US009716314B2

(12) **United States Patent**
Anderson

(10) **Patent No.: US 9,716,314 B2**
(45) **Date of Patent: Jul. 25, 2017**

(54) **STEERING SYSTEMS AND METHODS**

(71) Applicant: **TAOGLAS GROUP HOLDINGS**, Enniscorthy, County Wexford (IE)

(72) Inventor: **Christopher M. Anderson**, Minneapolis, MN (US)

(73) Assignee: **TAOGLAS GROUP HOLDINGS**, Enniscorthy, County Wexford (IE)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 70 days.

(21) Appl. No.: **14/794,247**

(22) Filed: **Jul. 8, 2015**

(65) **Prior Publication Data**

US 2016/0336651 A1 Nov. 17, 2016

Related U.S. Application Data

(60) Provisional application No. 62/159,491, filed on May 11, 2015.

(51) **Int. Cl.**
G05B 11/32 (2006.01)
H01Q 3/08 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 3/08*** (2013.01); ***G05B 11/01*** (2013.01); ***H01Q 1/125*** (2013.01); *H01Q 1/1228* (2013.01); *H01Q 19/132* (2013.01)

(58) **Field of Classification Search**
CPC H01Q 3/08; G05B 11/01
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,296,862 A * 3/1994 Rodeffer H01Q 1/125 342/359
5,471,219 A * 11/1995 Rodeffer H01Q 1/125 342/359

(Continued)

FOREIGN PATENT DOCUMENTS

EP 1860404 A1 11/2007

OTHER PUBLICATIONS

Bursky, "RF Switches Simplify Multi-Antenna Systems", Aug. 23, 2012. http://www.digikey.com/en-US/articles/techzone/2012/aug/rf-switches-simplify-multi-antenna-systems.

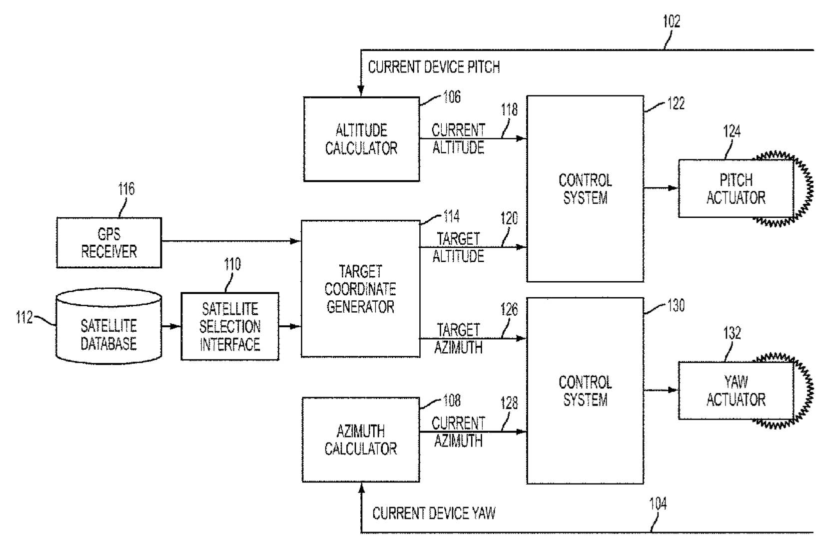
(Continued)

Primary Examiner — Erick Glass
(74) *Attorney, Agent, or Firm* — Shartsis Friese LLP; Cecily Anne O'Regan

(57) **ABSTRACT**

Disclosed are devices configurable with the location and motion of satellites can be configured to drive actuators connected to the motion of a steerable device. A steerable device may be augmented, for example, with gears or drivers to drive orientation, sensors to report current position and a mechanism to lock the device in place for the duration of the steering process such that power gears from the device mesh and can drive gears in the steerable device. Signals from the device intelligently guide the actuators to steer the orientation of the steerable device towards a satellite selected by a person or algorithm. Upon completion of the steering of steerable device by the device, the device can be detached, leaving the steerable device locked in place and fully functional as a steerable device, while also leaving the device capable if engaging with another similarly steerable device.

23 Claims, 7 Drawing Sheets



(51) **Int. Cl.**
H01Q 1/12 (2006.01)
G05B 11/01 (2006.01)
H01Q 19/13 (2006.01)

(58) **Field of Classification Search**
USPC 318/625
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,945,945	A *	8/1999	Wagner	H01Q 3/04 342/359
6,542,119	B2	4/2003	Howell et al.	
7,397,435	B2 *	7/2008	McEwan	H01Q 1/084 343/713
7,642,957	B2	1/2010	Lennen et al.	
7,786,933	B2	8/2010	Chang	
8,059,056	B2	11/2011	Ma et al.	
8,665,152	B1	3/2014	Kling et al.	
8,676,134	B2	3/2014	Mele et al.	
8,868,144	B2	10/2014	Shi	
2003/0107517	A1	6/2003	Ikeda et al.	
2008/0112468	A1	5/2008	Sheynblat et al.	
2011/0021166	A1	1/2011	Walley et al.	

OTHER PUBLICATIONS

LOCOSYS Technology Inc., LS20126 Stand-alone GPS with magnetic sensor smart antenna module. https://www.sparkfun.com/datasheets/GPS/Modules/LS20126_datasheet%20_VO.4%20-R.pdf.

Trimble, Antenna Companion Modules. http://www.trimble.com/embeddedsystems/antenna-companion-modules.aspx?dtID=overview.

* cited by examiner

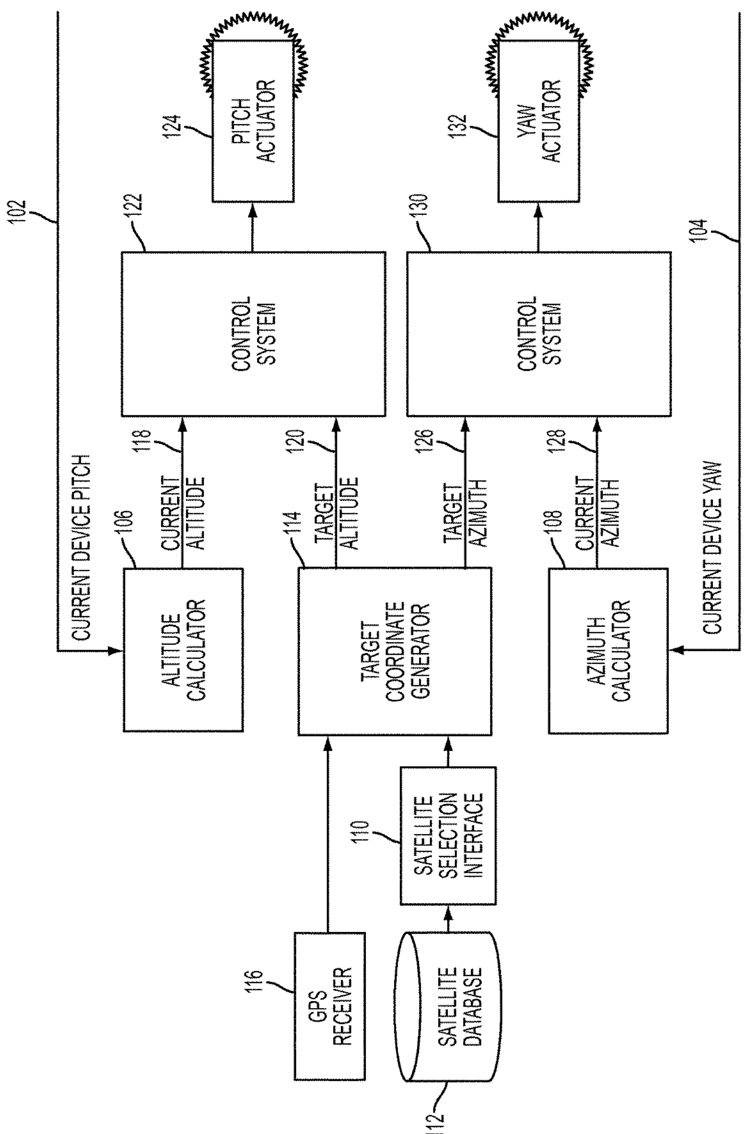

102
CURRENT DEVICE PITCH
106
ALTITUDE CALCULATOR
CURRENT ALTITUDE
118
122
CONTROL SYSTEM
124
PITCH ACTUATOR
116
GPS RECEIVER
112
SATELLITE DATABASE
110
SATELLITE SELECTION INTERFACE
114
TARGET COORDINATE GENERATOR
TARGET ALTITUDE
120
TARGET AZIMUTH
126
130
CONTROL SYSTEM
132
YAW ACTUATOR
108
AZIMUTH CALCULATOR
CURRENT AZIMUTH
128
104
CURRENT DEVICE YAW

FIG. 1

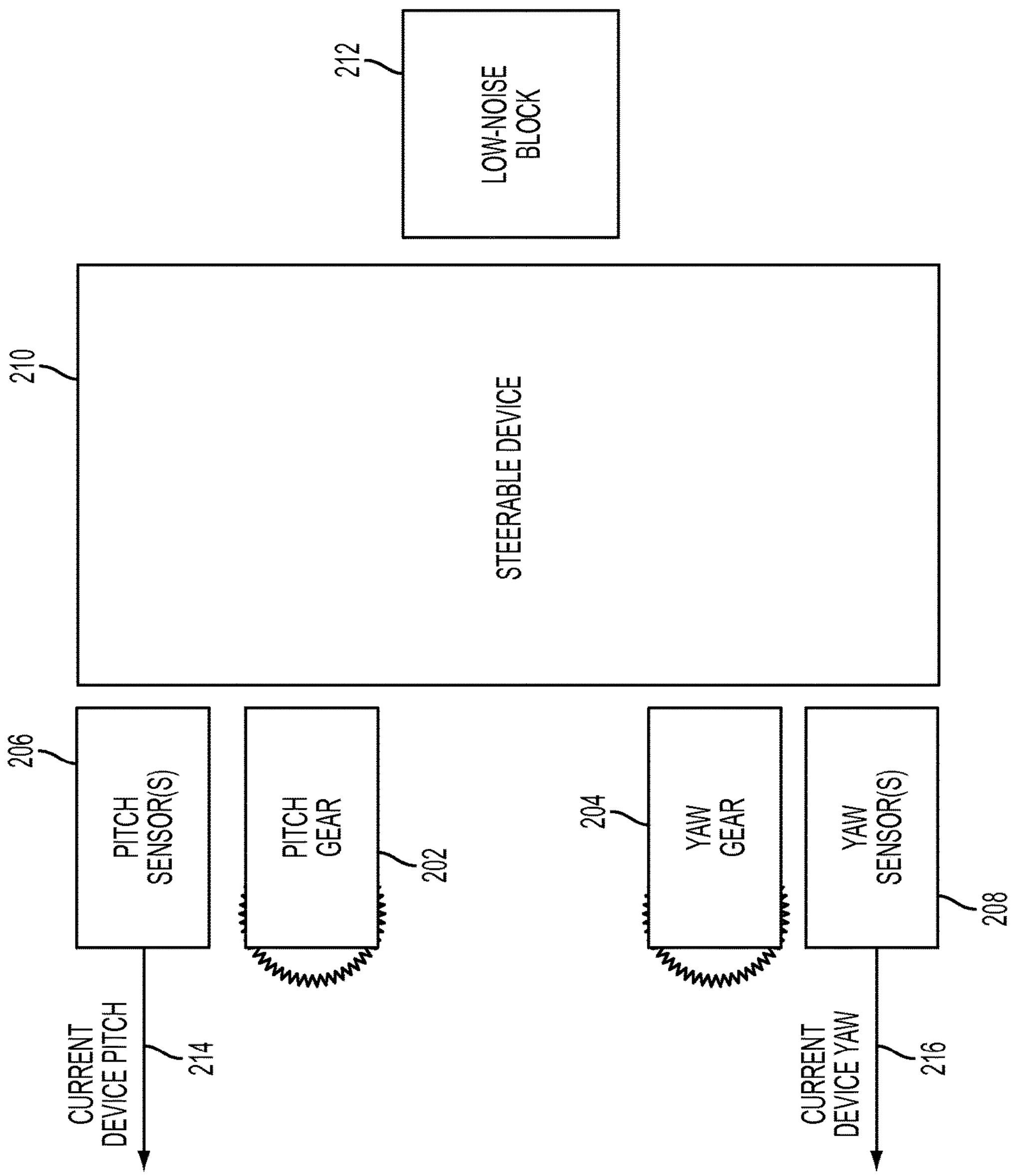

212
LOW-NOISE BLOCK
210
STEERABLE DEVICE
206
PITCH SENSOR(S)
PITCH GEAR
202
204
YAW GEAR
YAW SENSOR(S)
208
CURRENT DEVICE PITCH
214
CURRENT DEVICE YAW
216

FIG. 2

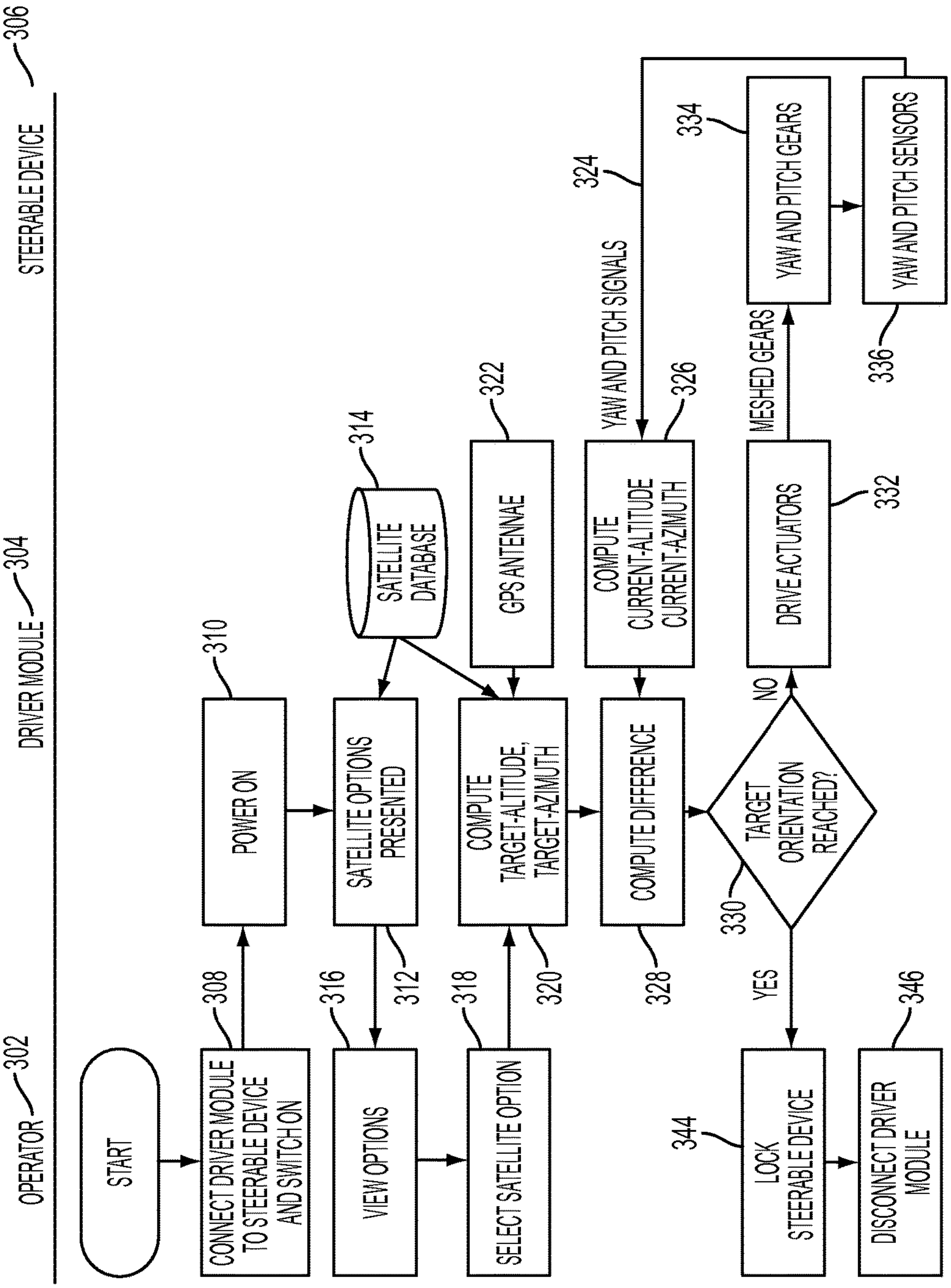

OPERATOR
302
DRIVER MODULE
304
STEERABLE DEVICE
306
START
CONNECT DRIVER MODULE TO STEERABLE DEVICE AND SWITCH ON
308
POWER ON
310
SATELLITE OPTIONS PRESENTED
312
SATELLITE DATABASE
314
VIEW OPTIONS
316
SELECT SATELLITE OPTION
318
COMPUTE TARGET-ALTITUDE, TARGET-AZIMUTH
320
GPS ANTENNAE
322
YAW AND PITCH SIGNALS
324
COMPUTE CURRENT-ALTITUDE CURRENT-AZIMUTH
326
COMPUTE DIFFERENCE
328
TARGET ORIENTATION REACHED?
330
NO
YES
DRIVE ACTUATORS
332
MESHED GEARS
YAW AND PITCH GEARS
334
YAW AND PITCH SENSORS
336
LOCK STEERABLE DEVICE
344
DISCONNECT DRIVER MODULE
346

FIG. 3

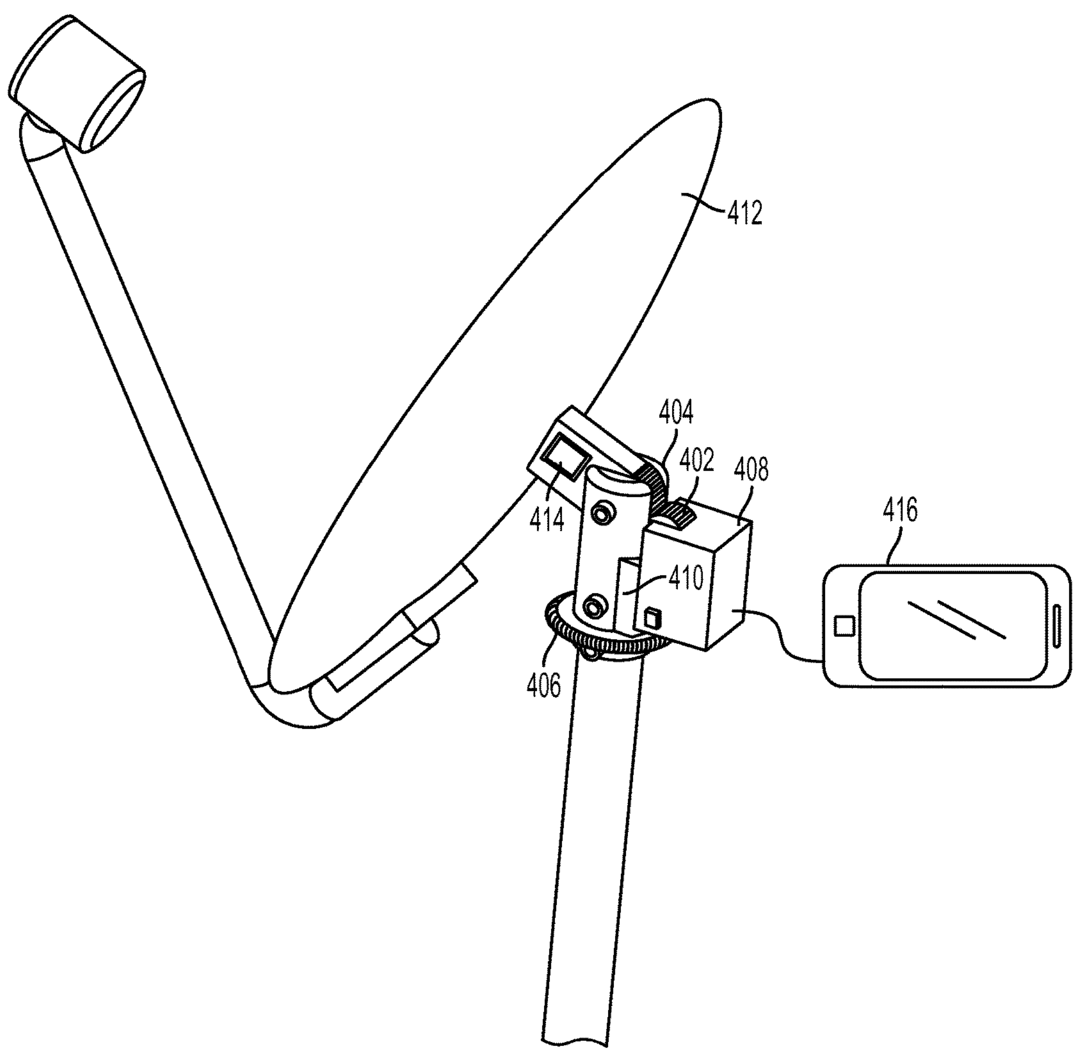


FIG. 4A

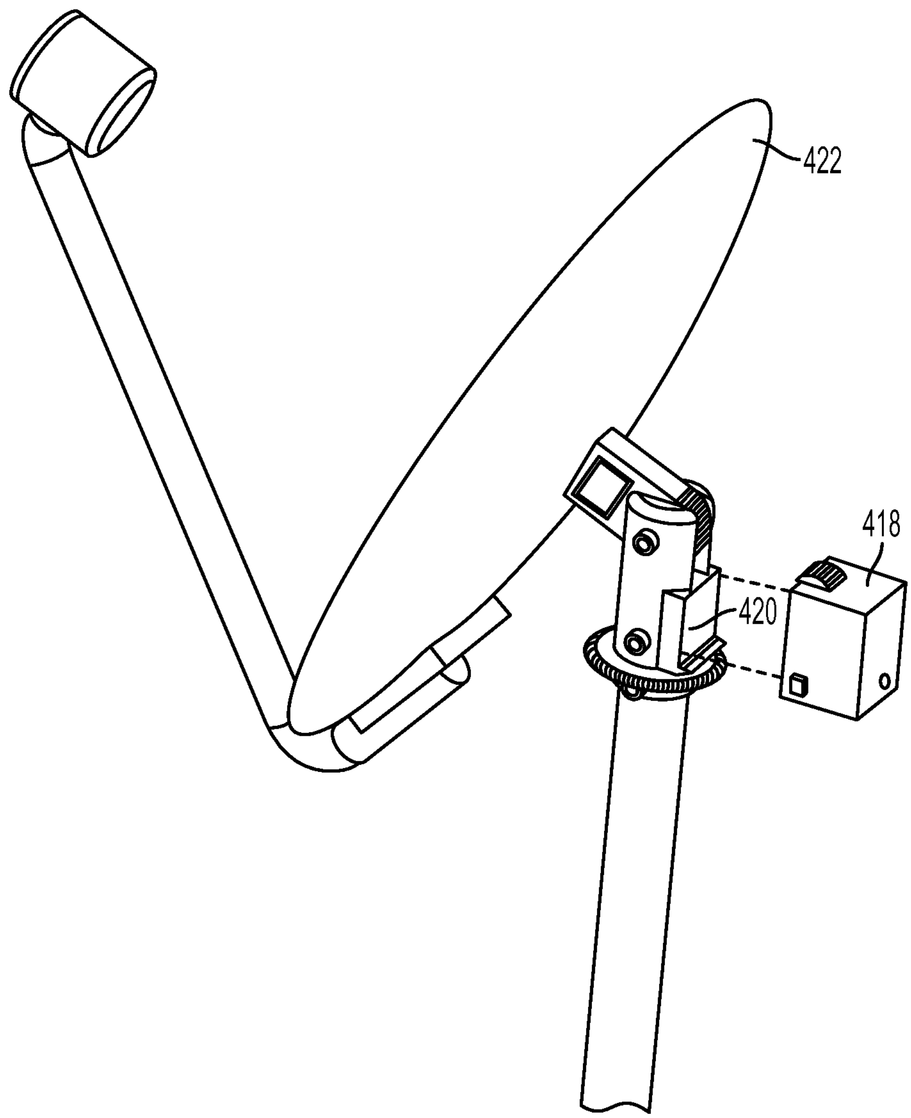


FIG. 4B

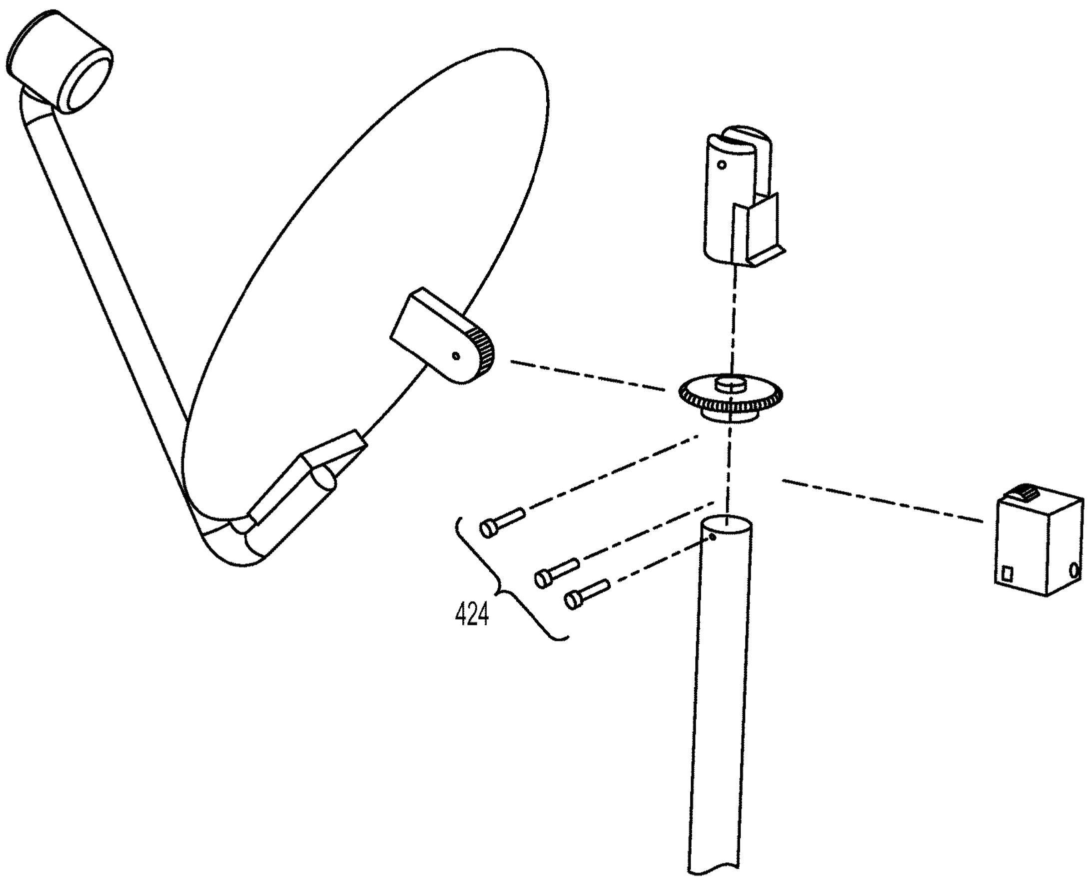
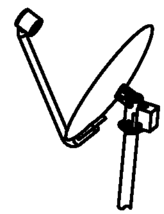
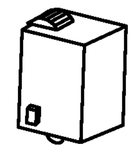
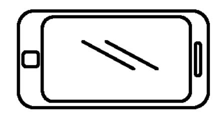


FIG. 4C







EXAMPLE VARIANTS	STEERABLE DEVICE	CUSTOM DEVICE	PORTABLE COMPUTING DEVICE
1	INTERNAL ACTUATORS		ALL LOGIC AND CONTROL
2		ACTUATORS	ALL LOGIC AND CONTROL
3	*INTERNAL ACTUATORS*	SOME LOGIC AND/OR CONTROL	SOME LOGIC AND/OR CONTROL
4		SOME LOGIC AND/OR CONTROL ACTUATORS	SOME LOGIC AND/OR CONTROL
5	INTERNAL ACTUATORS	ALL LOGIC AND CONTROL	
6		ALL LOGIC AND CONTROL ACTUATORS	

502 (row 2), 501 (row 6)

FIG. 5

STEERING SYSTEMS AND METHODS

CROSS-REFERENCE

This application claims the benefit of U.S. Provisional Application No. 62/159,491, filed May 11, 2015, entitled Steering Systems and Methods which application is incorporated herein by reference.

BACKGROUND

A variety of devices use steering systems. Steerable devices, such as antennas, are used for communication with a satellite in a geo-stationary orbit are either manually pointed by a human, or steered by use of a permanently attached steering apparatus. These antennas include, for example, satellite antennas and point terrestrial microwave antennas.

In many situations, such as used for satellite TV, the satellite dish is installed and pointed by a professional installation technician who has received expert training. The requirement for a trained technician to install the satellite dish adds significantly to the initial deployment cost for any commercial/consumer satellite system using geo-stationary satellites. Moreover, the steering apparatus and associated guidance system represent a great deal of cost. As will be appreciated by those skilled in the art, an expensive steering system to point a steerable device only once is wasteful and in many situations cost prohibitive. Other devices that rely on steering systems include, for example, telescopes and optical laser communication devices. What is needed is a way to install a steerable device which is optimized that is convenient and cost effective.

SUMMARY

An aspect of the disclosure is directed to steering systems. Steering systems comprise: a housing configurable to removably engage a steerable device; one or more drive actuators; and a controller configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to the one or more drive actuators. The steering system includes one or more drivers which drive a position of the steerable device. Drivers include, for example, gears, friction wheels, belts, chains or directly applied motors. Additionally, in at least some configurations, the steering system includes a user interface. The steering system can also be configurable to communicate with an external computing device having a user interface.

Another aspect of the disclosure is directed to methods for steering a steerable device. Suitable methods comprise: attaching a removable steering system housing to the steerable device; obtaining a position of a target orbiting satellite; generating a positional instruction; delivering a positional instruction to the steerable device; locking a position of the steerable device based on the generated positional instruction; and removing the steering system. Additionally, the method can include: instructing one or more drivers to drive a position of the steerable device from a first position to a second position. The instruction can be achieved manually by a user or automatically or semiautomatically from the system. Additionally, in some configurations, the target orbiting satellite can be selected from a list of available orbiting satellites. In some configurations, the method includes communicating with an external computing device.

Yet another aspect of the disclosure is directed to steerable device steering means. Suitable steerable device steering means comprise: a housing means configurable to removably engage a means for receiving a satellite signal; one or more drive actuators means; and a controller means configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to the one or more drive actuators means of the means for receiving the satellite signal. Additionally, the housing means is configurable to include one or more actuators means and one or more drivers means which drive a position of the means for receiving the satellite signal. In still other configurations, the steering system means includes a user interface means. The steering system means can also be configurable to communicate with an external computing device means.

Still another aspect of the disclosure is directed to methods for steering a means for receiving a satellite signal. Suitable methods comprise: attaching a removable steering system housing means to the means for receiving a satellite signal; obtaining a position of a target orbiting satellite; generating a positional instruction; delivering a positional instruction to the means for receiving a satellite signal; locking a position of the means for receiving a satellite signal based on the generated positional instruction; and removing the steering system means Additional steps can include one or more of instructing one or more positioning means to drive a position of the means for receiving the satellite signal from a first position to a second position; selecting the target orbiting satellite from a list of available orbiting satellites; and communicating with an external computing device means.

Another aspect of the disclosure is directed to steerable device systems. Systems comprise: a steerable device having one or more internal actuators; a steering system having a housing configurable to removably engage the steerable device; one or more drive actuators in communication with the one or more internal actuators of the steerable device; and a controller configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to one or more drive actuators of the steering system. The steering system housing can include one or more drivers which drive a position of the steerable device. The steering system can also include a user interface. In at least some configurations, the steering system is configurable to communicate with an external computing device having a user interface.

Yet another aspect of the disclosure is directed to steering systems. Steering systems comprise: a portable computing device having a GPS sensor and a compass sensor configurable to removably engage a steerable device; a controller configurable generate a positional instruction wherein the positional instruction is provided to at least one of a user and one or more drive actuators of the steerable device. The housing can include one or more actuators and one or more drivers which drive a position of the steerable device. Additionally, the steering system is configurable to communicate with a remote computing device.

INCORPORATION BY REFERENCE

All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference. References include: U.S. Pat. No. 6,542,119 B2 issued Apr. 1, 2003, to Howell, et al., for GPS Antenna Array; U.S. Pat. No. 7,786,933 B2 issued Aug. 31, 2010, to Chang, et al., for Digital Beam-Forming Apparatus and Technique for a

Multi-Beam Global Positioning System (GPS) Receiver; U.S. Pat. No. 8,059,056 B2 issued Nov. 15, 2011 to Ma, et al., for Directional Antenna and Portable Electronic Device Using the Same; U.S. Pat. No. 8,676,134 B2 issued Mar. 18, 2014, to Mele for Highly Reliable Receiver Front-End; U.S. Pat. No. 8,665,152 B1 issued Mar. 4, 2014, to Kling et al., for Enhancing Reception of Signals in Global Positioning System (GPS) Receiver Module; U.S. Pat. No. 8,868,144 B2 issued Oct. 21, 2014, to Shi for Smart Antenna System Using Orientation Sensors; US 2011/0021166 A1 published Jan. 27, 2011 to Walley et al. for Method and System for Antenna Diversity with Global Navigation Satellite Systems; US 2008/0112468 A1 published May 15, 2008 to Sheynblat, et al., for Apparatus and Method for Sensor-Based Wireless Receive Diversity; and EP 1860404 A1 published Nov. 28, 2007 to Shing et al. for GPS Product.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features of the invention are set forth with particularity in the appended claims. A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

FIG. **1** is a block diagram of sub-systems comprising a driver module, including sensor signals, processing components and operation of driver gears driven by controlled actuators;

FIG. **2** is a block diagram of sub-systems comprising the steerable device, including yaw and pitch gears which manipulate the steerable device, as well as the yaw and pitch sensors;

FIG. **3** illustrates the flow and operating functions of one implementation of the removable steering system, showing flow by which an operator, driver module and steerable device may interact;

FIG. **4**A illustrates a removable steering system when driver module is installed and engaged with an antenna; the image shows one embodiment of how a coupling mechanism on the antenna can hold and keep the driver module in place during steering;

FIG. **4**B illustrates a driver module decoupled from the antenna;

FIG. **4**C illustrates a locking mechanism in the antenna, once the steering process is complete; and

FIG. **5** is a table of design variants concerning the placement of logic, control and actuators.

DETAILED DESCRIPTION

Disclosed is a removable steering system configurable to engage a steerable device, such as an antenna, wherein a removable driver module is configurable for use one or more times to steer the steerable device towards a satellite signal source. Once the steerable device has been successfully steered by the driver module, the orientation of the steerable device can be locked in place and the driver module removed.

The removable driver module may then be used on any other steerable device configured to communicate with a removable driver module. As would be appreciated by those skilled in the art, additional components can be added to the steerable device. These additional components can provide additional functionality, including the ability for gears or other mechanical translational devices, to manipulate the pitch and yaw of the steerable device, sensors to measure the pitch and yaw, and also a coupling mechanism to mechanically engage the device driver for at least the duration of steering to a preset orientation. Friction, vibration, gas/liquid pistons or any other suitable mechanism can be used to move the steerable device without departing from the scope of the disclosure.

I. Driver Module

FIG. **1** is a block diagram of sub-components of a driver module according to the disclosure. The driver module is configurable to receive one or more raw sensor inputs. Raw sensor inputs include, for example, current steerable device pitch input **102** and current steerable device yaw input **104** which are receivable from the steerable device. Each raw sensor input, current steerable device pitch input **102** and current steerable device yaw input **104**, may not be in a form which immediately reports a steerable device coordinate. Thus, the steerable device pitch input **102** can feed into a current altitude calculator **106** which is configurable to compute a current altitude and provide a current-altitude output **118** of the steerable device. As will be appreciated by those skilled in the art, an algorithm by which the current altitude calculator **106** maps the current steerable device pitch input **102** into a current-altitude output **118** can depend on the nature and format of the raw sensor data of the current steerable device pitch input **102**. For example, the current steerable device pitch input **102** may be a raw accelerometer output, in order to minimize cost and complexity of the steerable device. The current altitude calculator **106** can then be configurable, in this example, to map raw accelerometer readings to compute the current-altitude output **118**.

Current steerable device yaw input **104** feeds into current azimuth calculator **108** which uses current steerable device yaw input **104** as an input to compute and generate a current azimuth output **128** of the steerable device. The algorithm by which the current azimuth calculator **108** maps the current steerable device yaw input **104** into a current-azimuth output **128** will depend on the nature and format of the raw sensor data of the current steerable device yaw input **104**. In one implementation, by example, the current steerable device yaw input **104** may comprise a fusion of sensor readings including magnetic compass and a calibrated, relative potentiometer reading. Both readings may be raw in order to minimize cost and complexity of the steerable device. The current azimuth calculator **108** can then be configured, in this example, to combine raw magnetometer readings with raw potentiometer readings to compute an accurate measure for the current-azimuth output **128**.

A satellite selection interface **110** may be configured to display options read or retrieved from a satellite database **112**. Each option pertains to specific geostationary satellite. An operator may select an option, thereby allowing selected satellite orbital data to be output to a target coordinate generator **114**. The target coordinate generator **114** in this embodiment receives GPS from a GPS receiver **116** which the target coordinate generator **114** utilizes to compute the target-altitude **120** and target-azimuth **126**.

In some configurations, a current-altitude output **118** and target-altitude output **120** are fed into a first control system **122** which utilizes a control strategy to drive a pitch actuator **124** such that current-altitude eventually converges with target-altitude as part of a closed control loop with the steerable device. The pitch actuator **124** in one embodiment contains a power gear which is used to drive a corresponding pitch gear in the steerable device when driver device is mechanically engaged with the steerable device. The pitch actuator **124** directly drives steerable device pitch and therefore the resulting output is sensed as feedback by way of the updated current steerable device pitch **102** as part of the control loop.

Similarly, in one embodiment, the current-azimuth output **128** and target-azimuth **126** are fed into a second control system **130** which utilizes a control strategy to drive a yaw actuator **132** such that current-azimuth eventually converges with target-azimuth as part of a closed control loop with the steerable device. The pitch actuator **124** in one embodiment contains a power gear which is used to drive a corresponding yaw gear when driver device is mechanically engaged with the steerable device. The yaw actuator **132** directly drives steerable device yaw and therefore the resulting output is sensed as feedback by way of the updated current steerable device yaw input **104** as part of the control loop.

In other configurations, current-azimuth output **128** and target-azimuth **126** result in an instruction generated for use by a user. The instruction can be in the form of one or more instructions for a user to steer the antenna to the optimal position in view of the data received. Thus, a user can select a target from a list or by giving detailed positional coordinates and a computing device, such as a mobile phone or tablet, can then use that information along with feedback from one or more of a compass, GPS, gyro and/or accelerometer in the computing device to provide instructions on which way to turn or elevate the steerable device and when the steerable device is optimally positioned.

An illustration of the driver module in various stages of engagement with a steerable device, such as an antenna, is provided in FIG. **4**A and FIG. **4**B. In FIG. **4**A, power gear from pitch actuator **402** can be seen driving pitch gear **404** of antenna **412**. A power gear from a yaw actuator, situated beneath the driver module, is shown engaging with the yaw gear **406** of the antenna **412**.

The mechanical coupling mechanism **410** is configurable to hold the actuators of the driver module **408** in place such that the gears from the driver module **408** and the antenna **412** can adequately mesh, allowing the driver module **408** actuators to steer the pitch and yaw of the antenna **412** to arrive at a target orientation. The target orientation is typically optimizable to provide the best satellite signal to the antenna.

In one aspect, the system is configurable so that a portable computing device, such as a tablet device **416**, is in communication with the driver module **408**. Where a portable computing device is utilized the portable computing device can be configured to implement part of the computation and control functions of the driver module **408**. In such a configuration, the driver module **408** then implements the mechanical translations required in the antenna **412**. Thus, the functions of the driver module **408** are implemented by combined action of the driver module **408** and the portable computing device, tablet **416**.

In another aspect, the system incorporates a computing device, such as a tablet device **416**, which is in communication with the driver module **408**. Where the computing device is incorporated in the system, the computing device is configurable to implement part of the computation and control functions of the driver module **408**. The driver module **408** then implements the mechanical translations required in the antenna **412**.

FIG. **4**B illustrates a driver module **418** detached from a mechanical coupling mechanism **420**, wherein the antenna **422** is configurable to remain completely operational as an antenna, locked in place, and driver module **418** is able to connect with and drive other antennas.

II. Steerable Device

In the description below, the example described includes a configuration wherein a gear is used for each degree of freedom with a steerable device. In other configurations, pulleys, hydraulics, pneumatics or other mechanical translational devices and means might alternatively be employed to effect the same movements in the steerable device, where the steerable device is, for example, a satellite dish, telescope, optical laser communication device, satellite antennas, point terrestrial microwave antennas, or any other device that benefits from being steered.

In one example, one gear is configurable to correspond to pitch movement of the satellite dish and another gear is configurable to correspond to yaw movement. Each gear is actuatable by a mechanical translation which causes the parabolic satellite dish to steer towards a desired target altitude and azimuth of the selected satellite. One or more controllers may be used to control the movement of the pitch gear (i.e., the gear that rotates about an X axis) and the yaw gear (i.e., the gear that rotates about a Y axis).

FIG. **2** illustrates a block diagram of electro-mechanical sub-components of a steerable device. Movement of a pitch gear **202** is translatable to mechanical movement of the upward-tilting pitch of the parabolic steerable device **210**. The pitch of the steerable device **210** can be sensed by one or more current pitch sensors **206**. The one or more pitch sensors **206** are configurable to output a steerable device pitch signal **214**, which can, in turn, be input into a driver module when connected to the steerable device. In some configurations, the current pitch sensor **206** is configurable to use an accelerometer to obtain a measure for absolute pitch position. The steerable device pitch signal **214** may, for example, be the raw accelerometer output, in order to minimize cost and complexity of the steerable device. Additionally, the steerable device pitch signal **214** can be provided dynamically in real-time, or near real time.

Movement of a yaw gear **204** translates to mechanical movement of a side-to-side yaw of the steerable device **210**. The yaw of the steerable device **210** is sensed by one or more yaw sensors **208**, which are configurable to output a steerable device yaw signal **216**, which can, in turn, be input into the driver module when connected to the steerable device. Additionally, the steerable device yaw signal **216** can be provided dynamically in real-time, or near real time. Additionally, the steerable device yaw signal **216** may comprise, for example, a fusion of sensor readings including magnetic compass and a calibrated, relative potentiometer reading. Both readings may be raw in order to minimize cost and complexity of the steerable device.

Also connectable to the steerable device **210** is a low noise block **212** making the unit a functional steerable device.

Additional features of a suitable steerable device, such as a satellite dish, are illustrated in the visual schematic of the satellite dish in FIG. **4**A. A driver module can be implemented by the combined actions of actuator device **408** and portable computing device such as tablet **416**. Actuator device **408** drives pitch gear **404** effecting a controlled change in pitch of the satellite dish toward the target pitch dictated by the driver module. Actuator device **408** also drives yaw gear **406** effecting a controlled change in yaw of the satellite dish toward the target yaw dictated by the driver module. Sensors for yaw and pitch are housed in a sensor patch **414** which sends sensory data back to the device module.

Turning now to FIG. **4**B, an illustration of a coupling mechanism **420** that permits the driving actuators from the driver module **418** to disengage with the gears and frame of the satellite dish **422** is provided. Upon disengagement, **422** remains locked and fully functional as a satellite dish and **418** retains the capability of engaging with and driving other satellite dishes.

FIG. **4**C illustrates a suitable locking mechanism for the satellite dish. In this example, three bolts **424** are shown to constrain yaw and pitch movements once the target orientation has been achieved. Other implementations may include variations of automatic and manual locking mechanisms.

III. Operation and Use of a Removable Steering System

FIG. **3** provides an illustration of a flow of a removable steering system, by way of an interaction diagram between three entities: an operator (or user) **302**, a driver module **304** and a steerable device **306**. As will be appreciated by those skilled in the art, the user can interact with a portable computing device and a driver module separately.

In step **308** an operator **302** commences the steering process by connecting the driver module **304** to a steerable device **306**, unlocking the steerable device **306** and switching on the driver module **304**. Driver module powers on **310** and, from a listing in connected satellite database **314**, presents an interface of available options of satellites to steer the steerable device to **312**. If there is just one satellite option, a simple confirmation button may be pressed by **302** to commence steering. Operator **302** views options **316** and selects desired satellite to steer to **318**. Driver module **304** looks up or returns orbital data for selected satellite and obtains a local GPS location, in this implementation from a GPS antenna **322**. The two data sources are combined to compute, relative to the position of the steerable device on the surface of the earth, a target-altitude and target-azimuth for the steerable device to align with the selected satellite **320**. Driver module **304** processes current yaw and pitch signals from the steerable device **324** to compute current-altitude and current-azimuth **326**.

A control loop is configurable to guide the steerable device to a target orientation. This can be implemented by the processes described herein. A difference between target coordinates from **320** and current coordinates from **326** is computed **328**. A check is made in case the target has been reached **330** and if not, an algorithm accordingly drives the actuators **332** which from **308** has its gears meshed with steerable device yaw and pitch gears **334**. Sensors measuring yaw and pitch **336** for the steerable device again are fed back **324** to the loop input to report current yaw and pitch orientation **326**, wherein the new difference is again computed **328** and a determination is made on whether target orientation has been reached **330**.

If target orientation has not been reached, the actuators **332** are again accordingly driven and the loop continues for another iteration back to **330**. If the target orientation, has been reached, that is, if current-altitude is considered sufficiently close to target-altitude and current-azimuth is considered sufficiently close to target-azimuth, then the steering process halts and the operator is alerted by way of a visual or auditory notification. The operator can then lock the steerable device **344** into a position and disconnect the driver module **346**.

IV. Examples

FIG. **5** illustrates by example that some implementations of the disclosure may involve actuators driving movement to be located in the steerable device, whereas in other implementations the actuators are provided in the driver module. The driver module may itself be partially or wholly composed of a smartphone, tablet or other commercially available configurable computing device and may also include a custom device implementing functionality not provided by the smartphone/tablet component.

Power to drive the actuators may originate from the smartphone/tablet, the custom device, or the steerable device.

For example, Variant 6 **501**, a custom device may implement in itself all the functionality of the driver module and also house the actuators.

In another example, Variant 2 **502**, the smartphone/tablet may implement most or all of the logic, control and user interface, while a connected custom device houses the actuators and is used to mechanically engage with the steerable device.

In another example, a portable electronic device, such as a smartphone or tablet, is mountable on the steerable device such that the internal accelerometer of the portable electronic device is used to sense or measure the current altitude and azimuth of the steerable device.

The systems and methods according to aspects of the disclosed subject matter may utilize a variety of computer and computing systems, communications devices, networks and/or digital/logic devices for operation. Each may, in turn, be configurable to utilize a suitable computing device that can be manufactured with, loaded with and/or fetch from some storage device, and then execute, instructions that cause the computing device to perform a method according to aspects of the disclosed subject matter.

A computing device can include without limitation a mobile user device such as a mobile phone, a smart phone and a cellular phone, a personal digital assistant ("PDA"), such as a BlackBerry®, iPhone®, a tablet, a laptop and the like. In at least some configurations, a user can execute a browser application over a network, such as the Internet, to view and interact with digital content, such as screen displays. A display includes, for example, an interface that allows a visual presentation of data from a computing device. Access could be over or partially over other forms of computing and/or communications networks. A user may access a web browser, e.g., to provide access to applications and data and other content located on a website or a webpage of a website.

A suitable computing device may include a processor to perform logic and other computing operations, e.g., a stand-alone computer processing unit ("CPU"), or hard wired logic as in a microcontroller, or a combination of both, and may execute instructions according to its operating system and the instructions to perform the steps of the method, or elements of the process. The user's computing device may be part of a network of computing devices and the methods of the disclosed subject matter may be performed by different computing devices associated with the network, perhaps in different physical locations, cooperating or otherwise interacting to perform a disclosed method. For example, a user's portable computing device may run an app alone or in conjunction with a remote computing device, such as a server on the Internet. For purposes of the present application, the term "computing device" includes any and all of the above discussed logic circuitry, communications devices and digital processing capabilities or combinations of these.

Certain embodiments of the disclosed subject matter may be described for illustrative purposes as steps of a method that may be executed on a computing device executing software, and illustrated, by way of example only, as a block diagram of a process flow. Such may also be considered as a software flow chart. Such block diagrams and like operational illustrations of a method performed or the operation of a computing device and any combination of blocks in a block diagram, can illustrate, as examples, software program code/instructions that can be provided to the computing device or at least abbreviated statements of the functionalities and operations performed by the computing device in executing the instructions. Some possible alternate implementation may involve the function, functionalities and operations noted in the blocks of a block diagram occurring out of the order noted in the block diagram, including occurring simultaneously or nearly so, or in another order or not occurring at all. Aspects of the disclosed subject matter may be implemented in parallel or seriatim in hardware, firmware, software or any combination(s) of these, co-located or remotely located, at least in part, from each other, e.g., in arrays or networks of computing devices, over interconnected networks, including the Internet, and the like.

The instructions may be stored on a suitable "machine readable medium" within a computing device or in communication with or otherwise accessible to the computing device. As used in the present application a machine readable medium is a tangible storage device and the instructions are stored in a non-transitory way. At the same time, during operation, the instructions may at some times be transitory, e.g., in transit from a remote storage device to a computing device over a communication link. However, when the machine readable medium is tangible and non-transitory, the instructions will be stored, for at least some period of time, in a memory storage device, such as a random access memory (RAM), read only memory (ROM), a magnetic or optical disc storage device, or the like, arrays and/or combinations of which may form a local cache memory, e.g., residing on a processor integrated circuit, a local main memory, e.g., housed within an enclosure for a processor of a computing device, a local electronic or disc hard drive, a remote storage location connected to a local server or a remote server access over a network, or the like. When so stored, the software will constitute a "machine readable medium," that is both tangible and stores the instructions in a non-transitory form. At a minimum, therefore, the machine readable medium storing instructions for execution on an associated computing device will be "tangible" and "non-transitory" at the time of execution of instructions by a processor of a computing device and when the instructions are being stored for subsequent access by a computing device.

While preferred embodiments of the present invention have been shown and described herein, it will be obvious to those skilled in the art that such embodiments are provided by way of example only. Numerous variations, changes, and substitutions will now occur to those skilled in the art without departing from the invention. It should be understood that various alternatives to the embodiments of the invention described herein may be employed in practicing the invention. It is intended that the following claims define the scope of the invention and that methods and structures within the scope of these claims and their equivalents be covered thereby.

What is claimed is:

1. A steering system comprising:
- a steerable device having steerable device actuators;
- a removable steering system housing configurable to removably engage the steerable device;
- one or more drive actuators in communication with the steerable device actuators; and
- a controller configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to the one or more drive actuators.

2. The steering system of **1** wherein the steering system includes one or more drivers which drive a position of the steerable device.

3. The steering system in **1** wherein the steering system includes a user interface.

4. The steering system in **1** wherein the steering system is configurable to communicate with an external computing device having a user interface.

5. A method for steering a steerable device comprising:
- attaching a removable steering system housing to the steerable device;
- obtaining a position of a target orbiting satellite;
- generating a positional instruction;
- delivering the positional instruction to the steerable device;
- locking a position of the steerable device based on the generated positional instruction; and
- removing the steering system.

6. The method for steering a steerable device of claim **5** comprising:
- instructing one or more drivers to drive a position of the steerable device from a first position to a second position.

7. The method for steering a steerable device of claim **5** comprising:
- selecting the target orbiting satellite from a list of available orbiting satellites.

8. The method for steering a steerable device of claim **5** comprising communicating with an external computing device.

9. A steerable device steering means comprising:
- a steerable device means for receiving a satellite signal having steerable device actuator means;
- a removable steering system housing means configurable to removably engage the steerable device actuator means for receiving the satellite signal;
- one or more drive actuators means in communication with the steerable device means; and
- a controller means configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to the one or more drive actuators means of the means for receiving the satellite signal.

10. The steering system means of **9** wherein the housing means includes one or more actuators means and one or more drivers means which drive a position of the means for receiving the satellite signal.

11. The steering system means of **9** wherein the steering system means includes a user interface means.

12. The steering system means in **9** wherein the steering system means is configurable to communicate with an external computing device means.

13. A method for steering a means for receiving a satellite signal comprising:

attaching a removable steering system housing means to the means for receiving a satellite signal;

obtaining a position of a target orbiting satellite;

generating a positional instruction;

delivering the positional instruction to the means for receiving a satellite signal;

locking a position of the means for receiving a satellite signal based on the generated positional instruction; and

removing the steering system means.

14. The method for steering the means for receiving the satellite signal of claim **13** comprising: instructing one or more positioning means to drive a position of the means for receiving the satellite signal from a first position to a second position.

15. The method for steering means for receiving the satellite signal of claim **13** comprising: selecting the target orbiting satellite from a list of available orbiting satellites.

16. The method for means for receiving the satellite signal of claim **13** comprising communicating with an external computing device means.

17. A steerable device system comprising:

a steerable device having one or more internal actuators;

a steering system having a housing configurable to removably engage the steerable device;

one or more drive actuators in communication with the one or more internal actuators of the steerable device; and

a controller configurable to receive a location and a motion of a target orbiting satellite and generate a positional instruction to one or more drive actuators of the steering system.

18. The steerable device system of **17** wherein the steering system housing includes one or more drivers which drive a position of the steerable device.

19. The steerable device system in **17** wherein the steering system includes a user interface.

20. The steerable device system in **17** wherein the steering system is configurable to communicate with an external computing device having a user interface.

21. A steering system comprising:

a portable computing device having a GPS sensor and a compass sensor;

a steerable device having one or more actuators configured to removably engage the portable computing device;

one or more drive actuators in communication with the one or more steering device actuators; and

a controller configurable receive data from the portable computing device and generate a positional instruction wherein the positional instruction is provided to at least one of a user and one or more drive actuators of the steerable device.

22. The steering system of **21** wherein the housing includes one or more actuators and one or more drivers which drive a position of the steerable device.

23. The steering system of **21** wherein the steering system is configurable to communicate with a remote computing device.

* * * * *