be appropriately extracted and immediately transmitted to the case station with the transmitter **8** installed on the floating body **5**. In such a configuration, the base station comprises a receiver for receiving the transmitted position data and a data processing unit for calculating the wave height and current direction and speed by processing the position data received by the receiver (in the aforesaid example, this data processing unit may be identical to the data processing unit **6** installed on the floating body **5**). The wave height and current direction and speed detected by the floating body **5** are calculated by the data processing unit in the base station. When the measurement device **1** is not provided with the transmitter **8**, the position data recorded by the data recording unit **4** are recovered at the same time as the measurement device **1** is recovered.

FIG. **2** is a graph illustrating a measurement example that has been measured with the GPS device **1** and system for measuring the wave height and current direction and speed in accordance with the present invention, this example relating to wave height measurements. FIG. **2**-A shows the height data measured with the GPS receiver **2** installed on the floating body **5** which floats on waves with a height of 0.5 m and a period of 1 Hz. Because an independent GPS navigation method based on the low-cost GPS receiver **2** is employed as means for position measurement in the measurement device **1**, the measurement data include not only the vertical movement (height 0.5 m) of floating body **5** on the waves, but also a position error exceeding 10 m and caused by the GPS ephemeris error, atmosphere delay error, multipath error, and the like. It is, therefore, clear that the structure using only the GPS receiver **2** is insufficient for measuring the wave height.

FIG. **2**-A also suggests that the position error exceeding 10 m changes slowly with a period of no less than 1 hour. Thus, when the position error is viewed from the standpoint of frequency range, the major part of the error is located in the low-frequency band. FIG. **2**-B shows in which region, in terms of frequency components thereof, the error data are present, those results being yielded by spectral analysis of the measurement data obtained with GPS. This figure demonstrates that the major part of the error is located in the low-frequency band. On the other hand, the wave (wave height) frequency is found to be present in a high-frequency band of 1 Hz, which is higher than that of the position error.

High-pass filter processing of position data of the GPS receiver for wave height measurement is implemented with the processing software **7**. By processing the position data of the GPS receiver obtained as a time series, the high-pass filter functions to delete the data components belonging to a low-frequency band and to leave the data components belonging to a high-frequency band. As a result, the position error of the GPS data can be removed and the wave height data can be separated and extracted. Appropriately determining the cut-off frequency of the high-pass filter in this process makes it possible to measure the wave height with a high accuracy by removing the GPS measurement error and not removing the swinging spectrum of the waves in the vertical direction.

FIG. **2**-C shows the results obtained by implementing the high-pass filter processing in the processing software **7**. As an example, a second-order high-pass filter was employed that had a cut-off frequency of 0.02 Hz. As a result, as follows from FIG. **2**-C, the error contained in the GPS position data is practically removed and only the wave height component derived from the vertical movement of floating body **5** is extracted. The wave height measurement error caused at this time by GPS has been improved to 0.08 m, which is almost equal to the measurement accuracy attained with the kinematic positioning method disclosed in the above-mentioned Japanese Patent Application Laid-open No. 10-186664. With the system disclosed in this open publication, two GPS receivers are required and the distance from the ground is limited to 10 km, whereas with the GPS wave height measurements in accordance with the present invention, using the processing software **7** having a high-pass filter makes it possible to attain the same accuracy as in the system disclosed in the aforesaid publication, but with only one receiver and without limitations.

The processing software **7** also conducts smoothing processing (or low-pass filter processing for passing only low-frequency components of horizontal plane position data) as a processing relating to current direction and speed. Setting the smoothing time (or cut-off frequency of the low-pass filter) to about 24 hours makes it possible to measure the current direction and speed with a high accuracy, so that information relating to the flow in the horizontal plane of the waves is not removed.

In the above-described embodiment, a high-pass filter was used for filter processing of wave height data. However, the present invention is not limited thereto and the measurement error of the independent GPS navigation method can be removed and wave height and current direction and speed measurements can be conducted by using smoothing and low-pass filter producing a similar effect. Furthermore, in the above-described embodiment the measurement device **1** drifted with the tide or current, but it can be also placed on an iceberg or drift ice and the degree of melting into the seawater can be detected by changes in the height thereof.

The GPS device for measuring the wave height and current direction and speed and GPS system for measuring the wave height and current direction and speed in accordance with the present invention have the above-described structure. Therefore, the wave height and current direction and speed on the surface of ocean, sea, lake, marsh, river, and the like, where the measurement device is floating can be measured accurately and simultaneously by measuring a three-dimensional position relating to the GPS antenna as the movement of the floating body with the GPS receiver installed on the measurement device and then removing the error of independent GPS navigation from the three-dimensional position data provided by GPS with a processing software. In the measurement device and system in accordance with the present invention, only one low-cost GPS receiver is required as a sensor, and the measurement device and measurement system can be designed without complicating the structure. Further, employing processing software for conducting high-pass filter processing and smoothing of three-dimensional position data provided by GPS as means for maintaining a high accuracy makes it possible to leave the necessary information, while removing the GPS measurement error. In addition, employing a data recording unit that can record large-volume data with a low power consumption allows the data recording unit to conduct long-term recording of three-dimensional position data provided by GPS and to implement the long-term operation. Moreover, the measurement device can be implemented at a low cost by using a simple configuration comprising a floating body, a GPS receiver, and a data recording unit.

What is claimed is:

1. A GPS device for measuring wave height and current direction and speed, comprising:

a floating body capable of floating on water;

a GPS antenna for receiving GPS signals;