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(54) **INK CARTRIDGE CHIP AND INK CARTRIDGE USING CHIP**

(57) Disclosed is an ink cartridge chip 10, comprising: a communication interface unit 11, used for communicating with an imaging device mounted with an ink cartridge, so as to receive or transmit ink level information in a first format; a data conversion unit 13, used for converting the ink level information in the first format received into ink level information in a second format, wherein the second format comprises more bits therein than the first format; and a storage unit 12, used for saving the ink level information in the second format, wherein when it

is necessary for the imaging device to read ink level information of the ink cartridge chip 10, the data conversion unit 13 is further used for restoring the ink level information in the second format as stored in the storage unit to the first format. Because ink level information stored in the storage unit 12 has more bits than the information received from the imaging device, an illegal device will not be able to obtain actual ink level information while reading the storage unit 12, thereby effectively ensuring data security of the ink cartridge chip 10.

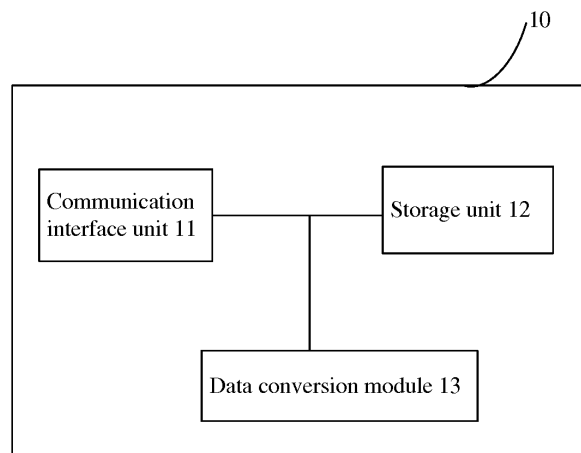


Fig. 1

Description**Cross-reference to Related Applications**

5 **[0001]** The present application claims the priority benefit of Chinese patent application CN 201410019068.4, entitled "Ink cartridge chip and ink cartridge using the same" and filed on January 15, 2014, the entirety of which is incorporated herein by reference.

Field of the Invention

10 **[0002]** The present disclosure relates to the field of imaging and developing technologies, and in particular, to an ink cartridge chip and an ink cartridge using the same.

Background of the Invention

15 **[0003]** As the imaging technology develops, imaging devices such as photocopiers, printers, fax machines, and word processors are widely used. Such an imaging device can comprise an ink cartridge that can be conveniently replaced by a user and is used for accommodating ink, and a print head that can perform an imaging operation on a medium. The ink cartridge can be stored with a prescribed level of ink, wherein it will be necessary to replace the ink cartridge with a new one in time when the stored ink is used up. In order to prevent damages to the print head due to continuous printing of the imaging device even after the ink in the ink cartridge is used up, the imaging device will calculate ink level information in the ink cartridge (remaining ink level information or consumed ink level information), and remind the user to replace the ink cartridge when the ink is to be used up.

20 **[0004]** Such ink level information is typically saved in a memory of the imaging device. Therefore, where an ink cartridge is removed from an imaging device after being used for a while therein, and mounted to another imaging device, the ink level information recorded in the former imaging device might be missing or go wrong. In order to prevent this from occurring, more and more ink cartridges are started to be provided with chips, in which the ink level information is saved. The imaging device will read the ink level information from the chip to check whether the ink level information saved in the imaging device per se is accurate.

25 **[0005]** However, as a matter of fact, the ink level information, as important data recording printing history of the user, is saved in the chip solely for confirmation of ink level by the imaging device. Personal data loss caused in case the ink level information is read by other people might bring harm to the user. In addition, in an existing chip, the ink level information tends to be directly saved in a fixed region thereof, and therefore can be easily tampered. This would lead to misreading of the ink level information by the imaging device, thereby threatening device and information security.

30 **[0006]** As a result, there is an urgent need of a chip that can assure information security of ink level data.

Summary of the Invention

35 **[0007]** Directed against the problems in the prior art, the present disclosure provides an ink cartridge chip, comprising:

40 a communication interface unit, used for communicating with an imaging device mounted with an ink cartridge, so as to receive or transmit ink level information in a first format;

45 a data conversion unit, used for converting the ink level information in the first format as received into ink level information in a second format, wherein the second format comprises more bits therein than the first format; and

a storage unit, used for saving the ink level information in the second format,

50 wherein when it is necessary for the imaging device to read ink level information of the ink cartridge chip, the data conversion unit is further used for restoring the ink level information in the second format as stored in the storage unit to the first format.

55 **[0008]** Because the ink level information stored in the storage unit has more bits therein than information received from the imaging device, other devices cannot acquire actual ink level information while reading from the storage unit, thereby effectively ensuring data security of the ink cartridge chip.

[0009] According to one embodiment of the present disclosure, the communication interface unit comprises a contact set for wire communications between the ink cartridge chip and the imaging device, or further comprises an antenna and a matching circuit for wireless communications between the ink cartridge chip and the imaging device. According

to one embodiment of the present disclosure, the storage unit comprises a nonvolatile storage device, or a storage circuit mainly constituted by a volatile storage device and a power storage device and having a nonvolatile function. The ink level information in the first format restored by the data conversion unit from the ink level information in the second format stored in the storage unit refers to ink level information last received from the imaging device and/or ink level information previously received from the imaging device.

[0010] According to one embodiment of the present disclosure, in the data conversion unit, the ink level information in the second format is obtained through the steps of:

calculating a percentage the ink level information in the first format accounting for of a total ink level;

predetermining a bit number contained in the second format; and

obtaining the ink level information in the second format according to said percentage and said bit number as predetermined in view of a corresponding relationship therebetween.

[0011] According to one embodiment of the present disclosure, in the data conversion unit, the ink level information in the second format is obtained through the steps of:

generating redundant data containing certain bits; and

mixing the redundant data with the ink level information in the first format to generate the ink level information in the second format.

[0012] According to one embodiment of the present disclosure, the step of mixing the redundant data with the ink level information in the first format comprises at least one of the following operations:

a) combining the redundant data, as high-bit data or low-bit data, with the ink level information in the first format, to form the ink level information in the second format;

b) grouping at least one of the redundant data and the ink level information in the first format as per a certain bit number, followed by rearrangement and superposition of these grouped data, to form the ink level information in the second format; and

c) performing logical operations on at least a part bits of the redundant data and at least a part bits of the ink level information in the first format, to generate the ink level information in the second format.

[0013] According to one embodiment of the present disclosure, the redundant data comprise at least one selected from a group consisting of predetermined data, true form of the ink level information in the first format, one's complement of the ink level information in the first format, two's complement of the ink level information in the first format, pseudo-random numbers, and at least a part of data restored from the ink level information in the second format, wherein the at least a part of data comprises the ink level information previously received from the imaging device.

[0014] According to one embodiment of the present disclosure, the data conversion unit further comprises a pseudo-random number generator which generates the pseudo-random numbers.

[0015] According to one embodiment of the present disclosure, the redundant data refer to the ink level information previously received from the imaging device.

[0016] According to one embodiment of the present disclosure, the data conversion unit further comprises a logic encryption module, which encrypts the ink level information in the first format as received, to generate the ink level information in the second format.

[0017] According to another aspect of the present disclosure, an ink cartridge mounted with the above ink cartridge chip is provided.

[0018] According to the present disclosure, data stored in the ink cartridge chip, especially the ink level information can be effectively protected. Extended ink level information formed by various combinations is beneficial for prevention of malicious read or write operations performed thereon by illegal devices. The data conversion unit in the chip can perform an inverse extension operation on the extended ink level information as stored for restoration thereof. As a result, normal reads of actual ink level information by the imaging device will not be affected.

[0019] Other features and advantages of the present disclosure will be further explained in the following description, and partly become self-evident therefrom, or be understood through implementing the present disclosure. The objectives and other advantages of the present disclosure will be achieved and obtained through the structure specifically pointed

out in the description, claims, and the accompanying drawings.

Brief Description of the Drawings

[0020] The drawings are provided to explain, rather than to limit the present disclosure. In the drawings:

Fig. 1 shows an internal structure of an ink cartridge chip according to one embodiment of the present disclosure;

Fig. 2 shows an internal structure of an ink cartridge chip according to another embodiment of the present disclosure;

Fig. 3 schematically shows ink level information extension performed according to one example of the present disclosure;

Fig. 4 schematically shows ink level information extension performed according to another example of the present disclosure; and

Fig. 5 schematically shows a logic operation performed on the ink level information and predetermined data to form information in an extended format.

Detailed Description of the Embodiments

[0021] The present disclosure will be explained with reference to the following detailed description of embodiments taken in connection with the accompanying drawings, whereby it can be readily understood how to solve the technical problem by the technical means according to the present disclosure and achieve the technical effects thereof, and thus the technical solution according to the present disclosure can be implemented. It is important to note that as long as there is no conflict, combinations of the above-described embodiments and of technical features therein are possible, and technical solutions obtained in this manner are intended to be within the scope of the present disclosure.

[0022] In an imaging operation, information interaction will occur between an imaging device and an ink cartridge chip, comprising: the imaging device sending a WRITE instruction to the ink cartridge chip, to transmit ink level information generated during a printing step to the ink cartridge chip; and the imaging device sending a READ instruction to the ink cartridge chip, to request the ink cartridge chip to return the ink level information to the imaging device, wherein when the imaging device cannot receive any ink level information from the ink cartridge chip, or when the ink level information received cannot satisfy a requirement of the imaging device, the imaging device will report an error or refuse a print operation. For example, when the ink level information returned to the imaging device by the ink cartridge chip indicates an insufficient ink level in the ink cartridge, the imaging device will refuse the print operation.

[0023] In order to satisfy such information interaction between the imaging device and the chip, the ink level information is typically stored in a memory of the imaging device and in a storage unit of the ink cartridge chip respectively in the form of a plurality of binary numbers in the prior art. For example, a set of 8-bit data can be used to indicate a ratio (ranging from 0% to 100%) a remaining ink level in the ink cartridge accounts for of a standard capacity of the ink cartridge. When the remaining ink level equals the capacity of the ink cartridge, the ink level information appears to be "1111 1111;" when the remaining ink level equals 50% the capacity of the ink cartridge, the ink level information appears to be "01111111;" and when the remaining ink level equals 0, the ink level information appears to be "00000000." That is, the standard capacity of the ink cartridge is divided into 28 parts, whenever the remaining ink level is reduced by 1/256, there will be a set of 8-bit data to correspond to the remaining ink level, and such a set of 8-bit data will be stored in fixed positions of the memory of the imaging device and in the storage unit of the ink cartridge chip, respectively.

[0024] As important history data recording print operations, the above ink level information is usually expected to be protected as privacy by the users. The chip, however, as an electronic element to be abandoned after a life-cycle of the ink cartridge, typically will not be protected for data stored therein with complex anti-cracking technologies in consideration of costs and service life thereof. Hence, in case the chip is cracked, data leakage will follow concerning usage conditions of the ink cartridge. In addition, the ink level information is stored in the chip directly in the forms of binary numbers respectively, and therefore can be easily tampered. For example, if the ink level information recorded in the chip indicates that ink in the ink cartridge will be exhausted, the service life of the chip will normally come to an end also. However, lawbreakers can perform renovation on the chip by amending the ink level information recorded therein into a capacity of the ink cartridge. Customers, however, cannot learn about this.

[0025] Therefore, the present disclosure provides a new technical solution. That is, upon receipt of ink level information from the imaging device, the ink cartridge chip will, by means of a data conversion unit, convert the ink level information into data having more bits (hereinafter referred to as extended data for convenience) than the ink level information as received, and write the extended data in a nonvolatile storage device provided in the chip. When the imaging device

reads the ink level information, the ink cartridge chip will convert the extended data as stored into ink level information having bits identifiable by the imaging device and return such ink level information to the imaging device. Such an ink cartridge chip can satisfy the requirements of the imaging device for identifying the ink level information. The extended data as stored, however, are somewhat different from the ink level information written by the imaging device, thereby preventing leakage of users' information.

[0026] In addition, the extended data stored in the ink cartridge chip have more bits than the ink level information written by the imaging device, which means that the data of actual ink level information have gone through a scattering or encrypting procedure. As a result, except for the designer or the manufacturer of the chip, other users cannot acquire the ink level information through cracking the chip, thereby effectively preventing the ink level information from being tampered.

[0027] In this regard, the present disclosure provides a chip 10 as shown in Fig. 1. The chip 10 comprises a communication interface unit 11, a data conversion unit 13 (or a data conversion module 13), and a storage unit 12 thereon.

[0028] The communication interface unit 11 can be used to communicate with an imaging device provided with an ink cartridge, so as to receive or transmit ink level information in a first format for communicating with the imaging device. Specifically, the communication interface unit 11 can be a contact set for contact communications with the imaging device, or can be an antenna and a matching circuit for wireless communications with the imaging device.

[0029] The storage unit 12 can be used for storing the ink level information. Specifically, the ink storage unit 12 can be a nonvolatile storage device, or can be a circuit which is constituted by a volatile memory and a power storage device, and having a nonvolatile storing function.

[0030] The data conversion unit 13 is electrically connected to the interface unit 11 and the storage unit 12, and used for performing data conversion on the ink level information received from the imaging device, that is, conversion of the ink level information from a first format to a second format. The ink level information in the second format, i.e., extended data as aforementioned (in the following, "extended data" and "ink level information in the second format" have the same meanings and can be used interchangeably) contains more bits than the ink level information in the first format. Or alternatively, the data conversion unit 13 can restore the ink level information in the second format read from the storage unit 12 to the ink level information in the first format. The ink level information in the first format restored by the data conversion unit 13 from the ink level information in the second format stored in the storage unit 12 can be ink level information last received by the chip 10 from the imaging device, or can be ink level information previously received from the imaging device. The term "previously" herein can refer to "previous one," which is the case adopted in the embodiments of the present disclosure. However, it can be understood that, "previously" can refer to "previous two" and "previous three" also, and in a word, any reading or receiving operations performed before a current operation. The present disclosure will not provide any limitations to this.

[0031] Specifically, when the imaging device writes the ink level information into the chip, the data conversion unit 13 can receive the ink level information from the imaging device through the communication interface unit 11, start a function of ink level information extension treatment, and store extended ink level information, i.e., ink level information in a second format, into the storage unit 12. When the imaging device reads the ink level information in the chip, the data conversion unit 13 will read the ink level information in the second format stored in the storage unit 12, start a function of information restoration treatment, and transmit restored ink level information in the first format to the imaging device through the communication interface unit 11.

[0032] Specifically, when the function of ink level information extension treatment is started, the data conversion unit 13 will convert the ink level information received from the imaging device into the ink level information in the second format containing more bits than the received ink level information. And according to the function of information restoration treatment, the data conversion unit 13 can convert the ink level information in the second format stored in the storage unit 12 into ink level information with bits identifiable by the imaging device. Through such extension treatment, the ink level information can be effectively prevented from being disclosed or tampered, thereby protecting customers' privacy and ensuring data security.

[0033] The data conversion unit 13 can accomplish data conversion by means of at least one specific data conversion approach selected from a group consisting of data splitting, redundant data insertion, execution of one or more of preset calculations or other logic encryption. The redundant data can be predetermined data, or pseudo-random numbers generated by a pseudo-random number generator. As shown in Fig. 2, the chip 10 can further comprise a pseudo-random number generator 31.

[0034] In the following, it will be explained in detail how the data conversion unit 13 processes data. Those skilled in the art should understand that the ink level information of the present disclosure refers to relevant data that are used to characterize the conditions of ink level in the ink cartridge, such as remaining ink level and consumed ink level.

[0035] A first data conversion approach is performed as follows.

[0036] The data conversion unit 13, via equal percentage conversion, completes data conversion between the ink level information and the extended data.

[0037] In this approach, the following steps are typically executed.

[0038] A percentage of the ink level information in the first format accounting for of a full ink level is calculated.

[0039] The number of bits contained in the second format is predetermined.

[0040] The ink level information in the second format is obtained in view of the percentage and the number of bits as predetermined, and corresponding relationship therebetween.

[0041] In one embodiment, for example, it can be assumed that the ink level information in the first format written into the chip by the imaging device is 16-bit data representing a remaining ink level, and the extended data have 32 bits. When the imaging device writes the remaining ink level into the chip, the data conversion unit 13 will, via the communication interface unit 11, receive the ink level information in the first format from the imaging device, and start a function of remaining ink level extension treatment. During such treatment, the data conversion unit 13 will convert the remaining ink level into a percentage value indicated in 32 bits through the following formula:

$$100 \times \frac{\text{Remaining ink level (16 bits)}}{\text{Capacity of the ink cartridge (16 bits)}}$$

[0042] Subsequently, the data conversion unit 13 will write 32-bit extended data that are obtained through conversion, as the ink level information in the second format, into the storage unit 12. When the imaging device reads the ink level information in the chip, the data conversion unit 13 will read the 32-bit ink level information in the second format stored in the storage unit 12, and start a function of information restoration treatment. During such treatment, the data conversion unit 13 will convert the ink level information in the second format into a percentage value indicated in 16-bit binary numbers, using the following formula:

$$100 \times \frac{\text{Extended data (32 bits)}}{\text{Extended data corresponding to the capacity of the ink cartridge (32 bits)}}$$

[0043] Subsequently, the data conversion unit 13 will, via the communication interface unit 11, transmit the restored 16-bit remaining ink level or the ink level information in the first format to the imaging device.

[0044] Since the ink cartridge has a fixed capacity, the 16-bit data indicating the capacity of the ink cartridge and the 32-bit extended data corresponding to the capacity of the ink cartridge are both fixed. The data conversion unit can readily accomplish interconversion between the ink level information in the first format and the ink level information in the second format through the above formulae.

[0045] Those skilled in the art should understand, the bit numbers of the ink level information in the first format and the ink level information in the second format as listed above are only examples for convenient understanding of the present disclosure. The present disclosure will not provided any limitations on specific bit number of the ink level information or that of the extended data in practice. In the present embodiment, the actual bit number of the extended data stored in the chip and the conversion approaches are only available to the designer or the manufacture of the chip only. This can effectively prevent the ink level information from being revealed or tampered, thereby protecting the customers' privacy and ensuring data security.

[0046] A second data conversion approach is performed as follows.

[0047] The data conversion unit 13, via mixing of the ink level information and the redundant data having a fixed value, accomplishes data conversion between ink level information in an original format and ink level information in an extended format, wherein the original format refers to the first format, and the extended format refers to the second format.

[0048] In the data conversion unit 13, the following steps are employed to perform the mixing and obtain the ink level information in the second format.

[0049] Redundant data comprising certain bits are generated.

[0050] The redundant data are mixed with the ink level information in the first format to generate the ink level information in the second format.

[0051] Specifically, the redundant data are mixed with the ink level information in the first format in at least one operation selected from a group consisting of:

a) combining the redundant data, as high-bit data or low-bit data, with the ink level information in the first format, to form the ink level information in the second format;

b) grouping at least one of the redundant data and the ink level information in the first format as per a certain bit

number, followed by rearrangement and superposition of these grouped data, to form the ink level information in the second format; and

c) performing logical operations on at least a part bits of the redundant data and at least a part bits of the ink level information in the first format, to generate the ink level information in the second format.

[0052] In another specific example, the ink level information in the original format can be mixed with the redundant data through simple superposition.

[0053] As indicated in Fig. 3, it can be assumed that the ink level information in the original format comprises 16 bits, and the ink level information in the extended format comprises 32 bits. When the imaging device writes ink level information 700 in the original format into the chip, the data conversion unit 13 will start a function of extension treatment, i.e., take the ink level information 700 in the original format as 16 high bits, and the redundant data stored in the chip, for example, predetermined data 800, as 16 low bits, to generate 32-bit extended data 100, which will be written into the storage unit 12. When the imaging device reads the ink level information in the chip, the data conversion unit 13 will read the 32-bit extended data 100 stored in the storage unit 12, and start the function of information restoration treatment. The data conversion unit 13 will extract the 16 high bits from the extended data as restored 16-bit ink level information, and transmitted the restored 16-bit ink level information to the imaging device.

[0054] Of course, the 32-bit extended data can also have the ink level information 700 as the 16 low bits, in which case the predetermined data 800 will be regarded as the 16 high bits.

[0055] Those skilled in the art should understand, the bit numbers and superposition sequence of the above ink level information and extended data constitute examples only to facilitate understanding of the present disclosure, rather than to limit the present disclosure.

[0056] In order to reinforce security of the ink level information, the ink level information and the redundant data can be mixed with each other through hybrid superposition. That is, when the data conversion unit 13 executes ink level information extension treatment, at least one of the ink level information and the redundant data will be divided into at least two groups, followed by rearrangement and superposition of grouped data successively.

[0057] As shown in Fig. 4, it can still be assumed that the ink level information has 16 bits and the extended data have 32 bits.

[0058] When the imaging device writes ink level information 710 in the original format, the data conversion unit 13 will start the function of ink level information extension treatment, to divide the ink level information 710 into three groups 711-713 as per a predetermined bit number, and divide predetermined data 810 stored in the chip into four groups 811-814 as per a predetermined bit number, followed by writing of the seven groups of data, which are rearranged and superposed into 32-bit extended data 110 as per a predetermined rule, into the storage unit 12.

[0059] When the imaging device reads the ink level information stored in the chip, the data conversion unit 13 will read the 32-bit extended data 110 stored in the storage unit 12, and start information restoration treatment, i.e., perform reverse dismantling on the 32-bit extended data 110 to restore the 16-bit ink information 710, followed by transmission of the 16-bit ink information 710 to the imaging device.

[0060] Those skilled in the art should understand, the bit numbers, group numbers, and superposition sequence of the above ink level information and extended data constitute examples only to facilitate understanding of the present disclosure, rather than to limit the present disclosure.

[0061] In order to reinforce security of the ink level information, the ink level information and the redundant data can be mixed with each other through operational superposition. That is, when the data conversion unit 13 executes the ink level information extension treatment, it will execute at least one logic operation selected from a group consisting of "and," "or," and "xor" on at least a part of the ink level information and at least a part of the redundant data.

[0062] As shown in Fig. 5, it can still be assumed that the ink level information has 16 bits and the extended data have 32 bits.

[0063] When the imaging device writes ink level information 720 in the original format into the chip, the data conversion unit 13 will start the function of ink level information extension treatment, i.e., execute logic operation "and" on the ink level information 720 and redundant data stored in the chip, such as 16 high-bit data 821 of preset data 820, and execute logic operation "xor" on the ink level information 720 and 16 low-bit data 822 of the preset data 820 stored in the chip, followed by writing of 32-bit extended data 120 obtained through superposition of operational results into the storage unit 12.

[0064] When the imaging device reads the ink level information stored in the chip, the data conversion unit 13 will read the 32-bit extended data 120 stored in the storage unit 12, and start information restoration treatment, i.e., perform reverse operation on the 32-bit extended data 120, restore the 16-bit ink level information 710, and transmit the restored 16-bit ink level information 710 to the imaging device. Those skilled in the art should understand, bit numbers, specific logic operations adopted, data groups involved in the operations of the above ink level information and extended data constitute examples only to facilitate understanding of the present disclosure, rather than to limit the present disclosure.

[0065] In order to reinforce security of the ink level information, data conversion between the ink level information and the extended data can be completed through at least one mixing approach selected from a group consisting of simple superposition, hybrid superposition, and operational superposition. For example, logic operations can be executed on the redundant data and grouped ink level information, followed by rearrangement of the redundant data and data obtained in the logic operations. In the present embodiment, values of the redundant data, and mixing manners between the redundant data and the ink level information are only available to the designer or the manufacturer of the chip. This can effectively prevent the ink level information from being revealed or tampered, thereby protecting the customers' privacy and ensuring data security.

[0066] As explained above, the redundant data can comprise at least one selected from a group consisting of predetermined data; true code, one's complement, or two's complement of the ink level information in the first format; pseudo-random number; and at least a part of data obtained through restoration of the ink level information in the second format stored in the storage unit.

[0067] In case the redundant data are the true form of the ink level information in the first format, when the imaging device writes the ink level information in the first format to the chip, the data conversion unit 13 will start the function of extension treatment, and mix the ink level information in the first format with the true form thereof, to obtain the ink level information in the second format, which will be written into the storage unit 12. When the imaging device reads the ink level information in the chip, the data conversion unit 13 will read the ink level information in the second format stored in the storage unit 12, start the function of information restoration treatment, to restore the ink level information in the first format, and transmit the restored ink level information in the first format to the imaging device. In case the redundant data are the one's complement or two's complement of the ink level information in the first format, it will be only necessary for the data conversion unit 13, when starting the function of extension treatment, to calculate the one's complement or two's complement of the ink level information in the first format, and then mix the ink level information in the first format with the one's complement or two's complement thereof, to obtain the ink level information in the second format, which will not be repeated herein. Specific mixing can be performed through at least one selected from a group consisting of operations a), b), and c) as described above.

[0068] In case the redundant data are the at least a part of data obtained through restoration of the ink level information in the second format stored in the storage unit, the data conversion unit 13 will complete data conversion between the ink level information and the extended data by mixing the ink level information currently received from the imaging device and the ink level information previously received from the imaging device.

[0069] The extended data stored in the storage unit 12 of the chip 10 can be used to restore the ink level information written by the imaging device in a last write operation thereof (current ink level information for short), and ink level information written by the imaging device in a previous write operation thereof as relative to said last write operation (previous ink level information for short), respectively. For an unused, entirely new chip, the extended data stored in the storage unit 12 thereof can be used to restore current ink level information characterizing a full ink level, and previous ink level information characterizing the full ink level, respectively.

[0070] When the imaging device writes ink level information A2 into the chip, the data conversion unit 13 will start the ink level information extension treatment, i.e., read extended data B1 stored in the storage unit 12, restore current ink level information A1, and then mix the ink level information A2 currently received from the imaging device and the current ink level information A1, to produce extended data B2 having more bits than the ink level information A2. The extended data B2 will then be used to update original extended data B1 stored in the storage unit 12. As such, the ink level information A2 will become new current ink level information, and the ink level information A1 will become new previous ink level information and can be restored by updated extended data B2. When the imaging device writes ink level information into the chip for a second time, the data conversion unit 13 will restore new current ink level information B2, which will be mixed with received ink level information, so on and so forth. Specific mixing can be performed through at least one selected from a group consisting of operations a), b), and c) as described above.

[0071] The chip provided in the present embodiment can provide the imaging device with the current ink level information and the previous ink level information, assist the imaging device in verification of ink level information, and provide the previous ink level information where the current ink level information fails to be written or transmitted, so as to compensate for losses caused by missing of the ink level information. When the imaging device reads the current ink level information in the chip, the data conversion unit 13 will read extended data stored in the storage unit 12, and start information restoration treatment, to restore the current ink level information, followed by transmission of the current ink level information as restored to the imaging device. When the imaging device reads the previous ink level information in the chip, the data conversion unit 13 will read the extended data stored in the storage unit 12, and start information restoration treatment, to restore the previous ink level information, followed by transmission of the previous ink level information as restored to the imaging device.

[0072] In the present embodiment, the two types of ink level information are mixed in a manner available to the designer or the manufacture of the chip only. This can effectively prevent the ink level information from being revealed or tampered, thereby protecting the customers' privacy and ensuring data security.

[0073] In addition to the above treatment manners, data conversion between the ink level information and the extended data can be completed through other manners. For example, existing encrypting means of secure hash algorithm (SHA-1) can be used to convert the ink level information into extended data having more bits than the ink level information. Moreover, the above treatment manners can be used in combination with each other.

[0074] For example, when the imaging device writes the ink level information into the chip, the data conversion unit 13 will start ink level information extension treatment, i.e., the data conversion unit 13 will read extended data stored in the storage unit 12 and restore the current ink level information. And the pseudo-random number generator 31 will generate at least one group of pseudo-random numbers, followed by division of both the ink level information currently received from the imaging device and the current ink level information into at least two groups, respectively. The above grouped data of ink level information will be used to execute logic operations between each and every two groups of data; or alternatively the grouped data of ink level information and the pseudo-random number groups will be used to execute logic operations between each grouped data of ink level information and each group of pseudo-random numbers. Data generated thereby and the pseudo-random numbers will be rearranged in accordance with a predetermined rule, to generate extended data, which have more bits than the ink level information and will be written into the storage unit 12. When the imaging device reads the ink level information in the chip, the data conversion unit 13 will read the extended data stored in the storage unit 12, and start information restoration treatment, to perform reverse operation on the extended data in accordance with an operational rule of the extension treatment, such that the current ink level information and the previous ink level information can be restored.

[0075] While the embodiments of the present disclosure are described above, the description should not be construed as limitations of the present disclosure, but merely as embodiments for readily understanding the present disclosure. Anyone skilled in the art, within the spirit and scope of the present disclosure, can make amendments or modification to the implementing forms and details of the embodiments. Hence, the scope of the present disclosure should be subject to the scope defined in the claims.

Claims

1. An ink cartridge chip, comprising:

a communication interface unit, used for communicating with an imaging device mounted with an ink cartridge, so as to receive or transmit ink level information in a first format;
 a data conversion unit, used for converting the ink level information in the first format as received into ink level information in a second format, wherein the second format comprises more bits therein than the first format; and
 a storage unit, used for saving the ink level information in the second format,
 wherein when it is necessary for the imaging device to read ink level information of the ink cartridge chip, the data conversion unit is further used for restoring the ink level information in the second format as stored in the storage unit to the first format.

2. The ink cartridge chip according to claim 1, wherein the ink level information in the first format restored by the data conversion unit from the ink level information in the second format stored in the storage unit refers to ink level information last received from the imaging device and/or ink level information previously received from the imaging device.

3. The ink cartridge chip according to claim 2, wherein in the data conversion unit, the ink level information in the second format is obtained through the steps of:

calculating a percentage the ink level information in the first format accounting for of a total ink level;
 predetermining a bit number contained in the second format; and
 obtaining the ink level information in the second format according to said percentage and said bit number as predetermined in view of a corresponding relationship therebetween.

4. The ink cartridge chip according to claim 2, wherein in the data conversion unit, the ink level information in the second format is obtained through the steps of:

generating redundant data containing certain bits; and
 mixing the redundant data with the ink level information in the first format to generate the ink level information in the second format.

5. The ink cartridge chip according to claim 4, wherein the step of mixing the redundant data with the ink level information in the first format comprises at least one of the following operations:

a) combining the redundant data, as high-bit data or low-bit data, with the ink level information in the first format, to form the ink level information in the second format;

b) grouping at least one of the redundant data and the ink level information in the first format as per a certain bit number, followed by rearrangement and superposition of these grouped data, to form the ink level information in the second format; and

c) performing logical operations on at least a part bits of the redundant data and at least a part bits of the ink level information in the first format, to generate the ink level information in the second format.

6. The ink cartridge chip according to claim 4 or claim 5, wherein the redundant data comprise at least one selected from a group consisting of predetermined data, true form of the ink level information in the first format, one's complement of the ink level information in the first format, two's complement of the ink level information in the first format, pseudo-random numbers, and at least a part of data restored from the ink level information in the second format.

7. The ink cartridge chip according to claim 6, wherein the at least a part of data comprises the ink level information previously received from the imaging device.

8. The ink cartridge chip according to claim 6, wherein the data conversion unit further comprises a pseudo-random number generator which generates the pseudo-random numbers.

9. The ink cartridge chip according to claim 1, wherein the data conversion unit further comprises a logic encryption module, which encrypts the ink level information in the first format as received, to generate the ink level information in the second format.

10. An ink cartridge mounted with the ink cartridge chip according to any one of claims 1-9.

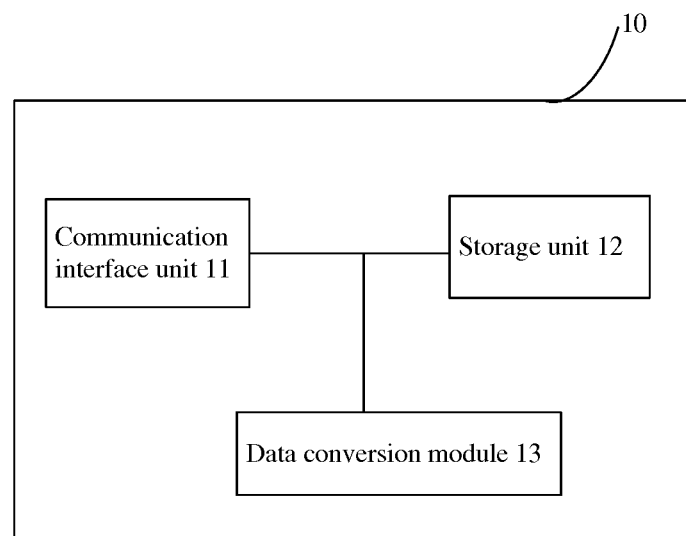


Fig. 1

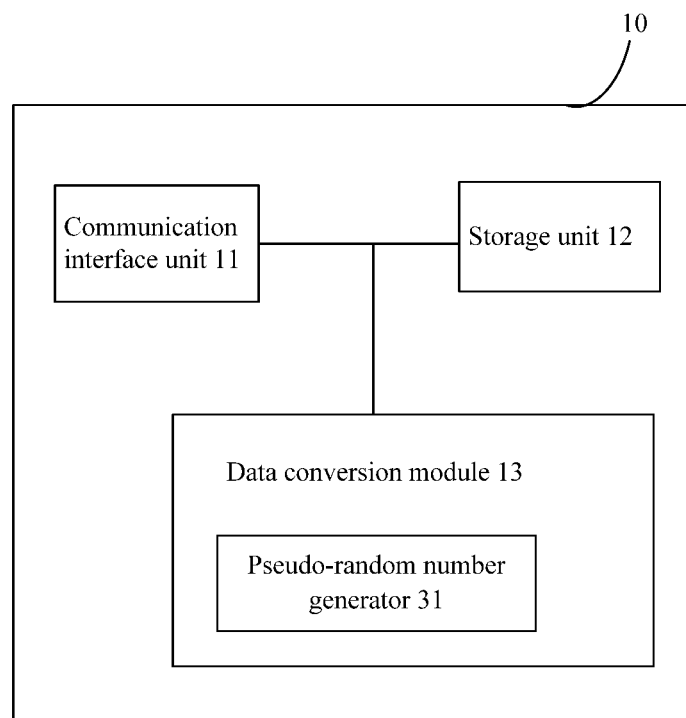


Fig. 2

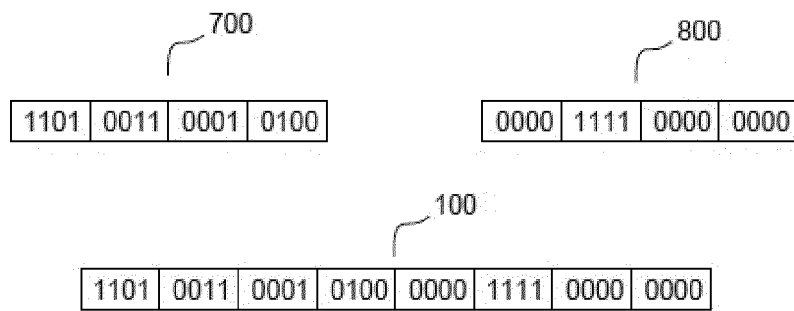


Fig. 3

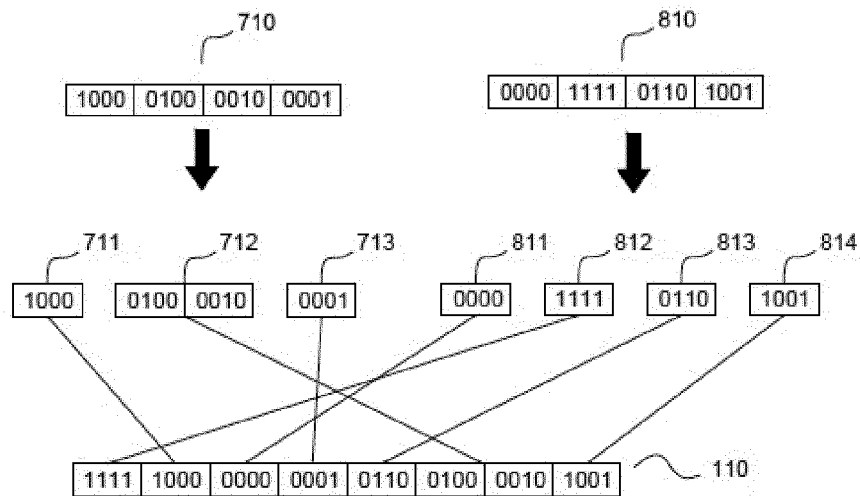


Fig. 4

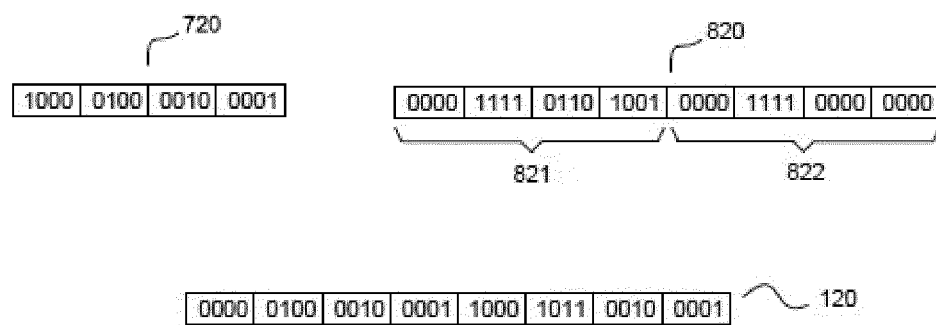


Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/094139

A. CLASSIFICATION OF SUBJECT MATTER

B41J 2/175 (2006.01) i; H04L 9/28 (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)

B41J2/-; H04L9/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI; EPODOC; CNPAT; CNKI: (ink w box+) or cartridge?, (ink w amount), communicat+, data, (conversion or convert+ or transform+), (memory or storage), encrypt+, (encod+ or decod+), (bit? or byte)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	CN 103862879 A (ZHUHAI APEX MICROELECTRONICS CO., LTD.) 18 June 2014 (18.06.2014) claims 1 to 10	1-10
X	CN 203324652 U (ZHUHAI APEX MICROELECTRONICS CO., LTD.) 04 December 2013 (04.12.2013) description, paragraphs [0033] to [0045], [0055] to [0069] and figures 1, 2 and 6 to 9	1, 2, 9, 10
A	CN 101782739 A (ZHUHAI APEX MICROELECTRONICS CO., LTD.) 21 July 2010 (21.07.2010) the whole document	1-10

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:	"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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 11 February 2015	Date of mailing of the international search report 02 March 2015
Name and mailing address of the ISA State Intellectual Property Office of the P. R. China No. 6, Xitucheng Road, Jimenqiao Haidian District, Beijing 100088, China Facsimile No. (86-10) 62019451	Authorized officer CHEN, Biao Telephone No. (86-10) 62085430

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2014/094139

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	CN 1868749 A (HEWLETT-PACKARD COMPANY) 29 November 2006 (29.11.2006) the whole document	1-10
A	US 2010/0053237 A1 (SEIKO EPSON CORPORATION) 04 March 2010 (04.03.2010) the whole document	1-10

Form PCT/ISA /210 (continuation of second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
 Information on patent family members

 International application No.
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CN 203324652 U	04 December 2013	None	
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