

An apparatus for pointing an instrument automatically
to a specified target

Field of the invention

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The present invention relates to an intelligent apparatus for pointing an instrument automatically to a planned and/or detected target.

Background of the Invention

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In the current modern world, a lot of human practices refer to track and point an instrument to a mobile target or an instrument on a mobile vehicle, such as car, ship and plane, to a fix or mobile target. The technologies and innovations on developing this kind of apparatus and instrument could be tracked back a century ago at least. However, an intelligent apparatus for this purpose are appearing in only 3 to 4 decades in defense and army industries and about a decade in civil industry. The usages of these apparatus are growing faster and wider obviously due to the accessibility of satellite based Global Positioning System (GPS) on personal device and civil industry.

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To date, only a few of such intelligent apparatus or instruments for this purpose are available in mainly army industry and some in special civil industry. There are two main reasons limiting this spread widely; firstly very wide technologies referred, including computer, IT, robotic technology, and intelligent navigation technology, and so on; secondly the higher cost of design due to its complexity, so blocking the value added to this application in civil industry. Therefore, the innovations and inventions to integrate related technologies into a practicable apparatus to meet the requirement of civil industry become a critical issue.

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Summary of the invention

- 5 The present invention aims to provide an intelligent apparatus for pointing an instrument, such as an antenna to receive and emit radio signals, to a specified target automatically.

10 In general, the present invention proposes an apparatus which comprises five functional modules:

- a robotic arm to hold and move the instrument;
- a Global Positioning System (GPS) signal receiver;
- a modem to enable the communication among the apparatus and user of the instrument;
- 15 • an Inertial Measurement Unit (IMU) together with a digital compass;
- a micro-processor based robotic controller to control the robotic arm and to process the signals from radio modem and IMU;

It is a GPS based apparatus, so could be working directly if the satellite signals are available. To be worked in somewhere without satellite signals such as in a building the apparatus has to be linked with a suitable Indoor Positioning System (IPS), which is not included in this invention.

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The apparatus may be used for pointing any instrument to a specified target for any usable applications, such as:

- 25 (a) Install on a ship with an antenna to receive the strongest signals from the ground stations;
- (b) Install on a ground station with an antenna to track and position a mobile target, such as a ship, a plane and a car.
- (c) Install on a car with an antenna to receive possible signals from nearest
- 30 signal stations.

(d) Install on any mobile vehicles, such as an Unmanned Aerial Vehicle (UAV) with a detecting instrument, such as a digital camera, to inspect the situation of specified targets.

5 (e) Install on a fixed station with a detecting instrument to track and inspect the situation of a mobile target.

Brief Description of the Figures

An embodiment of the invention will now be illustrated for the sake of examples only with reference to the following drawings, in which:

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Fig. 1(a) is a perspective view of an apparatus according to an embodiment of the present invention 100. It comprises with a dome 101 and support base 102 with the components 103 to 109 on it.

15 Fig. 1(b) is the perspective view of the apparatus 100 without covered by a dome 101 to present the components 103 to 109.

Figs. 2(a) – 2(j) are the perspective views of the components comprising the apparatus 100, including the dome 101, the support base 102, the antenna 103, the antenna support frame 104, the turning base 105, the splitter 106, the modem 107, the servo motor together with gear box and controller 108, the control and process unit 109 and the power supplier 110.

20 Fig. 3(a) is a perspective view of the apparatus 100 without covered by dome 101 and viewed from front direction. The pitch moving direction of antenna 103 on the shaft 301 supported by frame 104 and turned by 108 is shown by the arrow 302.

25 Fig. 3(b) is a perspective view of the apparatus 100 without covered by dome 101 and viewed from left direction. The roll direction of antenna together with the support frame is shown by arrow 303.

Fig. 3(c) is a perspective view of the apparatus 100 without covered by dome 101 and viewed from top direction;

Fig. 3(d) is a perspective view of the apparatus 100 without covered by dome 101 and viewed from bottom direction. The control and process unit 109 could be installed and dis-installed by four screws 306.

5 Fig. 4(a) is a perspective cross-sectional view of the apparatus 100 along the centre front plane from top to bottom. Two bearings 402 enable the antenna moving along pitch direction 302 smoothly. A round hole 404 enable a simple installation the apparatus on a round pipe.

10 Fig. 4(b) is a perspective cross-sectional view of the apparatus 100 along the center side plane from top to bottom. Two bearings 405 enable the antenna moving along roll direction 303 smoothly. Two screw holes 406 are for the tight he apparatus on the pipe.

Fig. 5 is a perspective view of ground stations 501 along the shore of Singapore and a ship 502 installed with the apparatus 100;

15 Fig. 6 is schematic view for an overview of electrical and electronic controlling and communicating system of the apparatus 100.

Detailed Description of the Embodiments

5 An apparatus 100 which is an embodiment of the invention will now be described with reference to Figs. 1 – 6. The apparatus 100 serves to point an antenna 103 to a planned or detected target automatically.

10 Fig. 1(b) is a perspective view of the apparatus 100 without covered by the dome 101. The apparatus 100 comprises ten components with perspective views of Figs. 2(a) to 2(j).

The dome 101 in the Fig 2(a) is made by fibre glass material with the painting to enable the radio signal passing through it easily. The shape of the dome is preferable on resisting any disturbs from environment such as wind and wave.
15 An L shape slot 201 at the bottom prevents the water splashed into the apparatus.

The support base 102 in the Fig 2(b) is function as a support for all of components in apparatus 100. There is a square closable window 202 on the
20 bottom to enable easy monitoring the operation of the apparatus 100 and easy maintenance and updating the system without the necessary of opening the dome 101. The installation block 203 with a round hole 404 provides an easy install mechanism such that the apparatus 100 could be installed on the ship to a matching pipe in minutes and then locking by two set screws only shown in
25 406 of Fig. 4.

The antenna 103 could be any one depending on the application. The size should be matching the antenna support frame 104.

30 The antenna support frame 104 is driving by a servo motor 108. It comprises by a U shape frame 205 and a turning shaft 204 support on the frame through two

bearings 407 on two ends. The worm gear 401 on the servo motor 108 prevents the position change of antenna in case of power off.

5 The support frame is integrated onto the turning base 105 by four screws. The centre slot and holes 402 enable the cables go in from them. Two bearings 405 on the two ends of the turning beam 206 provide a firm support to prevent sea wave disturbance.

10 The splitter 106 is for providing an additional output to other communication system, besides the signals into modem 107. The modem 107 could be any one, such as 3G or 4G modems, depending on the application.

15 The servo motor together with a worm gear box 108 is for driving the related mechanisms which carrying an instrument, such as antenna for the embodiment. The use of worm gear in the embodiment is for resisting the disturbance caused by sea wave or wind. An encode based controller together with servo controlling through potentiometer installed in the servo motor to provide accuracy and reliable driving mechanisms.

20 The most of electronic systems are built in component 109, including a microprocessor based digital device, robotic controller, a nine axis IMU together with a digital compass, a GPS signal receiver and related circuits. It is not including the modem which could be changed anytime, so easy to meet the requirement for more advanced IT systems, such as 4G and higher.

25 The whole perspective electronic and electrical system of apparatus 100 is presented in Fig.6. The switching DC power supplier 110 is a normal power supplier, which provides the power to related components as shown in Fig. 6.

30 The apparatus 100 serves as a computerized antenna system which is capable of pointing to any planned targets by turning the antenna 360° along the shaft

301 on pitch direction 302 and also turning the antenna 360° along the axis 304 on roll direction 303 at a higher accuracy.

5 The home plane which goes through axis 305 and axis in turning beam of the apparatus 100 has been set to pass the centre of IMU and digital compass. Therefore, any fixed target in the geographic space could be automatically detected and pointed by means of apparatus 100.

10 The targets 501 in Fig. 5 are the perspective ground stations of radio signals. The antenna installed in the apparatus on ship 502 can be pointed automatically to these stations or any points planned. The Received Signal Strength Indication (RSSI) enables the apparatus to identify sites with strongest signals and then build the sites into the system forming on a knowledge-based system. Therefore, the apparatus can point the antenna to the strongest ground station,
15 which may not be a nearest station due to some reasons, such as the ship blocked by another bigger ship.

The apparatus 100 provides a fully programmable procedure and a knowledge-based intelligent system and serves as a useful tool to enable an instrument or
20 tool to be pointed precisely to a specified target performing special task. The pointing procedure is carrying out automatically with higher speed and accuracy.

25 Many variants of the embodiment are possible within the scope of the invention, as will be clear to a skilled reader. For example, a further drive mechanism can be provided to turn the antenna rotating along its centre axis, i.e. yaw direction.

Claims

1. An intelligent apparatus for pointing an instrument to a planned or detected target, the device comprising:
 - 5 a device turning mechanism to turn the instrument along the pitch direction;
 - a device swing mechanism to turn the instrument along the roll direction;
 - a microprocessor based digital device to handle the intelligent and knowledge-based task with on board embedded and on-the-fly updated information;
 - 10 a robotic controller to control the driving mechanisms for pointing the instrument to specified target;
 - an inertial measurement unit or IMU with digital compass, gyroscopes, and accelerometers for position the instrument to specified target;
 - a satellite based Global Positioning System (GPS) to tracking and
 - 15 positioning the apparatus in geographic space;
 - a radio modem matching the signals for collect the signals and information;
 - a splitter to enable the signals received by the antenna output to the apparatus and the local network of user.
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2. An apparatus according to claim 1, wherein the north direction detected by the digital compass and IMU in geographic space is specified as a Ground Direction in relation to the home plane through the center of IMU.
- 25 3. An apparatus according to claim 1, wherein the turning mechanism comprises:
 - a support shaft with two bearings at the ends;
 - a U shape support frame enable the antenna go through the frame;
 - a servo motor together with a servo control card and potentiometer to
 - 30 drive the instrument 360° along the pitch direction;

4. An apparatus according to claims 1 and 3, wherein the support shaft driving by the servo motor through a worm gear box to prevent the move of instrument along the pitch direction in case the power is off.
- 5 5. An apparatus according to claim 1, wherein the swing mechanism comprises:
a support beam with two bearings at the top and bottom ends;
a servo motor together with a servo control card and potentiometer to drive the instrument 360° along the roll direction;
- 10 6. An apparatus according to claims 1 and 5, wherein the support beam driving by the servo motor through a worm gear box to prevent the move of instrument along the roll direction in case the power is off.
- 15 7. An apparatus according to claims 1 and 5, wherein a round slot through the rotating center together with two round holes at the sides to enable the cable goes through it.
8. An apparatus according to claim 1, wherein the target to be pointed is
20 decided by the RSSI detected by the apparatus.
9. An apparatus according to claim 1, wherein the dome made by the fiber glass with an L shape slot on the bottom to prevent water splashed into the apparatus.
- 25 10. An apparatus according to claim 1, wherein a window opened on the support base to enable of monitoring the movement of antenna.
11. An apparatus according to claim 1, wherein the robotic control unit is
30 integrated with a nine axis IMU together with a digital compass.

12. An apparatus according to claims 1 and 11, wherein the IMU is fixed on the support base with the home plane of the apparatus goes through the center of the IMU.
- 5 13. An apparatus according to claim 1, wherein the status of the apparatus are reported to owner through an internet protocol suit TCP/IP or SMS.
14. An apparatus according to claim 1, wherein the modem will be selected depending on the signal available.
- 10 15. An apparatus according to claim 1, wherein the target to be pointed can be planned and changed by following the position changes detected by the GPS.
- 15 16. An apparatus according to claim 1, wherein the new targets can be detected and validated by means of some detected parameters, such as RSSI.
17. An apparatus according to claims 1 and 16, wherein any of validated targets are saved in the system and then work as knowledge based system to
20 check and validate other targets.
18. An apparatus according to any preceding claim, wherein the driving mechanisms can be up to 64, depending on the application.
- 25 19. An apparatus according to any preceding claim, wherein the instrument can be installed on a ground station to point a mobile target.
20. An apparatus according to any preceding claim, wherein the instrument can be any tool and device to perform a special task on a specified target, fixed
30 one or mobile one.

21. An apparatus according to any preceding claim, wherein the target to be pointed can be one target or multi-targets to be pointed one by one, switching by the planned schedule.
- 5 22. An apparatus according to claim 21, wherein the schedule can be installed or updated through TCP/IP network anytime.
23. An apparatus according to any preceding claim, wherein the target can be re-specified by changing the control parameters through TCP/IP network
10 anytime.
24. An apparatus according to any preceding claim, wherein the system can be re-initialized at the control station through TCP/IP network anytime.
- 15 25. An apparatus according to any preceding claim, wherein the warning message can be sent back through SMS or TCP/IP network.