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Improved Signal Processing for Time Division MIMO Radars

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Since 2017 CMOS 1-chip radars have become widespread, and, thanks to the benefits of high integration, TD (Time Division) MIMO technology has also become widespread. But, TD-MIMO has an important drawback of narrow dynamic range of velocity, explained in Fig.1. Recently, two technologies in Fig.1 are emerging: One is DD (Doppler Division) MIMO, and the other is Random (Massive) TD-MIMO. This paper focuses on the latter one.

Random (Massive) TD-MIMO can widen velocity dynamic range but has another drawback. It requires very complicated randomized chirp sequences in Fig.2(d), but most of the currently available radar chips cannot create such signals.

In this paper, we propose a backward compatible signal processing, which covers not only Random (Massive) TD-MIMO signal in Fig.2(d) but also extremely simplified signals in Fig.2(b)(c), which some of the currently available chips can create. In addition to it, the proposed signal processing can widen the velocity dynamic range of the traditional simple and periodical TD-MIMO signal in Fig.2(a), which seems contradictory to our traditional knowledge in Fig.1.

The proposed signal processing is, in one word, advanced version of spectrum analysis, which is commonly used for sparse antennas with randomized spacing. In sparse antenna analysis, usually one-dimensional OMP (Orthogonal Matching Pursuit) is applied only to the antenna number dimension. In the proposed signal processing, two- or three-dimensional MP (Matching Pursuit) is applied simultaneously to over two or three dimensions with physically different meanings, which are multi-chirp time dimension and antenna number dimensions.

In order to put high-dimensional MP into practical use, we have some challenges. The most important problem is the huge size of the “dictionary” which is a numerical lookup table. For example, two-dimensional MP requires four-dimensional dictionary. In this paper, a practical algorithm is also proposed, in which N-dimensional MP requires only one-dimensional dictionary.

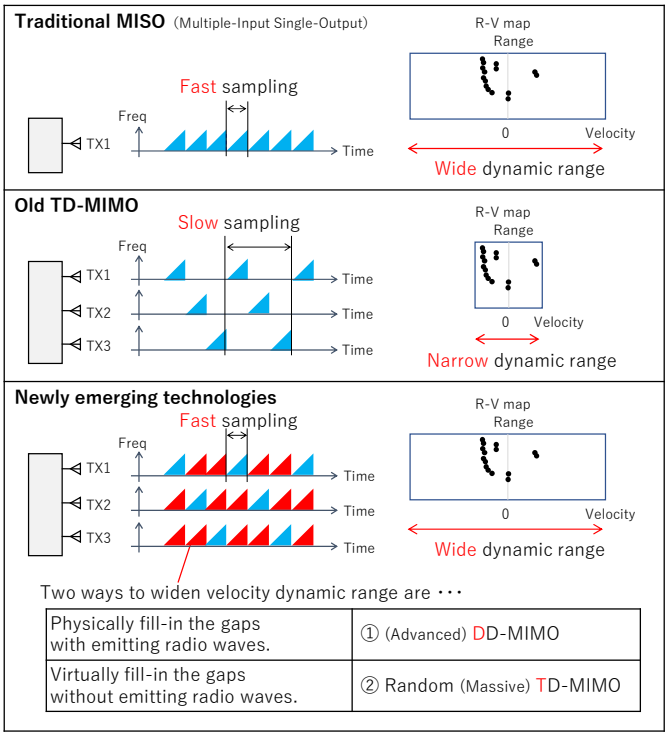

Fig.1 Drawback of TD-MIMO and it’s solutions

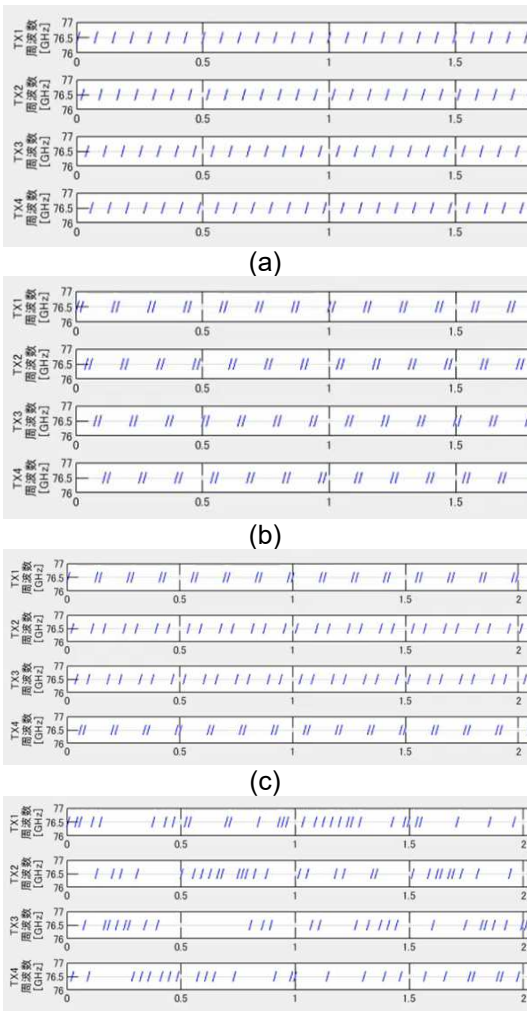

Fig.2 Test signals for the proposed signal processing