

INFORMATION CODE

FIELD OF THE INVENTION

The present invention relates to an information code which can store electronic data

BACKGROUND OF THE INVENTION

Various methods have been proposed for conversion of electronic data into information code, as well as for recording and restoration of the information code on and from print medium. Specifically, those methods include: one-dimensional or two-dimensional bar-code which records information in black-and-white pattern; and color code which uses colors such as red and blue.

However, bar-code which records information in black-and-white pattern provides poor recording efficiency, so that it cannot store large volume electronic data such as image or audio.

To solve this issue, various types of color coding systems, which aim to increase the recording density, have been proposed. However, a disadvantage of color code is that, if detection of a reading unit varies, then the corresponding data may more possibly vary than it is the case with black-and-white code, making the color code to be susceptible to color fading, uneven print, illuminated light, etc., providing lesser restoration accuracy as compared to bar-code. Therefore, in actual usage environments of restoring, with a reading unit, color code recorded on printing medium, the above fact requires each cell to be made larger, or number of usable colors to be limited to something like three or four. Color code has not achieved large recording density, as it was expected to be according to those proposals.

Generally, identification of a code and each cell is made by optical color difference, so that the greater the difference of the colors being used is, the more difficult the identification becomes. Further more, effects of color fading, uneven print, illuminated light, etc., will change the color, so that the narrower the region of each color being used becomes, the more possibly the color is identified as a different one. This means that the more the number of colors to be used becomes, the narrower the region of each color becomes, resulting in higher possibility of causing misidentification.

Generally, a camera or a scanner is used as a reading unit, into which an image, including a code, is read as digital data, which is then restored by analysis. However, although the image makes the code visually identifiable therefrom, it is no more than aggregate of pixel holding color information in RGB values; code area is not distinguished from other regions. Therefore, the color information (RGB values) is the only information source which can be used for digitally distinguishing the code area

from the rest. Ideally, only a code area should be read when an image is read into. However, in actual usage environment where ordinary image input devices, such as a digital camera of a mobile phone, a web camera attached to or installed in a personal computer, or a scanner, are used, reading a code area alone is technically difficult and not practical.

Depending on image-photographing environment, the same color as being used in a code may exist in a non-code area, or a shadow or a shifting light source may blur boundary of a code or a cell. If this is the case, it is difficult to identify the code or cell regions by color information alone. Further, increasing the number of colors to be used in a code for improvement of recording efficiency lessens the degree of color difference between each color, resulting in being easily affected by a shadow or a shifting light source; therefore the identification becomes even more difficult.

Every color is a wavelength, so what happens in a color boundary area is that different wavelengths are interfering with each other. Because a code image read into from a print medium has been converted from wavelengths to a digital image, and color boundary area is data-processed with color information in which wavelengths of neighboring colors are mixed with each other. Therefore, gradation state is likely to happen in a color boundary area. The smaller the size of a cell becomes, the more proximate the boundaries of each color becomes, resulting that interference-affected pixel area expands, while non-interference-affected pixel area is further lost.

The conventional method, which is dependent on color component analysis for extraction of a code area and identification of a color of each cell, requires as great degree of color difference and large cell size as to be free from effect of color shift caused by interference. Therefore it is not a rational method for combining color codes, which aims improvement of recording efficiency by increasing the number of colors or by reduction of the cell size. Also, generally in many cases, the conventional method judges the color by analyzing all the color information composing a cell. Handling the large volume of pixel information puts load on processing, and requires time for restoration.

As described above, the conventional code system has a disadvantage that increasing the recording density on print medium only decreases restoration accuracy, which fact makes this method not very practical for recording electronic data thereon. In actual usage environments where restoration accuracy is essential, only cells of practically usable size (specifications), which should be large enough to secure enough accuracy, is used. In order to make use of the information code as a method for recording data on print medium, a restoration-accuracy maintainable code system and its restoration method are needed even if the recording accuracy is being improved.

Patent Document 1: Japanese Patent No. 3996520

SUMMARY OF THE INVENTION

In consideration of the above described conventional disadvantage, the present invention is the information code having two code references including the excision code portion and the data recording code portion, the excision code being a code system which provides easy excision of a code because the excision code serves as an initial clue to excise a code from an image, by which decoding, information needed for extraction and decoding the data recording code portion can be obtained. Accordingly, the present invention has a purpose to provide an information code which enables excision and decoding, by means of mathematical calculation, of even a data recording code portion which has high recording density and thus is difficult to increase number of colors or reduce cell size for excision and decoding by color component analysis

In order to achieve the above described purpose, the present invention composes an excision code portion based on a code system which allows easy excision, by means of color code analysis, of a code area from an image data containing the code area itself, and a data recording code portion which is capable of recording subject electronic data in high recording density, the information code being able to improve recording density of the data recording code portion by increasing number of colors and/or reduction of cell size, by making possible of extraction from and decoding of the excision code portion using mathematical calculation not solely depending on color component analysis, by decoding the excision code portion.

ADVANTAGEOUS EFFECT OF THE INVENTION

As is clear from the above-mentioned explanations, the present invention as hereinabove defined provides the effects enumerated below.

(1) It comprises an excision code portion based on a code system which allows easy excision, by means of color code analysis, of a code area from an image data containing the code area itself, and a data recording code portion which is capable of recording subject electronic data in high recording density, the information code being able to improve recording density of the data recording code portion by increasing number of colors and/or reduction of cell size, by making possible of extraction from and decoding of the excision code portion using mathematical calculation not solely depending on color component analysis, by decoding the excision code portion, therefore, both recording density and restoration accuracy can be retained.

(2) Claim 2 has the same effect as the above (1), and it can also improve recording density of the data recording code portion by decoding of the excision code portion.

PREFERRED EMBODIMENTS OF THE INVENTION

Preferred embodiments of the present invention will now be described in detail below referring to the accompanying drawings.

A first preferred embodiment of the present invention is illustrated in FIGS. 1 to 5.

An information code 1 is comprised of an excision code portion based on a code system which allows easy excision, by means of color code analysis, of a code area from an image data containing the code area itself, and a data recording code portion which is capable of recording subject electronic data in high recording density, the information code being able to improve recording density of the data recording code portion by increasing number of colors and/or reduction of cell size, by making possible of extraction from and decoding of the excision code portion using mathematical calculation not solely depending on color component analysis, by decoding the excision code portion.

The above-described excision code portion 2 has two roles; one is to serve as a reference for easy excision of an information code from image data which contains the information code therein, and the other is to encode information minimally required for excision of the data recording code portion 3 as well as for analysis of the number and composition of the cells. To fulfill those roles, the code system to be used shall be of high excision and restoration accuracy. Limiting the number of colors to be used to two or three, e.g. black-and-white, RGB or CMY, in order to maintain enough color difference, contributes to lessen the effect of color fading, uneven printing or illumination light, whereas enlarging the cell size makes shape identification easier.

A possible alternative method for the excision code portion 2 is to use code systems like proven QR code or the Japanese Published Examined Application 2008-27029, to carry the function.

Role of data recording code portion 3 is to serve as a code system which prioritizes recording efficiency for electronic data. Therefore, ideally, maximum number of colors shall be used within a range to maintain the target decoding accuracy, and the cell size shall be reduced within a range to be reproducibly printed.

A code to be used for the excision code portion 2 needs not to be limited but can be arbitrary one such as bar-code, QR code, color code, etc. However, assume that encoding and decoding methods disclosed in the Japanese Published Examined Application 2008-27029 are applied here as examples. Assume that the data recording code portion employs a typical encoding method which assigns a color to a bit pattern, and is explained utilizing FIG. 1 as an example.

For example, assume that the excision code portion 2 has been encoded with one or more data therein, the data being such that it is or they are used for excision and decoding of the data recording portion 3, including a figure which represents number of cells on one side of the data recording code portion 3, number of colors, data code position, vertical and horizontal identification, cell size, code shape, etc.

Data recording code portion 3 can represent eight different patterns on a cell if eight colors can be used, therefore, in case subject electronic data to be converted to code is replaced with binary data which is represented as 0 and 1 sequence, one cell can represent 3-bit array.

Now each eight color is assigned to 3-bit equivalent each sequence pattern. For

example, assume that the colors to be used are RGBCMYKW, it is assumed that the following PGB values are assigned:

001 = R (R255, G000, B000)
 010 = G (R000, G255, B000)
 100 = B (R000, G000, B255)
 011 = C (R000, G128, B255)
 110 = M (R255, G000, B128)
 101 = Y (R255, G255, B000)
 000 = K (R000, G000, B000)
 111 = W (R255, G255, B255)

Subject electronic data may be compressed, instead of direct code conversion, by using an ordinary data-compression technique such as ZIP or IZH in order to improve recording efficiency.

It is then converted to a bit pattern train of the subject electronic data, which is divided in every 3-bits, and is further converted to color cells in accordance with the above color allocation table.

In order for the cell to be represented having the same number of cells vertically and horizontally, the code shall be composed in a way that a new line is started for each number calculated by rounding-up after the decimal point for a radical root of (size of an compressed file $\times 8 \div 3$).

The excision code portion 2 and the data recording code portion 3 are laid out in such a way that they are in a certain positional relationship with the excision code portion 2 serving as a reference, so that the data recording code portion 3 can be located. In this case, the excision code portion 2 is defined as a ninety degree angled L-letter shape, and is located in such a way that it surrounds the data recording code portion 3 at its top and left sides with one cell equivalent distance in between.

(Recording Method on Print Medium)

Then, a prior color management, that is, color information conversion suitably adjusted to specifications of a printing machine or a printer, is made in order to keep the color unchanged for assignment to the information code 1 and for printing.

This is because that the color of the information code 1 generated on electronic medium is color-represented in RGB values, which data has to be converted to CMYK values for printing; a typical conversion method will make the color from the same data change depending on difference between papers, printing machines (including printers) or print color references, resulting in such that correct color information cannot be rendered when printed on print medium.

Print color references differ from country to country; those for Japan are Japan Color, JMPA, etc. Successful printing can be achieved without changing color by converting RGB values to CMYK values according to the corresponding print color reference; Japan Color, JMPA, etc.

There is a chance that difference of printing machines (including printers) and/or papers to be used may result in difference in printed color. A useful solution to this problem is to comprehend characteristics of the paper and/or the printing machine based on a color chart (colorimetric print) printed out from the printing machine on the paper, from which a database is created, and based on which RGB values are converted to CMYK values. A method for converting RGB values to CMYK values is such that, based on data of print reference, paper, and characteristics of printing machine, a profile (data which indicates RGB values and corresponding CMYK values for conversion) by which RGB values are automatically converted to CMYK values is made in advance, the data being processed by the profile for automatic conversion to corresponding print reference and standard. By printing the converted data, the same color can be reproduced on the printing surface; therefore decoding accuracy of the information code 1 is improved.

(Code Decoding Method)

Decoding method of excision code 2 is now explained using FIG. 3. In case of FIG. 3, cell size is large and number of colors is limited in order to be excised by conventional analysis of color components. The decoding method of the excision code 2 is dependent on decoding method of the code system to be used.

As illustrated in sections 1 and 2 of FIG. 3, the excision code 2 is excised as illustrated in sections 1 and 2 of FIG. 3.

As illustrated in section 3 of FIG. 3, based on points A, B, and C of the excision code portion 2, information area is excised.

As illustrated in section 4 of FIG. 3, according to a program (for example, point B is calculated based on a rule that it locates at twice the length of one side of the excision code 2 in the direction from point B to point D) to calculate area of the data recording code portion 3 with the points A, B, and C of the excision code portion 2, points A', B', and C' are calculated and data recording code portion 3 is excised.

As illustrated in section 3 of FIG. 3, the image data is rotated to be horizontal with A'—C' being the top side of it. By following the steps as illustrated in sections 1 to 5 of FIG. 3, it is possible to excise the data recording code portion 3, in which positional relationship to the excision code portion 2 is utilized. Judgment by color components allows the data recording code portion 3 to be excised even when discrimination of the data recording code portion 3 from other areas is difficult.

Supposedly most ideal way to identify color of each cell is to identify center of the cell, where effect of interference is minimal, and identify the color based on pixels surrounding the center. In the present invention, number of cells per side has been obtained at the time of decoding the excision code 2, and based on the figure, center of each cell of the data recording code portion 3 can be calculated. For example, as illustrated in FIG. 4, assume that a figure which represents a number of cells per side has been obtained as 60, by decoding the excision code 2 when an excised code image has 540 x 540 pixels. Based on an assumption that the cells are evenly positioned, it is understood that each unit is composed of 9 x 9 pixels. It is easily understood that center of the 9 x 9 pixels is at 5 x 5 pixels inward from each side of a cell.

Because the data recording code portion 3 has been excised as described above, and unnecessary data has been eliminated, it is also possible to locate the central point by means of change in component value of the data recording code portion 3. The central point has the highest possibility of retaining assigned color components, thus, for example, if an image of the data recording code portion 3, being excited as described above, is represented in a wave pattern on a 0 — 100 scale, of which 100 indicates the closest to the component value of the assigned color while 0 indicates the farthest to that, a pixel at the peaks of the wave pattern is considered to have a high possibility to be a color at the central point of an assigned cell. An emergence distribution chart can be made representing mountain peaks of the wave patterns of each assigned color, which indicates that central points emerge under certain regularity where cells with different colors are arrayed. Interval between adjacent mountains can be considered as that between central points of adjacent cells, so that a point of which wavelength is hardly identified can be found by mathematical calculation of the interval.

Color of each cell is identified based on color information of a pixel of the central point or pixels within a certain area therefrom. A method for identification can be of typical color analysis. For example, assume that a color is identified based on color information of $3 \times 3 = 9$ pixels, of a central point and its immediate surroundings, and assume that an RGB value of each pixel is as follows:

A (R255, G010, B004)
 B (R245, G006, B002)
 C (R250, G020, B020)
 D (R239, G000, B000)
 E (R248, G013, B014)
 F (R251, G003, B006)
 G (R254, G010, B001)
 H (R255, G002, B000)
 I (R255, G001, B004)

If color of each cell is judged as the closest one to color components of RGBCMYKW which have been assigned for encoding, then the color can be identified as R (R255, G000, B000). Assume that the cell is R, and 001 can be obtained by converting it to bit pattern column according to the decoding assignment chart. A pixel of the central point or pixels within a certain area therefrom are least affected by interference, therefore this can be the most accurate color identification method. This method allows minimizing the pixel information to be used for analysis, so that it provides high calculation efficiency while not requiring high resolution.

By converting each cell in turn by the above mentioned method, bit pattern columns of corresponding electronic data can be obtained. Then, by assigning extensions representing file types of corresponding data, which have been obtained at the time of decoding the excision code portion, can be obtained.

As far as it is a compressed file, decoding is made in accordance with decoding

method of compression technique being used.

INDUSTRIAL APPLICABILITY

The present invention is applicable in the industry where an information code having both recording density and restoration accuracy is used.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front view showing a first preferred embodiment of the present invention;

FIG. 2 is an explanatory drawing showing the first preferred embodiment of the present invention;

FIG. 3 is an explanatory drawing showing a method to excise an information code area by using an excision code;

FIG. 4 is a method to restore an excised data code; and

FIG. 5 is an explanatory drawing showing disadvantages of a color code.

Claims:

1. An information code comprising an excision code portion based on a code system which allows easy excision, by means of color code analysis, of a code area from an image data containing the code area itself, and a data recording code portion which is capable of recording subject electronic data in high recording density, the information code being able to improve recording density of the data recording code portion by increasing number of colors and/or reduction of cell size, by making possible of extraction from and decoding of the excision code portion using mathematical calculation not solely depending on color component analysis, by decoding the excision code portion.
2. The information code according to claim 1, wherein the excision code portion is being encoded therein with two or more data including data code position, vertical and horizontal identification, cell size, number of colors, and code shape.