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The MIMO Method for Transmission of Telecode Information

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Abstract—A new method is suggested for signal processing in the pulsed MIMO system using the space of beams in the receiving digital antenna array. The paper also describes an approach to simultaneous treatment of the communication and radiolocation tasks based on combination of radio-pulse transmission of telecode data and multifrequency OFDM-sounding of air space.

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A serious problem in multiposition radiolocation is transmission of radar information to the central control station. Particularly, severe requirements, in terms of data exchange speed, are imposed on the system of telecode communication if we deal with technology of sensor networks or cooperative processing of signals, when each of the radar system positions is regarded as an element of a widely spaced digital antenna array.

The purpose of this paper is to disclose a new approach to implementation of the system of telecode communication based on the methods used in MIMO (Multiple Input—Multiple Output) communication systems [1].

This work is an extension of the method described in [2] and is devoted to synthesis of procedures of processing of multisignal mixture at the output of the digital pattern-shaping system of demodulation of multisignal mixture at the output of the receiving digital antenna array (DAA) in the case of pulsed mode of operation of the MIMO system.

It is known that processing of signals in the receiving DAA can be performed after digital pattern-shaping, with transition to the "space of beams", i.e., at the outputs of secondary spatial channels synthesized with the aid of the fast Fourier transform. Figure 1 illustrates directivity characteristics of the synthesized (with the aid of FFT) secondary spatial channels for a four dipole array. This approach has become the subject of much investigation, particularly, in connection with the design of MIMO systems. An example of such inquiry is a dissertation [3] devoted to preprocessing of signals, where we can also find a reference to another work [4] supposedly considered as pioneering in preprocessing of MIMO signals. It should be said nevertheless that the idea of such preliminary processing of signals in the reception segment of MIMO system was proposed quite independently in [2, 5].

By analogy with radiolocation, the advantage of the "space of beams" decision consists in spatial coherent accumulation of the received signals. As a result, in the presence of Gaussian noncorrelated noise, the signal-to-noise ratio for the output voltage of these secondary spatial channels can be raised by a factor proportional to the square root taken of the number of reception channels used in the antenna array (for example, by a factor of two in the case of four elements).

If applied to the telecode communication system, this technique also allows for effective protection from active interference acting, for instance, over one of major beams of the synthesized secondary reception channels. As for selection of the pulsed mode of operation, this principle offers a whole number of advantages over OFDM signals widely used in Communication Standards 802.16-2004, 802.16e, and draft version of Standard 802.11n. Particularly, as distinct from the OFDM method, in the pulsed mode of operation there is no necessity in observance of orthogonality of signals' carrier frequencies. As a result, we can narrow the spectral band of the communication radio line—to set the same carrier frequency for all pulses radiated, and perform communication with movable objects, for example, with pilotless flying vehicles. Moreover, the suggested approach to construction of MIMO system permits to improve immunity of communication channels to unsanctioned access, and to raise the rate of data transmission to longer distances (against several hundred meters inherent in the known MIMO-system implementations based on OFDM).