Experimental Study on a Stabilized Platform System for Shipborne Helicopter

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ABSTRACT

Shipborne helicopters are widely used, but their takeoffs and landings are very dangerous. For improving the security, a stabilized platform system, which is connected with ship body by hydraulic cylinders and has the function of ship motion compensation, is proposed. When the system works, the platform rises up to the deck and gets the general effect of ship movements (i.e. rolling, pitching and heaving) compensation by the way of each cylinder performing heave compensation of the corresponding point of the deck of ship. Laboratory experimental observations on the behavior of the system are reported and control performance researches are described. The results of the study indicate that the scheme of the stabilized platform system for shipborne helicopter is feasible; the controllers used in the system are effective and they can better solve the time-delay problem of the hydraulic mechanism and greatly improve the compensation accuracy of the system.

KEY WORDS: Helideck; helicopter; ship; motion compensation; intelligent control; model test; hydraulic system.

INTRODUCTION

Shipborne helicopters possess a wide variety of operational use, but their takeoffs and landings are very dangerous. For the sake of safety, shipborne helicopters usually stop flying and training when the sea conditions are severer than third degree or when the ship’s rolling exceeds ±5°, pitching exceeds ±2°, heaving exceeds 2 m and wind velocity is bigger than 15 m/s. According to statistics (Mu, 2000; Newman, 2004), the accident rate of shipborne helicopters is 5 times to that of spacecrafts, 10 times to that of bombers and 54 times to that of civil airplanes. There were 300 shipborne helicopters of American navy which fell into the sea from 1963 to 1983 and 380 people died. And about 50% of the accidents occurred during takeoffs and landings. In addition, there were 14 accidents of helicopters falling into sea in the infrequent sea works and training of CAAC in the lately 30 years.

The present approach for improving the takeoff and landing security of shipborne helicopter is to predict their takeoff and landing opportunity by using prediction technologies of frequency domain and time domain (Cai et al., 2003; Yang et al., 2008). Firstly, frequency domain analysis method is adopted to predict whether the sea conditions are meeting the demand of the helicopter’s takeoff and landing; secondly, if the answer is yes, time domain analysis method will be adopted immediately to predict the ship’s rolling, pitching and heaving for deciding the certain time of the coming minute that the helicopter can safely take off or land. Obviously, this is a passive method to wait for the opportunity to come. And the severer the sea conditions are, the fewer opportunities there are.

In view of this, a ship motion compensation scheme is proposed. Through the application of ship motion prediction and active control technology, a stabilized platform is set up, which can maintain still and horizontal while the ship is rolling, pitching and heaving, and then ensure the takeoff and landing safety of the shipborne helicopter.

The scheme will be of great importance to the smaller ships, because in the same sea conditions, their movement amplitudes are larger than that of the bigger ships and their helicopter’s takeoffs and landings are also more dangerous. The common technique is controlling the whole ship to reduce its 6-DOF movement amplitudes. But the measure is not very effective, and the result is usually worse especially when the ship is smaller. Therefore, this research accepts the scheme of building a stabilized platform system which has the function of ship motion compensation. The system directly controls the movements of the stabilized platform. As the stabilized platform is only one part of the ship, and in general, partial control is easier to achieve and better in control quality and efficiency than the integral control, it can be deduced to the result that the solution of this research would be the better choice not only in control quality but also in control efficiency.

At present, wave compensation technique is mainly used in deep-ocean mining system, offshore drilling system, offshore crane system and other aspects of underwater applications. Brink and Chung (1981), Chung (2004) and Chung (2010) developed an integrated ship-pipe-buffer-link miner system. In their researches, an automatic position control scheme was introduced and extensive computer simulation and performance analysis and assessment were carried out. Furthermore, full-scale at-sea tests of a 5,000-m-long pipe with a heave compensator...