TABLE 3: Comparative 3D object detection results on the KITTI test BEV detection benchmark. 3D bounding box IoU threshold is 0.7 for cars and 0.5 for pedestrians and cyclists. The modalities are LiDAR (L) and image (I). 'E', 'M' and 'H' represent easy, moderate and hard classes of objects, respectively. For simplicity, we omit the '%' after the value. The symbol '-' means the results are unavailable.

Method			Modality	Speed (fps)	Cars			Pedestrians			Cyclists		
					E	M	H	E	M	H	E	M	H
Region Proposal -based Methods	Multi-view Methods	MV3D [4]	L & I	2.8	86.62	78.93	69.80	-	-	-	-	-	-
		AVOD [97]	L & I	12.5	89.75	84.95	78.32	42.58	33.57	30.14	64.11	48.15	42.37
		ContFuse [98]	L & I	16.7	94.07	85.35	75.88	-	-	-	-	-	-
		MMF [99]	L & I	12.5	93.67	88.21	81.99	-	-	-	-	-	-
		SCANet [102]	L & I	11.1	90.33	82.85	76.06	-	-	-	-	-	-
		RT3D [103]	L & I	11.1	56.44	44.00	42.34	-	-	-	-	-	-
	Segmentation -based Methods	IPOD [104]	L & I	5.0	89.64	84.62	79.96	60.88	49.79	45.43	78.19	59.40	51.38
		PointRCNN [105]	L	10.0	92.13	87.39	82.72	54.77	46.13	42.84	82.56	67.24	60.28
		PointRGCN [106]	L	3.8	91.63	87.49	80.73	-	-	-	-	-	-
		PointPainting [107]	L & I	2.5	92.45	88.11	83.36	58.70	49.93	46.29	83.91	71.54	62.97
		STD [110]	L	12.5	94.74	89.19	86.42	60.02	48.72	44.55	81.36	67.23	59.35
	Frustum -based Methods	F-PointNets [112]	L & I	5.9	91.17	84.67	74.77	57.13	49.57	45.48	77.26	61.37	53.78
		SIFRNet [113]	L & I	-	-	-	-	-	-	-	-	-	-
		PointFusion [116]	L & I	-	-	-	-	-	-	-	-	-	-
		RoarNet [117]	L & I	10.0	88.20	79.41	70.02	-	-	-	-	-	-
		F-ConvNet [111]	L & I	2.1	91.51	85.84	76.11	57.04	48.96	44.33	84.16	68.88	60.05
		Patch Refinement [118]	L	6.7	92.72	88.39	83.19	-	-	-	-	-	-
	Other Methods	3D IoU loss [119]	L	12.5	91.36	86.22	81.20	-	-	-	-	-	-
		Fast Point R-CNN [121]	L	16.7	90.76	85.61	79.99	-	-	-	-	-	-
		VoteNet [122]	L	-	-	-	-	-	-	-	-	-	-
		Feng et al. [123]	L	-	-	-	-	-	-	-	-	-	-
		Part-A^2 [124]	L	12.5	91.70	87.79	84.61	-	-	-	81.91	68.12	61.92
Single Shot Methods	BEV-based Methods	PIXOR [100]	L	28.6	83.97	80.01	74.31	-	-	-	-	-	-
		HDNET [128]	L	20.0	89.14	86.57	78.32	-	-	-	-	-	-
		BirdNet [129]	L	9.1	76.88	51.51	50.27	20.73	15.80	14.59	36.01	23.78	21.09
	Point Cloud -based Methods	VeloFCN [125]	L	1.0	0.02	0.14	0.21	-	-	-	-	-	-
		3D FCN [126]	L	<0.2	70.62	61.67	55.61	-	-	-	-	-	-
		Vote3Deep [127]	L	-	-	-	-	-	-	-	-	-	-
		3DBN [130]	L	7.7	89.66	83.94	76.50	-	-	-	-	-	-
		VoxelNet [108]	L	2.0	89.35	79.26	77.39	46.13	40.74	38.11	66.70	54.76	50.55
		SECOND [120]	L	26.3	89.39	83.77	78.59	55.99	45.02	40.93	76.50	56.05	49.45
		MVX-Net [131]	L & I	16.7	92.13	86.05	78.68	-	-	-	-	-	-
		PointPillars [109]	L	62.0	90.07	86.56	82.81	57.60	48.64	45.78	79.90	62.73	55.58
	Other Methods	LaserNet [132]	L	83.3	79.19	74.52	68.45	-	-	-	-	-	-
		LaserNet++ [133]	L & I	26.3	-	-	-	-	-	-	-	-	-