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# Structural Synthesis of an observing device in the microclimate Control System of a Vegetable Storehouse

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**ABSTRACT:** The paper considers the issues of synthesis and development of the structure and organization of functioning (a complex of functional algorithms) the observation subsystem in the control system of the object under study –the microclimate of vegetable storehouses.

**KEYWORDS:** system, subsystem, control, microclimate, vegetable storehouses, measuring tools, observing device, synthesis, development, structure and organization of functioning the observation subsystem.

## I.INTRODUCTION

The theoretical and applied issues of the synthesis and development of the structure and organization of functioning (a complex of functional algorithms) the observation subsystem in the control system of the object under study are of independent theoretical and applied interest. An important subsystem of the climate control system of vegetable warehouses is the observation subsystem, i.e. the subsystem for measuring, collecting, evaluating and restoring information about the dispersed parameters of an object that characterize its state at the current time. The importance is also determined by the technical complexity of locating all the necessary measuring tools (sensors, observers, etc.), and the need to determine the optimal (in terms of necessity and sufficiency) the number and topology (locations) of the placement of these devices. Therefore, of the entire set of issues of building a control system, the paper focuses on the issues of building the observation subsystem.

## II. STATEMENT OF THE PROBLEM OF SYNTHESIS AND DEVELOPMENT OF THE STRUCTURE AND ORGANIZATION OF FUNCTIONING THE OBSERVATION SUBSYSTEM IN THE CLIMATE CONTROL SYSTEM OF VEGETABLE STOREHOUSES

The issues of studying the synthesis of the observer in the climate control system of vegetable storehouses are set as follows. A control system with full-order observers is considered. In this case, the equation of the entire system shall take the form [1]:

$$\overline{x} = Ax + Bu; \tag{1}$$

$$y = Cx; \tag{2}$$

$$\dot{\hat{x}} = (A - KC)\hat{x} + Ky + Bu; \tag{3}$$

$$u = -p\hat{x}, \tag{4}$$

where (1), (2) are the equations of an object with two inputs and one output,(3) and (4) are, respectively, the equations of a full-order observer and a controller. All equations are written in a vector form. Figure 1 shows a block diagram of a system with a full-order observer builton the basis of these equations. Replacing the variables $x, \hat{x}$ with the variables $x, \tilde{x}$, where $\tilde{x} = \hat{x} - x,$ we shall transform the equations (1) to (4) so that they would be as follows:

$$\dot{x} = (A - Bp)x - Bp\tilde{x}, \tag{5}$$

$$\dot{\tilde{x}} = (A - KC)\tilde{x}. \tag{6}$$

The equation (6) is obtained by subtracting (1) from (3) and replacing $y$ with $Cx$, and the equation (5) is obtained by substituting $u = -p\hat{x}$ into (1) and replacing $\hat{x} = x + \tilde{x}$.

The system (5) – (6) has a matrix

$$\begin{vmatrix} A - Bp & -Bp \\ 0 & A - KC \end{vmatrix}. \tag{7}$$

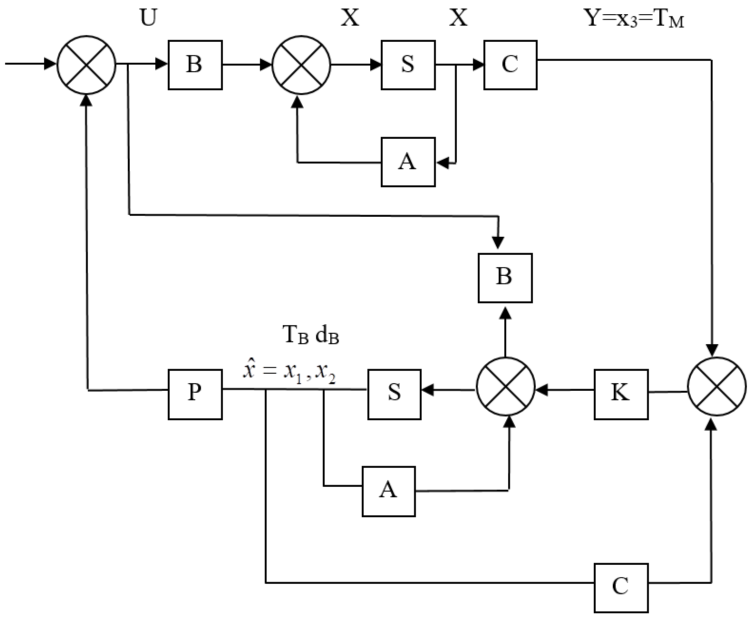


Fig. 1:A block diagram of a system with a full-order observer.

Whence the characteristic polynomial of the system

$$\det(\lambda E_n - A + Bp)\det(\lambda E_n - A + KC), \tag{8}$$

Follows that represents the product of the characteristic equations of the closed “object - controller” system and the observer.

Thus, the controller $p$ can be synthesized by assuming a perfectly accurate measurement of the object state variables $(x_1 = T_B,\ x_2 = d_B,\ x_3 = T_M)$ and being guided only by the desired dynamic properties of this device. In practice, the matrix $K$ is usually chosen so that the observer’s roots are somewhat negative as compared to the roots of the closed-loop control system.

Based on the previous results [1, 2, 3], let us consider the issue of synthesizing an observing device in the microclimate control system of vegetable storehouses.

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At the first step, let us construct the block diagram of a reduced-order observer based on the matrix transfer coefficients of links which are taken from the observer equations [4]. The developed block diagram of the reduced observer with matrix transfer coefficients is shown in Fig. 2, where the indices indicate the coefficients by which the transfer functions shall be determined.

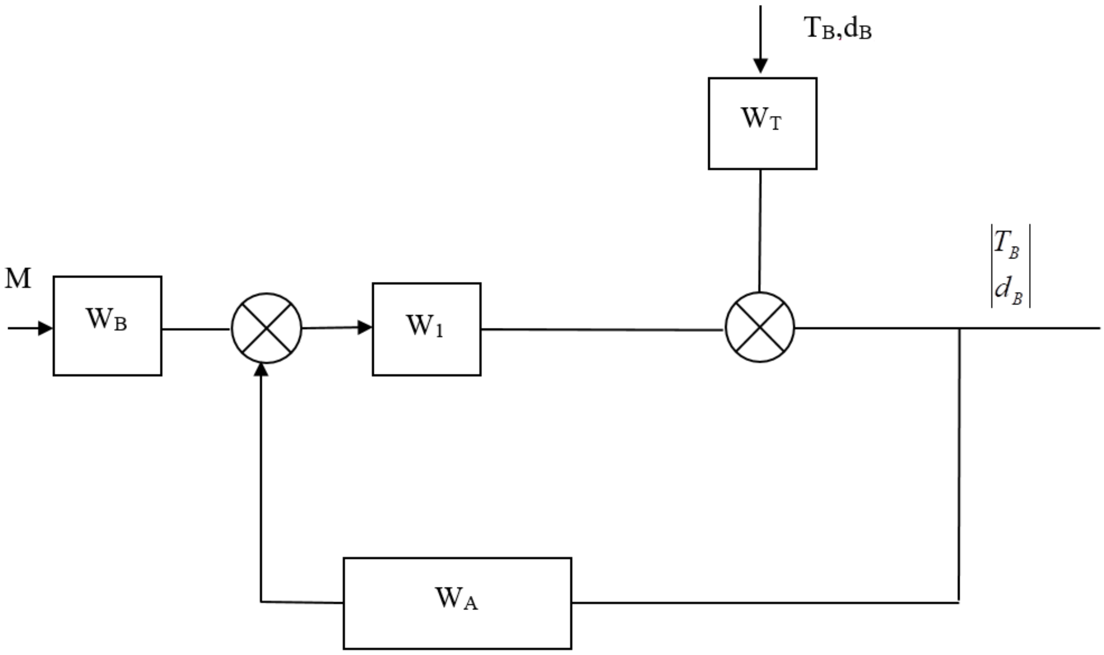


Fig. 2: Block diagram of the reduced observer with matrix transfer coefficients

The second step is the construction of transfer functions, which are based on the equations of observers [4, 5]. The block diagram (Fig. 3) is implemented with the help of summing amplifiers and $RC$-contours. The gains and time constants of the links of this diagram are determined by the parameters of the controlled object.

The third step is to use a low-order observer in the closed-loop control system of temperature and humidity conditions of vegetable storehouses. For this purpose, equivalent circuit transformations have been performed (see Fig. 3), which lead us tothe observer's block diagram (Fig. 4).

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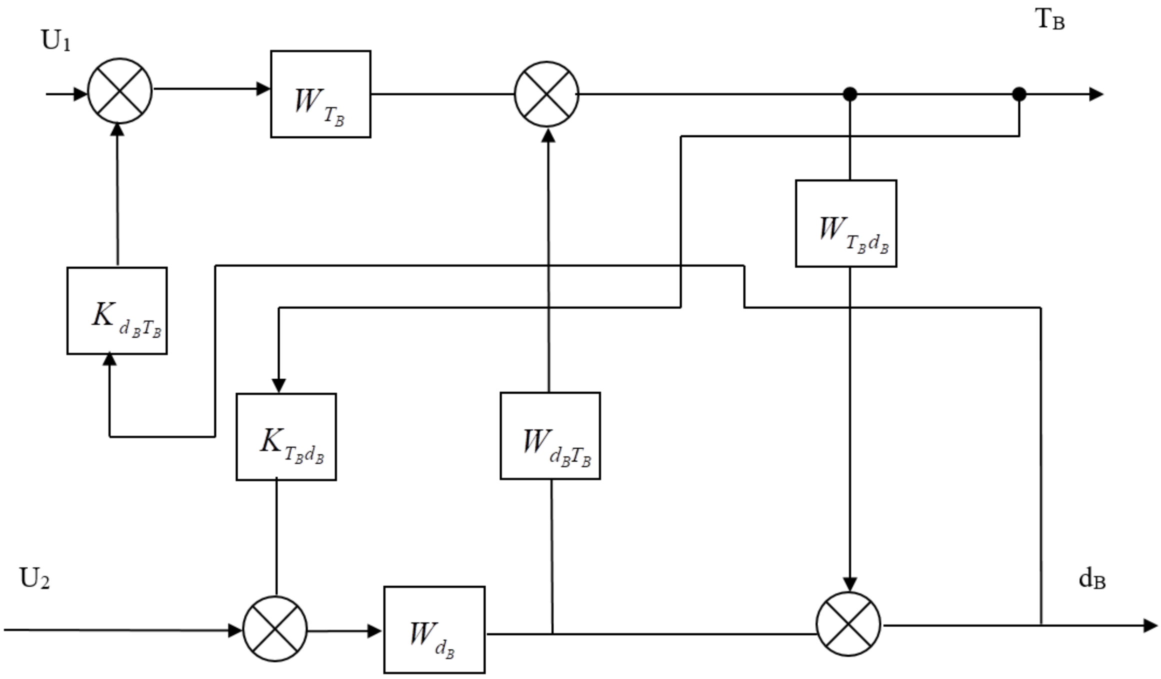


Fig. 3: Block diagram with scalar transfer functions of a reduced-order observer

The observer shown in Fig. 4 is implemented by passive $RC$ - elements. The roots of this device links are equal to the roots of the observer, which have been found earlier [6]. Therefore, they are easy to control and can be made real negative and aliquant, which is a condition for the realizability of the transfer function by passive $RC$ - chains.

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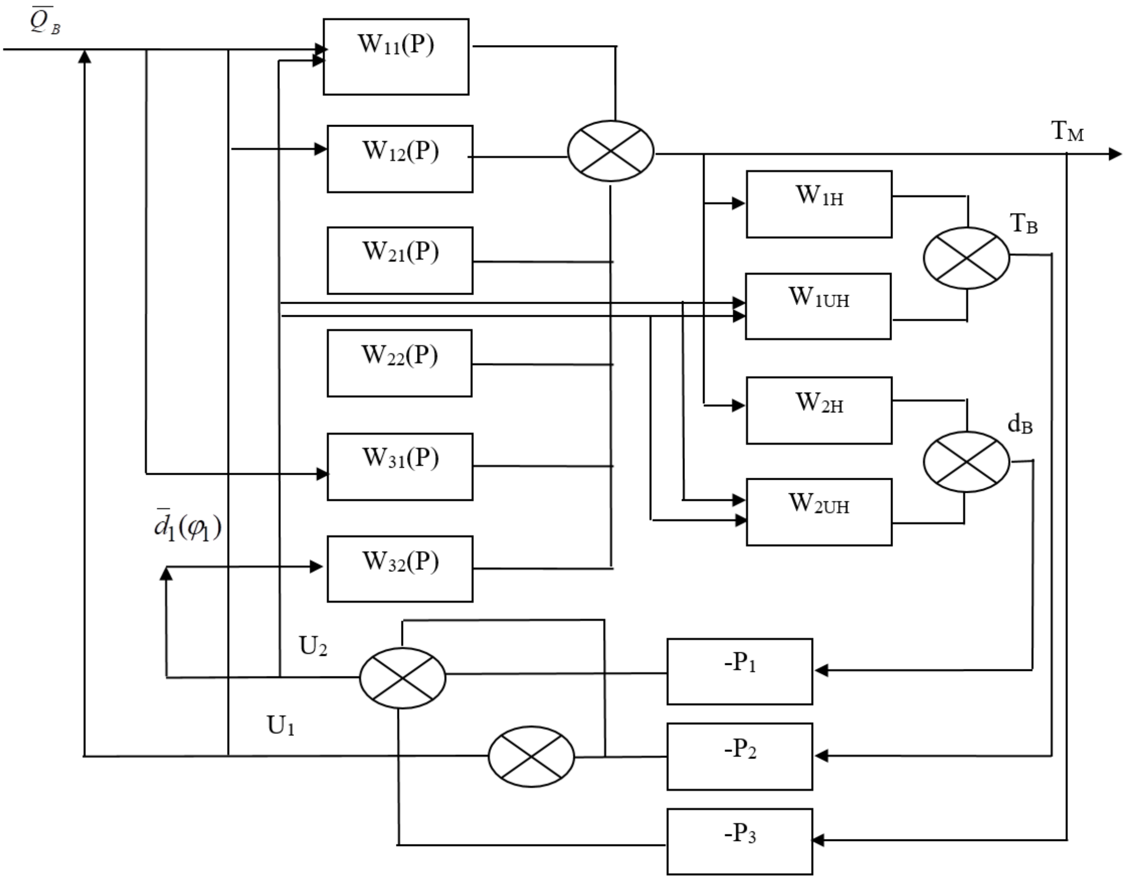


Fig. 4: Block diagram of a closed control system with a reduced-order observer

## III.CONCLUSION

Thus, the functional-structural synthesis of an observing device in the microclimate control system of vegetable storehouses is proposed. The major focus is on the issues of building the observation subsystem, taking into account the whole set of the issues of building the control system. The developed block diagram of the control system has been analyzed with full-order and reduced-order observers. In conclusion, it is worth pointing out that, in practice, the matrix is chosen so that the observer's roots are negative as compared to the roots of the closed-loop control system.

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