Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 194 (2017) 386 – 393

Procedia Engineering

www.elsevier.com/locate/procedia

10th International Conference on Marine Technology, MARTEC 2016

Implementation of Digital IMU for Increasing the Accuracy of Hydrographic Survey

Shadman Sakib[a,*]

[a]*Department of Naval Architecture & Marine Engineering, Bangladesh University of Engineering & Technology, Dhaka-1000, Bangladesh*

Abstract

Hydrographic survey is of great importance in many fields. The accuracy of the survey has a huge dependency on the sea condition, which is the main parameter of the vessel's motion. Modern vessels use inertial measurement units to track the motion and compensate its effect. However, it is still under development as an optimum solution is yet to be found. Most of the techniques require special "ground markings" and complex procedures. Companies which use IMUs did not reveal their technology. Moreover, they use special kind of IMUs which are very expensive and bulky. In this paper, low cost digital Inertial Measurement Units (IMU) are used to determine the vessel's rotational motions and a general expression is derived from scratch for the correction of depth and position data in real-time, which is incorporated with a simple working algorithm. This compensation will enable the survey vessels to work under harsh weather. Focus is given on the roll and pitch motion as these two have the prime effect on the measurement and cannot be not detected using GPS.

Peer-review under responsibility of the organizing committee of the 10th International Conference on Marine Technology.
Keywords: Survey; Motion; IMU

1. Assumptions

In order to simplify the model, some position related conditions are assumed. Expressions are derived based on these assumptions. But in the end, they are modified again to exclude most of them.

The assumptions are:

1. Transducer is mounted right under the GPS receiver. So, the position data obtained by the GPS is the position of the transducer at upright condition.
2. Change in the position of the transducer in a fixed place due to only rolling and pitching is negligible.
3. Change in the relative position of the transducer and the GPS due to rolling and pitching is negligible.

* Corresponding author. Tel.:+8801629007190
E-mail address: shadman.sakib_siam@yahoo.com

Peer-review under responsibility of the organizing committee of the 10th International Conference on Marine Technology.
doi:10.1016/j.proeng.2017.08.161

2. Correction for roll

2.1. Depth

When the survey vessel is inclined, the sonar pulse does not travel in the same line underwater. And so, assuming the half of the total distance travelled by the pulse to be the depth right below the vessel is not accurate. From fig.1, we can see-

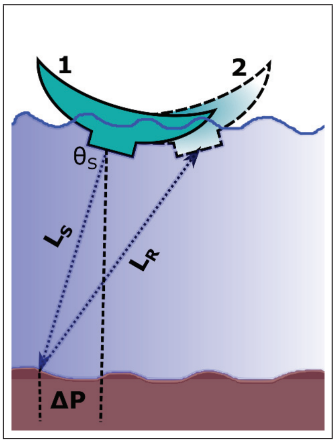

Fig. 1. Variation of sounding position for roll.

$$L_T = L_S + L_R$$

where L_S and L_R is the distance traveled by the generated and reflected pulse respectively. Now, from assumption no. 2, we can write-

$$L_T = 2L_S$$
$$\Rightarrow D = \frac{V_w \Delta t \cos\theta}{2}$$

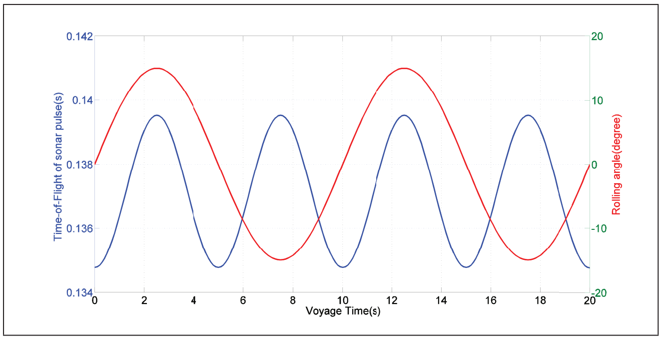

Fig. 2. Variation of time-of-flight of the sonar pulse in a fixed place for different angle of roll.

2.2. Sounding Position

Due to the angular direction of the shot pulse, the measured depth is not of the position of the ship, but of a position transversely away of the ship.