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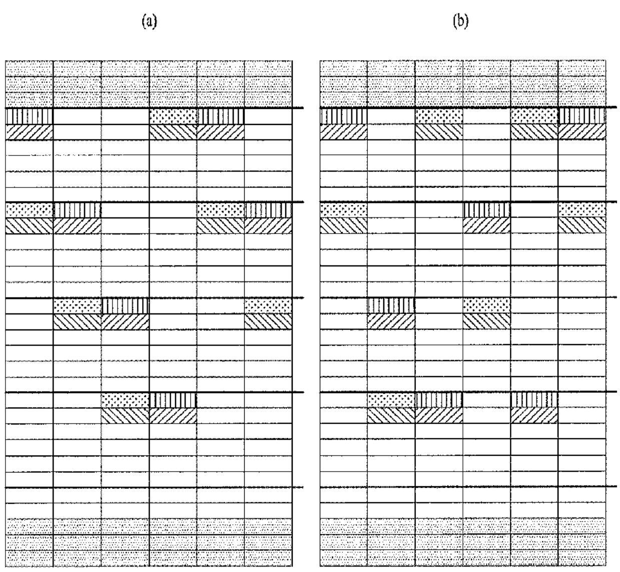
[Continued on next page]

(54) Title: FREQUENCY HOPPING PATTERN AND METHOD FOR TRANSMITTING UPLINK SIGNALS USING THE SAME

FIG. 3



(57) Abstract: A frequency hopping pattern and a method for transmitting uplink signals using the same are disclosed. A frequency hopping pattern is defined by combination of subband hopping, which is performed over one or more subbands divided from a system band for transmission of the uplink signals, and mirroring where resource blocks within one subband are arranged reversely based on the center of the subband. Sequences as to whether to apply mirroring and subband hopping amount are cell-specific random numbers, and are generated independently or in combination.

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FREQUENCY HOPPING PATTERN AND METHOD FOR TRANSMITTING UPLINK SIGNALS USING THE SAME

[DESCRIPTION]

TECHNICAL FIELD

The present invention relates to a mobile communication system, and more particularly, to a method for efficiently establishing frequency hopping and a method for transmitting uplink signals using the same.

BACKGROUND ART

In a multiple carrier cellular mobile communication system, a frequency hopping method is used to obtain frequency diversity for improving receiving performance of a base station with respect to a packet transmitted from a user equipment (UE) to an uplink. The frequency hopping method means that a spectrum of a carrier modulated by an information signal is hopped within a wide and constant frequency band.

This frequency hopping method is mainly used in either an anti-jamming system for impeding an influence of jamming which is an impedance signal serving to intentionally or non-intentionally deteriorate performance of the communication system, or a communication system in which many users share a common channel. Frequency hopping can be used to improve sensitivity to slow fading and to improve a carrier to interference (C/I) margin in a cellular wireless telephone system.

It is preferable that frequency hopping used to transmit uplink signals as described above satisfies the following requirements.

First of all, the frequency hopping should ensure frequency diversity.

Second, the frequency hopping should ensure interference randomization.

The above requirements are regarded as basic requirements for frequency hopping.

In addition, in a wireless communication system, which uses multiple carriers, including 3GPP LTE system, SC-FDMA mode is adopted for uplink signal transmission. In other words, DFT is performed for a transport signal to solve a problem such as PAPR in uplink transmission, whereby a feature similar to that of single carrier transmission can be obtained.

In this regard, frequency hopping should ensure a single carrier feature for uplink transmission. To this end, uplink signals are preferably arranged in continuous frequency regions.

Meanwhile, uplink transmission of a specific user equipment (UE) can be performed through a specific frequency region in accordance with frequency selective scheduling of a base station. Uplink transmission of a user equipment which uses frequency hopping is preferably established so as not collide with a signal of a user equipment (UE) which follows frequency selective scheduling. Accordingly, a frequency hopping pattern should be established considering frequency selective scheduling.

DETAILED DESCRIPTION OF THE INVENTION

TECHNICAL PROBLEMS

Accordingly, the present invention is directed to a method for efficiently establishing a frequency hopping pattern and a method for transmitting uplink signals using the same, which substantially obviate one or more problems due to limitations and disadvantages of the related art.

An object of the present invention is to provide a method for establishing a frequency hopping pattern which satisfies the aforementioned requirements and efficiently transmitting uplink signals using the frequency hopping pattern.

TECHNICAL SOLUTIONS

In one aspect of the present invention, a method for transmitting uplink signals in time domain transmission unit of a predetermined size comprises mapping the uplink signals with a specific resource block index in accordance with a predetermined frequency hopping pattern; and transmitting the uplink signals through a resource block corresponding to the mapped resource block index, wherein the predetermined frequency hopping pattern is defined to include subband hopping performed over one or more subbands divided from a system band for transmission of the uplink signals, and the subband hopping is defined that a resource block index used for transmission of the uplink signals in the specific time domain transmission unit becomes an index obtained by allowing a predetermined reference index to undergo cyclic shift, as much as a specific integer multiple of the number of resource blocks included in the one subband, within the range of a resource block region to which the frequency hopping can be applied.

At this time, the subband hopping is equally applied to transmission of uplink signals of all user equipments (UE) within a cell.

Also, the predetermined reference index is a resource block index used for transmission of the uplink signals in a time domain transmission unit followed by the specific time domain transmission unit or a resource block scheduled from a base station.

At this time, an integer value corresponding to the specific integer multiple is generated as a cell-specific random value. Specifically, the cell-specific random value is given by an m-sequence generator which uses cell-specific information as an initial value. Also, the specific integer multiple (m) is given by calculation which includes performing modular calculation for a state value (a) of a shift register of the m-sequence generator using an integer obtained by subtracting 1 from the number (M) of the subbands; and adding 1 to the modular calculated value.

Preferably, resource blocks used for transmission of uplink signals of one user equipment (UE) are located in a single subband.

Also, the method further comprises receiving uplink scheduling grant information as to whether to apply the frequency hopping. The time domain transmission unit of the predetermined size is slot or subframe. Frequency hopping according to the predetermined frequency hopping pattern is used in interlace unit in which HARQ process is operated.

Furthermore, the predetermined frequency hopping pattern is defined to further include mirroring which allows resource blocks within one subband to be arranged reversely based on the center of the subband.

In another aspect of the present invention, a method for transmitting uplink signals in time domain transmission unit of a predetermined size comprises mapping the uplink signals with a specific resource block index in accordance with a predetermined frequency hopping pattern; and transmitting the uplink signals through a resource block corresponding to the mapped resource block index, wherein the predetermined frequency hopping pattern is defined by combination of subband hopping, which is performed over one or more subbands divided from a system band for transmission of the uplink signals, and mirroring where resource blocks within one subband are arranged reversely based on the center of the subband, and the subband hopping is defined that a resource block index used for transmission of the uplink signals in the specific time domain transmission unit becomes an index obtained by allowing a predetermined reference index to undergo cyclic shift, as much as a specific integer multiple of the number of resource blocks included in the one subband, within the range of a resource block region to which the frequency hopping can be applied.

ADVANTAGEOUS EFFECTS

According to the aforementioned frequency hopping pattern and the method for transmitting uplink signals using the same, a frequency hopping pattern can be defined easily to ensure frequency diversity and interference randomization.

Also, as far as uplink transmission of one user equipment is performed within one subband, a single carrier feature of uplink transmission can be maintained.

Moreover, the frequency hopping can easily coexist with scheduling UE in accordance with establishment of index relation such as scheduling RB index, subband hopping, mirroring, etc.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagram illustrating a concept of mirroring according to one embodiment of the present invention;

FIG. 2 is a diagram illustrating a concept of subband hopping according to one embodiment of the present invention;

FIG. 3 is a diagram illustrating a method of using subband hopping according to one embodiment of the present invention in detail;

FIG. 4 is a diagram illustrating a problem that may occur when uplink transmission of one user equipment is not performed within one subband in a state that subband hopping is performed in accordance with one embodiment of the present invention;

FIG. 5 is a graph illustrating a graph, which compares four kinds of performance that can combine inter-subframe hopping with inter-slot hopping to identify their performance;

FIG. 6 is a diagram illustrating a concept of subbband based mirroring in accordance with one embodiment of the present invention;

FIG. 7 is a diagram illustrating an example of combining subband hopping with subband based mirroring in accordance with one embodiment of the present invention; and

FIG. 8 is a diagram illustrating a concept of frequency hopping performed for each interlace for HARQ process in accordance with one embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Hereinafter, the preferred embodiments of the present invention will be described with reference to the accompanying drawings. It is to be understood that the detailed description, which will be disclosed along with the accompanying drawings, is intended to describe the exemplary embodiments of the present invention, and is not intended to describe a unique embodiment with which the present invention can be carried out. Hereinafter, the following detailed description includes detailed matters to provide full understanding of the present invention. However, it will be apparent to those skilled in the art that the present invention can be carried out without the detailed matters. For example, although the following description will be made based on some terminologies, the following description will not be limited to such terminologies and other terminologies may be designated as same meaning.

Meanwhile, in some cases, to prevent the concept of the present invention from being ambiguous, structures and apparatuses of the known art will be omitted, or will be shown in the form of a block diagram and/or a flow chart based on main functions of each structure and apparatus. Also, wherever possible, the same reference numbers will be used throughout the drawings and the specification to refer to the same or like parts.

In a frequency hopping pattern, one user equipment (UE) can use different frequency bands where data packets are transmitted within a time domain transmission unit for one data packet, for example, a transmission time interval (TTI). At this time, the time domain transmission unit could be a slot or subframe in accordance with requirements of the system. Also, one user equipment (UE) can use different frequency bands, in which data packets are transmitted, per retransmission of packet for same data. If two or more different frequency bands are used for one data packet or retransmission data packets, a receiving side can acquire frequency diversity gain when receiving one data packet or retransmission packets for same data.

Hereinafter, two modes, i.e., mirroring and subband hopping will be described as the aforementioned frequency hopping patterns.

First of all, mirroring according to one embodiment of the present invention suggests that all uplink signal transmission bands undergo mirroring per time domain transmission unit. In this case, "mirroring" means that frequency hopping is performed in such a manner that a resource block within a frequency band where mirroring is performed is arranged reversely based on a specific reference frequency region. Hereinafter, mirroring will be described with reference to the accompanying drawing.

FIG. 1 is a diagram illustrating a concept of mirroring according to one embodiment of the present invention.

In FIG. 1, a horizontal axis represents a time domain, and a vertical axis represents a frequency region. One transmission unit in the time domain could be one slot or one subframe in accordance with a unit of frequency hopping. In the example of FIG. 1, it is assumed that the time domain transmission unit is a slog having a predetermined size (ns) and an uplink signal, which is transmitted, is a physical uplink shared channel (PUSCH) of the 3GPP LTE system.

In the 3GPP LTE system, both end parts of a system band are allocated for transmission of a physical uplink control channel (PUCCH). Accordingly, a band except for a region for PUCCH signal transmission corresponds to the system band to which frequency hopping can be applied.

First of all, four packet data transmitted from slot 0 are changed with one another in slot 1 based on the center of the system band. The four packet data are again changed with one another in slot 2 based on the center of the system band and then transmitted to the same position as slot 3.

If frequency hopping is defined as above, it is advantageous in that frequency hopping can be defined very simply. Also, it is advantageous in that resource blocks (RB) for frequency selective scheduling can be allocated continuously.

However, if mirroring as illustrated in FIG. 1 is only used, it is difficult to obtain interference randomization. Also, frequency diversity is acquired by only two types of frequency hopping patterns. Furthermore, frequency diversity through frequency hopping is varied depending on RBs allocated for specific uplink packet transmission. Moreover, frequency selectivity over a frequency selective scheduling band may be very small depending on the amount of frequency hopping RBs.

In this respect, it is preferable that the aforementioned mirroring is used if a relatively small system band is used or RBs used for frequency hopping are small. Accordingly, the preferred embodiments of the present invention, which will be described later, suggest that a system band where frequency hopping is performed is divided into one or more subbands. Also, as another frequency hopping pattern, subband hopping will be described using a concept of subband in accordance with one embodiment of the present invention. Moreover, after the aforementioned mirroring is described with respect to a concept based on subband, a method of combining subband hopping with subband based mirroring will be described.

First of all, subband hopping according to one embodiment of the present invention will be described.

FIG. 2 is a diagram illustrating a concept of subband hopping according to one embodiment of the present invention.

In subband hopping according to the embodiment of the present invention, a system band for uplink signal transmission is divided into one or more subbands. Namely, it is assumed that the system band for uplink signal transmission includes $N_{\mathrm{RB}}^{\mathrm{UL}}$ number of RBs and is divided into N_{sb} number subbands each of which includes $N_{\mathrm{RB}}^{\mathrm{sb}}$ number of RBs. After the aforementioned system band is divided into one or more subbands, subband hopping can be established in such a manner that it is performed in subband unit.

In the example of FIG. 2, N_{sb} =4, $N_{\mathrm{RB}}^{\mathrm{sb}}$ =6 RB, and two RBs are not used for frequency hopping. Namely, in the embodiment of the present invention, subband hopping can be performed on a frequency region, which is divided into subbands, not the system band, wherein the frequency region includes N_{RB}^{FH} (= N_{sb} * $N_{\mathrm{RB}}^{\mathrm{sb}}$) number of RBs. However, the example of FIG. 2 is only exemplary, and subband hopping according to the embodiment of the present invention will not limited to the aforementioned subband structure.

The embodiment of the present invention suggests that the user equipment (UE) sets RB index used for uplink transmission to become an index cyclically shifted based on a subband unit in a specific slot. Namely, the amount for moving the reference index is set to become a specific integer multiple of the number of RBs included in one subband, and the specific integer multiple can be set to a random number.

If the reference index is set to an index used in a previous slot in the detailed embodiment, a subband hopping pattern according to the embodiment of the present invention can be expressed as follows.

[Equation 1]

$$RB(t) = \left(RB(t-1) + a(t) \cdot N_{\mathrm{RB}}^{\mathrm{sb}}\right) \bmod N_{RB}^{FH}$$

In the above Equation 1, RB(t) represents RB index (RB index given within N_{RB}^{FH} RB) used for uplink transmission in the tth slot (or subframe). Accordingly, in case of the first slot (or subframe), an uplink signal is transmitted using RB index scheduled from the base station.

Also, a(t) represents a cell-specific random number generated within the range of 1 to N_{sb} -1. In this case, it is preferable that a value of a(t) in a specific time is commonly applied to all user equipments (UE) within a single cell. As a result, collision between different user equipments (UE) can be avoided in PUSCH transmission.

FIG. 3 is a diagram illustrating a method of using subband hopping according to one embodiment of the present invention in detail.

Subband hopping according to the embodiment of the present invention can be performed simply by a(t)=1. (a) of FIG. 3 illustrates an example where one subband shifts per transmission slot (subframe) as a(t)=1 is set as above. Meanwhile, (b) of FIG. 3 illustrates an example where a(t) is randomly set to a cell specific random number.

As described above, since subband hopping in the embodiment of the present invention is commonly applied to uplink signal transmission of all user equipments (UE0 within a cell, collision between different user equipments for signal transmission can be avoided.

Meanwhile, if the aforementioned subband hopping is used in connection with FIG. 2 and FIG. 3, uplink signal transmission of one user equipment is preferably performed through the same subband.

FIG. 4 is a diagram illustrating a problem that may occur when uplink transmission of one user equipment is not performed within one subband in a state that subband hopping is performed in accordance with one embodiment of the present invention.

As illustrated in FIG. 4, if uplink signal transmission of one user equipment is performed for two subbands, the uplink signal transmission of one user equipment can be performed through a non-continuous frequency band in accordance with the subband hopping pattern. In FIG. 4, if a PUSCH signal of user equipment UE1 is transmitted to two subbands in slot 0, PUSCH transmission of the user equipment UE1 is performed through a non-continuous frequency band in slot 1 in accordance with the subband hopping pattern, whereby a single carrier feature is lost in uplink transmission. Accordingly, the embodiment of the present invention suggests that uplink signal transmission of one user equipment (UE) is performed through a single subband.

Meanwhile, although it is assumed that RB index used in a previous slot (or subframe) is used as the reference index in the Equation 1, another reference index can be used as described above. For example, RB index initially allocated by persistent scheduling command or RB index with respect to initial transmission or random retransmission by dynamic scheduling command can be used as the reference RB index. At this time, a(t)*N_{sb} represents shift from the RB index scheduled as above to RB index used for uplink transmission at a specific time.

In the aforementioned subband hopping according to the embodiment of the present invention, interference randomization can be acquired by applying a cell-specific random number a(t). Also, frequency diversity can be acquired using N_{sb} number of hopping patterns. Moreover, an uplink signal transmitted from one user equipment is allocated to one subband so that a single carrier feature can be maintained in uplink transmission.

For the aforementioned frequency hopping, the embodiment of the present invention suggests the following signaling information.

First of all, in order to specify a frequency hopping mode, i.e., in order to inform whether mirroring or subband hopping is used, it is preferable that broadcast or RRC signaling information of 1 bit is received. Also, it is preferable that signaling information for uplink scheduling grant is received. This uplink scheduling grant can be used for on/off signaling of frequency hopping with 1 bit, and can be received through a physical downlink control channel (PDCCH).

Furthermore, it is preferable that signaling of the number N_{sb} of subbands within the system band and the number N_{RB}^{sb} of RBs included in the subband is received. If any one of signaling of the number of N_{sb} of subbands and signaling of the number N_{RB}^{sb} of RBs is identified, the other one can be identified. Accordingly, it is more efficient that any one of signaling of the number of N_{sb} of subbands and signaling of the number N_{RB}^{sb} of RBs is performed. Although the embodiment of the present invention suggests that N_{RB}^{sb} is set to have a range of 10~50 RBs and received as signaling information of 6 bits, N_{RB}^{sb} is not limited to the above embodiment.

In the Equation 1, a(t) can be generated by m-sequence generator. Also, synchronization between different user equipments (UE) can be performed through RRC signaling for the m-sequence generator status or RRC signaling for relationship between the m-sequence generator status and system frame number.

Meanwhile, the aforementioned frequency hopping can be performed by inter-subframe hopping, inter-slot hopping or their combination.

FIG. 5 is a graph illustrating a graph, which compares four kinds of performance that can combine inter-subframe hopping with inter-slot hopping to identify their performance.

In more detail, FIG. 5 illustrates a link-level processing rate for a case where inter-subframe frequency hopping is only performed, a case where inter-slot frequency hopping is only performed, and a case where both inter-subframe frequency hopping and inter-slot frequency hopping are performed.

According to the result illustrated in FIG. 5, inter-subframe hopping represents a relatively high processing rate in a low SNR region, and combination of inter-subframe hopping and inter-slot hopping represents a relatively high processing rate in a high SNR region.

Accordingly, the preferred embodiment of the present invention suggests that an inter-subframe hopping mode is used as a basic hopping mode and inter-slot hopping is semi-statically powered on/off.

Meanwhile, the embodiment of the present invention suggests that subband based mirroring is additionally applied to the aforementioned subband hopping. Namely, in the embodiment of the present invention, a cell-specific mirroring for RBs included in each subband is defined in such a manner that the cell-specific mirroring is added to a hopping pattern by cell-specific cyclic shift, whereby frequency hopping is performed.

FIG. 6 is a diagram illustrating a concept of subbband based mirroring in accordance with one embodiment of the present invention.

In more detail, (a) of FIG. 6 illustrates a case where subband based mirroring is performed and a case where subband based mirroring is not performed under the assumption that one subband includes six RBs. Namely, if it is assumed that number within each RB is RB index in (a) of FIG. 6, RB index is arranged in a reverse order based on a center frequency in the RB within the subband when mirroring is performed within the subband. Meanwhile, (b) of FIG. 6 illustrates a case where transmission packets of different user equipments multiplexed within a specific subband undergo mirroring in next transmission unit and a case where the transmission packets do not undergo mirroring.

The embodiment of the present invention suggests a method of improving frequency diversity gain and inter-cell interference randomization by combining cell-specific cyclic shift type hopping of the subband unit with on/off of cell-specific mirroring within each subband. More particularly, the embodiment of the present invention suggests that on/off pattern of cell-specific mirroring is equally applied to all subbands for a specific TTI of a specific cell so as to simplify a frequency hopping pattern.

FIG. 7 is a diagram illustrating an example of combining subband hopping with subband based mirroring in accordance with one embodiment of the present invention.

In the example of FIG. 7, the PUSCH transmission band is divided into four subbands. A mirroring pattern represents whether a random transmission slot (or subframe) applies mirroring of a previous subband to a previous transmission slot (or subframe). Also, a subband hopping pattern represents whether a random transmission slot (or subframe) applies cyclic shift corresponding to several subframes to a previous transmission slot (or subframe). However, as described above, subband hopping can be used in such a manner that RB index for cyclic shift is defined based on RB index allocated through scheduling with respect to initial transmission or random retransmission not previous slot (or subframe).

Hereinafter, for convenience of description, the amount (a(t) * N_{RB}^{sb}) of index cyclically shifted based on the reference index in accordance with subband hopping is represented as m, and the number N_{sb} of subbands is represented as M.

Hereinafter, a method of defining m value sequence and mirroring on/off sequence in detail under the above assumption will be described.

First of all, a method of defining the aforementioned m value sequence and mirroring on/off sequence respectively will be described.

In the embodiment of the present invention, a method of generating a cell-specific m value sequence between the base station and the user equipment within each cell and a method of generating a cell-specific mirroring on/off sequence are respectively defined. Then, the embodiment of the present invention suggests that frequency hopping transmission and reception are performed by combination of the two sequences. In more detail, the two sequences can be generated using different maximum length sequences.

For example, a cyclic shift pattern of a total of m subbands can be obtained in such a manner that a clock of a m-sequence generator having a specific length increases per transmission time and at the same time the following calculation is performed for a shift register state value 'a' of the m-sequence generator.

[Equation 2]

If $0 \leq m \leq M-1$ is defined, $m = a \bmod M$

However, if the value m generated by the above Equation 2 includes 0, in which the same index as the previous RB index (or reference RB index) is used. The embodiment of the present invention suggests that the following calculation is used to prevent RB index used for uplink signal transmission at a specific time from being identical with the RB index (or reference RB index) used during previous transmission.

[Equation 3]

If $1 \leq m \leq M-1$ is defined, $m = (a \bmod (M-1))+1$

In other words, modular calculation is performed for the shift register state value 'a' of the m-sequence generator using an integer obtained by subtracting 1 from the number M of subbands. And, 1 is added to the modular calculation value to avoid m=0. The embodiment of the present invention suggests that the value m is defined through the above calculation or another calculation which includes the above calculation.

Meanwhile, m value patterns of different cells can be obtained in such a manner that different phase offsets of the m-sequence generator are given to different cells.

Likewise, the mirroring on/off pattern can be defined in such a manner that a value of 0 and a value of 1 are respectively mapped with on/off or off/on with respect to independent m-sequences. Alternatively, one bit of the shift register status value used to generate a cyclic shift pattern of a cell-specific subband is used as the mirroring on/off pattern so that load required to generate two independent random sequences is reduced.

At this time, if the value m represents the amount of cyclic shift for reference transmission not cyclic shift for previous transmission, the value m should be changed per transmission so that the value m is not regarded as the same cyclic shift amount as the previous cyclic shift amount, whereby the same subband is not used for continuous transmission. Namely, when possible cyclic shift of a total of M number of subbands from 0 to M-1 subbands exists, M-1 number of m values from 1 to M-1 are generated per transmission time. In this case, it is suggested that the generated m values are mapped with M-1 number of cyclically shifted values excluding cyclically shifted value mapped with the value m generated at the previous transmission time among M number of cyclically shifted values.

Similarly, one of M number of values from 0 to M-1 is generated as the m value. If the same m value as the m value generated during previous transmission is generated, a specific integer $b(b \neq 0, |b| < M)$ is added to the generated value and modular calculation is performed using M, whereby a value different from the previously generated value m can be obtained.

Next, a method of defining a combined pattern of the aforementioned m value sequence and the mirroring on/off sequence will be described.

Supposing that M-1 number of possible m values exist, a total of (M-1)*2 number of combined patterns of the possible m values and the mirroring on/off sequence are obtained. Accordingly, the (M-1)*2 number of combined patterns are previously mapped with values between 0 and (M-1)*2-1 and then cell-specific random number sequences having values between 0 and (M-1)*2-1 are generated. In this way, the cell-specific frequency hopping pattern can be used.

At this time, the random sequences between 0 and (M-1)*2-1 can be generated using m-sequence (maximum length sequence). Namely, the random sequences can be obtained in such a manner that the clock of the m-sequence generator having a specific length increases per transmission time and at the same time the following calculation is performed for the cyclic shift state value 'a' of the m-sequence generator.

[Equation 4]

If $0 \le m \le M-1$ is defined: m = (a mod (M*2))

If $1 \le m \le M-1$ is defined: m = (a mod ((M-1)x2))

At this time, patterns of different cells can be obtained in such a manner that different phase offsets are given to the different cells.

In this case, (M-1)*2 number of m values are divided into M-1 number of pairs mapped with mirroring on and mirroring off within the amount of a single subband cyclic shift. Also, if cyclic shift is defined for the reference RB index not the previous transmission RB index, M-1 number of possible m value pairs should be changed per transmission so that the m values are not regarded as the same cyclic shift amount as the previous cyclic shift amount, thereby preventing signal transmission from being performed through a single subband in continuous transmission. Namely, when the amount of possible cyclic shifts of a total of M number of subbands from 0 to M-1 subbands exists, the m value pairs are mapped with the subband cyclically shifted values so that the m values generated per transmission time are mapped with M-1 number of cyclically shifted values excluding cyclically shifted value mapped with the m value generated at the previous transmission time among M number of cyclically shifted values.

Similarly, one of 2M number of values from 0 to 2M-1 is generated as the m value. If the same m value, which is mapped with cyclic shift, as the m value generated during previous transmission is generated, a specific integer b($b \neq 0$, $|b| < M$) is added to the cyclically shifted value and modular calculation is performed using M, whereby a value different from the previously generated value m can be obtained.

Additionally, even if the value m is equal to 0, continuous transmission is performed through different frequency bands when mirroring is in on state, whereby minimum frequency diversity and interference randomization can be obtained. Accordingly, the m values are 0 ~ M-1 and 2*M-1 number of combined patterns except for m=0 and mirroring=off among 2*M number of combined patterns obtained through mirroring on/off are mapped with 2*M-1 numbers (for example, 0, 1, …, 2M-2). Then, random number sequences within the above numbers are generated. In this way, the cell-specific frequency hopping pattern can be used.

Furthermore, when the data transmission band is divided into M number of subbands, the number of RBs within each subband may be different from that within another suband if the number of RBs of the data transmission band is not divided exactly by M. The reason why that frequency hopping is defined in subband unit in the SC-FDMA system is that packet transmission of one user equipment is performed through continuous subcarriers to maintain a low PAPR feature. Accordingly, in a state that different bandwidths or RBs exist in different subbands, if the number of RBs in a subband of a minimum bandwidth is defined as RB', it is preferably limited that RBs less than RB' are only allocated for packet transmission to which frequency hopping pattern using subband is applied.

Meanwhile, the aforementioned frequency hopping pattern can be used for each interlace where HARQ process is operated, or can be used in slot unit within each interlace.

Particularly, in the system to which synchronous HARQ is applied, since retransmission of same packets of a random user equipment (UE) is performed at a fixed slot interval, a hopping sequence pattern is preferably operated for each interlace where HARQ process is operated.

FIG. 8 is a diagram illustrating a concept of frequency hopping performed for each interlace for HARQ process in accordance with one embodiment of the present invention.

In detail, (a) of FIG. 8 illustrates a case where four HARQ processes are defined in the system and frequency hopping is applied in subframe (or packet) unit. In this case, the hopping pattern sequence is operated for each HARQ process. Also, in (b) of FIG. 8, one packet is divided into two slots for frequency hopping. At this time, the hopping pattern sequence is operated for each HARQ process in slot unit.

In more detail, a frequency hopping sequence a(n) of a random cell can be defined as follows.

[Equation 5]

$$a(n) = m(n) \text{ modulo } N$$

In the Equation 5, m(n) is an output value using a generator which generates integers more than 0. Particularly, the generator could be m-sequence generator. More particularly, different cells may have different initial values (or phase values) of a shift register which includes m-sequence generator.

It will be apparent to those skilled in the art that the present invention can be embodied in other specific forms without departing from the spirit and essential characteristics of the invention. Thus, the above embodiments are to be considered in all respects as illustrative and not restrictive. The scope of the invention should be determined by reasonable interpretation of the appended claims and all change which comes within the equivalent scope of the invention are included in the scope of the invention.

INDUSTRIAL APPLICABILITY

The aforementioned embodiments of the present invention can equally be applied to various wireless communication systems, which seek diversity gain through frequency hopping, as well as the 3GPP LTE system.

WHAT IS CLAIMED IS:

1. A method for transmitting uplink signals in time domain transmission unit of a predetermined size, the method comprising:

mapping the uplink signals with a specific resource block index in a specific time domain transmission unit in accordance with a predetermined frequency hopping pattern including a subband hopping performed over one or more subbands divided from a system band for transmission of the uplink signals; and

transmitting the uplink signals through a resource block corresponding to the mapped resource block index,

wherein the subband hopping is defined such that the specific resource block index is mapped with an index obtained by performing cyclic shift to a predetermined reference index by an amount of a specific integer multiple (m) of a number of resource blocks included in the one subband within a range of a resource block region to which the frequency hopping is applied.

2. The method of claim 1, wherein the subband hopping is equally applied to transmission of uplink signals of all user equipments (UE) within a cell.

3. The method of claim 1, wherein the predetermined reference index is a resource block index used for transmission of the uplink signals in a previous time domain transmission unit followed by the specific time domain transmission unit or a resource block index scheduled from a base station.

4. The method of claim 1, wherein an integer value corresponding to the specific integer multiple is generated as a cell-specific random value.

5. The method of claim 4, wherein the cell-specific random value is given by an m-sequence generator which uses cell-specific information as an initial value.

6. The method of claim 5, wherein the specific integer multiple (m) is given by calculation operation which includes performing modular calculation for a state value (a) of a shift register of the m-sequence generator using an integer obtained by subtracting 1 from a number (M) of the subbands; and adding 1 to the modular calculated value.

7. The method of claim 1, wherein resource blocks

used for transmission of uplink signals of one user equipment (UE) are located in a single subband.

8. The method of claim 1, further comprising receiving uplink scheduling grant information as to whether to apply the frequency hopping.

9. The method of claim 1, wherein the predetermined frequency hopping pattern is defined to further include mirroring which allows resource blocks within one subband to be arranged reversely based on a center of the subband.

10. The method of claim 1, wherein the time domain transmission unit of the predetermined size is slot or subframe.

11. The method of claim 1, wherein a frequency hopping according to the predetermined frequency hopping pattern is used in a unit of an interlace unit in which HARQ process is operated.

12. A method for transmitting uplink signals in time domain transmission unit of a predetermined size, the method comprising:

mapping the uplink signals with a specific resource block index in accordance with a predetermined frequency hopping pattern; and

transmitting the uplink signals through a resource block corresponding to the mapped resource block index,

wherein the predetermined frequency hopping pattern is defined by combination of subband hopping, which is performed over one or more subbands divided from a system band for transmission of the uplink signals, and mirroring where resource blocks within one subband are arranged reversely based on a center of the subband, and

the subband hopping is defined that a resource block index used for transmission of the uplink signals in the specific time domain transmission unit is mapped to an index obtained by performing cyclic shift to a predetermined reference index by an amount of a specific integer multiple of a number of resource blocks included in one subband, within the range of a resource block region to which the frequency hopping is applied.

FIG. 1

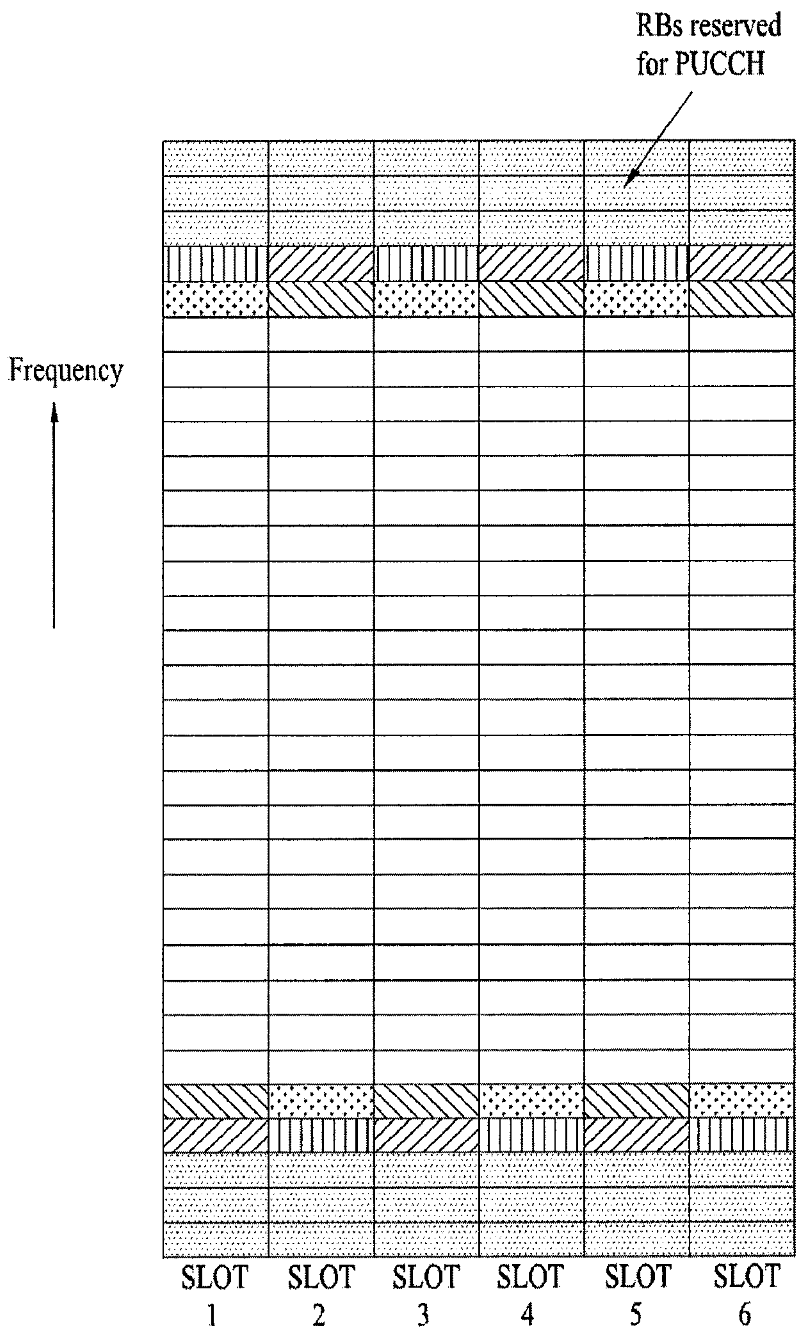

RBs reserved
for PUCCH
Frequency
SLOT 1
SLOT 2
SLOT 3
SLOT 4
SLOT 5
SLOT 6

FIG. 2

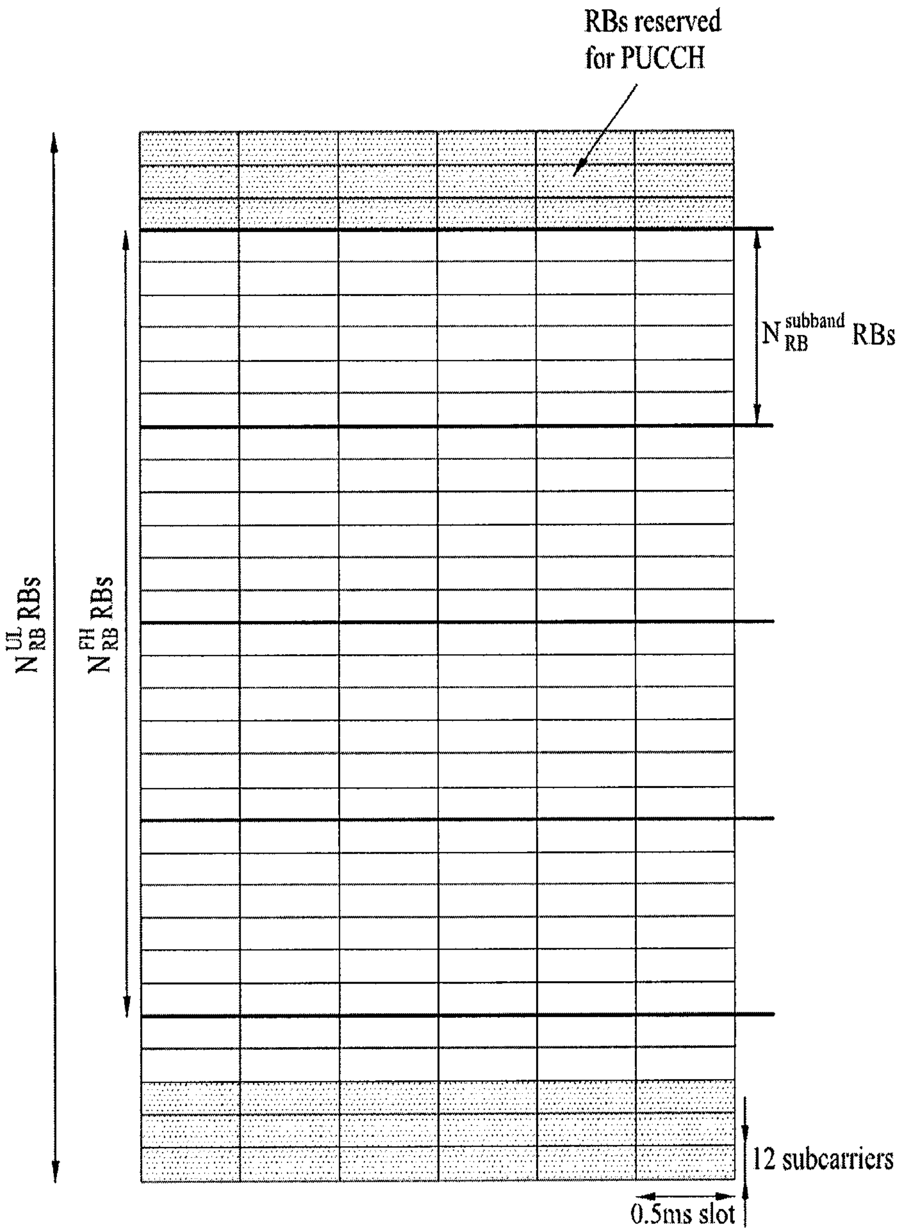

RBs reserved
for PUCCH
$N_{RB}^{subband}$ RBs
N_{RB}^{UL} RBs
N_{RB}^{FH} RBs
12 subcarriers
0.5ms slot

FIG. 3

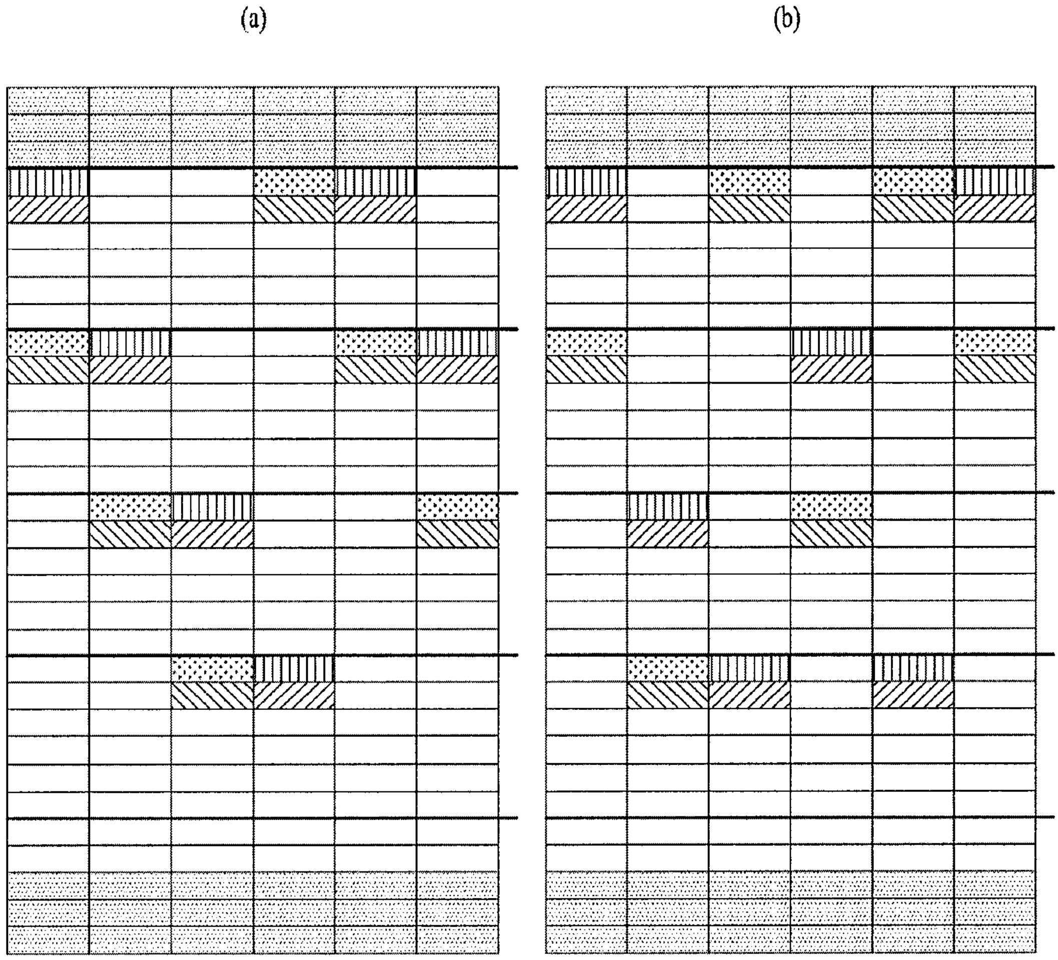


FIG. 4

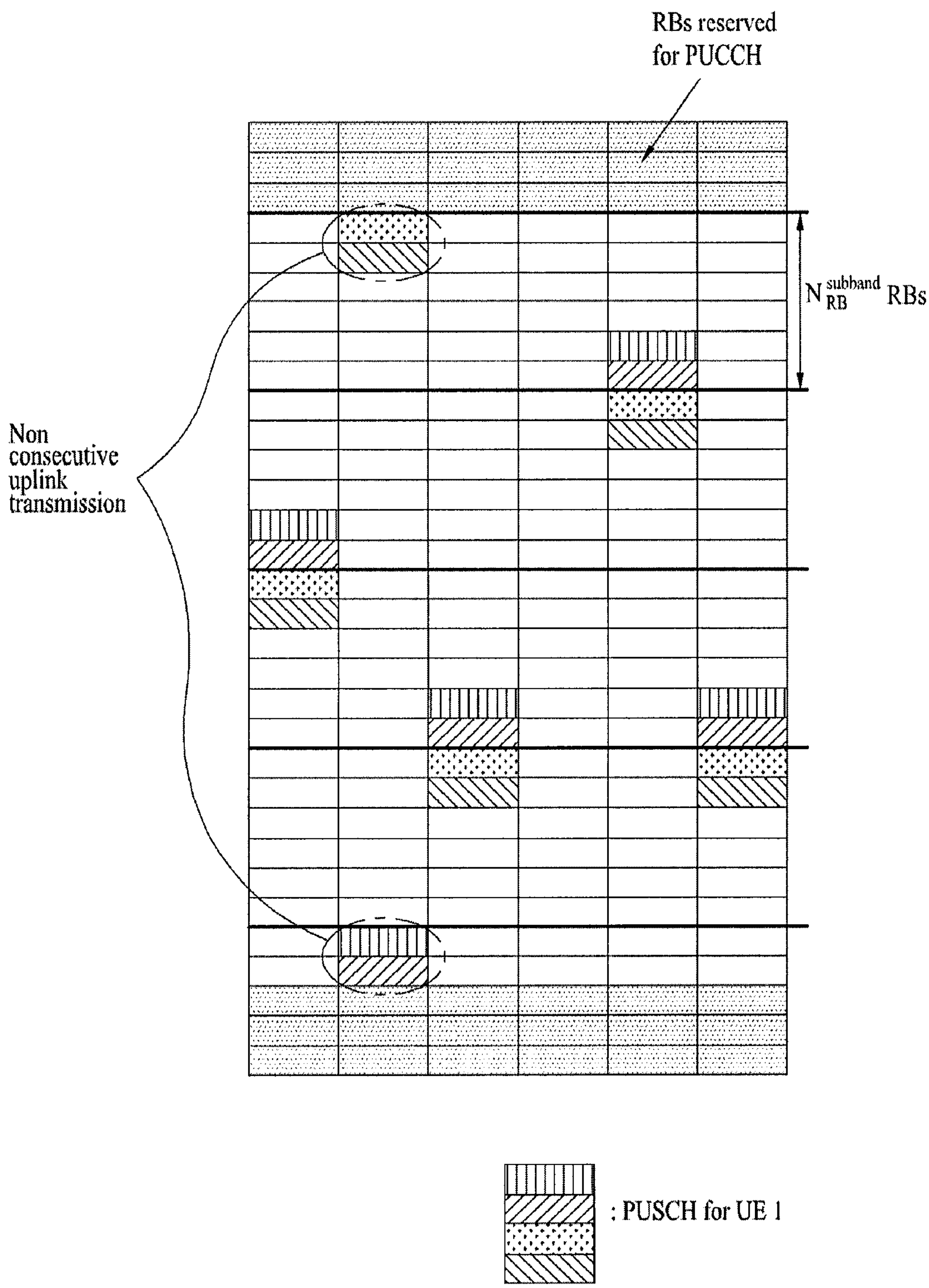

RBs reserved
for PUCCH
$N_{RB}^{subband}$ RBs
Non
consecutive
uplink
transmission
: PUSCH for UE 1

FIG. 5

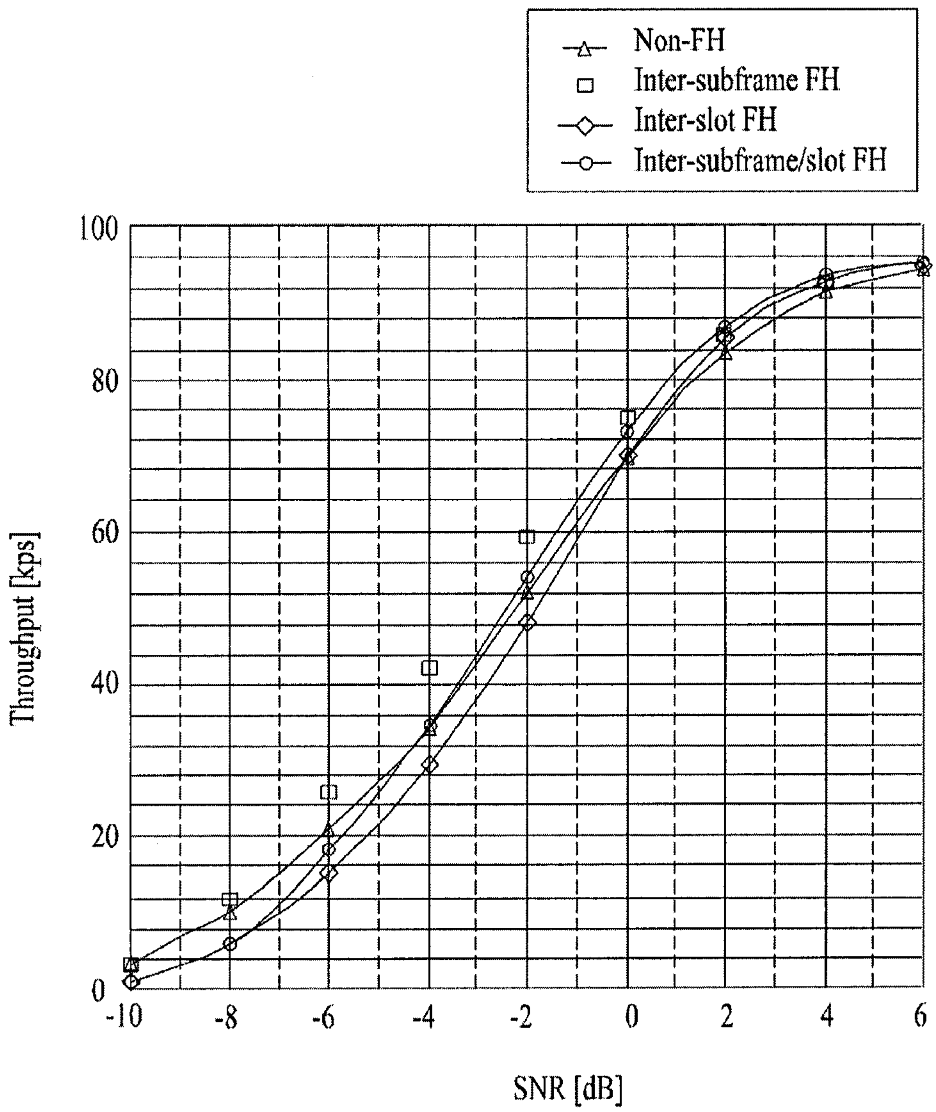

Non-FH
Inter-subframe FH
Inter-slot FH
Inter-subframe/slot FH
Throughput [kps]
100
80
60
40
20
0
-10
-8
-6
-4
-2
0
2
4
6
SNR [dB]

FIG. 6

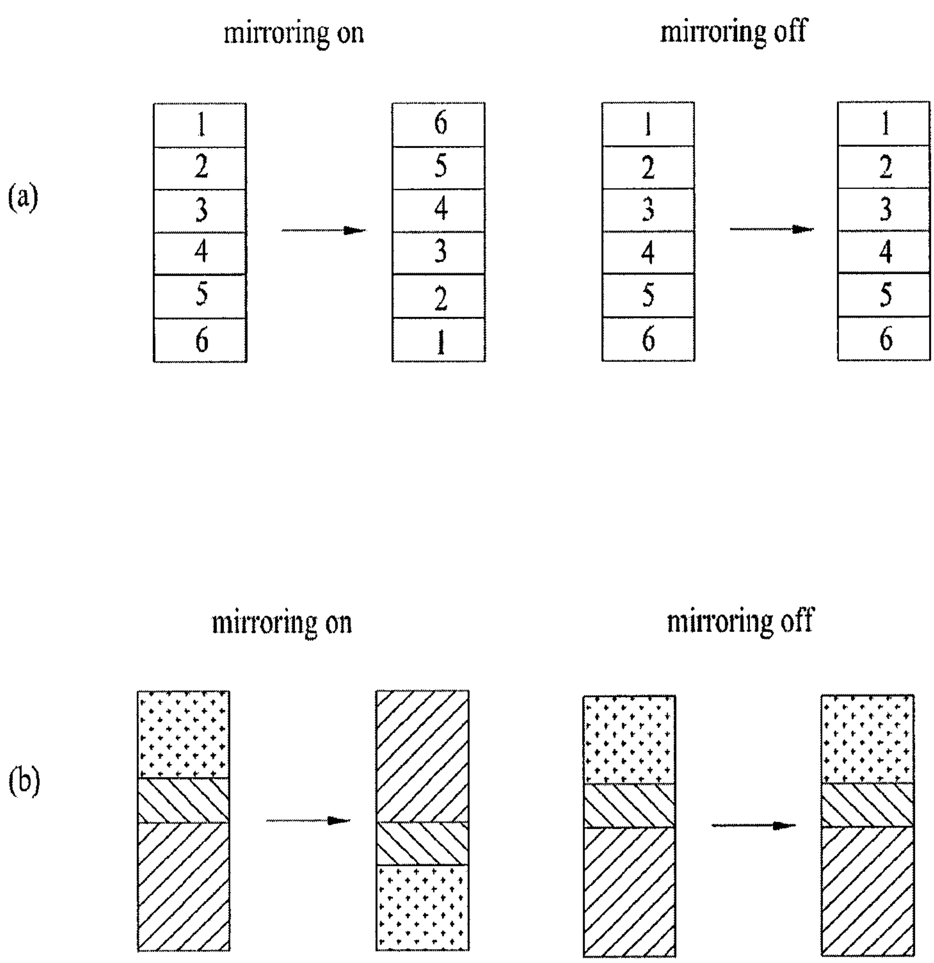

mirroring on
mirroring off
(a)
1
2
3
4
5
6
6
5
4
3
2
1
1
2
3
4
5
6
1
2
3
4
5
6
mirroring on
mirroring off
(b)

FIG. 7

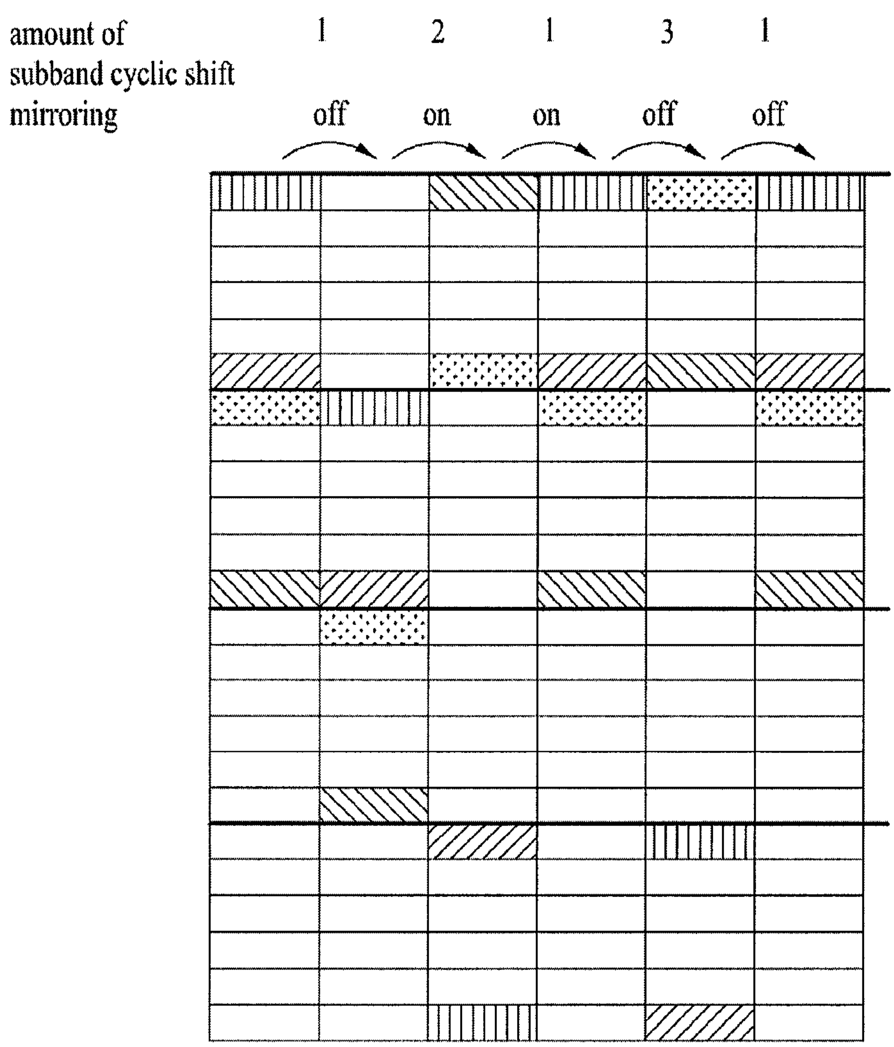
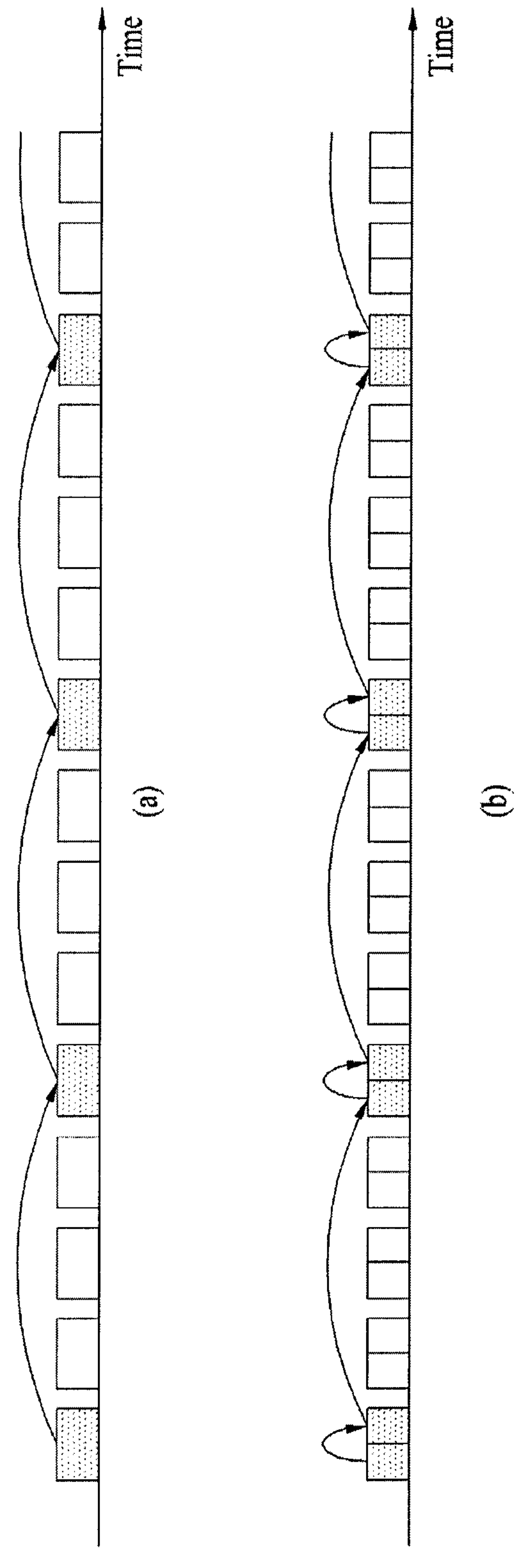

amount of
subband cyclic shift
mirroring
1
2
1
3
1
off
on
on
off
off

FIG. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/005776

A. CLASSIFICATION OF SUBJECT MATTER

H04B 7/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 8 : H04B 7/12, H04B 1/69, H04Q 7/38, H04B 7/26

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) "frequence hopping", "subband", "mirroring"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	KR 10-2007-0009232 A (SAMSUNG ELECTRONICS CO., LTD) 18 January 2007 see abstract, fig. 1 and claims 1, 14	1-12
A	WO 2005/125262 A1 (QUALCOMM INCORPORATED) 29 December 2005 see abstract, fig.9 and claims 1, 22	1-12
A	US 7177297 B2 (QUALCOMM INCORPORATED) 13 February 2007 see abstract, figs. 1-3 and claims 1-4	1-12

☐ Further documents are listed in the continuation of Box C.   ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 JANUARY 2009 (09.01.2009)	**09 JANUARY 2009 (09.01.2009)**

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/005776

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CA 2569633 A1	29.12.2005
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		EP 1757151 A1	28.02.2007
		JP 2008-502280 A	24.01.2008
		KR 10-2007-0026787 A	08.03.2007
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		EP 1623505 A2	08.02.2006
		JP 2007-500486 A	11.01.2007
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