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Research on Carrier-attacker Control before launching Air-ground Guidance Weapons

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Abstract. Carrier-attacker controls are involved in navigation control and attitude stabilization control. Modes of navigation control and channels of the longitudinal and lateral-directional are analyzed to solve the problem of carrier-attacker controls before launching air-ground guiding weapons. The homing rules design and the control realization of course, pitch, altitude and velocity are studied. At last, the ways and means is approached to experiment and test them by half material object simulation on ground.

Introduction

In general, the gesture control of carrier-attacker is accomplished by longitudinal and transverse lateral two control channels, longitudinal channel can stabilize and control angle of pitch, height degree, and speed of carrier-attacker. Transverse lateral channel can stabilize and control course angle, angle of inclination and cross track error of carrier-attacker.

The navigation control of carrier-attacker before launching air-ground guidance weapons and the stable control of carrier-attacker' gesture (or altitude) when launching need to manual work anytime and anywhere, this ground-depth simulation is rare in the literatures, This article discusses the method of semi-physical simulation, The semi-physical tests are used in the navigation control of carrier-attacker before launching air-ground guidance weapons and the stable control of carrier-attacker' gesture (or altitude) when launching, and the simulation results are discussed.

Pitch attitude, airspeed and altitude control modeling of carrier-attacker before launching air-ground guidance weapons

Maintain and control model of pitch attitude. When launching air-ground guidance weapons, in order to satisfy the normal launch, relaxed conditions and emergency conditions, pitch attitude needs to be stable in a certain range, this is accomplished mainly through to maintain and control the pitch attitude.

In the time of pitch attitude maintain /control modeling, dynamics model of carrier-attacker can use the short cycle modal to approximate, Pitching angle velocity signal can obtain pitch attitude signal through an integrator.

Maintain and control model of altitude control. The highly controlled carrier aircraft belongs to the center of gravity control. When the aircraft flights at a great circle route, in a complex navigation area or launching guided weapons, it need to maintain high stability that can not be accomplished by controlling the pitch angle which will produce highly drift in vertical air flow. The system including barometric altimeters, radio altimeters and air data sensors changes aircraft flight path by controlling the path angle of inclination basing on height error.

Maintain and control model of mach number. When the carrier-attacker flying in the low dynamic pressure, if the speed of carrier-attacker increase Δv, in order to keep the carrier-attacker flight direction is constant, we must reduce the attack angle of carrier-attacker, make lift force increment is zero, that is the carrier-attacker must bend to generate negative angle increment, but it might lead to speed continues to increase, thus appeared speed instability phenomenon, using the speed control system can ensure that the aircraft flight in the low dynamic pressure situation, make carrier-attacker still with speed stability. In addition, carrier-attacker track control is actually implemented by controlling the angular motion of carrier-attacker, but this premise is that in the control angle motion of carrier-attacker, and flight speed is a constant, When in the low dynamic pressure or motor for a long time, can't guarantee this premise, general air-ground guidance weapons carrier-attacker in the flight phase are working under the low dynamic pressure, speed control system is necessary.

Simulation implementation

The carrier-attacker automatic navigation control simulation before launching. In the air-ground weapons carried on board, automatic navigation system is mainly composed of inertial navigation, autopilot, heading to contact equipment, etc. The function of inertial navigation is measurement and calculate in automatic navigation, It is mainly based on their own inertia of components constantly measure the aircraft's current location east, north to acceleration component, the actual track Angle and instant location, latitude, and then comparison with the flight plan route, Solution to calculate the drift distance, the plane's flight path Angle error, ground speed deviation from voyage route. To calculate a high-precision dc voltage control signal by the navigation equations, The signal is transferred to the signal transformer of the autopilot after control modulation, amplification of heading contact device, then $\gamma_{\psi c}$ and ψ_c are output by transformer. They are input to the autopilot inclined channel and course channel to enlarge, and through the aileron steering engine and the direction s steering engine of the autopilot control aircraft route correction and rerouted around the corner, to achieve the goal of control aircraft autopilot. System control principle as shown in Fig. 1.

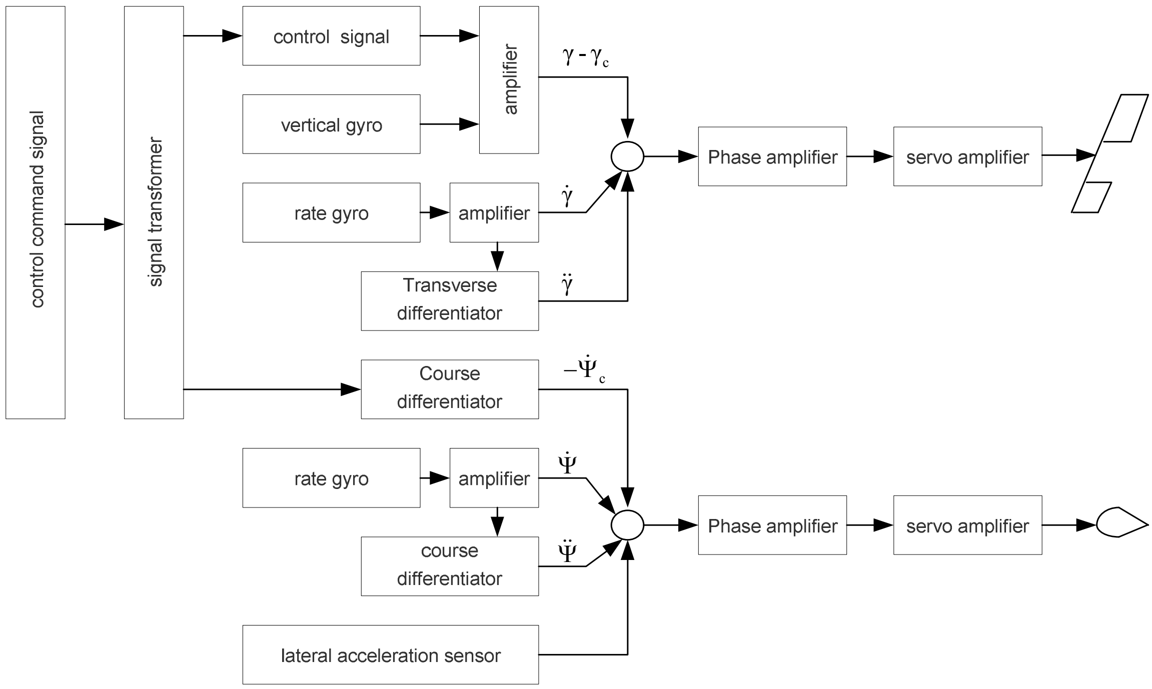

Fig. 1 Navigation control principle diagram

Inertial automatic navigation use the autopilot control regulation law to control carrier-attacker routes stability and automatic change routes, This compared with the pilot controls the aircraft using the autopilot, it can get the same effect, but also reduces the autopilot stability and manipulate the state transformation, thus improve the reliability of the system and the degree of automation, reduce the workload of pilot. In the process of using the autopilot flight, although the airline's stability is automatic, but divert of the plane must operate by the pilot. In the process of automatic navigation, flight path stability and divert are all automatical.

Pitch attitudes maintain and control simulation of carrier-attacker before launching. The disturbance of pitch deviation is joined in system simulation computer to simulate carrier-attacker get a disturbance when flying, take carrier-attacker nose-up pitch as an example, in this time itching angle change of carrier-attacker is affected by the vertical gyro in simulation system, and output signal. The angular velocity gyroscope group feels around the horizontal shaft angular velocity and the output signal, At the same time, the signal is input in differential amplifier circuit, and output angular acceleration signals. The three signal added to the comprehensive input port phase of the Phase detector pre-amplifier l at the same time, after enlarge the drive elevator with the integrated signal is proportional to the speed turns down. Under the effect of torque produced by the elevator, the carrier-attacker's pitching angle is restored to the initial state. In the process of recovery, the pitching angle deviation of carrier-attacker is reduced; the angular velocity and angular acceleration of the carrier-attacker are in the opposite direction with the carrier-attacker's movement in the interference. The sum of these signals drives the rudder for the initial position. Choose the three parameters of the transmission ratio, can guarantee the stability of carrier-attacker have good performance, and elevator also restored to the initial position when pitching angle restore to its original posture. Stable principle is shown in Fig.2.

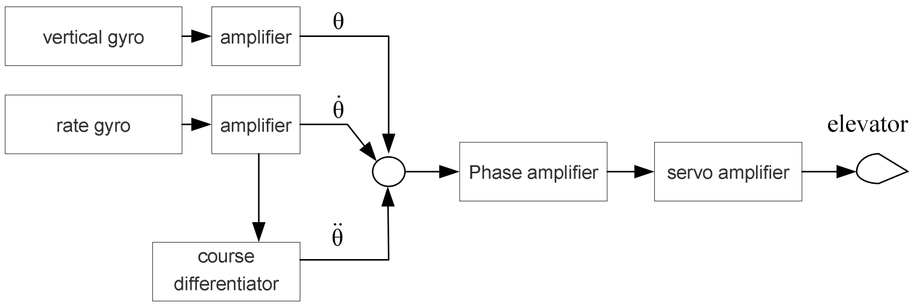

Fig.2 Pitching angle stability principle block diagram

If the carrier-attacker flight by a disturbance, take carrier-attacker nose-up pitch as an example, in this time pitching angle change of carrier-attacker is affected by the vertical gyro in simulation system, and output signal. The angular velocity gyroscope group feels around the horizontal shaft angular velocity and the output signal, At the same time, the signal is input in differential amplifier circuit, and output angular acceleration signals. The three signal added to the comprehensive input port phase of the Phase detector pre-amplifier l at the same time, after enlarge the drive elevator with the integrated signal is proportional to the speed turns down. Under the effect of torque produced by the elevator, the carrier-attacker's pitching angle is restored to the initial state. In the process of recovery, the pitching angle deviation of carrier-attacker is reduced; the angular velocity and angular acceleration of the carrier-attacker are in the opposite direction with the carrier-attacker's movement in the interference. The sums of these signals drive the rudder for the initial position. Choose the three parameters of the transmission ratio, can guarantee the stability of carrier-attacker have good performance, and elevator also restored to the initial position when pitching angle restore to its original posture.

Flight altitude stability simulation. The principle of stable flight altitude as shown in fig.3.The signal of attitude deviation is joined in system simulation computer to simulate carrier-attacker straight and level flight at schedule attitude, Due to some kind of interference, carrier-attacker deviated from the schedule attitude, if the attitude is reduced, the height difference sensor of simulation system will feel out of the carrier-attacker flight altitude speed deviation and the speed of the altitude change, the altitude signal proportional to the height deviation output by parity generator and lifting speed signal proportional to vertical speed output by tachometer generator are at the same time sent to integrated preamplifier for integrated amplifier, they are enlarged to drive the elevator up, and rotate with the rotate speed proportional to integrated signal, the look up torque is generated to make carrier-attacker upward flight. Due to the carrier-attacker raise its head, pitching angle signals, angular velocity and angular acceleration signals output by vertical gyro and the angular velocity gyroscope, these signals not only stop the elevator go to partial, and also try to make the elevator deflection down, make the carrier-attacker looked up slowly. When signal $\theta, \dot{\theta}, \ddot{\theta}$ keep balance with ΔH , $\dot{H}$,this is $U_{\theta} + U_{\dot{\theta}} + U_{\ddot{\theta}} = U_{\Delta H} + U_{\dot{H}}$ the elevator back to the middle position ,then the carrier-attacker at a certain pitch continues to climb. When the altitude is about to reach a predetermined altitude, signal ΔH gradually tends to zero, integrated signal reverse (opposite in sign), elevator shift the helm. Then the angle of elevation of the carrier-attacker reduce gradually, when the carrier-attacker arrived in schedule altitude, the elevator back to the middle position, the carrier-attacker will level flying on the scheduled altitude.

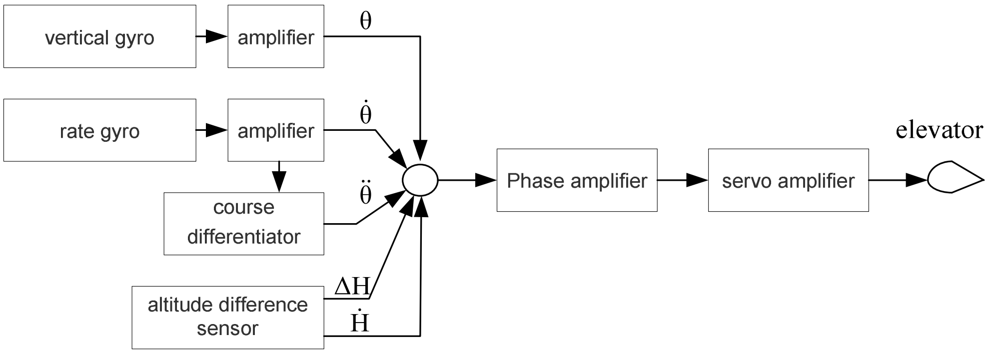

Fig. 3 The principle of stable flight altitude block diagram

Conclusion

The effective control for navigation, the pitch attitude /altitude maintained, speed stability of carrier-attacker is the necessary conditions of air-ground guided weapons to accurately hit targets, this paper just studies the control law of carrier-attacker before launching weapons, and the semi-physical simulation approach are discussed in this paper, specific application according to the specific situation, From the view point of engineering, concrete engineering implementation issues into consideration.

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