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METHOD FOR IMPROVING SMART ANTENNA ARRAY COVERAGE

Field of the Technology

The present invention relates generally to a smart antenna array technology used in a cellular mobile communication system, and more particularly to a method which can improve smart antenna array coverage.

Background of the Invention

In a cellular mobile communication system using a smart antenna array, the smart antenna array is built in a radio base station, in general. The smart antenna array must use two kinds of beam forming for transmitting and receiving signals: one kind is the fixed beam forming, while another is the dynamic beam forming. The fixed beam forming, such as omnidirectional beam forming, strip beam forming or sector beam forming, is mainly used for transmitting omnidirectional information, such as broadcasting, paging etc. The dynamic beam forming is mainly used for tracing subscribers and transfers a subscriber data and signaling information etc to a specific user.

Fig.1 shows a cell distributing diagram of a cellular mobile communication network. Coverage is the first issue needed to be considered, when designing a cellular mobile communication system. In general, a smart antenna array of a wireless base station is located at the center of a cell, as shown by black dot 11 in Fig.1. Most cells have normal circle coverage, as shown by 12. Part of cells has non-symmetric circle coverage, as shown by 13, and strip coverage, as shown by 14. The normal circle coverage 12, non-symmetric circle coverage 13 and strip coverage 14 are overlapped for non-gap coverage.

As is well known that a power radiation diagram of an antenna array is determined by those parameters: such as geometrical arrangement shape for antenna units of the antenna array, characteristic of each antenna unit, phase and amplitude of radiation level of each antenna unit, etc. When designing an antenna array, in order to make the design can be commonly used, the design is taken under a relatively ideal environment, which includes free space, equipment works normally, etc. When a



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designed antenna array is put in practical use, the real power coverage of the antenna array will be certainly changed, because of different installing location and position, different landforms and land surface feature, different buildings height and different arrangement of antenna units, etc.

Fig.2 (part of Fig.1) shows a difference of an expected coverage 21 (normal circle) and a real coverage 22, because of different landforms and land surface feature, etc. The real coverage can be measured at site. It is possible that every cell has this kind of difference, so except adjustment at site otherwise a real coverage of a mobile communication network may be very bad. Besides, it is need to reconfigure an antenna array when an individual antenna unit of the antenna array does not work normally or coverage requirement has been changed, at this time, the coverage of the antenna array must be adjusted in real time.

Principle of the adjustment is: based on fixed beam forming for omnidirectional coverage of a cell, a smart antenna array implements dynamic beam forming (dynamic directional radiation beam) for individual subscriber.

For formula (1): $A(\phi)$ represents shape parameter of the expected beam forming, i.e. the needed coverage, wherein ϕ represents polar coordinate angle of an observing point, and $A(\phi)$ is radiation strength on ϕ direction with same distance. Suppose there are N antennas for an smart antenna array, wherein any antenna n has a position parameter $D(n)$, a beam forming parameter $W(n)$ and a emission power P on angle ϕ direction, then the real coverage is represented by formula (2):

$$P(\phi) = \left| \sum_{n=1}^N f(\phi, D(n)) \times W(n) \right|^2 \quad \dots\dots (2)$$

Wherein form of function $f(\phi, D(n))$ is related with type of a smart antenna array.

In a land mobile communication system, taking into account two dimensions coverage on plane is enough, in general. When dividing antennas in arrangement, there are a linear array and a ring array, a circular array can be seen as a special ring array (refer to China Patent 97202038.1 "A ring smart antenna array used for radio communication system"). In a cellular mobile communication system, when implementing sector coverage, in general a linear array is used, and when

implementing omnidirectional coverage, a circular array is used. In the invention, a circular array is used as an example.

Suppose it is a circular array, then $D(n) = 2 \times (n - 1) \times \pi / N$;

$$f(\phi, D(n)) = \exp(j \times 2 \times r / \lambda \times \pi \times \cos(\Phi - D(n))) \quad (\text{find exponent}).$$

Wherein r is the radius of a circular antenna array and λ is the working wavelength. Fig.3 shows a power directional diagram of an omnidirectional beam forming for a normal circle antenna array with 8 antennas. Squares of digits 1.0885, 2.177, 3.2654, shown in Fig.3, represent power.

With minimum mean-square error algorithm, the mean square error ε in formula (3) is the minimum one:

$$\varepsilon = \frac{1}{K} \sum_{i=1}^K |P(\phi)^{1/2} - A(\phi)|^2 \times C(i) \quad \dots\dots (3)$$

In formula (3), K is the number of sampling point, when using approximation algorithm; and $C(i)$ is a weight. For some points, if the required approximation is high, then $C(i)$ is set larger, otherwise $C(i)$ is set smaller. When required approximations for all points are coincident, $C(i)$ will be set as 1, in general.

Besides, considering that transmission power of every antenna unit is limited, when taking amplitude of $W(n)$ to represent the transmission power of an antenna unit, and setting maximum transmission power of each antenna unit as $T(n)$, the limited condition can be expressed as:

$$|W(n)| \leq T(n)^{1/2} \quad \dots\dots (\text{condition 1})$$

Obviously, to find out an optimal value of the transmission power within the limit for every antenna unit, in general it only can be solved by selection and exhaustion of unsolved $W(n)$ accuracy, except for some special situations which can be directly solved by a formula. Nevertheless, when using exhaustive solution, calculation volume is considerable large and has an exponential relationship with the number of antenna units N . Although, the calculation volume can be decreased by gradually raising accuracy and decreasing scope of value to be solved, but even only to solve the sub-optimal value, the calculation volume is still too large.

Summary of the Invention

In order to improve effectively smart antenna array coverage, a method to improve smart antenna array coverage has been designed. The improvement includes that the real coverage of an antenna array approaches to the design coverage; and when part of antenna units is shut down because of trouble, the antenna radiation parameter of other normal working antenna units can be immediately adjusted to recover rapidly the cell coverage.

Purpose of the invention is to provide a method, which can adjust parameters of antenna units of an antenna array according to a practical need. With this method, an antenna array has a specific beam forming satisfying requirement, and a emission power optimal value of each antenna unit can be rapidly solved within a limit to obtain a local optimization effect.

The method of the invention is one kind of baseband digital signal processing methods. The method changes size and shape of coverage area of a smart antenna array, by adjusting parameter of each antenna (excluding those shut down antennas) of the smart antenna array, to obtain a local optimization effect coinciding with requirement under minimum mean-square error criterion. The specific adjusting scheme is that according to a difference of size and shape between coverage required in engineering design and actually realized coverage, an antenna radiation parameters is adjusted by method of step-by-step approximation under the minimum mean-square error criterion, in order to make the actually coverage of an antenna array approximates the requirement under local optimization condition.

According to the invention, adjusting the beam forming parameter $W(n)$ for each antenna unit n of a N antenna array, according to actually situation, further comprises:

- A. setting an accuracy of $W(n)$ to be solved, i.e. an adjusting step length;
- B. setting initial values include: an initial value $W_0(n)$ of beam forming parameter $W(n)$ for antenna unit n ; an initial value ε_0 of minimum mean-square error ε ; a counting variable for recording the minimum adjustment times; an adjustment ending threshold value M and a maximum emission power amplitude $T(n)$ for antenna unit n ;
- C. entering a loop for $W(n)$ adjustment which comprises: generating a random number; deciding a change of $W(n)$ by the set step length and calculating a new $W(n)$; when deciding the absolute value of $W(n)$ being less than or equal to $T(n)^{1/2}$,

calculating the minimum mean-square error ε ; when ε being greater than or equal to ε_0 , keeping the ε and increment the counting variable by 1;

D. repeating the step C until the counting variable being greater than or equal to the threshold value M , then ending the adjusting procedure and getting the result; recording and storing the final $W(n)$, replacing the ε_0 with the new ε .

When comparing ε and ε_0 in the step C, if ε is less than ε_0 , then the calculation result $W(n)$ of this time adjustment is recorded and stored, the ε_0 is replaced with the new calculated ε and the counting variable is reset to zero.

The adjusting step length can be fixed or varied. If the adjusting step length is varied, then setting a minimum adjusting step length is also included during setting initial values. When the counting variable is greater than or equal to the threshold value M but the adjusting step length is not equal to the minimum adjusting step length, the adjusting step length is continually decreased and the adjusting procedure of $W(n)$ is continued.

The adjusting procedure ending conditions further includes a preset adjustment ending threshold value ε' , and when $\varepsilon < \varepsilon'$, the adjustment is ended.

The number of the initial value $W_0(n)$ is related to the number of antenna units, which consist of the smart antenna array.

When setting the initial value $W_0(n)$ of $W(n)$, $W_0(n)$ is set to zero for shut down antenna units of the smart antenna array and $W(n)$ for the shut down antenna units will not be adjusted in the successive adjusting loop.

The minimum mean-square error ε is calculated by the formula:

$$\varepsilon = \frac{1}{K} \sum_{i=1}^K \left| P(\phi_i)^{1/2} - A(\phi_i) \right|^2 \times C(i),$$

Wherein $P(\phi_i)$ is an antenna unit emission power when beam forming parameter of the antenna unit is $W(n)$ and the directional angle is ϕ , and $P(\phi_i)$ is related to the antenna array type; $A(\phi_i)$ is the ϕ directional radiation strength with equal distance and the expected observation point having phase ϕ for polar coordinates; K is the number of sample point when using approximate method and $C(i)$ is a weight.

The setting an accuracy of $W(n)$ to be solved, i.e. an adjusting step length, comprises:

Setting stepping change of a real part and an imaginary part for a complex number $W(n)$, respectively; or setting stepping change of an amplitude and a phase for a polar coordinates $W(n)$, respectively;

when using the stepping change of a real part and an imaginary part for a complex number $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$$
,
 wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are the adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values are decided by a generated random number;

when using the stepping change of an amplitude and a phase for a polar coordinates $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)^{L_A^U}} * e^{j * [\phi^U(n) + (-1)^{L_\phi^U} \Delta \phi^U(n)]}$$
,
 wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are the adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively, their value are decided by a generated random number;

The U is the U^{th} adjustment and $U+1$ is the next adjustment.

The method of the invention concerns the case that when a radio base station uses a smart antenna array for fixed beam forming of omnidirectional coverage, the smart antenna array coverage can be effectively improved. The coverage size and shape of a smart antenna array is changed by adjusting each antenna unit parameter of the antenna array in order to obtain a local optimal effect of coincident requirement under the minimum mean-square error criterion.

The method of the invention is that according to a difference of size and shape between coverage required in engineering design and actually realized coverage, an antenna radiation parameters is adjusted by method of step-by-step approximation under the minimum mean-square error criterion, in order to make the actually

coverage of an antenna array approximates the requirement under local optimization condition.

One application of the method is at installation site of a smart antenna array; where coverage size and shape of a smart antenna array can be changed by adjusting each antenna unit parameter of the smart antenna array to obtain an omnidirectional radiation beam forming which very approximates to an expected beam forming shape and has a local optimization result for coinciding with a requirement. Another application of the method is that when part of antenna units in a smart antenna array is not normal and has been shut down, antenna radiation parameter of the remain normal antenna units can be immediately adjusted by the method to recover omnidirectional coverage for the cell immediately.

Brief Description of the Drawings

Fig.1 is a cell distribution diagram for a cellular mobile communication network.

Fig.2 is a diagram of difference between needed cell coverage and real cell coverage.

Fig.3 is an omnidirectional beam forming power direction diagram of an eight-antenna array with normal circle coverage.

Fig.4 is a flowchart of rapidly improving an antenna array beam forming coverage with a fixed step length.

Fig.5 is a flowchart of rapidly improving an antenna array beam forming coverage with an alterable step length.

Fig.6 is a flowchart having an ending condition for rapidly improving an antenna array beam forming coverage with a alterable step length.

Fig.7 and Fig.8 are power direction diagrams before adjustment and after adjustment, respectively, for an eight-antenna array with normal circle coverage omnidirectional beam forming when there is one antenna unit without working normally.

Fig.9 and Fig.10 are power direction diagrams before adjustment and after adjustment, respectively, for an eight-antenna array with circular coverage omnidirectional beam forming when there are two antenna units without working normally.

Embodiments of the Invention

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

Fig.1 to Fig.3 have been described before, and will not be repeated.

Refer to Fig.4, Fig.5 and Fig.6. The invention is a method which rapidly solves, within a limited scope, an optimization value of the beam forming parameter $W(n)$ for any antenna unit n in an antenna array to obtain local optimization effect. The method roughly includes the following five steps:

Step1

Set accuracy of $W(n)$ to be solved, i.e. adjusting step length of $W(n)$ during whole solving procedure. There are two kinds of adjusting step length setting methods: one is to set, respectively, real part and imaginary part of a $W(n)$ in complex number and changes in step; another is to set, respectively, amplitude and angle of a $W(n)$ in polar coordinates and changes in step.

Suppose after the U^h adjustment, the $W(n)$ is $W^U(n)$.

When using the first adjustment method, $W^U(n)$ is expressed in complex number: $W^U(n) = I^U(n) + j \times Q^U(n)$. After next adjustment, the $W^{U+1}(n)$ can be expressed as (formula 4):

$$W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$$

..... (4)

Wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values will be decided by random decision method in step 2.

When using the second adjustment method, $W^U(n)$ is expressed by a polar coordinate: $W^U(n) = A^U(n)e^{j\phi^U(n)}$. After next adjustment, the $W^{U+1}(n)$ can be expressed as (formula 5):

$$W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)L_A^U} * e^{j[\phi^U(n) + (-1)L_\phi^U \Delta \phi^U(n)]} \dots\dots (5)$$

Wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively, their value will be decided by random decision method in step 3.

Step 2

Set a set of $W(n)$ initial value $W_0(n)$, which satisfies limit condition 1: $|W(n)| \leq T(n)^{1/2}$, number of $W_0(n)$ relates to antenna units number N of the antenna array. For those shut down antenna units, their $W_0(n)$ should be zero and they will not be adjusted in the successive steps. Selection of the initial value $W_0(n)$ has a certain degree influence for convergent speed of the algorithm and the final result. If a rough scope of $W(n)$ has been known before, then it is better to select a set of $W_0(n)$ corresponding to the scope, and this is also benefit for raising the result accuracy.

Then, set an initial value ε_0 of the minimum mean-square error ε . In order to enter the loop adjustment stage faster, in general, the initial value ε_0 is set with a larger value and the counting variable (count) is set to 0. The "count" is used to record the minimum adjustment times needed for $W(n)$ under a ε_0 corresponding to a set of $W_0(n)$. M is a required threshold used to decide when the adjustment would be ended and the result can be outputted. Obviously, with larger M value, the result is more reliable.

The initial value setting procedures, mentioned above, are shown in blocks 401, 501 and 601 of Fig.4, 5 and 6, respectively. These include the following setting: $W_0(n)$, M, adjusting step length ("step"), initial value of minimum mean-square error ε_0 , maximum transmission power of n^{th} antenna $T(n)$ and counting variable (count). The difference between blocks 501,601 and block 401 are that blocks 501, 601 further include setting a minimum adjusting step length min_step, which is needed for using alterable step length adjustment.

Step 3

With the procedure in step 1 and formulas (4) or (5), a new $W(n)$ is created, i.e. adjusting $W(n)$. Each time, a set of random number is generated, then according to the random number, changing direction of $W(n)$ is decided. If after adjustment, $W(n)$ breaks the limit of condition 1 ($|W(n)| \leq T(n)^{1/2}$), then the $W(n)$ is added or subtracted, the amount of add or subtract is decided by adjusting step length ("step"). As at this moment the correct changing trend is not known, so same add probability and subtract probability are taken. Operation of step 3 is shown at blocks 402, 403, 502, 503, or 602, 603 in Figs 4, 5 or 6, respectively.

Step 4

After adjustment, if $W(n)$ satisfies condition 1 limitation, then a new minimum mean-square error ε is calculated with formula 3. If $\varepsilon < \varepsilon_0$, then $W(n)$ of this time is recorded and stored, ε_0 is replaced by a new ε , and counting variable is set to zero (count = 0). The operation of this step is shown at blocks 404, 405, 406, 504, 505, 506, or 604, 605, 606 in Figs 4, 5 or 6, respectively. In Fig. 6, $\varepsilon < \varepsilon'$ is an ending condition of the adjustment, so before making decision $\varepsilon < \varepsilon_0$, decision $\varepsilon < \varepsilon'$ must be made first; when ε is greater than ε' , then decision $\varepsilon < \varepsilon_0$ will be made, as shown in block 612. If $\varepsilon \geq \varepsilon_0$ then the ε is kept and the counting variable is increment (count+1), the operation is shown at blocks 407, 507 or 607 in Figs 4, 5 or 6, respectively. After decision $\varepsilon \geq \varepsilon_0$, has been made and blocks 407, 507 or 607 have been executed, each time the counting variable "count" should be checked weather it is greater than the preset threshold value M, the operation is shown at block 408, 508 or 608 in Figs 4, 5 or 6, respectively.

Step 5

When $\varepsilon \geq \varepsilon_0$ and "count" is less than the preset threshold value M have been decided, it is returned to step 3, i.e. blocks 402, 502 or 602 in Figs 4, 5 or 6 are executed again. Consequently, a set of random number is regenerated; and $W(n+1)$ is calculated, if a set of $W(n)$ has been calculated, then restart from $W(1)$. Repeat the procedure above until "count" $\geq M$ has been detected at blocks 408, 508 or 608. Then, the whole adjusting procedure is ended. At this moment, the recorded $W(n)$ is a set of optimal solutions, ε_0 is the corresponding minimum mean-square error, and the counting variable is set to zero (count = 0). The operation is shown at blocks 409, 509 or 609.

The solution obtained from the steps above is only a local optimization solution, but the calculation volume is much less and a set of solution can be quickly obtained. If it is not satisfied with the solution of this time, then the procedure can be repeated, several sets of solution can be obtained and a set of solution with minimum mean-square error ε can be got. Of course, when the procedure is repeated, the initial value $W_0(n)$ of $W(n)$ must be updated.

If the result is still unsatisfied, then alterable step length and raising accuracy can be used to improve the algorithm mentioned above, as shown in Figs 5 and 6. In blocks 501 or 601, during setting initial values, a minimum adjusting step length min_step is set. At the beginning of the adjustment, a larger step length is used for adjustment. At blocks 510 or 610, when "count" is greater than M but "step" is greater than min_step , the calculation procedure is not ended instead of executing blocks 511 or 611. The adjusting step length is decreased at blocks 511 or 611, with the decreased step length the $W(n)$ is changed and the minimum mean-square error ε is calculated again and so on. Only when "count" is greater than M and "step" equals to min_step (step = min_step); then the calculation is ended, the result is outputted and a set of $W(n)$ and the corresponding mean-square error ε are obtained. Under same accuracy condition, varied length, in Figs 5 or 6, can raise calculation speed in certain degree.

Fig.6 shows a procedure where a system has a definite requirement of the mean-square error ε . This is expressed as $\varepsilon < \varepsilon'$, wherein ε' is a preset threshold value. In

this case, the procedure ending condition must be changed accordingly, that is a block 612 is added before block 605, and when $\varepsilon < \varepsilon'$, the procedure is ended. In an implementation, $\varepsilon < \varepsilon'$ can be deployed as ending condition, but using a fixed step length algorithm (as shown in Fig.4) to quick improved antenna array beam forming coverage.

Figs 7 and 8 describe an application effect of the invention with comparison of two diagrams, by taking a circular antenna array with eight units as an example, as shown in Fig.3 (the invention is appropriate to any type of an antenna array and can dynamically make beam forming in real time, here only taking circular antenna array as an example). When an antenna unit (including the antenna, feeder cable and connected radio frequency transceiver etc.) of the antenna array has trouble, the radio base station must shut down the antenna unit with trouble and the radiation diagram of the antenna array is greatly worse. Fig.7 shows that when one antenna unit does not work, the radiation diagram of the antenna array is changed from an ideal circle to an irregular graph 71, and the cell coverage is worse immediately. With the method of the invention, the radio base station obtains parameter of other normal antenna units and adjusts them immediately by changing feed amplitude and phase of all normal antenna units, so a coverage shown by graph 81 in Fig.8 is obtained which has an approximate circle coverage.

Figs 9 and 10 describe another application effect of the invention with comparison of two diagrams, by also taking a circular antenna array with eight units as an example, as shown in Fig.3 (the invention is appropriate to any type of an antenna array and can dynamically make beam forming in real time, here only taking circular antenna array as an example). When two antenna units, separated by $\pi/4$ as shown in Fig.3, do not work, the radiation diagram of the antenna array is changed from an ideal circle to an irregular graph 91, and the cell coverage is much worse. When this happens, with the method of the invention, the radio base station adjusts parameter of other normal antenna units immediately by changing feed amplitude and phase of all normal antenna units, so a coverage shown by graph 101 in Fig.10 is obtained which is obviously more approximate to a circle coverage.

It should be noted that when part of antenna units stop working, without increasing maximum emission power of normal antenna units, radius of the whole

coverage is definitely decreased, as shown in Fig.7 and Fig.9. Consequently, cells coverage overlap decreases (refer to Fig.1), so it is possible that communication blindness area appears, as shown by the examples in Fig.7 and Fig.9. Under equal distance, when emission power level is decreased 3 ~ 5 dB, the coverage radius will be decreased 10% ~ 20%. Therefore, in order to solve this problem, it is necessary to increase emission power for part of antenna units, or using "breath" function of neighbor cells.

The method improving antenna array coverage is an adjusting parameter procedure of antenna array. The beam forming parameter $W(n)$ can be quickly obtain and a local optimization effect will be got.

Claims

1. A method for improving coverage of a smart antenna array, comprises:
deciding difference of size and shape between coverage of smart antenna array designed by mobile communication network engineering design parameters and actually realized coverage;
adjusting radiation parameters of antenna units consisting of the smart antenna array by a step-by-step approximation method with minimum mean-square error arithmetic, to make the actually realized coverage approximates to the coverage of engineering design smart antenna array, under a local optimization condition.
2. The method according to claim 1, wherein the smart antenna array is consisted of n antenna units, the radiation parameter is beam forming parameter $W(n)$, and the adjusting procedure comprises:
 - A. setting an accuracy of $W(n)$ to be solved, i.e. an adjusting step length;
 - B. setting initial values include: an initial value $W_0(n)$ of beam forming parameter $W(n)$ for antenna unit n ; an initial value ε_0 of minimum mean-square error ε ; a counting variable for recording the minimum adjustment times; an adjustment ending threshold value M and a maximum emission power amplitude $T(n)$ for antenna unit n ;
 - C. entering a loop for $W(n)$ adjustment which comprises: generating a random number; deciding a change of $W(n)$ by the set step length and calculating a new $W(n)$; when deciding the absolute value of $W(n)$ being less than or equal to $T(n)^{1/2}$, calculating the minimum mean-square error ε ; when ε being greater than or equal to ε_0 , keeping the ε and increment the counting variable by 1;
 - D. repeating the step C until the counting variable being greater than or equal to the threshold value M , then ending the adjusting procedure and getting the result; recording and storing the final $W(n)$, replacing the ε_0 with the new ε .
3. The method according to claim 2, wherein the step C further comprises when ε being less than ε_0 , recording and storing the calculation result $W(n)$ of this time adjustment, replacing the ε_0 with the new ε and resetting the counting variable to zero.
4. The method according to claim 2, wherein the adjusting step length is fixed.

5. The method according to claim 2, wherein the adjusting step length is varied and the setting initial values further include a minimum adjusting step length; when the counting variable is greater than or equal to the threshold value M , the step D further comprises:

deciding whether the adjusting step length being equal to the minimum adjusting step length, if not, then decreasing the adjusting step length and going to step C.

6. The method according to claim 2, wherein the setting initial values further include an adjustment ending threshold value ε' , when the counting variable is greater than or equal to the threshold M , the step D further comprises:

deciding whether ε being less than ε' , if not, then going to step C.

7. The method according to claim 2, wherein the number of the initial value $W_0(n)$ is related to the number of antenna units, which consist of the smart antenna array.

8. The method according to claim 2, wherein when setting the initial value $W_0(n)$ of $W(n)$, $W_0(n)$ is set to zero for shut down antenna units of the smart antenna array and $W(n)$ for the shut down antenna units will not be adjusted in the successive adjusting loop.

9. The method according to claim 2, wherein the minimum mean-square error ε is calculated by the formula: $\varepsilon = \frac{1}{K} \sum_{i=1}^K |P(\phi_i)^{1/2} - A(\phi_i)|^2 \times C(i)$, wherein $P(\phi_i)$ is an antenna unit emission power when beam forming parameter of the antenna unit is $W(n)$ and the directional angle is ϕ , and $P(\phi_i)$ is related to the antenna array type; $A(\phi_i)$ is the ϕ directional radiation strength with equal distance and the expected observation point having phase ϕ for polar coordinates; K is the number of sample point when using approximate method and $C(i)$ is a weight.

10. The method according to claim 2, wherein setting an accuracy of $W(n)$ to be solved, i.e. an adjusting step length, comprises:

setting stepping change of a real part and an imaginary part for a complex number $W(n)$, respectively; or setting stepping change of an amplitude and a phase for a polar coordinates $W(n)$, respectively;

when using the stepping change of a real part and an imaginary part for a complex number $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$$
,
 wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are the adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values are decided by a generated random number;

when using the stepping change of an amplitude and a phase for a polar coordinates $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)^{L_A^U}} * e^{j * [\phi^U(n) + (-1)^{L_\phi^U} \Delta \phi^U(n)]}$$
,
 wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are the adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively, their value are decided by a generated random number;

the U is the U^{th} adjustment and $U+1$ is the next adjustment.

11. A method for improving coverage of a smart antenna array, comprises:

A. setting initial values include: an initial value $W_0(n)$ of beam forming parameter $W(n)$ for antenna unit n , constituting the smart antenna array; an adjustment ending threshold value M ; an accuracy of $W(n)$, i.e. an adjusting step length "step"; an initial value ε_0 of minimum mean-square error ε , a maximum value of emission power amplitude $T(n)$ and a counting variable "count" for recording the minimum adjustment times;

B. generating a set of random numbers, deciding $W(n)$ changing direction, deciding $W(n)$ changing size by the "step", generating $W(n)$ of the U^{th} adjusting by the formula: $W^{U+1}(n) = W^U(n) + \Delta W^U(n)$;

C. comparing the $W(n)$ and $T(n)$: when the absolute value of $W(n)$ being greater than $T(n)^{1/2}$, continuing the $W(n)$ generating operation; when the absolute value of $W(n)$ being less than or equal to $T(n)^{1/2}$, calculating the minimum mean-square error ε ;

D. comparing ε and ε_0 : when ε being less than ε_0 , setting ε_0 being equal to ε and resetting "count" being equal to zero, then continuing the $W(n)$ generating operation; when ε being not less than ε_0 , keeping the ε and increasing "count" by 1;

E. comparing "count" and M : when "count" being less than M , continuing the $W(n)$ generating operation; when "count" being greater than or equal to M , ending the adjustment, getting the result $W(n)$, ε and resetting "count" to zero.

12. The method according to claim 11, wherein the minimum mean-square error ε is calculated by the formula: $\varepsilon = \frac{1}{K} \sum_{i=1}^K |P(\phi_i)^{1/2} - A(\phi_i)|^2 \times C(i)$, wherein $P(\phi_i)$ is an antenna unit emission power when beam forming parameter of the antenna unit is $W(n)$ and the directional angle is ϕ , and $P(\phi_i)$ is related to the antenna array type; $A(\phi_i)$ is the ϕ directional radiation strength with equal distance and the expected observation point having phase ϕ for polar coordinates; K is the number of sample point when using approximate method and $C(i)$ is a weight.

13. The method according to claim 11, wherein setting accuracy of $W(n)$ to be solved, i.e. an adjusting step length, comprises:

setting stepping change of a real part and an imaginary part for a complex number $W(n)$, respectively; or setting stepping change of an amplitude and a phase for a polar coordinates $W(n)$, respectively;

when using the stepping change of a real part and an imaginary part for a complex number $W(n)$, the new $W(n)$ is calculated by the formula: $W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$, wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are the adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values are decided by a generated random number;

when using the stepping change of an amplitude and a phase for a polar coordinates $W(n)$, the new $W(n)$ is calculated by the formula: $W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)^{L_A^U}} * e^{j * [\phi^U(n) + (-1)^{L_\phi^U} \Delta \phi^U(n)]}$, wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are the adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively, their value are decided by a generated random number;

the U is the U^h adjustment and $U+1$ is the next adjustment.

14. A method for improving coverage of a smart antenna array, comprises:

A. setting initial values include: an initial value $W_0(n)$ of beam forming parameter $W(n)$ for antenna unit n , constituting the smart antenna array; an adjustment ending threshold value M ; an accuracy of $W(n)$, i.e. an adjusting step length "step"; an initial value ε_0 of minimum mean-square error ε , a maximum value of emission power amplitude $T(n)$, a counting variable "count" for recording the minimum adjustment times and a minimum adjusting step length min_step;

B. generating a set of random numbers, deciding $W(n)$ changing direction, deciding $W(n)$ changing size by the "step", generating $W(n)$ of the U^{th} adjusting by the formula: $W^{U+1}(n) = W^U(n) + \Delta W^U(n)$;

C. comparing the $W(n)$ and $T(n)$: when the absolute value of $W(n)$ being greater than $T(n)^{1/2}$, continuing the $W(n)$ generating operation; when the absolute value of $W(n)$ being less than or equal to $T(n)^{1/2}$, calculating the minimum mean-square error ε ;

D. comparing ε and ε_0 : when ε being less than ε_0 , setting ε_0 being equal to ε and resetting "count" being equal to zero, then continuing the $W(n)$ generating operation; when ε being not less than ε_0 , keeping the ε and increasing "count" by 1,;

E. comparing "count" and M : when "count" being less than M , continuing the $W(n)$ generating operation; when "count" being greater than or equal to M , going to step F;

F. deciding weather "step" being equal to min_step: when "step" being not equal to min_step, decreasing the "step" and continuing the $W(n)$ generating operation; when "step" being equal to min_step, ending the adjustment, getting the result $W(n)$, ε and resetting "count" to zero.

15. The method according to claim 14, wherein the minimum mean-square error

ε is calculated by the formula: $\varepsilon = \frac{1}{K} \sum_{i=1}^K |P(\phi_i)^{1/2} - A(\phi_i)|^2 \times C(i)$, wherein $P(\phi_i)$ is

an antenna unit emission power when beam forming parameter of the antenna unit is $W(n)$ and the directional angle is ϕ , and $P(\phi_i)$ is related to the antenna array type; $A(\phi_i)$ is the ϕ directional radiation strength with equal distance and the expected

observation point having phase ϕ for polar coordinates; K is the number of sample point when using approximate method and $C(i)$ is a weight.

16. The method according to claim 14, wherein setting accuracy of $W(n)$ to be solved, i.e. an adjusting step length, comprises:

setting stepping change of a real part and an imaginary part for a complex number $W(n)$, respectively; or setting stepping change of an amplitude and a phase for a polar coordinates $W(n)$, respectively;

when using the stepping change of a real part and an imaginary part for a complex number $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$$
,
 wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are the adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values are decided by a generated random number;

when using the stepping change of an amplitude and a phase for a polar coordinates $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)^{L_A^U}} * e^{j * [\phi^U(n) + (-1)^{L_\phi^U} \Delta \phi^U(n)]}$$
,
 wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are the adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; their value are decided by a generated random number;

the U is the U^{th} adjustment and $U+1$ is the next adjustment.

17. A method for improving coverage of a smart antenna array, comprises:

A. setting initial values include: an initial value $W_0(n)$ of beam forming parameter $W(n)$ for antenna unit n , constituting the smart antenna array; an adjustment ending threshold value M ; an accuracy of $W(n)$, i.e. an adjusting step length "step"; an initial value ε_0 of minimum mean-square error ε , a maximum value of emission power amplitude $T(n)$, a counting variable "count" for recording the minimum adjustment times, an adjustment ending threshold value ε' of minimum mean-square error ε and a minimum adjusting step length min_step;

B. generating a set of random numbers, deciding $W(n)$ changing direction, deciding $W(n)$ changing size by the "step", generating $W(n)$ of the U^{th} adjusting by the formula: $W^{U+1}(n) = W^U(n) + \Delta W^U(n)$;

C. comparing the $W(n)$ and $T(n)$: when the absolute value of $W(n)$ being greater than $T(n)^{1/2}$, continuing the $W(n)$ generating operation; when the absolute value of $W(n)$ being less than or equal to $T(n)^{1/2}$, calculating the minimum mean-square error ε ;

D. comparing the ε and ε' : when ε being less than ε' , ending the adjustment, getting the result $W(n)$, ε and resetting "count" to zero; when ε being not less than ε' , going to step E;

E. comparing the ε and ε_0 : when ε being less than ε_0 , setting ε_0 being equal to ε and resetting "count" being equal to zero, then continuing the $W(n)$ generating operation; when ε being not less than ε_0 , keeping the ε and increasing "count" by 1;

F. comparing "count" and M : when "count" being less than M , continuing the $W(n)$ generating operation; when "count" being greater than or equal to M , going to step G;

G. deciding weather "step" being equal to min_step: when "step" being not equal to min_step, decreasing the "step" and continuing the $W(n)$ generating operation; when "step" being equal to min_step, ending the adjustment, getting the result $W(n)$, ε and resetting "count" to zero.

18. The method according to claim 17, wherein the minimum mean-square error ε is calculated by the formula: $\varepsilon = \frac{1}{K} \sum_{i=1}^K \left| P(\phi_i)^{1/2} - A(\phi_i) \right|^2 \times C(i)$, wherein $P(\phi_i)$ is an antenna unit emission power when beam forming parameter of the antenna unit is $W(n)$ and the directional angle is ϕ , and $P(\phi_i)$ is related to the antenna array type; $A(\phi_i)$ is the ϕ directional radiation strength with equal distance and the expected observation point having phase ϕ for polar coordinates; K is the number of sample point when using approximate method and $C(i)$ is a weight.

19. The method according to claim 17, wherein setting accuracy of $W(n)$ to be solved, i.e. an adjusting step length, comprises:

setting stepping change of a real part and an imaginary part for a complex number $W(n)$, respectively; or setting stepping change of an amplitude and a phase for a polar coordinates $W(n)$, respectively;

when using the stepping change of a real part and an imaginary part for a complex number $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) + \Delta W^U(n) = I^U(n) + (-1)^{L_I^U} \Delta I^U(n) + j * [Q^U(n) + (-1)^{L_Q^U} \Delta Q^U(n)]$$
 ,
 wherein $\Delta I^U(n)$ and $\Delta Q^U(n)$ are the adjusting step length of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; L_I^U and L_Q^U decide adjusting direction of the real part $I^U(n)$ and imaginary part $Q^U(n)$, respectively; their values are decided by a generated random number;

when using the stepping change of an amplitude and a phase for a polar coordinates $W(n)$, the new $W(n)$ is calculated by the formula:

$$W^{U+1}(n) = W^U(n) * \Delta W^U(n) = A^U(n) * \Delta A^U(n)^{(-1)^{L_A^U}} * e^{j * [\phi^U(n) + (-1)^{L_\phi^U} \Delta \phi^U(n)]}$$
 ,
 wherein $\Delta A^U(n)$ and $\Delta \phi^U(n)$ are the adjusting step length of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively; L_A^U and L_ϕ^U decide adjusting direction of the amplitude $A^U(n)$ and phase $\phi^U(n)$, respectively, their value are decided by a generated random number;
 the U is the U^{th} adjustment and $U+1$ is the next adjustment.