Image-based Automated Winter Road Condition Monitoring – a Deep Learning Approach

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Presented by

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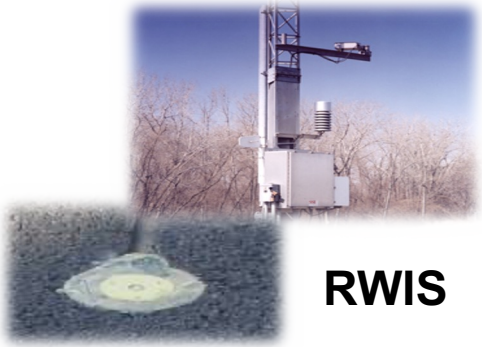
Winter Road Condition Monitoring –

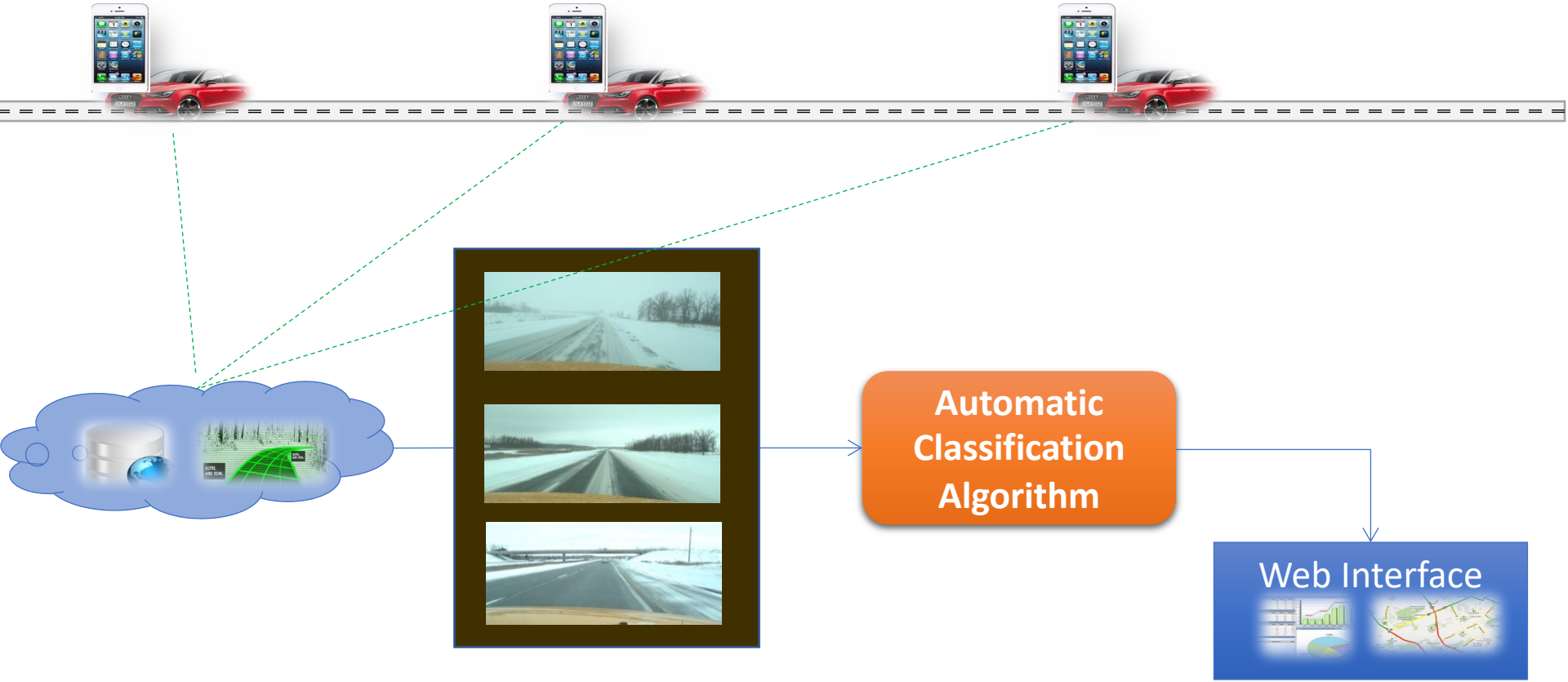
The Needs ?

- Optimize Maintenance
- Measure Performance
- Inform Drivers
- Prove Due Diligence

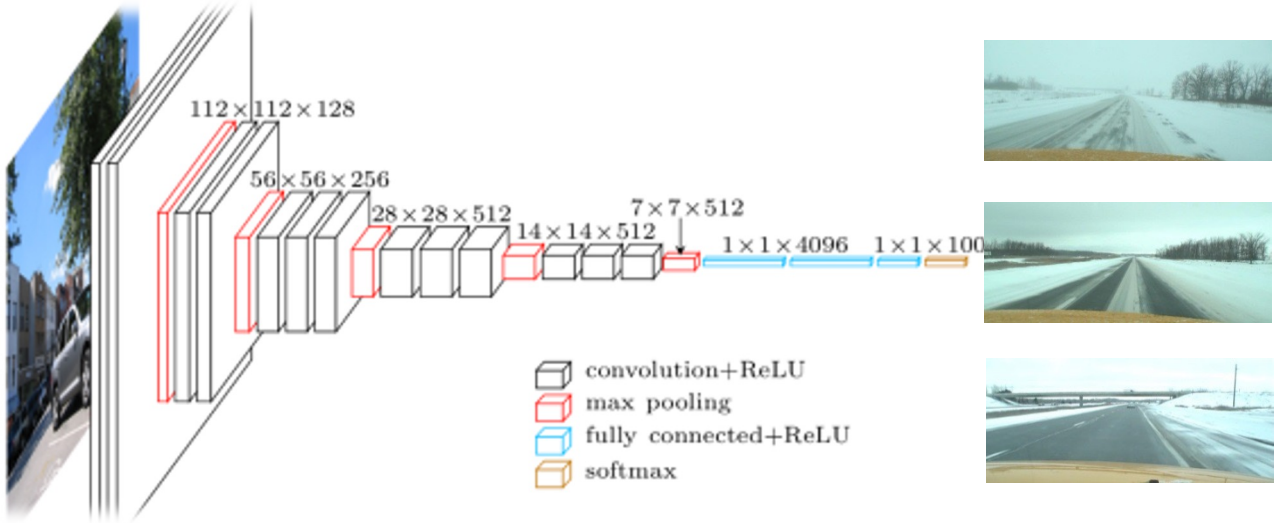
Winter Road Condition Monitoring…

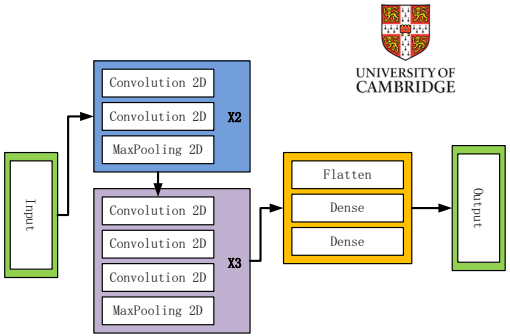


Crowdsourced Winter Road Condition Monitoring Solution

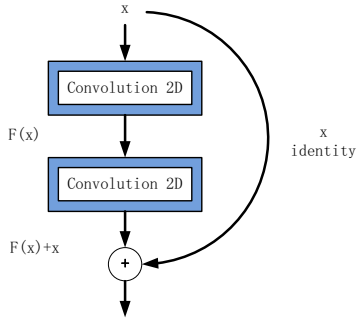


Proposed Solution:
Using a Pretrained Deep Convolutional Neural Network (CNN)

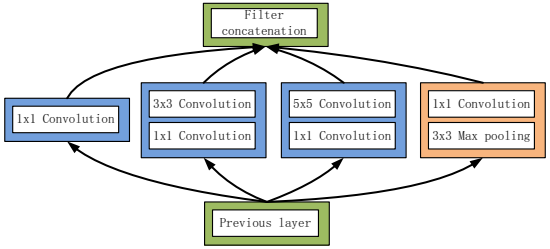




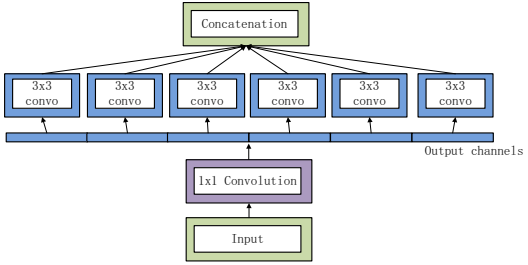
VGG16



ResNet50 base module

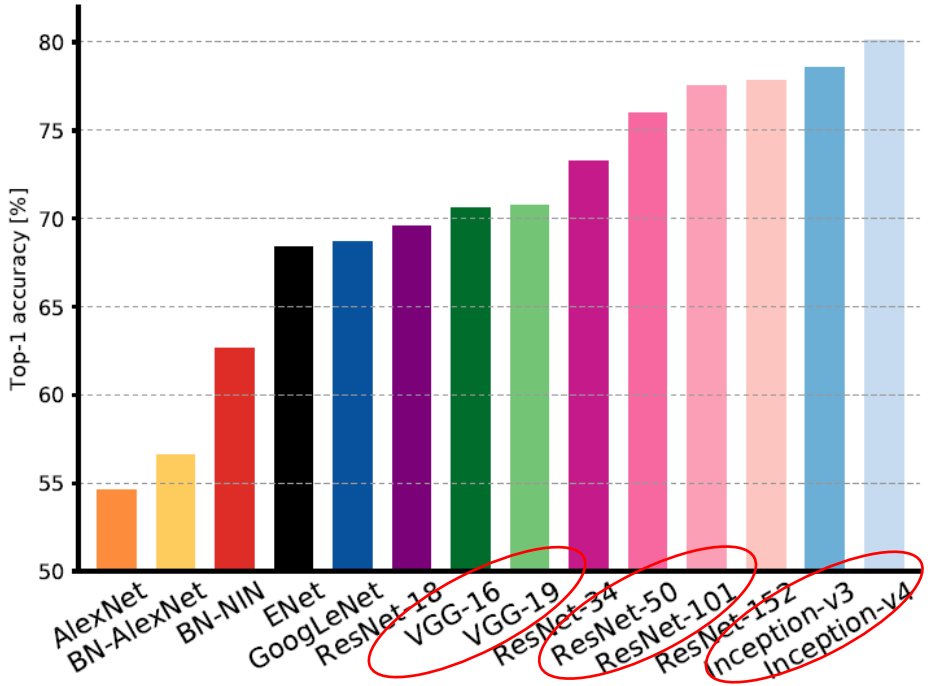


InceptionV3 base module



Xception base module

Pre-Trained Image Classification Models



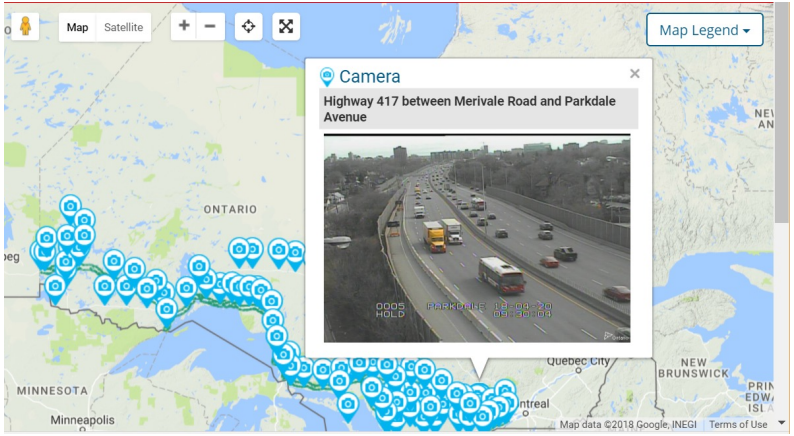
+ Xception

ImageNet Challenge

IMAGENET

- 1,000 object classes (categories).
- Images:
  - 1.2 M train
  - 100k test.

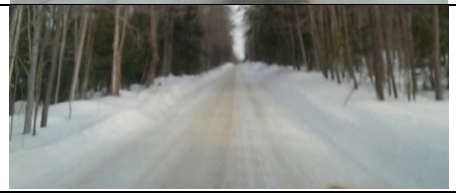
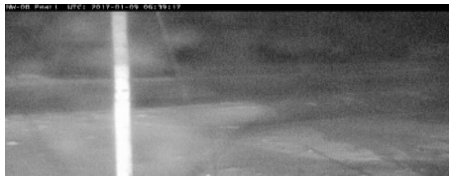
Experimental Study …



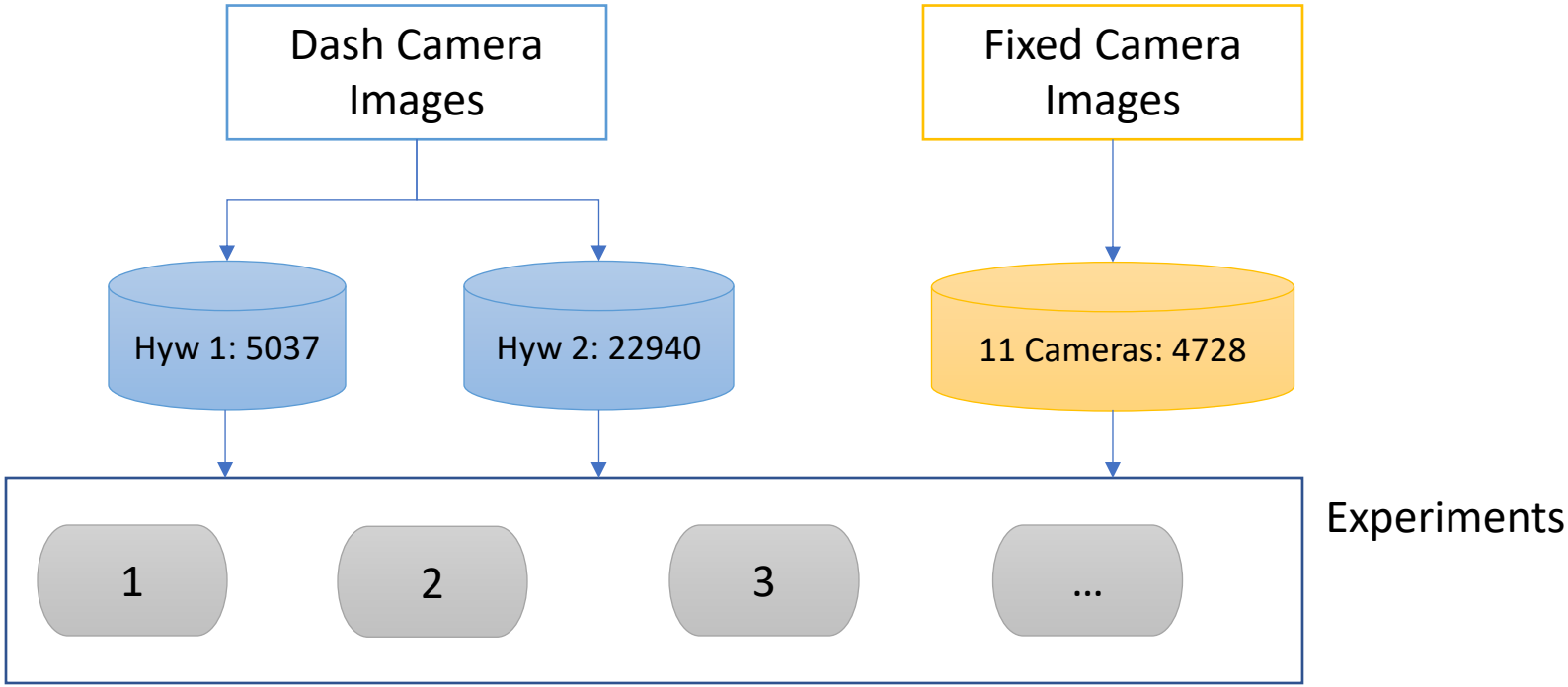
MTO RWIS Cameras

MTO Mobile Data Collection Unit
(HIIFP Projects, 2013-2018)

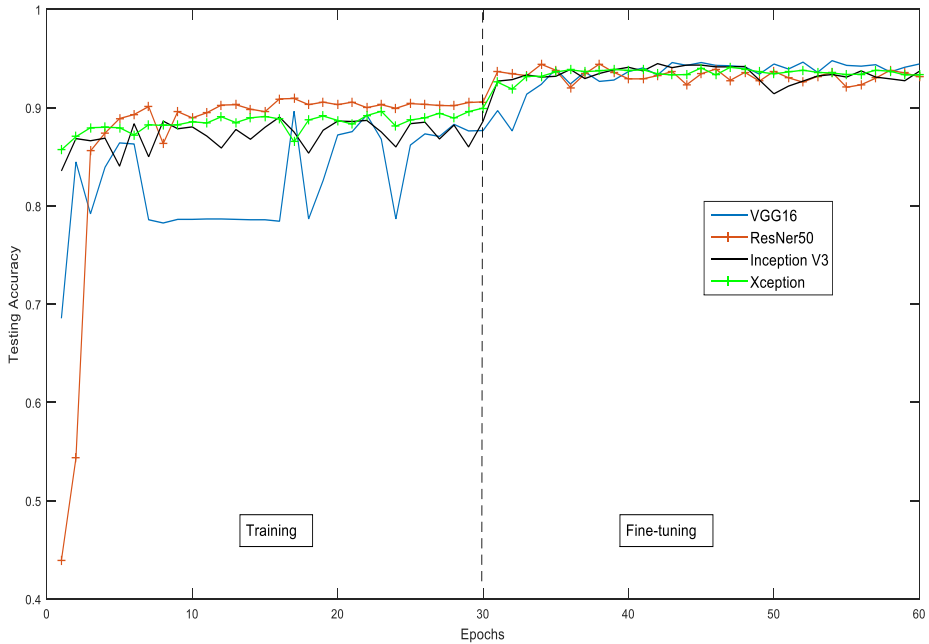
Definition of RSC Classes and Manual Classification

Sample Image	Description	Four-Class Description
	At least 3 meters of the pavement cross-section in all lanes clear of snow or ice.	Bare (less than 10% snow coverage)
	Only part of wheel path is clear of snow or ice.	Partly Snow Covered
	No wheel path clear of snow or ice.	Fully Snow Covered (more than 90% snow coverage)
	Not recognizable because of too dark, too much light or too blurry	Not Recognizable

Data for Training/Testing

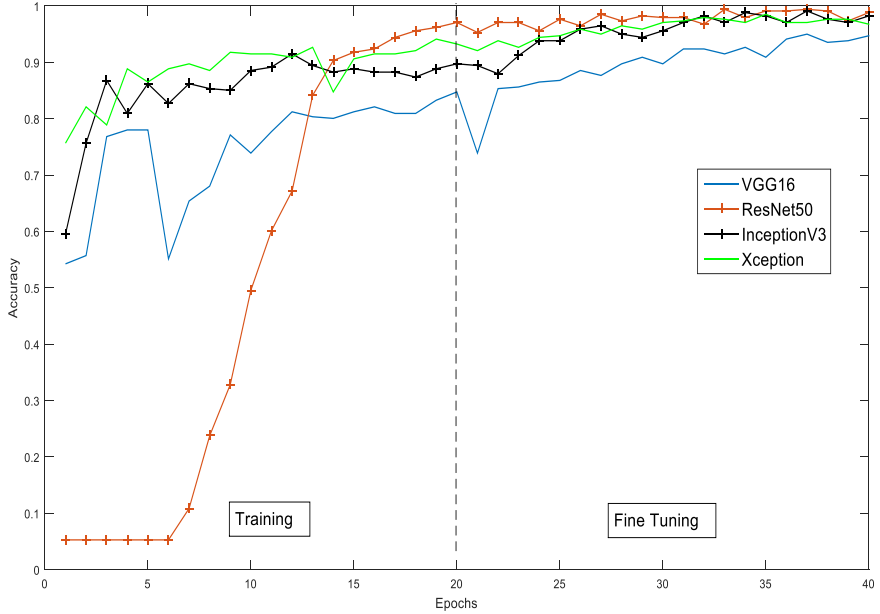


Experiment 1 - Testing on In-vehicle Devices



Models	Min	Ave	Max
VGG16	0.876	0.935	0.948
ResNet50	0.920	0.933	0.944
InceptionV3	0.914	0.934	0.945
Xception	**0.919**	**0.935**	**0.941**

Experiment 2 - Testing on Fixed Traffic Cameras



Models	Min	Ave	Max
VGG16	0.739	0.898	0.950
ResNet50	**0.950**	**0.978**	**0.994**
InceptionV3	0.880	0.956	0.991
Xception	0.921	0.961	0.985

Experiment 3 - Testing on Mixed Cameras (RestNet50)

Fully Connected Layers	Dataset 1	Dataset 2	Dataset 3
512	0.939	0.885	0.989
512-512	0.924	0.888	0.992
1000	0.929	0.878	0.993
1000-1000	**0.933**	**0.886**	**0.991**

Concluding Remarks

- The experimental study has shown great promise with the Deep Neural Networks
- Our experiments have expanded to over 60 cameras
- We have just initiated a new project funded by MTO for full-scale deployment/test

Demo…