Proceedings of the Seventeenth (2007) International Offshore and Polar Engineering Conference
Lisbon, Portugal, July 1-6, 2007

ISBN 978-1-880653-68-5; ISBN 1-880653-68-0(Set); ISSN 1098-6189 (Set)

A Development of Image Analysis Scheme for the Control of the Riser End

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ABSTRACT

The objective of this study is to develop an image analysis scheme for the control of riser end, which is important for the riser connection with the seabed wellhead in offshore oil drilling and production. In the scheme, a single camera is used to get the image of the targets, an approach of 3D position recognition is used to get the 3D coordinate of targets from the images, and thereby the displacement of targets between different images can be obtained. In the study, the static and dynamic experiments on the image analysis scheme were carried out. This scheme can be applied to the re-entry operation of riser end, and its preliminary experiment was carried out.

KEY WORDS: Riser; riser end control; image analysis scheme.

INTRODUCTION

Riser technology is widely used in offshore oil drilling and production (Brink, et al, 1981; Koterayama, et al, 2005). Drilling riser pipe is held on a vessel, floating with ocean wave. Considering that it is made of rigid material, thin and long, easy to be damaged, it should be disconnected from the seabed wellhead when the sea condition becomes bad. After the sea condition turns better, the riser end may need to be connected with the seabed wellhead again. To accomplish the connection, the riser end (in this paper, riser end means riser lower end, and riser top means riser upper end) should be surveyed by a position recognition system, and moved by the riser controller. Generally speaking, cameras installed on the ROV are used to observe the riser end, an operator guesses its distance between the riser end and the sea bottom wellhead connector from the image, and then moves the riser end empirically, but it’s not an easy task and sometimes takes too much time. Also many kinds of displacement sensors can detect the distance between targets (Suzuki, ea al, 1993; Machado, et al, 1999), but they may need many additional devices and cause much inconvenience in the deep sea.

For the control of riser end, here we have resorted to image analysis scheme. Prof. Nakamura developed an automatic position adjustable elevator by image analysis scheme (Nakamura, et al, 2005), but in the scheme an additional marked board is attached to the target to get the target position, which is inconvenient for the riser end survey, because the riser end must be plugged into the blowout preventer. So in the image analysis for the riser end survey, we should determine the 3D position of riser end only by its own shape in the image. In this paper, a special image analysis scheme is develop for the control of riser end, in which the image of the riser end and the seabed wellhead is taken by a single camera, the 3D relative positions of riser end and seabed wellhead are calculated according to the magnifying rates and center positions of their matching shapes in images, and thereby their distance can be obtained for the riser end control. To test the accuracy of this image analysis scheme, the static and dynamic experiments were carried out, and their results are shown. The image analysis scheme can be applied to the riser re-entry operation. The preliminary experiment of re-entry operation was carried out in the air, and the result is also shown in this paper.

IMAGE ANALYSIS SCHEME

For the image analysis of this study, the riser end and seabed wellhead are viewed as surveying targets. Since the 3D position of the targets is got by many coordinate transformations, the coordinate systems should be introduced firstly.

Coordinate System

In the image analysis scheme for the riser end control, there are 3 coordinate systems: 2D Image Plane Coordinate System (IPCS), 2D Pixel Plane Coordinate System (PPCS), 3D Image Coordinate System (ICS), as shown in Fig.1. In surveying, the target shape is projected through the camera lens onto the image plane, on which IPCS exists. In IPCS, U axis is parallel to the width direction of the cell array on the camera chip, V axis is parallel to the height direction of the cell array, and the origin is located at the intersection of lens axis with the image plane.

The image on the image plane is converted to the pixel signal, sent to the upper computer and shown on the computer screen on which the PPCS exists. In PPCS, the C axis is parallel to the pixel column direction, R axis is parallel is to the pixel row direction, and the origin is located at the top left of the screen.