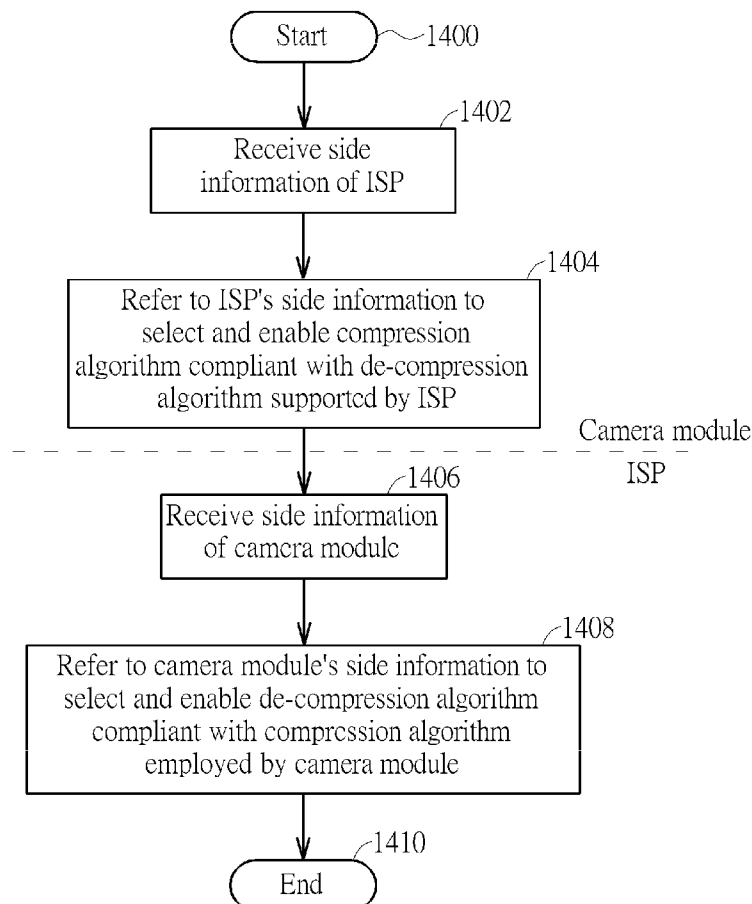




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(19) **United States**(12) **Patent Application Publication**
Ju et al.(10) **Pub. No.: US 2014/0146874 A1**(43) **Pub. Date: May 29, 2014**(54) **DATA PROCESSING APPARATUS WITH
ADAPTIVE
COMPRESSION/DE-COMPRESSION
ALGORITHM SELECTION FOR DATA
COMMUNICATION OVER CAMERA
INTERFACE AND RELATED DATA
PROCESSING METHOD****Publication Classification**(51) **Int. Cl.**
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CPC **H04N 19/00212** (2013.01)
USPC **375/240.02**(71) Applicant: **MEDIATEK INC.**, Hsin-Chu (TW)(72) Inventors: **Chi-Cheng Ju**, Hsinchu City (TW);
Tsu-Ming Liu, Hsinchu City (TW)(73) Assignee: **MEDIATEK INC.**, Hsin-Chu (TW)(21) Appl. No.: **14/022,203**(22) Filed: **Sep. 9, 2013****Related U.S. Application Data**(60) Provisional application No. 61/729,426, filed on Nov.
23, 2012.(57) **ABSTRACT**

A data processing apparatus has a compressor and an output interface. The compressor generates an output multimedia data according to an input multimedia data. The output interface packs the output multimedia data into an output bitstream, and outputs the output bitstream to another data processing apparatus via a camera interface. The camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm according to context characteristics in the input multimedia data, power supply status, operational status of a storage device, image capture characteristic, configuration of the another data processing apparatus, and/or compression algorithm supported by the another data processing apparatus. Further, the another data processing apparatus adaptively adjusts a de-compression algorithm according to a compression algorithm supported by the compressor.



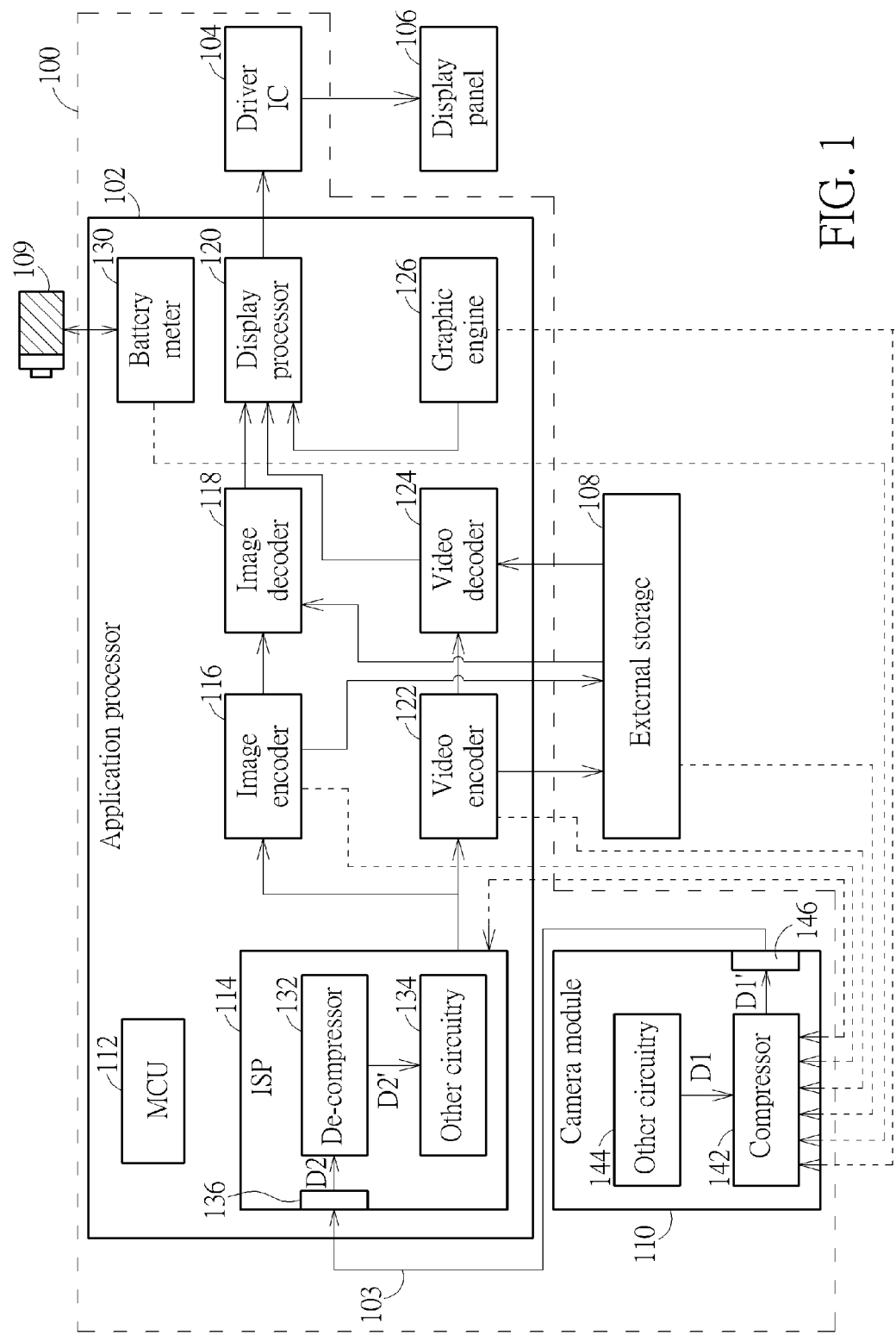


FIG. 1

Type of Algorithm	Complexity	Power	Ratio M	Compression Efficiency
Compression Algorithm 1	5 (Highest)	5 (Highest)	1/8	5 (Highest)
Compression Algorithm 2	4	4	1/4	4
Compression Algorithm 3	3	3	1/4	3
Compression Algorithm 4	2	2	1/2	2
Compression Algorithm 5	1 (Lowest)	1 (Lowest)	1/2	1 (Lowest)

FIG. 2

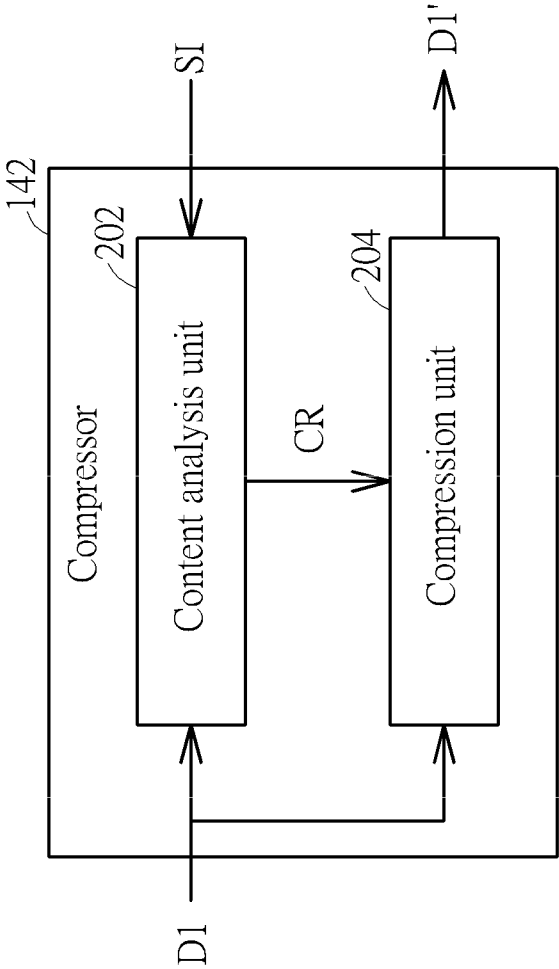


FIG. 3

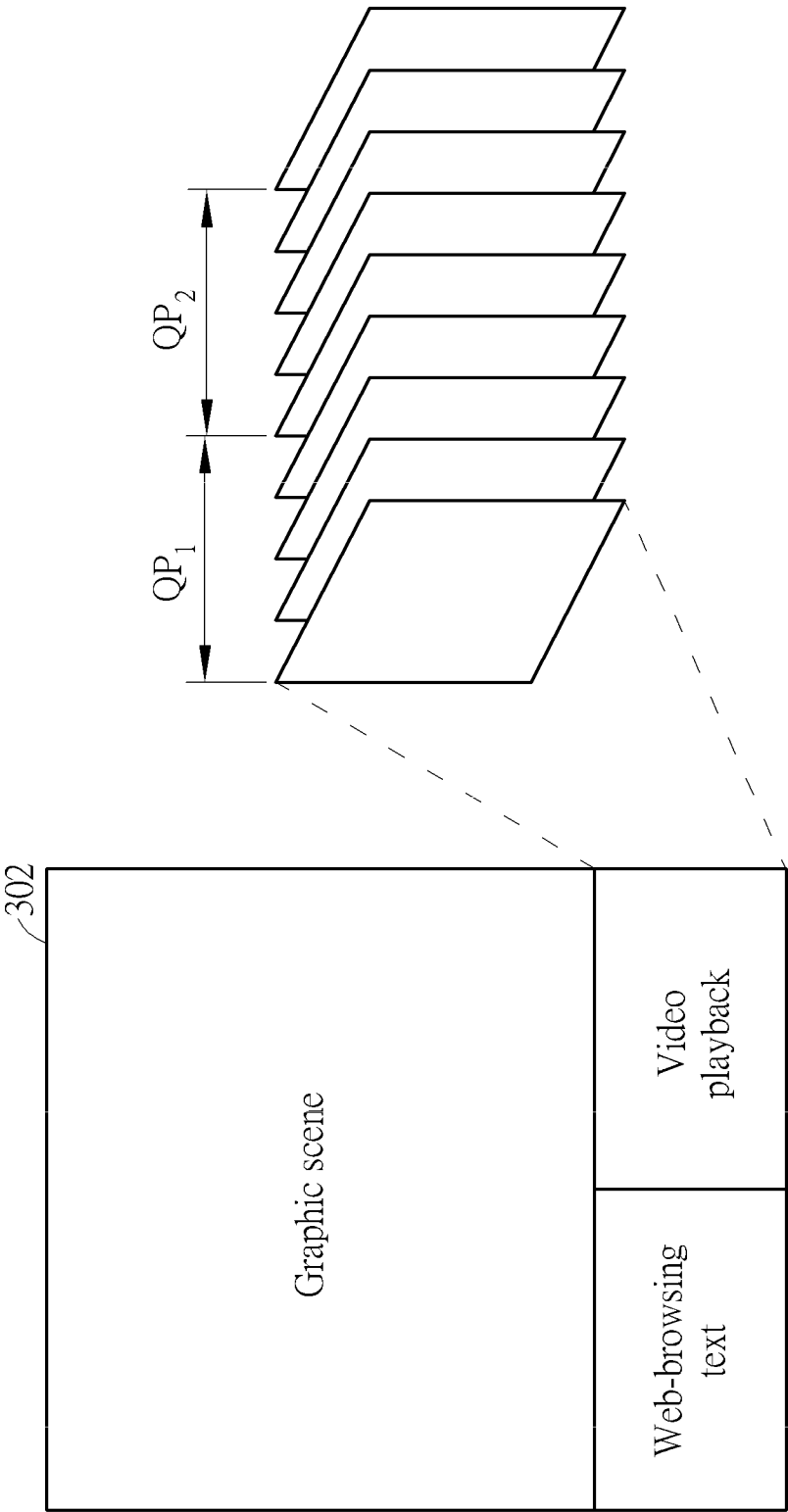


FIG. 4

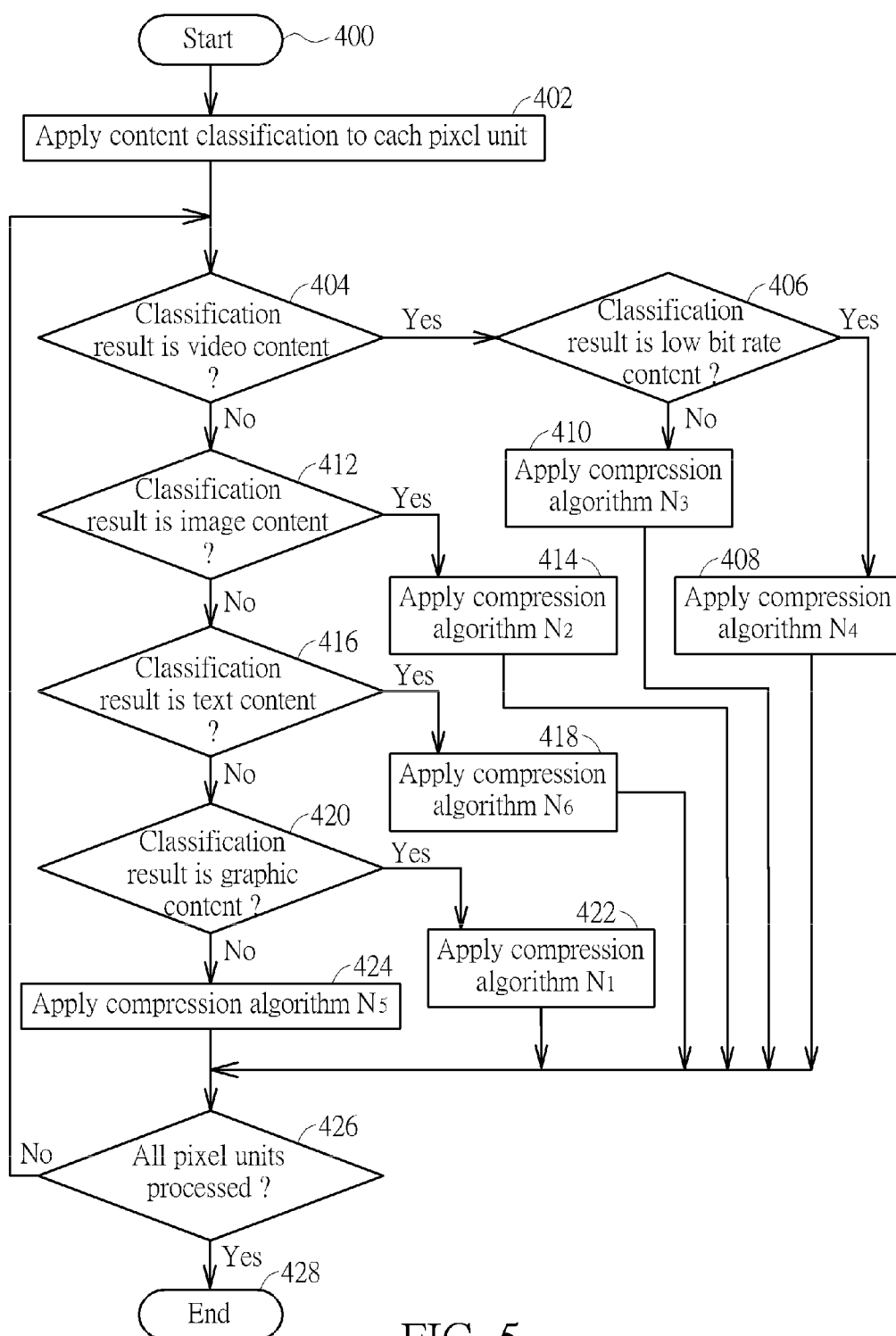


FIG. 5

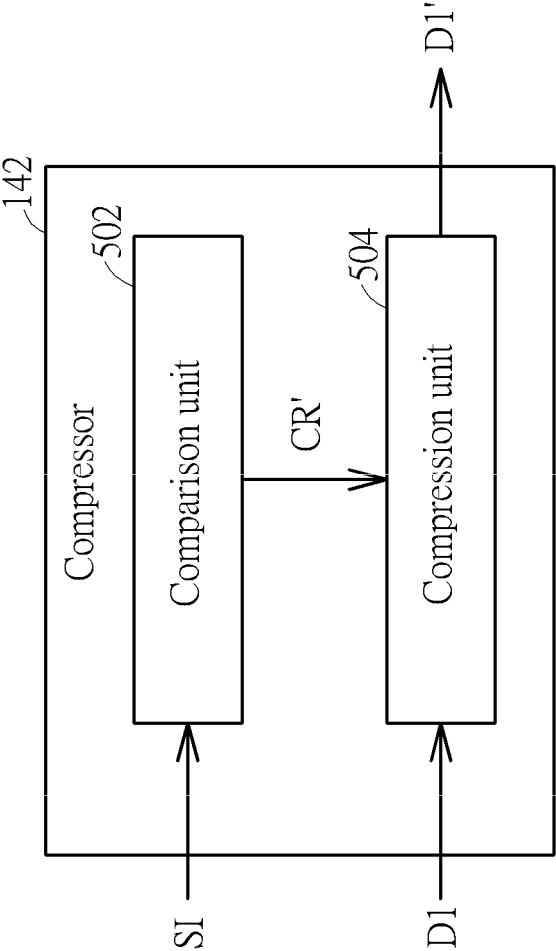


FIG. 6

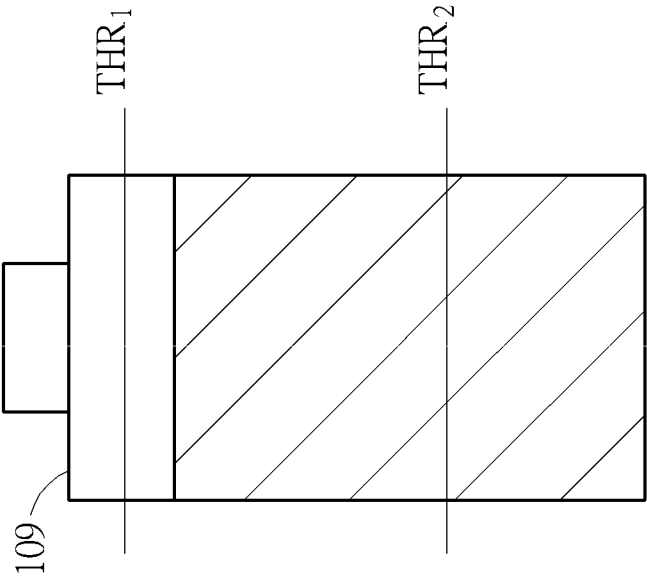


FIG. 7

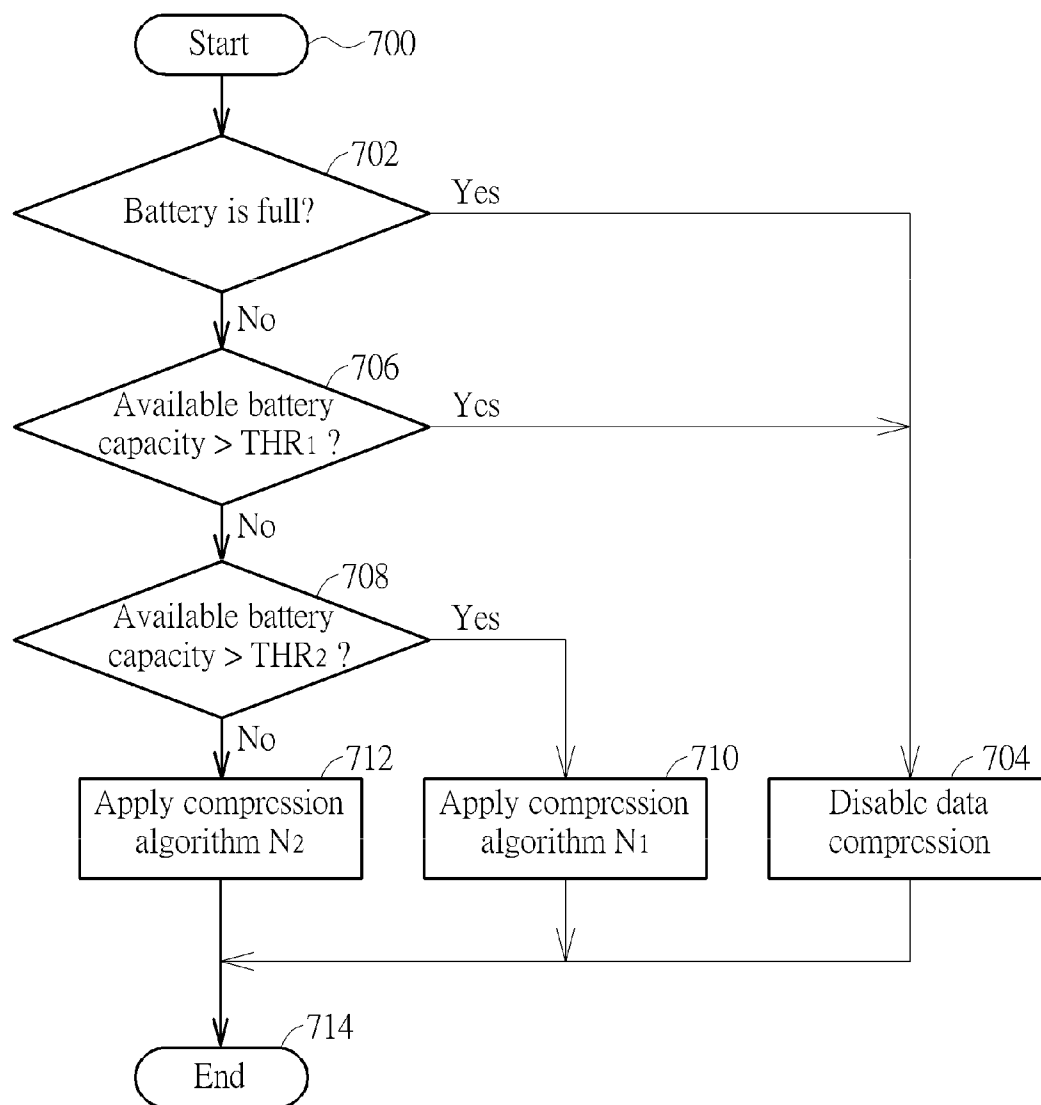


FIG. 8

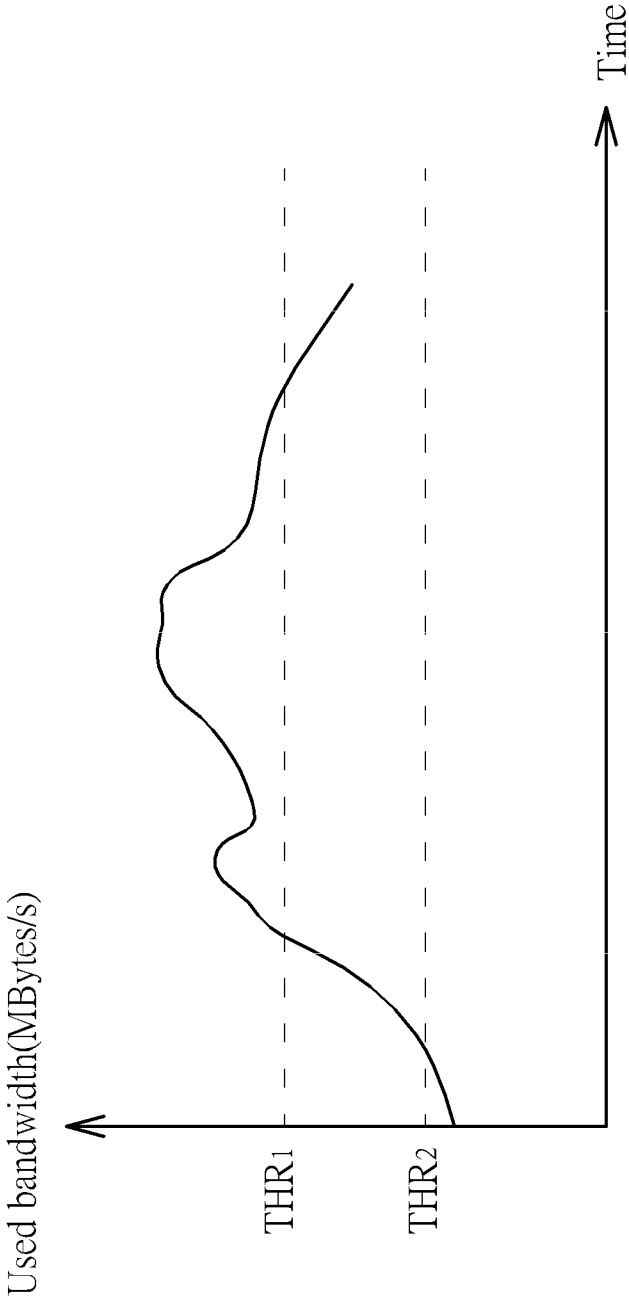


FIG. 9

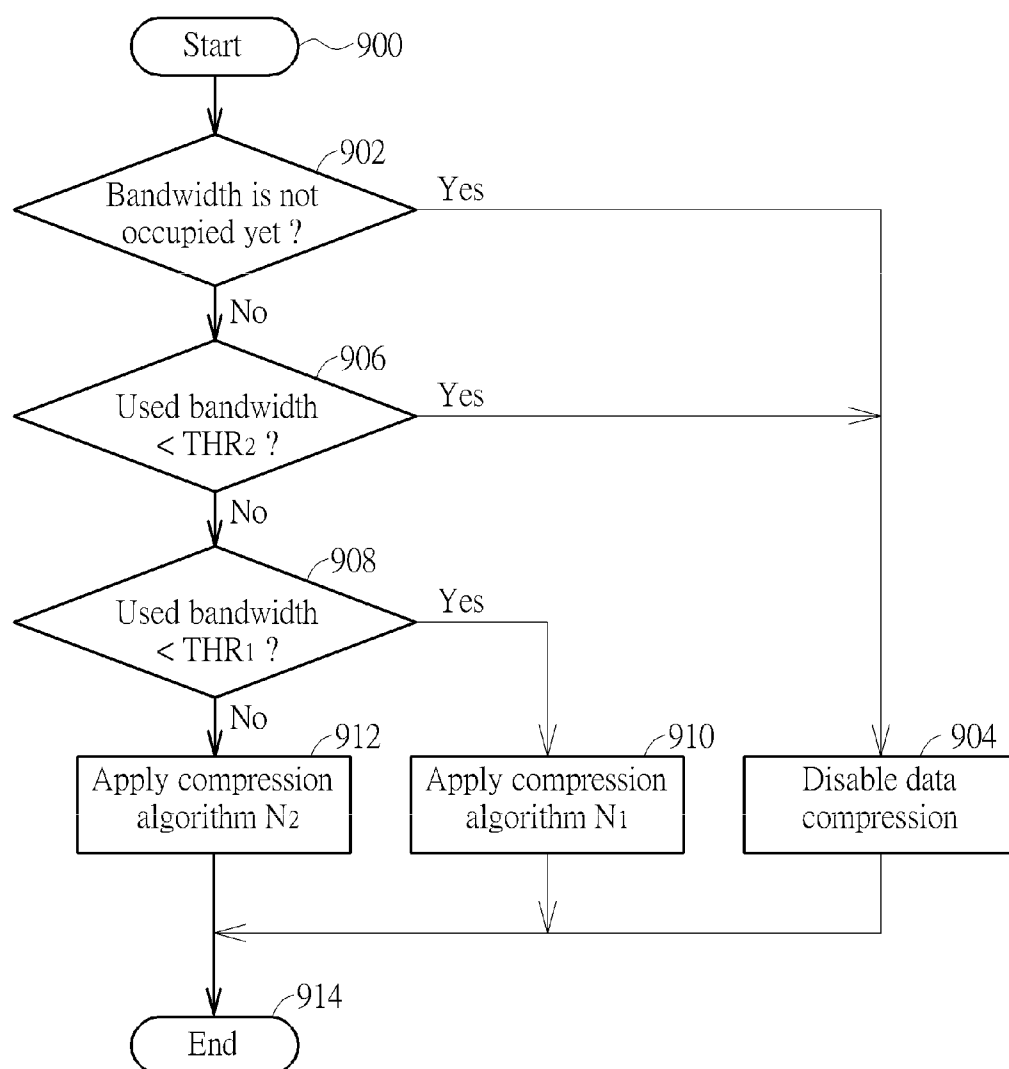


FIG. 10

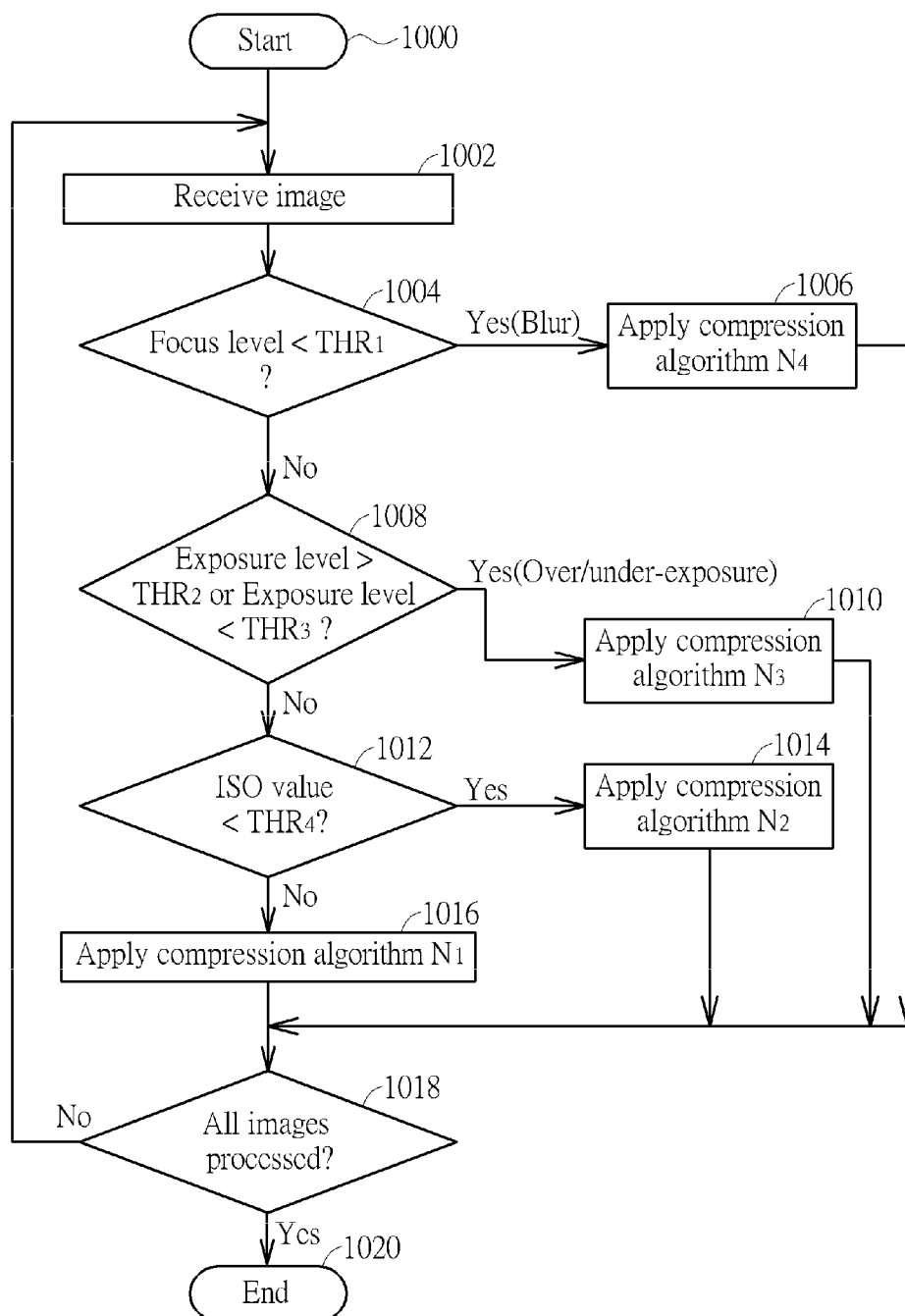


FIG. 11

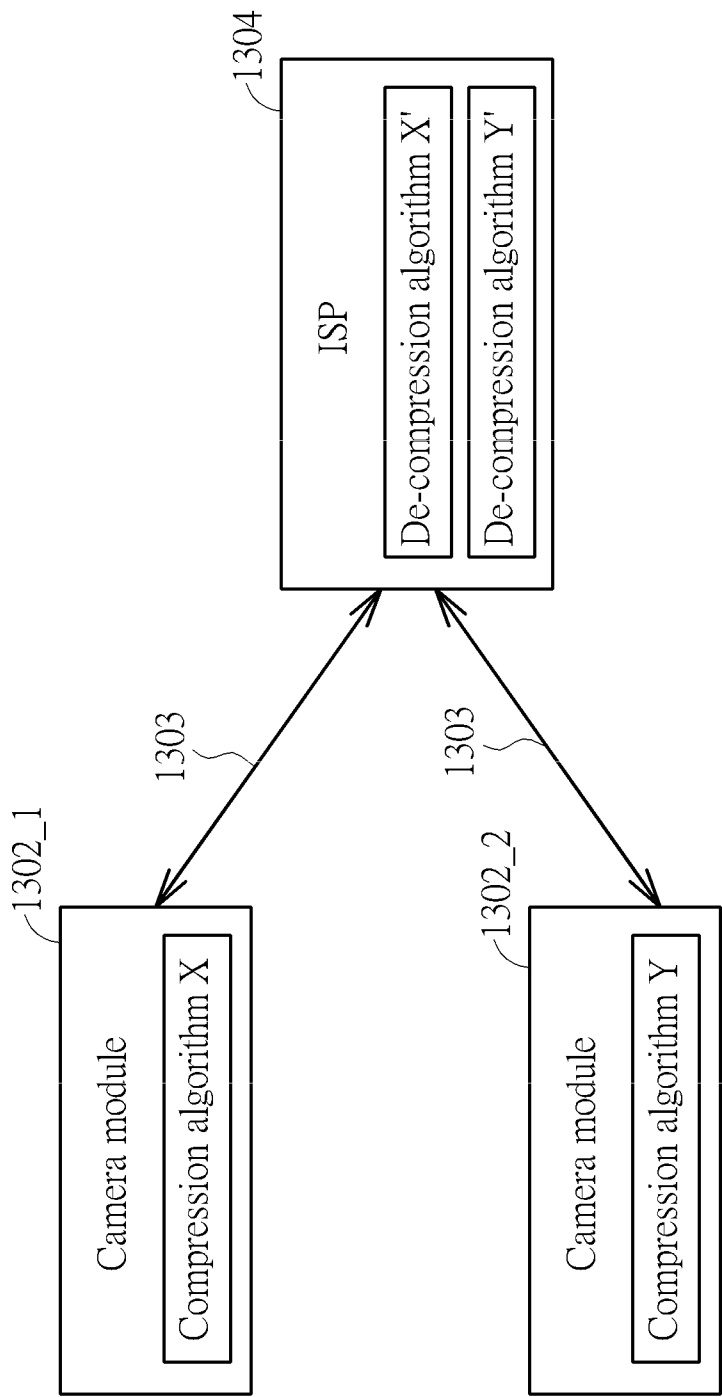


FIG. 12

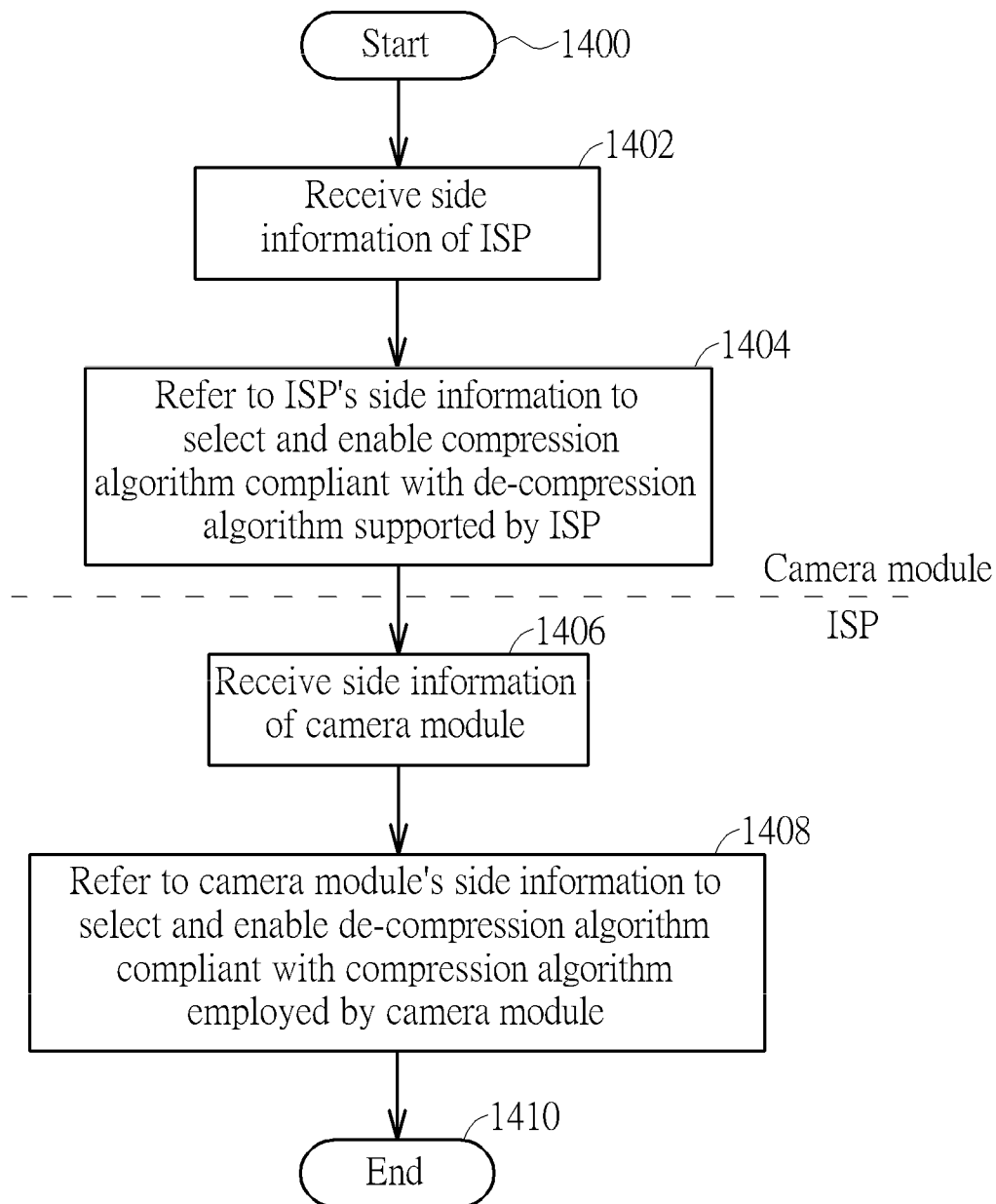


FIG. 13

**DATA PROCESSING APPARATUS WITH
ADAPTIVE
COMPRESSION/DE-COMPRESSION
ALGORITHM SELECTION FOR DATA
COMMUNICATION OVER CAMERA
INTERFACE AND RELATED DATA
PROCESSING METHOD**

**CROSS REFERENCE TO RELATED
APPLICATIONS**

[0001] This application claims the benefit of U.S. provisional application No. 61/729,426, filed on Nov. 23, 2012 and incorporated herein by reference.

BACKGROUND

[0002] The disclosed embodiments of the present invention relate to transmitting and receiving multimedia data over a camera interface, and more particularly, to a data processing apparatus with adaptive compression/de-compression algorithm selection for data communication over a camera interface and related data processing method.

[0003] A camera interface is disposed between a first chip and a second chip to transmit multimedia data from the first chip to the second chip for further processing. For example, the first chip may include a camera module, and the second chip may include an image signal processor (ISP). The multimedia data may include image data (i.e., a single captured image) or video data (i.e., a video sequence composed of captured images). When a camera sensor with a higher resolution is employed in the camera module, the multimedia data transmitted over the camera interface would have a larger data size/data rate, which increases the power consumption of the camera interface inevitably. If the camera module and the ISP are both located at a portable device (e.g., a smartphone) powered by a battery device, the battery life is shortened due to the increased power consumption of the camera interface. Thus, there is a need for an innovative design which can effectively reduce the power consumption of the camera interface.

SUMMARY

[0004] In accordance with exemplary embodiments of the present invention, a data processing apparatus with adaptive compression/de-compression algorithm selection for data communication over a camera interface and related data processing method are proposed.

[0005] According to one aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes a compressor and an output interface. The compressor is arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data. The output interface is arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to context characteristics of the input multimedia data.

[0006] According to another aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes a com-

pressor and an output interface. The compressor is arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data. The output interface is arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to a power supply status.

[0007] According to another aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes a compressor and an output interface. The compressor is arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data. The output interface is arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to an operational status of a storage device.

[0008] According to another aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes a compressor and an output interface. The compressor is arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data. The output interface is arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to at least one image capture characteristic.

[0009] According to another aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes a compressor and an output interface. The compressor is arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data. The output interface is arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream to another data processing apparatus via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). In addition, the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to a de-compression algorithm supported by the another data processing apparatus.

[0010] According to another aspect of the present invention, an exemplary data processing apparatus is disclosed. The exemplary data processing apparatus includes an input interface and a de-compressor. The input interface is arranged for receiving an input bitstream from another data processing apparatus via a camera interface, and un-packing the input bitstream into an input multimedia data, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI). The de-compressor is arranged for generating a de-compressed multime-

dia data according to the input multimedia data when the input multimedia data is a compressed multimedia data. In addition, the de-compressor adaptively adjusts a de-compression algorithm according to a compression algorithm employed by the another data processing apparatus.

[0011] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input multimedia data; adaptively adjusting a compression algorithm according to context characteristics of the input multimedia data; generating an output multimedia data according to the compression algorithm and the input multimedia data; and packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0012] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input multimedia data; adaptively adjusting a compression algorithm according to a power supply status; generating an output multimedia data according to the compression algorithm and the input multimedia data; and packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0013] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input multimedia data; adaptively adjusting a compression algorithm according to an operational status of a storage device; generating an output multimedia data according to the compression algorithm and the input multimedia data; and packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0014] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input multimedia data; adaptively adjusting a compression algorithm according to at least one image capture characteristic; generating an output multimedia data according to the compression algorithm and the input multimedia data; and packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0015] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input multimedia data; adaptively adjusting a compression algorithm according to a de-compression algorithm supported by a data processing apparatus; generating an output multimedia data according to the compression algorithm and the input multimedia data; and packing the output multimedia data into an output bitstream, and outputting the output bitstream to the data processing apparatus via a camera interface, wherein the camera interface is a

camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0016] According to another aspect of the present invention, an exemplary data processing method is disclosed. The exemplary data processing method includes at least the following steps: receiving an input bitstream from a data processing apparatus via a camera interface, and un-packing the input bitstream into an input multimedia data, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI); adaptively adjusting a de-compression algorithm according to a compression algorithm employed by the data processing apparatus; and when the input multimedia data is a compressed multimedia data, generating a de-compressed multimedia data according to the input multimedia data and the de-compression algorithm.

[0017] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] FIG. 1 is a block diagram illustrating a data processing system according to an embodiment of the present invention.

[0019] FIG. 2 is a table showing characteristics of different compression algorithms supported by the compressor shown in FIG. 1.

[0020] FIG. 3 is a diagram illustrating an embodiment of the compressor shown in FIG. 1.

[0021] FIG. 4 is a diagram illustrating one frame included in the input multimedia data.

[0022] FIG. 5 is a flowchart illustrating an adaptive compression method based on context characteristics of the input multimedia data according to an embodiment of the present invention.

[0023] FIG. 6 is a diagram illustrating another embodiment of the compressor shown in FIG. 1.

[0024] FIG. 7 is a diagram illustrating thresholds of the battery capacity of the battery device.

[0025] FIG. 8 is a flowchart illustrating an adaptive compression method based on a power supply status according to an embodiment of the present invention.

[0026] FIG. 9 is a diagram illustrating thresholds of the bandwidth of the storage device.

[0027] FIG. 10 is a flowchart illustrating an adaptive compression method based on an operating status of a storage device according to an embodiment of the present invention.

[0028] FIG. 11 is a flowchart illustrating an adaptive compression method based on at least one image capture characteristic according to an embodiment of the present invention.

[0029] FIG. 12 is a diagram illustrating configuration of a compressor in a camera module and configuration of a de-compressor in an ISP according to an embodiment of the present invention.

[0030] FIG. 13 is a flowchart illustrating an adaptive compression and de-compression method based on side information communicated between a camera module and an ISP according to an embodiment of the present invention.

DETAILED DESCRIPTION

[0031] Certain terms are used throughout the description and following claims to refer to particular components. As one skilled in the art will appreciate, manufacturers may refer to a component by different names. This document does not intend to distinguish between components that differ in name but not function. In the following description and in the claims, the terms “include” and “comprise” are used in an open-ended fashion, and thus should be interpreted to mean “include, but not limited to . . .”. Also, the term “couple” is intended to mean either an indirect or direct electrical connection. Accordingly, if one device is coupled to another device, that connection may be through a direct electrical connection, or through an indirect electrical connection via other devices and connections.

[0032] The present invention proposes applying data compression to a multimedia data and then transmitting a compressed multimedia data over a camera interface. As the data size/data rate of the compressed multimedia data is smaller than that of the original un-compressed multimedia data, the power consumption of the camera interface is reduced correspondingly. Besides, the present invention further proposes an adaptive compression/de-compression scheme which is based on side information given by one or more signal processing elements (e.g., an image signal processor (ISP), a video/image codec, a graphic engine, a display processor, an external storage, and a battery meter). This may allow the configuration of the compressor and the counterpart de-compressor to be adjusted in a static or dynamic way. In general, data compression is exploited to remove the information redundancy under a specific pixel size (i.e., a unit size of compression) and produce a compressed data constrained by a compression ratio. In a case where the compression ratio is equal to 0.5, the size of the compressed data is half of the size of the uncompressed data. As the compression performance is strongly related to some design factors such as the unit size of compression and the constrained compression ratio, the present invention therefore proposes using the adaptive compression scheme for enabling a compression algorithm selected from a plurality of candidate compression algorithms, where the selected compression algorithm most efficiently compresses the multimedia data. Compared to a typical compression scheme using a fixed compression algorithm, the proposed adaptive compression scheme achieves better performance. Besides, the ISP may refer to side information given by the camera module to adaptively select a de-compression algorithm compliant with the compression algorithm employed by the camera module. In this way, the compressed data stream from the camera module can be correctly de-compressed by the ISP. Further details will be described as below.

[0033] FIG. 1 is a block diagram illustrating a data processing system according to an embodiment of the present invention. The data processing system 100 includes a plurality of data processing apparatuses such as a camera module 110 external to an application processor 102 and an image signal processor (ISP) 114 included in the application processor 102. The camera module 110 and the ISP 114 may be implemented in different chips, and the camera module 110 communicates with the ISP 114 via a camera interface 103. Alternatively, the ISP 114 may be integrated within the camera module 110, and a single chip having the ISP 114 and the camera module 110 included therein communicates with another data processing apparatus in the application proces-

sor 102 via the camera interface 103. In this embodiment, the camera interface 103 may be a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

[0034] The camera module 110 is coupled to the camera interface 103, and supports un-compressed data transmission and compressed data transmission. When the camera module 110 is used to transmit un-compressed data to the ISP 114, the camera module 110 generates an un-compressed multimedia data, and transmits the un-compressed multimedia data over the camera interface 103. When the camera module 110 is used to transmit compressed data to the ISP 114, the camera module 110 generates a compressed multimedia data, and transmits the compressed multimedia data over the camera interface 103.

[0035] As shown in FIG. 1, the camera module 110 includes a compressor 142, other circuitry 144, and an output interface 146. Other circuitry 144 includes circuit elements required for capturing incident light to obtain an input multimedia data D1. For example, other circuitry 144 may have a lens module, a camera sensor, a camera controller, a camera buffer, multiplexer(s), etc. When the camera module 110 is operated in the compression mode, the compressor 142 performs data compression upon the input multimedia data D1 generated from other circuitry 144, and accordingly generates an output multimedia data D1', wherein the compressed multimedia data (i.e., output multimedia data D1') is packed/packetized into an output bitstream by the output interface 146 according to the transmission protocol of the camera interface 103, and the output bitstream is transmitted to the ISP 114 via the camera interface 103.

[0036] Regarding the ISP 114, it is coupled to the camera interface 103, and supports un-compressed data reception and compressed data reception. When the camera module 110 transmits the un-compressed data to the ISP 114, the ISP 114 is operated under a non-decompression mode to receive an un-compressed data from the camera interface 103 and generate a processed multimedia data according to the un-compressed multimedia data. When the camera module 110 transmits the compressed data to the ISP 114, the ISP 114 is operated under a de-compression mode to receive a compressed multimedia data from the camera interface 103 and generate the processed multimedia data according to a de-compressed multimedia data derived from de-compressing the compressed multimedia data. If there is no error introduced during the data transmission, the un-compressed data transmitted under the non-compression mode should be identical to the un-compressed data received under the non-decompression mode, and the compressed data transmitted under the compression mode should be identical to the compressed data received under the de-compression mode.

[0037] As shown in FIG. 1, the ISP 114 includes a de-compressor 132, other circuitry 134, and an input interface 136. The input interface 136 receives an input bitstream from the camera interface 103, and un-packs/un-packetizes the input bitstream into an input multimedia data D2 which is a compressed multimedia data when the camera module 110 is operated under the compression mode. In this embodiment, the de-compressor 132 is arranged to perform data de-compression upon the input multimedia data D2, and accordingly generate a de-compressed multimedia data D2'. Other circuitry 134 is arranged to generate a processed multimedia data according to the de-compressed multimedia data D2'. Specifically, other circuitry 134 includes circuit elements

required for generating the processed multimedia data according to an internal transmission mode (e.g., an on-the-fly mode or an off-line mode). For example, other circuitry **134** may have a write direct memory access (DMA) controller, a read DMA controller, an image processor, multiplexers, etc.

[0038] As the present invention focuses on the adaptive compression and de-compression scheme for configuring the compressor **142** and the de-compressor **132**, further details directed to transmitting compressed/un-compressed multimedia data from the camera module **110** to the ISP **114** via the camera interface **103** and generating the processed multimedia data based on the compressed/un-compressed multimedia data received from the camera interface **103** are omitted here for brevity.

[0039] As shown in FIG. 1, the application processor **102** further includes a micro control unit (MCU) **112**, an image encoder **116**, an image decoder **118**, a display processor **120**, a video encoder **122**, a video decoder **124**, a graphic engine **126**, and a battery meter **130**. The battery meter **130** is arranged to monitor the power status of a power source such as the battery capacity of a battery device **109**. In this embodiment, the camera module **110** and other data processing apparatuses shown in FIG. 1 are powered by the battery device **109**. The MCU **112** serves as a display controller used for controlling generation of a display data, and therefore controls circuit elements within the application processor **102** to generate a desired display data to the driver IC **104**. In other words, the MCU **112** controls the operation of the application processor **102**. The ISP **114** serves as a backend processor for an image/video output of the camera module **110**. For example, the ISP **114** may be used to perform auto white balance (AWB), auto exposure (AE) and auto focus (AF). In a case where the camera module **110** generates a single captured image to the ISP **114** under a photo mode, a processed image generated from the ISP **114** may be transmitted to the image encoder **116**, and an encoded image is generated from the image encoder **116** to an external storage **108** such as a dynamic random access memory (DRAM). In another case where the camera module **110** generates a video sequence composed of successive captured images to the ISP **114** under a video recording mode, a processed video generated from the ISP **114** may be transmitted to the video encoder **122**, and an encoded video is generated from the video encoder **122** to the external storage **108**.

[0040] The image decoder **118** receives an encoded image from the external storage **108**, and generates a decoded image to the display processor **120**. The video decoder **124** receives an encoded video from the external storage **108**, and generates a decoded video to the display processor **120**. However, it is possible that the single captured image/video sequence generated from the ISP **114** may be bypassed to the display processor **120** without additional encoding and decoding operations applied thereto. The graphic engine **126** generates graphic data (e.g., a 3D graphic image) to the display processor **120**.

[0041] The display processor **120** is arranged to generate a display data based on one or more of the image data, video data, graphic data, etc., and transmit the display data to a driver integrated circuit (IC) **104**. Hence, the display data generated at the application processor **102** is derived from the output multimedia **D1'** transmitted from the camera module **110** to the ISP **114** via the camera interface **103**. For example, the display processor **120** may combine video data, text data

and graphic data to generate a multimedia data of a frame, such that the display of the frame would show a graphic scene, a web-browsing text content, and a video playback content. The driver IC **104** is coupled between the display processor **120** and a display panel **106**, and drives the display panel **106** according to the display data generated from the display processor **120**. By way of example, the display panel **106** may be implemented using any 2D/3D display device (e.g. a retina display), and the pixel arrangement may be a rectangle layout, a triangle layout or a pentile layout.

[0042] In this embodiment, the compressor **142** supports a plurality of compression algorithms having different compression characteristics. Please refer to FIG. 2, which is a table showing characteristics of different compression algorithms supported by the compressor **142** shown in FIG. 1. A compression algorithm represents a set of coding tools so as to remove the data redundancy on the input multimedia data **D1**. The coding tools may be any kind of compression methods developed by proprietary algorithms or specified by state-of-the-art video standards (e.g., MPEG-1/2/4, H.261/262/263/264, and HEVC) or image standards (e.g., PEG, JPEG-1s, JPEG-2000, JPEG-XR, PNG, and GIF). As shown in FIG. 2, these compression algorithms indicate different capability of compression performance in terms of compression ratio, compression efficiency, compression complexity, and power dissipation. Specifically, the compression efficiency is the ability of a compression algorithm to encode the input multimedia data **D1** at the lowest possible bit rate while maintaining a certain level of visual quality. There are two standard ways to measure the compression efficiency of a compression algorithm. One is to use an objective metric, such as a peak signal-to-noise ratio (PSNR). The other is to use a subjective assessment of video/image quality. If the compression efficiency of a compression algorithm is high, it means that the compression algorithm can preserve more input data information after compression is performed under a certain compression ratio. If the compression efficiency of a compression algorithm is low, it means that the compression algorithm will lose more input data information after compression is performed under a certain compression ratio. Hence, a high compression efficiency algorithm can preserve more input data information under a certain compression ratio, and the de-compressed multimedia data can have better visual appearance and visual quality.

[0043] The compressor **142** is capable of adaptively adjusting a compression algorithm applied to the input multimedia data **D1** according to at least the side information shown as dotted lines in FIG. 1, where the side information may be provided by at least one of external storage **108**, ISP **114**, image encoder **116**, video encoder **122**, display processor **120**, graphic engine **126**, and battery meter **130**. As the compressor **142** refers to the side information to select an adequate compression algorithm from supported compression algorithms having different compression characteristics, the compression performance can be optimized. For better understanding of technical features of the present invention, several embodiments are illustrated as below.

[0044] In a first exemplary embodiment, the compressor **142** may adaptively adjust a compression algorithm applied to the input multimedia data **D1** according to context characteristics of the input multimedia data **D1**. Please refer to FIG. 3, which is a diagram illustrating an embodiment of the compressor **142** shown in FIG. 1. As shown in FIG. 3, the compressor **142** includes a content analysis unit **202** and a com-

pression unit **204**. The content analysis unit **202** receives the input multimedia data **D1** and side information **SI**, where the side information **SI** may include information provided by the display processor **120**, the image encoder **116**, the video encoder **122**, and/or the graphic engine **126**. In one exemplary design, the content analysis unit **202** may be configured to analyze the input multimedia data **D1** to classify contents included in the input multimedia data **D1**, and accordingly generate a content classification result **CR**. More specifically, the content analysis unit **202** could recognize the pixel data as text, graphic user interface (UI), video scene or image scene by detecting features in each received pixel unit of the input multimedia data **D1**, where the size of the pixel unit to be compressed may be any positive value based on actual design requirement/consideration.

[0045] The contents classified by the content analysis unit **202** may include a video content, an image content, a text content (i.e., a text-rich image content), and a graphic content. For example, the content analysis unit **202** could check if the received pixel unit is data generated by a video engine (e.g., video decoder **124**) by comparing the characteristic of pixels with typical video data characteristics. If the characteristic of the pixels match the characteristic of video data, the content analysis unit **202** could classify the received pixel unit as data generated by the video engine (e.g., video decoder **124**). In a similar way, the content analysis unit **202** could check if the received pixel unit is data generated by an image engine (e.g., image decoder **118**) by comparing the characteristic of pixels with typical image data characteristics. Also, the content analysis unit **202** could check if the received pixel unit is data generated by the graphic engine **126** by matching it with several typical graphic data patterns such as monotonic repeated pixels, monotonic gradient color, and clear sharp edges. In another exemplary design, the content analysis unit **202** may refer to the side information **SI** to classify the contents of the input multimedia data **D1** into video contents generated by the video engine (e.g., video decoder **124**), image contents are generated by the image engine (e.g., image decoder **118**), and graphic contents generated by the graphic engine **126**.

[0046] The compression unit **204** is arranged for referring to the content classification result **CR** to adaptively adjust the compression algorithm employed. In this way, a content-aware compression based on the content classification result **CR** is achieved. FIG. 4 is a diagram illustrating one frame **302** included in the input multimedia data **D1**. The content classification result **CR** indicates that the frame **302** include graphic contents at a top portion of the frame **302**, text contents at the bottom-left portion of the frame **302**, and video contents at the bottom-right portion of the frame **302**. After the classification procedure, compression algorithms N_1 and N_2 are selected when the received pixel units are classified as graphic content and image content, respectively. Compression algorithms N_3 and N_4 are dedicated to the data classified as video content, where compression algorithm N_3 is suitable for the high bit rate video content and compression algorithm N_4 is suitable for the low bit rate video content. Moreover, the compression algorithm N_6 is suitable for a text-rich image on web-browsing scenario. The compression algorithm N_5 is the default algorithm when none of above contents is detected. The classification of high bit rate content and low bit rate content may depend on the quantization parameter (QP) of a video bitstream such as an HEVC or H.264 encoded bitstream. When the QP is higher than a threshold, the input data

is classified as low bit rate content; otherwise, it is high bit rate content. For example, when $QP_1 > THR$, the compression algorithm N_4 is employed by the compression unit **204**; and when $QP_2 \leq THR$, the compression algorithm N_3 is employed by the compression unit **204**. Another embodiment is to calculate the data variance of the input data. When the variance is higher than a threshold, the input data is classified as high bit rate content; otherwise, it is low bit rate content.

[0047] FIG. 5 is a flowchart illustrating an adaptive compression method based on context characteristics of the input multimedia data **D1** according to an embodiment of the present invention. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. 5. The exemplary adaptive compression method may be briefly summarized by following steps.

[0048] Step 400: Start.

[0049] Step 402: Apply a content classification to each received pixel unit included in the input multimedia data **D1**, and accordingly generate the content classification result **CR**.

[0050] Step 404: Check if the content classification result **CR** indicates that the received pixel unit is a video content. If yes, go to step 406; otherwise, go to step 412.

[0051] Step 406: Check if the content classification result **CR** indicates that the received pixel unit is a low bit rate content (e.g., $QP > THR$). If yes, go to step 408; otherwise, go to step 410.

[0052] Step 408: Apply the compression algorithm N_4 . Go to step 426.

[0053] Step 410: Apply the compression algorithm N_3 . Go to step 426.

[0054] Step 412: Check if the content classification result **CR** indicates that the received pixel unit is an image content. If yes, go to step 414; otherwise, go to step 416.

[0055] Step 414: Apply the compression algorithm N_2 . Go to step 426.

[0056] Step 416: Check if the content classification result **CR** indicates that the received pixel unit is a text content. If yes, go to step 418; otherwise, go to step 420.

[0057] Step 418: Apply the compression algorithm N_6 . Go to step 426.

[0058] Step 420: Check if the content classification result **CR** indicates that the received pixel unit is a graphic content. If yes, go to step 422; otherwise, go to step 424.

[0059] Step 422: Apply the compression algorithm N_1 . Go to step 426.

[0060] Step 424: Apply the compression algorithm N_5 .

[0061] Step 426: Check if all of the received pixel units included in the input multimedia data **D1** have been processed. If yes, go to step 428; otherwise, go to step 404 to process the next received pixel unit.

[0062] Step 428: End.

[0063] It should be noted that step 402 is performed by the content analysis unit **202**, and steps 404-426 are performed by the compression unit **204**. As a person skilled in the art can readily understand details of each step shown in FIG. 5 after reading above paragraphs, further description is omitted here for brevity.

[0064] In a second exemplary embodiment, the compressor **142** may adaptively adjust a compression algorithm applied to the input multimedia data **D1** according to a power supply status. As shown in FIG. 1, the camera module **110** and other data processing apparatuses are powered by the battery device **109**, and the side information given by the battery meter **130** would include the power supply status indicative of

an available battery capacity of the battery device 109. Please refer to FIG. 6, which is a diagram illustrating another embodiment of the compressor 142 shown in FIG. 1. The compressor 142 includes a comparison unit 502 and a compression unit 504. The comparison unit 502 receives side information SI from the battery meter 130. The comparison unit 502 compares the available battery capacity of the battery device 109 as indicated by the side information SI with at least one predetermined threshold to generate a comparison result CR'. The compression unit 504 supports a plurality of compression algorithms having different characteristics, and refers to the comparison result CR' to select one of the supported compression algorithms for data compression. For example, as shown in FIG. 7, the comparison unit 502 employs a first predetermined threshold THR_1 and a second predetermined threshold THR_2 , where $THR_1 > THR_2$. The first predetermined threshold THR_1 is checked to see if the data compression can be disabled to avoid information loss caused by a lossy compression algorithm. More specifically, the compressor 142 is arranged to disable the data compression when the power supply status indicates that the available battery capacity is higher than the first predetermined threshold THR_1 , and enable the data compression when the power supply status indicates that the available battery capacity is not higher than the first predetermined threshold THR_1 . To put it another way, when the battery power is full or higher than the first predetermined threshold THR_1 , the compression algorithm is disabled to get better visual quality; and when the battery power is lower than the first predetermined threshold THR_1 , a compression algorithm is enabled to save power dissipation of the camera interface 103.

[0065] The second predetermined threshold THR_2 is checked to select one compression algorithm from supported compression algorithms having different characteristics. More specifically, the compressor 142 is arranged to employ the compression algorithm N_1 for compressing the input multimedia data D1 when the power supply status indicates that the available battery capacity is higher than the second predetermined threshold THR_2 , and employ the compression algorithm N_2 for compressing the input multimedia data D1 when the power supply status indicates that the available battery capacity is not higher than the second predetermined threshold THR_2 , where the compression algorithm N_1 is more complex than the compression algorithm N_2 , and/or the compression algorithm N_1 has a higher compression efficiency than the compression algorithm N_2 . To put it another way, when the battery power is almost full or higher than the second predetermined threshold THR_2 , a more complex and higher compression efficiency algorithm can be selected by the compression unit 504 to get better visual quality; and when the battery power is almost empty or lower than the second predetermined threshold THR_2 , a less complex and lower compression efficiency algorithm can be selected by the compression unit 504 to save power dissipation of the camera interface 103.

[0066] FIG. 8 is a flowchart illustrating an adaptive compression method based on a power supply status according to an embodiment of the present invention. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. 8. The exemplary adaptive compression method may be briefly summarized by following steps.

[0067] Step 700: Start.

[0068] Step 702: Check if the battery is full. If yes, go to step 704; otherwise, go to step 706.

[0069] Step 704: Disable data compression.

[0070] Step 706: Check if the available battery capacity is higher than the first predetermined threshold THR_1 . If yes, go to step 704; otherwise, go to step 708.

[0071] Step 708: Check if the available battery capacity is higher than the second predetermined threshold THR_2 . If yes, go to step 710; otherwise, go to step 712.

[0072] Step 710: Apply the compression algorithm N_1 . Go to step 714.

[0073] Step 712: Apply the compression algorithm N_2 .

[0074] Step 714: End.

[0075] It should be noted that steps 702, 706, 708 are performed by the comparison unit 502, and steps 704, 710, 712 are performed by the compression unit 504. As a person skilled in the art can readily understand details of each step shown in FIG. 8 after reading above paragraphs, further description is omitted here for brevity.

[0076] In a third exemplary embodiment, the compressor 142 may adaptively adjust a compression algorithm applied to the input multimedia data D1 according to an operational status of a storage device such as the external storage 108. The side information SI given by the external storage 108 would include the operational status indicative of a used bandwidth of the external storage 108. Please refer to FIG. 6 again. In this embodiment, the comparison unit 502 receives the side information SI from the external storage 108. Next, the comparison unit 502 compares the used bandwidth of the external storage 108 as indicated by the side information SI with at least one predetermined threshold to generate the comparison result CR'. The compression unit 504 supports a plurality of compression algorithms having different characteristics, and refers to the comparison result CR' to select one of the supported compression algorithms for data compression. For example, as shown in FIG. 9, the comparison unit 502 employs a first predetermined threshold THR_1 and a second predetermined threshold THR_2 , where $THR_1 > THR_2$. The second predetermined threshold THR_2 is checked to see if the data compression can be disabled to avoid information loss caused by a lossy compression algorithm. More specifically, the compressor 142 is arranged to disable the data compression when the side information SI indicates that the used bandwidth is lower than the second predetermined threshold THR_2 , and enable the data compression when the side information SI indicates that the used bandwidth is not lower than the second predetermined threshold THR_2 .

[0077] The first predetermined threshold THR_1 is checked to select one compression algorithm from candidate compression algorithms having different characteristics. More specifically, the compressor 142 is arranged to employ the compression algorithm N_1 for compressing the input multimedia data D1 when the side information SI indicates that the used bandwidth is lower than the first predetermined threshold THR_1 , and employ the compression algorithm N_2 for compressing the input multimedia data D1 when the side information SI indicates that the used bandwidth is not lower than the first predetermined threshold THR_1 , where the compression algorithm N_1 is more complex than the compression algorithm N_2 , and/or the compression algorithm N_1 has a higher compression efficiency than the compression algorithm N_2 . To put it another way, when the used bandwidth is lower than the first predetermined threshold THR_1 , a more complex and higher compression efficiency algorithm can be

selected by the compression unit **504** to get better visual quality; and when the bandwidth is almost used or the used bandwidth is not lower than the first predetermined threshold THR_1 , a less complex and lower compression efficiency algorithm can be selected by the compression unit **504** to save power dissipation of the camera interface **103**.

[0078] FIG. **10** is a flowchart illustrating an adaptive compression method based on an operating status of a storage device according to an embodiment of the present invention. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. **10**. The exemplary adaptive compression method may be briefly summarized by following steps.

[0079] Step **900**: Start.

[0080] Step **902**: Check if the bandwidth is not occupied yet. If yes, go to step **904**; otherwise, go to step **906**.

[0081] Step **904**: Disable data compression. Go to step **914**.

[0082] Step **906**: Check if the used bandwidth is lower than the second predetermined threshold THR_2 . If yes, go to step **904**; otherwise, go to step **908**.

[0083] Step **908**: Check if the used bandwidth is lower than the first predetermined threshold THR_1 . If yes, go to step **910**; otherwise, go to step **912**.

[0084] Step **910**: Apply the compression algorithm N_1 . Go to step **914**.

[0085] Step **912**: Apply the compression algorithm N_2 .

[0086] Step **914**: End.

[0087] It should be noted that steps **902**, **906**, **908** are performed by the comparison unit **502**, and steps **904**, **910**, **912** are performed by the compression unit **504**. As a person skilled in the art can readily understand details of each step shown in FIG. **10** after reading above paragraphs, further description is omitted here for brevity.

[0088] In a fourth exemplary embodiment, the compressor **142** may adaptively adjust a compression algorithm applied to the input multimedia data **D1** according to at least one image capture characteristic. The ISP **114** may be configured to perform digital gain adjustment for a focus level, an exposure level, and an ISO (International Organization for Standardization) value. Hence, the side information **SI** given by the ISP **114** may include at least one of the focus level, the exposure level, and the ISO value. Please refer to FIG. **6** again. In this embodiment, the comparison unit **502** receives the side information **SI** from the ISP **114**, and compares the side information **SI** with at least one predetermined threshold to generate the comparison result **CR'**. The compression unit **504** supports a plurality of compression algorithms having different characteristics, and refers to the comparison result **CR'** to select one of the supported compression algorithms to achieve better compression performance or visual quality. For example, a blurred image is captured when the focus level is lower than a first predetermined threshold THR_1 . Hence, the compression algorithm N_4 particularly designed for compressing the blurred image is selected by the comparison unit **502**. An over-exposure or under-exposure image is obtained when the exposure level is out of a specific range delimited by a second predetermined threshold THR_2 and a third predetermined threshold THR_3 , where $THR_2 > THR_3$. Hence, the compression algorithm N_3 particularly designed to manipulate this kind of captured image is selected by the comparison unit **502**. Alternatively, the over-exposure image and the under-exposure image may be processed by different compression algorithms. In addition, the ISO value from the ISP **114** can be exploited as side information since it impacts the noise level

on the captured image. Specifically, the ISO value is positively correlated to the noise level. Hence, if the ISO value is not lower than a fourth predetermined threshold THR_4 , a high ISO image can be compressed using the compression algorithm N_1 such that noise pixels can be properly considered during the compression. If the ISO value is lower than the fourth predetermined threshold THR_4 , the compression algorithm N_2 is selected by the compression unit **504** to achieve better compression performance for the low ISO image.

[0089] FIG. **11** is a flowchart illustrating an adaptive compression method based on at least one image capture characteristic according to an embodiment of the present invention. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. **11**. The exemplary adaptive compression method may be briefly summarized by following steps.

[0090] Step **1000**: Start.

[0091] Step **1002**: Receive an image.

[0092] Step **1004**: Check if the focus level of the image is lower than the first predetermined threshold THR_1 . If yes, go to step **1006**; otherwise, go to step **1008**.

[0093] Step **1006**: Apply the compression algorithm N_4 . Go to step **1018**.

[0094] Step **1008**: Check if the exposure level of the image is higher than the second predetermined threshold THR_2 or lower than the third predetermined threshold THR_3 . If yes, go to step **1010**; otherwise, go to step **1012**.

[0095] Step **1010**: Apply the compression algorithm N_3 . Go to step **1018**.

[0096] Step **1012**: Check if the ISO value of the image is lower than the fourth predetermined threshold THR_4 . If yes, go to step **1014**; otherwise, go to step **1016**.

[0097] Step **1014**: Apply the compression algorithm N_2 . Go to step **1018**.

[0098] Step **1016**: Apply the compression algorithm N_1 .

[0099] Step **1018**: Check if all of the images have been processed. If yes, go to step **1020**; otherwise, go to step **1002** to process the next image.

[0100] Step **1020**: End.

[0101] It should be noted that steps **1004**, **1008**, **1012** are performed by the comparison unit **502**, and steps **1006**, **1010**, **1014**, **1016**, **1018** are performed by the compression unit **504**. As a person skilled in the art can readily understand details of each step shown in FIG. **11** after reading above paragraphs, further description is omitted here for brevity.

[0102] In a fifth exemplary embodiment, the compressor **142** may adaptively adjust a compression algorithm applied to the input multimedia data **D1** according to a de-compression algorithm supported by the ISP **114**, and the de-compressor **132** may adaptively adjust a de-compression algorithm applied to the input multimedia data **D2** according to a compression algorithm supported by the camera module **110**. Please refer to FIG. **12**, which is a diagram illustrating a configuration of a compressor in a camera module and a configuration of a de-compressor in an ISP according to an embodiment of the present invention. Each of the camera modules **1302_1** and **1302_2** supports a plurality of compression algorithms, and the ISP **1304** supports a plurality of de-compression algorithms. When the ISP **1304** (e.g., ISP **114** shown in FIG. **1**) is used to connect the camera module **1302_1** (e.g., camera module **110** shown in FIG. **1**) via a camera interface **1303** (e.g., camera interface **103** shown in FIG. **1**), the ISP **1304** sends side information to inform the camera module **1302_1** of the supported de-compression

algorithms X' and Y'. As the compression algorithm X supported by the camera module **1302_1** is compliant with the de-compression algorithm X', the camera module **1302_1** therefore selects and enables the compression algorithm X of the compressor (e.g., compressor **142** shown in FIG. 1). In addition, the camera module **1302_1** sends side information to inform the ISP **1304** of the employed compression algorithm X. As the de-compression algorithm X' supported by the ISP **1304** is compliant with the compression algorithm X, the ISP **1304** therefore selects and enables the de-compression algorithm X' of the de-compressor (e.g., de-compressor **132** shown in FIG. 1).

[0103] The ISP **1304** may be used in a variety of applications, and therefore supports different de-compression algorithms. Thus, in one exemplary application, the ISP **1304** is used to connect the camera module **1302_1**. However, in another application, the ISP **1304** is used to connect the camera module **1302_2**. When the ISP **1304** is used to connect the camera module **1302_2** via the camera interface **1303**, the ISP **1304** sends side information to inform the camera module **1302_2** of the supported de-compression algorithms X' and Y'. As the compression algorithm Y supported by the camera module **1302_2** is compliant with the de-compression algorithm Y', the camera module **1302_2** therefore selects and enables the compression algorithm Y of the compressor. In addition, the camera module **1302_2** sends side information to inform the ISP **1304** of the employed compression algorithm Y. As the de-compression algorithm Y' supported by the ISP **1304** is compliant with the compression algorithm Y, the ISP **1304** therefore selects and enables the de-compression algorithm Y' of the de-compressor.

[0104] FIG. 13 is a flowchart illustrating an adaptive compression and de-compression method based on side information communicated between a camera module and an ISP according to an embodiment of the present invention. Provided that the result is substantially the same, the steps are not required to be executed in the exact order shown in FIG. 13. The exemplary adaptive compression and de-compression method may be briefly summarized by following steps.

[0105] Step **1400**: Start.

[0106] Step **1402**: Receive side information of the ISP.

[0107] Step **1404**: Refer to the ISP's side information to select and enable a compression algorithm compliant with a de-compression algorithm supported by the ISP.

[0108] Step **1406**: Receive side information of the camera module.

[0109] Step **1408**: Refer to the camera module's side information to select and enable a de-compression algorithm compliant with a compression algorithm employed by the camera module.

[0110] Step **1410**: End.

[0111] It should be noted that steps **1402** and **1404** are performed by the camera module, and steps **1406** and **1408** are performed by the ISP. As a person skilled in the art can readily understand details of each step shown in FIG. 13 after reading above paragraphs, further description is omitted here for brevity.

[0112] Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A data processing apparatus comprising:

a compressor, arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data; and
an output interface, arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

wherein the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to context characteristics of the input multimedia data.

2. The data processing apparatus of claim 1, wherein the compressor comprises:

a content analysis unit, arranged for analyzing the input multimedia data to classify contents included in the input multimedia data and accordingly generating a content classification result; and
a compression unit, arranged for referring to at least the content classification result to adaptively adjust the compression algorithm.

3. The data processing apparatus of claim 2, wherein the contents are selected from a group consisting of a video content, an image content, a text content, and a graphic content.

4. The data processing apparatus of claim 2, wherein the contents comprise a first content generated using a first quantization level and a second content generated using a second quantization level which is different from the first quantization level.

5. The data processing apparatus of claim 2, wherein the contents comprise a first content with a first bit rate and a second content with a second bit rate which is different from the first bit rate.

6. A data processing apparatus comprising:

a compressor, arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data; and
an output interface, arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

wherein the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to a power supply status.

7. The data processing apparatus of claim 6, wherein the data processing apparatus is powered by a battery device, and the power supply status indicates an available battery capacity of the battery device.

8. The data processing apparatus of claim 7, wherein the compressor is arranged to employ a first compression algorithm as the compression algorithm when the power supply status indicates that the available battery capacity is higher than a predetermined threshold, and employ a second compression algorithm as the compression algorithm when the power supply status indicates that the available battery capacity is not higher than the predetermined threshold, where the second compression algorithm is different from the first compression algorithm.

9. The data processing apparatus of claim 8, wherein the first compression algorithm is more complex than the second compression algorithm; or the first compression algorithm has a higher compression efficiency than the second compression algorithm.

10. The data processing apparatus of claim 7, wherein the compressor is arranged to disable the compression algorithm when the power supply status indicates that the available battery capacity is higher than a predetermined threshold, and enable the compression algorithm when the power supply status indicates that the available battery capacity is not higher than the predetermined threshold.

11. A data processing apparatus comprising:

a compressor, arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data; and

an output interface, arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

wherein the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to an operational status of a storage device.

12. The data processing apparatus of claim 11, wherein the operational status indicates a used bandwidth of the storage device.

13. The data processing apparatus of claim 12, wherein the compressor is arranged to employ a first compression algorithm as the compression algorithm when the operational status indicates that the used bandwidth is lower than a predetermined threshold, and employ a second compression algorithm as the compression algorithm when the operational status indicates that the used bandwidth is not lower than the predetermined threshold, where the second compression algorithm is different from the first compression algorithm.

14. The data processing apparatus of claim 13, wherein the first compression algorithm is more complex than the second compression algorithm; or the first compression algorithm has a higher compression efficiency than the second compression algorithm.

15. The data processing apparatus of claim 12, wherein the compressor is arranged to disable the compression algorithm when the operational status indicates that the used bandwidth is lower than a predetermined threshold, and enable the compression algorithm when the operational status indicates that the used bandwidth is not lower than the predetermined threshold.

16. A data processing apparatus comprising:

a compressor, arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data; and

an output interface, arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

wherein the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to at least one image capture characteristic.

17. The data processing apparatus of claim 16, wherein the at least one image capture characteristic includes at least one

of a focus level, an exposure level, and an ISO (International Organization for Standardization) value.

18. A data processing apparatus comprising:

a compressor, arranged for receiving an input multimedia data and generating an output multimedia data according to the input multimedia data; and

an output interface, arranged for packing the output multimedia data into an output bitstream, and outputting the output bitstream to another data processing apparatus via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

wherein the compressor adaptively adjusts a compression algorithm applied to the input multimedia data according to a de-compression algorithm supported by the another data processing apparatus.

19. A data processing apparatus comprising:

an input interface, arranged for receiving an input bitstream from another data processing apparatus via a camera interface, and un-packing the input bitstream into an input multimedia data, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI); and

a de-compressor, arranged for generating a de-compressed multimedia data according to the input multimedia data when the input multimedia data is a compressed multimedia data;

wherein the de-compressor adaptively adjusts a de-compression algorithm according to a compression algorithm employed by the another data processing apparatus.

20. A data processing method comprising:

receiving an input multimedia data;

adaptively adjusting a compression algorithm according to context characteristics of the input multimedia data;

generating an output multimedia data according to the compression algorithm and the input multimedia data; and

packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

21. A data processing method comprising:

receiving an input multimedia data;

adaptively adjusting a compression algorithm according to a power supply status;

generating an output multimedia data according to the compression algorithm and the input multimedia data; and

packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

22. A data processing method comprising:

receiving an input multimedia data;

adaptively adjusting a compression algorithm according to an operational status of a storage device;

generating an output multimedia data according to the compression algorithm and the input multimedia data; and

packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera

interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

23. A data processing method comprising:
receiving an input multimedia data;
adaptively adjusting a compression algorithm according to at least one image capture characteristic;
generating an output multimedia data according to the compression algorithm and the input multimedia data;
and
packing the output multimedia data into an output bitstream, and outputting the output bitstream via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

24. A data processing method comprising:
receiving an input multimedia data;
adaptively adjusting a compression algorithm according to a de-compression algorithm supported by a data processing apparatus;
generating an output multimedia data according to the compression algorithm and the input multimedia data;
and

packing the output multimedia data into an output bitstream, and outputting the output bitstream to the data processing apparatus via a camera interface, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI).

25. A data processing method comprising:
receiving an input bitstream from a data processing apparatus via a camera interface, and un-packing the input bitstream into an input multimedia data, wherein the camera interface is a camera serial interface (CSI) standardized by a Mobile Industry Processor Interface (MIPI);

adaptively adjusting a de-compression algorithm according to a compression algorithm employed by the data processing apparatus; and

when the input multimedia data is a compressed multimedia data, generating a de-compressed multimedia data according to the input multimedia data and the de-compression algorithm.

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