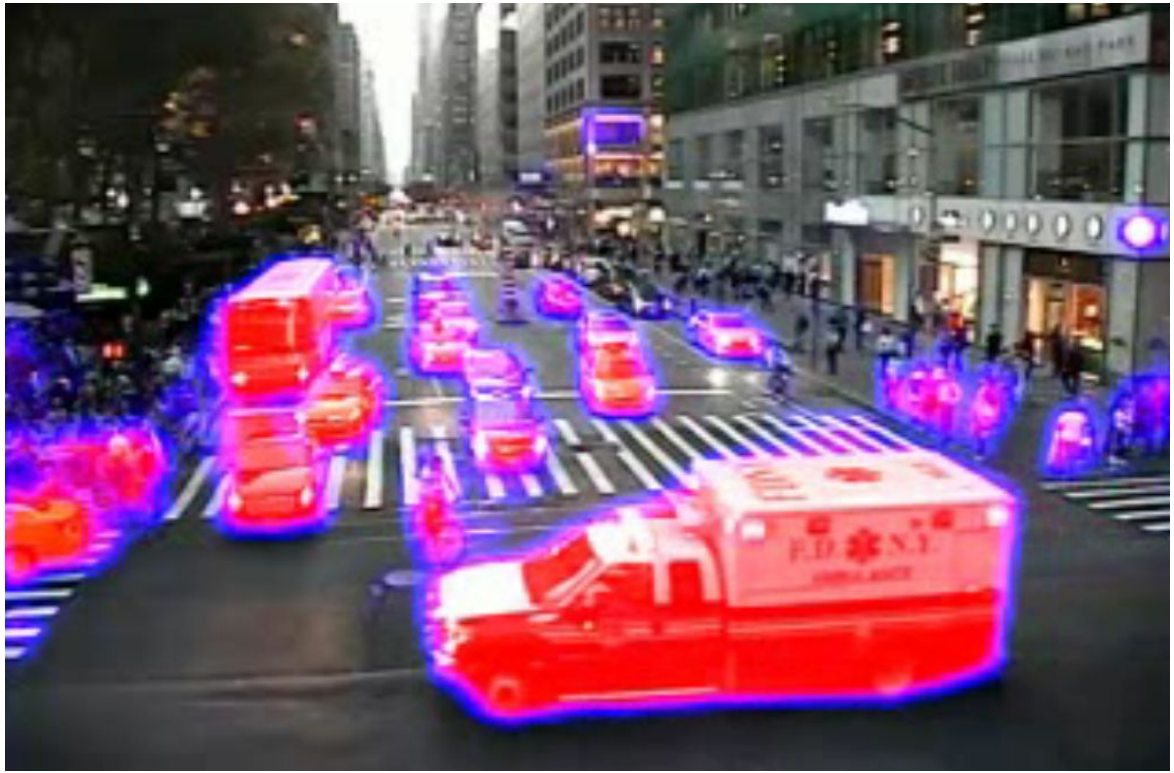
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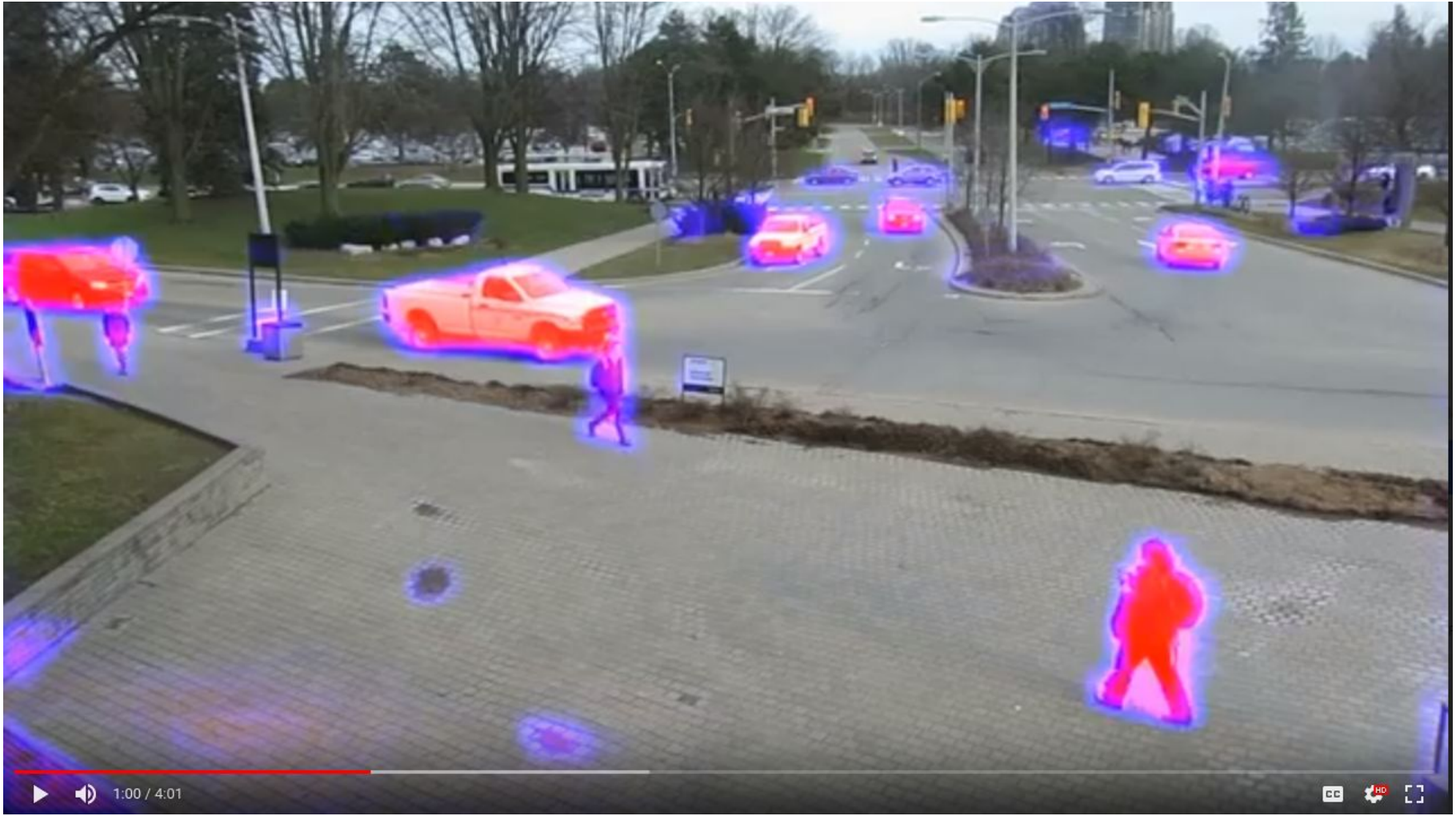
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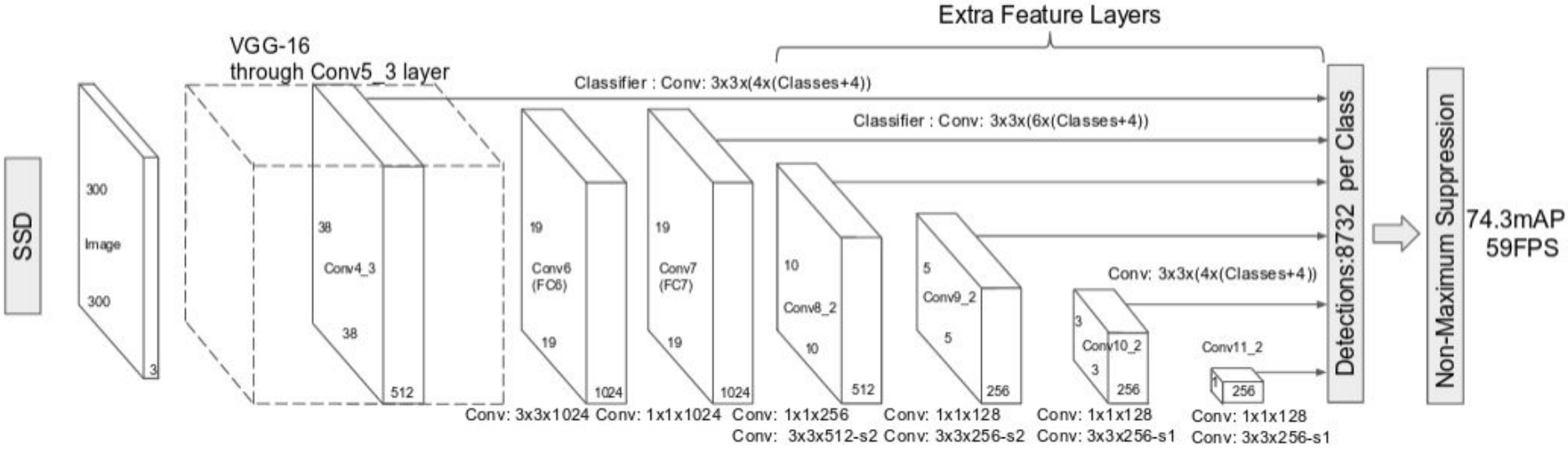
Embedded Deep Neural Network

SSD, 2016



Embedded Deep Neural Network

SSD with MobileNet feature extraction, 2017

Andrew G. Howard et al., "MobileNets: Efficient Convolutional Neural Networks for Mobile Vision Applications," CoRR, 2017, arXiv:1704.04861

Depthwise Separable vs Full Convolution

Model	ImageNet Accuracy	Million Mult-Adds	Million Parameters
Conv MobileNet	71.7%	4866	29.3
MobileNet	70.6%	569	4.2

COCO Object Detection Results

Framework Resolution	Model	mAP	Billion Mult-Adds	Million Parameters
SSD 300	deeplab-VGG	21.1%	34.9	33.1
	Inception V2	22.0%	3.8	13.7
	MobileNet	19.3%	1.2	6.8
Faster-RCNN 300	VGG	22.9%	64.3	138.5
	Inception V2	15.4%	118.2	13.3
	MobileNet	16.4%	25.2	6.1
Faster-RCNN 600	VGG	25.7%	149.6	138.5
	Inception V2	21.9%	129.6	13.3
	Mobilenet	19.8%	30.5	6.1

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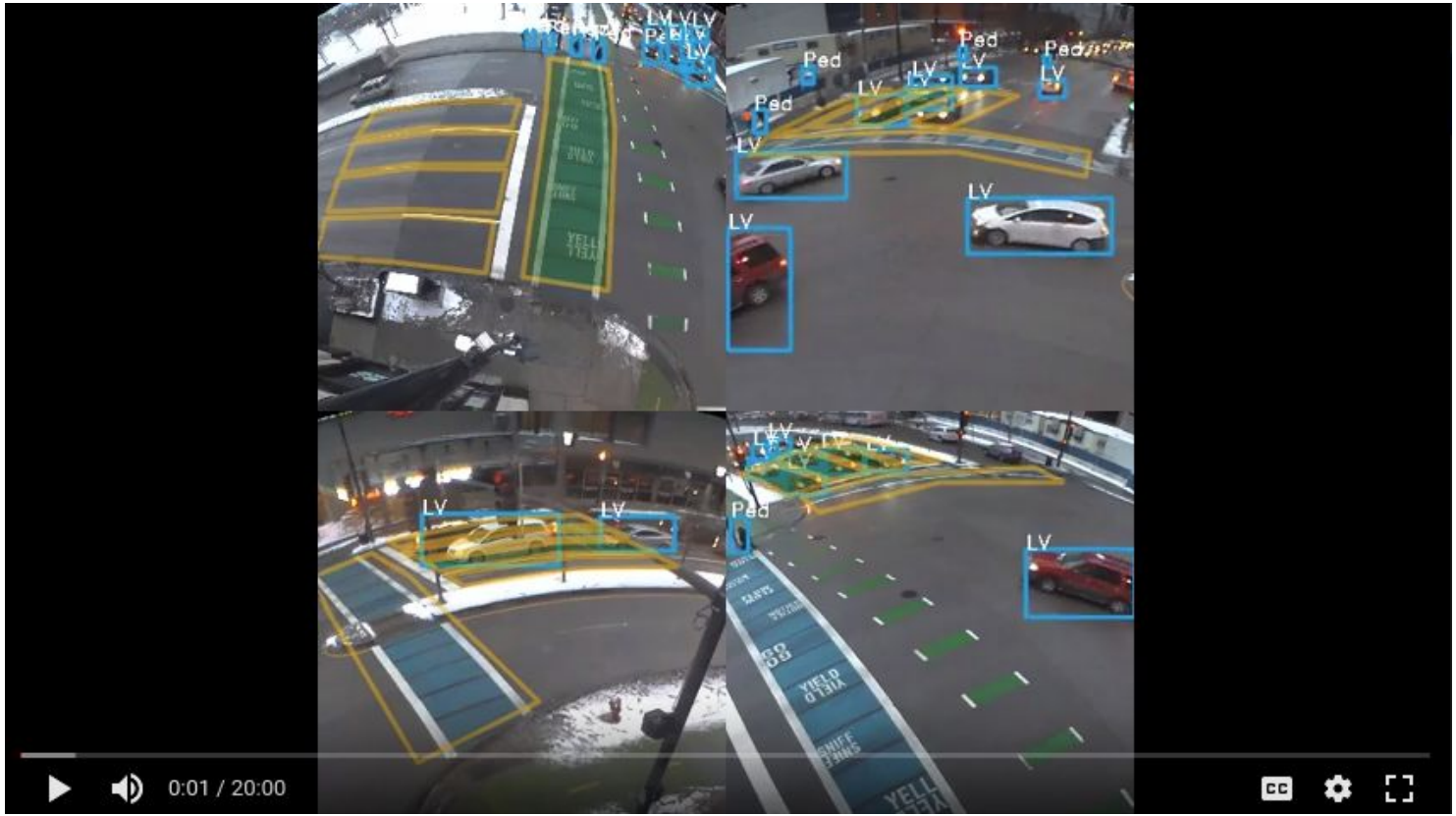

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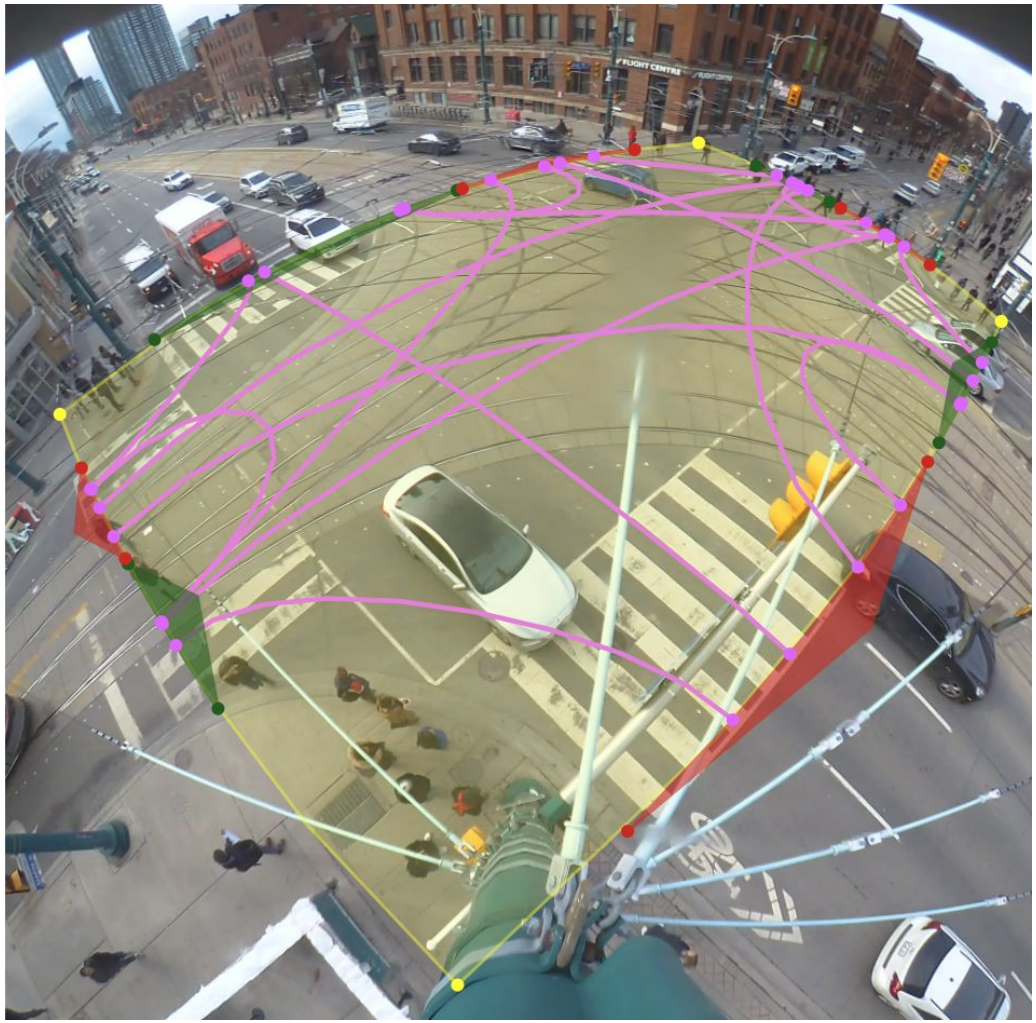

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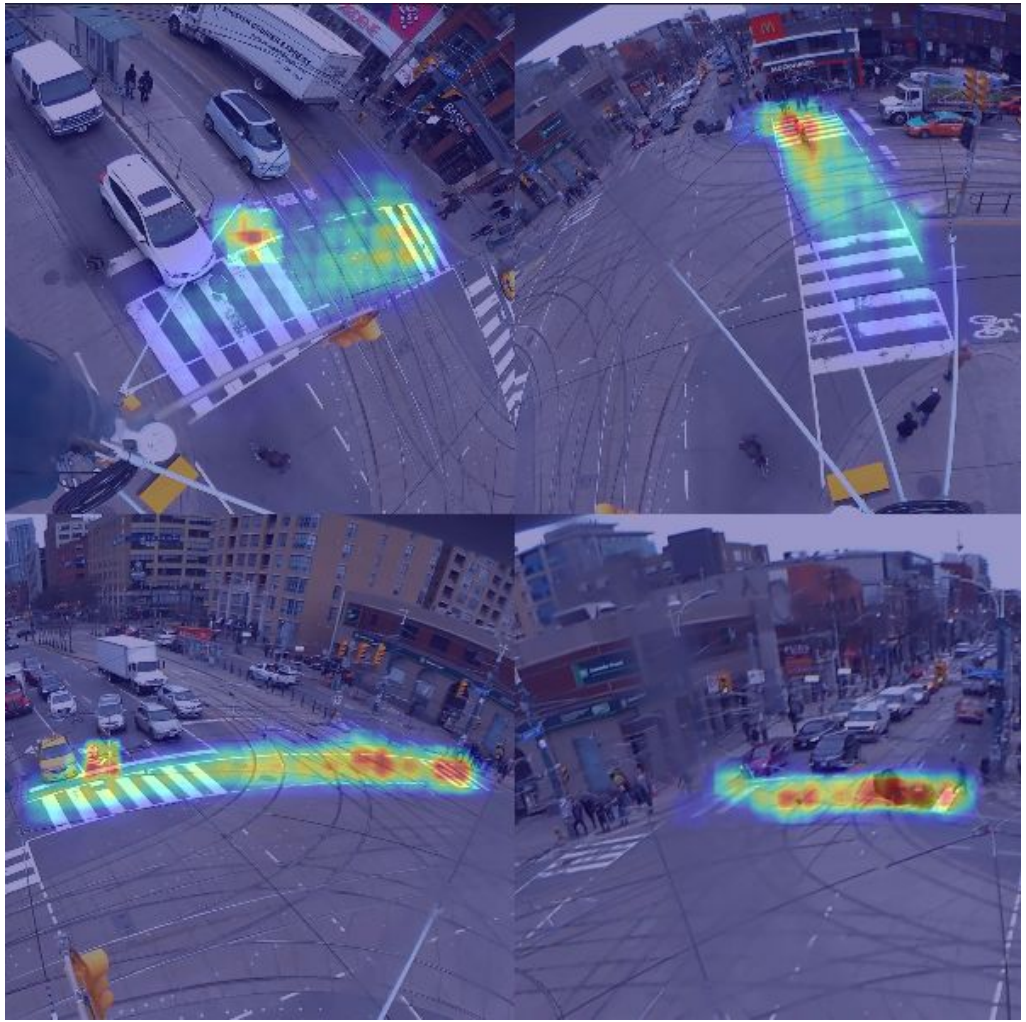

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