Analysis of Laser Gyro Strap-down Inertial Navigation System for its Self-Navigation and Integrated-Navigation Experiments in the Static State

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Abstract. In this paper, the test for the laser gyro strap-down inertial navigation system is studied. The self-navigation and the integrated navigation are introduced. By comparing the measuring results with the real data, the accuracy for the integrated-navigation is obtained. The errors for the head, the roll and the pitch are 11.16″, 3.52″, 2.08″, for the location is 0.13m. In the same way, the accuracy for the self-navigation is obtained. The errors for the head, the roll and the pitch are 15.17″, 3.74″, 5.22″, for the location is 0.56m. As a result, we can find that the accuracy for the integrated navigation is better than the self-navigation, however they both agree well with the designing results.

Introduction

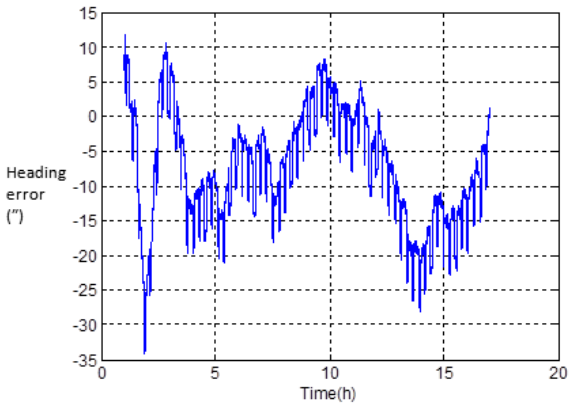
The laser gyro strap-down inertial navigation system has a lot of merits, such as high accuracy, short start-up time, and so on [1-4]. In the recent years, with the development of this technique, its application is more and more widely. Before the laser gyro strap-down inertial navigation system ploughed into use, several important tests need to be done first, including static test, dynamic test, and the electromagnetic compatibility test [5-8]. This paper presents the static test of the laser gyro strap-down inertial navigation system both in the self-navigation and the integrated navigation. By comparing the measuring results with the real data, the accuracy for the integrated-navigation is obtained.

Navigation test.

To obtain the navigation accuracy of the system in the static state, the self-navigation and the integrated navigation are considered.

(1)The integrated navigation test

Firstly the stance data for the vessel are measured by the system, the roll-, pitch- and heading angle are obtained. By comparing the measuring results with the real data, the error of the roll- pitch- and heading for the integrated-navigation is obtained, which are shown in Fig. 1.



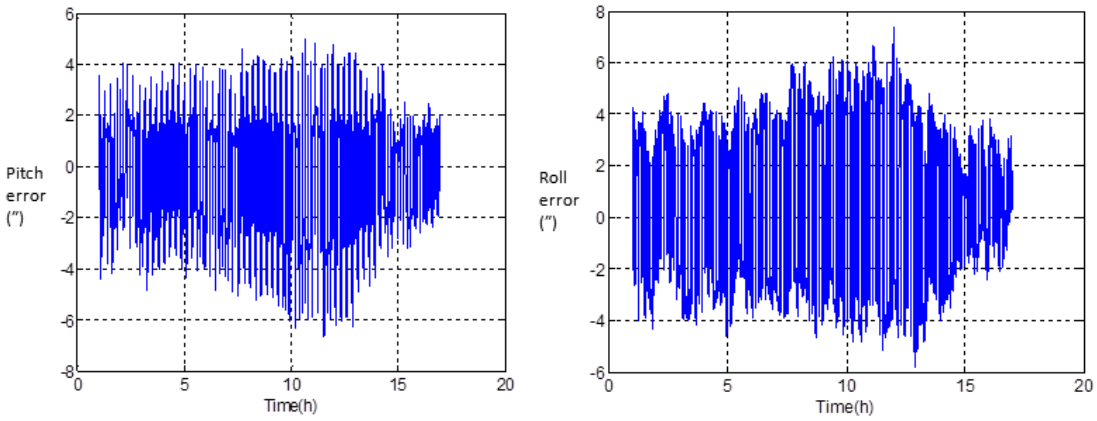


Fig.1. The error of the roll- pitch- and heading for the integrated-navigation.

Secondly, the position data for the vessel are also measured by the system, the error of the position is shown in Fig. 2. From Fig. 2 we can see that the error is smaller than 1.5m, so the position accuracy is very high.

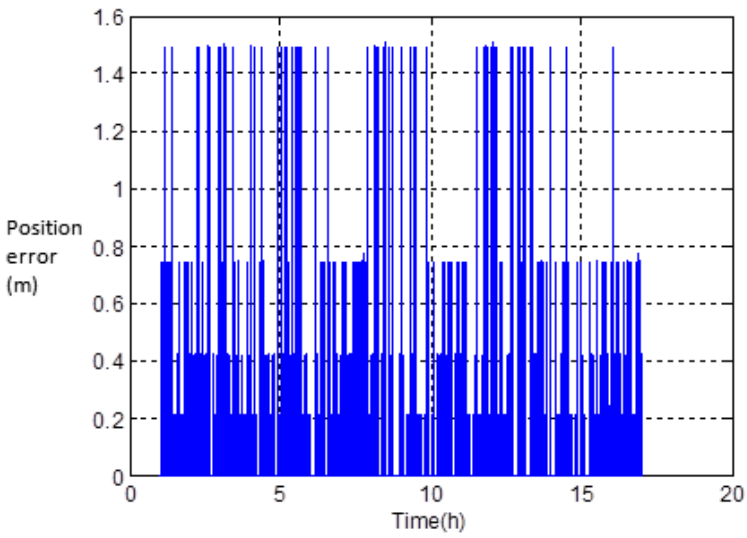


Fig. 2. The error of the position between the system and the GPS in the integrated-navigation test.

To see more clearly, we selected a data every 30 min between the whole test. The results are shown in table 1.

Table 1 The sample of the roll- pitch- and heading error for the integrated-navigation

Time (h)	Pitch error (″)	Roll error (″)	Heading error (″)
1.0	-0.83	-1.87	6.59
1.5	-1.91	-3.28	1.97
2.0	2.05	2.92	-25.11
2.5	1.59	3.78	0.49
3.0	-2.18	-2.08	-0.01
3.5	-2.34	-2.90	-10.22
4.0	1.47	4.18	-13.35
4.5	2.07	3.50	-10.77
5.0	-2.19	-3.96	-8.80
5.5	-1.42	-1.56	-10.33
6.0	1.16	2.69	-1.98

6.5	1.12	3.96	-4.40
7.0	-2.78	-2.84	-9.67
7.5	-2.99	-3.48	-17.26
8.0	1.70	4.81	-7.04
8.5	1.75	5.02	-2.37
9.0	-2.40	-3.57	3.51
9.5	-2.87	-3.38	6.64
10.0	1.43	4.06	4.55

From table 1 we can see that the pitch error is smaller than 4″ , the roll error is smaller than 6″ , the heading error is smaller than 25″ , in most of the time the heading error is smaller than 20″ , so the system has high accuracy for its stance angle.

(2)The self-navigation test

In the self-navigation test, we compare the measuring results with the real data, the error of the roll- pitch- and heading for the integrated-navigation are shown in Fig. 3.

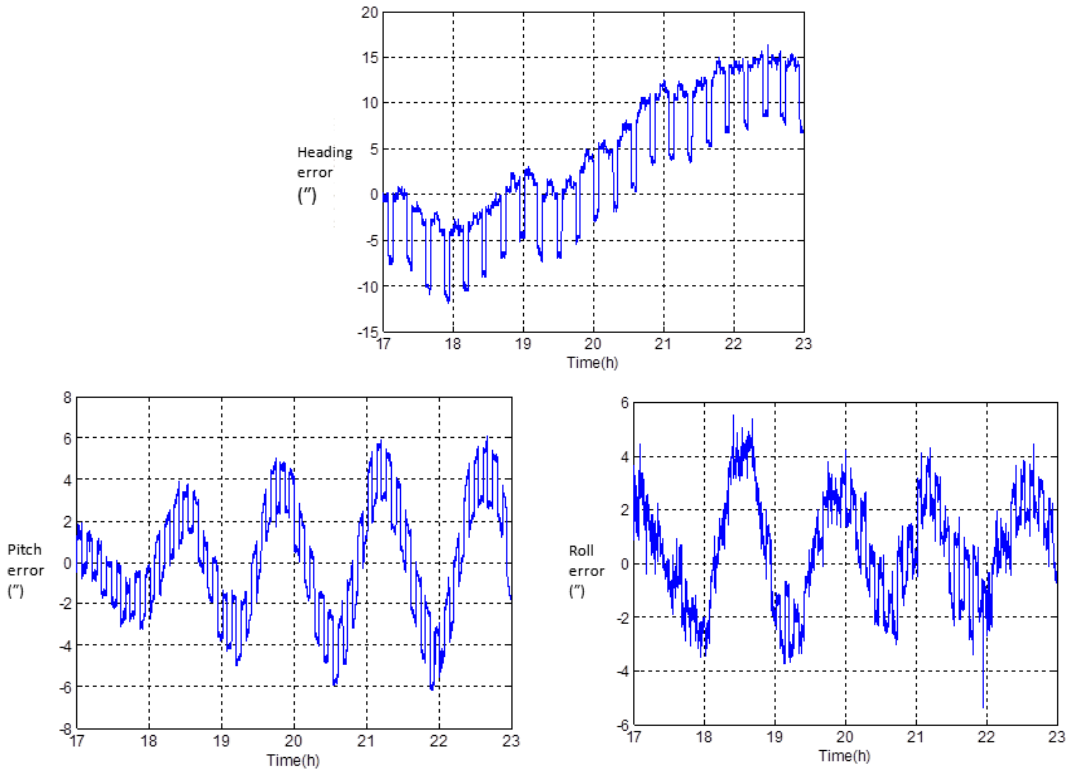


Fig. 3 The error of the roll- pitch- and heading for the self-navigation.

The position data for the vessel are also measured by the system, the error of the position is shown in Fig. 4. From Fig. 4 we can see that the error is smaller than 0.3 nmile.

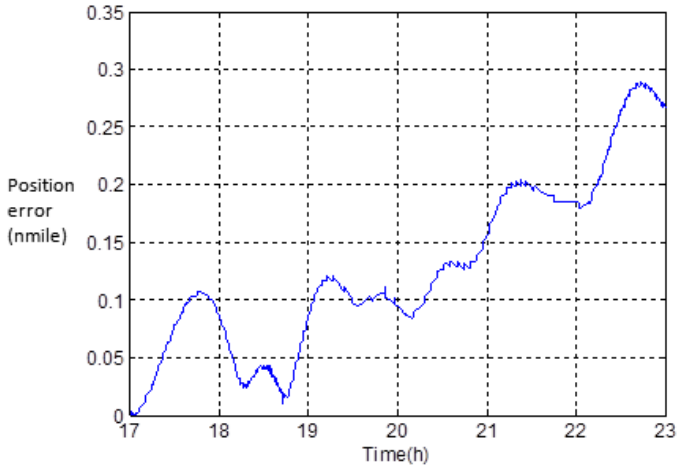


Fig. 4 The error of the position between the system and the GPS in the self-navigation test

The pitch error is smaller than 5″ , the roll error is smaller than 4″ , the heading error is smaller than 15″ , so the system has high accuracy for its stance angle.

Summary

In this paper, the test for the laser gyro strap-down inertial navigation system is presented. In the integrated navigation, the errors for the head, the roll and the pitch are 11.16″, 3.52″, 2.08″, for the location is 0.13m. In the self-navigation, the errors for the head, the roll and the pitch are 15.17″, 3.74″, 5.22″, for the location is 0.56m.

Acknowledgements

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