

The Key Technologies for High-Precision and High-Frequency GNSS Marine Positioning Research

Ying Xu, Hongzhan Zhou, Guangxu Zhang and Mengqi Han (China, PR)

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SUMMARY

The 21st century is the century of the ocean. Modern marine activities are rapidly advancing toward a new era of automation. Positioning is the prerequisite for the normal operation of unmanned Surface vessels. However, current GNSS marine precise positioning still faces challenges such as the difficulty in generating atmospheric enhancement information, broadcasting the enhancement information, and achieving robust positioning in the high-dynamic marine environment. To address this, a GNSS marine high-frequency, low-cost precise positioning system based on Beidou short message communication was designed. A theoretical model for non-isotropic tropospheric delay with high spatiotemporal resolution in the marine environment was proposed, breaking through the constraints of isotropic and anisotropic frameworks, and improving the accuracy of marine tropospheric delay estimation from the dm level to the cm level. An innovative high-frequency fusion positioning method based on a single Beidou short message communication was developed, overcoming the limitations of small bandwidth and low frequency of Beidou short messages. This increased the marine positioning frequency from 1/60 Hz to 1 Hz with a single Beidou short message. Additionally, an anti-interference adaptive GNSS-INS integrated navigation model suitable for unmanned vessels was proposed, addressing the issue that the general motion constraint model for vehicles is not applicable to marine platforms in GNSS signal denial environments. This improvement prevented the divergence and poor robustness of marine positioning results, enhancing the positioning accuracy from the meter level to the decimeter level. Based on the aforementioned innovative achievements, a fast, cost-effective, and robust Beidou marine precise positioning hardware and software platform has been established. This platform provides precise positioning technical support for marine search and rescue, as well as the intelligent operation and maintenance of marine ranches, yielding significant socio-economic benefits.

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