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RELIABILITY ASSESSMENT OF AIRCRAFT WITH REGARD OF INFORMATION FACTORS AND FEEDBACK LOOPS

Considered calculation of the probability of failure-free operation ergatic the aircraft and the pilot on the example of flight control channel rating the probability of failurefree operation is given based on the information and errors feedback.

Usually functional diagram channel of flight control represents using the circuit, which is on Fig.1.

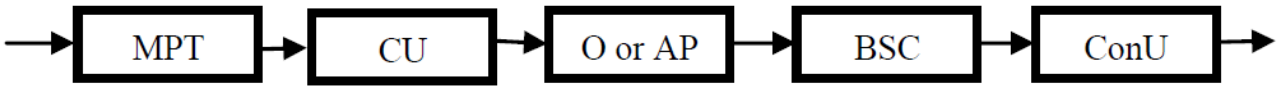

Fig.1. Functional diagram of the flight control channel: MTP - a measure of the trajectory parameters; CU - the communication unit; O - operator respectively, AP autopilot; BSC – block of the servo control; ConU - control unit; δ - signals of the control parameters of the motion path

In this scheme, there is no comparison unit and specify a communication channel between flight mode and the real mode, which should be linked using the feedback system communication [1-6].

When moving the aircraft operator is the link between given and real flight paths. When moving a real object relationship between the given and real motion path always exists.

The weakening of the feedback associated with increased dynamic stereotype in occurrence factor linings.

Operator functions are reduced to compare of the flight data from an external source of information (e.g. maps, information received from the operator ATC, visual information) with the real rate of motion parameters, and then correcting and managing the flight path.

Emphasize that the functional diagram of the motion of the real object, moving in space independently, does not differ from, shown in Figure 1. Be sure there is a feedback.

In memory incorporated information about the route of object. This information is compared with the real movement of the object (Fig. 2).

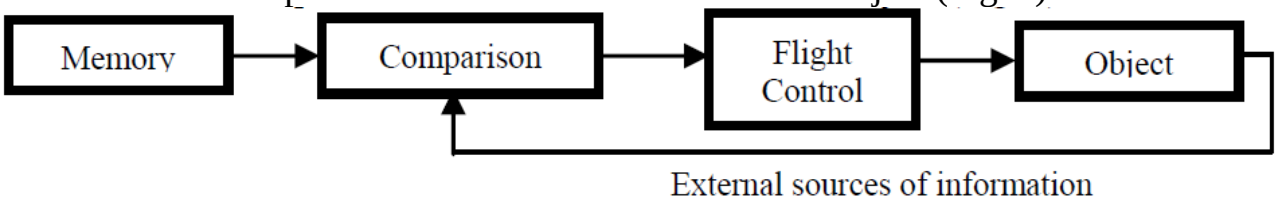

Fig.2. Functional diagram of the external manifestations of the operator when an object moves

Detail the block diagram shown in Figure 1, the three parameters that determine the course of the aircraft and its position in space: azimuth, elevation and velocity. In fact, these parameters is much more roll, pitch, etc.

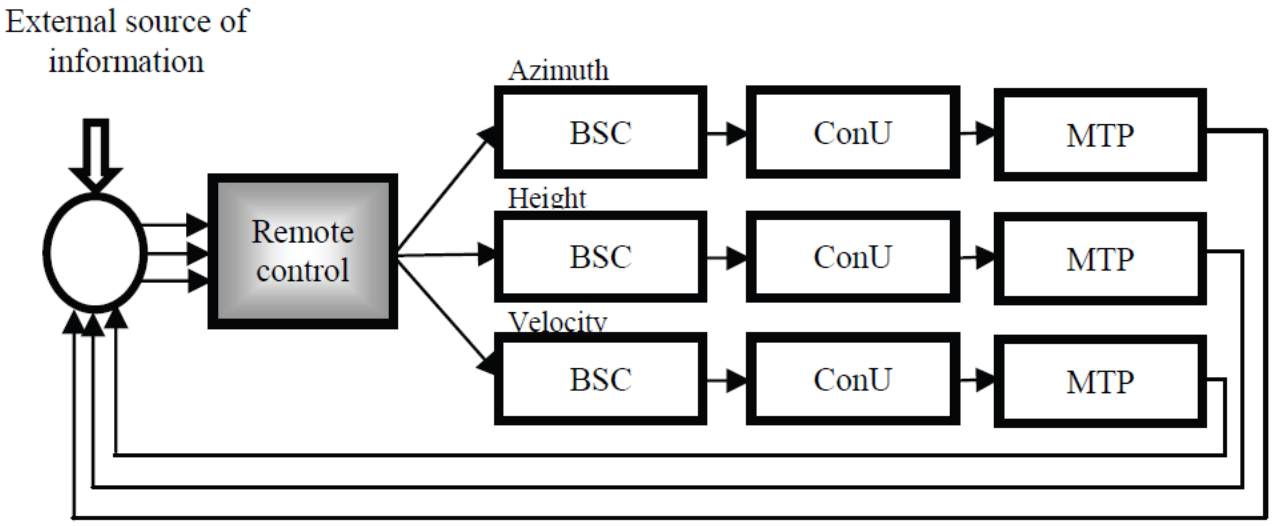

Fig. 3. Structurally logic channel of air traffic control:
BSC – block of the servo control respectively in azimuth, altitude and velocity;
ConU - control units (azimuth, altitude, speed); MTP -
MTP - a measure of the trajectory parameters (specific parameters)

Structurally logic scheme presented in Fig. 3, is not accurate, as meters flight parameters perform their functions by interacting with airframe: azimuth (compass, gyroscope), height (optical locator, barometric altimeter, altimeter), speed (SHS, vario). Based on this, must create a refined structural and logical scheme of air flight control channel (Fig. 1).

In structural logic scheme airframe should be submitted for two reasons: the air vibration; the deformation of the airframe and the displacement of the sensors. These phenomena lead to errors, that is, to reduce transmission probability of useful information, a reduced reliability of the system and the probability of non-failure operation.

Find a mathematical expression for the function of communication system and reliability of its constituent elements.

Function of communication structural logic scheme flight control by one parameter. R denote the probability of failure of any block system on any parameter that determines the movement of the letter i ($1,2,3, \ldots n$), where n-number of measured values (number of channels).

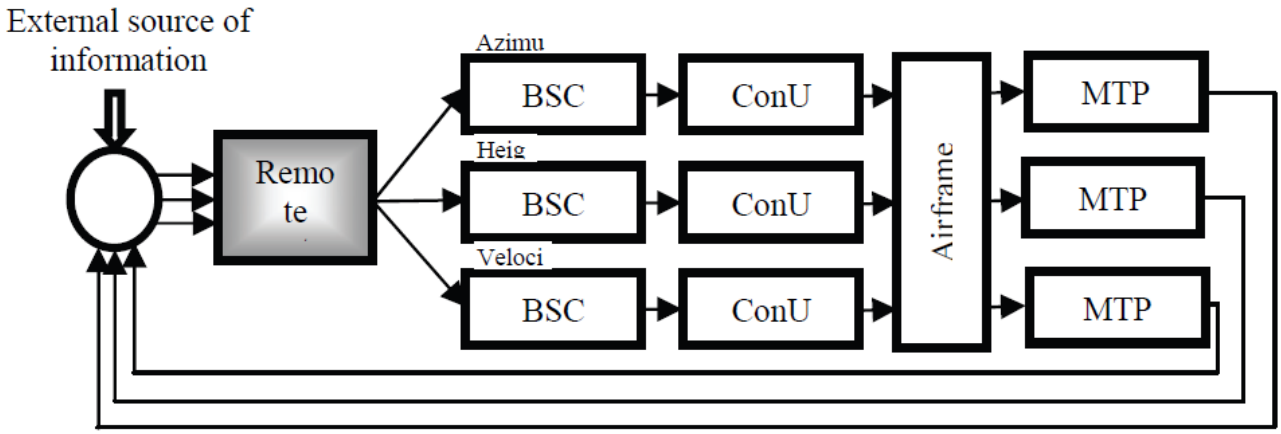

Fig. 4. Detailed structural logic scheme of channel flight control

Reliability function R - its probability of that within given operating time or a predetermined time interval object failure does not occur [7].

Then, based on structural and logical channel scheme of control circuit flight shown in Fig. 4, can designate the reliability function on any channel, measuring a various parameters.

I_0 – full quantity of useful information

$R_i^{external}$ - reliability function of measurement, amount of useful external information

R_i^{oper} - reliability function of external information transmission from operator to aircraft.

R_i^{BSC} reliability function of the block gain servo

R_i^{CU} - reliability function of the control unit

$R_i^{airframe}$ - reliability function of the airframe (for measuring)

R_i^{MU} - reliability function of measurement units

R_{si} - reliability function of i-system

Then the significative of non-failure work (for *i* - parameter) of communication link is:

$$Rsi = R_i^{MU} \cdot R_i^{airframe} \cdot R_i^{CU} \cdot R_i^{BSC} \cdot R_i^{oper} \quad (1)$$

The information received by the operator from the system:

$$R_{si} \cdot I_0 \quad (2)$$

Information, which the operator receives from an external source, is equal to I_0.

It is necessary that the information, which the operator receives from the system, be arbitrarily close to the information received from an external source.

Consequently, the control signal is equal to δ:

$$R_i^{external} \cdot I_0 - R_i^{MU} \cdot R_i^{airframe} \cdot R_i^{CU} \cdot R_i^{BSC} \cdot R_i^{oper}(R_i^{external} \cdot I_0) = S_i \quad (3)$$

where: δ - the value of lost information, it is always positive largest and used to control the *i*-th aircraft parameter ($\delta = \Delta I0 = I0\text{-}Rsi \cdot I0$ at $Rexternal = 1$).

Ideally $\delta i = 0$ or close to zero, δ - used as a signal of control for compensating the lost information in the feedback system, both living organisms and the different technical systems.

Let us analyze the expression (3) in the mode of stable flight. Assume that of reliability information retrieval and transfer of external information aircraft operator are equal to unity in this case, the expression (3) simplified

$$1 - R_i^{MU} \cdot R_i^{airframe} \cdot R_i^{CU} \cdot R_i^{BSC} = S_i/I_0 \quad (4)$$

In this case, i.e. in a stable flight mode reliability of the *i*-th system is determined only by the technical parameters of air vessel. We assume that the probability of a wrong decision is the operator zero, as in a tranquil setting enough time to evaluate situation.

$$R'_{si} = R_i^{MU} \cdot R_i^{airframe} \cdot R_i^{CU} \cdot R_i^{BSC} \quad (5)$$

From (4) and (5) determine the relationship between the accuracy (or error) flight *i* - parameter defines the course of the aircraft and of the significative of nonfailure work of system

$$R'_{si} = 1 - S_i/I_0 \quad (6)$$

When the operator is not careful, then $R_i^{oper} < 1$; $R_i^{external} < 1$. Therefore, when calculations must take into account the human factor

$$R'_{si} = (1 - S_i/I_0 \cdot R_i^{external}) \cdot 1/ R_i^{oper} \quad (7)$$

Using equation (7), and knowing the level of preparedness of the operator can determine what is the minimum state probability to be in technical system *i* - parameter. Equation (7) shows that decrease R_i^{oper} function to improve the quality of work should be increased. However, with decreasing $R_i^{external}$ function may decrease. This is due, in first glance, the fact that the probability of failure of the technical system of the aircraft may not be sufficiently high if the increased uncertainty in the flight path, the aircraft course. However, it unreal situation, because usually the operator is in a quiet environment, time of searching solutions *i*-parameter is large, $R_i^{external}$ is large and, consequently, R'_{si} tends to unity.

Ratio $(I_0 - \Delta I_{i0}) / I_0$ is the probability of a precise definition of the amount of information that is reliability function.

Conclusion

When calculating the reliability function of operation of the ergatic system airplane and pilot must take into account the impact of information and external factors effects, and the effects of pilot as the system operator. The impact of these components in emergency modes are most pronounced.

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