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THE CONDITIONS FAVORABLE TO SEARCH OF DYNAMIC OBJECTS BY A MULTI-POSITIONAL INFORMATION SYSTEM

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Based on established conditions, favorable to successful search, the situation of search for a dynamic object by a multi-positional information system is analyzed. The new conditions characterize the possibility for concentration of search efforts in the areas of the largest probability of location of the sought object, and the possibility of evaluation of parameters to be measured.

In various fields of the control theory, when devising the scientific and methodical apparatus and in its practical applications, we often consider some general provisions that help us not only develop algorithms, convenient in use, but also explain the logical rules of their generation and functioning. Moreover, construction of algorithms may take form of illustrations rather than strict proofs. For example, in the theory of filtering, when choosing the sensors for measurement systems and the estimation algorithms, of importance is a special type of observability called "the condition favorable to accurate estimation" [1, 2].

A promising line of application of the theory of conditional Markovian processes is the search of dynamic objects (DO) by multi-positional information systems (MIS). Particularly, in [3] we can find a new model of distribution of search efforts, where the model, as distinct from search strategies considered as search densities [4], makes it possible to coordinate individual search positions (SP) comprising the radar system. For immobile solitary objects we deduced some equivalent criterion of probability of non-detecting such object by a prescribed time instant. In [5, 6] this method has been extended to a case when motion of the object of search is conditionally determinate and stochastic. Thus, in [3, 5, 6] the theoretical basis of trajectory search of dynamic objects is laid down. However, for further development of this line of research, we have to work out general provisions used subsequently for analysis of the algorithms developed, and to outline the ways of their improvement.

For one of these provisions, as in the case of optimal nonlinear filtering, we may introduce some conditions favorable to successful search. Hence derivation of these conditions is the topical problem.

Consider a MIS consisting of J searching points (sites) involved in continuous search. The equations of search by an SP may be written as $Y_j(t) = H_j(z, t, \widetilde{Z}_j) + Q_j(\widetilde{Z}_j, t) N_j(t)$, where $j = \overline{1, J}$, $t \in [t_0, T]$, $Y_j \in R^{m_{1j}}$, $H_j \in R^{m_{1j}}$, $Q_j \in R^{m_{1j} \times m_{1j}}$, $\mathrm{rank}(Q_j) = m_{1j}$, $N_{jk} \in R^{m_{1j}}$, $\widetilde{Z}_j \in R^n$, N_j is the vector of the shaping white centered Gaussian noise components with unit intensities, Q_j are the known diagonal matrices of intensities, $\widetilde{Z}_j(t)$ is the trajectory of search performed by the jth SP, and $\widetilde{Z}_j(t) \in \widetilde{Z}_j^{\mathrm{per}}$, $j = \overline{1, J}$, where $\widetilde{Z}_j^{\mathrm{per}}$ is the permissible set of values of the vector, which sets the trajectory of search by the jth SP, and $\widetilde{Z}_j(t), \widetilde{Z}_j^{\mathrm{per}} \in R^n$.

The functions $H_j(z, t, \widetilde{Z}_j)$ are assumed continuous and known. They characterize the stock of parameters to be measured and dependence of their values on the trajectory of search and on target's position.

REFERENCES

1. A. A. Krasovskii, The general condition promoting accurate estimation, DAN SSSR, Vol. 273, No. 5, pp. 1067–1069, 1983.
2. A. A. Krasovskii (editor), Handbook of Automatic Control Theory [in Rissian], Nauka, Moscow, 1987.
3. A. A. Strotsev, Izv. VUZ. Radioelektronika, Vol. 45, No. 10, pp. 34–41, 2002.
4. O. Hellman, Foundations of the Optimal Search Theory [Russian translation], Nauka, Moscow, 1985.
5. A. A. Strotsev, Avtomatika i Vychislitel'naya Tekhnika, No. 3, pp. 12–21, 2004.
6. A. A. Strotsev, Izv. VUZ. Radioelektronika, Vol. 47, No. 9, pp. 22–29, 2004.

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