H∞ Control of Slow Drift Oscillation of Moored Floating Platform with Thrusters

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ABSTRACT

The paper is concerned with a H∞ control of the slow drift oscillation of a moored floating platform (catenary shaped mooring chains were used). Slow drift oscillation appears as a result of resonance between the mooring system and the drifting force and the amplitude is very large, but it can be counteracted by thrusters because of its small exciting force. Our aim is to suppress slow drift oscillation using thruster activities that are not affected by wave frequency motion. The H∞ controller was designed using a simplified linear mathematical model obtained from nonlinear motion equations of a floating platform and mooring chains. Model tests were carried out and some successful experimental results were obtained. Moreover the simulated results were in good agreement with experimental ones.

KEY WORDS: Slow drift oscillation, H∞ control, Floating platform, Mooring, Catenary, Model tests

NOMENCLATURE

\( \bar{K}_{act} \) : Transfer function of H∞ controller with actuator dynamics
\( L \) : Length of platform
\( I_z \) : Position of point of application of drag force in steady flow
\( m \) : Mass of platform
\((o, y, z)\) : Moving coordinate system
\((O, Y, Z)\) : Space-fixed coordinate system
\( \rho \) : Angular velocity (see Fig.4)
\( S_w \) : Length of catenary part of mooring chain
\( T_ho \) : Horizontal component of initial tension of mooring chain
\( T_{th} \) : Time constant
\( T_{w-z} \) : Transfer function from \( u \) to \( y \)
\( \nu, w \) : Translational velocity in \( x, y \)-direction (see Fig.4)
\( \nu_0, w_0 \) : Relative velocity
\( (\nu = \nu_x - \nu_{wp}, w = w_x - w_{wp}) \)
\( \nu_0, w_c \) : Current velocity in \( y \) and \( z \)-direction
\( \nu_s, w_s \) : Velocity of water particle
\( \nu_c \) : Current velocity (see Fig.4)
\( \nu_{in} \) : Input voltage to thruster
\( W_1, W_2 \) : Weight function
\( \bar{\eta} \) : Surge and sway of a level with the mooring point
\( Y_w \) : Horizontal length of catenary part of mooring chain
\( z_e \) : Vertical displacement of mooring chain element
\((O, z_o)\) : Position of center of gravity
\( z_T \) : Distance from origin \( o \) to thruster in \( z \)-direction
\( \varphi \) : Eulerian angles
\( \rho \) : Water density

1. INTRODUCTION

A floating offshore platform is useful for developing resources in the ocean and many such platforms are now in operation. They are