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(54) **Satellite positioning method, satellite pesudorange calculation apparatus and satellite pesudorange calculation method.**

(57) A satellite positioning method, a satellite pesudorange calculation apparatus and a satellite pesudorange calculation method thereof are provided. The satellite pesudorange calculation apparatus is used for calculating a pesudorange between a satellite and a satellite positioning receiving device, wherein the pesudorange includes an integer code value and a decimal code value. The satellite pesudorange calculation apparatus comprises a receiver and a processor electrically connected with the receiver. The receiver is configured to receive a code phase from a satellite signal acquisition unit, and the processor is configured to calculate the decimal code value according to the code phase. The receiver is further configured to define an approximation position and calculate the integer code value according to the approximate position and the decimal code value. The satellite positioning method is used for positioning the satellite positioning receiving device.

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SATELLITE POSITIONING METHOD, SATELLITE PESUDORANGE CALCULATION APPARATUS AND SATELLITE PESUDORANGE CALCULATION METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a satellite positioning method, a satellite pesudorange calculation apparatus and a satellite pesudorange calculation method thereof. More particularly, the present invention provides a satellite positioning method, a satellite pesudorange calculation apparatus and a satellite pesudorange calculation method thereof that relate to quick cold start.

Descriptions of the Related Art

Satellite positioning has numerous advantages. For example, the satellite positioning has a high global coverage rate (up to 98%), a high precision and a wide application scope, is quick and time-saving, and allows for mobile positioning. Therefore, the satellite positioning has become an important representative technology for outdoor positioning.

The positioning process of a conventional satellite positioning receiving device may be divided into three procedures, namely, an acquisition procedure, a tracking procedure and a positioning procedure. During the acquisition procedure, the satellite positioning receiving device calculates a code phase and a Doppler shift of a visible satellite in the sky. During the tracking procedure, the satellite positioning receiving device synchronizes a local signal to the satellite signal to analyze parameters such as the satellite ephemeris. The satellite ephemeris is a parameter indispensable for the subsequent positioning procedure, and comprises an absolute transmitting time of the satellite and the satellite orbit information. During the positioning procedure, the satellite positioning receiving device obtains the correct satellite position and the correct pesudorange between the satellite and the satellite positioning receiving device according to the parameters including the satellite ephemeris and calculates a position where it is located.

For the conventional satellite positioning receiving device, it will be impossible to obtain the absolute transmitting time of the satellite and the satellite orbit information once the conventional satellite positioning receiving device fails to obtain the satellite ephemeris during the tracking procedure. Absence of the absolute transmitting time of the satellite and the satellite orbit information will make it impossible for the conventional satellite positioning receiving device to obtain the correct satellite position and the correct pesudorange between the satellite and the satellite positioning receiving device, and as a result, the position of the user cannot be calculated.

The conventional satellite positioning receiving device may comprise a radio frequency (RF) front-end unit, a satellite signal acquisition unit, a satellite signal tracking unit and a position calculating unit. The RF front-end unit is used as a communication interface between the satellite and the satellite positioning receiving device, and the satellite signal acquisition unit, the satellite signal tracking unit and the position calculating unit are used to perform the acquisition procedure, the tracking procedure and the positioning procedure respectively. Because the satellite transmits the satellite ephemeris at a very low transmission rate (about 50bps), it takes the satellite signal tracking unit much time (about 30 seconds to a few minutes) to download and process a whole piece of satellite ephemeris data (including the absolute transmitting time of the satellite and the satellite orbit information). Therefore, most of conventional satellite positioning receiving devices are confronted with an urgent problem to be tackled: that is, the speed of an initial positioning (or termed as "cold start") is very low, so the user has to wait for a too long time, which may have an effect on the applications of the satellite positioning receiving devices.

Accordingly, an urgent need exists in the art to improve the problem that the conventional satellite positioning receiving devices have a very low initial positioning speed because the satellite signal tracking unit thereof must spend much time to download from the satellite and process a whole ephemeris of the satellite.

SUMMARY OF THE INVENTION

The primary objective of the present invention is to provide a satellite positioning method, a satellite pesudorange calculation apparatus and a satellite pesudorange calculation method thereof. The satellite positioning method, the satellite pesudorange calculation apparatus and the satellite pesudorange calculation method thereof of the present invention allow the conventional satellite positioning receiving device to, in the absence of the satellite ephemeris, directly calculate the pesudorange between the satellite and the satellite positioning receiving device and the absolute transmitting time of the satellite so as to calculate the position of the user (i.e., the position of the satellite positioning receiving device). In other words, the satellite positioning method, the satellite pesudorange calculation apparatus and the satellite pesudorange calculation method thereof of the present invention can be used to replace or be used with the satellite signal tracking unit of the conventional satellite positioning receiving device. Therefore, it can be effectively improved that the conventional satellite positioning receiving device is with slow initial positioning speed because the satellite signal tracking unit thereof must spend much time to download and process a whole satellite ephemeris from the satellite.

To achieve the aforesaid objective, the present invention provides a satellite pesudorange calculation apparatus, which is configured to calculate a pesudorange between a satellite and a satellite positioning receiving device. The pesudorange comprises an integer code value and a decimal code value. The satellite pesudorange calculation apparatus comprises a receiver and a processor electrically connected with the receiver. The receiver is configured to receive a code phase from a satellite signal acquisition unit. The processor is configured to execute the following operations: calculating the decimal code value according to the code phase; defining an approximation position; and calculating the integer code value according to the approximation position and the decimal code value.

To achieve the aforesaid objective, the present invention further provides a satellite pesudorange calculation method for calculating a pesudorange between a satellite and a satellite positioning receiving device. The pesudorange comprises an integer code value and a decimal code value. The satellite pesudorange calculation method comprises the following steps of:

(a) enabling a receiver of the satellite positioning receiving device to receive a code phase from a satellite signal acquisition unit of the satellite positioning receiving device;

(b) enabling a processor, which is electrically connected to the receiver, of the satellite positioning receiving device to calculate the decimal code value according to the code phase;

(c) enabling the processor to define an approximation position; and

(d) enabling the processor to calculate the integer code value according to the approximation position and the decimal code value.

To achieve the aforesaid objective, the present invention further provides a satellite positioning method for positioning a satellite positioning receiving device. The satellite positioning receiving device has a pesudorange from each of a plurality of satellites respectively, and each of the pesudoranges comprises an integer code value and a decimal code value. The satellite positioning method comprises the following steps of:

(a) enabling a receiver of the satellite positioning receiving device to receive a code phase of one of the satellites from a satellite signal acquisition unit of the satellite positioning receiving device;

(b) enabling a processor, which is electrically connected to the receiver, of the satellite positioning receiving device to calculate the decimal code value according to the code phase;

(c) enabling the processor to define an approximation position;

(d) enabling the processor to calculate the integer code value according to the approximation position and the decimal code value;

(e) repeating the step (a) to step (d) to obtain the pesudoranges between the satellites and the satellite positioning receiving device respectively; and

(f) enabling a position calculation unit, which is electrically connected to the processor, of the satellite positioning receiving device to position the satellite positioning receiving device according to the pesudoranges.

The detailed technology and preferred embodiments implemented for the subject invention are described in the following paragraphs accompanying the appended drawings for people skilled in this field to well appreciate the features of the claimed invention.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic view of a satellite positioning receiving device 1 according to a first embodiment of the present invention;

FIG. 2 is a flowchart diagram of a satellite pesudorange calculation method according to a second embodiment of the present invention;

FIGS. 2A and **2B** are detail flowchart diagrams of a satellite satellite pesudorange calculation method according to a second embodiment of the present invention;

FIG. 3 is a flowchart diagram of a satellite positioning method according to a third embodiment of the present invention; and

FIGS. 3A and **3B** are detail flowchart diagrams of a satellite satellite positioning method according to a third embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the following descriptions, the present invention will be explained with reference to embodiments thereof. It shall be appreciated that, these embodiments are not intended to limit the present invention to any specific environments, applications or particular implementations described in these embodiments. Therefore, description of these embodiments is only for purpose of illustration rather than to limit the present invention. In the following embodiments and the attached drawings, elements not directly related to the present invention are omitted from depiction; and dimensional relationships among individual elements in the attached drawings are illustrated only for ease of understanding but not to limit the actual scale.

A first embodiment of the present invention is as shown in **FIG. 1**, which depicts a satellite positioning receiving device **1**. The satellite positioning receiving device **1** comprises a radio frequency (RF) front-end unit **11**, a satellite signal acquisition unit **13**, a satellite pesudorange calculation apparatus **15** and a position calculation unit **17**. The satellite pesudorange calculation apparatus **15** comprises a receiver **151** and a processor **153** electrically connected to the receiver **151**. The satellite positioning receiving device **1** may be implemented as, but not limited to, a mobile phone, a personal digital assistant (PDA), a digital camera, a notebook computer, a tablet computer or some other device that can be implemented by hardware, firmware or software and that has a satellite positioning function.

The RF front-end unit **11**, which is used as a communication interface between satellites (not shown) visible on the earth and the satellite positioning receiving device **1**, is configured to receive signals/data transmitted by the satellites and optionally transform the signals/data into a desired signal/data format for the satellite signal acquisition unit **13**. The satellite signal acquisition unit **13** is configured to acquire satellite signals that the RF front-end unit **11** receives from the satellites, and calculate such parameters as code phases and Doppler Shifts transmitted by the satellites. The position calculation unit **17** is configured to calculate the current position of the satellite positioning receiving device **1** (i.e., the position of the user) according to the parameters calculated by the satellite pesudorange calculation apparatus **15**, e.g., the pesudoranges between the satellites and the satellite positioning receiving device **1** and the absolute transmitting times of the satellites.

In principal, the RF front-end unit **11**, the satellite signal acquisition unit **13** and the position calculation unit **17** described in this embodiment may be considered as an RF front-end unit, a satellite signal acquisition unit and a position calculation unit included in a conventional satellite positioning receiving device. Therefore, related operations and functions of the RF front-end unit **11**, the satellite signal acquisition unit **13** and the position calculation unit **17** described in this embodiment can be appreciated by those of ordinary skill in the art and, thus, will not be further described herein.

Different from the conventional satellite positioning receiving device, the satellite pesudorange calculation device **15** described in this embodiment can directly calculate the pesudoranges between the satellites and the satellite positioning receiving device **1** and the absolute transmitting times of the satellites in the absence of a satellite ephemeris that would otherwise be provided by a satellite signal tracking unit. Then, the position calculation unit **17** can calculate the current position of the satellite positioning receiving device **1** (i.e., the position of the user) according to the pesudoranges between the satellites and the satellite positioning receiving device **1** and the absolute transmitting times of the satellites.

The pesudoranges between the satellites and the satellite positioning receiving device **1** may usually be measured in units of codes. Generally speaking, the pesudoranges between the satellites and the satellite positioning receiving device **1** are about 67 to 86 codes, with one code having a duration of **1** millisecond (ms). Then, a product of the total code number with the light speed (about 3×10^8 m/s) is just the pesudorange between a corresponding satellite and the satellite positioning receiving device **1**. The total code number comprises a decimal code value and an integer code value. Therefore, once the decimal code value and the integer code value of the pesudorange between the satellite and the satellite positioning receiving device **1** are known, the pesudorange between the satellite and the satellite positioning receiving device **1** will be known directly.

Hereinbelow, operations of the satellite pesudorange calculation apparatus **15** in calculating the pesudoranges between the satellites and the satellite positioning receiving device **1** will be further described. For convenience of description, calculation of a pesudorange between a satellite and the satellite positioning receiving device **1** will be taken as an example, and calculations of pesudoranges between other satellites and the satellite positioning receiving device **1** will be readily known by those of ordinary skill in the art on the basis of the following descriptions.

The receiver **151** of the satellite pesudorange calculation apparatus **15** is configured to receive a code phase (not shown) corresponding to the satellite from the satellite signal acquisition unit **13**, and the processor **153** is configured to calculate the decimal code value of the pesudorange between the satellite and the satellite positioning receiving device **1** according to the code phase. How to calculate the decimal code value of the pesudorange between the satellite and the satellite positioning receiving device **1** according to the code phase is known to those of ordinary skill in the art. In other words, the decimal code value is a parameter known to the satellite pesudorange calculation apparatus **15**.

Generally speaking, the satellite transmits codes at a code rate of 1023 kHz, and the satellite positioning receiving device has a code sampling rate of 16368 kHz. Therefore, the processor **153** can obtain the decimal code value of the pesudorange between the satellite and the satellite positioning receiving device **1** by dividing the code phase by the aforesaid code sampling rate of the satellite positioning receiving device **1**. For example, if the code phase is 8074, then the decimal code value is equal to 8074/16368=0.493 ms.

The processor 153 of the satellite pesudorange calculation apparatus **15** is further configured to define an approximation position, and calculate the integer code value of the pesudorange between the satellite and the satellite positioning receiving device **1** according to the approximation position and the decimal code value. More specifically, the processor **153** calculates the integer code value through the following operations: performing a linearization processing on the approximation position (e.g., calculating a Taylor expansion of the approximation position); calculating a unit vector matrix from the approximation position to the satellite according to the Taylor expansion; calculating an estimated decimal code value of the pesudorange between the satellite and the satellite positioning receiving device **1** according to the unit vector matrix and the decimal code value; and approximating the estimated decimal code value to the decimal code value by means of an iteration algorithm to calculate the integer code value.

Hereinafter, how the processor **153** calculates the integer code value will be further described by use of arithmetic expressions. However, the following description is not intended to limit the present invention. Firstly, a pesudorange observation equation between the satellite and the satellite positioning receiving device **1** may be represented as follows:

$$R_u = \rho_u + E \tag{1}$$

where ρ_u represents a pesudorange between the satellite and the satellite positioning receiving device **1**, E represents an error value. The error value may comprise a combination of an ionosphere delay error I, a troposphere delay error T, a clock error b and a system random error ε and so on. Generally speaking, an error value of the pesudorange caused by the errors is less than one code. In other words, the errors are covered by one code.

According to the concept of geometric distance, a geometric distance ρ_u between the satellite and the satellite positioning receiving device **1** may be represented as follows:

$$\rho_u = \sqrt{(x_u - x_i)^2 + (y_u - y_i)^2 + (z_u - z_i)^2} \tag{2}$$

where (x_u, y_u, z_u) represents a geometric position of the satellite positioning receiving device **1**, and (x_i, y_i, z_i) represents a geometric position of the satellite. Furthermore, according to the geometric expression of Equation (2), a pesudorange observation equation between the satellite and the satellite positioning receiving device **1** may be represented as follows:

$$R_u = \sqrt{(x_u - x_i)^2 + (y_u - y_i)^2 + (z_u - z_i)^2} + E \qquad (3)$$

The processor **153** may define an approximation position, and a geometric distance from the approximation position to the satellite may be represented as follows:

$$\rho_0 = \sqrt{(x_0 - x_i)^2 + (y_0 - y_i)^2 + (z_0 - z_i)^2} \qquad (4)$$

where the geometric position (x_0, y_0, z_0) of the approximation position may be any position in a free space. Preferably, the geometric position (x_0, y_0, z_0) of the approximation position **B** may be set to fall within a range visible to the satellite, but this is not intended to limit the present invention.

Next, the processor **153** may calculate a linearization processing on the approximation position. The linearization processing may be a Taylor expansion, which may be represented as follows:

$$\rho_u = \rho_0 + \frac{\partial \rho_u}{\partial x}(x_u - x_0) + \frac{\partial \rho_u}{\partial y}(y_u - y_0) + \frac{\partial \rho_u}{\partial x}(z_u - z_0) \qquad (5)$$

Because the unit vector from the geometric position (x_0, y_0, z_0) of the approximation position to the satellite may be represented as follows:

$$\begin{aligned} g_{xi} &= \frac{\partial \rho_u}{\partial x} = \frac{(x_0 - x_i)}{\rho_0} \\ g_{yi} &= \frac{\partial \rho_u}{\partial y} = \frac{(y_0 - y_i)}{\rho_0} \\ g_{zi} &= \frac{\partial \rho_u}{\partial z} = \frac{(z_0 - z_i)}{\rho_0} \end{aligned} \qquad (6)$$

the Taylor expansion shown in Equation (5) may be further represented as follows:

$$\rho_u = \rho_0 + g_{xi}(x_u - x_0) + g_{yi}(y_u - y_0) + g_{zi}(z_u - z_0) \tag{7}$$

By substituting Equation (7) into Equation (1), the pesudorange observation equation between the satellite and the satellite positioning receiving device **1** may be further represented as follows:

$$R_u = \rho_0 + g_{xi}(x_u - x_0) + g_{yi}(y_u - y_0) + g_{zi}(z_u - z_0) + E \tag{8}$$

Through transposition, Equation (8) may be further represented as follows:

$$[R_u\text{-}(\rho_0 + E)] = [g_{xi} \quad g_{yi} \quad g_{zi}] \begin{bmatrix} x_u - x_0 \\ y_u - y_0 \\ z_u - z_0 \end{bmatrix} \tag{9}$$

Finally, Equation (9) may be represented by a linear model as follows:

$$(y\text{-}N) = G\delta\mathrm{X} \tag{10}$$

where, y is the observed pesudorange R_u between the satellite and the satellite positioning receiving device **1**, N is a sum of the geometric distance ρ_0 from the approximation position to the satellite and the error value E, G is the unit vector matrix $[g_{xi} \quad g_{yi} \quad g_{zi}]$ from the geometric position (x_0, y_0, z_0) of the approximation position to the satellite, $\delta\mathrm{X}$ is an offset matrix $[x_u - x_0 \quad y_u - y_0 \quad z_u - z_0]^{\mathrm{T}}$ between the geometric position (x_u, y_u, z_u) of the satellite positioning receiving device **1** and the geometric position (x_0, y_0, z_0) of the approximation position.

By means of Equation (10), the processor **153** can calculate the estimated decimal code value of the geometric distance ρ_u between the satellite and the satellite positioning receiving device **1** according to the unit vector matrix G and the decimal code value. Firstly, the processor **153** can estimate an estimated offset matrix between the geometric position (x_u, y_u, z_u) of the satellite positioning receiving device **1** and the geometric position (x_0, y_0, z_0) of the approximation position as follows:

$$\delta\hat{X} = \left(G^T G\right)^{-1} G^T (y - N) \tag{11}$$

Then, by substituting Equation (11) into Equation (10), the processor **153** can calculate the estimated decimal code value of the geometric distance ρ_u between the satellite and the satellite positioning receiving device **1** according to the unit vector matrix *G* and the decimal code value as follows:

$$D = G\left(G^T G\right)^{-1} G^T (y - N) \tag{12}$$

where *D* just represents the estimated decimal code value.

If the error value *E* is not taken into account, then the observed pesudorange R_u between the satellite and the satellite positioning receiving device **1** is just a sum of the integer code value and the decimal code value. In other words, a difference value obtained by subtracting the integer code value from the observed pesudorange R_u between the satellite and the satellite positioning receiving device **1** is just the decimal code value. Because the processor **153** can calculate the decimal code value between the satellite and the satellite positioning receiving device **1** according to the code phase corresponding to the satellite that is received by the receiver **151** from the satellite signal acquisition unit **13**, the decimal code value is a parameter known to the processor **153**.

Then, the processor **153** can calculate the integer code value simply by using an iteration algorithm to approximate the estimated decimal code value to the decimal code value. Hereinbelow, a least square iteration algorithm will be used for purpose of description. However, the least square iteration algorithm described below is not intended to limit the present invention.

Specifically, the processor **153** will execute the following operations: defining a square error between the estimated decimal code value and the decimal code value; defining a cost function of the integer code value according to the square error; and searching for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

Firstly, the processor **153** calculates a residual error vector obtained by subtracting the estimated decimal code value from the decimal code value according to Equation (10) and Equation (12):

$$R = (y - N) - D = (y - N) - P(y - N) \tag{13}$$

where $P = G(G^{T}G)^{-1}G^{T}$.

Letting $(I - P) = Q$, then Equation (13) may be further represented as follows:

$$R = (y - N)Q \tag{14}$$

Next, the processor **153** calculates a square of the residual error vector obtained by subtracting the estimated decimal code value from the decimal code value, and defines a cost function of the integer code value according to the square as follows:

$$c(N) = (y - N)^{T}Q(y - N) \tag{15}$$

Finally, the processor **153** searches for a minimum value of the square error between the estimated decimal code value and the decimal code value through iteration according to the cost function of Equation (15) to calculate the integer code value. The integer code value ranges from 67 to 86.

So far, the integer code value and the decimal code value have been derived by the processor **153**. Thus, the geometric distance ρ_u between the satellite and the satellite positioning receiving device **1** has been derived by the processor **153.** For the satellite positioning receiving device **1,** the time taken by the satellite signal transmitted from the satellite to reach the satellite positioning receiving device **1** is already known, so the processor **153** can calculate an absolute transmitting time at which the satellite transmits the satellite signal, and calculates a satellite position according to the absolute transmitting time. Thus, the position calculation unit **17** now can receive from the satellite pesudorange calculation apparatus **15** parameters necessary for calculating the current position of the satellite positioning receiving device **1** (i.e., the position of the user), thus eliminating the need of providing the satellite ephemeris by the conventional satellite signal tracking unit.

In other embodiments, the satellite pesudorange calculation apparatus **15** of the present invention may also be used with the conventional satellite signal tracking unit in the satellite positioning receiving device **1.** During the initial positioning (cold start), the satellite pesudorange calculation apparatus **15** provides the parameters necessary for calculating the current position of the satellite positioning receiving device **1** to the position calculation unit **17;** and then, the satellite positioning receiving device **1** may be adaptively switched to a mode of providing the parameters (including the satellite ephemeris and so on) necessary for calculating the current position of the satellite positioning receiving device **1** from the conventional satellite signal tracking unit to the position calculation unit **17.** In other words, the satellite pesudorange calculation apparatus **15** of the present invention can either be used to replace or be used with the conventional satellite signal tracking unit in the satellite positioning receiving device **1.**

A second embodiment of the present invention is shown in **FIG. 2**, which depicts a satellite pesudorange calculation method for calculating a pesudorange between a satellite and a satellite positioning receiving device. The pesudorange comprises an integer code value and a decimal code value. The satellite positioning receiving device described in this embodiment may be considered as the satellite positioning receiving device **1** described in the first embodiment, and a satellite pesudorange calculation apparatus described in this embodiment may be considered as the satellite pesudorange calculation apparatus **15** described in the first embodiment.

As shown in **FIG. 2**, step **S21** is executed to enable a receiver of the satellite pesudorange calculation apparatus to receive a code phase from a satellite signal acquisition unit of the satellite pesudorange calculation apparatus. Step **S23** is executed to enable a processor, which is electrically connected to the receiver, of the satellite pesudorange calculation apparatus to calculate the decimal code value according to the code phase. Step **S25** is executed to enable the processor to define an approximation position. Step **S27** is executed to enable the processor to calculate the integer code value according to the approximation position and the decimal code value.

As shown in **FIG. 2A**, in other embodiments, the step **S27** described in this embodiment further comprises the following steps: step **S271** is executed to enable the processor to perform a linearization processing on the approximation position; step **S273** is executed to enable the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing; step **S275** is executed to enable the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value; and step **S277** is executed to enable the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm.

As shown in **FIG. 2B**, in other embodiments, the step **S277** described herein further comprises the following steps: step **S2771** is executed to enable the processor to define a square error between the estimated decimal code value and the decimal code value; step **S2773** is executed to enable the processor to define a cost function of the integer code value according to the square error; and step **S2775** is executed to enable the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

In addition to the aforesaid steps, the satellite pesudorange calculation method of this embodiment can also execute all the operations set forth in the first embodiment and have all the corresponding functions. How the satellite pesudorange calculation method of this embodiment executes these operations and has these functions can be readily appreciated by those of ordinary skill in the art based on the explanation of the first embodiment, and thus will not be further described herein.

A third embodiment of the present invention is shown in **FIG. 3**, which depicts a satellite positioning method for positioning a satellite positioning receiving device. The satellite positioning receiving device has a pesudorange from each of a plurality of satellites respectively, and each pesudorange comprises an integer code value and a decimal code value. The satellite positioning receiving device described in this embodiment may be considered as the satellite positioning receiving device **1** described in the first embodiment, and a satellite pesudorange calculation apparatus described in this embodiment may be considered as the satellite pesudorange calculation apparatus **15** described in the first embodiment.

As shown in **FIG. 3**, step **S31** is executed to enable a receiver of the satellite pesudorange calculation apparatus to receive a code phase of one of the satellites from a satellite signal acquisition unit of the satellite pesudorange calculation apparatus. Step **S32** is executed to enable a processor, which is electrically connected to the receiver, of the satellite pesudorange calculation apparatus to calculate the decimal code value according to the code phase. Step **S33** is executed to enable the processor to define an approximation position. Step **S34** is executed to enable the processor to calculate the integer code value according to the approximation position and the decimal code value. In step **35**, the aforesaid steps (i.e., step **S31**, step **S32**, step **S33** and step **S34**) are repeated to obtain pesudoranges between the satellites and the satellite positioning receiving device respectively. Step **S36** is executed to enable a position calculation unit, which is electrically connected to the processor, of the satellite positioning receiving device to position the satellite positioning receiving device according to the pesudoranges.

As shown in **FIG. 3A**, in other embodiments, the step **S34** described in this embodiment further comprises the following steps: step **S341** is executed to enable the processor to perform a linearization processing on the approximation position; step **S343** is executed to enable the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing; step **S345** is executed to enable the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value; and step **S347** is executed to enable the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm.

As shown in **FIG. 3B**, in other embodiments, the step **S347** described herein further comprises the following steps: step **S3471** is executed to enable the processor to define a square error between the estimated decimal code value and the decimal code value; step **S3473** is executed to enable the processor to define a cost function of the integer code value according to the square error; and step **S3475** is executed to enable the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

In addition to the aforesaid steps, the satellite pesudorange calculation method of this embodiment can also execute all the operations set forth in the aforesaid embodiments and have all the corresponding functions. How the satellite pesudorange calculation method of this embodiment executes these operations and has these functions can be readily appreciated by those of ordinary skill in the art based on the explanation of the aforesaid embodiments, and thus will not be further described herein.

According to the above descriptions, the present invention provides a satellite positioning method, a satellite pesudorange calculation apparatus and a satellite pesudorange calculation method thereof. The satellite positioning method, the satellite pesudorange calculation apparatus and the satellite pesudorange calculation method thereof of the present invention allow the conventional satellite positioning receiving device to, in the absence of the satellite ephemeris, directly calculate the pesudorange between the satellite and the satellite positioning receiving device and the absolute transmitting time of the satellite to know the position of the satellite. Then, the position of the user (i.e., the satellite positioning receiving device) can be derived. In other words, the satellite positioning method, the satellite pesudorange calculation apparatus and the satellite pesudorange calculation method thereof of the present invention can be used to replace or be used with the satellite signal tracking unit of the conventional satellite positioning receiving device. Therefore, it can be effectively improved that the conventional satellite positioning receiving device is with slow initial positioning speed because the satellite signal tracking unit thereof must spend much time to download and process a whole satellite ephemeris from the satellite.

The above disclosure is related to the detailed technical contents and inventive features thereof. People skilled in this field may proceed with a variety of modifications and replacements based on the disclosures and suggestions of the invention as described without departing from the characteristics thereof. Nevertheless, although such modifications and replacements are not fully disclosed in the above descriptions, they have substantially been covered in the following claims as appended.

Clauses

1. A satellite pesudorange calculation apparatus, being configured to calculate a pesudorange between a satellite and a satellite positioning receiving device, and the pesudorange comprising an integer code value and a decimal code value, the satellite pesudorange calculation apparatus comprising:

a receiver, being configured to receive a code phase from a satellite signal acquisition unit; and

a processor electrically connected with the receiver, being configured to execute the following operations:

calculating the decimal code value according to the code phase;

defining an approximation position; and

calculating the integer code value according to the approximation position and the decimal code value.

2. The satellite pesudorange calculation apparatus as claimed in clause 1, wherein the processor is further configured to execute the following operations:

performing a linearization processing on the approximation position;

calculating a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing;

calculating an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value; and

approximating the estimated decimal code value to the decimal code value by means of an iteration algorithm to calculate the integer code value.

3. The satellite pesudorange calculation apparatus as claimed in clause 2, wherein the processor executes the following operations by means of the iteration algorithm:

defining a square error between the estimated decimal code value and the decimal code value;

defining a cost function of the integer code value according to the square error; and

searching for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

4. The satellite pesudorange calculation apparatus as claimed in clause 1, wherein the approximation position falls within a range visible to the satellite.

5. A satellite pesudorange calculation method for calculating a pesudorange between a satellite and a satellite positioning receiving device, the pesudorange comprising an integer code value and a decimal code value, the satellite pesudorange calculation method comprising the following steps of:

(a) enabling a receiver of the satellite positioning receiving device to receive a code phase from a satellite signal acquisition unit of the satellite positioning receiving device;

(b) enabling a processor, which is electrically connected to the receiver, of the satellite positioning receiving device to calculate the decimal code value according to the code phase;

(c) enabling the processor to define an approximation position; and

(d) enabling the processor to calculate the integer code value according to the approximation position and the decimal code value.

6. The satellite pesudorange calculation method as claimed in clause 5, wherein the step (d) further comprises the following steps of:

(d1) enabling the processor to perform a linearization processing on the approximation position;

(d3) enabling the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing;

(d5) enabling the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value; and

(d7) enabling the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm.

7. The satellite pesudorange calculation method as claimed in clause 6, wherein the step (d7) further comprises the following steps of:

(d71) enabling the processor to define a square error between the estimated decimal code value and the decimal code value;

(d73) enabling the processor to define a cost function of the integer code value according to the square error; and

(d75) enabling the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

8. The satellite pesudorange calculation method as claimed in clause 5, wherein the approximation position falls within a range visible to the satellite.

9. A satellite positioning method for positioning a satellite positioning receiving device, the satellite positioning receiving device having a pesudorange from each of a plurality of satellites respectively, and each of the pesudoranges comprising an integer code value and a decimal code value, the satellite positioning method comprising the following steps of:

(a) enabling a receiver of the satellite positioning receiving device to receive a code phase of one of the satellites from a satellite signal acquisition unit of the satellite positioning receiving device;

(b) enabling a processor, which is electrically connected to the receiver, of the satellite positioning receiving device to calculate the decimal code value according to the code phase;

(c) enabling the processor to define an approximation position;

(d) enabling the processor to calculate the integer code value according to the approximation position and the decimal code value;

(e) repeating the step (a) to step (d) to obtain the pesudoranges between the satellites and the satellite positioning receiving device respectively; and

(f) enabling a position calculation unit, which is electrically connected to the processor, of the satellite positioning receiving device to position the satellite positioning receiving device according to the pesudoranges.

10. The satellite positioning method as claimed in clause 9, wherein the step (d) further comprises the following steps of:

(d1) enabling the processor to perform a linearization processing on the approximation position;

(d3) enabling the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing;

(d5) enabling the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value;

(d7) enabling the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm.

11. The satellite positioning method as claimed in clause 10, wherein the step (d7) further comprises the following steps of:

(d71) enabling the processor to define a square error between the estimated decimal code value and the decimal code value;

(d73) enabling the processor to define a cost function of the integer code value according to the square error; and

(d75) enabling the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value.

12. The satellite positioning method as claimed in clause 9, wherein the approximation position falls within a range visible to the satellite.

Conclusies

1. Satelliet-pseudoafstand-berekeningsnrichting, die ingericht is om een pseudoafstand te berekenen tussen een satelliet en een satelliet-positionerings-ontvangstinrichting, waarbij de pseudoafstand een codewaarde in gehele getallen en een codewaarde in decimalen omvat, waarbij de satelliet-pseudoafstand-berekeningsinrichting omvat:

- een ontvanger, die ingericht is om een codefase te ontvangen van een satellietsignaal-acquisitie-eenheid, en
- een processor die elektrisch verbonden is met de ontvanger en die ingericht is om de volgende bewerkingen uit te voeren:
- het berekenen van de decimale codewaarde in overeenstemming met de codefase;
- het bepalen van een benaderingspositie; en
- het berekenen van de gehele getal-codewaarde in overeenstemming met de benaderingspositie en de decimale codewaarde.

2. Satelliet-pseudoafstand-berekeningsinrichting volgens conclusie 1, waarbij de processor verder ingericht is om de volgende bewerkingen uit te voeren:

- het uitvoeren van een linearisatiebewerking op de benaderingspositie;
- het berekenen van een eenheidsvectormatrix vanaf de benaderingspositie naar de satelliet op basis van de linearisatiebewerking;
- het berekenen van een geschatte decimale codewaarde van de pseudoafstand in overeenstemming met de eenheidsvectormatrix en de decimale codewaarde; en

- het benaderen van de decimale codewaarde door de geschatte decimale codewaarde door middel van een iteratiealgoritme om de gehele getal-codewaarde te berekenen.

3. Satelliet-pseudoafstand-berekeningsinrichting volgens conclusie 2, waarbij de processor de volgende bewerkingen uitvoert door middel van het iteratiealgoritme:

- het bepalen van een gekwadrateerde afwijking tussen de geschatte decimale codewaarde en de decimale codewaarde;

- het bepalen van een kostenfunctie van de gehele getal-codewaarde in overeenstemming met de gekwadrateerde afwijking; en

- het zoeken naar een minimale waarde van de gekwadrateerde afwijking door iteratie volgens de kostenfunctie om de gehele getal-codewaarde te berekenen.

4. Satelliet-pseudoafstand-berekeningsindex volgens conclusie 1, waarbij de benaderingspositie binnen een bereik valt dat zichtbaar is voor de satelliet.

5. Satelliet-pseudoafstand-berekeningswijze voor het berekenen van een pseudoafstand tussen een satelliet en een ontvangstinrichting voor satellietpositionering, waarbij de pseudoafstand een codewaarde als geheel getal en een decimale codewaarde omvat, waarbij de satelliet-pseudoafstand-berekeningswijze de volgende stappen omvat:

(a) een ontvanger van de satellietpositionering-ontvangstinrichting in staat stellen om een codefase te ontvangen van een satellietsignaal-acquisitieeenheid van de satelliet-positionering-ontvangstinrichting,

(b) een processor van de satelliet-positionering-ontvangstinrichting die elektrisch verbonden is met de ontvanger in staat stellen om de decimale codewaarde te berekenen in overeenstemming met de codefase,

(c) de processor in staat stellen een benaderingspositie te bepalen, en

(d) de processor in staat stellen de gehele getal-codewaarde te berekenen in overeenstemming met de benaderingspositie en de decimale codewaarde.

6. Satelliet-pseudoafstand-berekeningswijze volgens conclusie 5, waarbij stap (d) verder de volgende stappen omvat:

(d1) de processor in staat stellen een linearisatie uit te voeren op de benaderingspositie;

(d3) de processor in staat stellen een eenheidsvectormatrix te berekenen van de benaderingspositie naar de satelliet op basis van de linearisatiebewerking;

(d5) de processor in staat stellen een geschatte decimale codewaarde te berekenen van de pseudoafstand in overeenstemming met de eenheidsvectormatrix en de decimale codewaarde; en

(d7) de processor in staat stellen de gehele getal-codewaarde te berekenen door de decimale codewaarde te benaderen met de geschatte decimale codewaarde via een iteratiealgoritme.

7. Satelliet-pseudoafstand-berekeningswijze volgens conclusie 6, waarbij de stap (d7) verder de volgende stappen omvat:

(d71) de processor in staat stellen een gekwadrateerde afwijking te bepalen tussen de geschatte decimale codewaarde en de decimale codewaarde;

(d73) de processor in staat stellen een kostenfunctie te bepalen van de gehele getal-codewaarde in overeenstemming met de gekwadrateerde afwijking; en

(d75) de processor in staat stellen te zoeken naar een minimale waarde van de gekwadrateerde afwijking door iteratie in overeenstemming met de kostenfunctie teneinde de gehele getal-codewaarde te berekenen.

8. Satelliet-pseudoafstand-berekeningswijze volgens conclusie 5, waarbij de benaderingspositie valt binnen een bereik dat zichtbaar is voor de satelliet.

9. Satelliet-positioneringswijze voor het positioneren van een satelliet-positionerings-ontvangstinrichting, waarbij de satelliet-positionering-ontvangstinrichting respectievelijk een pseudoafstand vertoont vanaf elk van een aantal satellieten, en elk van de pseudoafstanden een codewaarde als geheel getal en een decimale codewaarde omvat, waarbij de satelliet-positioneringswijze de volgende stappen omvat:

(a) een ontvanger van de satellietpositionering-ontvangstinrichting in staat stellen om een codefase van een van de satellieten te ontvangen van een satellietsignaal-acquisitieeenheid van de satelliet-positionering-ontvangstinrichting,

(b) een processor van de satelliet-positionering-ontvangstinrichting die elektrisch verbonden is met de ontvanger in staat stellen om de decimale codewaarde te berekenen in overeenstemming met de codefase,

(c) de processor in staat stellen een benaderingspositie te bepalen,

(d) de processor in staat stellen de gehele getal-codewaarde te berekenen in overeenstemming met de benaderingspositie en de decimale codewaarde,

(e) het herhalen van stap (a) tot stap (d) om respectievelijk de pseudoafstanden tussen de satellieten en de satelliet-positionering-ontvangstinrichting te verkrijgen, en

(f) een positieberekeningseenheid van de satellietpositionering-ontvangstinrichting, die elektrisch verbonden is met de processor, in staat stellen om de satellietpositionerings-ontvangstinrichting te positioneren in overeenstemming met de pseudoafstanden.

10. Satelliet-positioneringswijze volgens conclusie 9, waarbij stap (d) verder de volgende stappen omvat:

(d1) de processor in staat stellen een linearisatie uit te voeren op de benaderingspositie;

(d3) de processor in staat stellen een eenheidsvectormatrix te berekenen van de benaderingspositie naar de satelliet op basis van de linearisatiebewerking;

(d5) de processor in staat stellen een geschatte decimale codewaarde te berekenen van de pseudoafstand in overeenstemming met de eenheidsvectormatrix en de decimale codewaarde; en

(d7) de processor in staat stellen de gehele getal-codewaarde te berekenen door de decimale codewaarde te benaderen met de geschatte decimale codewaarde via een iteratiealgoritme.

11. Satelliet-positioneringswijze volgens conclusie 10, waarbij de stap (d7) verder de volgende stappen omvat:

(d71) de processor in staat stellen een gekwadrateerde afwijking te bepalen tussen de geschatte decimale codewaarde en de decimale codewaarde;

(d73) de processor in staat stellen een kostenfunctie te bepalen van de gehele getal-codewaarde in overeenstemming met de gekwadrateerde afwijking; en

(d75) de processor in staat stellen te zoeken naar een minimale waarde van de gekwadrateerde afwijking door iteratie in overeenstemming met de kostenfunctie teneinde de gehele codewaarde te berekenen.

12. Satelliet-positioningswijze volgens conclusie 9, waarbij de benaderingspositie valt binnen een bereik dat zichtbaar is voor de satelliet.

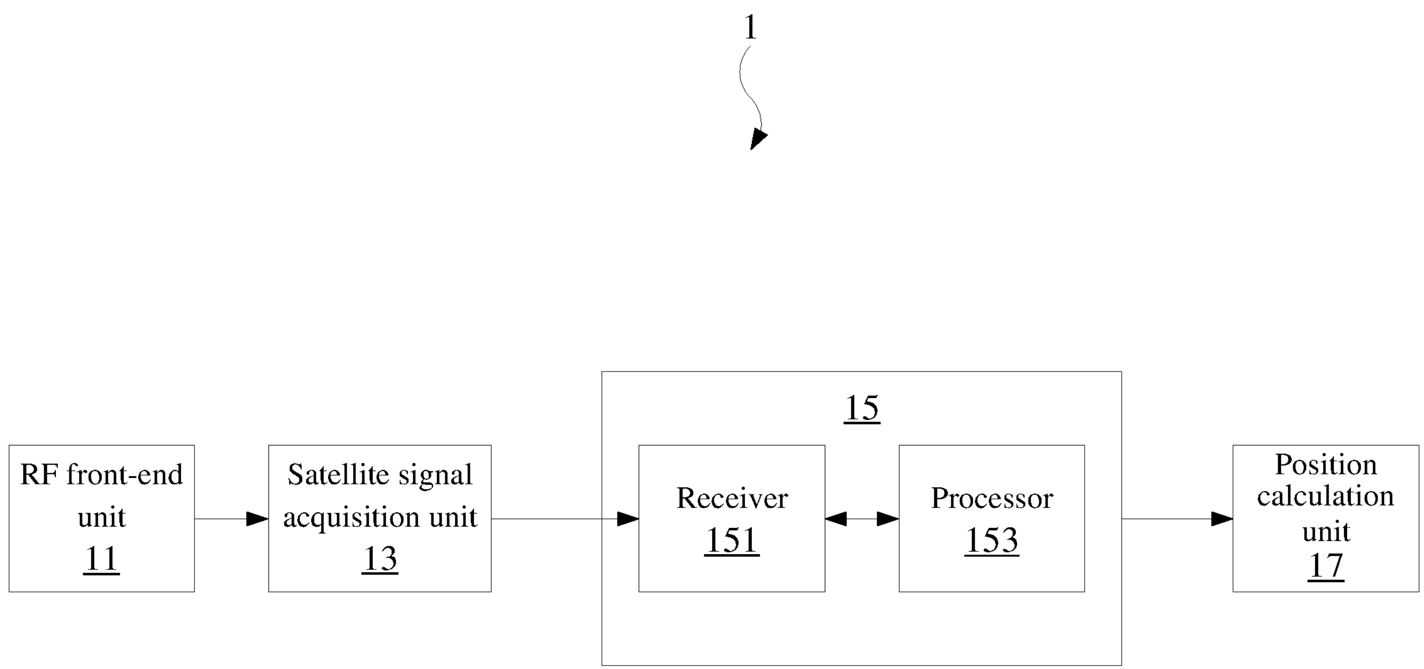
1
RF front-end unit 11
Satellite signal acquisition unit 13
15
Receiver 151
Processor 153
Position calculation unit 17

FIG. 1

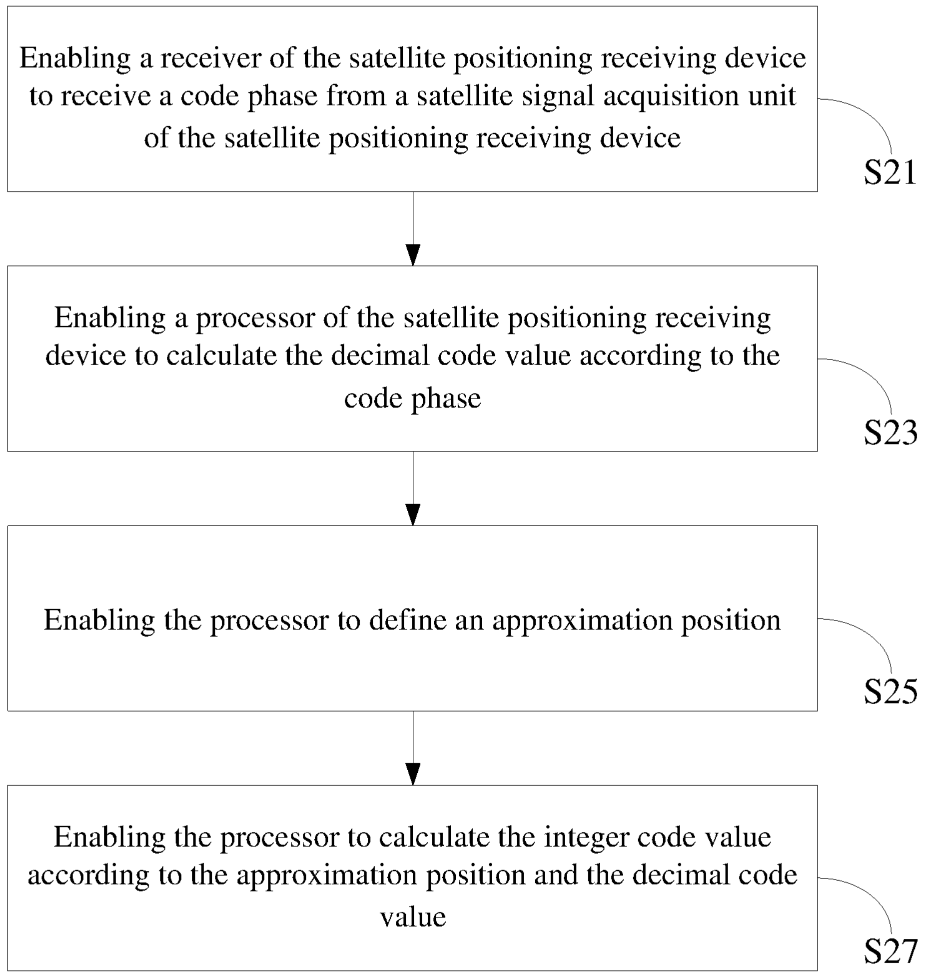
Enabling a receiver of the satellite positioning receiving device to receive a code phase from a satellite signal acquisition unit of the satellite positioning receiving device
S21
Enabling a processor of the satellite positioning receiving device to calculate the decimal code value according to the code phase
S23
Enabling the processor to define an approximation position
S25
Enabling the processor to calculate the integer code value according to the approximation position and the decimal code value
S27

FIG. 2

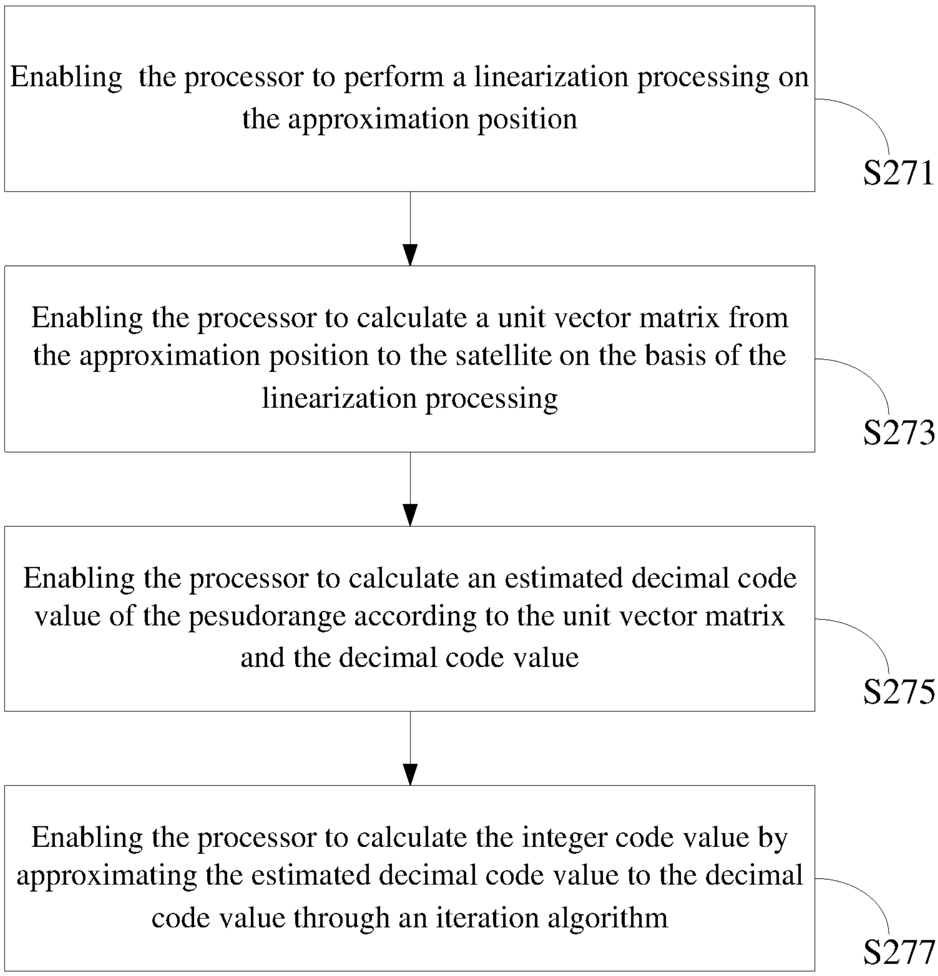
Enabling the processor to perform a linearization processing on the approximation position
S271
Enabling the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing
S273
Enabling the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value
S275
Enabling the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm
S277

FIG. 2A

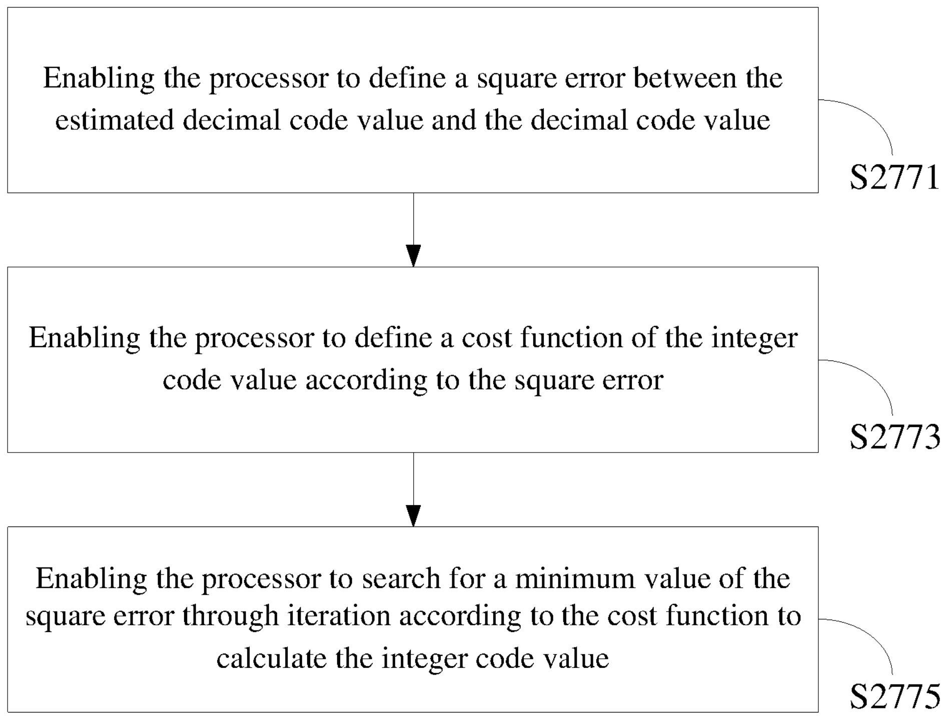
Enabling the processor to define a square error between the estimated decimal code value and the decimal code value
S2771
Enabling the processor to define a cost function of the integer code value according to the square error
S2773
Enabling the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value
S2775

FIG. 2B

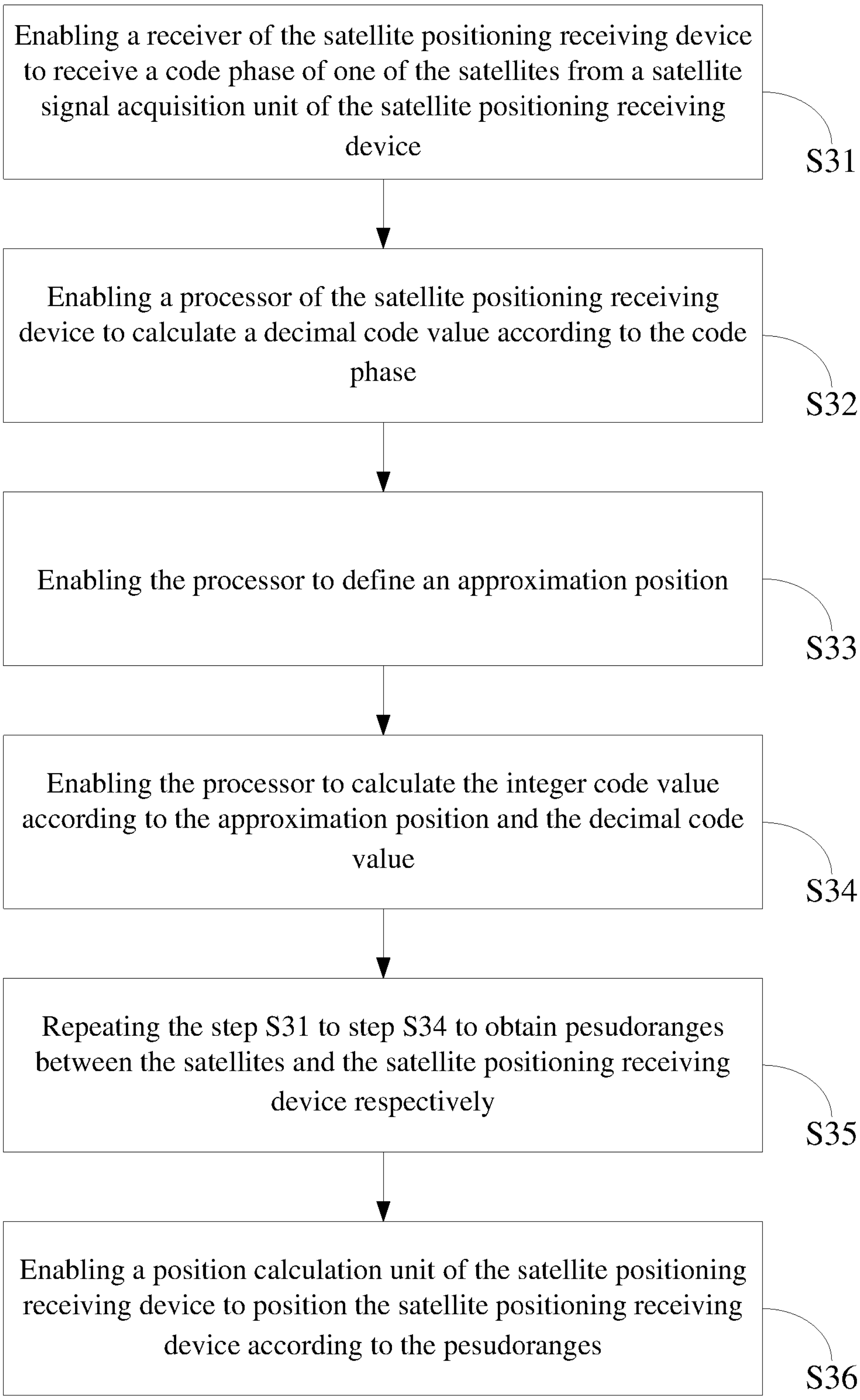
Enabling a receiver of the satellite positioning receiving device to receive a code phase of one of the satellites from a satellite signal acquisition unit of the satellite positioning receiving device
S31
Enabling a processor of the satellite positioning receiving device to calculate a decimal code value according to the code phase
S32
Enabling the processor to define an approximation position
S33
Enabling the processor to calculate the integer code value according to the approximation position and the decimal code value
S34
Repeating the step S31 to step S34 to obtain pesudoranges between the satellites and the satellite positioning receiving device respectively
S35
Enabling a position calculation unit of the satellite positioning receiving device to position the satellite positioning receiving device according to the pesudoranges
S36

FIG. 3

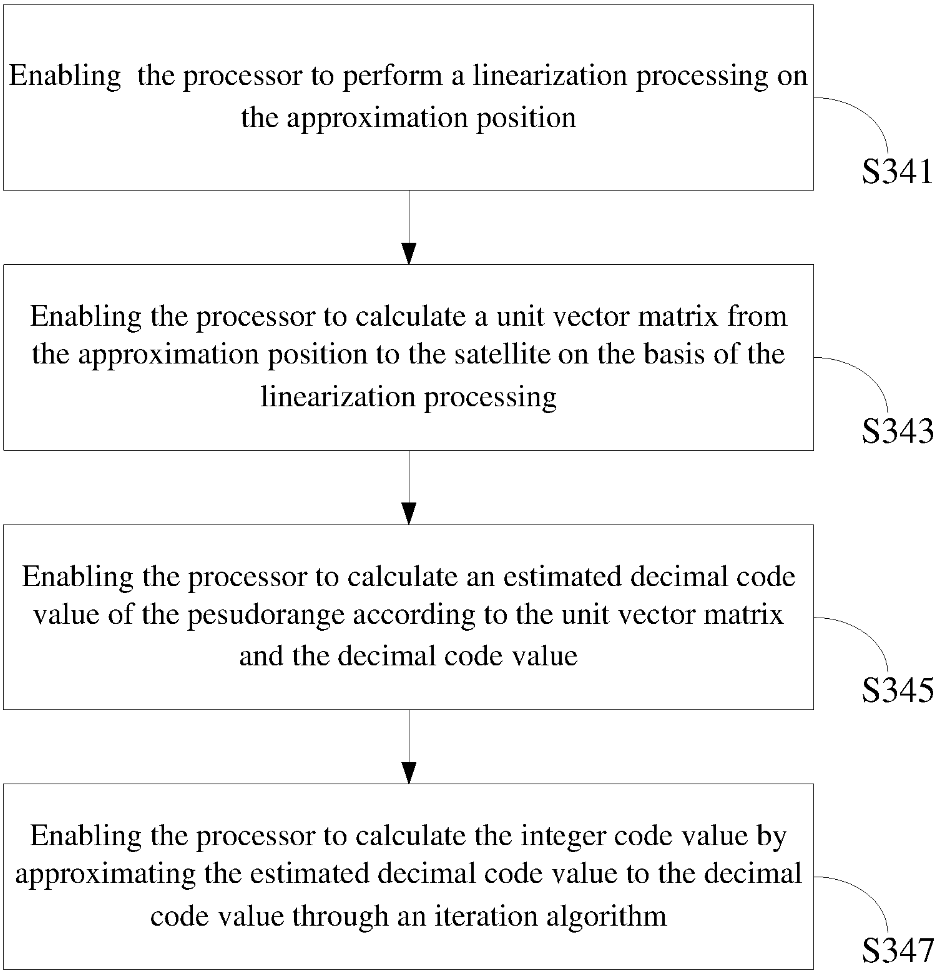
Enabling the processor to perform a linearization processing on the approximation position
S341
Enabling the processor to calculate a unit vector matrix from the approximation position to the satellite on the basis of the linearization processing
S343
Enabling the processor to calculate an estimated decimal code value of the pesudorange according to the unit vector matrix and the decimal code value
S345
Enabling the processor to calculate the integer code value by approximating the estimated decimal code value to the decimal code value through an iteration algorithm
S347

FIG. 3A

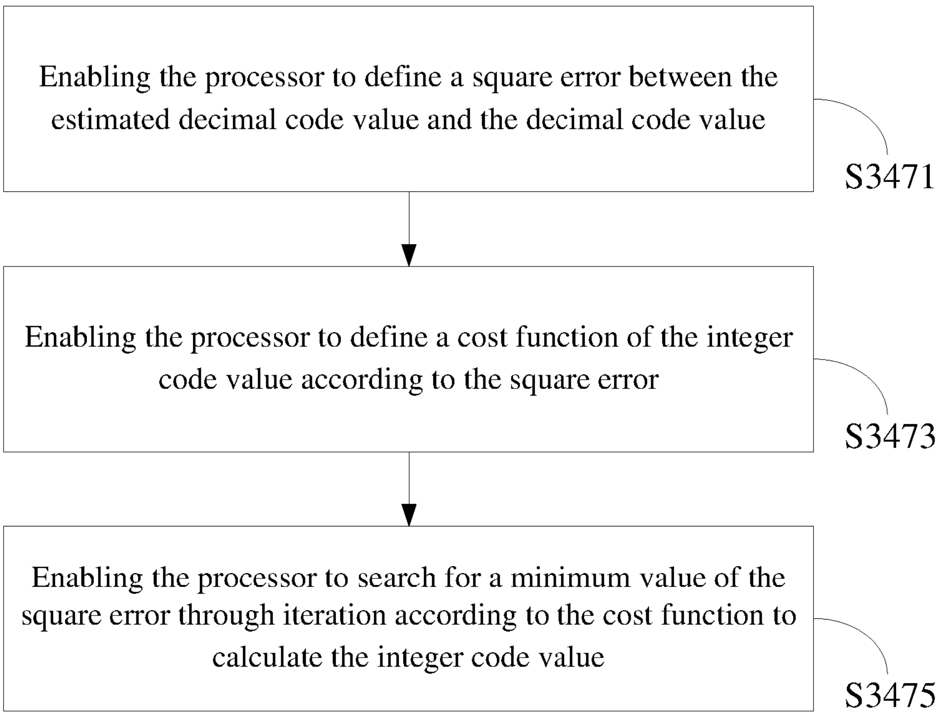
Enabling the processor to define a square error between the estimated decimal code value and the decimal code value
S3471
Enabling the processor to define a cost function of the integer code value according to the square error
S3473
Enabling the processor to search for a minimum value of the square error through iteration according to the cost function to calculate the integer code value
S3475

FIG. 3B

Agentschap NL
Ministerie van Economische Zaken

OCTROOIAANVRAAG NR.:
NO 138672
NL 2010840

ONDERZOEKSRAPPORT

BETREFFENDE HET RESULTAAT VAN HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

RELEVANTE LITERATUUR

Categorie[1]	Literatuur met, voor zover nodig, aanduiding van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr:	Classificatie (IPC)
X	WO 01/14903 A1 (TRIMBLE NAVIGATION LTD [US]) 1 maart 2001 (2001-03-01)	1,5,9	INV. G01S19/30 G01S19/42
Y	* samenvatting * * bladzijde 9, laatste alinea - bladzijde 11, alinea 3 * * bladzijde 15, alinea 1 - laatste alinea *	2,4,6,8, 10,12	

Y	US 6 417 801 B1 (VAN DIGGELEN FRANK [US]) 9 juli 2002 (2002-07-09)	2,4,6,8, 10,12	
A	* samenvatting * * kolom 6, regel 37 - kolom 8, regel 5 *	1,5,9	

A	US 2003/236621 A1 (SIROLA NIILO [FI] ET AL) 25 december 2003 (2003-12-25) * samenvatting * * alineas [0016], [0026] *	3,7,11	

A	US 4 797 677 A (MACDORAN PETER F [US] ET AL) 10 januari 1989 (1989-01-10) * samenvatting * * kolom 2, regel 16 - regel 62 * * kolom 7, regel 8 - regel 46 *	1,4,5,8, 9,12	Onderzochte gebieden van de techniek: G01S

Indien gewijzigde conclusies zijn ingediend, heeft dit rapport betrekking op de conclusies ingediend op:

Plaats van onderzoek:	Datum waarop het onderzoek werd voltooid:	Bevoegd ambtenaar:
's-Gravenhage	11 november 2013	Roost, Joseph

[1] CATEGORIE VAN DE VERMELDE LITERATUUR

X: de conclusie wordt als niet nieuw of niet inventief beschouwd ten opzichte van deze literatuur
Y: de conclusie wordt als niet inventief beschouwd ten opzichte van de combinatie van deze literatuur met andere geciteerde literatuur van dezelfde categorie, waarbij de combinatie voor de vakman voor de hand liggend wordt geacht
A: niet tot de categorie X of Y behorende literatuur die de stand van de techniek beschrijft
O: niet-schriftelijke stand van de techniek
P: tussen de voorrangsdatum en de indieningsdatum gepubliceerde literatuur
T: na de indieningsdatum of de voorrangsdatum gepubliceerde literatuur die niet bezwarend is voor de octrooiaanvrage, maar wordt vermeld ter verheldering van de theorie of het principe dat ten grondslag ligt aan de uitvinding
E: eerdere octrooi(aanvrage), gepubliceerd op of na de indieningsdatum, waarin dezelfde uitvinding wordt beschreven
D: in de octrooiaanvrage vermeld
L: om andere redenen vermelde literatuur
&: lid van dezelfde octrooifamilie of overeenkomstige octrooipublicatie

AANHANGSEL BEHORENDE BIJ HET RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK, UITGEVOERD IN DE OCTROOIAANVRAGE NR.

NO 138672
NL 2010840

Het aanhangsel bevat een opgave van elders gepubliceerde octrooiaanvragen of octrooien (zogenaamde leden van dezelfde octrooifamilie), die overeenkomen met octrooischriften genoemd in het rapport.
De opgave is samengesteld aan de hand van gegevens uit het computerbestand van het Europees Octrooibureau per
De juistheid en volledigheid van deze opgave wordt noch door het Europees Octrooibureau, noch door het Bureau voor de Industriële eigendom gegarandeerd; de gegevens worden verstrekt voor informatiedoeleinden.

11-11-2013

In het rapport genoemd octrooigeschrift	Datum van publicatie	Overeenkomend(e) geschrift(en)	Datum van publicatie
WO 0114903 A1	01-03-2001	US 6191731 B1	20-02-2001
		WO 0114903 A1	01-03-2001
US 6417801 B1	09-07-2002	AT 484758 T	15-10-2010
		EP 1334371 A2	13-08-2003
		EP 2256510 A2	01-12-2010
		JP 2004518135 A	17-06-2004
		US 6417801 B1	09-07-2002
		US 2003052817 A1	20-03-2003
		WO 02059634 A2	01-08-2002
US 2003236621 A1	25-12-2003	AU 2002304371 A1	02-12-2003
		BR 0215711 A	22-02-2005
		CA 2485601 A1	27-11-2003
		CN 1625697 A	08-06-2005
		EP 1506430 A1	16-02-2005
		JP 2005526251 A	02-09-2005
		US 2003236621 A1	25-12-2003
		WO 03098259 A1	27-11-2003
US 4797677 A	10-01-1989	GEEN	

OCTROOICENTRUM NEDERLAND

SCHRIFTELIJKE OPINIE

DOSSIER NUMMER	INDIENINGSDATUM	VOORRANGSDATUM	AANVRAAGNUMMER
NO138672	22.05.2013	05.12.2012	NL2010840
CLASSIFICATIE INV. G01S19/30 G01S19/42			
AANVRAGER Institute For Information Industry			

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☒ Onderdeel I Basis van de schriftelijke opinie
- ☐ Onderdeel II Voorrang
- ☐ Onderdeel III Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☐ Onderdeel IV De aanvraag heeft betrekking op meer dan één uitvinding
- ☒ Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI Andere geciteerde documenten
- ☐ Onderdeel VII Overige gebreken
- ☐ Onderdeel VIII Overige opmerkingen

	DE BEVOEGDE AMBTENAAR
	Roost, Joseph

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2010840

Onderdeel I Basis van de Schriftelijke Opinie

1. Deze schriftelijke opinie is opgesteld op basis van de meest recente conclusies ingediend voor aanvang van het onderzoek.

2. Met betrekking tot **nucleotide en/of aminozuur sequenties** die genoemd worden in de aanvraag en relevant zijn voor de uitvinding zoals beschreven in de conclusies, is dit onderzoek gedaan op basis van:

   a. type materiaal:

   ☐ sequentie opsomming

   ☐ tabel met betrekking tot de sequentie lijst

   b. vorm van het materiaal:

   ☐ op papier

   ☐ in elektronische vorm

   c. moment van indiening/aanlevering:

   ☐ opgenomen in de aanvraag zoals ingediend

   ☐ samen met de aanvraag elektronisch ingediend

   ☐ later aangeleverd voor het onderzoek

3. ☐ In geval er meer dan één versie of kopie van een sequentie opsomming of tabel met betrekking op een sequentie is ingediend of aangeleverd, zijn de benodigde verklaringen ingediend dat de informatie in de latere of additionele kopieën identiek is aan de aanvraag zoals ingediend of niet meer informatie bevatten dan de aanvraag zoals oorspronkelijk werd ingediend.

4. Overige opmerkingen:

Aanvraag nr.:

SCHRIFTELIJKE OPINIE

NL2010840

Onderdeel V Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid

1. Verklaring

Nieuwheid	Ja:	Conclusies	2-4, 6-8, 10-12
	Nee:	Conclusies	1, 5, 9
Inventiviteit	Ja:	Conclusies	3, 7, 11
	Nee:	Conclusies	1, 2, 4-6, 8-10, 12
Industriële toepasbaarheid	Ja:	Conclusies	1-12
	Nee:	Conclusies	

2. Citaties en toelichting:

Zie aparte bladzijde

1 **Re Item V**

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1.1 Reference is made to the following documents:

D1 WO 01/14903 A1 (TRIMBLE NAVIGATION LTD [US]) 1 maart 2001 (2001-03-01)

D2 US 6 417 801 B1 (VAN DIGGELEN FRANK [US]) 9 juli 2002 (2002-07-09)

D3 US 2003/236621 A1 (SIROLA NIILO [FI] ET AL) 25 december 2003 (2003-12-25)

2 The present application does not meet the criteria of patentability, because the subject-matter of claims 1, 5, 9 is not new.

2.1 Document D1 discloses (see D1, abstract and page 11, paragraph 3):
a satellite pseudorange calculation apparatus, being configured to calculate a pesudorange between a satellite and a satellite positioning receiving device, and the pesudorange comprising an integer code value and a decimal code value, the satellite pesudorange calculation apparatus comprising:
a receiver, being configured to receive a code phase from a satellite signal acquisition unit; and
a processor electrically connected with the receiver, being configured to execute the following operations:
calculating the decimal code value according to the code phase;
defining an approximation position; and
calculating the integer code value according to the approximation position and the decimal code value.

2.2 Similarly, the corresponding satellite pseudorange calculation method according to claim 5 and the satellite positioning method according to claim 9 are not new, as they are also disclosed in D1.

3 Dependent claims 2-4, 6-8, 10-12 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, meet the requirements of novelty and/or inventive step, the reasons being as follows:
the features of these claims have already been employed for the same purpose in a similar apparatus/method (see D2 and D3). It would therefore be

obvious to the person skilled in the art to apply these features with corresponding effect to an apparatus/method according to D1, thus arriving at an apparatus/method according to claims 1, 5, 9.