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# Synthesis and Research of New Marked Signal-Code Structures and Methods of Their Processing for Use in Modern Detection Systems with Multiple Transmitting and Receiving Antennas in a Complex Interference Environment

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One of the promising directions in the development of telecommunication radar systems is the transition to multi-position implementations – several separated transmitting and receiving antennas. Along with the traditional approach, the possibility of building distributed stations, based on the technology of multiple access with use of new quasi-orthogonal Mersenne-Walsh functions, has recently been considered.

The multi position radar technology allows, while remaining within the framework of active radar methods, to provide high tactical radar performance with improved noise immunity, resolution and accuracy. One of the distinctive features of such radar system is the use of a set of orthogonal probing signals. Most of the high tactical requirements of the radar are provided with wideband and ultra-wideband signals.

In the field of synthesis and processing of signals and their coding there is a situation characterized by the following contradictions. First, the increasing requirements for guaranteed transmission of modulated radio signals under conditions of increasing levels of natural and artificial interference with constant approaches to the formation of classical codes. Second, the provision in the radio channel, error-correcting encoding of the signals due to the weakening of the requirements for the autocorrelation function with simultaneous transition to the new asymmetrical performance codes. In this regard, the task of selecting specific types of complex probing signals in the development of distributed radars using technology with multiple spaced transmitting and receiving antennas is relevant.

Nowadays, there are a many studies on the synthesis and processing of complex signals in communication technology. Similar studies are being carried out with regard to radar systems. However, if the choice of signals in communication systems focuses on the correlation properties for the signal system, the solution of radar problems is important to assess the properties of the uncertainty function, which takes into account not only the correlation of signals in time but also in frequency.

The present study is focused on the search for new noise-resistant codes, code combinations, marked code-modulated signals, as well as special methods of their processing in modern radar, telecommunications, ultra-wideband, optical and "intelligent" systems of data detection and transmission as an alternative to $m$-sequences, pseudorandom sequences, Frank, Barker, Lewis and Krechmer codes ($P_1$, $P_2$, $P_3$, $P_4$), polyphase codes $P(n,k)$. The approach used in the current work is the construction of codes based on quasi-orthogonal matrices, which include special Mersenne and Raghavarao matrices of both cyclic and symmetric structures.

During the solving of relevant problems, we used the methodology of constructing multi-position on-board radar systems, the theory of generation, reception and processing of complex labeled code-modulated signals.

The main results of the present work are aimed at developing the theory of coding signals used in high-precision coordinate determination systems, as well as to ensure reliable detection of a useful signal in a complex interference environment in radar with high resolution coordinate range when detecting physical objects, including hidden ones. The advantages of the obtained codes are discussed in the aspects of improving the characteristics of signal compression, their detection, resolution and noise immunity in the radio channels of distributed multi-position systems.