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# 深層学習を使った 5G ミリ波セルラーネットワークにおけるユーザ間距離の推定

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# Inter-User Distance Estimation in 5G mmWave Cellular Networks Using Deep Learning

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**Abstract**　In mmWave massive MIMO system, the distance between each pair of user equipments (UE) is of great importance and consideration. In the current work, a new method for inter-user distance estimate has been developed employing beam energy-based images. We consider a system where the Base Station (BS) creates beams with different width by means of an analog beamformer and sweep them during the broadcasting. Here, we consider that the BS sweeps a total number of beams equal to 4×4 or 8×8. By sensing the beams, each User Equipment (UE) reports the Received Signal Strength Indicator (RSSI) for each beam. At the BS, the RSSI report from each UE is transformed into a 2D image, where each pixel represents 1 beam. The color intensity of the pixel corresponds to the RSSI level. Given images generated for 2 users, we consider the difference between them (i.e., another image made of the pixel-wise subtraction) and use it as input to a neural network whose objective is to estimate the distance between them given such input image. To reduce the feedback overhead, while maintaining good performance, we employ SR on the 4×4 low resolution images to enhance them to match the 8×8 ones. We train the same Neural Network (NN) that we used in [1] to recover 8×8 images from the 4×4 ones. Throughout experiments, we show that the proposed method performed much better than the any conventional method that relies on the individual location detection even when using the images of size 4×4 without enhancement. Nonetheless, after applying SR to 4×4 images, we obtained results that are comparable to those of the 8×8 ones. It is worth mentioning that our method is more robust to change of the BS location compared to the location-based one.

**Keywords**　5G mmWave networks, Co-location, Inter-user distance estimation, Deep learning