

Point-Voxel CNN for Autonomous Racing Vehicle



Zhijian Liu



Yujun Lin



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Nick Stathas

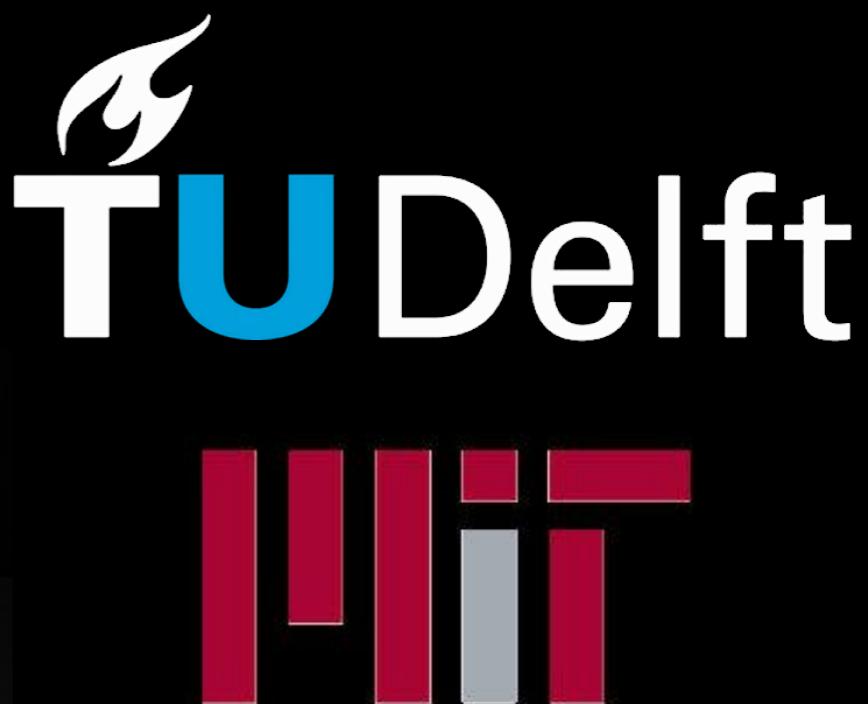
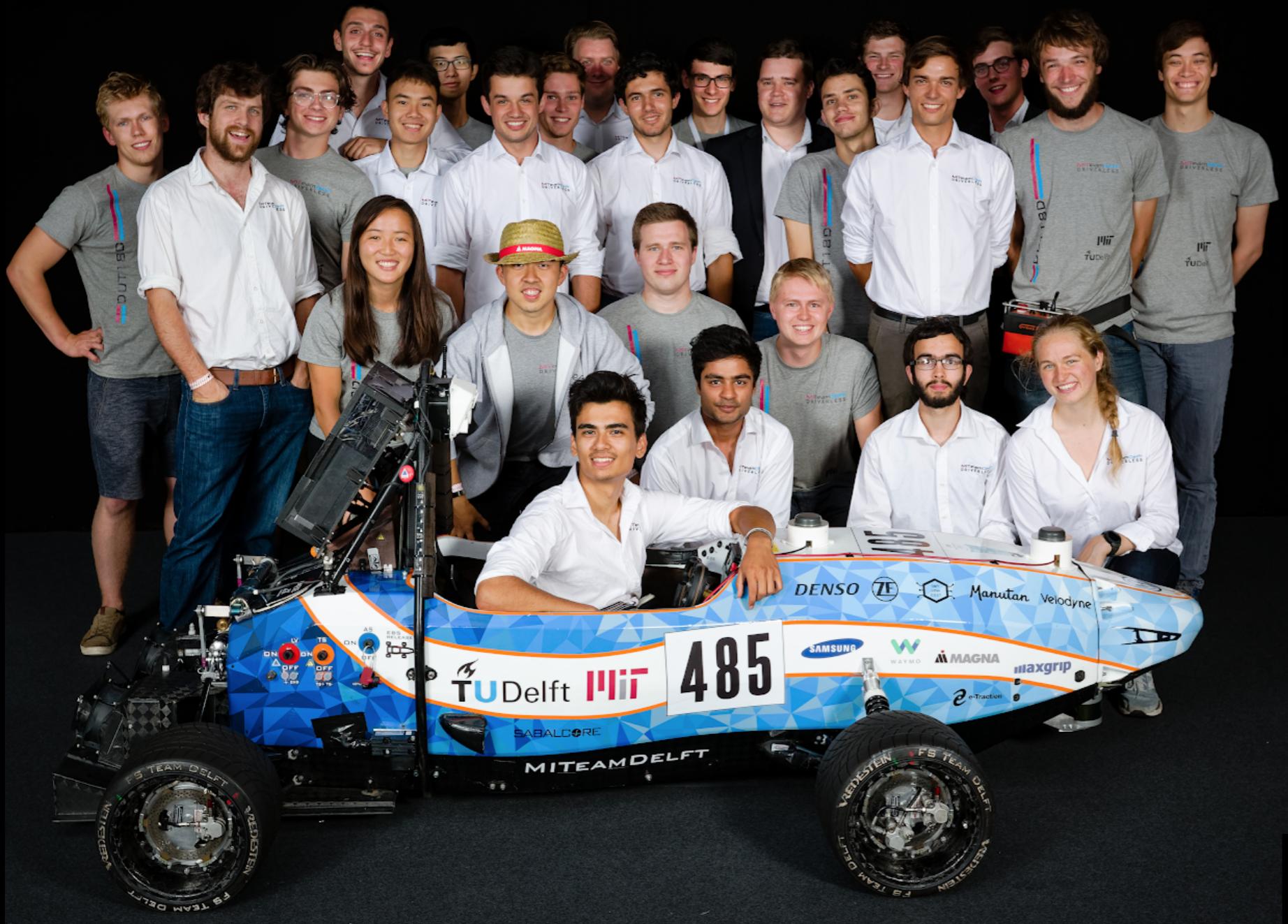


Song Han

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MIT
DRIVERLESS

International Collaboration with TU Delft





Car 485: NL Delft TU // Lap: 3 // 75.77 s

Share with #FSG19

Cars on Track
485 Formula Student Team Delft Driv..
2019/08/18, 9:29:52

Formula Student Racing Objectives



High Accuracy

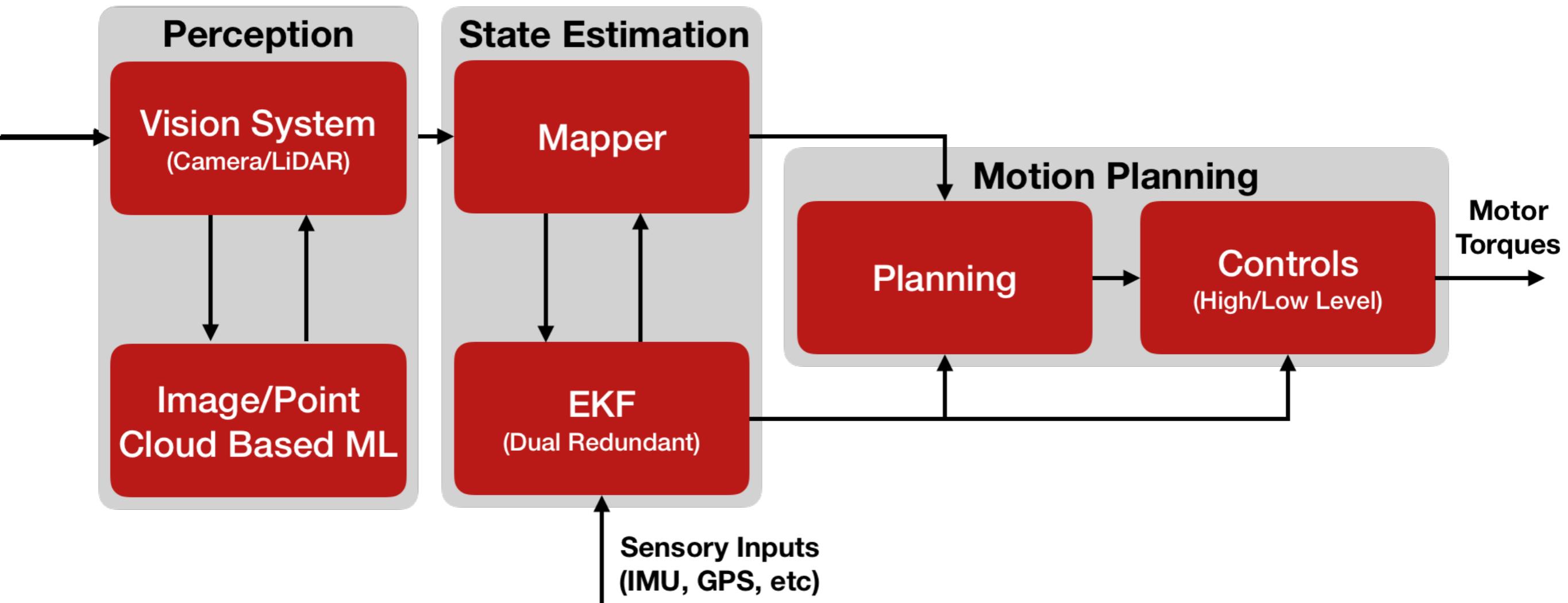
- Don't hit traffic cones
- Planning needs accurate mapping



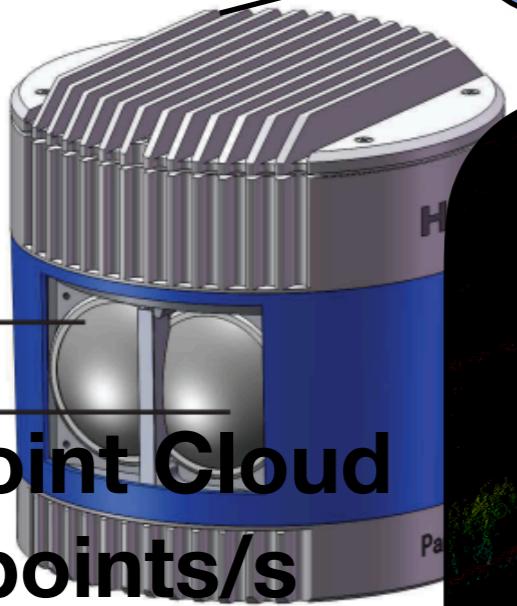
Low Latency

- Car drives fast

Autonomous Pipeline Overview



LiDAR

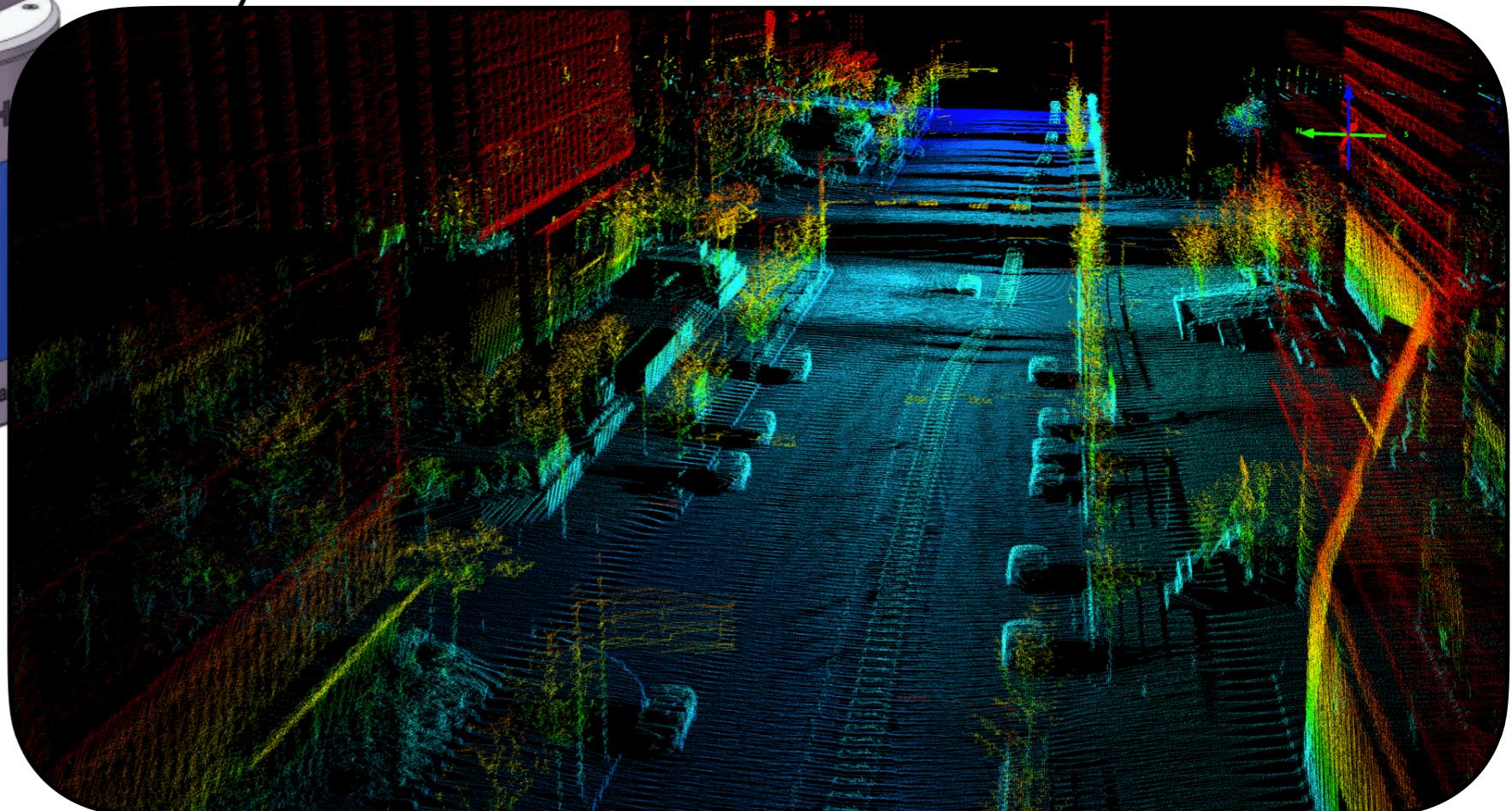


Laser Receiver

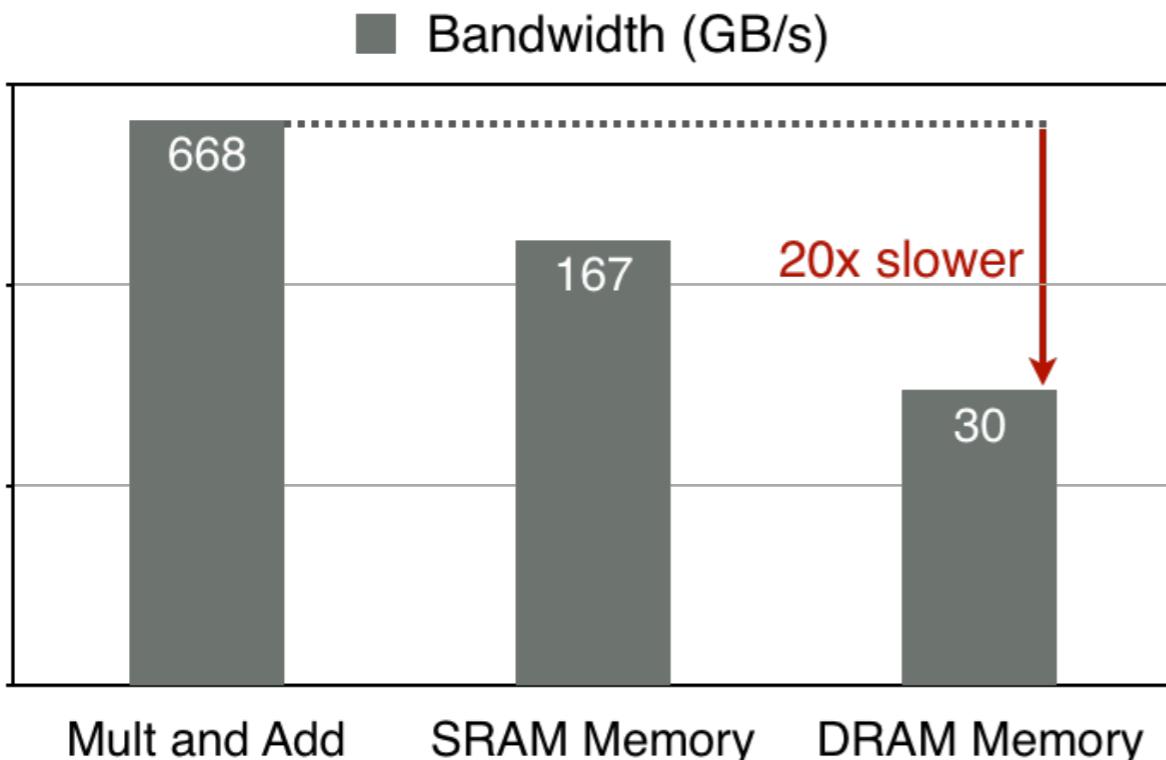
Laser Emitter

LiDAR Point Cloud

- 500k+ points/s
- x, y, z, intensity

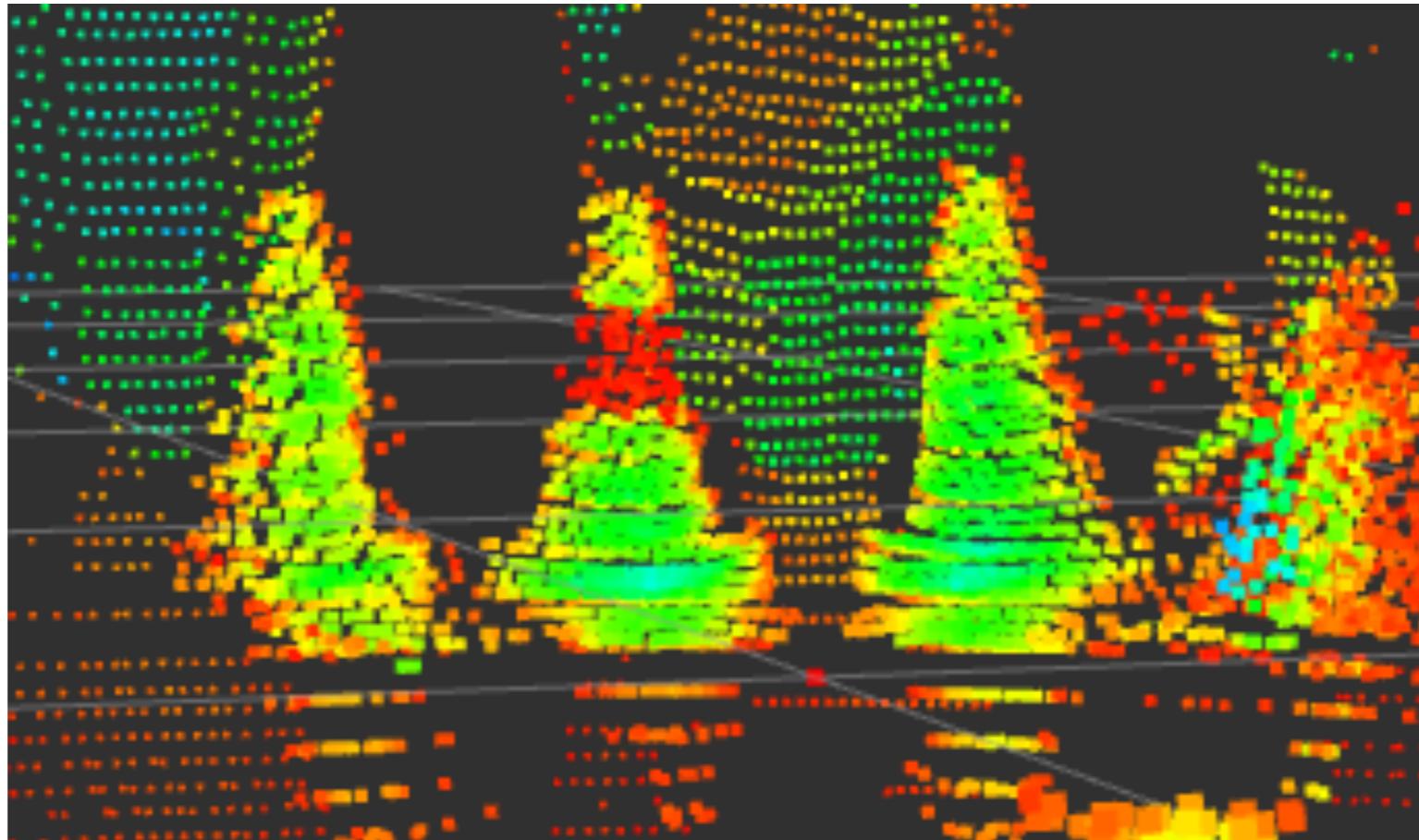


Conventional 3D Approach is Accurate but Slow



- GPU server computation
- Limited room on vehicle
- Potential danger

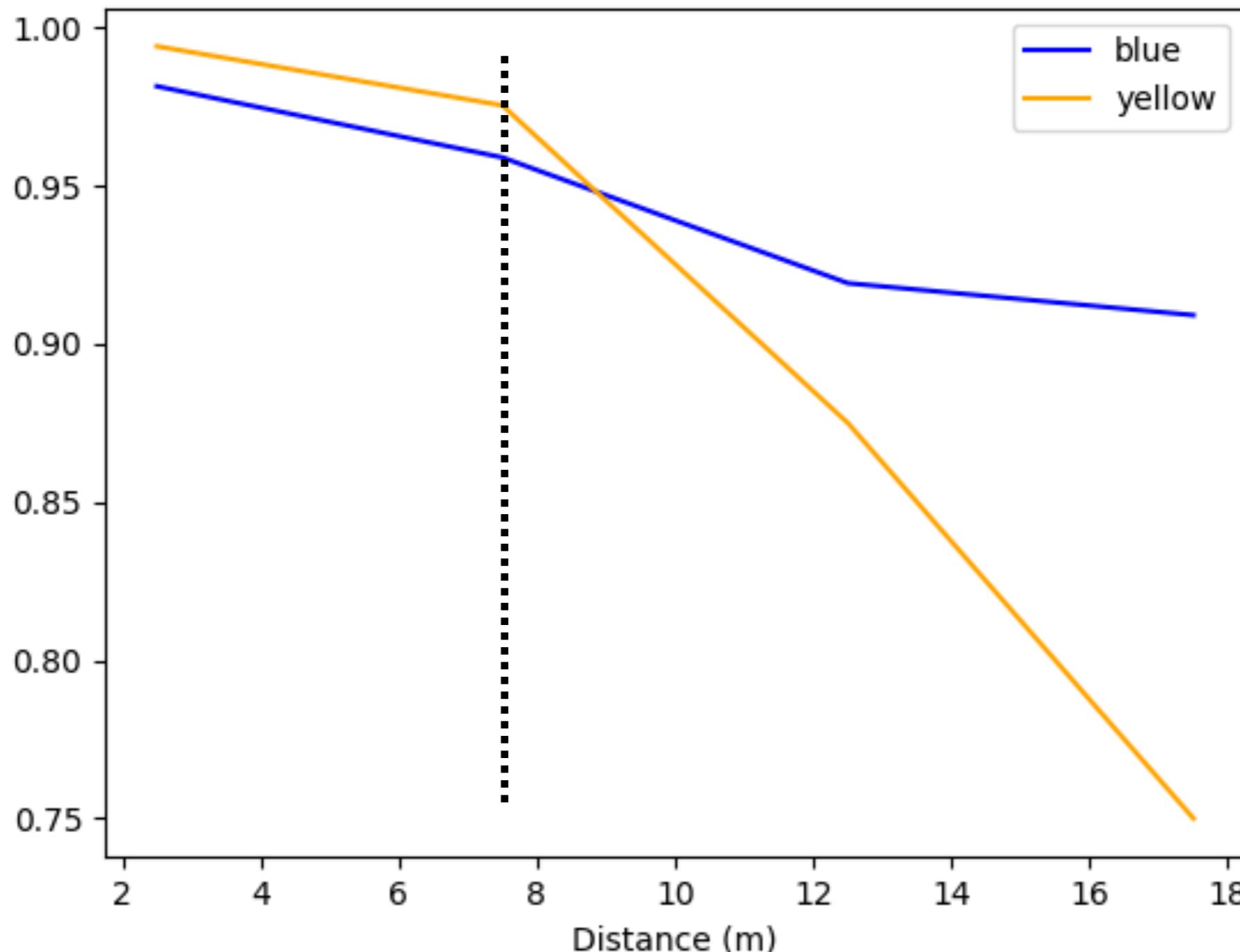
Conventional 2D Approach is Fast but Inaccurate



- Information loss
- Weak on small clusters

Last Year's Limitations

Color Classification Accuracy



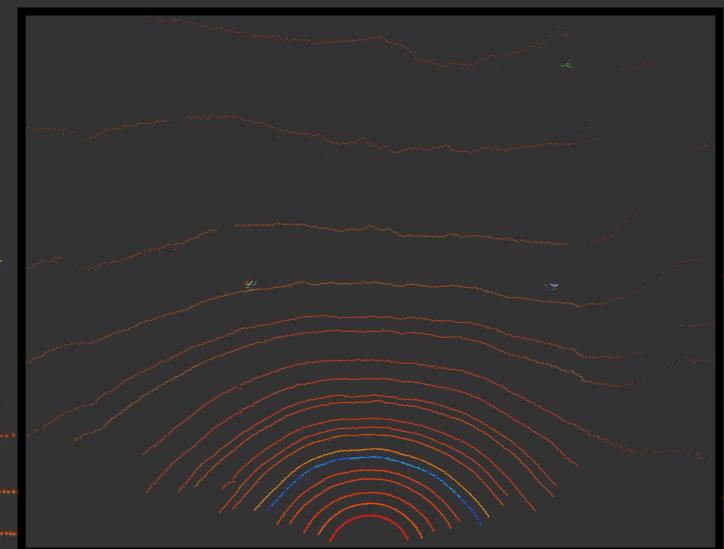
Let's see what if we use PVCNN:

- **3D model inference accuracy**
- **2D Inference computation**

Old Pipeline

Accuracy: 95%

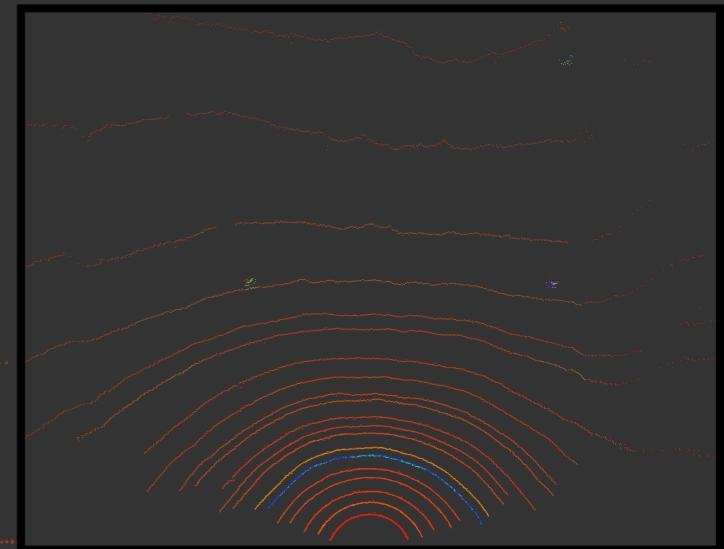
Range: 8 meters



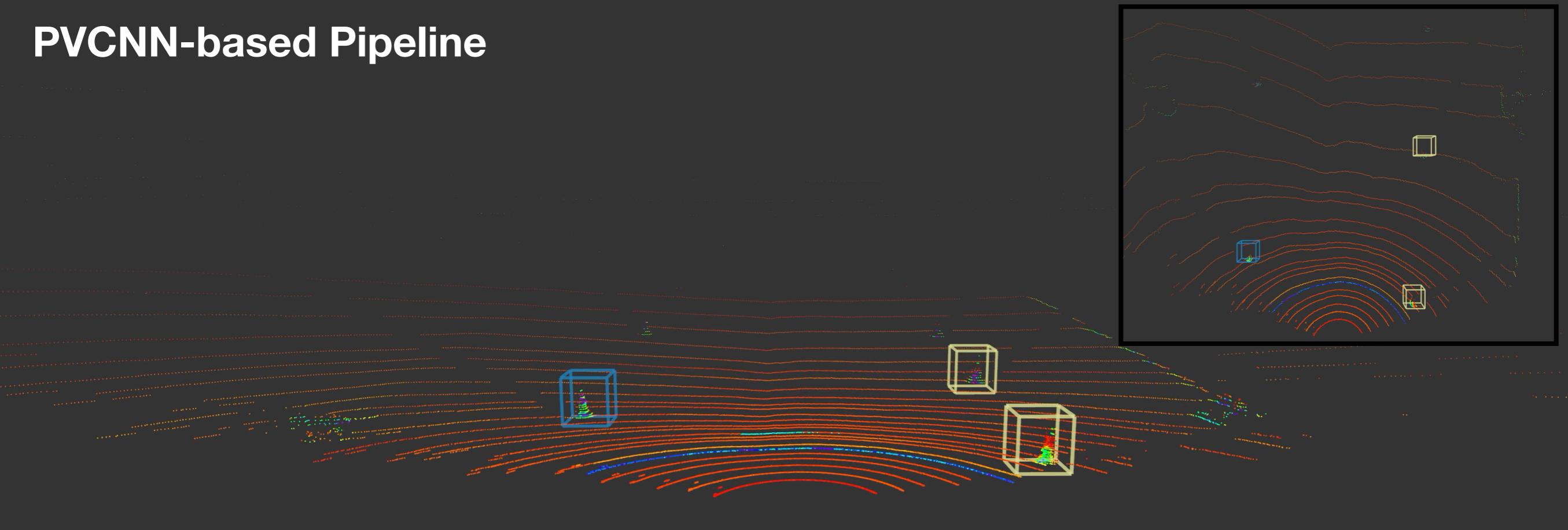
PVCNN-based Pipeline

Accuracy: 99.93%

Range: 12 meters



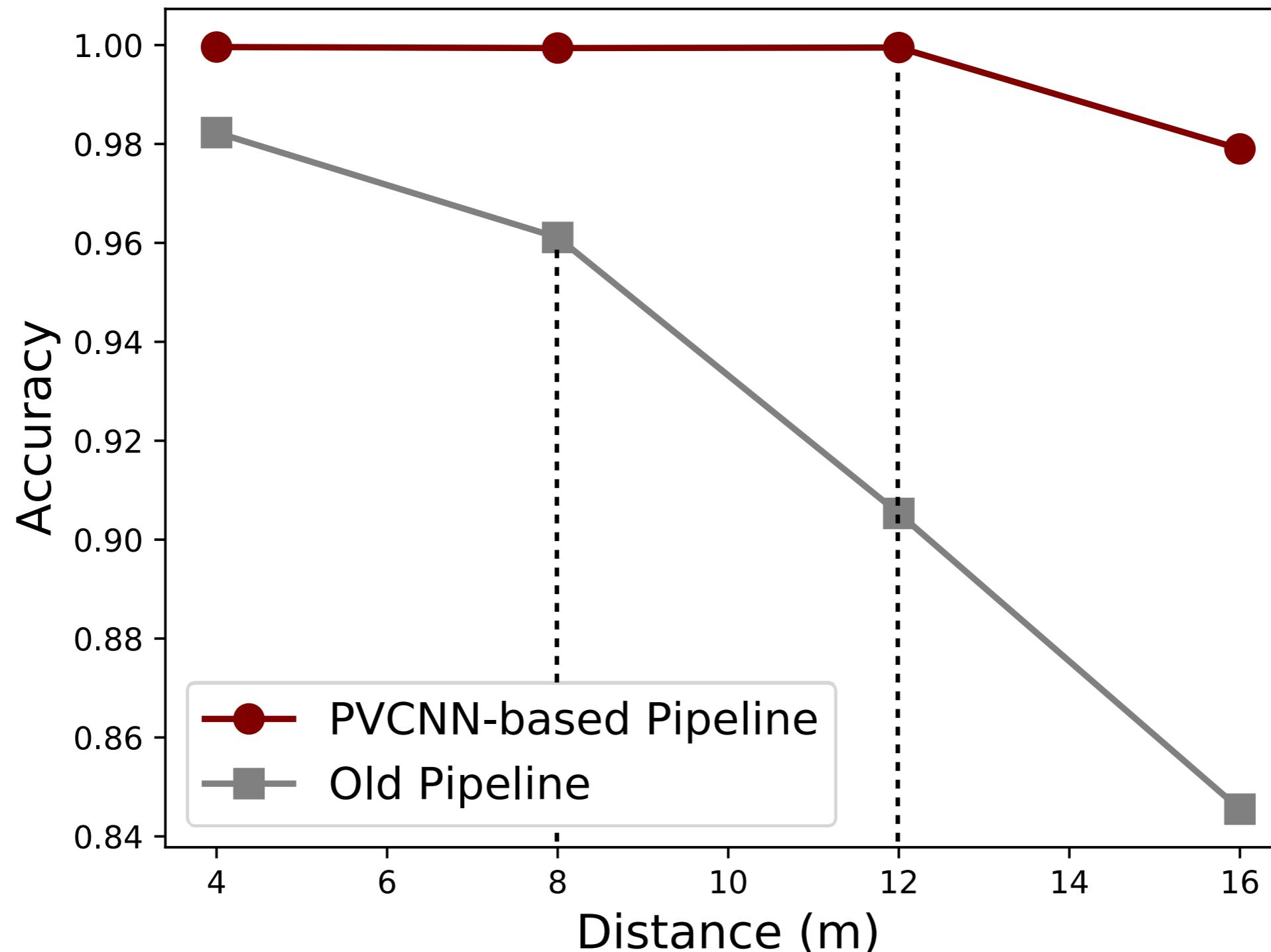
PVCNN-based Pipeline



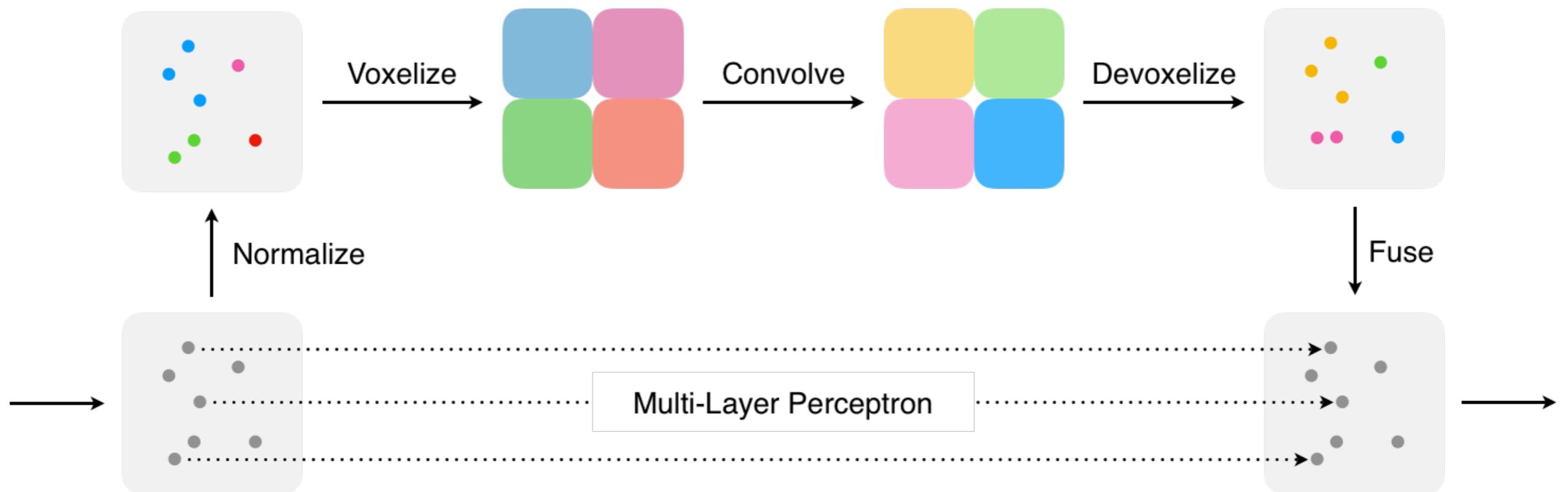
Evaluation Metrics Comparison

	Accuracy	Range	Latency
Old Pipeline	95%	8 meters	2 ms/object
PVCNN	99.93%	12 meters	1.25 ms/object

Accuracy vs. Distance Comparison

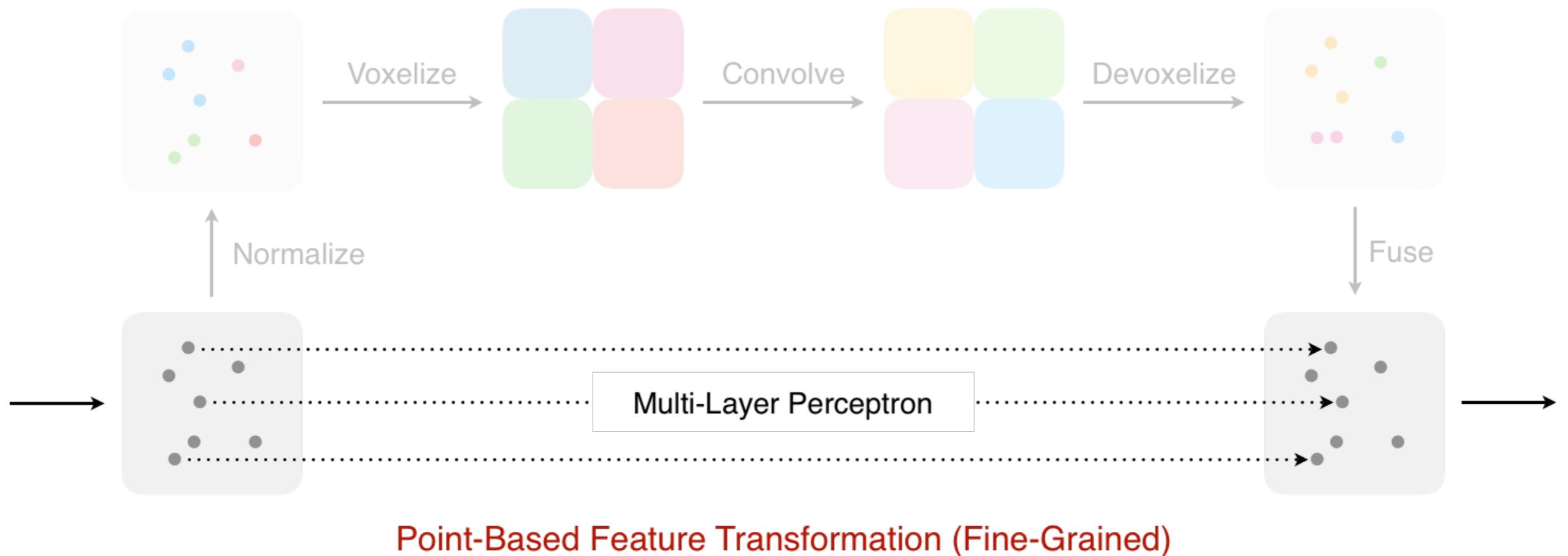


Point-Voxel Convolution (PVConv)



Zhijian Liu, Haotian Tang, Yujun Lin, Song Han,
Point-Voxel CNN for Efficient 3D Deep Learning, NeurIPS'19, spotlight
Website: <http://pvcnn.mit.edu>

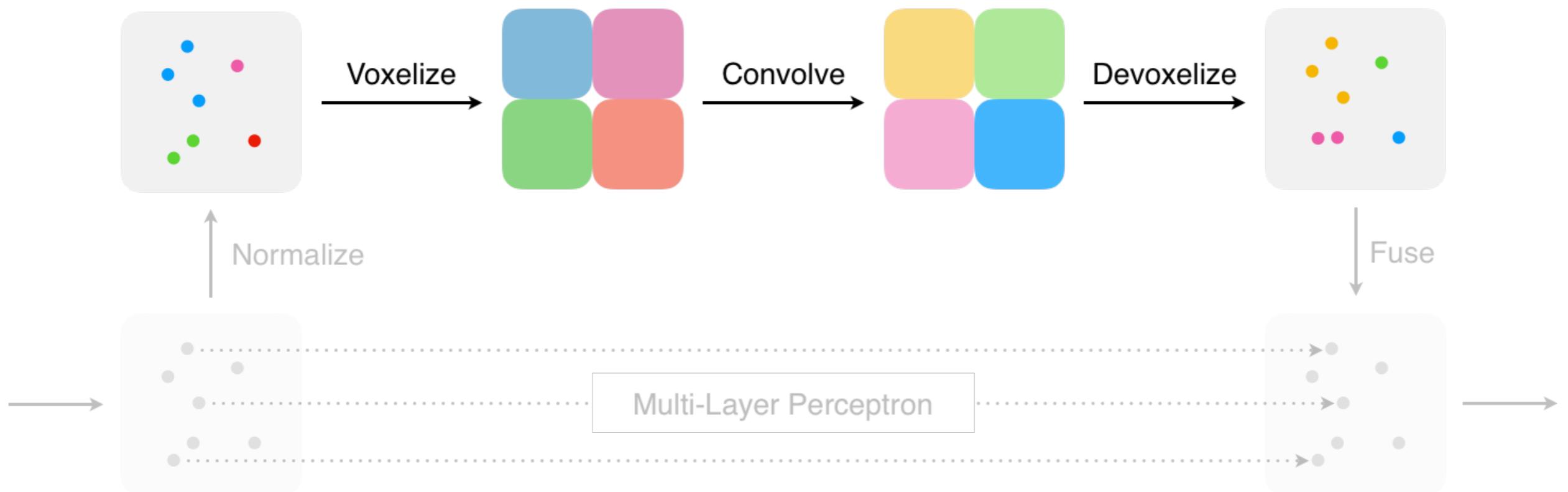
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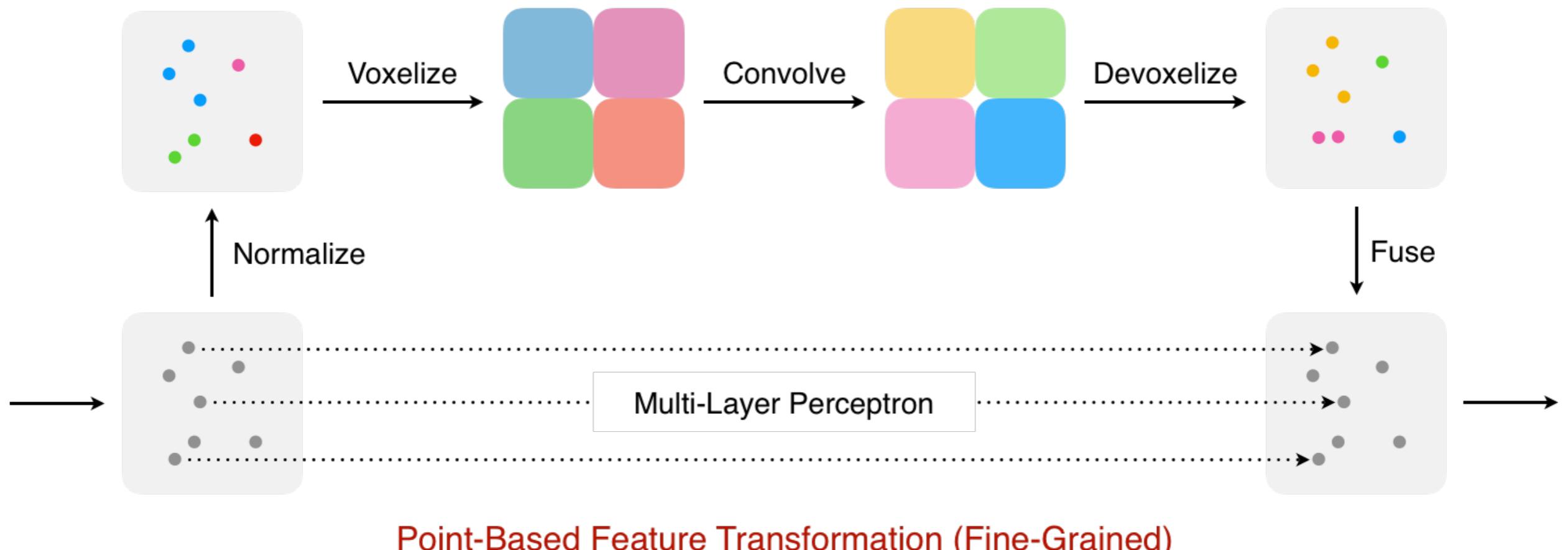
Voxel-Based Feature Aggregation (Coarse-Grained)



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Voxel-Based Feature Aggregation (Coarse-Grained)



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Thank you!

Help us making autonomous racing car
drives fast and safely!



Haotian Tang



Ravi Rahman



Paul van Houtum



Nassim Oufattole