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SCHOOL OF ELECTRONICS, PEKING UNIVERSITY

Research Group of Prof. Xiang Cheng, School of Electronics, Peking University: A Dataset of Wireless Communication Channels for Complex High-Mobility Vehicular Scenarios

1. Description: A benchmark dataset of massive multiple-input multiple-output (MIMO) millimeter wave (mmWave) channels under complex high-mobility vehicular communication scenarios is developed. In the dataset, each base station (BS) is equipped with 128 antenna elements, each vehicle is equipped with 32 antenna elements, and the carrier frequency is 28 GHz with 2 GHz communication bandwidth. The dataset contains 1500 snapshots of vehicular channel information and covers vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication links. Currently, the dataset contains 27000 channel impulse response (CIR) matrices, which can support the research related to vehicular channels.
2. Novelties & Contributions
   ① Comprehensive and accurate simulation dataset: It is significantly difficult to carry out massive MIMO mmWave channel measurement campaigns under complex high-mobility vehicular communication scenarios. To efficiently support the research of vehicular channels, our group develops a comprehensive and realistic dataset of massive MIMO mmWave channels under complex high-mobility vehicular communication

scenarios.

② Multi-trajectory and multi-velocity vehicle simulation: In the dataset, multiple vehicular movement trajectories (VMTs) of dynamic vehicles are mimicked. Furthermore, by setting different snapshot values, the dataset can contain vehicular channel information under different vehicular velocities.

③ Dataset validation through collision detection: To validate the generated complex high-mobility vehicular scenarios, the collision detection of dynamic vehicles is conducted based on the VMTs of dynamic vehicles. If dynamic vehicles collide, the names of the colliding dynamic vehicles and the collision snapshot can be obtained.

④ Large-scale dataset as a result of batch generation of dynamic scenarios, queuing simulation, and automatic result export: The positions of objects and antennas are revised in batches to generate complex high-mobility vehicular communication scenarios with 1500 snapshots. Furthermore, the generated scenarios are queued for simulation and the results are exported automatically.

3. Scenario Description & Parameter Setting

① Scenario: Complex high-mobility vehicular communications under urban crossroad scenarios.

② Volume: Vehicular channel information with 1500 snapshots and 27000 CIR matrices.

③ Object: 11 BSs, 12 vehicles (9 cars and 3 buses), 6 pedestrians, trees, and buildings. All BSs, cars, and buses are both transmitter (Tx) and receiver (Rx).

④ Antenna: Each BS is equipped with a uniform linear antenna (ULA), which contains 128 half-wave dipole antenna elements. Each vehicle is equipped with a ULA, which contains 32 half-wave dipole antenna elements.

⑤ Frequency: 28 GHz carrier frequency with 2 GHz communication bandwidth.

⑥ Link: V2V links and V2I links.

⑦ Material: Ground and building surface are made of concrete. Vehicle surface is made of metal. Trees are made of “Dense Deciduous Forest, In Leaf”.

⑧ Power: Transmit power of each Tx is 0 dBm. Noise power is -6.99 dBm.

⑨ Propagation: Reflection=4, diffraction=1, transmission=0.

⑩ Weather: Temperature=22.2°C, pressure=1013 mbar, humidity=50%.

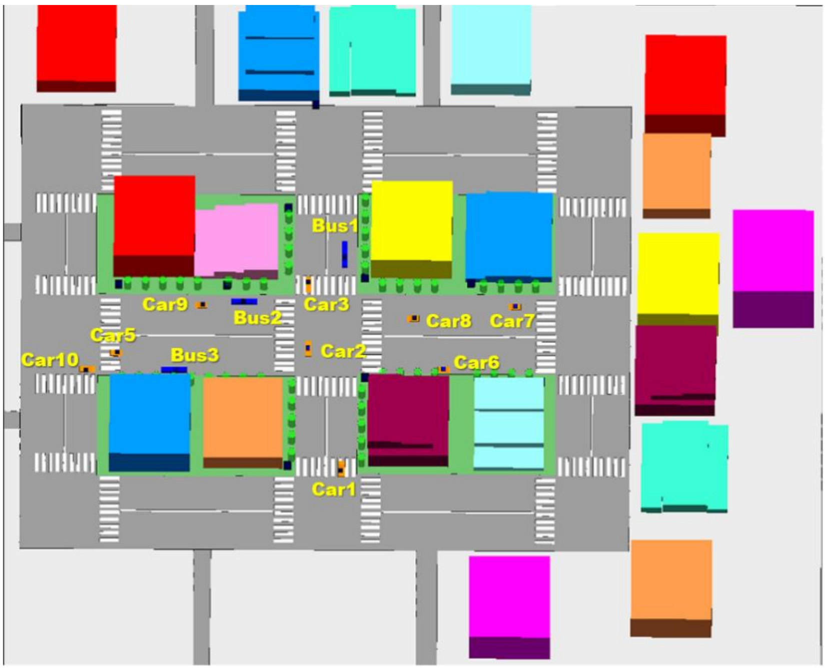

Fig. 1. Scenario representation at Snapshot 1.

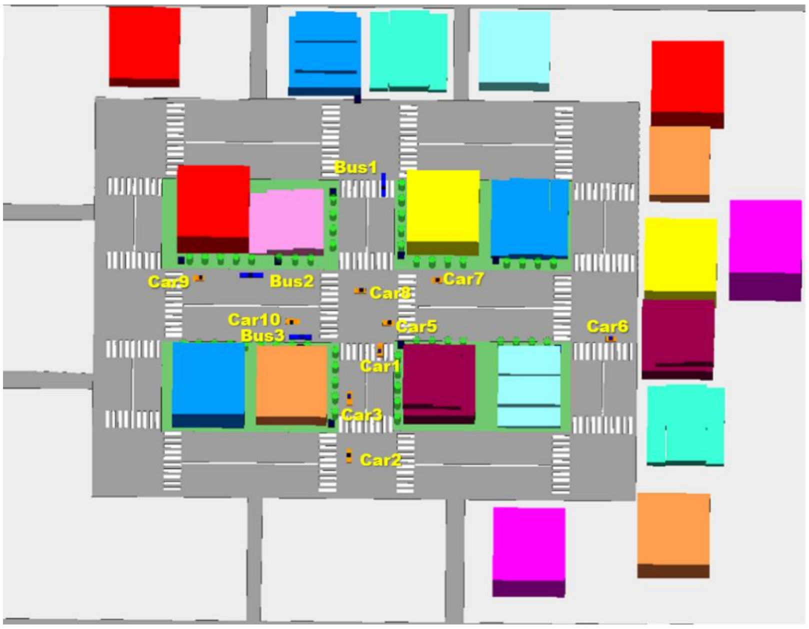

Fig. 2. Scenario representation at Snapshot 450.

4. Trajectory Setting

Object name	X-axis velocity （m/snapshot）	Y-axis velocity （m/snapshot）	Z-axis velocity （m/snapshot）	Motion start snapshot	Motion end snapshot
Car1	0.0833	0	0	1	300
Car2	-0.1	0	0	1	830
Car3	-0.1	0	0	1	950
Car5	0	-0.15	0	1	835
Car6	0	-0.1	0	1	480
Car7	0	0.07	0	1	1500
Car8	0	0.06	0	1	1500
Car9	0	0.04	0	1	1000
Car10	0	-0.1	0	1	300
	0.1	-0.1	0	300	350
	0	-0.1	0	350	660
	-0.1	0.1	0	660	710
	0	-0.1	0	710	1300
	0	-0.05	0	1300	1500

Bus1	0	0.05	0	1	320
Bus2	0	0.03	0	1	1500
Bus3	0	-0.05	0	1	1500

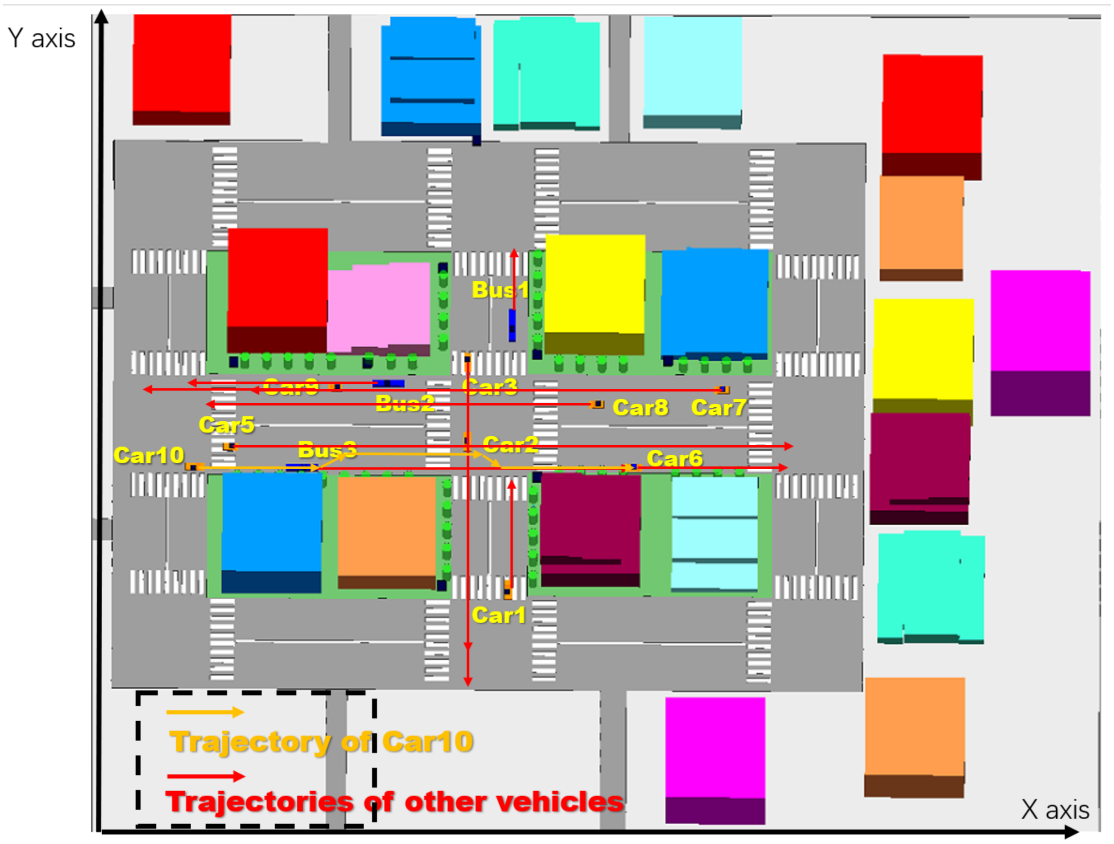

Fig. 3. Movement trajectories of dynamic vehicles.

5. Summary of exported links

Each snapshot exports the CIRs of the following links and stores them in ".mat" file

Tx Set	Rx Set	Name
BS3	Car2	BS3_Car2.mat
BS3	Car3	BS3_Car3.mat
BS3	Car5	BS3_Car5.mat
BS3	Car10	BS3_Car10.mat
BS5	Car5	BS5_Car5.mat
BS5	Car10	BS5_Car10.mat
BS6	Car6	BS6_Car6.mat
BS6	Car7	BS6_Car7.mat
BS7	Car5	BS7_Car5.mat
BS7	Car10	BS7_Car10.mat

BS8	Car5	BS8_Car5.mat
BS8	Car10	BS8_Car10.mat
Bus3	Car10	Bus3_Car10.mat
Car2	Car3	Car2_Car3.mat
Car5	Car7	Car5_Car7.mat
Car7	Car8	Car7_Car8.mat
Car10	Bus3	Car10_Bus3.mat
Car10	Car9	Car10_Car9.mat

6. Simulation results

6.1 Example 1: Snapshot 1

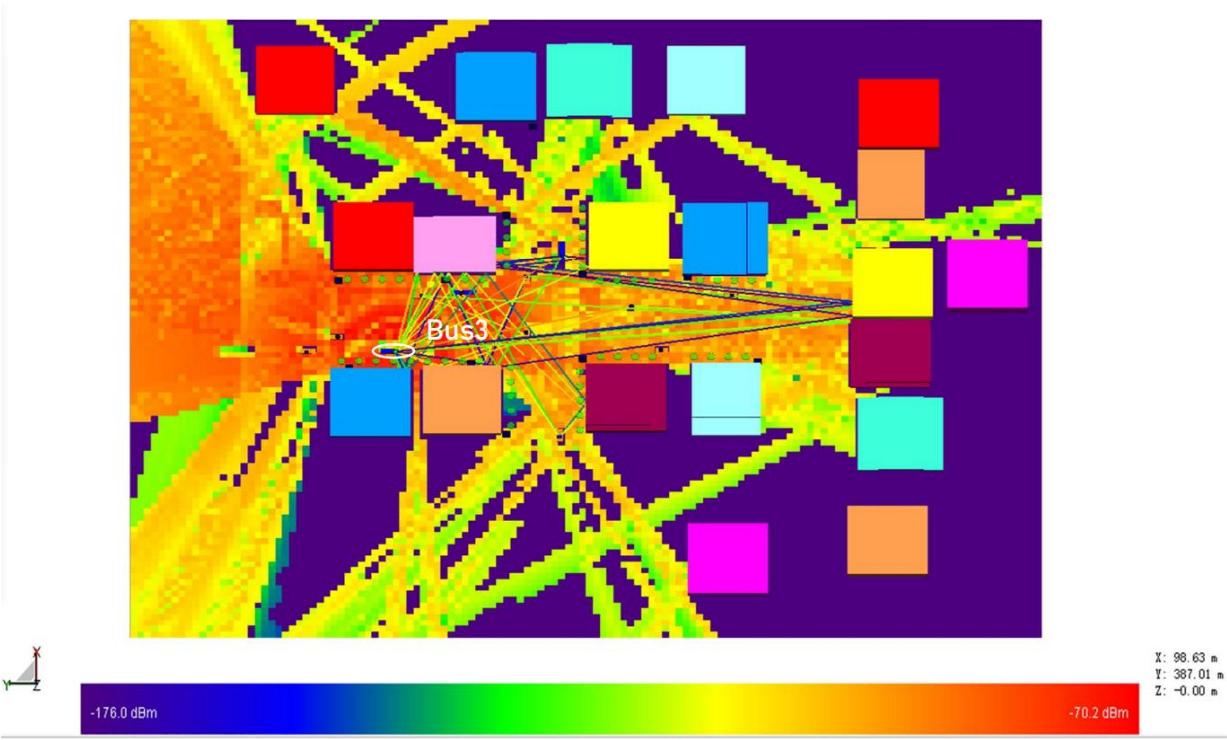

Fig. 4. Heat map and propagation paths of Bus3 (Tx) at Snapshot 1.

6.2 Example 2: Snapshot 450

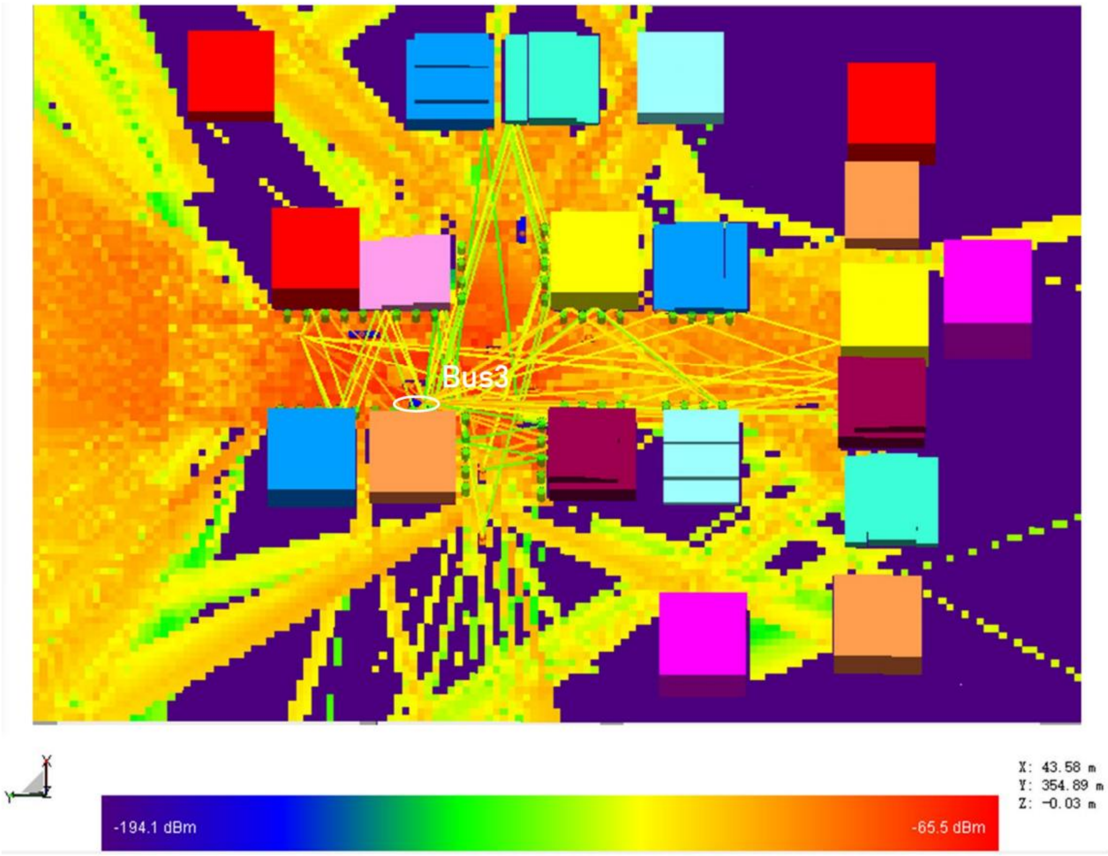

Fig. 5. Heat map and propagation paths of Bus3 (Tx) at Snapshot 450.

6.3 Analysis

Taking Bus3 as the Tx as an example, it can be observed that the heat maps and propagation paths at Snapshot 1 and Snapshot 450 are significantly different, which can adequately validate the accuracy of moving dynamic vehicles in batches.

7. How to get the dataset

① Please contact Ziwei Huang, ziweihuang@pku.edu.cn using the following template:

a) Subject: Obtaining the dataset of wireless communication channels for complex high-mobility vehicular scenarios

b) Body:

i. Explain the use of the dataset, i.e., what research needs to be supported by the dataset

ii. Name and affiliation

② If you find the dataset helpful, please consider citing the following references:

a) X. Cheng, Z. Huang, and L. Bai, "Channel non-stationarity and consistency for beyond 5G and 6G: A survey," *IEEE Communications Surveys & Tutorials*, vol. 24, no. 3, pp. 1634-1669, third-quarter 2022.

b) X. Cheng, D. Duan, S. Gao, and L. Yang, "Integrated sensing and communications (ISAC) for vehicular communication networks (VCN)," *IEEE Internet of Things Journal*, Early access, 2022. Doi: 10.1109/JIOT.2022.3191386.

c) Z. Huang and X. Cheng, "A 3D non-stationary model for beyond 5G and 6G vehicle-to-vehicle mmWave massive MIMO channels," *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 7, pp. 8260-8276, Jul. 2022.

d) Z. Huang, L. Bai, X. Cheng, X. Yin, P. E. Mogensen, and X. Cai, "A non-stationary 6G V2V channel model with continuously arbitrary trajectory," *IEEE Transactions on Vehicular Technology*, Early access, 2022. Doi: 10.1109/TVT.2022.3203229.

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