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Application and division of automatic control system

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Abstract:

To make the machine operate optimally and produce the best possible results, we need to complete the following steps: set the goal, measure deviation, correct deviation, and develop control strategies by analyzing feedback mechanisms. The control objectives can be either a constant control to maintain a specific value or a following control to track a present trajectory. The system will measure the deviation between the actual output and the target output, and according to it, the system will generate the corresponding control signal to reduce the size of the deviation. This process involves comparing the difference between the actual output and the desired output and generating control instructions based on this difference.

Keywords: automatic, control signal, mechanisms, system

Introduction

The control system is a management system that is composed of a control subject, control object, and control media to reach its own goal and function. It means that any amount of interest or variable within a machine, mechanism, or other device can be maintained and changed in the desired manner using it. At the same time, the control system is implemented to make the controlled object reach the predetermined ideal state. The control system tends the controlled object to a certain desired stable state.

To make the machine operate optimally and produce the best possible results, we need to complete the following steps: set the goal, measure deviation, correct deviation, and develop control strategies by analyzing feedback mechanisms. The control objectives can be either a constant control to maintain a specific value or a following control to track a present trajectory. The system will measure the deviation between the actual output and the target output, and according to it, the system will generate the corresponding control signal to reduce the size of the deviation. This process involves comparing the difference between the actual output and the desired output and generating control instructions based on this difference.

Control System

The specific design and implementation of the control system depend on the type of controller used; some common ones are open-loop control systems and closed-loop control systems. In a closed-loop control system, the controller's output affects the system's input, thus forming a closed control loop. Such a system can respond to perturbations in the external environment, ensuring that the output is always close to the target value. An aircraft is a canonical example of an automatic control system, combining open-loop and closed-loop systems. The purpose of an airplane's control system is to replace the pilot in whole or in part to control and stabilize the movement of the aircraft and can improve the quality of the flight feedback control system. In addition to the function of autopilot, it can also improve the maneuverability and stability of the craft and achieve track control, automatic navigation, automatic landing, terrain following, automatic control of wing load distribution in maneuvering flight, automatic targeting, and formation flight. To play these roles, the aircraft is equipped with various functional subsystems, such as a control stability augmentation system, autopilot, altitude, and speed control system, side track control system, automatic landing system, terrain-following system, maneuvering load control system, aiming control system, formation control system, etc. The aircraft flight automatic control system is the combination of each subsystem. Each subsystem generally includes sensors to measure the relevant motion parameters of the aircraft, computers to process the parameters, actuators to drive the relevant control surfaces and throttles, and components such as automatic zero return systems, couplers, and flight control boxes. In the early stage of aircraft control, the aircraft is analyzed as a linear, time-invariant system, which means that the input and output are linear, corresponding to the linearization of small disturbances. Time-invariant means that the system performance does not change with time. Corresponding to the trim point, the aircraft maintains a state for long during flight, such as cruise, and the speed and height are unchanged. Aircraft controls are time-invariant. To cope with the time change, we implement the strategy of gain scheduling and switching flight modes (The linear relation is realized by the Laplace transform, and this linear relation is realized from the perspective of the frequency domain). The current state of the aircraft is determined by three variables: the initial state, the control input, and the external disturbance. External disturbances such as wind are beyond our control (meaning that we can't improve it through feedback, only improve the system performance). The response to this disturbance is completely determined by the aircraft's open-loop performance, whether it has stability (open-loop gain can be adjusted, limiting the range of open-loop gain), and the size of steady-state error (the larger the open-loop gain, the smaller the steady-state error). These two properties are contradictory, which is the necessity of our open-loop analysis of the system. The aircraft control system can learn the best flight conditions and how to control the aircraft at different altitudes, airspeeds, and weather conditions and feed this information back to the pilot. And it is designed and operated with a focus on safety. The system is equipped with multiple safety measures to avoid operational errors, such as stall protection and flight attitude control protection. The good performance of the open-loop system means that the aircraft is naturally beautiful, which largely depends on the aircraft's aerodynamic design and the components' performance. The control input is something we can improve based on feedback, which can achieve automatic control or improve man-machine matching performance,

The aircraft's control system mainly includes two aspects: manual control and automatic flight control systems. In the manual control system, the pilot directly controls the aircraft's flight by operating the rudder and throttle lever through the mechanical control system. In this mode, the pilot needs to constantly adjust the driving strategy according to the actual situation of the flight and promptly respond to the dynamics of the aircraft. In the automatic flight control system the flight of the aircraft is controlled by the automatic flight control system, which realizes the automatic control of the flight of the aircraft through the automatic operation of the rudder surface and the throttle rod. In this case, the driver's role changes to that of a monitor rather than a direct participant. Automatic flight control systems usually adopt the principle of negative feedback, comparing the actual movement of the aircraft with the desired movement and then adjusting the rudder surface and throttle rod to correct the deviation and maintain the stable flight of the aircraft. Whether it is manual control or an automatic flight control system, the flight control of aircraft follows the feedback control principle. The aircraft and the automatic control system form a closed loop (flight control loop) according to the principle of negative feedback. Classical or modern control theory can be used to analyze and manage the flight control loop to design an effective aircraft flight control system.

Conclusion

In addition, the aircraft is also equipped with some other subsystems, such as a control stability augmentation system, autopilot, altitude, and speed control system, side track control system, automatic landing system, terrain-following system, maneuvering load control system, aiming control system, formation control system, etc. Together, these systems constitute a complete automatic flight control system. It can improve the maneuverability and stability of the aircraft and achieve more complex flight missions.

In a word, in the application of the control system, we get the advantages of high precision return and automatic compensation for the influence of disturbance because of the closed-loop control system. Also, we can get responses quickly without considering stability through the open-loop control system. In complex engineering operations like aircraft, It is because these two control components each other that we achieve the ideal operations and data of the machines,

Reference

Aircraft flight control system. (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Aircraft_flight_control_system

Control theory. (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Control_theory

Aircraft engine controls. (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Aircraft_engine_controls

Regulator (automatic control). (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Regulator_(automatic_control)

Autopilot. (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Autopilot

Automation: Control. (n.d.). In Wikipedia. Retrieved March 5, 2024, from https://en.wikipedia.org/wiki/Automation#Control