Integrated calibration and magnetic disturbance compensation of three-axis magnetometers

Hongfeng Pang, Jinfei Chen, Ji Li, Qi Zhang, Shitu Luo, Mengchun Pan

PII: S0263-2241(16)30348-7
DOI: http://dx.doi.org/10.1016/j.measurement.2016.06.056
Reference: MEASUR 4176

To appear in: *Measurement*

Received Date: 25 September 2013
Accepted Date: 24 June 2016

Please cite this article as: H. Pang, J. Chen, J. Li, Q. Zhang, S. Luo, M. Pan, Integrated calibration and magnetic disturbance compensation of three-axis magnetometers, *Measurement* (2016), doi: http://dx.doi.org/10.1016/j.measurement.2016.06.056

Integrated calibration and magnetic disturbance compensation of three-axis magnetometers

Hongfeng Pang, Jinfei Chen, Ji Li, Qi Zhang, Shitu Luo and Mengchun Pan

College of Mechatronics Engineering and Automation, National University of Defense Technology, Changsha 410073, People's Republic of China

E-mail: panghongfeng@126.com

Abstract: Technological limitations in sensor manufacturing and unwanted magnetic fields will corrupt the measurements of three-axis magnetometers. An experiment with four different magnetic disturbance situations is designed, and the influence of hard-iron and soft-iron material is analyzed. The calibration method with magnetic disturbance parameters is proposed for calibration and magnetic disturbance compensation of three axis magnetometers. It is not necessary to compute pseudo-linear parameters, thus the integrated parameters are computed directly by solving nonlinear equations. To employ this method, a nonmagnetic rotation equipment, a CZM-3 proton magnetometer, a DM-050 three-axis magnetometer, two magnets and two steel tubes are used. Calibration performance is discussed in the four situations. Compared with several traditional calibration methods, experiment results show that the proposed method has better integrated compensation performance in all situations, and error is reduced by several orders of magnitude. After compensation, RMS error is reduced from 10797.962 nT to 15.309 nT when the big magnet and steel tube are deployed. It suggests an useful method for calibration and magnetic disturbance compensation of three-axis magnetometers.

Keywords: three-axis magnetometer, calibration, magnetic disturbance compensation, hard-iron, soft-iron, nonlinear equations.

1. Introduction

Three-axis magnetometers are widely used in satellites, aircraft navigation, autonomous underwater vehicles (AUV) navigation [1, 2]. The accuracy of three-axis magnetometers is limited by different scale, bias of each axis and