OBSERVABILITY OF LINEAR TIME-VARYING CONTROL SYSTEMS

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It is known that system control can be carried out either according to a program or on the basis of the feedback principle. For the practical implementation of feedback control, it is necessary to know the state of the system at each specific moment in time. However, it usually turns out that not all phase coordinates of the system are available for measurement. Therefore, it is natural to consider the possibility of a complete description of the behavior of the system's phase coordinates based on the results of incomplete observation [2].
Let the controlled system be described by the equation:

$$\dot{x}(t) = A(t)x + B(t)u, \;\; 0 < t < T, \tag{1}$$

in which $A(t)$ and $B(t)$ are continuous matrices of dimensions $n \times n$ and $n \times r$, respectively. Let, for system (1), the set of admissible controls consist of vector functions $u(t)$ belonging to the space $L_2^r(0,T)$, where T is an arbitrary but fixed number. Denote by $y = \{y_1, y_2, ..., y_m\}$ the vector whose components are linear combinations of the phase coordinates x_i, $i = \overline{1,n}$, and the control components u_j, $j = \overline{1,r}$; that is, assume that

$$y = C(t)x + D(t)u, \tag{2}$$

where $C(t)$ and $D(t)$ are continuous matrices of dimensions $m \times n$ and $m \times r$, respectively.

The main observation problem in this case is, based on the obtained observation results (i.e., the functions $y(t)$ are known), to determine the values of the function $x(t)$ for all $t \in [0,T]$, which is a solution of equation (1) for $u = u(t)$.

This solution can be represented in the form:

$$x(t) = K(t,0)x^0 + \int_0^t K(t,s)B(s)u(s)\,ds, \tag{3}$$

where x^0 is an unknown initial state.

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