Urban object classification with 3D Deep-Learning

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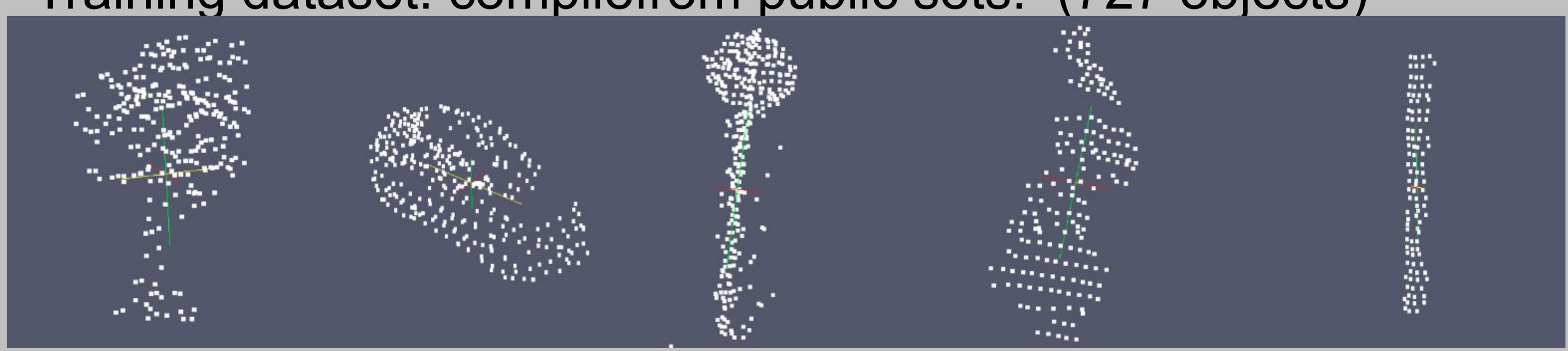
INTRODUCTION

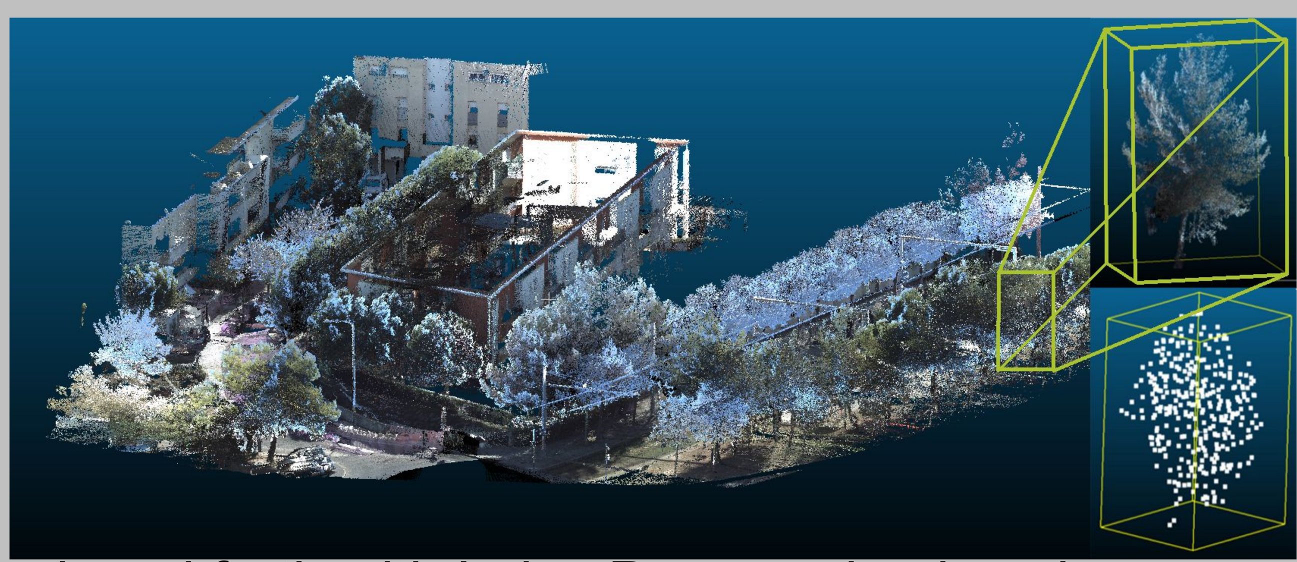
- Urban environment monitoring and management [1].
- Dynamic LiDAR acquisition to scan entire scene.
- Urban object detection and recognition.
- Deep-learning [2] techniques.
- Projecting all collected data in GIS.

3D URBAN OBJECT DATASETS

- 1 urban object = 1 point cloud = 512 points by uniform sampling
- 8 classes : tree, car, traffic sign, pole, pedestrian, building, noise
- Training dataset: compilefrom public sets: (727 objects)



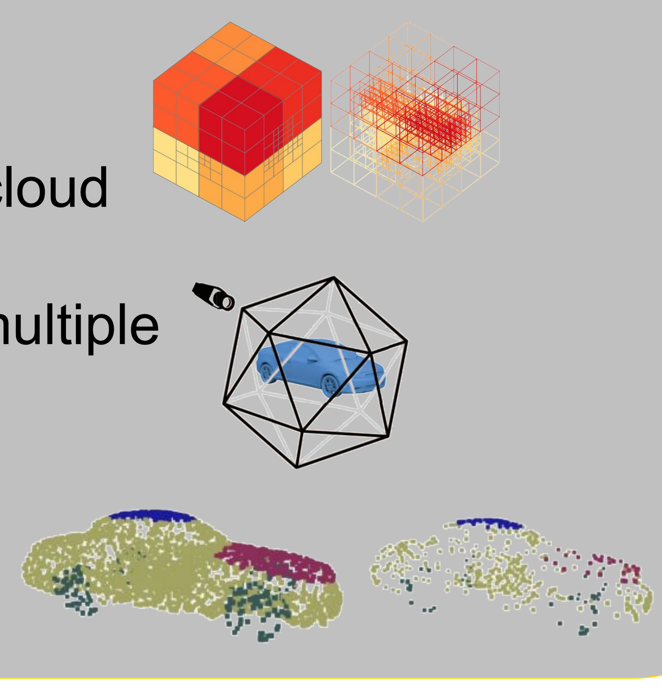
  - Sydney urban dataset:
    http://www-personal.acfr.usyd.edu.au/a.quadros/objects4.html
  - Kevin Lai dataset:
    https://sites.google.com/site/kevinlai726/datasets
  - Paris rue Madame dataset:
    http://cmm.ensmp.fr/~serna/rueMadameDataset.html
- Test dataset: our LiDAR acquisition:



  - 200 meters back and forth with Leica Pegasus backpack
  - 27 millions points (x, y, z) + RGB
  - 174 urban objects isolated manually
    - **http://www.lirmm.fr/~zegaoui/**

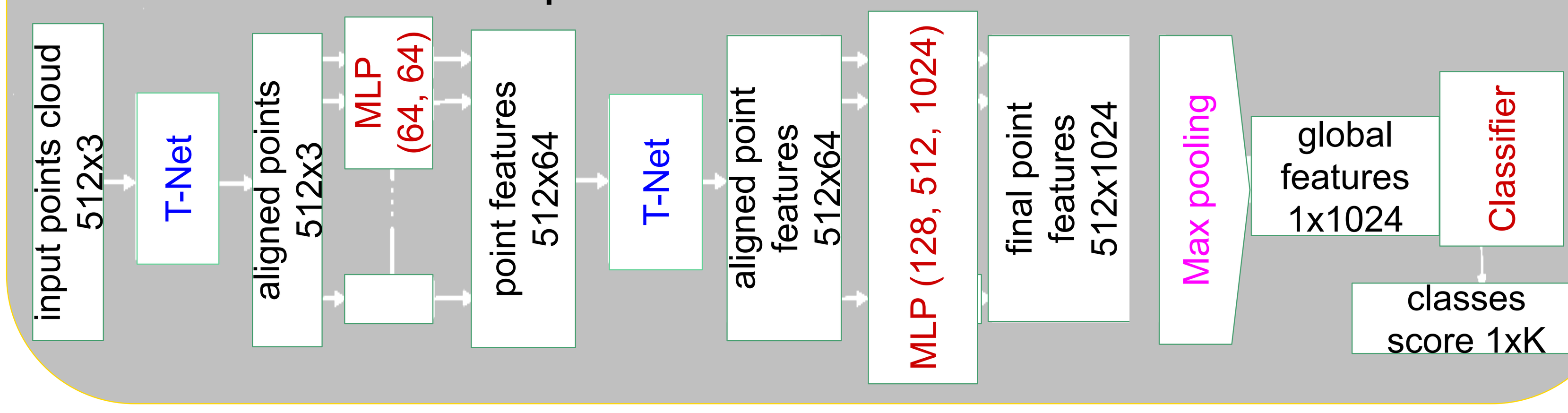
DEEP-LEARNING FOR 3D POINT CLOUD CLASSIFICATION

- Voxelizing the clouds [3]
  - Discretizing space around the cloud
- Using multi-views [4]
  - Synthesizing 2D images from multiple point of view around the cloud
- Learning directly on point [5]



SELECTED METHOD: POINT-NET FRAMEWORK [5]

- Points (x, y, z) are directly processed
- Coordinate frame normalized with T-Net
- Invariant w.r.t. the point order



BASELINE CLASSIFICATION EXPERIMENT [6]

- F measure is used to evaluate the performances

		Ground Truth				
		Tree (75)	Car (39)	Traffic sign/light (8)	Pole (23)	Pedestrian (15)
Classification	Tree	69	2	0	8	0
	Car	1	33	0	0	0
	Traffic sign/light	4	0	4	12	2
	Pole	0	0	3	1	0
	Pedestiran	1	0	1	0	12
	Building	0	0	0	2	0
	Noise	0	4	0	0	1
F measure		0.896	0.904	0.267	0.074	0.828

CLASSIFICATION EXPERIMENT WITH ADDITIONAL DATA

- We enrich our training set with clouds from the Paris-Lille dataset:
  http://caor-mines-paristech.fr/fr/paris-lille-3d-dataset/

		Ground Truth				
		Tree (75)	Car (39)	Traffic sign/light (8)	Pole (23)	Pedestrian (15)
Classification	Tree	70	0	0	2	1
	Car	2	39	0	0	1
	Traffic sign/light	2	0	7	10	2
	Pole	0	0	1	11	0
	Pedestiran	0	0	0	0	11
	Building	1	0	0	0	0
	Noise	0	0	0	0	0
F measure		0.946	0.963	0.467	0.629	0.815

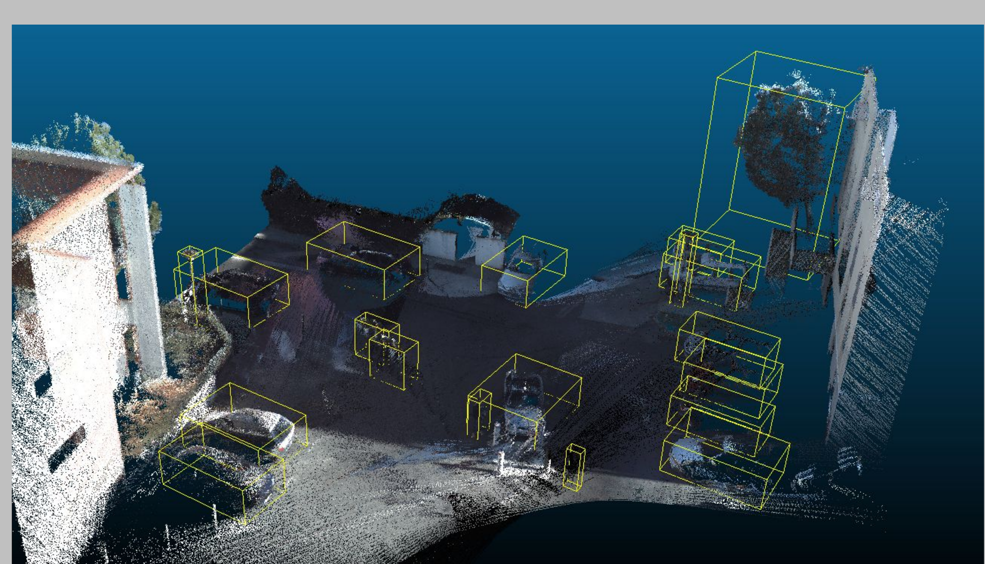
CLASSIFICATION EXPERIMENT WITH CLASS FUSION

We fuse traffic sign/light and pole classes into TLSP class

		Ground Truth			
		Tree (75)	Car (39)	TSLP (31)	Pedestrian (15)
Classification	Tree	69	3	3	0
	Car	1	27	0	0
	Pole	2	0	28	5
	Pedestiran	0	0	0	9
	Building	1	0	0	0
	Noise	2	9	0	1
F measure		0.920	0.806	0.849	0.750

CONCLUSION

- Interesting results for classification despite the small size of our dataset
- Class confusion “traffic sign”/”pole” in the prediction step
- Adding training data improves results



FUTURE WORK

- Acquisitions of new datasets
- Object localization in a scene
- 3D+t analysis of scene variation

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