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Study on the Float-Type Wave Energy Converter with Power Stabilization Technique

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ABSTRACT

This paper investigates numerically the effect of tension pulley on various physical quantities such as the flattening power output and the cable tension for the float counterweight wave energy converter (Hadano 2006). The tension pulley, a combination of a spring and a pulley, is located on the float side to maintain tension in the suspension cable when the tension generated by the weight of the counterweight is not sufficient to prevent the slackening of the cable. The current dynamics model has been modified to incorporate the dynamics of the tension pulley. Calculation results indicate that this application is successful in suppressing large fluctuations of the cable tension and also in preventing the occurrence of negative tension.

KEY WORDS: tension pulley; spring; cable tension; power stabilization.

INTRODUCTION

The authors have developed a novel device that can extract the energy from ocean waves utilizing the heaving motion of a floating mass. The major components of the energy converter are: a float, a counterweight, a cable, a driving pulley, two idler pulleys, a ratchet, and a generator shown in Fig. 1. The device generates power through the tension force in the cable and the weight difference between the float and the counterweight. When the system is at static free condition, the tension in the cable is equal to the weight of the counterweight which is minimum. Therefore it is desirable to keep the counterweight lighter than the float. However, experiments show that during the rise of the water level, the torque generated by weight of the counterweight is insufficient to rotate the driving pulley which causes the cable on the float side to slack. As a result, the float descends rapidly during the subsequent lowering of the water level. This causes sharp and instantaneous fluctuations of the cable tension force which accelerates the wearing of the device components and the cable itself. In addition, a large fluctuation in the resulting mechanical work rate and the electrical power output is also observed since these quantities depend on the tension force. To avoid this situation, an energy storage device is combined with the float-counterweight wave energy converter. The proposed application of the tension pulley rectifies these problems by preventing the cable from becoming slack when the water level rises.

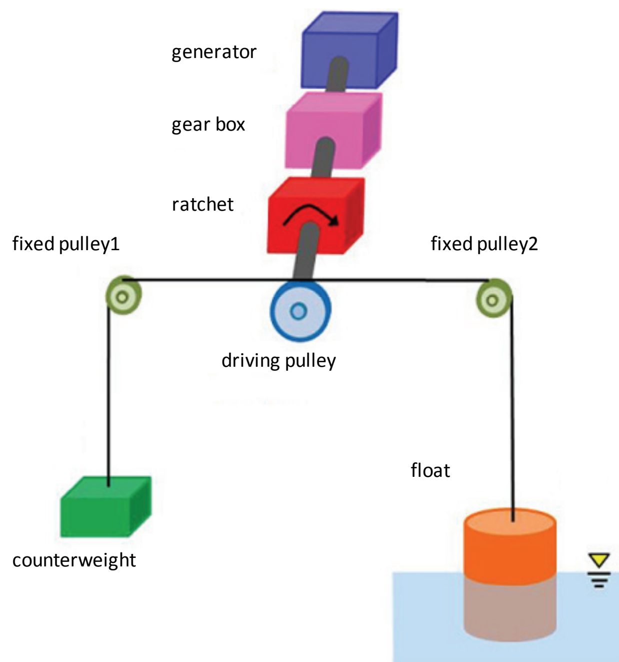

Fig. 1 Schematic diagram of the energy converter

In this paper, the current dynamics model (Hadano 2006) is modified to incorporate the dynamics of the tension pulley. This has been achieved by first writing the dynamical equations for the tension pulley and the energy converter separately and combining them later. This paper investigates numerically the effect of the tension pulley on various physical quantities such as the cable tension, the float displacement, and the float velocity. Results obtained indicate that this application is successful in suppressing large fluctuations of the cable tension.