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(54) **INTERACTIVE DEVICE CAPABLE OF TRANSMITTING PARAMETERS OF IMAGE OBJECTS**

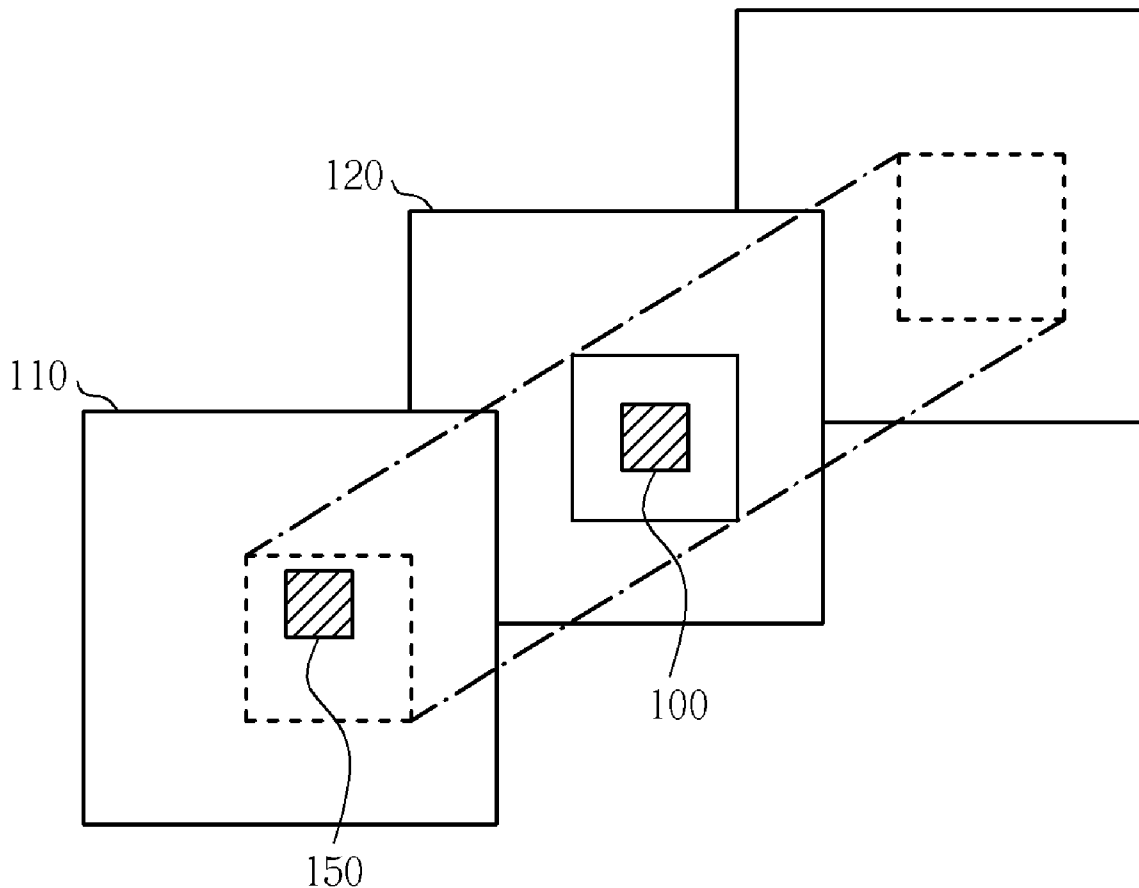(76) Inventors: **Hsuan-Hsien Lee**, Hsin-Chu Hsien (TW); **Chin-Hsin Yang**, Hsin-Chu Hsien (TW); **Tzu-Yi Chao**, Hsin-Chu Hsien (TW)

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(57) **ABSTRACT**

An interactive device includes an image sensor for generating a plurality of pixel signals, and a processor for determining a static parameter of at least one image object of the image based on the plurality of pixel signals. A transmission interface is used for outputting a control signal based on the static parameter determined by the processor.

10

14

Micro-controller

16

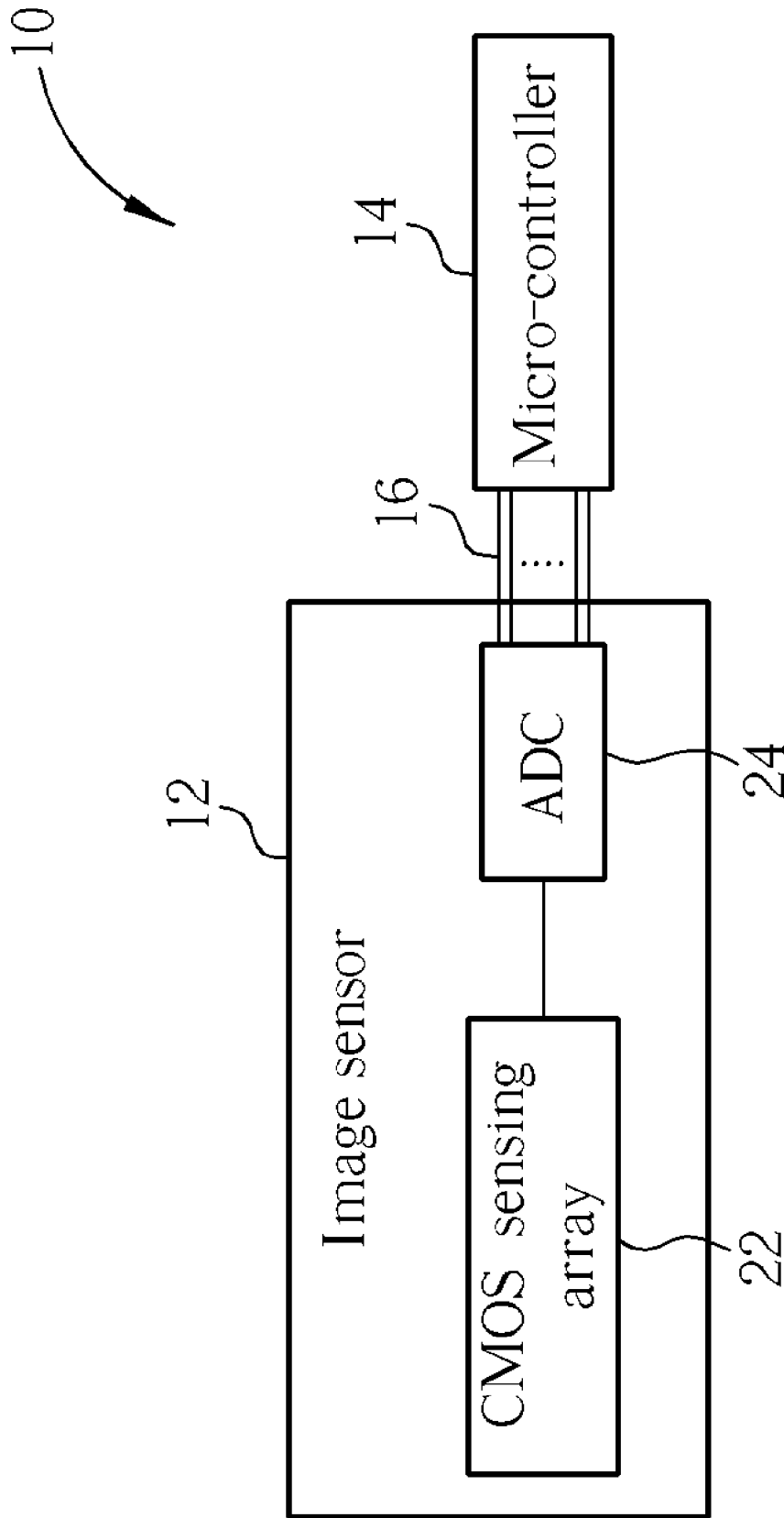....

12

ADC

24
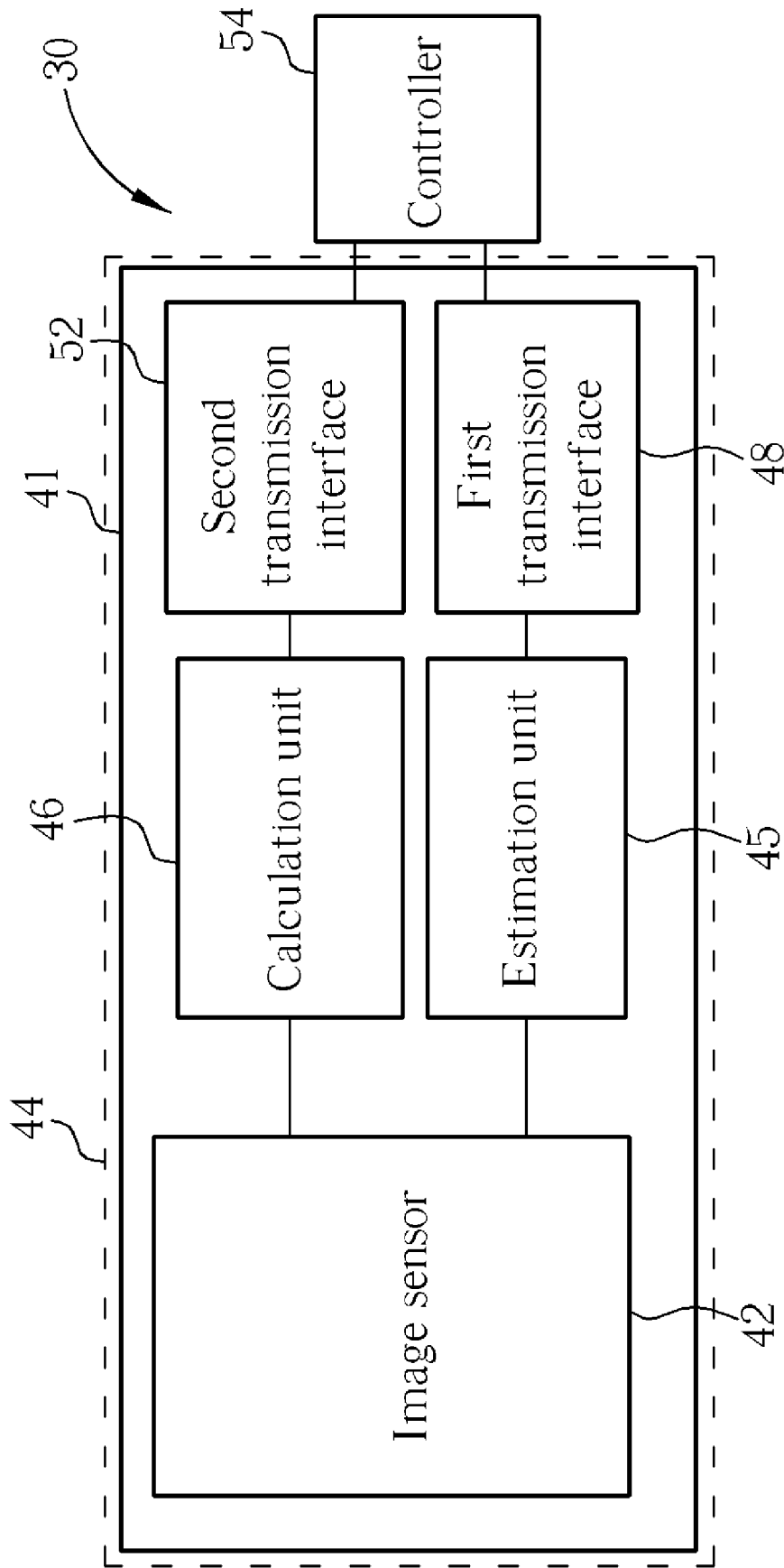
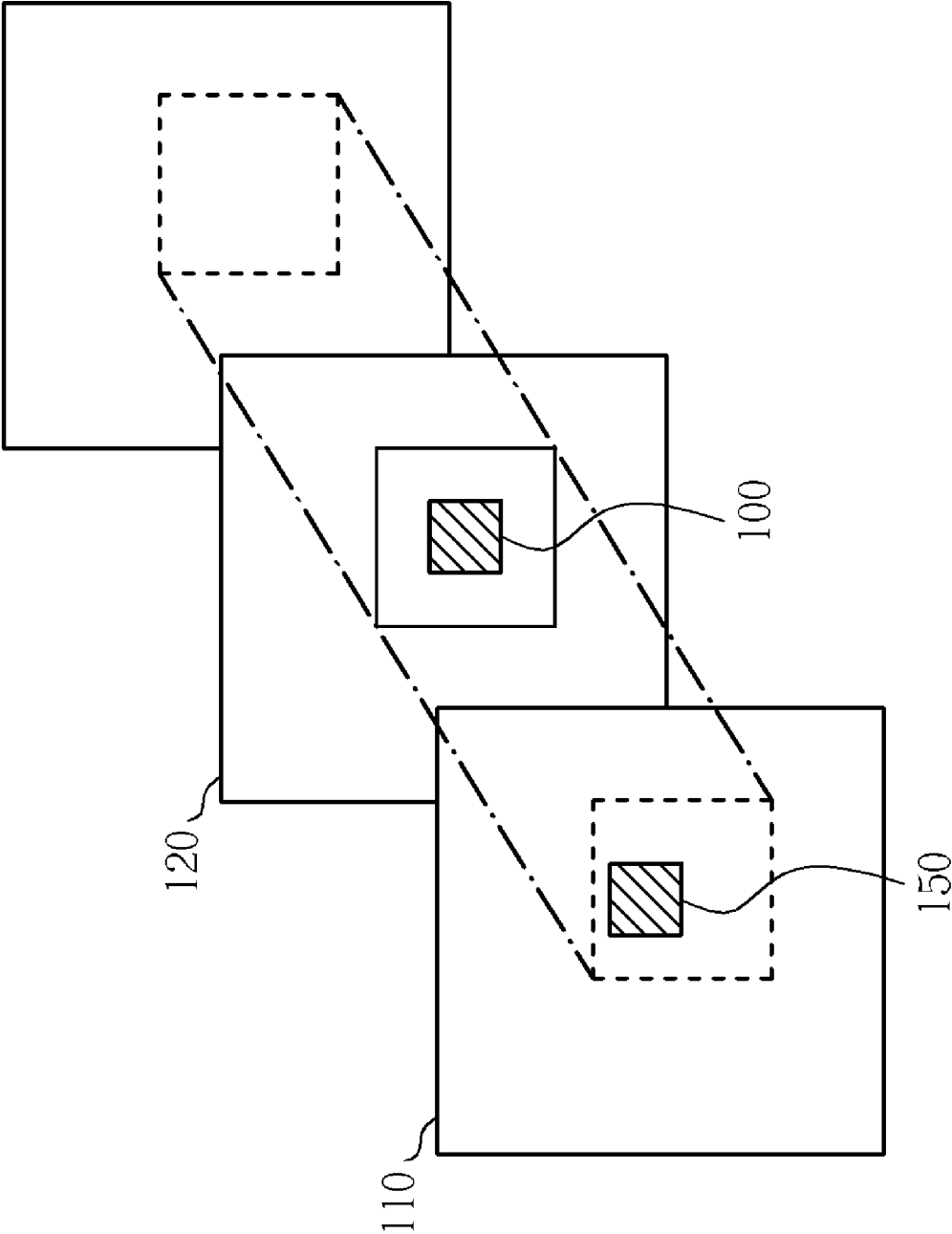Image sensor

CMOS sensing array

22

Fig. 1 Prior Art

Fig. 2

Fig. 3
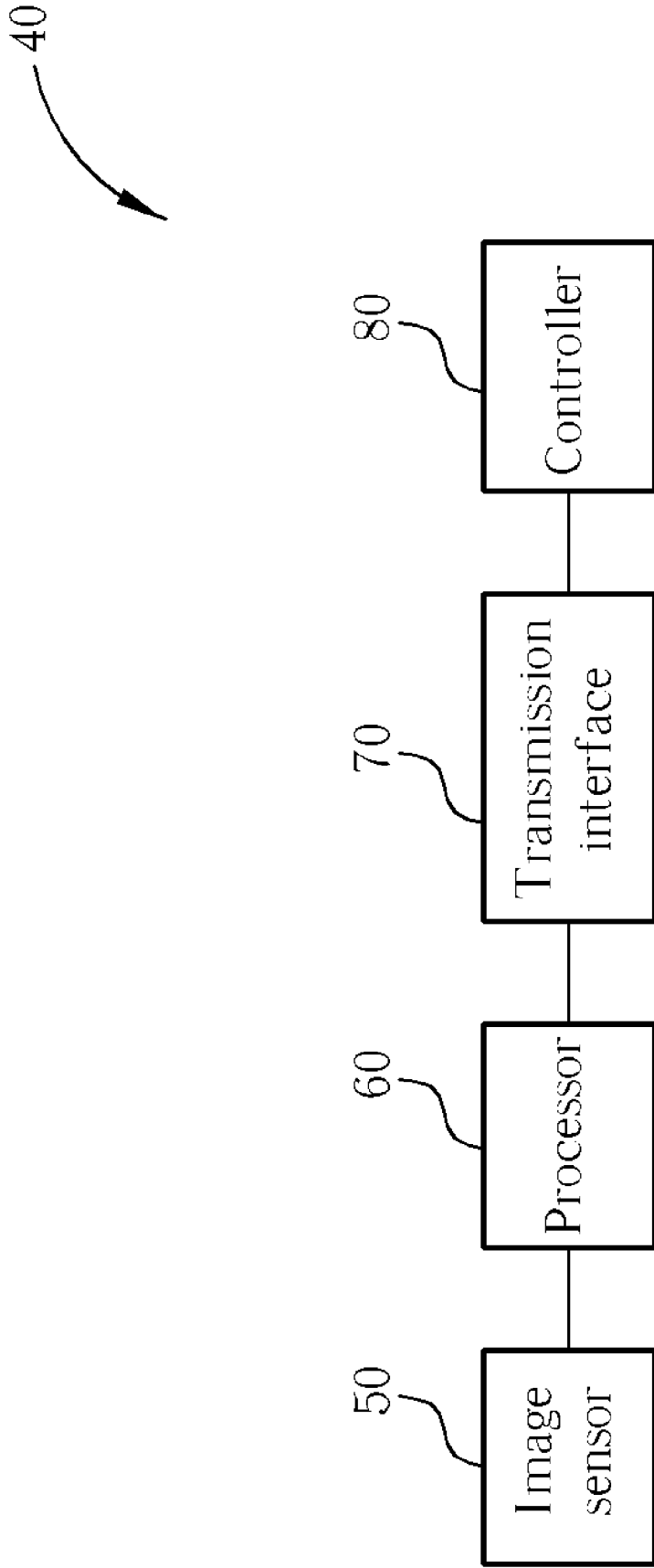
Fig. 4

INTERACTIVE DEVICE CAPABLE OF TRANSMITTING PARAMETERS OF IMAGE OBJECTS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This is a continuation-in-part of application Ser. No. 10/904,301, filed Nov. 3, 2004, which is included in its entirety herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention relates to an interactive device, and more specifically, to an interactive device capable of transmitting parameters of image objects.

[0004] 2. Description of the Prior Art

[0005] In conventional interactive devices, image sensors are used to capture human motions as controlling instructions. Take electronic pets for example; the built-in image sensors installed inside the electronic pets functions as an "eye" of the interactive toy to capture image pictures of human motions. Then, the captured and digitized pictures are transmitted to the following device to identify the controlling instructions. Eventually, the electronic pets would act according to the identified instructions.

[0006] Please refer to **FIG. 1**. **FIG. 1** is a functional block diagram of an interactive device **10** according to the prior art. The interactive device **10** includes an image sensor **12**, a micro-controller **14**, and a parallel transmission bus **16**. The image sensor **12** contains a CMOS sensing array **22** and an analog to digital converter (ADC) **24**. Data sensed by the CMOS sensing array **22** is transmitted to the analog to digital converter **24**. Because the CMOS sensing array **22** is capable of sensing a plurality of pixel data for forming images, the CMOS sensing array **22** of the image sensor **12** would generate various pixel data continuously while taking continuously moving images. In order to transmit a considerable amount of pixel data, the pixel data are transmitted from the image sensor **12** to the micro-controller **14** through the parallel transmission bus **16**, and then the micro-controller **14** recomposes the images, extracts image objects on the recomposed images, and then determines the condition of the image object to control the operation of the interactive device **10**.

[0007] Here, an image object refers to a group of at least one pixel having similar properties, such as similar gray intensities or similar colors.

[0008] The total amount of the data is considerable, and the micro-controller **14** still has to determine and analyze the necessary data after receiving the data transmitted through the parallel transmission interface **16**. However, for most applications, the micro-controller **14** does not need to deal with the entire image data. Take object tracking application for example, the micro-controller **14** does not need to obtain and deal with the entire image data, but can calculate the difference of the coordinates of the gravity centers for the corresponding image objects to obtain the trail of relative motions of these image objects. As a result, if users utilize the conventional image sensor **12** for generating pixel data,

the micro-controller **14** has to receive and process all pixel data, resulting in a major burden while processing the image data.

SUMMARY OF THE INVENTION

[0009] Instead of transmitting the entire image data, the claimed invention discloses an interactive device capable of transmitting parameters of image objects. The interactive device comprises an image sensor, a processor, and a transmission interface. The image sensor generates a plurality of pixel signals corresponding to an image. The processing module determines at lease one static parameter of at least one image object within the image based on the plurality of pixel signals. Here, an image object refers to a group of at least one pixel having similar properties, such as similar gray intensities or similar colors. The transmission interface outputs a digitized signal comprising at least one value based on the at least one static parameter of at least one image object.

[0010] 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

[0011] **FIG. 1** is a functional block diagram of the interactive device according to the prior art.

[0012] **FIG. 2** is a functional block diagram of the interactive device according to the present invention.

[0013] **FIG. 3** shows multiple image pictures.

[0014] **FIG. 4** is another functional block diagram of the interactive device according to the present invention.

DETAILED DESCRIPTION

[0015] Please refer to **FIG. 2**. **FIG. 2** is a functional block diagram of an interactive device **30** according to the present invention. The interactive device **30** can be one component of an interface controller, one component of a game controller, or one component of an interactive toy. The interactive device **30** comprises a processing module **44** that is a chip, and a controller **54**. The processing module **44** comprises an image sensor **42**, which is a charge-coupled device (CCD) or a CMOS image sensor (CIS), for generating a plurality of digital pixel signals. Then, the plurality of pixel signals is transmitted to the processing module **44**. The processing module **44** comprises a substrate **41**, an estimation unit **45**, a calculation unit **46**, and transmission interfaces **48**, **52**. In this embodiment, the image sensor **42**, the estimation unit **45**, the calculation unit **46**, and the transmission interfaces **48**, **52** are all integrated in a single chip. For an SOC solution, the image sensor **42**, the estimation unit **45**, and the transmission interfaces **48**, **52** are all formed on the substrate **41**.

[0016] Please refer to **FIG. 3**. **FIG. 3** shows multiple image pictures. Each picture comprises a plurality of pixel signals. For each picture, the image sensor **42** is used to generate a plurality of pixel signals. Then, the plurality of generated pixel signals are transmitted to the estimation unit **45**. Once the pixel signals are received, the estimation unit

45 would estimate various parameters of each image object based on a plurality of pixel signals. Take a target picture 120 for example. A target object 100 comprising a group of at least one pixel with similar gray intensities or similar colors in the target picture 120 is extracted first. Then various image parameters of the target object are estimated. The image parameters include the area of the target object 100, which indicates the total pixel number of the target object 100, the average color of the target object 100, which indicates the averaged color of all pixels' colors, the orientation of the target object 100, the boundaries of a minimum square enclosing the target object 100, the characteristic points of the target object 100, which especially indicate the corner points and/or the high curvature points of the target object 100, the geometrical shape of the target object 100, the length to width ratio of the target object 100 and the coordinate of the gravity center of the target object 100, which can be estimated by the equation (1):

$$(\bar{X}, \bar{Y}) = \left[\frac{\sum_{i=1}^{M} X_i}{M}, \frac{\sum_{i=1}^{M} Y_i}{M} \right], \quad (1)$$

[0017] where $(\bar{X},\bar{Y})$ denotes the coordinate of the gravity center of the target object, (X_i,Y_i) denotes the coordinate of each pixel within the image object, and M denotes the pixel number within the target object.

[0018] Further more, the image parameters which indicate whether the inner of the target object 100 is filled or unfilled with background pixels, and the number of objects with different colors from the target object enclosed in the target object 100, etc, can also be estimate. After the aforementioned parameters are estimated, the estimation unit 45 can generate the extended parameters based on the estimated parameters. For example, the estimation unit 45 can generate the normalized coordinate of the gravity center of the target object with respect to a specified length and a specified width.

[0019] The target object 100 is taken as a set of the pixel signals with similar colors, and the estimation unit 45 is capable of determining parameters of the target object 100 in the target picture 120 (e.g. the area, the color, the orientation, and the boundaries) based on the number of the pixel signals, the pixel colors, and their corresponding coordinates. The estimation unit 45 can also determine parameters, such as characteristic points of the target object 100, the geometrical shape of the target object 100, the coordinate of the gravity center of the target object 100, and the length to width ratio of the target object 100. For example, if the target object 100 is in a rectangular shape, the estimation unit 45 is able to determine that the number of the corner points of the target object 100 is 4. That is to say, the static image parameters are the measurable parameters of the target object 100 while the target object 100 is being statically captured by an image sensor.

[0020] Furthermore, please keep referring to FIG. 3. To estimate the motion vector as the difference of the gravity coordinates of two image objects either on the same picture or on the different pictures obtained at different time. The

image pixels with similar properties are grouped into image objects. Then the coordinate difference between the reference object 150 and the target object 100, which can be calculated as the difference between the coordinate of the gravity center of one image object and the coordinate of the gravity center of another image object, representing the motion vector of the target image object. The calculation unit 46 is able to determine the motion vector between two different objects in above-mentioned way.

[0021] After obtaining parameters for image objects in one picture or more than one picture, the estimation unit 45 and the calculation unit 46 can transmit the parameters to the transmission interfaces 48, 52. The transmission interfaces 48, 52 can be a universal asynchronous receiver/transmitter (UART) interface. Asynchronous serial transmission has the advantages of small volume, low price, and the ability to transmit over a long distance. For instance, a universal asynchronous transceiver is an asynchronous serial/parallel data transmitter for transmitting data between serial devices that control and connect to the interactive device 30 (or a processor).

[0022] In addition to the aforementioned UART interface (RS-232 is one kind of UART interface), the transmission interfaces 48, 52 can be I²C (inter-IC), USB interfaces, wireless USB or SPI (serial peripheral interface). Because the principle of transforming serial data and parallel data with I²C, USB, wireless USB, or SPI is similar to that with UART interface and is well known to those skilled in the art, there is no further description hereinafter.

[0023] In other words, the first transmission interface 48 and the second transmission interface 52 can each use at least one kind of interface from the serial transmission groups including the UART interface, I²C (inter-IC), USB interface, and wireless USB interface.

[0024] Ultimately, after receiving the motion vectors or the static parameters (e.g. the coordinate of the gravity center of the image object, the area of the image object, the average color of the image object, the orientation of the image object, the boundary of the image object, the characteristic points, such as corner points and/or high curvature points, the geometrical shape of the image object, and the length to width ratio of the image object) transmitted from the transmission interfaces 48, 52, the controller 54 is able to utilize codes of each object in the previous picture 110 in cooperation with motion vectors and static parameters of each object to recover the target picture 120. The controller 54 may take further action based on the parameters for controlling the operation of the interactive device 30.

[0025] In another embodiment, the first transmission interface 48 for transmitting the data generated by the estimation unit 45 and the second transmission interface 52 for transmitting the motion vectors calculated by the calculation unit 46 can be combined into a single interface.

[0026] In the third embodiment, the processing module 44 comprises the image sensor 42, the calculation unit 46, and the second transmission interface 52, and all are integrated in a single chip. For an SOC solution, the processing module 44 comprises the image sensor 42, the calculation unit 46, and the second transmission interface 52 are all formed on the same substrate 41. Thus, the third embodiment does not make use of the estimation unit 45 and the first transmission interface 48.

[0027] In the fourth embodiment, the image sensor **42**, the estimation unit **45**, and the first transmission interface **48** are integrated in a single chip. For an SOC solution, the image sensor **42**, the estimation unit **45**, and the first transmission interface **48** are all formed on the same substrate **41**, and the calculation unit **46** and the second transmission interface **52** are not used.

[0028] Please refer to **FIG. 4**, which is another functional block diagram of an interactive device **40** according to the present invention. The interactive device **40** comprises an image sensor **50**, a processor **60**, a transmission interface **70**, and a controller **80**. In this embodiment, the processor **60** determines static parameters of the image object as the estimation unit **45** does, and determines the motion vector between two different image objects as the calculation unit **46** does. Additionally, the processor **60** can be a digital signal processor (DSP), a micro control unit (MCU), or other modules capable of determining static parameters and/or motion vectors. Data can be transmitted to the controller **80** in a serial or parallel manner through the transmission interface **70**, and thereby the transmission interface **70** can be an I²C interface, a universal serial bus (USB) interface, a wireless USB inter face, a universal asynchronous receiver/transmitter (UART) interface, a parallel transmission interface, or other interfaces. Data transmitted through the transmission interface **70** comprise the area of the image object, the color of the image object, the orientation indicating the image object, the boundaries of the image object, the characteristic points of the image object, the geometrical shape of the image object, the length to width ratio of the image object, and the coordinate of the gravity center of the image object.

[0029] In **FIG. 2**, the image sensor **42**, the estimation unit **45**, the calculation unit **46**, and the transmission interfaces **48**, **52** are all integrated in a single chip. For an SOC solution, the image sensor **42**, the estimation unit **45**, the calculation unit **46**, and the transmission interfaces **48,52** are all formed on the same substrate **41**. Also, these elements can be distributed in different chips. As shown in **FIG. 4**, the image sensor **50**, the processor **60**, and the transmission interface **70** are not necessarily integrated in the same chip. They can be distributed in different chips. That is, they can be formed on different substrates.

[0030] The present invention determines static parameters of the image object, and determines the motion vector among different image objects before transmitting data to the controller at the rear end. The transmission interface transmits the calculated image parameters by the UART interface or any other serial and/or parallel transmission interfaces. In this way, the controller at the rear end does not need to process considerable sensed data any more, which reduces the circuit design complexity and shortens the development period of interactive devices.

[0031] 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. An interactive device capable of transmitting parameters of image objects, the interactive device comprising:

an image sensor for generating a plurality of pixel signals corresponding to an image;

a processor for determining at least one static parameter set of the at least one image object within the image based on the plurality of pixel signals; and

a transmission interface for outputting at least one output signal.

2. The interactive device of claim 1, wherein the static parameter set comprises one or more parameters from a group comprising a coordinate of an gravity center of an image object, an area of the image object, a direction indicating the image object orientation, an average color of the image object, coordinates of some specified object points of the image object, a length to width ratio of the image object, a shape of the image object, and boundaries of the image object.

3. The interactive device of claim 2, wherein the some specified object points of the image object indicate corner points or high curvature points of the image object.

4. The interactive device of claim 1, wherein the output signal comprises at least one parameter from the at least one image object.

5. The interactive device of claim 1, wherein the output signal comprises at least one value calculated with a combination of at least one parameter from the at least one image object.

6. The interactive device of claim 1, wherein the output signal comprises a motion vector calculated in any combination of at least two parameters from the at least two image objects.

7. The interactive device of claim 4, wherein the parameters of the image objects comprise the one or more parameters from the group comprising the coordinate of the gravity center of the image object, the area of the image object, the direction indicating the image object orientation the average color of the image object, coordinates of some specified object points of the image object, the length to width ratio of the image object, the shape of the image object, and the boundaries of the image object.

8. The interactive device of claim 5, wherein the parameters of the image objects comprise the one or more parameters from the group comprising the coordinate of the gravity center of the image object, the area of the image object, the direction indicating the image object orientation the average color of the image object, coordinates of some specified object points of the image object, the length to width ratio of the image object, the shape of the image object, and the boundaries of the image object.

9. The interactive device of claim 6, wherein the parameters of the image objects comprise the one or more parameters from the group comprising the coordinate of the gravity center of the image object, the area of the image object, the direction indicating the image object orientation the average color of the image object, coordinates of some specified object points of the image object, the length to width ratio of the image object, the shape of the image object, and the boundaries of the image object.

10. The interactive device of claim 1, wherein the transmission interface is selected from a group comprising an I²C interface, a universal serial bus (USB) interface, a wireless USB inter face, a serial peripheral interface (SPI), a universal asynchronous receiver/transmitter (UART) interface, and a parallel transmission interface.

11. The interactive device of claim 1, wherein the image sensor is a CMOS sensor, or a charge-coupled device (CCD) sensor.

12. The interactive device of claim 1, wherein the processor is a digital signal processor (DSP), or a micro control unit (MCU).

13. The interactive device of claim 1 further comprising a controller for controlling operation of the interactive device based on the control signal.

14. The interactive device of claim 1, wherein the image sensor, the processor, and the transmission interface are integrated in a single chip.

15. The interactive device of claim 1, wherein the image sensor, the processor, and the transmission interface are formed on the same substrate.

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