

AUTOMATIC SATELLITE TRACKING METHOD AND APPARATUS, DEVICE, AND STORAGE MEDIUM

This application claims priority to Chinese Patent Application No. 202011247505.X filed with the China National Intellectual Property Administration (CNIPA) on Nov. 10, 2020, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present application relates to the technical field of satellite communications, for example, a method and an apparatus for automatically tracking a satellite, a device, and a storage medium.

BACKGROUND

With the continuous development of satellite television and satellite communications, automatic tracking satellite dishes face new challenges. For example, when an ocean-going vessel needs to access a global network, an antenna disposed on the vessel needs to be switched to a target satellite so that access to the global network is guaranteed. However, due to the harsh ocean environment, information provided through inertial navigation alone cannot ensure that the antenna can be switched to the target satellite quickly and stably. For another example, as low Earth orbit communications satellites on land become increasingly popular, an antenna disposed on a terminal also needs to be switched to a target satellite quickly and stably to implement low Earth orbit satellite communications. Since the automatic tracking satellite dishes have no pointing function, part of communication antennas in motion on the vessel rely on a compass of the vessel to acquire the azimuth of the bow. In this case, the installation and debugging of an antenna are very cumbersome since a position of the antenna needs to be aligned with the direction of the bow. Communication antennas in static on the ground rely on a magnetometer to acquire a heading angle. Every time the magnetometer is disturbed, it needs to be recalibrated, causing inconvenience for the usage of the antennas.

SUMMARY

The present application provides a method and an apparatus for automatically tracking a satellite, a device, and a storage medium so that an automatic tracking satellite dish can track a target satellite quickly and accurately.

A method for automatically tracking a satellite is provided, including the steps described below.

Geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two global navigation satellite system (GNSS) antennas are determined according to radio frequency signals of the two GNSS antennas.

5 A current azimuth angle of a main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas.

A current elevation angle of the main lobe of the automatic tracking satellite dish is determined.

The main lobe of the automatic tracking satellite dish is adjusted to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

10 An apparatus for automatically tracking a satellite is further provided, including a first angle determination module, a second angle determination module, a third angle determination module, and an adjustment module.

The first angle determination module is configured to determine geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two
15 GNSS antennas according to radio frequency signals of the two GNSS antennas.

The second angle determination module is configured to determine a current azimuth angle of a main lobe of the automatic tracking satellite dish according to the azimuth angle of the line between the two GNSS antennas.

20 The third angle determination module is configured to determine a current elevation angle of the main lobe of the automatic tracking satellite dish.

The adjustment module is configured to adjust the main lobe of the automatic tracking satellite dish to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

25 An electronic device is further provided, including one or more processors and a storage apparatus.

The storage apparatus is configured to store one or more programs.

The one or more programs are executed by the one or more processors to cause the one or more processors to perform the preceding method for automatically tracking a satellite.

5 A computer-readable storage medium is further provided. The computer-readable storage medium stores a computer program, where the computer program, when executed by a processor, implements the preceding method for automatically tracking a satellite.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a view of a device for automatically tracking a satellite according to an embodiment of the present application.

10 FIG. 2 is a flowchart of a method for automatically tracking a satellite according to an embodiment of the present application.

FIG. 3 is a flowchart of another method for automatically tracking a satellite according to an embodiment of the present application.

FIG. 4 is a structure diagram of an apparatus for automatically tracking a satellite according to an embodiment of the present application.

15 FIG. 5 is a block diagram of an electronic device according to an embodiment of the present application.

DETAILED DESCRIPTION

Technical solutions in embodiments of the present application are described below in conjunction with drawings in the embodiments of the present application.

20 Before the embodiments of the present application are described, a device for automatically tracking a satellite according to an embodiment of the present application is introduced. FIG. 1 is a view of a device for automatically tracking a satellite according to an embodiment of the present application. As shown in FIG. 1, the device for automatically tracking a satellite includes an automatic tracking satellite dish 110, a GNSS signal processor 120, and two GNSS
25 antennas 130. The two GNSS antennas 130 are connected to the GNSS signal processor 120, and the automatic tracking satellite dish 110 is connected to the GNSS signal processor 120. A projection of a line between the two GNSS antennas 130 on a horizontal plane is perpendicular

to a main lobe of the automatic tracking satellite dish 110. Optionally, the GNSS signal processor 120 may be configured in an electronic device performing a method for automatically tracking a satellite according to an embodiment of the present application.

Embodiment one

5 FIG. 2 is a flowchart of a method for automatically tracking a satellite according to an embodiment of the present application. This embodiment is applicable to the case where an automatic tracking satellite dish is used for receiving a satellite signal in a global navigation satellite system. The method for automatically tracking a satellite according to this embodiment may be performed by an apparatus for automatically tracking a satellite according to an
10 embodiment of the present application. The apparatus may be implemented by software and/or hardware and integrated in an electronic device performing the method.

Referring to FIG. 2, the method of this embodiment includes, but is not limited to, the steps below.

15 In S210, geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two GNSS antennas are determined according to radio frequency signals of the two GNSS antennas.

The GNSS broadly refers to all satellite navigation systems, such as the Global Positioning System (GPS) of the United States, GLONASS of Russia, Galileo of Europe, and the BeiDou Navigation Satellite System of China. The geographic location information refers to longitude
20 and latitude information of a position where the automatic tracking satellite dish is located. GNSS antennas may be configured as transmitting antennas of a co-channel forwarding system. The azimuth angle of the line between the two GNSS antennas refers to a horizontal angle from the north end of the standard direction to the line between the two GNSS antennas in a clockwise direction, and the azimuth angle ranges from 0° to 360°.

25 In an embodiment of the present application, the radio frequency signals of the GNSS antennas are received by the two GNSS antennas. The radio frequency signals of the GNSS antennas received by the two GNSS antennas are processed by a GNSS signal processor and are converted into the geographic location information (longitude information and latitude information) of the automatic tracking satellite dish and the azimuth angle of the line between
30 the two GNSS antennas. The geographic location information of the automatic tracking satellite

dish and the azimuth angle of the line between the two GNSS antennas are sent to a main control chip of the automatic tracking satellite dish. Optionally, the main control chip may be configured in the electronic device performing the method for automatically tracking a satellite according to the embodiment of the present application.

- 5 Optionally, the geographic location information of the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS antennas may be determined according to the radio frequency signals of the two GNSS antennas by using a carrier phase differential technique. The carrier phase differential technique is also known as integrated Doppler. A carrier phase is a cumulative phase of navigation satellite signal carriers measured after the
10 GNSS signal processor is started.

In an embodiment of the present application, the GNSS signal processor can support the carrier phase differential technique using a real-time kinematic (RTK) algorithm. The carrier phase differential technique can utilize the received radio frequency signals of the GNSS antennas to calculate the azimuth angle of the line between the two GNSS antennas and acquire the
15 geographic location information of the automatic tracking satellite dish at the same time. For example, the azimuth angle of the line between the two GNSS antennas is calculated through the RTK algorithm in the GNSS signal processor.

In S220, a current azimuth angle of a main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas.

- 20 In an embodiment of the present application, the current azimuth angle of the main lobe of the automatic tracking satellite dish may be determined according to a preset rotation direction, a preset rotation angle, and the azimuth angle of the line between the two GNSS antennas. Optionally, in this embodiment, the preset rotation direction may be clockwise or counterclockwise, and the preset rotation angle may be determined according to the preset
25 rotation direction. For example, if the preset rotation direction is clockwise, the preset rotation angle may be 90°.

After the main control chip of the automatic tracking satellite dish receives the azimuth angle of the line between the two GNSS antennas, the main control chip of the automatic tracking satellite dish rotates the azimuth angle of the line between the two GNSS antennas by the preset
30 rotation angle (for example, 90°) along the preset rotation direction (for example, clockwise) so that the current azimuth angle of the main lobe of the automatic tracking satellite dish can be

obtained.

In S230, a current elevation angle of the main lobe of the automatic tracking satellite dish is determined.

5 In an embodiment of the present application, the current elevation angle of the main lobe of the automatic tracking satellite dish may be determined according to an initial elevation position of the main lobe of the automatic tracking satellite dish or according to data information collected by an internal component of the automatic tracking satellite dish.

10 The current elevation angle of the main lobe of the automatic tracking satellite dish refers to a current inclined angle between the main lobe of the dish and a horizontal plane. The internal components of the automatic tracking satellite dish include a gyroscope, an accelerometer, and other components.

If the automatic tracking satellite dish is on flat ground, the current elevation angle of the main lobe of the automatic tracking satellite dish may be determined according to an initial position switch and the initial elevation position of the main lobe of the automatic tracking satellite dish.

15 If the automatic tracking satellite dish is on an ocean-going vessel, when a global network is accessed to, the current elevation angle of the main lobe of the automatic tracking satellite dish may be determined by using the gyroscope and the accelerometer of the internal components in the automatic tracking satellite dish.

20 In S240, the main lobe of the automatic tracking satellite dish is adjusted to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

The target satellite to be tracked may be a geosynchronous satellite or a low Earth orbit satellite.

25 In an embodiment of the present application, the location information of the target satellite may be acquired according to the main control chip of the automatic tracking satellite dish and an antenna controller.

Optionally, this step may be implemented by the two sub-steps described below.

In S2401, a target azimuth angle and a target elevation angle of the main lobe of the automatic tracking satellite dish when the main lobe of the automatic tracking satellite dish points to the

target satellite are calculated according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

5 In an embodiment of the present application, after receiving the geographic location information, the main control chip of the automatic tracking satellite dish calculates an azimuth angle and an elevation angle required for the main lobe of the automatic tracking satellite dish to point to the target satellite, that is, the target azimuth angle and the target elevation angle, according to the geographic location information, the location information of the target satellite to be tracked, and the current azimuth angle and the current elevation angle of the main lobe of the automatic tracking satellite dish. In the embodiment of the present application, the manner for calculating the azimuth angle and the elevation angle required for the main lobe of the automatic tracking satellite dish to point to the target satellite is not limited, and a calculation manner in the related art may be used.

15 Optionally, the location information of the target satellite may be input in an interaction manner such as a screen key or a computer. Optionally, the location information of the target satellite is built in the automatic tracking satellite dish.

In S2402, the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite according to the target azimuth angle and the target elevation angle.

20 In an embodiment of the present application, the main control chip of the automatic tracking satellite dish controls, according to the target azimuth angle and the target elevation angle, a motor to adjust the main lobe of the automatic tracking satellite dish in real time so that the main lobe of the automatic tracking satellite dish is aligned with the target satellite. The main control chip of the automatic tracking satellite dish communicates with a satellite signal strength detector of the dish so that the signal strength and the signal quality of the target satellite can be acquired. The main control chip of the automatic tracking satellite dish may further control, according to the signal strength and the signal quality of the target satellite, the motor to finely adjust the main lobe of the dish so that the main lobe of the automatic tracking satellite dish is aligned with a direction where the signal strength and the signal quality of the target satellite are highest. Through the preceding process, the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite, avoiding the problem in the related art where an automatic tracking satellite dish is prone to lock a side lobe of the dish falsely.

In an embodiment, a projection of the line between the two GNSS antennas on the horizontal plane is perpendicular to the main lobe of the automatic tracking satellite dish, where the length of the projection of the line between the two GNSS antennas on the horizontal plane is greater than a preset distance.

- 5 In an embodiment of the present application, optionally, the preset distance may be 0.3 m. The length of the projection of the line between the two GNSS antennas on the horizontal plane is greater than the preset distance. The greater the length of the projection, the more accurate the azimuth angle of the line between the two GNSS antennas can be. Generally, the automatic tracking satellite dish is a parabolic or flat-panel antenna, so the projection of the line between
10 the two GNSS antennas on the horizontal plane is configured to be perpendicular to the main lobe of the automatic tracking satellite dish. In this manner, it is more convenient to install a device for automatically tracking a satellite and the target satellite can be tracked quickly and accurately.

- According to the technical solutions in this embodiment, the geographic location information of
15 the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS antennas are determined according to the radio frequency signals of the two GNSS antennas; the current azimuth angle of the main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas; the current elevation angle of the main lobe of the automatic tracking satellite dish is determined; and the
20 main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle. According to the embodiment of the present application, the automatic tracking satellite dish can track the target satellite quickly and accurately, solving the problems of a slow search and switching
25 speed and proneness to false locking of the automatic tracking satellite dish and improving the stability and practicability of a system for automatically tracking a satellite.

Embodiment two

- FIG. 3 is a flowchart of another method for automatically tracking a satellite according to an embodiment of the present application. This embodiment of the present application is described
30 based on the preceding embodiment. Optionally, the process of how the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite is explained and illustrated in this embodiment.

Referring to FIG. 3, the method of this embodiment includes, but is not limited to, the steps below.

5 In S310, geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two GNSS antennas are determined according to radio frequency signals of the two GNSS antennas.

In S320, a current azimuth angle of a main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas.

In S330, a current elevation angle of the main lobe of the automatic tracking satellite dish is determined.

10 In 340, the main lobe of the automatic tracking satellite dish is adjusted to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

15 In 350, the signal strength of the target satellite is searched for within a preset range, and the main lobe of the automatic tracking satellite dish is adjusted to point at an azimuth angle corresponding to a highest signal strength of the target satellite and an elevation angle corresponding to the highest signal strength of the target satellite.

The preset range refers to a range where the main lobe of the automatic tracking satellite dish is finely adjusted to the left or right with a target azimuth angle and a target elevation angle as the center.

20 In an embodiment of the present application, in the preceding step, that the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle belongs to a rough adjustment. Based on the rough adjustment, a fine adjustment in this step may be performed so
25 that the main lobe of the automatic tracking satellite dish points at the azimuth angle and the elevation angle corresponding to the highest signal strength of the target satellite. The signal strength of the target satellite is searched for within the preset range, and a main control chip of the automatic tracking satellite dish may further control a motor to finely adjust the main lobe of the dish so that the automatic tracking satellite dish receives the highest signal strength and

signal quality of the target satellite. Through the rough adjustment and the fine adjustment, the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite, avoiding the problem in the related art where an automatic tracking satellite dish is prone to lock a side lobe of the dish falsely.

- 5 In S360, whether the main lobe of the automatic tracking satellite dish points to the target satellite is determined according to the signal strength and the signal quality of the target satellite found within a preset time range after an orientation of the main lobe of the automatic tracking satellite dish is adjusted.

10 In the embodiment of the present application, the rough adjustment and the fine adjustment are performed on the main lobe of the automatic tracking satellite dish in the preceding steps so that the main lobe of the automatic tracking satellite dish points at the azimuth angle and the elevation angle corresponding to the highest signal strength of the target satellite. At this time, whether the automatic tracking satellite dish finally locks the target satellite may be determined according to satellite signals received by the automatic tracking satellite dish within the preset
15 time range. Optionally, the preset time range may be set by a user.

Whether the main lobe of the automatic tracking satellite dish points to the target satellite is determined according to the signal strength and the signal quality of the target satellite found within the preset time range after the orientation of the main lobe of the automatic tracking satellite dish is adjusted. If the satellite signals received by the automatic tracking satellite dish
20 within the preset time range have good signal strength and signal quality, it indicates that the main lobe of the automatic tracking satellite dish is pointing to the target satellite; if the satellite signals received by the automatic tracking satellite dish within the preset time range have poor signal strength and signal quality, the azimuth angle and the elevation angle of the main lobe of the automatic tracking satellite dish are further adjusted until the satellite signals received by the
25 automatic tracking satellite dish have good signal strength and signal quality.

Optionally, a satellite signal strength detection module may be used for detecting the strengths and qualities of current satellite signals. Optionally, the satellite signal strength detection module may be configured in an electronic device performing the method for automatically tracking a satellite according to the embodiment of the present application.

- 30 According to the technical solutions in this embodiment, the geographic location information of the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS

antennas are determined according to the radio frequency signals of the two GNSS antennas; the current azimuth angle of the main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas; the current elevation angle of the main lobe of the automatic tracking satellite dish is determined; and the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle; the signal strength of the target satellite is searched for within the preset range, and the main lobe of the automatic tracking satellite dish is adjusted to point at the azimuth angle and the elevation angle corresponding to the highest signal strength of the target satellite; and whether the main lobe of the automatic tracking satellite dish points to the target satellite is determined according to the signal strength and the signal quality of the target satellite found within the preset time range after the orientation of the main lobe of the automatic tracking satellite dish is adjusted. In the embodiment of the present application, the rough adjustment and the fine adjustment are performed on the main lobe of the automatic tracking satellite dish so that the main lobe of the automatic tracking satellite dish points at the azimuth angle and the elevation angle corresponding to the highest signal strength of the target satellite. Moreover, whether the automatic tracking satellite dish finally locks the target satellite is determined according to the satellite signals received by the automatic tracking satellite dish. According to the embodiment of the present application, the automatic tracking satellite dish can track the target satellite quickly and accurately, solving the problems of a slow search and switching speed and proneness to false locking of the side lobe of the automatic tracking satellite dish and improving the stability and practicability of a system for automatically tracking a satellite.

Embodiment three

FIG. 4 is a structure diagram of an apparatus for automatically tracking a satellite according to an embodiment of the present application. As shown in FIG. 4, an apparatus 400 may include a first angle determination module 410, a second angle determination module 420, a third angle determination module 430, and an adjustment module 440.

The first angle determination module 410 is configured to determine geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two GNSS antennas according to radio frequency signals of the two GNSS antennas.

The second angle determination module 420 is configured to determine a current azimuth angle

of a main lobe of the automatic tracking satellite dish according to the azimuth angle of the line between the two GNSS antennas.

The third angle determination module 430 is configured to determine a current elevation angle of the main lobe of the automatic tracking satellite dish.

- 5 The adjustment module 440 is configured to adjust the main lobe of the automatic tracking satellite dish to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

- 10 The adjustment module 440 is configured to calculate a target azimuth angle and a target elevation angle of the main lobe of the automatic tracking satellite dish when the main lobe of the automatic tracking satellite dish points to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle; and adjust the main lobe of the automatic tracking satellite dish to point to the target satellite according to the target azimuth angle and the
15 target elevation angle.

Optionally, the first angle determination module 410 is configured to determine the geographic location information of the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS antennas according to the radio frequency signals of the two GNSS antennas by using a carrier phase differential technique.

- 20 Optionally, the second angle determination module 420 is configured to determine the current azimuth angle of the main lobe of the automatic tracking satellite dish according to a preset rotation direction, a preset rotation angle, and the azimuth angle of the line between the two GNSS antennas.

- 25 Optionally, the third angle determination module 430 is configured to determine the current elevation angle of the main lobe of the automatic tracking satellite dish according to an initial elevation position of the main lobe of the automatic tracking satellite dish or data information collected by an internal component of the automatic tracking satellite dish.

The apparatus 400 for automatically tracking a satellite may further include a second adjustment module.

The second adjustment module is configured to search for the signal strength of the target satellite within a preset range and adjust the main lobe of the automatic tracking satellite dish to point at an azimuth angle and an elevation angle corresponding to a highest signal strength of the target satellite.

- 5 The apparatus 400 for automatically tracking a satellite may further include a determination module.

The determination module is configured to determine whether the main lobe of the automatic tracking satellite dish points to the target satellite according to the signal strength and the signal quality of the target satellite found within a preset time range after an orientation of the main
10 lobe of the automatic tracking satellite dish is adjusted.

Optionally, a projection of the line between the two GNSS antennas on a horizontal plane is perpendicular to the main lobe of the automatic tracking satellite dish, where the length of the projection of the line between the two GNSS antennas on the horizontal plane is greater than a preset distance.

- 15 The apparatus for automatically tracking a satellite according to this embodiment is applicable to the method for automatically tracking a satellite according to any preceding embodiment and has functions and effects corresponding to the method.

Embodiment four

- 20 According to embodiments of the present application, the present application further provides an electronic device and a readable storage medium.

FIG. 5 is a block diagram of an electronic device according to an embodiment of the present application. The electronic device is intended to represent various forms of digital computers, for example, a laptop computer, a desktop computer, a worktable, a personal digital assistant, a server, a blade server, a mainframe computer, or other applicable computers. Electronic devices
25 may also represent various forms of mobile apparatuses, for example, a personal digital assistant, a cellphone, a smartphone, a wearable device, or other similar computing apparatuses. Herein the shown components, the connections and relationships between these components, and the functions of these components are illustrative only and are not intended to limit the implementation of the present application as described and/or claimed herein.

As shown in FIG. 5, the electronic device includes one or more processors 510, a memory 520, and an interface configured to be connected to components, where the interface includes a high-speed interface and a low-speed interface. The components are connected to each other by different buses and may be mounted on a common mainboard or in other manners as desired.

5 The processor 510 may process instructions executed in the electronic device, including instructions stored in the memory 520 or instructions for displaying graphic information of a graphical user interface (GUI) on an external input/output apparatus (such as a display device coupled to the interface). In other implementations, if required, multiple processors 510 and/or multiple buses may be used with multiple memories 520. Similarly, multiple electronic devices
10 may be connected to provide some necessary operations (for example, as a server array, a set of blade servers, or a multi-processor system). FIG. 5 shows one processor 510 as an example.

The memory 520 is a non-transitory computer-readable storage medium provided in the present application. The memory stores instructions executable by at least one processor 510 to cause the at least one processor 510 to perform the method for automatically tracking a satellite in the
15 present application. The non-transitory computer-readable storage medium of the present application stores computer instructions for causing a computer to perform the method for automatically tracking a satellite in the present application.

The memory 520, as a non-transitory computer-readable storage medium, may be configured to store a non-transitory software program, a non-transitory computer-executable program, and
20 modules, for example, program instructions/modules corresponding to the method for automatically tracking a satellite in the embodiment of the present application (for example, the first angle determination module 410, the second angle determination module 420, the third angle determination module 430, and the adjustment module 440 shown in FIG. 4). The processor 510 executes non-transitory software programs, instructions, and modules stored in
25 the memory 520 to execute various function applications and data processing of a server, that is, to implement the method for automatically tracking a satellite in the preceding method embodiments.

The memory 520 may include a program storage region and a data storage region, where the program storage region may store an operating system and an application program required by
30 at least one function; and the data storage region may store data created according to the use of the electronic device for automatically tracking a satellite. Additionally, the memory 520 may include a high-speed random-access memory and may also include a non-transient memory, for example, at least one disk memory, a flash memory, or another non-transient solid-state memory.

In some embodiments, the memory 520 optionally includes memories that are remotely disposed relative to the processor 510 and these remote memories may be connected to the electronic device for automatically tracking a satellite via a network. Examples of the preceding network include, but are not limited to, the Internet, an intranet, a local area network, a mobile communication network, and a combination thereof.

The electronic device for automatically tracking a satellite may further include an input apparatus 530 and an output apparatus 540. The processor 510, the memory 520, the input apparatus 530, and the output apparatus 540 may be connected by a bus or in other manners. FIG. 5 shows the connection by a bus as an example.

The input apparatus 530 may receive input number or character information and generate key signal input related to user settings and function control of the electronic device for automatically tracking a satellite. The input apparatus 560 may be, for example, a touchscreen, a keypad, a mouse, a trackpad, a touchpad, a pointing stick, one or more mouse buttons, a trackball, or a joystick. The output apparatus 540 may include a display device, an auxiliary lighting device (for example, a light-emitting diode (LED)), or a haptic feedback device (for example, a vibration motor). The display device may include, but is not limited to, a liquid-crystal display (LCD), a light-emitting diode (LED) display, or a plasma display. In some embodiments, the display device may be a touchscreen.

Various embodiments of the systems and techniques described herein may be implemented in digital electronic circuitry, integrated circuitry, application-specific integrated circuit (ASIC), computer hardware, firmware, software, and/or combinations thereof. The various embodiments may include implementations in one or more computer programs. The one or more computer programs are executable and/or interpretable on a programmable system including at least one programmable processor. The programmable processor may be a special-purpose or general-purpose programmable processor for receiving data and instructions from a memory system, at least one input apparatus and at least one output apparatus and transmitting data and instructions to the memory system, the at least one input apparatus and the at least one output apparatus.

These computing programs (also referred to as programs, software, software applications, or codes) include machine instructions of a programmable processor. These computing programs may be implemented in a high-level procedural and/or object-oriented programming language and/or in an assembly/machine language. As used herein, the term "machine-readable medium"

or "computer-readable medium" refers to any computer program product, device, and/or apparatus (for example, a magnetic disk, an optical disk, a memory, or a programmable logic device (PLD)) for providing machine instructions and/or data for a programmable processor, including a machine-readable medium for receiving machine instructions as machine-readable signals. The term "machine-readable signal" refers to any signal for providing machine instructions and/or data for a programmable processor.

In order that interaction with a user is provided, the systems and techniques described herein may be implemented on a computer. The computer has a display apparatus (for example, a cathode-ray tube (CRT) or a LCD monitor) for displaying information to the user; and a keyboard and a pointing apparatus (for example, a mouse or a trackball) through which the user can provide input to the computer. Other types of apparatus may also be used for providing interaction with a user. For example, feedback provided for the user may be sensory feedback in any form (for example, visual feedback, auditory feedback, or tactile feedback); and input from the user may be received in any form (including acoustic input, voice input, or haptic input).

The systems and techniques described herein may be implemented in a computing system including a back-end component (for example, a data server), a computing system including a middleware component (for example, an application server), a computing system including a front-end component (for example, a client computer having a graphical user interface or a web browser through which a user can interact with embodiments of the systems and techniques described herein), or a computing system including any combination of such back-end, middleware or front-end components. Components of a system may be interconnected by any form or medium of digital data communication (for example, a communication network). Examples of the communication network include a local area network (LAN), a wide area network (WAN), the Internet, and a blockchain network.

A computer system may include clients and servers. A client and a server are generally remote from each other and typically interact through a communication network. The relationship between the client and the server arises by virtue of computer programs running on respective computers and having a client-server relationship to each other. The server may be a cloud server, also referred to as a cloud computing server or a cloud host. As a host product in a cloud computing service system, the server solves the defects of difficult management and weak service scalability in a conventional physical host and a virtual private server (VPS).

According to the technical solutions in this embodiment, the geographic location information of

the automatic tracking satellite dish and the azimuth angle of the line between two GNSS antennas are determined according to the radio frequency signals of the two GNSS antennas; the current azimuth angle of the main lobe of the automatic tracking satellite dish is determined according to the azimuth angle of the line between the two GNSS antennas; the current
5 elevation angle of the main lobe of the automatic tracking satellite dish is determined; and the main lobe of the automatic tracking satellite dish is adjusted to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle. According to
10 the embodiment of the present application, the automatic tracking satellite dish can track the target satellite quickly and accurately, solving the problems of a slow search and switch speed and proneness to falsely locking of the automatic tracking satellite and improving the stability and practicability of a system for automatically tracking a satellite.

Various units and modules included in the embodiment of the apparatus for automatically tracking a satellite are divided according to functional logic, and the division is not limited to
15 this as long as the corresponding functions can be implemented. In addition, the names of functional units are just intended for distinguishing between each other and are not to limit the scope of the present application.

Various forms of the preceding flows may be used, with steps reordered, added, or removed. For example, the steps described in the present application may be executed in parallel, in sequence,
20 or in a different order as long as the desired results of the technical solutions disclosed in the present application can be achieved. The execution sequence of these steps is not limited herein.

Claims

1. A method for automatically tracking a satellite, comprising:

determining geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two global navigation satellite system (GNSS) antennas according to radio frequency signals of the two GNSS antennas;

determining a current azimuth angle of a main lobe of the automatic tracking satellite dish according to the azimuth angle of the line between the two GNSS antennas;

determining a current elevation angle of the main lobe of the automatic tracking satellite dish; and

adjusting the main lobe of the automatic tracking satellite dish to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

2. The method according to claim 1, wherein adjusting the main lobe of the automatic tracking satellite dish to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle comprises:

calculating, according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle, a target azimuth angle of the main lobe of the automatic tracking satellite dish and a target elevation angle of the main lobe of the automatic tracking satellite dish when the main lobe of the automatic tracking satellite dish points to the target satellite; and

adjusting the main lobe of the automatic tracking satellite dish to point to the target satellite according to the target azimuth angle and the target elevation angle.

3. The method according to claim 1, wherein determining the geographic location information of the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS antennas according to the radio frequency signals of the two GNSS antennas comprises:

determining the geographic location information of the automatic tracking satellite dish and the azimuth angle of the line between the two GNSS antennas according to the radio frequency signals of the two GNSS antennas by using a carrier phase differential technique.

4. The method according to claim 1, wherein determining the current azimuth angle of the main lobe of the automatic tracking satellite dish according to the azimuth angle of the line between the two GNSS antennas comprises:

5 determining the current azimuth angle of the main lobe of the automatic tracking satellite dish according to a preset rotation direction, a preset rotation angle, and the azimuth angle of the line between the two GNSS antennas.

5. The method according to claim 1, wherein determining the current elevation angle of the main lobe of the automatic tracking satellite dish comprises:

10 determining the current elevation angle of the main lobe of the automatic tracking satellite dish according to an initial elevation position of the main lobe of the automatic tracking satellite dish or according to data information collected by an internal component of the automatic tracking satellite dish.

6. The method according to claim 1, after adjusting the main lobe of the automatic tracking satellite dish to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle, further comprising:

20 searching for a signal strength of the target satellite within a preset range and adjusting the main lobe of the automatic tracking satellite dish to point at an azimuth angle corresponding to a highest signal strength of the target satellite and an elevation angle corresponding to the highest signal strength of the target satellite.

7. The method according to claim 1, after adjusting the main lobe of the automatic tracking satellite dish to point to the target satellite to be tracked according to the location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle, further comprising:

25 determining whether the main lobe of the automatic tracking satellite dish points to the target satellite according to a signal strength of the target satellite and a signal quality of the target satellite that are found within a preset time range after an orientation of the main lobe of the automatic tracking satellite dish is adjusted.

8. The method according to any one of claims 1 to 7, wherein

30 a projection of the line between the two GNSS antennas on a horizontal plane is perpendicular to the main lobe of the automatic tracking satellite dish; and

a length of the projection of the line between the two GNSS antennas on the horizontal plane is greater than a preset distance.

9. An apparatus for automatically tracking a satellite, comprising:

5 a first angle determination module, which is configured to determine geographic location information of an automatic tracking satellite dish and an azimuth angle of a line between two global navigation satellite system (GNSS) antennas according to radio frequency signals of the two GNSS antennas;

10 a second angle determination module, which is configured to determine a current azimuth angle of a main lobe of the automatic tracking satellite dish according to the azimuth angle of the line between the two GNSS antennas;

a third angle determination module, which is configured to determine a current elevation angle of the main lobe of the automatic tracking satellite dish; and

15 an adjustment module, which is configured to adjust the main lobe of the automatic tracking satellite dish to point to a target satellite to be tracked according to location information of the target satellite to be tracked, the geographic location information, the current azimuth angle, and the current elevation angle.

10. An electronic device, comprising:

at least one processor; and

a storage apparatus, which is configured to store at least one program;

20 wherein the at least one program is executed by the at least one processor to cause the at least one processor to perform the method for automatically tracking a satellite according to any one of claims 1 to 8.

25 11. A computer-readable storage medium, which is configured to store a computer program, wherein the computer program, when executed by a processor, implements the method for automatically tracking a satellite according to any one of claims 1 to 8.