DIRECTIONAL ANTENNA AND SMART ANTENNA SYSTEM USING THE SAME

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ABSTRACT

The present invention discloses a directional antenna for a portable device. The directional antenna includes at least one antenna, disposed on a side of a display of the portable device, for utilizing a metal part of the display as a reflector to generate a directional radiation pattern.
DIRECTIONAL ANTENNA AND SMART ANTENNA SYSTEM USING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefits of U.S. Provisional Application No. 61/382,922, filed on Sep. 15, 2010 and entitled “SMART ANTENNA AND SYSTEM USING THE SAME”, U.S. Provisional Application No. 61/422,660, filed on Dec. 14, 2010 and entitled “SMART ANTENNA SYSTEM”, and U.S. Provisional Application No. 61/425,252, filed on Dec. 21, 2010 and entitled “PORTABLE DEVICE WITH SMART ANTENNA” the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to a directional antenna and smart antenna system using the same, and more particularly, to a directional antenna and smart antenna system using the same capable of utilizing a metal part of a display of a portable device as a reflector to generate a directional radiation pattern.

[0004] 2. Description of the Prior Art

[0005] Antenna design is crucial to a portable device with wireless communication function, such as wireless local area network (WLAN) or other mobile communication systems. In a conventional wireless communication device, one or a plurality of omni-directional antennas are used to receive radio signals from all directions. Antenna diversity technique is also used to determine which one or more omni-directional antennas should be used to receive or transmit signals. However, the efficiency and gain of omni directional antennas are not good enough. Hence, there’s a need for an antenna design that provides smarter and better receiving quality.

SUMMARY OF THE INVENTION

[0006] It is therefore an object of the present invention to provide a directional antenna and smart antenna system using the same capable of utilizing a metal part of a display of a portable device as a reflector to generate a directional radiation pattern.

[0007] The present invention discloses a directional antenna for a portable device. The directional antenna includes at least one antenna, disposed on a side of a display of the portable device, for utilizing a metal part of the display as a reflector to generate a directional radiation pattern.

[0008] The present invention further discloses a smart antenna system for a portable device. The smart antenna system includes a plurality of directional antennas. Each directional antenna includes at least one antenna, disposed on a side of a display of the portable device, for utilizing a metal part of the display as a reflector to generate a directional radiation pattern. All of directional radiation patterns generated by the plurality of directional antennas substantially form an omni directional radiation pattern.

[0009] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a schematic diagram of a smart antenna system according to an embodiment of the present invention.

[0011] FIG. 2A is a schematic diagram of an omni-directional antenna and a corresponding radiation pattern according to an embodiment of the present invention.

[0012] FIG. 2B is a schematic diagram of another omni-directional antenna with a reflector and a corresponding radiation pattern according to an embodiment of the present invention.

[0013] FIG. 3 is a directional antenna according to an embodiment of the present invention.

[0014] FIG. 4A is a schematic diagram of the directional antenna shown in FIG. 3 disposed on a left side of a display of a laptop according to an embodiment of the present invention.

[0015] FIG. 4B is a schematic diagram a radiation coefficient of the directional antenna according to an embodiment of the present invention.

[0016] FIG. 5A is a directional antenna and a corresponding directional radiation pattern according to an embodiment of the present invention.

[0017] FIG. 5B is a schematic diagram a radiation coefficient of the directional antenna shown in FIG. 5A according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0018] Please refer to FIG. 1, which is a schematic diagram of a smart antenna system 10 according to an embodiment of the present invention. The smart antenna system 10 includes omni directional antennas ANT1, ANT2, ANT3, ANT4. A directional antenna ANT dir of the directional antennas ANT1, ANT2, ANT3, ANT4 includes at least one antenna. The at least one antenna is disposed on a side of a display 14 of the portable device 12, and utilizes a metal part of the display 14 as a reflector to generate a directional radiation pattern DRP dir. The side of the display 14 can be a left side, a right side, a bottom side, a top side or a back side (not shown) of the display 14. All of directional radiation patterns DRP dir of the directional antennas ANT1, ANT2, ANT3, ANT4 substantially form an omni directional radiation pattern.

[0019] Noticeably, compared with an omni directional antenna, an ordinary directional antenna has many advantages in a corresponding directional radiation pattern, such as high gain for desired signal, long transmission distance, better received signal strength indication (RSSI), low side lobe for interference, low noise floor, and low power consumption under the same Equivalent isotropically radiated power (EIRP) requirement, etc. Therefore, in such a configuration, the omni directional radiation pattern substantially formed by the directional radiation patterns DRP dir of the directional antennas ANT1, ANT2, ANT3, ANT4 has better efficiency than an omni directional radiation pattern formed by one or a plurality of omni directional antennas. As a result, the smart antenna system 10 can have better gain and efficiency.

[0020] In detail, please refer to FIG. 2A and FIG. 2B. FIG. 2A is a schematic diagram of an omni-directional antenna 20 and a corresponding radiation pattern DRP according to an embodiment of the present invention, and FIG. 2B is a schematic diagram of another omni-directional antenna 22 with a...
reflector 24 and a corresponding radiation pattern DRP according to an embodiment of the present invention. As shown in FIG. 2A and FIG. 2B, the omni-directional antenna 22 with the reflector 24 can provide a directional field DRP. Therefore, the omni-directional antenna 22 with the reflector 24 can act as a directional antenna, which provides a larger peak gain than that of omni-directional antenna 20. For example, a dipole antenna with a driver (as shown in FIG. 2A) has a maximum antenna peak gain of 2 dB. If a reflector is added to the dipole antenna (as shown in FIG. 2B), the peak gain will be 5 dB, which is twice the gain of the dipole antenna with the driver.

In such a situation, please continue referring to FIG. 1. In order to place the directional antenna ANT into a space between the side of the display 14 and a housing of the portable device 12, at least one antenna can utilize the metal part of the display 14 as the reflector to generate a directional radiation pattern DRP. Noticeably, since a frame of the display 14 is metal, the metal part can be used as a ground, e.g. for a plane inverse F antenna (PIFA) antenna used in a conventional notebook, the metal part is used as the ground to design an omni-directional antenna. In comparison, in the present invention, at least one antenna utilizes the metal part of the display 14 as the reflector of the directional antenna ANT that provides higher gain. Moreover, the at least one antenna can be further designed to have constructive interference in a far field for more gain enhancement.

For example, please refer to FIG. 3, which is a directional antenna 30 according to an embodiment of the present invention. The directional antenna 30 is utilized as the directional antenna ANT when the directional antenna ANT is disposed on one of the left side, the right side, the bottom side and the top side of the display 14, where the space is very narrow.

As shown in FIG. 3, the directional antenna 30 includes at least one antenna. Take the directional antenna 30 as a series feed dipole array antenna for example, the directional antenna 30 further includes a feed line, a pad and a two layer substrate for a top metal and a bottom metal, which can be a FR4 substrate with a length L1 and a thickness W (e.g. 140 mm and 0.6 mm, respectively). The at least one antenna is series-fed, and can be a dipole antenna D1 with a length L1 and a dipole antenna D2 with a length L2, wherein the length L1 equals to the length L2 (e.g. 50 mm). A distance d between the dipole antenna D1 and the dipole antenna D2 can be designed, e.g. 70 mm, such that the dipole antenna D1 and the dipole antenna D2 have a specific phase difference. The feed line feeds signals in a dual conductor way by feeding the signals to the dipole antenna D1 and feeding to the dipole antenna D2 with the specific phase difference, such that the dipole antenna D1 and the dipole antenna D2 have constructive interference in the far field. The pad is located at a feeding point for impedance matching. A fire wire of a co-axial wire is bonded to the feed line of the bottom metal, while the a wire is bonded to the pad of the top metal. With this design, the maximum gain of the antenna can be increased.

Please refer to FIG. 4A and FIG. 4B. FIG. 4A is a schematic diagram of the directional antenna 30 shown in FIG. 3 disposed on a left side of a display 44 of a laptop 40 according to an embodiment of the present invention, and FIG. 4B is a schematic diagram a reflection coefficient of the directional antenna 30 according to an embodiment of the present invention. As shown in FIG. 4A and FIG. 4B, the directional antenna 30 can utilize a metal part of the display 44 as a reflector to generate a directional radiation pattern with an antenna peak gain of 6 dB. Besides, the directional antenna 30 can have a return loss less than –10 dB between 2.4 GHz–2.5 GHz. By the same token, the directional antenna 30 can be disposed on the right side and the top side of the display 44, so as to utilize the metal part of the display 44 as a reflector to generate directional radiation patterns as well.

On the other hand, please refer to FIG. 5A, which is a directional antenna 50 and a corresponding directional radiation pattern according to an embodiment of the present invention. The directional antenna 50 is utilized as the directional antenna ANT when the directional antenna ANT is disposed on the back side of the display 14, where the space is very thin but broad.

As shown in FIG. 5A, the directional antenna 50 includes at least one antenna. Take the directional antenna 50 as a parallel feed patch array antenna for example, the at least one antenna is parallel-fed, and can be four patch antennas P1-P4 with similar size and a parallel feed-in network. The directional antenna 50 can utilize a metal part of the display 14 as a reflector to generate a directional radiation pattern with an antenna gain of 8 dB. Besides, the directional antenna 50 can have a return loss less than –10 dB between 2.4 GHz–2.5 GHz as shown in FIG. 5B, which is a schematic diagram a return loss of the directional antenna 50 shown in FIG. 5A according to an embodiment of the present invention.

Noticeably, the spirit of the present invention is to utilize a metal part of a display of a portable device as a reflector to generate a directional radiation pattern, such that all directional radiation patterns generated can substantially form an omni directional pattern and thus have better gain and efficiency. Those skilled in the art shoot make modifications or alterations accordingly. For example, the portable device 12 is preferably a laptop, but can be a tablet computer, a mobile phone, etc.

Besides, the at least one antenna of the directional antenna 30 is not limited to any feeding type, antenna type or number, as long as the at least one antenna can be disposed on one of the left side, the right side, the bottom side and the top side of the display 14, where the space is very narrow, to utilize a metal part of a display as a reflector to generate a directional radiation pattern. For example, the at least one antenna of the directional antenna 30 is not limited to be series-fed, and can be parallel-fed as well; the at least one antenna of the directional antenna 30 is not limited to be dipole antenna, and can be folded dipole antenna or other antenna types.

On the other hand, the at least one antenna of the directional antenna 50 is also not limited to any feeding type, antenna type or number, as long as the at least one antenna can be disposed on the back side of the display 14, where the space is very thin but broad, to utilize a metal part of a display as a reflector to generate a directional radiation pattern. For example, the at least one antenna of the directional antenna 50 is not limited to be parallel-fed, and can be series-fed as well, as long as two of the at least one antenna of the directional antenna 50 have a specific phase difference, such that the two of the at least one antenna of the directional antenna 50 have constructive interference in a far field.

In the prior art, efficiency and gain of omni directional antennas are not good enough. In comparison, the present invention utilize the metal part of the display as a reflector to generate directional radiation patterns, so as to
substantially form an omnidirectional pattern with better gain and efficiency. Moreover, the present invention provides a series feed dipole array antenna design for the left side, the right side, the bottom side and the top side of the display, and a parallel feed patch array antenna for a back side of the display, so as to generate directional radiation with higher gain and efficiency.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A directional antenna for a portable device, comprising:
   - at least one antenna, disposed on a side of a display of the portable device, for utilizing a metal part of the display as a reflector to generate a directional radiation pattern.
   - The directional antenna of claim 1, wherein two of the at least one antenna have constructive interference in a far field.
   - The directional antenna of claim 1, wherein the at least one antenna is disposed on one of a right side, a left side, a top side and a bottom side of the display of the portable device.
   - The directional antenna of claim 3, wherein the at least one antenna is series-fed.
   - The directional antenna of claim 4, wherein two of the at least one antenna have a specific phase difference, such that the two of the at least one antenna have constructive interference in a far field.
   - The directional antenna of claim 3, wherein the at least one antenna is parallel-fed.
   - The directional antenna of claim 3 further comprising a pad, located at a feeding point of the at least one antenna, for impedance matching.
   - The directional antenna of claim 3, wherein the at least one antenna is at least one dipole antenna.
   - The directional antenna of claim 3, wherein the at least one antenna is at least one folded dipole antenna.
   - The directional antenna of claim 1, wherein the at least one antenna is disposed on a back side of the display of the portable device.
   - The directional antenna of claim 10, wherein the at least one antenna is parallel-fed.
   - The directional antenna of claim 10, wherein the at least one antenna is series-fed.
   - The directional antenna of claim 12, wherein two of the at least one antenna have a specific phase difference, such that the two of the at least one antenna have constructive interference in a far field.

14. The directional antenna of claim 10, wherein the at least one antenna is at least one patch antenna.

15. A smart antenna system for a portable device, comprising:
   - a plurality of directional antennas, each directional antenna comprising:
     - at least one antenna, disposed on a side of a display of the portable device, for utilizing a metal part of the display as a reflector to generate a directional radiation pattern;
     - wherein all of directional radiation patterns generated by the plurality of directional antennas substantially form an omnidirectional radiation pattern.

16. The smart antenna system of claim 15, wherein two of the at least one antennas have constructive interference in a far field.

17. The smart antenna system of claim 15, wherein the at least one antenna is disposed on one of a right side, a left side, a top side and a bottom side of the display of the portable device.

18. The smart antenna system of claim 17, wherein the at least one antenna is series-fed.

19. The smart antenna system of claim 18, wherein two of the at least one antennas have a specific phase difference, such that the two of the at least one antennas have constructive interference in a far field.

20. The smart antenna system of claim 17, wherein the at least one antenna is parallel-fed.

21. The smart antenna system of claim 17, wherein the each directional antenna further comprises a pad, located at a feeding point of the at least one antenna, for impedance matching.

22. The smart antenna system of claim 17, wherein the at least one antenna is at least one dipole antenna.

23. The smart antenna system of claim 17, wherein the at least one antenna is at least one folded dipole antenna.

24. The smart antenna system of claim 15, wherein the at least one antenna is disposed on a back side of the display of the portable device.

25. The smart antenna system of claim 24, wherein the at least one antenna is parallel-fed.

26. The smart antenna system of claim 24, wherein the at least one antenna is series-fed.

27. The smart antenna system of claim 26, wherein two of the at least one antennas have a specific phase difference, such that the two of the at least one antennas have constructive interference in a far field.

28. The smart antenna system of claim 24, wherein the at least one antenna is at least one patch antenna.

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