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# Reliable vessel attitude estimation by wide angle camera

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## Abstract

*In the maritime field, one of the most sensitive information is the vessel attitude, because in several scenarios it could compromise the safety of the ship. Gyrocompasses provide the yaw angle with high accuracy, while the roll and pitch angles are directly measured by traditional sensor such as the classical inclinometers. In maritime dynamic positions systems, high-performance inertial sensors are employed to obtain continues attitude information; such systems are very expensive, and they are not spread on all common ships. The goal of this work is to develop a low-cost and non-invasive system able to estimate the roll and pitch angle. The developed system is based on visual observation obtained by a consumer camera. Roll and Pitch measurements are computed on the position and slope of the horizon line that falls within the image. The paper describes the procedures developed to obtain the attitude parameters.*

*Keywords: Visual Navigation; Attitude estimation; Computer Vision; INS; Photogrammetry.*

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## 1. Introduction

Nowadays the marine traffic covers most of the world trade: the shipping is a fundamental part of the modern global-model of import and export. Position, velocity and attitude are of great interest for mariners and owner for different type of ship and several scenarios, such-as open sea, waterways, congested harbour and high traffic zones. Specifically, during important operations one of the most sensitive information is the vessel attitude. Indeed, in loading and discharging movements, or during supply operations, the estimation of the vessel attitude is required, because it could compromise the safety conclusion of operation or even the safety of the ship.

Reliable estimation of the state of a 6-Degree of Freedom body is a fundamental task for the safety and economy of the ship and the focus of this work is to develop a low-cost system based on visual information to estimate the attitude parameters of a vessel. All the ships are equipped with a gyrocompass, that provides the yaw angle with high accuracy, while the roll and pitch angles are directly measured by traditional sensors such as bubble levels or the classical inclinometer. Attitude parameters can be indirectly estimated from ship motion monitoring as well. In maritime dynamic positions systems, as well as, in offshore drilling, high-performance inertial sensors are employed to obtain continues attitude information. Such systems are very expensive, and they are not spread on all common ships. The specific goal of this work is to estimate roll and pitch angles from the horizon line position within the image, using a generic consumer camera; the system is non-invasive and low-cost.

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