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Research on Automatic System for Limiting Angle of Attack and Overload on Iak-130 Aircraft

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A B S T R A C T

The article presents the overload and angle of attack limit system on aircraft. This is a system that plays a very important role in keeping the aircraft from falling into dangerous states. Therefore, the system is applied on many types of aircraft today to help improve the efficiency of aircraft. The content of the article can be used in the transfer learning process at school as well as the exploitation and use of aircraft at units.

Keywords: Uhs: Control systems; Parameter limits; Hazardous flight conditions.

1. Introduction

In modern warfare today, fighter aircraft are designed to conduct air combat to conquer and maintain air superiority, ensuring the protection of frontline targets and the country's territory. To successfully carry out their missions, fighter aircraft must have good maneuverability, that is, the ability to change direction and flight speed quickly. This requires creating a large force that changes the direction and magnitude of the aircraft's velocity vector. In other words, the aircraft must have an angle of attack and correspondingly a large vertical overload. But if these parameters exceed the allowable value, a number of dangerous phenomena may occur such as: separation of boundary layer flow on the wing surface, self-rotation, stalling, loss of control stability when the angle of attack is too large or deformation or destruction of aircraft structural parts when the overload is too large. To prevent these dangerous phenomena, on modern aircraft today, there are many methods to help prevent aircraft from exceeding the limit regime.

2. Methodology

2.1. Method of pushing the rudder when the angle of attack or overload exceeds the limit.

This is an active flight safety system and is designed to keep the aircraft from exceeding the critical angle of attack value limit. In this system, when the parameters have not exceeded the critical value, the pilot operates the aircraft normally without being affected by the system. When the parameters reach and exceed the critical value, the system will work, directly affecting the steering stick to push the steering stick in the direction to help the aircraft reduce the angle of attack and overload, thereby keeping the parameters within the prescribed limits. The diagram of this type of system is shown in Figure 1.

This type of system is widely used on the MIG-29 and its many variants..

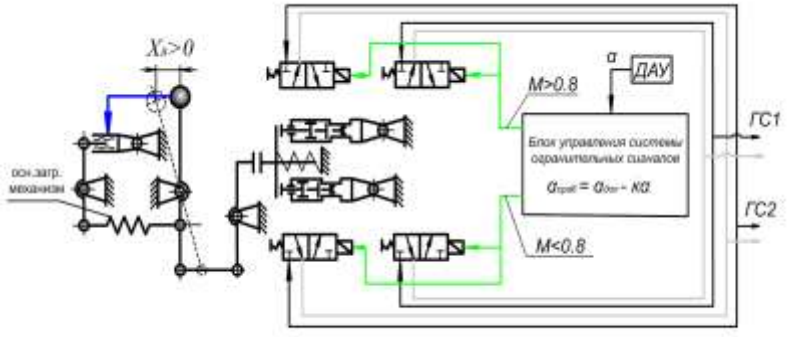

Figure 1: Schematic diagram of aircraft control system

2.2. Method of increasing steering column tension using electro-hydraulic power steering

This is a system that applies force directly to the aircraft's control lever by means of an additional load generating mechanism (spring) controlled by an electro-hydraulic drive system. In the case where the aircraft is controlled within the allowable range of angle of attack and vertical overload, the system is not active, the distance Δ from the additional spring mechanism to the control lever is kept basically unchanged. The pilot controlling the aircraft only feels the force generated by the main load generating mechanism. When one of the two values of angle of attack and vertical overload exceeds the prescribed limit value, or the aircraft shakes when stalling, the system will work, the hydraulic cylinder will come out, connecting the additional load generating mechanism to the control lever, the load of the control lever increases, preventing the pilot from controlling in the direction of increasing angle of attack or overload.

The schematic diagram of this type of angle of attack and vertical overload limiting system is shown in Figure 2.

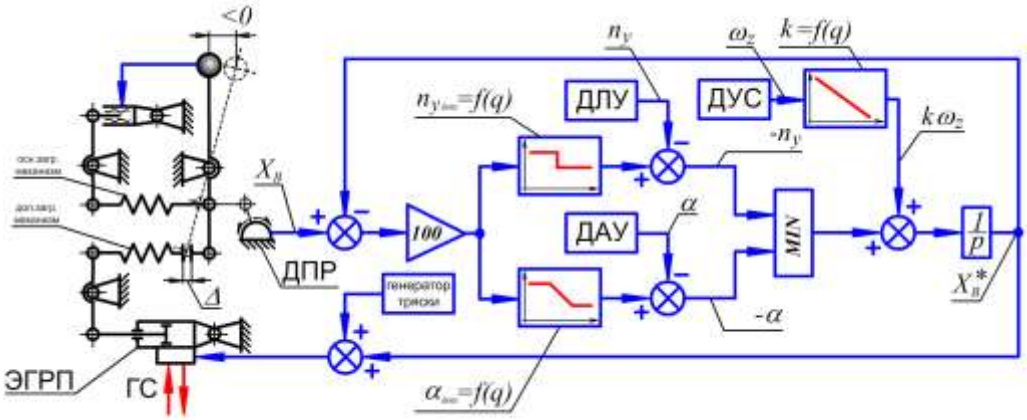

Figure 2: Schematic diagram of the limited mode limit system with electro-hydraulic power steering

This type of system is deployed on SU-27C, SU-27CM, SU-27UB, SU-27SK, SU-30, SU-33, SU-34... aircraft.

2.3. Nonlinear calculation method on control system

This is a system that limits the parameters without any mechanical impact on the control stick. When controlling, the pilot can move the control stick all the way forward and backward freely, only feeling the force from the spring mechanism that creates the load. The principle of the system is that in the remote control system, an algorithm is integrated to control the approach of the aircraft to the limit values (maximum and minimum) of the angle of attack and overload. That is, the computer will calculate so that the output parameter adjusts the controller so that the current angle of attack and the overload value are within the acceptable range. The result is that the maximum tilt of the control stick must correspond to the angle of attack or overload depending on which of the parameters reaches the maximum value first.

The schematic diagram of this type of system is shown in Figure 3.

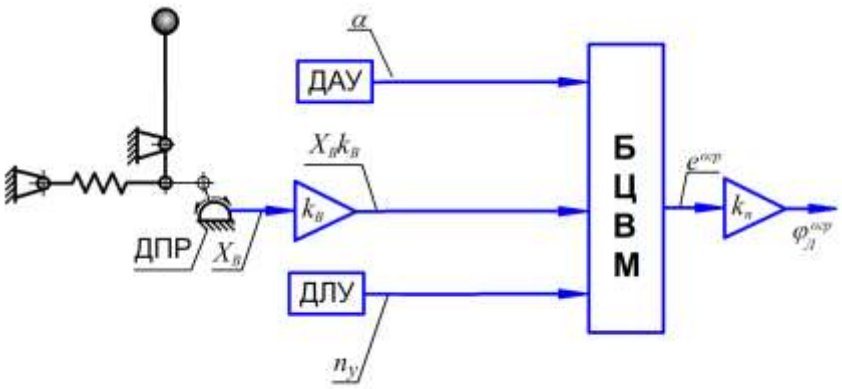

Figure 3: Schematic diagram of the nonlinear calculation system on the aircraft

3. Results and discussion

+ Results of applying the method of limiting angle of attack and critical overload on IAK-130 aircraft

This is the vertical control channel of the aircraft with the КСУ-130 digital remote control system. The scheme is based on the principle of adaptive adjustment of aircraft parameters and real-time (in-flight) adjustment of control of these parameters. The scheme of the КСУ system is shown in Figure 4.

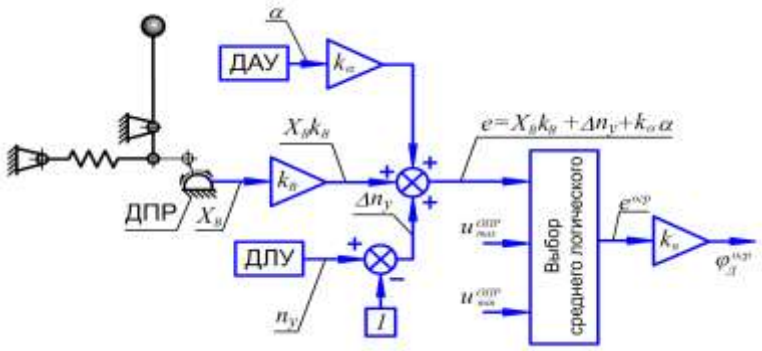

Figure 4: Functional diagram of vertical channel of КСУ

During the vertical channel control of the aircraft, the pilot pushes and pulls the control stick to generate the XB control signal. This signal will be combined with the feedback signals about the angle of attack (measured by the aerodynamic angle sensor ДАУ) and the feedback signal about overload (measured by the acceleration sensor ДЛУ). The output signal will help tilt the rudder up and down to control the aircraft along the vertical channel. This signal, before being sent to the rudder control, will be passed through the limit parameter limiter to ensure that the aircraft is always controlled within the allowable limit value.

The principle of this limiter is illustrated in figure 5.

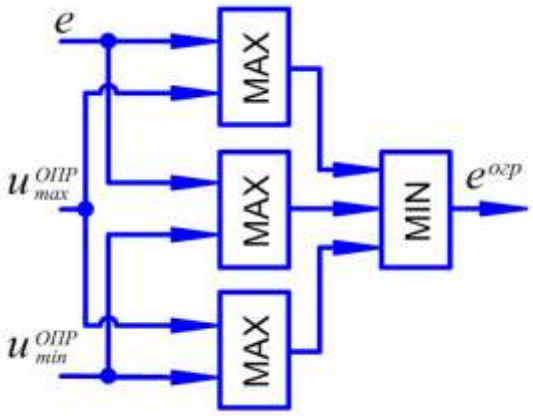

Figure 4: Schematic diagram of the upper limit system IAK-130

This system operates on the principle of selecting the middle value. Specifically, the control value when reaching the limit will be pre-calculated by the computer. Through the selector, a reasonable control value will be selected. If the control signal is still within the allowable limit, the system will select this signal as the output signal for the normal aircraft control process. In case the aircraft exceeds the specified limit parameters, the system will select the middle value, that is, the upper or lower limit control value. Thereby keeping the parameter value unchanged will help the aircraft not exceed the specified limit range.

The system combining both angle of attack and overshoot limits is illustrated in Figure 5.

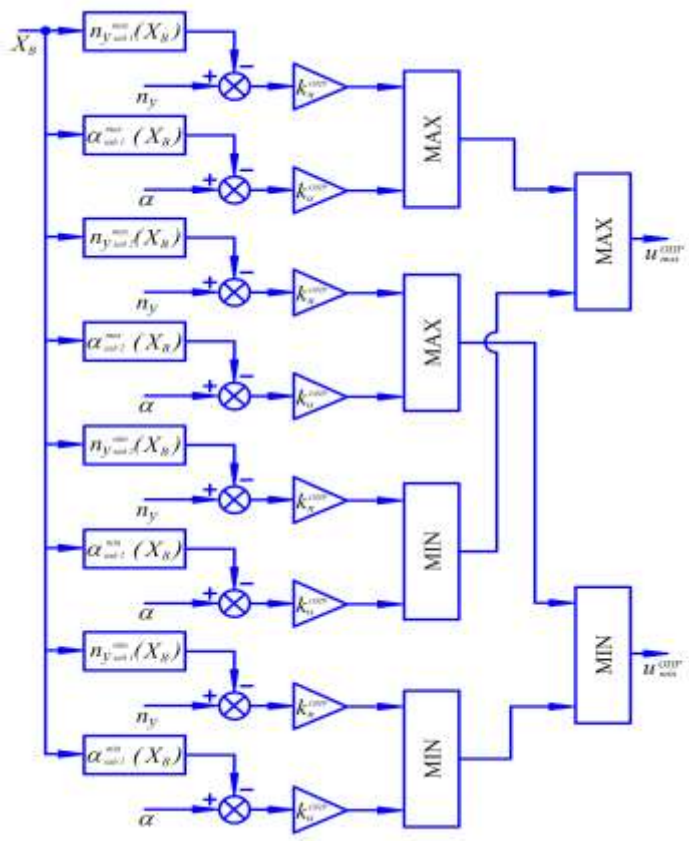

Figure 5: Diagram of the angle of attack and overload limiting system on the IAK-130

4. CONCLUSION

The critical parameter limit system is a system that plays a very important role on modern fighter aircraft today. The system ensures that parameters are automatically maintained within the specified range when controlling the aircraft. This helps pilots not to worry about parameters exceeding the limit during the control process, thereby being able to concentrate on performing combat missions. This is the basis for ensuring flight safety and improving aircraft performance during the mission.

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