(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 September 2008 (04.09.2008)

PCT

(10) International Publication Number
WO 2008/105569 Al

(51) International Patent Classification:
H04N 7124 (2006.01)

(21) International Application Number:
PCT/KR2007/001037

(22) International Filing Date:
28 February 2007 (28.02.2007)

(25) Filing Language: Korean

(26) Publication Language: English

(71) **Applicant** *(for all designated States except US):* **KOREA UNIVERSITY INDUSTRIAL & ACADEMIC COLLABORATION FOUNDATION** [KR/KR]; Industrial & Academic Collaboration Foundation, Korea University, 1, 5-ga, Anam-dong, Seongbuk-gu, Seoul 136-713 (KR).

(72) **Inventors; and**
(75) **Inventors/Applicants** *(for US only):* **WOO, Jae-Hyeon** [KR/KR]; Samsung DreamVil 101, 189-273, Wonmi 2-dong, Wonmi-gu, Bucheon-si, Kyeonggi-do 420-1 10 (KR). **KIM, Hyoung-Joong** [KR/KR]; 86-501 Banpo Apt., Banpobondong, Seocho-gu, Seoul 137-040 (KR). **LIM, Jong-In** [KR/KR]; Samsung Park Place 101-901, Naesoo-dong, Iongro-gu, Seoul 110-070 (KR).

(74) **Agent: KIM,** Saπisoo; Eruum Patent Law Firm, 5F, Boseong Bldg., 1005-8, Daechi-dong, Kangnam-gu, Seoul 135-280 (KR).

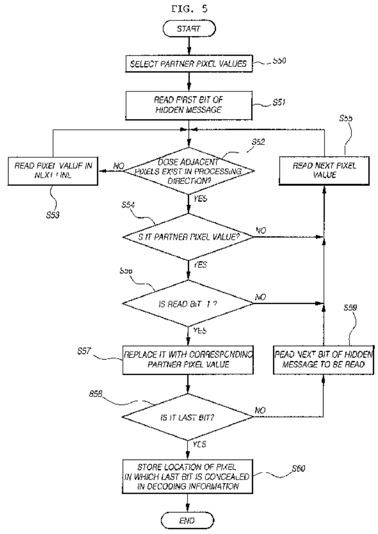
(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, **BR,** BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, **HR,** HU, **ID,** IL, IN, IS, **JP,** KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) **Title:** METHOD FOR ENCODING AND DECODING FOR STEGANOGRAPHY

FIG. 5



(57) **Abstract:** An encoding method for steganography is disclosed. A plurality of partner pixel values are selected so that the ranges of adjacent pixel values, located in the encoding processing direction, for the partner pixel values do not overlap each other. Next pixel values are read until a pixel value has one or more adjacent pixel values located in the encoding processing direction and corresponds to one of the partner pixel values. The found pixel value, corresponding to one of the partner pixel values, is replaced by the corresponding partner pixel value or the corresponding pixel value is left unchanged, depending on the bit value of a hidden message to be concealed. The found pixel value is replaced with the corresponding partner pixel value or the corresponding pixel value is left unchanged. Information about the location of a pixel in which the last bit is concealed is stored in decoding information.

WO 2008/105569 A1

[DESCRIPTION]

[invention Title]

METHOD FOR ENCODING AND DECODING FOR STEGANOGRAPHY

[Technical Field]

The present invention relates to an encoding method for concealing a hidden message in original data and a decoding method for restoring the resulting data and extracting the hidden message and the original data.

[Background Art]

Reversible steganography technology, called reversible data hiding, is technology that is used when specific information is concealed in original data.

FIG. 1 is a block diagram showing the configuration of a general reversible steganography system. The reversible steganography system includes an encoder 11 and a decoder 12. The encoder 11 performs the encoding of concealing a hidden message in original data, and then outputs the resulting data as output data. The decoder 12 receives the output data in which the hidden message is concealed, and then performs the decoding of restoring the original data and the hidden message.

Meanwhile, since conventional reversible steganography technology has laid stress only on hidden messages to be concealed, a method of integrally changing the values of Least Significant Bits (LSBs) into a message to be concealed has been used. At present, the restoration of original data is considered important, an example of which is the case in which the integrity of original data or an electrical signature is concealed in original data. For example, in the case of the transmission of an image, if a watermark is inserted into an original image and then the combination image is transmitted, a receiving side restores both the original image and the watermark, thereby proving the integrity using the information.

Recently, reversible steganography or watermarking technology has been widely researched. In the steganography technology, with regard to the concealment of information, a difference expansion method of concealing information by expanding the difference between adjacent pixel values, a companding method of previously reducing the size of input data, concealing information while expanding the reduced data, and concealing errors generated at this moment, and a shifting histogram method of concealing information by shifting a histogram have been proposed.

The difference expansion method is a method of, with an eye on the fact that there is a high correlation between adjacent pixels, obtaining the difference between the adjacent pixels, and multiplying the difference by 2 so as to make an even number, thereby generating a space for concealing one bit. Since there may be the case in which the expansion is impossible, an expanded pixel pair and an unexpanded pixel pair can be distinguished from each other by concealing a location map. Recently, not only the technique using the difference between pixels but also various types of predictive coding techniques have been used. The technique using the difference between two pixels is used as one of the predictive coding methods .

Further, the companding technique uses a method of arbitrarily reducing a pixel value and then expanding the reduced pixel value. In the meantime, when a pixel value is reduced and then expanded, an error occurs due to the difference from an original value. This error is appropriately coded and then concealed. Further, a space capable of concealing information is generated during the expansion, and then one bit is concealed in the space.

The shifting histogram method is a method of making an empty color by shifting part of the histogram of an original image by one, and then concealing secret information using the empty color. If there is a color that has not been used at all, this color is referred to as a "zero point". The color having the highest frequency in the histogram is referred to as a "peak point". When a zero point is shifted from a color adjacent to a peak point by one, the color that is immediately adjacent to the peak point becomes a new zero point. In this method, when a bit is concealed in a peak point, there is no change if a bit value is '0', and the color of the peak point is changed to the color of the zero point that is immediately adjacent to the peak point if a bit value is '1'.

However, the conventional methods of concealing a specific message in original data have a problem in that they require a large amount of coding information to perform encoding and decoding. Further, there is a problem in that the size of the message that can be concealed in specific original data is restricted. That is, in the difference expansion method, a location map must be concealed, and, in the companding technique, a companding error must be concealed. Further, in the shifting histogram method, information which performs a function similar to that of a location map must be concealed in the case in which a zero point does not exist.

[Disclosure]

[Technical Problem]

The present invention has been made to solve the above problems, and proposes a scheme capable of reducing the amount of coding information required for the encoding of concealing a specific hidden message in original data and for the decoding of restoring the resulting data. Further, the present invention proposes a scheme capable of increasing the size of a hidden message that can be concealed in limited original data.

[Technical Solution]

In order to accomplish the above object, the present invention provides an encoding method for steganography, including a first step of selecting a plurality of partner pixel values so that the ranges of adjacent pixel values, located in the encoding processing direction, for the partner pixel values do not overlap each other; a second step of reading next pixel values until a pixel value, read in the encoding processing direction, has one or more adjacent pixel values located in the encoding processing direction and corresponds to one of the partner pixel values; a third step of replacing the found pixel value, corresponding to one of the partner pixel values, with the corresponding partner pixel value or leaving the corresponding pixel value unchanged, depending on the bit value of a hidden message to be concealed; a fourth step of replacing the found pixel value with the corresponding partner pixel value or leaving the corresponding pixel value unchanged by repeating the second step and the third step until the last bit of the hidden message to be concealed is reached; and a fifth step of storing information about the location of a pixel in which the last bit is concealed in decoding information. Further, the third step includes replacing the found pixel value with the corresponding partner pixel value when the bit of the hidden message to be concealed is '1', and leaving the corresponding pixel value unchanged when the bit of the hidden message is '0'. Further, the encoding processing direction includes lateral rightward and leftward directions, vertical upward and downward directions, and diagonal directions.

Further, a decoding method for steganography, includes: a first step of receiving decoding information, including information about a plurality of partner pixel values so that the ranges of adjacent pixel values, located in the encoding processing direction, for the partner respective pixel values do not overlap each other, information about the encoding processing direction, the ranges of adjacent pixel values, located in the encoding processing direction, for the respective partner pixel values, and the location of a pixel in which the last bit of a hidden message is concealed; a second step of moving a decoding start point to the location of the pixel in which the last bit is concealed based on the decoding information when encoding is performed; a third step of, when the encoding is performed, reading pixel values from the location of the pixel in which the last bit is concealed in the direction opposite the encoding processing direction until a pixel value corresponding to one of the partner pixel values is found; a fourth step of, based on whether an adjacent pixel value, located in the encoding processing direction related to the found pixel value, is included in the range of adjacent pixel values of the decoding information, determining the bit value of the hidden message concealed in a found pixel, and determining whether to replace the found pixel value with the corresponding partner pixel value; and a fifth step of extracting a bit '0' or '1', included in the hidden message, by repeating the third step and the fourth step until a last pixel value is reached, and leaving the found pixel value corresponding to one of the partner pixel values unchanged or replacing the found pixel value with the corresponding partner pixel value. Further, the fourth step includes extracting a bit '0' and then leaving the found pixel value unchanged when the adjacent pixel value, located in the encoding processing direction related to the found pixel value, is included in the range of adjacent pixel values of the decoding information; and extracting a bit '1' and then replacing the found pixel value with the corresponding partner pixel value when the adjacent pixel value is out of the range of adjacent pixel values.

[Advantageous Effects]

As described above, the present invention can effectively reduce coding information required for the encoding of concealing a specific hidden message in original data and for the decoding of restoring the resulting data. Further, the size of a hidden message that can be concealed in the limited original data can be effectively increased.

[Description of Drawings]

FIG. 1 is a block diagram showing the configuration of a general reversible steganography system;

FIG. 2 is a view showing part of an expanded image;

FIG. 3 is a view showing a spatial relationship between pixels;

FIG. 4 is a view showing the encoding for concealing a hidden message in an original 8*8 image block and the decoding for restoring the resulting block to the original image block and detecting the hidden message according to an embodiment of the present invention;

FIG. 5 is a flowchart showing an encoding process of concealing a hidden message in an original image according to an embodiment of the present invention; and

FIG. 6 is a flowchart showing a decoding process of restoring an original image and then extracting a hidden message by decoding the image, encoded through the process of FIG. 5, according to an embodiment of the present invention.

[Mode for Invention]

Embodiments of the present invention will be described in detail below with reference to the attached drawings. In the following description, when reference numerals are given to the respective elements of the drawings, it should be noted that the same reference numerals are used throughout the different drawings to designate the same components as far as possible.

FIG. 2 is a view showing part of an expanded image and FIG. 3 is a view showing a spatial relationship between pixels.

In the case of an image of a picture existing in the natural world, there is little difference between a pixel and a pixel adjacent thereto. For example, as shown in FIG. 2, even when the black pupil of an eye meets the white eyeball area, the color at the boundary therebetween does not rapidly change from a black color to a white color, but there is gradual transition therebetween. When this fact is generalized, a pixel adjacent to a given pixel has a specific upper limit or lower limit rather than a random value.

There is a spatial relationship between pixels, in which, when it is assumed that the pixel value of a pixel (i,j) is X(i,j), as shown in FIG. 3, X(i,j) has a separate spatial relationship with each of X(i,j+1), X(i+l,j), X(i-l,j), X(i,j-1), X(i-1, j-1), X(i+l,j+l), X(i+l,j-l), and X(i-l,j+l). For example, there exists a spatial relationship between a pixel (i,j) and a pixel (i,j+l), which are located to the right of the pixel (i,j) .

The present invention provides a method of concealing data using the spatial relationship between respective pixels. For example, it is assumed that P is a specific pixel value, that R(P) is a set of the pixel values of pixels at the right of the pixel having the pixel value P, and that P" is the pixel value of an element of R(P) . Here, P" exists between P"min and P"max, that is, P"min ≤ P" ≤ P"max .

The P"min means the minimum value of elements of R(P), and P"max means the maximum value of elements of R(P).

If two pixel values are P and Q (P ≠ Q) and there is no intersection between sets of pixel values at the right of the respective pixel values P and Q (that is, R(P) D R(Q) = 0), predetermined data can be concealed by exchanging the pixel values P and Q . That is, when it is apparent that P", which is an element of R(P), is not an element of R(Q), and Q", which is an element of R(Q), is not an element of R(P), data 'b' which consists of one bit can be concealed as the following Equation 1 .

[Equation 1]

(P, P") : = {(P, P") if b = 0, (Q, P") if b = 1}

(Q, Q") : = UQ, Q") if b = 0, (P, Q") if b = 1}

That is, it is assumed that a pixel value is P and a pixel value to the right of the pixel value P is P". If the bit 'b' to be concealed is 0, the pixel value P is left unchanged, and if the bit 'b' to be concealed is 1, the pixel value P is replaced by the corresponding partner pixel value Q. In the same manner, it is assumed that a pixel value is Q and that the pixel value to the right of the pixel value Q is Q". If the bit 'b' to be concealed is 0, the pixel value Q is left unchanged; and if the bit 'b' to be concealed is 1, the pixel value Q is replaced by the corresponding partner pixel value P.

As described above, a bit is concealed by replacing pixel values, and then the concealed bit is found by performing decoding. That is, with the use of the decoding information of the provided (P"min, P, P"max) and (Q"min, Q, Q"max), when the fact that P and Q are not replaced is detected, it is determined that bit 0 is concealed, and when the fact that P and Q are replaced is detected, the replaced pixel values are restored to original pixel values and it is determined that bit 1 is concealed.

An embodiment of the encoding of concealing one bit of a hidden message in original data and the decoding the resulting data will be described below with reference to FIG. 4, showing an image block having 8 * 8 pixels as an example.

FIG. 4 is a view showing the encoding of concealing a hidden message in an original 8*8 image block and the decoding of restoring the resulting block to the original image block and detecting the hidden message according to the embodiment of the present invention.

FIG. 4(a) is an original image before the hidden message is concealed. Values mean 0 to 255 colors included in grayscale. Of course, this method can be applied to a colored image as well as a grayscale image.

In the case in which pixel values are 48 and 71 in the image of FIG. 4(a), when pixels to the right of a pixel having the pixel value 48 are considered (since the last pixel value 48 has no pixel to the right thereof, it is not considered), it can be seen that the values thereof are 49, 70, 61, 48, and 40. That is, when it is assumed that the pixel value 48 is P, it can be seen that a set R(P), which is a set of pixels to the right of the pixel value P, is a set having elements {40, 48, 49, 61, 70}.

For an element P" of R(P), it can be seen that P"rnin is 40 and P"max is 70. Therefore, in the case of the pixel having the pixel value 48, the element P", located to the right of the corresponding pixel, is in the range of $40 \leq P" \leq 70$.

In the same manner, when pixels to the right of a pixel having a pixel value 171 are considered, it can be seen that the values thereof are 170 and 180. As a result, when it is assumed that a pixel value 171 is Q, it can be seen that a set R(Q), which is a set of pixels to the right of the pixel value Q, is {170, 180}. For an element Q" of R(Q), it can be seen that Q"inin is 170 and Q"max is 180. Therefore, in the case of a pixel having the pixel value 171, the element Q", located to the right of the corresponding pixel, is in the range of $170 \leq Q'' \leq 180$.

As a result, when it is assume that P" indicates pixel value elements to the right of the pixel value 48 and Q" indicates pixel value elements to the right of the pixel value 171, the following values are obtained.

$40 \leq P'' \leq 70$ (therefore, P"max = 70 and P"min = 40)

$170 \leq Q'' \leq 180$ (therefore, Q"max = 180 and Q"min = 170)

Therefore, it can be seen that Q"min) P"max. The pixel values 48 and 171 have no part in which the range of pixel values to the right of the pixel value 48 and the range of pixel values to the right of the pixel value 171, that is, P" and Q", overlap each other. In the present invention, two colors, the ranges of which do not overlap each other, are set to a pair 48 and 171 and referred to as partner pixel values .

The case of concealing a hidden message which consists of the bit string '0110101' in an original message will be described as an example using the partner pair 48 and 171 in which the ranges of pixel values to the right thereof do not overlap each other. First, a search is started from a first pixel and conducted toward the right. If the pixel value is 48 or 171, a bit value is concealed. If the bit value to be concealed is '0', the pixel value is left unchanged. If the bit value is 'l', the pixel value is replaced by its partner value.

For example, the case of concealing a hidden message, which consists of the bit string *0110101', in an original message is shown in FIG. 4(b). In the case of a pixel having a first pixel value 48, the pixel value 48 is left unchanged so that ^0', which is the first bit of the given bit string ^0110101', can be detected when decoding is performed. In the case of a pixel having a second pixel value 48, it can be seen that the pixel value 48 is replaced by a pixel value 171, which is the partner pixel value thereof, so as to show the fact that the second bit ^l' of the bit string ^0110101' is concealed. For reference, since a pixel having the pixel value 48, which has a black border, has no pixel to the right thereof, it dose not conceal any bit information.

Meanwhile, in order to perform the decoding of restoring the original message, in which the hidden message which consists of the bit string is concealed, as shown in FIG. 4(b), the decoding is performed in the direction opposite the encoding processing direction of FIG. 4(b). That is, bits are found from a pixel that conceals the last bit to the first pixel in a backward direction, and then the original image is restored.

In the case in which a pixel value, read in the direction opposite the encoding processing direction, is 48, which corresponds to one of the partner pixel values, and the pixel value to the right thereof is larger than 70, it can be seen that the concealed bit is '1' and the pixel value 48 is restored to the corresponding partner pixel value 171. If the pixel value to the right thereof is equal to or smaller than 70, it can be seen that the hidden bit is ^0' and the corresponding pixel value 48 is left unchanged. In the same manner, in the case in which the pixel value is 171 and the pixel value to the right thereof is larger than 70, the hidden bit is '0' and the corresponding pixel value 171 is left unchanged. If the pixel value to the right thereof is equal to or smaller than 70, the hidden bit is ^1' and the pixel value 171 is restored to the corresponding partner pixel value 48. As a result, pixel values are read in the direction opposite the encoding processing direction and decoding is performed, so that the hidden message ^0110101' is finally restored, as shown in FIG. 4(c), and the decoded image can be restored to be the same as the original image.

Meanwhile, although pixels to the right of a predetermined pixel have been described as an example until now, left direction, upward/downward direction, and downward diagonal right/left directions can also be used as examples, and the directions can be mixed and then used, so as to increase size. If pixels to the left of a specific pixel are selected, the reading direction, when encoding is performed, starts from the right to left direction, and a decoding is performed from the left to right direction. In order to conceal bits in an original image and then restore them, only information values, such as i, j, processing direction, and boundary values, are required. If only one processing direction is used, the processing direction information is not required.

FIG. 5 is a flowchart showing an encoding process of concealing a hidden message in an original image according to an embodiment of the present invention.

Although an encoding process of concealing a hidden message in an original image will be described below, a process of concealing a hidden message in original data which has a data type other than an image type will be performed in the same manner.

First, partner pixel values are selected at step S50, and a plurality of partner pixel values, in which the ranges of adjacent pixel values located in the encoding processing direction of respective specific pixel values do not overlap each other, are selected at step S51. Although an example in which the encoding processing direction is to the right will be described below, various encoding processing directions, such as left, diagonal, upward, and downward directions, can be used as other embodiments.

The partner pixel values are selected such a way that the ranges of the adjacent pixel values located to the right of the corresponding pixels do not overlap each other. For example, pixel values 48 and 171 are selected as partner pixel values in FIG. 4. Since adjacent pixel values located to the right of a pixel having the pixel value 48 are {40, 48, 49, 61, 70}, it can be seen that the range of the adjacent pixel values ranges from 40 to 70, and since the adjacent pixel values located to the right of a pixel having the pixel value 171 are {170, 180}, it can be seen that the range of the adjacent pixel values ranges from 170 to 180. Therefore, because the range of the adjacent pixel values of the pixel value 48 and the range of the adjacent pixel values of the pixel value 171 do not overlap each other, the pixel values 48 and 171 can be selected as partner pixel values. As a result, as long as the ranges of adjacent pixel values located to the right of specific pixels do not overlap each other, it will be apparent that various partner pixel values can be selected.

After the partner pixel values are selected, the first bit of a hidden message to be concealed is read at step S51.

After partner pixel values are selected and the first bit of the hidden message is read, pixel values are sequentially read until a pixel value read in the right direction (in the encoding processing direction) has one or more adjacent pixel values located to the right thereof and, simultaneously, the read pixel value corresponds to one of the selected partner pixel values. Thereafter, the corresponding pixel value is replaced by the corresponding partner pixel value or is left unchanged, depending on the bit value of a hidden message to be concealed.

To be more particular, after the partner pixel values are selected at step S50 and the first bit of the hidden message is read at step S51, the first pixel value of the original image is read when reading is conducted toward the right, and whether the read pixel value has one or more adjacent pixel values located to the right thereof, that is, in the encoding processing direction, is determined at step S52. When there is no adjacent pixel value located to the right of the read pixel value, that is, in the processing direction, pixel values in the next line are read at step S53.

Meanwhile, for the read pixel value, when one or more adjacent pixel values located to the right thereof exist, whether the read pixel value corresponds to one of the selected partner pixel values is determined at step S54. If the read pixel value does not correspond to one of the selected partner pixel values, the next pixel value is read at step S55, and the above processes are repeated at steps S52, S53, and S54 .

In contrast, when the read pixel value corresponds to one of the selected partner pixel values (for example, a pixel value 48 or 171, which is selected as the partner pixel value), whether the first bit of the read hidden message is '1' is determined at step S56. If the first bit is not '1' but '0', the corresponding pixel value is left unchanged and the next pixel value is read at step S55, and the above steps S52, S53, S54, and S56 are repeated.

Meanwhile, when the bit of the read hidden message is '1', the corresponding pixel value is replaced by the corresponding partner pixel value at step S57. Thereafter, if it is found that the bit is not the last bit of the hidden message at step S58, the next bit of the hidden message is read at step S59, and the above steps S55, S52, S53, S54, S56, S57, and S58 are repeated, thereby finally generating an encoded image, as shown in FIG. 4(b).

On the other hand, if the read bit is the last bit of the hidden message, the location of a corresponding pixel, in which the last bit is concealed, is stored in decoding information. The reason for this is, when decoding is performed, to perform the decoding from the pixel in which the last bit is concealed in a backward direction rather than to perform a search from the last pixel. After all of the desired bits are concealed, remaining partner colors are ignored. The reason for this is that, if pixels, in each of which a desired bit is not concealed, are searched, a problem may occur in that erroneous decoding may be performed in which it is determined that each of the pixels, in each of which the desired bit is not concealed, conceals a bit '0'. Therefore, since pixels that were ignored when encoding is performed must be ignored, decoding is performed from the pixel that conceals the last bit.

FIG. 6 is a flowchart showing a decoding process of restoring an original image and then extracting a hidden message by decoding an image encoded through the process of FIG. 5 according to an embodiment of the present invention.

First, before decoding is performed, decoding information must be received at step S61. The decoding information can be received from the encoder, and the decoding information includes information about a plurality of partner pixel values, information about an encoding direction, information about the range of adjacent pixel values in the encoding processing directions for the respective partner pixel values, and the location of the pixel in which the last bit of a hidden message is concealed. Hereinafter, it is assumed that partner pixel values 'i' and 'j' are 48 and 171, as described in the examples of the encoding of FIG. 4(b) and FIG. 5, that the encoding processing direction is the direction toward the right, that for the pixel value 48, the range of adjacent pixel values located to the right of the pixel value 48 ranges from 40 to 70, and, that for the pixel value 171, the range of adjacent pixel values located to the right of the pixel value 171 ranges from 170 to 180.

Decoding is performed based on the decoding information. The decoding start point is moved to the pixel that conceals the last bit of a hidden message at step S62. The reason for this is to read pixel values from the pixel that conceals the last bit in a direction reverse to the encoding processing direction. The reason for this is that, although all of the remaining partner colors are ignored when all of the desired bits are concealed during the encoding, erroneous decoding may be performed, so that it is determined that each of the pixels conceals a bit ^0 when the pixels, in each of which the desired bit is not concealed, are searched. Therefore, since pixels which have been ignored during the encoding must be ignored during the decoding, decoding starts from the pixel that conceals the last bit.

After the decoding start point is moved, the encoded image, including the hidden message which consists of a bit string, is read from the pixel value corresponding to the location of the pixel that conceals the last bit, in the direction opposite the encoding processing direction, that is, to the left direction, at step S63. For example, with reference to FIG. 4(b), the pixel value 48, located in a pixel (8,3) which conceals the last bit, is read.

Whether the read pixel value is consistent with one of the partner pixel values 48 and 171 is determined at step S64. When the read pixel value is not consistent with one of the partner pixel values, the next pixel value is read at step S65. For example, when the pixel values are read in the direction opposite the encoding processing direction in FIG. 4(b), the pixel values are read in the order of 48 → 170 → 143 → 150 → 160 → · · ·.

As the result of the reading, when the read pixel value is consistent with one of the partner pixel values, it is determined whether the read pixel value is out of the range of the pixel value read before the corresponding pixel value is read, that is, the range of adjacent pixel values located in the encoding processing direction (in the right direction) at step S66.

In the case in which the pixel value read before the corresponding pixel value is out of the range of adjacent pixel values, the corresponding pixel value is replaced by the corresponding partner pixel value at step S67. Furthermore, since the pixel value is replaced, the bit value is determined to be '1' at step S69. For example, when the pixel values are read in the left direction, that is, in the direction opposite the encoding processing direction, in FIG. 4(b), the pixel values are read in the order of 48 → 170 → 143 → 150 → 160 → · · ·. When the pixel value 48, which is one of the partner pixel values, is read, a pixel value 180, located to the right of the pixel value 48, exceeds the maximum value 70 of the adjacent pixel values of the pixel value 48 and is out of the range of the adjacent pixel values. Therefore, the corresponding pixel value 48 is replaced by the corresponding partner pixel value 171 and a hidden bit '1' is extracted.

Meanwhile, when the adjacent pixel value, adjacent to the read pixel value, is not out of the range thereof and is included in the corresponding range, the corresponding pixel value is left unchanged and the bit value is determined to be '0' at step S67, the next pixel value is read at step S65, and then the above steps S64, S66, S67, S68, S69, S70, and S65 are repeated. The above steps are repeated until the pixel value of the first pixel, which is the last pixel in the direction opposite the encoding processing direction, is read at step S70.

Although the embodiments of the present invention have been disclosed, various modifications are possible without departing from the scope of the invention. Therefore, it will be apparent that the scope of the patent rights of the present invention is not determined by the above-described embodiments, but encompasses all equivalent scope as well as the claims .

[industrial Applicability]

The present invention proposes a method of reducing the amount of coding information required for the encoding of concealing a specific hidden message in original data and for the decoding of restoring the resulting data. Furthermore, the present invention proposes a method of increasing the size of a hidden message that can be concealed in limited original data.

[CLAIMS]

[Claim 1]

An encoding method for steganography, comprising:

a first step of selecting a plurality of partner pixel values so that ranges of adjacent pixel values, located in an encoding processing direction, for the partner pixel values do not overlap each other;

a second step of reading next pixel values until a pixel value, read in the encoding processing direction, has one or more adjacent pixel values located in the encoding processing direction and corresponds to one of the partner pixel values;

a third step of replacing the found pixel value, corresponding to one of the partner pixel values, with the corresponding partner pixel value or leaving the corresponding pixel value unchanged, depending on a bit value of a hidden message to be concealed;

a fourth step of replacing the found pixel value with the corresponding partner pixel value or leaving the corresponding pixel value unchanged by repeating the second step and the third step until a last bit of the hidden message to be concealed is reached; and

a fifth step of storing information about a location of a pixel in which the last bit is concealed in decoding information.

[Claim 2]

The encoding method according to claim 1, wherein the third step comprises replacing the found pixel value with the corresponding partner pixel value when the bit of the hidden message to be concealed is '1', and leaving the corresponding pixel value unchanged when the bit of the hidden message is '0'.

[Claim 3]

The encoding method according to claim 1, wherein the encoding processing direction comprises lateral rightward and leftward directions, vertical upward and downward directions, and diagonal directions.

[Claim 4]

A decoding method for steganography, comprising:

a first step of receiving decoding information, including information about a plurality of partner pixel values so that ranges of adjacent pixel values, located in an encoding processing direction, for the partner respective pixel values do not overlap each other, information about the encoding processing direction, the ranges of adjacent pixel values, located in the encoding processing direction, for the respective partner pixel values, and a location of a pixel in which a last bit of a hidden message is concealed;

a second step of moving a decoding start point to the location of the pixel in which the last bit is concealed based on the decoding information when encoding is performed;

a third step of, when the encoding is performed, reading pixel values from the location of the pixel in which the last bit is concealed in a direction opposite the encoding processing direction until a pixel value corresponding to one of the partner pixel values is found;

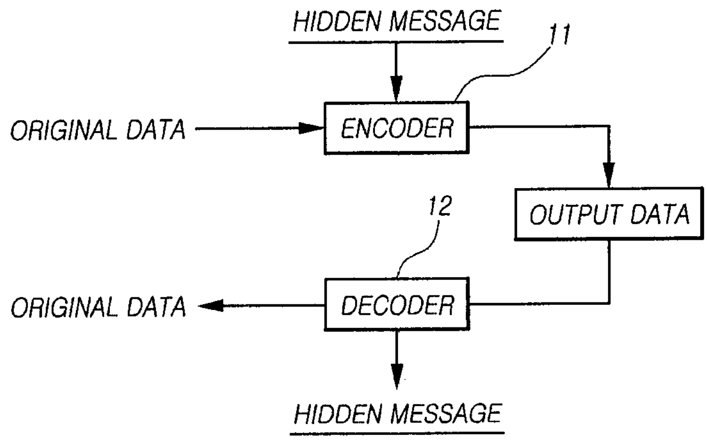
a fourth step of, based on whether an adjacent pixel value, located in the encoding processing direction related to the found pixel value, is included in the range of adjacent pixel values of the decoding information, determining a bit value of the hidden message concealed in a found pixel, and determining whether to replace the found pixel value with the corresponding partner pixel value; and

a fifth step of extracting a bit ^0' or ^l', included in the hidden message, by repeating the third step and the fourth step until a last pixel value is reached, and leaving the found pixel value corresponding to one of the partner pixel values unchanged or replacing the found pixel value with the corresponding partner pixel value.

[Claim 5]

The encoding method according to claim 4, wherein the fourth step comprises extracting a bit '0' and then leaving the found pixel value unchanged when the adjacent pixel value, located in the encoding processing direction related to the found pixel value, is included in the range of adjacent pixel values of the decoding information; and extracting a bit '1' and then replacing the found pixel value with the corresponding partner pixel value when the adjacent pixel value is out of the range of adjacent pixel values.

FIG. 1



HIDDEN MESSAGE
11
ORIGINAL DATA
ENCODER
OUTPUT DATA
12
ORIGINAL DATA
DECODER
HIDDEN MESSAGE

FIG. 2

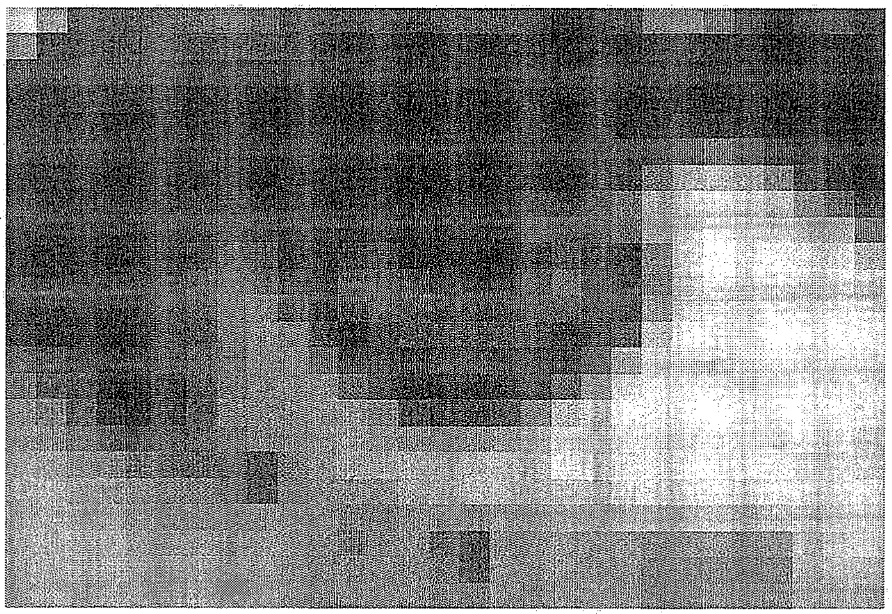


FIG. 3

X(i-1 ,j-1)	X(i-1 ,j)	X(i-1,j+1)
X(i ,j-1)	X(i ,j)	X(i ,j+1)
X(i+1,j-1)	X(i+1,j)	X(i+1,j+1)

FIG. 4

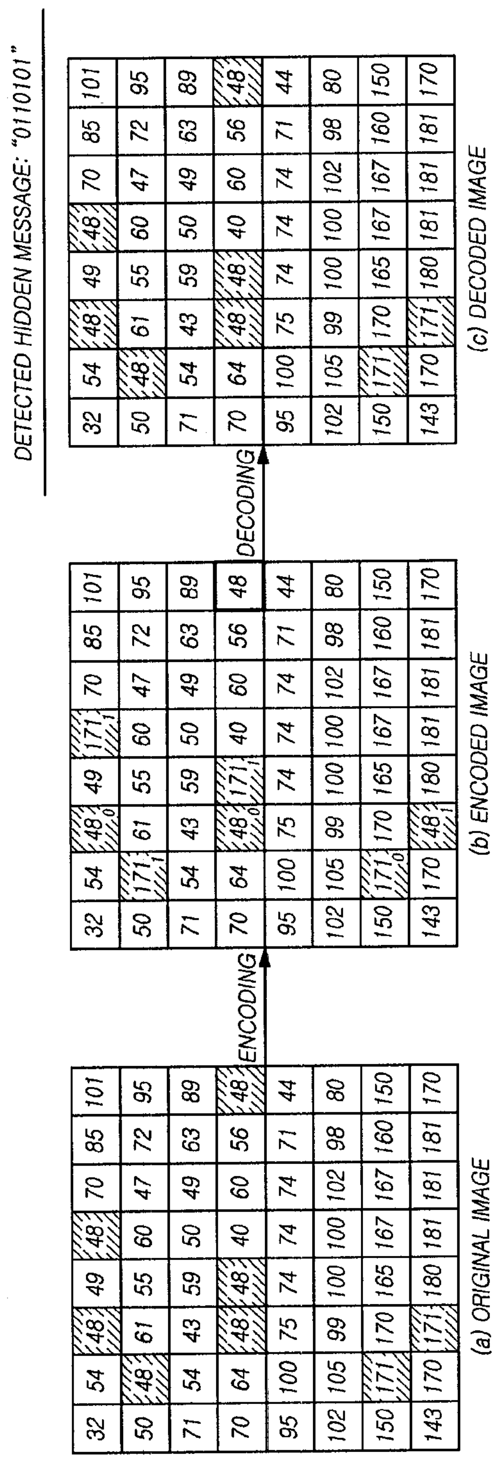

DETECTED HIDDEN MESSAGE: "0110101"
ENCODING
DECODING
(a) ORIGINAL IMAGE
(b) ENCODED IMAGE
(c) DECODED IMAGE

FIG. 5

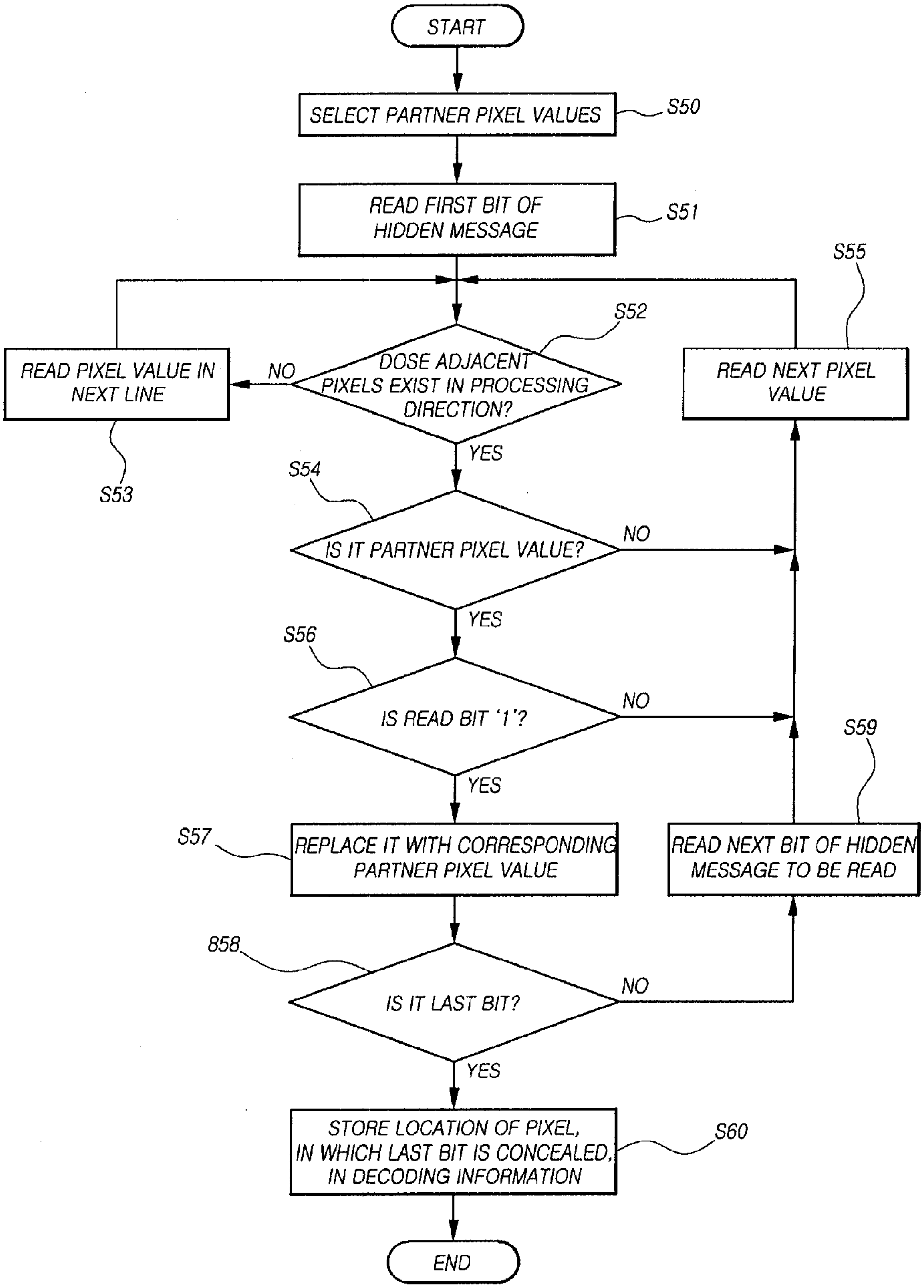
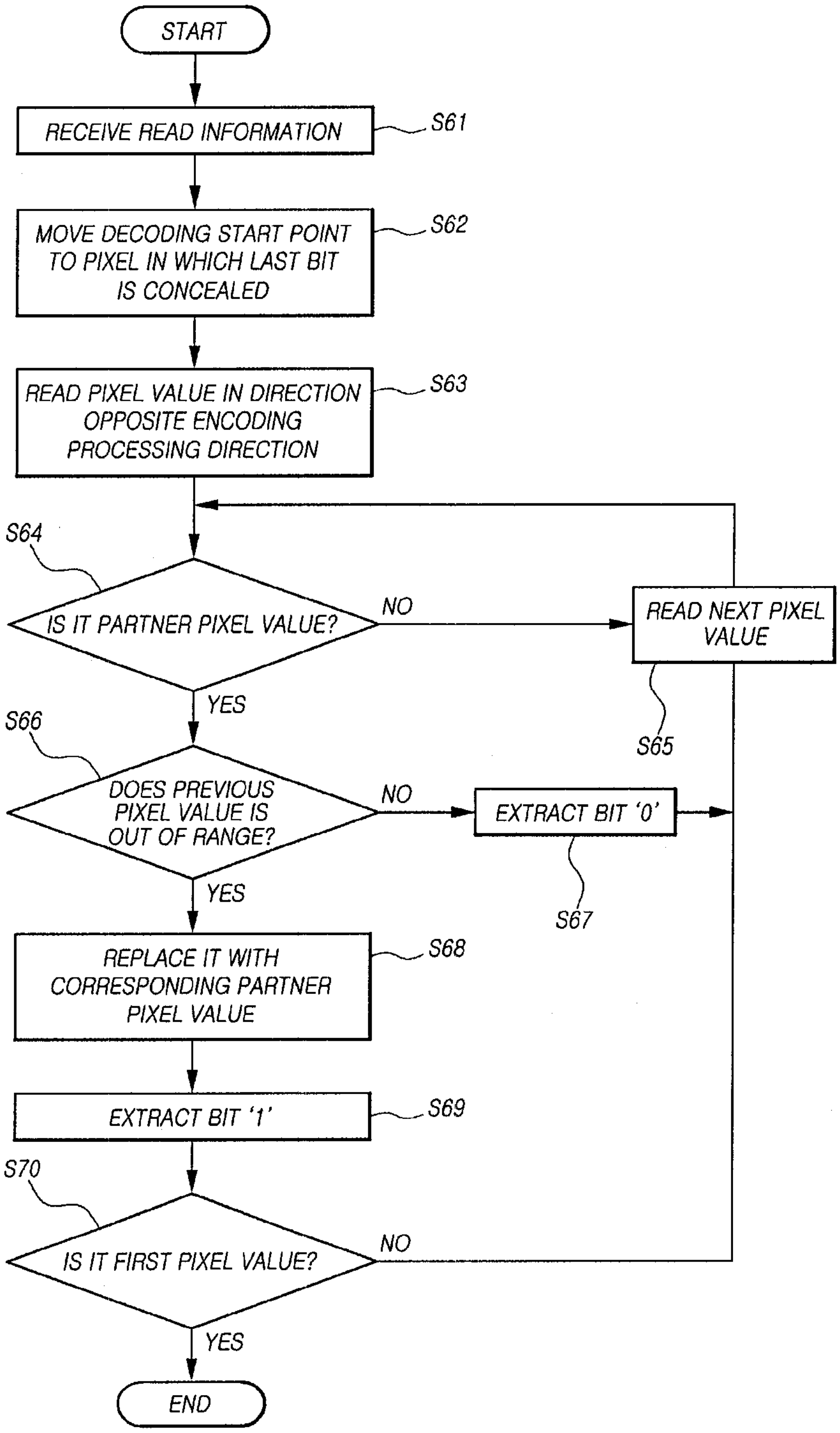

START
SELECT PARTNER PIXEL VALUES
S50
READ FIRST BIT OF HIDDEN MESSAGE
S51
S55
S52
READ PIXEL VALUE IN NEXT LINE
NO
DOSE ADJACENT PIXELS EXIST IN PROCESSING DIRECTION?
READ NEXT PIXEL VALUE
S53
YES
S54
IS IT PARTNER PIXEL VALUE?
NO
YES
S56
IS READ BIT '1'?
NO
S59
YES
S57
REPLACE IT WITH CORRESPONDING PARTNER PIXEL VALUE
READ NEXT BIT OF HIDDEN MESSAGE TO BE READ
858
IS IT LAST BIT?
NO
YES
STORE LOCATION OF PIXEL, IN WHICH LAST BIT IS CONCEALED, IN DECODING INFORMATION
S60
END

FIG. 6


START
RECEIVE READ INFORMATION
S61
MOVE DECODING START POINT TO PIXEL IN WHICH LAST BIT IS CONCEALED
S62
READ PIXEL VALUE IN DIRECTION OPPOSITE ENCODING PROCESSING DIRECTION
S63
S64
IS IT PARTNER PIXEL VALUE?
NO
READ NEXT PIXEL VALUE
S65
YES
S66
DOES PREVIOUS PIXEL VALUE IS OUT OF RANGE?
NO
EXTRACT BIT '0'
S67
YES
REPLACE IT WITH CORRESPONDING PARTNER PIXEL VALUE
S68
EXTRACT BIT '1'
S69
S70
IS IT FIRST PIXEL VALUE?
NO
YES
END

INTERNATIONAL SEARCH REPORT

International application No
PCT/KR2007/001037

A. CLASSIFICATION OF SUBJECT MATTER

H04N 7/24(2006.01)1

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 H04N G06K

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
Japanese 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, SEARCH TERMS Reversible Steganography, Data Hiding, Encoding/Decoding, and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No
A	US 20050031 156 A1(GEOFFREY B RHOADS) Feb 10, 2005 See Abstract, page 9, paragraph [0123] - page 13, paragraph [0189]	1-5
A	US 20030026447 Al(JESSICA FRIDRICH et al) Feb 06, 2003 See Abstract, page 1, paragraph [001 1] - page 5, paragraph [0054]	1-5
A	US 20020085718 A1(GEOFFREY B RHOADS) JUI 04, 2002 See Abstract, page 1, paragraph [0007] - page 11, paragraph [0159]	1-5

☐ 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
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"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
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"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
2 1 NOVEMBER 2007 (21 11 2007)	21 NOVEMBER 2007 (21.11.2007)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No 82-42-472-7140

Authorized officer
PARK, Sang Choi
Telephone No 82-42-481-8372

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/KR2007/001037

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		US2003026447AA	06.02.2003
		US6831991BB	14.12.2004
US20020085718A1	04.07.2002	US06654887	25.11.2003
		US2002085718A1	04.07.2002
		US2002085718AA	04.07.2002
		US6654887BB	25.11.2003