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July 16, 2012

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 REPUBLIC OF KOREA 135-080



Re: US Patent Number: 8,200,147
 Title: WIRELESS COMMUNICATION SYSTEM FOR CONTROLLING
 COMMUNICATION AREA BY JAMMING
 Grant Date: June 12, 2012
 Inventor: Hee-Jo Lee et al.
 Your Reference: OPP20092694US
 Our Reference: YOU-17002/00

Dear Mr. Song:

We have received and are enclosing the original and two copies of United States Letters Patent No. 8,200,147 for the above-identified Patent issued June 12, 2012. We will proofread a copy of this patent to be sure that the Patent Office printed the patent correctly. If necessary, we will prepare and file a Certificate of Correction. Assuming all maintenance fees are timely paid, this patent is valid for twenty years from the filing date of the parent application. The term of this patent has been adjusted by 231 days due to a Patent Term Adjustment. Patent Term Adjustment is added to the term of a patent if the Patent Office causes delays during prosecution.

Maintenance fees for this patent will become due on the 3-1/2, 7-1/2, and 11-1/2 year anniversaries of the issue date of the patent. We are of the understanding that you will docket these dates and will advise your client in due time regarding their payments. If you would like us to be responsible for docketing and payment of these maintenance fees, please notify us in writing; otherwise, we will consider our files closed.

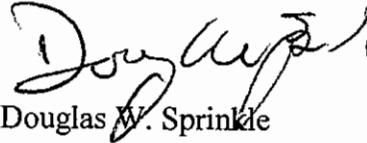
Products covered by this patent or advertisements relating thereto should now include notice of the patent including the patent number.

**GIFFORD, KRASS, SPRINKLE,
ANDERSON & CITKOWSKI, P.C.**

Mr. Manho Song
July 13, 2012
Page 2

We are pleased to have been of service to you in this matter.

Very truly yours,

A handwritten signature in black ink, appearing to read "Douglas W. Sprinkle". The signature is written in a cursive style with a large initial "D".

Douglas W. Sprinkle

DWS/en
Enclosure

The
United
States
of
America



**The Director of the United States
Patent and Trademark Office**

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

David J. Kappos

Director of the United States Patent and Trademark Office

MAINTENANCE FEE NOTICE

If the application for this patent was filed on or after December 12, 1980, maintenance fees are due three years and six months, seven years and six months, and eleven years and six months after the date of this grant, or within a grace period of six months thereafter upon payment of a surcharge as provided by law. The amount, number and timing of the maintenance fees required may be changed by law or regulation. Unless payment of the applicable maintenance fee is received in the United States Patent and Trademark Office on or before the date the fee is due or within a grace period of six months thereafter, the patent will expire as of the end of such grace period.

PATENT TERM NOTICE

If the application for this patent was filed on or after June 8, 1995, the term of this patent begins on the date on which this patent issues and ends twenty years from the filing date of the application or, if the application contains a specific reference to an earlier filed application or applications under 35 U.S.C. 120, 121, or 365(c), twenty years from the filing date of the earliest such application ("the twenty-year term"), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b), and any extension as provided by 35 U.S.C. 154(b) or 156 or any disclaimer under 35 U.S.C. 253.

If this application was filed prior to June 8, 1995, the term of this patent begins on the date on which this patent issues and ends on the later of seventeen years from the date of the grant of this patent or the twenty-year term set forth above for patents resulting from applications filed on or after June 8, 1995, subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b) and any extension as provided by 35 U.S.C. 156 or any disclaimer under 35 U.S.C. 253.



US008200147B2

(12) **United States Patent**
Lee et al.

(10) **Patent No.:** **US 8,200,147 B2**
(45) **Date of Patent:** **Jun. 12, 2012**

(54) **WIRELESS COMMUNICATION SYSTEM FOR CONTROLLING COMMUNICATION AREA BY JAMMING**

(75) **Inventors:** **Hee-Jo Lee, Namyangju (KR); Yu-Seung Kim, Suwon (KR); Hyogon Kim, Songpa-Gu (KR)**

(73) **Assignee:** **Korea University Industry and Academy Collaboration Foundation, Seoul (KR)**

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 231 days.

(21) **Appl. No.:** **12/626,160**

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(30) **Foreign Application Priority Data**
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(51) **Int. Cl.**
H04K 3/00 (2006.01)
(52) **U.S. Cl.** 455/1; 455/456.2; 455/67.11; 455/67.13
(58) **Field of Classification Search** 455/1, 414.1, 455/414.2, 446, 456.1, 456.3, 515, 434, 63.1, 455/67.11, 69, 67.13, 456.2, 278.1; 342/173, 342/13

See application file for complete search history.

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(57) **ABSTRACT**

A wireless communication system for geographically controlling a communication area includes an access point for communicating with a terminal in a first area, and a jammer for generating noise for intercepting communication between the access point and a terminal in a second area. A jamming boundary for dividing an area in which the terminal can communicate with the access point and an area in which the terminal cannot communicate with the access point in an area in which the first area and the second area are overlapped is formed, and the jamming boundary is formed by a ratio between power of a signal transmitted to the terminal by the access point and power of a signal of the noise.

7 Claims, 6 Drawing Sheets

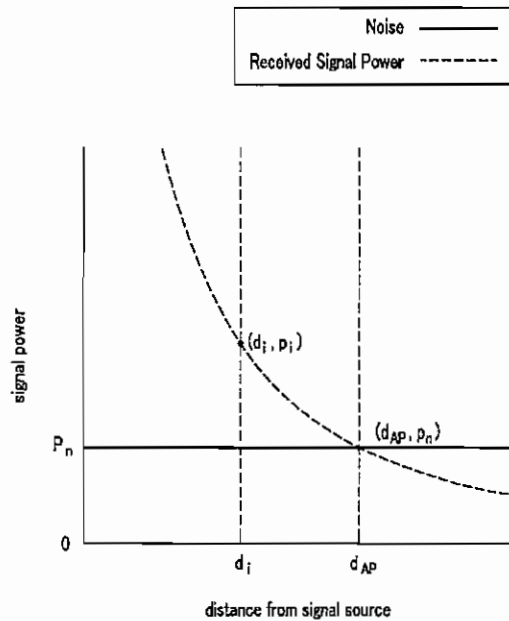


FIG. 1

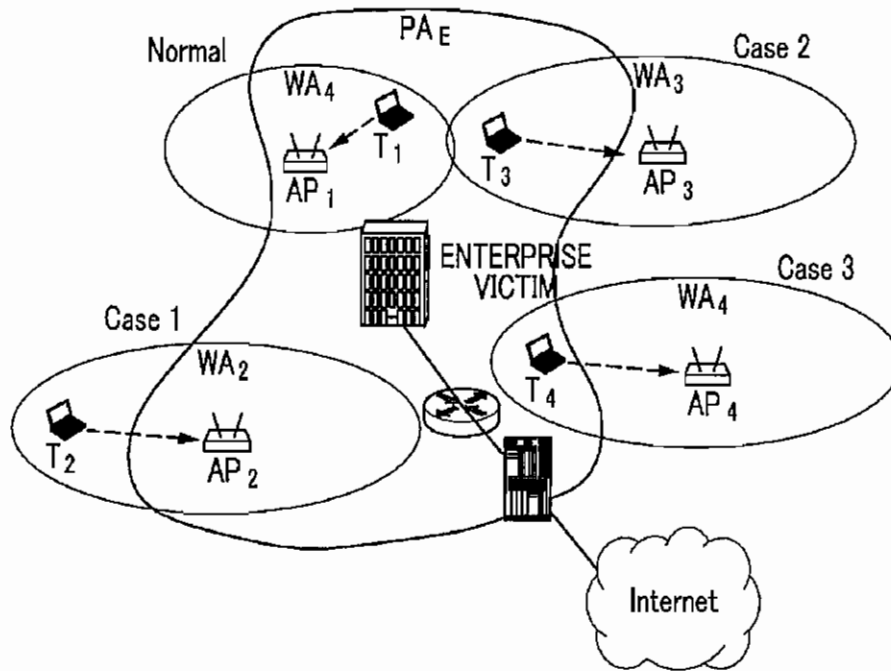


FIG. 2

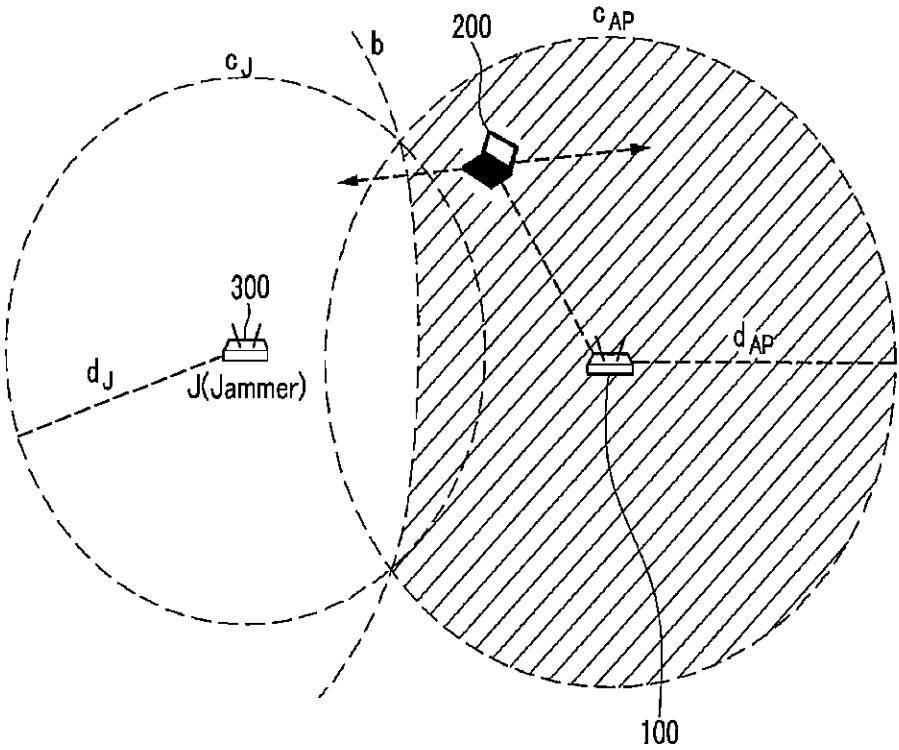


FIG. 3

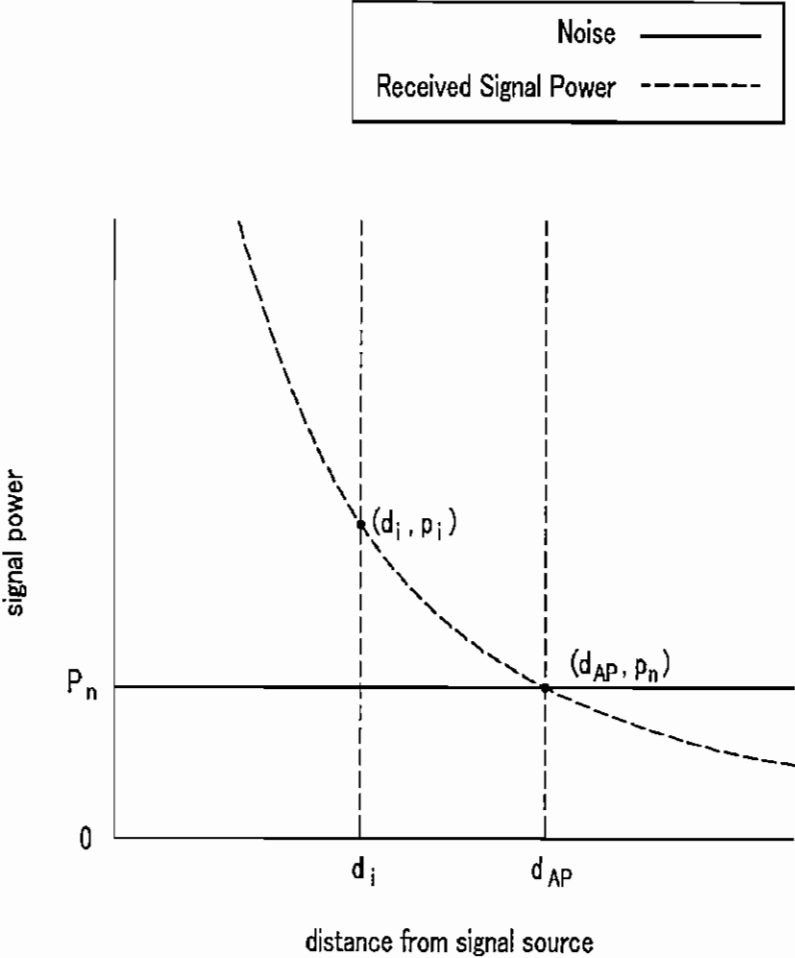


FIG. 4

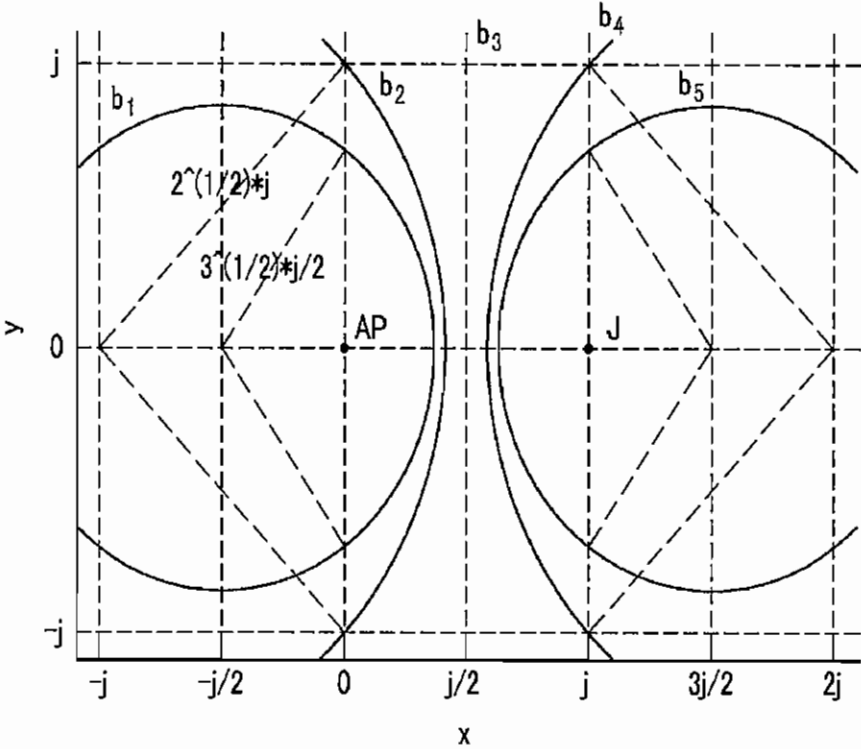


FIG. 5

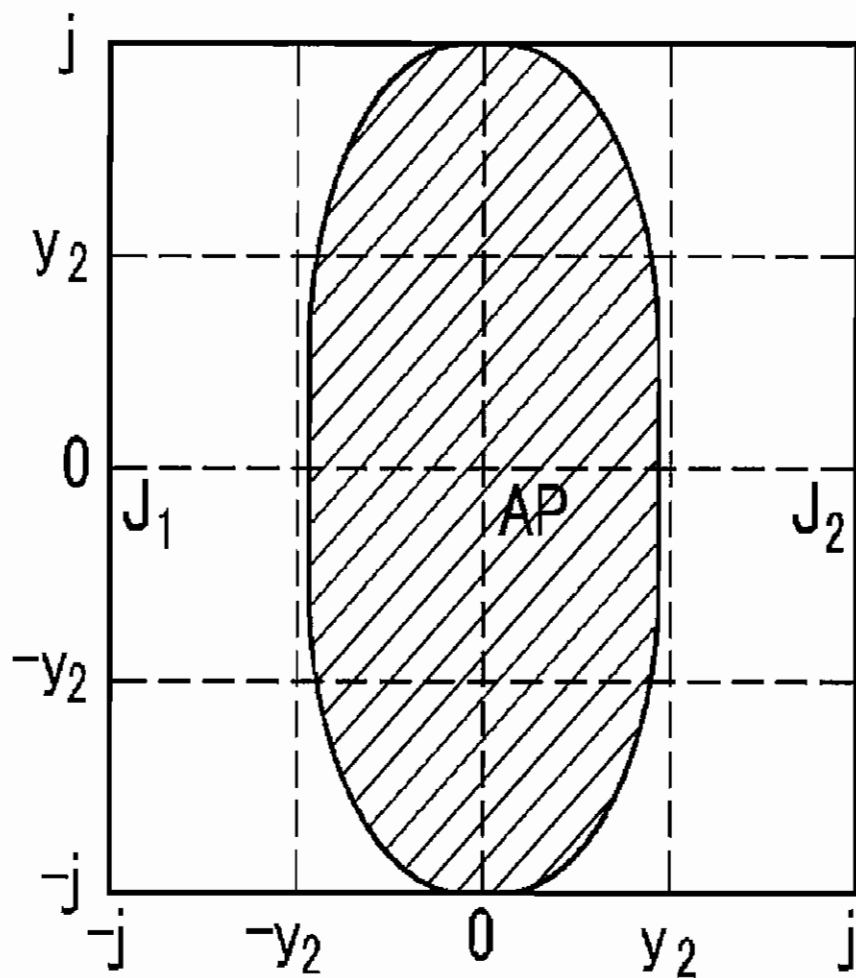
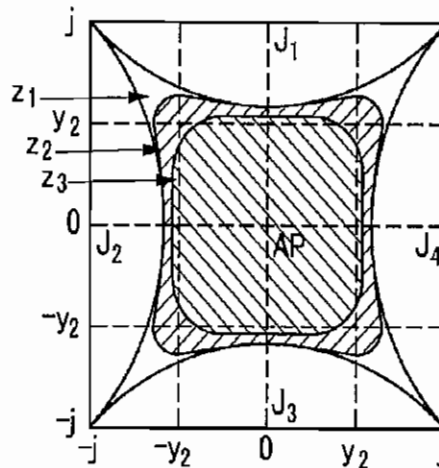
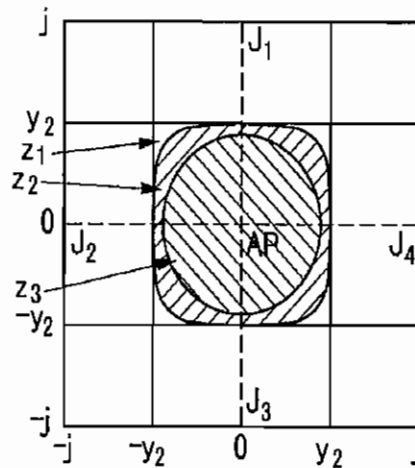


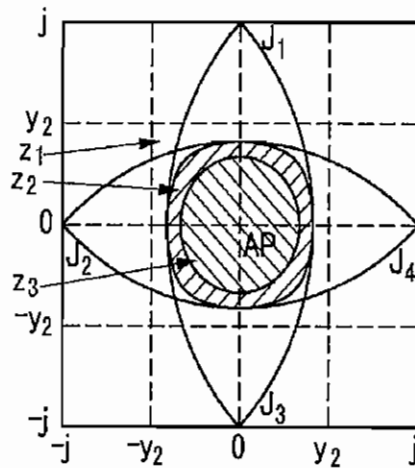
FIG. 6



(A) $P_{AP} = 4P_j$ for $n = 4$, $P_{AP} = 2P_j$ for $n = 2$



(B) $P_{AP} = P_j$ for both $n = 4$ and $n = 2$



(C) $4P_{AP} = P_j$ for $n = 4$, $2P_{AP} = P_j$ for $n = 2$

**WIRELESS COMMUNICATION SYSTEM FOR
CONTROLLING COMMUNICATION AREA
BY JAMMING**

CROSS-REFERENCE TO RELATED
APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2009-0098814 filed in the Korean Intellectual Property Office on Oct. 16, 2009, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

(a) Field of the Invention

The present invention relates to wireless network security.

(b) Description of the Related Art

As wireless communication techniques have been developed, company information leakage through wireless networks has become a serious problem. In order to prevent illegal access to the wireless network environment from the outside, many methods such as user authentication and data encryption have been proposed, but they generate information leakage in subsequent cases.

FIG. 1 shows a general wireless network environment of a company.

Referring to FIG. 1, a plurality of access points AP1 and AP2 and terminals T1, T3, and T4 are provided in a physical perimeter PA_E of a company, and a plurality of access points AP3 and AP4 and a terminal T2 are provided outside the physical perimeter PA_E .

The access point AP1 and the terminal T1 in the physical perimeter PA_E of the company communicate with each other in the normal case, and when an external rogue terminal T2 hacks the key for authentication to communicate with the internal access point AP2 (Case 1) or an internal rogue terminal T3 forms another channel with a rogue access point AP3 and communicates with the same (Case 2), the company's information may be leaked.

Further, when an internal innocent terminal T4 communicates with an external rogue access point AP4 unintentionally by an automatic wireless connection manager program (Case3), information leakage occurs. Therefore, to fundamentally intercept the company's information leakage, it is required to isolate a specific geographical area from the wireless access to/from the outside.

The above information disclosed in this Background section is only for enhancement of understanding of the background of the invention and therefore it may contain information that does not form the prior art that is already known in this country to a person of ordinary skill in the art.

SUMMARY OF THE INVENTION

The present invention has been made in an effort to provide a wireless communication system for geographically controlling a communication area caused by an access point by using jamming.

An exemplary embodiment of the present invention provides a wireless communication system for geographically controlling a communication area including an access point for communicating with a terminal in a first area, and a jammer for generating noise for intercepting communication between the access point and a terminal in a second area. A jamming boundary for dividing an area in which the terminal can communicate with the access point and an area in which the terminal cannot communicate with the access point in an

area in which the first area and the second area are overlapped is formed, and the jamming boundary is formed by a ratio between power of a signal transmitted to the terminal by the access point and power of a signal of the noise.

When power of the signal transmitted to the terminal by the access point corresponds to power of the noise generated by the jammer, the jamming boundary is formed at a point having the same distance from the access point and the jammer, respectively.

The jamming boundary moves toward the access point as power of the noise is increased compared to power of a signal transmitted to the terminal by the access point, and the jamming boundary moves toward the jammer as power of the noise is decreased compared to power of a signal transmitted to the terminal by the access point.

The jamming boundary is proportional to the distance between the access point and the terminal and the distance between the jammer and the terminal, and signal power of the access point received by the terminal corresponds to power of the noise received by the terminal at the jamming boundary.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a general wireless network environment of a company.

FIG. 2 shows a wireless communication system according to an exemplary embodiment of the present invention.

FIG. 3 shows signal power P_R of an access point 100 received by a terminal 200 based on the distance between the access point 100 and the terminal 200.

FIG. 4 shows a form of a jamming boundary (b) according to power of an access point 100 and a jammer 300.

FIG. 5 shows a secure wireless zone formed when two jammers J1 and J2 are provided near an access point 100.

FIG. 6 shows a secure wireless zone formed when four jammers J1, J2, J3, and J4 are provided near an access point 100.

DETAILED DESCRIPTION OF THE
EMBODIMENTS

In the following detailed description, only certain exemplary embodiments of the present invention have been shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

Throughout the specification, unless explicitly described to the contrary, the word "comprise" and variations such as "comprises" or "comprising" will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

In the specification, an access point (AP) may indicate a base station (BS), a node B, an evolved node B (eNodeB), a radio access station (RAS), a base transceiver station (BTS), and a mobile multihop relay (MMR)-BS, and it may include entire or partial functions of the node B, the eNodeB, the AP, the RAS, the BTS, and the MMR-BS.

Also, a terminal may indicate an access terminal (AT), a mobile terminal (MT), a mobile station (MS), a subscriber station (SS), a portable subscriber station (PSS), and user equipment (UE), and it may include entire or partial functions of the AT, the MT, the MS, the SS, the PSS, and the UE.

In the present specification, a jamming boundary represents a boundary where a communication area of an access point is controlled by a jammer, and the communication area controlled by the jammer is defined to be a protected wireless zone.

A wireless communication system according to an exemplary embodiment of the present invention will now be described in detail with reference to accompanying drawings.

FIG. 2 shows a wireless communication system according to an exemplary embodiment of the present invention. Referring to FIG. 2, the wireless communication system includes an access point 100, a terminal 200, and a jammer 300.

The access point 100 communicates with the terminal 200 through a specific frequency. In this instance, received signal power P_R of the access point 100 received by the terminal 200 is expressed in Equation 1.

$$P_R = G_{AP-T} \cdot P_{AP} \cdot G_{T-AP} \frac{\lambda^2}{(4\pi)^2 (d_{AP-T})^4} \quad \text{[Equation 1]}$$

Here, G_{AP-T} represents an antenna gain of the access point 100 in the direction of the terminal 200, P_{AP} indicates signal power output by the antenna, and G_{T-AP} shows an antenna gain of the terminal 200 in the direction of the access point 100. Also, λ represents wavelength of a signal output by the antenna of the access point 100, and d_{AP-T} is a distance between the access point 100 and the terminal 200.

The signal power P_R of the access point 100 received by the terminal 200 in Equation 1 can be shown as FIG. 3 based on the distance between the access point 100 and the terminal 200.

Referring to FIG. 3, signal power of the access point 100 received by the terminal 200 is reduced as the terminal 200 becomes far from the access point 100.

When noise power P_n is constant in FIG. 3, the signal-to-noise ratio (SNR) at the distance d_i from the access point 100 is P/P_n , and the SNR at the point ($P_{AP}=P_n$) where power of the signal and the noise is the same becomes 1 (0 dB).

In this instance, the case in which the SNR is 1 represents that the terminal 100 receives no signal from the access point 100, and the terminal 200 can communicate with the access point 100 in the area C_{AP} included in the circle with the radius d_{AP} with respect to the access point 100. That is, in FIG. 2 the area C_{AP} that is included in the circle with the radius d_{AP} with respect to the access point 100 indicates the area where the terminal 200 can communicate with the access point 100.

Further, in FIG. 2, the jammer 300 generates and transmits noise so as to present an obstacle to communication by the terminal 200 with the access point 100. The signal power of the jammer 300 received by the terminal 200 is reduced as the terminal 200 is far from the jammer 300 as shown in FIG. 3, and the SNR becomes 1 at the point ($P_J=P_n$) where the jammer's noise and noise power are equal (0 dB).

In this instance, the case in which the SNR is 1 signifies that the terminal 100 is no longer influenced by the noise of the jammer 300, and the terminal 200 receives noise caused by the jammer 300 in the area C_J included in the circle with the radius d_J with respect to the jammer 300. That is, in FIG. 2, the area C_J included in the circle with the radius d_J with respect to the jammer 300 represents the area where the terminal 200 receives noise from the jammer 300.

In FIG. 2, a jamming boundary (b) is formed in the common area of the area C_A in which the terminal 200 can communicate with the access point 100 and the area (C_J) in which the terminal 200 receives noise from the jammer 300.

When the terminal 200 is provided on the side of the access point 100 with reference to the jamming boundary (b) in the common area, the terminal 200 can receive a signal of the access point 100, and when the terminal 200 is provided on the side of the jammer 300 with reference to the jamming boundary (b), the terminal 200 cannot receive the signal of the access point 100 because of noise of the jammer 300.

The signal power P_R of the access point 100 received by the terminal 200 on the jamming boundary (b) corresponds to the signal power of the jammer 300 received by the terminal 200, and satisfies Equation 2.

$$\frac{P_{AP-T}}{P_{J-T}} = \frac{G_{AP-T} \cdot P_{AP} \cdot G_{T-AP} \frac{\lambda_{AP}^2}{(4\pi)^2 (d_{AP-T})^4}}{G_{J-T} \cdot P_J \cdot G_{T-J} \frac{\lambda_J^2}{(4\pi)^2 (d_{J-T})^4}} = 1 \quad \text{[Equation 2]}$$

Here, P_{AP-T} represents signal power received by the terminal 200 from the access point 100, and P_{J-T} indicates signal power received by the terminal 200 from the jammer 300.

In this instance, assuming that the access point 100 and the jammer 300 use the same antenna and frequency ($G_{AP-T}=G_{J-T}$, $G_{T-AP}=G_{T-J}$ and $\lambda_{AP}=\lambda_J$), Equation 2 can be expressed as Equation 3.

$$P_{AP} \cdot P_J = (d_{AP-T})^4 \cdot (d_{J-T})^4 \quad \text{[Equation 3]}$$

According to Equation 3, the jamming boundary (b) depends on power of the access point 100 and the jammer 300, and distance among the access point 100, the jammer 300, and the terminal 100.

In detail, the form of the jamming boundary (b) according to power of the access point 100 and the jammer 300 will be described.

FIG. 4 shows a form of a jamming boundary (b) according to power of an access point 100 and a jammer 300, and Table 1 shows a power relation of the access point 100 and the jammer 300 for the jamming boundary (b) of FIG. 4.

TABLE 1

Loss Exponent	n = 2	n = 4
b ₁	3P _A = P _J	9P _A = P _J
b ₂	2P _A = P _J	4P _A = P _J
b ₃	P _A = P _J	P _A = P _J
b ₄	P _A = 2P _J	P _A = 4P _J
b ₅	P _A = 3P _J	P _A = 9P _J

In FIG. 4, the access point 100 is provided at (0,0) in the x-y plane, and the jammer 300 is provided at (j,0) in the x-y plane.

Referring to FIG. 4 and Table 1, when the access point 100 and the jammer 300 have the same power, the jamming boundary (b) is formed by the straight line (b₃) generated by connecting the points having the same distance from the access point 100 and the jammer 300, respectively.

As power P_J of the jammer 300 is increased in proportion to power P_{AP} of the access point 100, the jamming boundary (b) approaches the access point 100.

In detail, when power P_J of the jammer 300 becomes four times the power P_{AP} of the access point 100 (i.e., $P_J=4P_{AP}$), the jamming boundary (b) forms a circle (b₂) with the center of (-j/2,0) and the radius of $\sqrt{2} \cdot (j/2)$. Also, when power P_J of the jammer 300 becomes nine times the power P_{AP} of the access point 100 (i.e., $P_J=9P_{AP}$), the jamming boundary (b) forms a circle (b₁) with the center of (-j/2,0) and the radius of $\sqrt{3} \cdot (j/2)$.

That is, as power P_J of the jammer 300 is increased compared to power P_{AP} of the access point 100, the center of the circle forming the jamming boundary (b) moves towards the access point 100, and the radius of the circle forming the jamming boundary (b) is reduced.

On the contrary, when power P_{AP} of the access point 100 is increased to be greater than the power P_J of the jammer 300, the jamming boundary (b) is formed near the jammer 300 (b4) and (b5).

Here, the loss exponent (n) is variable by environmental conditions, and it is given as 2 in the free space (n=2), it is given as 4 on the flat surface (n=4), and it is given as greater than 4 in the internal space except the tunnel. FIG. 4 shows the case of a flat surface (n=4).

The case in which an access point 100 is surrounded by a plurality of jammers 300_1, 300_2, . . . 300_n will now be described.

When K jammers 300_1, 300_2, . . . 300_k using the same frequency are provided near the access point 100, signal power P_R of the access point 100 received by the terminal 200 is expressed in Equation 4.

$$P_R = P_{AP-T} + \sum_i^k P_{J_i-S} + N \quad \text{[Equation 4]}$$

Here, P_{AP-T} represents signal power from the access point 100, P_{J_i-S} indicates signal power from the i-th jammer (J_i, 300_i), and N is an environmental noise floor. That is, a plurality of jammers 300_1, 300_2, . . . 300_k obstruct the terminal 200 in receipt of a signal from the access point 100.

In this instance, if the environmental noise floor N is ignored, the SNR at the point (x,y) is expressed in Equation 5.

$$SNR = \frac{P_{AP-T}(x,y)}{\sum_i^k P_{J_i-T}(x,y)} \quad \text{[Equation 5]}$$

Here, $P_{J_i-T}(x,y)$ represents the function of (x,y) for indicating signal power transmitted from the jammer (300_i, J_i) to the point of (x,y), and can communicate with the access point 100 in the area having the value of Equation 5 that is greater than 1.

In the situation of a plurality of jammers 300_1, 300_2, . . . 300_k, the area that can be communicated with the access point 100 is included in the area where the areas available for communication with the access point 100 for a plurality of respective jammers 300_1, 300_2, . . . 300_k are overlapped.

In this instance, when the area available for communication with the access point 100 is intercepted from the outside, the intercepted area will be called a "secure wireless zone."

Hereinafter, the secure wireless zone will be described in detail with reference to FIG. 5 and FIG. 6.

FIG. 5 shows a secure wireless zone formed when two jammers J1 and J2 are provided near an access point 100.

The jamming boundary (b) is formed at the point where signal power (P_R) of the access point 100 received by the terminal 200 according to Equation 2 corresponds to a summation of signal power of the jammers J1 and J2 received by the terminal 200. In detail, the jamming boundary (b) is formed as in Equation 6.

$$\frac{P_{AP-T}(x,y)}{P_{J_1-T}(x,y) + P_{J_2-T}(x,y)} = 1 \quad \text{[Equation 6]}$$

Assuming that the access point 100 is provided at (0,0) on the x-y plane, J1 is provided at (-j,0), J2 is provided at (j,0), the terminal 200 is provided at (x,y), and the access point 100 and the jammers J1 and J2 use the same antenna and frequency ($G_{AP-J} = G_{J_1-T} = G_{J_2-T}$, $G_{T-AP} = G_{T-J_1} = G_{T-J_2}$ and $\lambda_{AP} = \lambda_{J_1} = \lambda_{J_2}$), Equation 6 can be expressed as Equation 7.

$$\frac{P_{AP}}{(D_{AP-T})^n} = \frac{P_{J_1}}{(D_{J_1-T})^n} + \frac{P_{J_2}}{(D_{J_2-T})^n} \quad \text{[Equation 7]}$$

Assuming that the loss exponent is n=2, and $P_{AP} = P_{J_1} = P_{J_2}$ in the free space, the jamming boundary is expressed as Equation 8.

$$\frac{1}{x^2 + y^2} = \frac{1}{(x-j)^2 + y^2} + \frac{1}{(x+j)^2 + y^2} \quad \text{[Equation 8]}$$

In FIG. 5, the inner part of the jamming boundary with respect to the access point 100 is a "secure wireless zone."

FIG. 6 shows a secure wireless zone that is formed when four jammers J1, J2, J3, and J4 are provided near the access point 100. In this instance, the distance between the jammers J1, J2, J3, and J4 and the access point 100 is given as j.

In FIG. 6, 3 cases including the first case in which power P_J of the four jammers J1, J2, J3, and J4 is respectively less than power P_{AP} of the access point 100 ($P_{AP} > P_J$), the second case in which power P_J of the four jammers J1, J2, J3, and J4 is respectively equal to power P_{AP} of the access point 100 ($P_{AP} = P_J$), and the third case in which power P_J of the four jammers J1, J2, J3, and J4 is respectively greater than power P_{AP} of the access point 100 ($P_{AP} < P_J$) are applicable.

Referring to the power relationship between the access point 100 and the jammer 300 and the jamming boundary (b) of Table 1, in FIG. 6, Z1 indicates an intersection of the areas accessible to the access point 100 under each single jammer J1, J2, J3, and J4, Z2 represents an area accessible to the access point 100 under four jammers J1, J2, J3, and J4 in the case of n=4, and Z3 shows an area accessible to the access point 100 under four jammers J1, J2, J3, and J4 in the case of n=2.

In FIG. 6, Z2 and Z3 are included in Z1, and as n is increased, the size of the area accessible to the access point 100 is increased to be approximated as Z1.

Table 2 shows the size of the secure wireless zone according to the loss exponent and the jammer's power. Referring to Table 2, the size of Z2 is 54_63% of Z1, and the size of Z3 is 86_90% of Z1.

TABLE 2

	Area	P_A	Size	Relative size
Case (a)	Z ₁	4P _J (n = 4)	1.72j ²	100%
	Z ₂	2P _J (n = 2)	1.48j ²	86.0%
	Z ₃	2P _J	1.09j ²	63.4%
Case (b)	Z ₁	P _J (n = 2 or 4)	j ²	100%
	Z ₂	P _J	0.91j ²	90.8%
	Z ₃	P _J	0.63j ²	63.2%

TABLE 2-continued

	Area	P_A	Size	Relative size
Case (c)	Z_1	$0.25P_J (n=4)$ $0.5P_J (n=2)$	$0.63j^2$	100%
	Z_2	$0.25P_J$	$0.55j^2$	87.8%
	Z_3	$0.5P_J$	$0.34j^2$	54.7%

As described above, according to the exemplary embodiment of the present invention, information leakage can be fundamentally prevented by actually controlling the communication area of the access point compared to the existing logical wireless network protecting methods.

Further, the current invention is applicable to the general communication system since it does not depend on a special protocol but uses power of the jammer and a relative position of the terminal.

In addition, regarding the attempt for the jammer to escape from the radio channel, since the jammer influences the adjacent channel, the trial of escape can be prevented by extending the several number of the jamming channels of the jammer. In detail, 13 channels can be covered by jamming 4 to 5 channels in the 2.4 GHz bandwidth of the IEEE 802.11.

According to an embodiment of the present invention, a wireless communication system for geographically controlling a communication area caused by an access point by using jamming is provided.

The above-described embodiments can be realized through a program for realizing functions corresponding to the configuration of the embodiments or a recording medium for recording the program in addition to through the above-described device and/or method, which is easily realized by a person skilled in the art.

While this invention has been described in connection with what is presently considered to be practical exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

The invention claimed is:

1. A wireless communication system for geographically controlling a communication area, comprising:

an access point for communicating with a terminal in a first area; and

a jammer for generating noise for intercepting communication between the access point and the terminal in a second area,

wherein a jamming boundary for dividing an area in which the terminal can communicate with the access point and an area in which the terminal cannot communicate with the access point in an area in which the first area and the second area are overlapped is formed, and

a position of the jamming boundary is determined based on a ratio between power of a signal transmitted to the terminal by the access point and power of a signal of the noise.

2. The wireless communication system of claim 1, wherein,

when power of the signal transmitted to the terminal by the access point corresponds to power of the noise, the jamming boundary is formed at a point having the same distance from the access point and the jammer, respectively.

3. The wireless communication system of claim 1, wherein the jamming boundary moves toward the access point as power of the noise is increased compared to power of a signal transmitted to the terminal by the access point.

4. The wireless communication system of claim 1, wherein the jamming boundary moves toward the jammer as power of the noise is decreased compared to power of a signal transmitted to the terminal by the access point.

5. The wireless communication system of claim 1, wherein the jamming boundary is proportional to the distance between the access point and the terminal and the distance between the jammer and the terminal.

6. The wireless communication system of claim 1, wherein signal power of the access point received by the terminal corresponds to power of the noise received by the terminal at the jamming boundary.

7. The wireless communication system of claim 1, wherein the signal to noise ratio for a signal from the access point on the boundary of the first area is 1, and the signal to noise ratio for a signal from the jammer on the boundary of the second area is 1.

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