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Kim et al.

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(54) **3D VIDEO COMMUNICATION APPARATUS AND METHOD FOR VIDEO PROCESSING OF 3D VIDEO COMMUNICATION APPARATUS**

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H04N 13/00 (2006.01)
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(52) **U.S. Cl.**

CPC ***H04N 7/147*** (2013.01); ***H04N 13/007*** (2013.01); ***H04N 13/0022*** (2013.01); ***H04N 13/0059*** (2013.01); ***H04N 13/0239*** (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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(57) **ABSTRACT**

A video communication method includes: acquiring a plurality of 2D images corresponding to a talker using a 3D camera; adjusting a point of convergence of the plurality of 2D images using a feature point of the talker; detecting an object located between the talker and the 3D camera using the acquired plurality of 2D images; scaling an original sense of depth of the detected object to a new sense of depth; and generating a 3D talker image including the object with the new sense of depth and transmitting the 3D talker image to a 3D video communication apparatus of a listener.

33 Claims, 13 Drawing Sheets

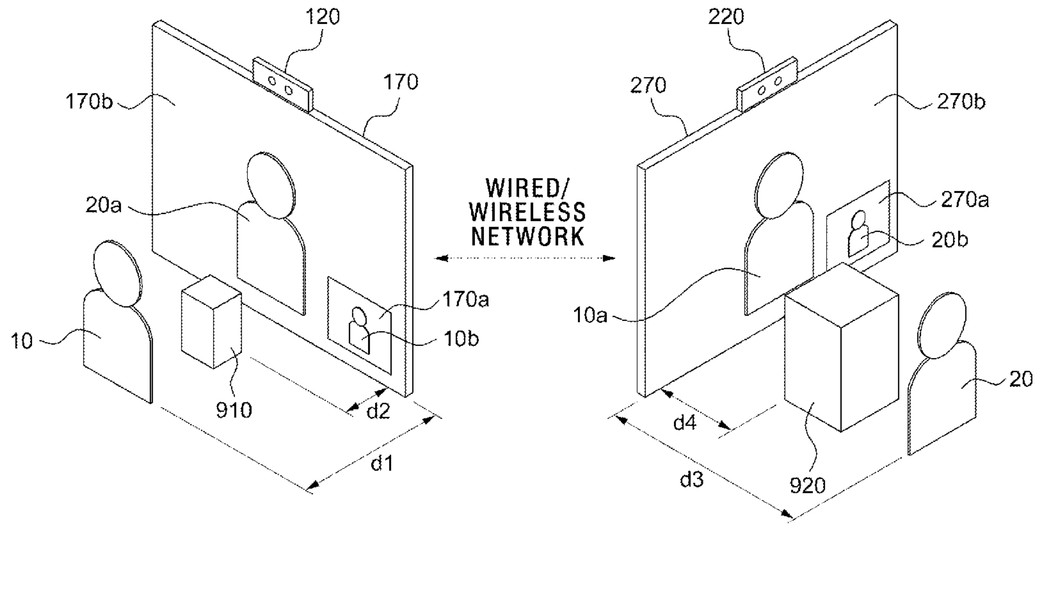


FIG. 1

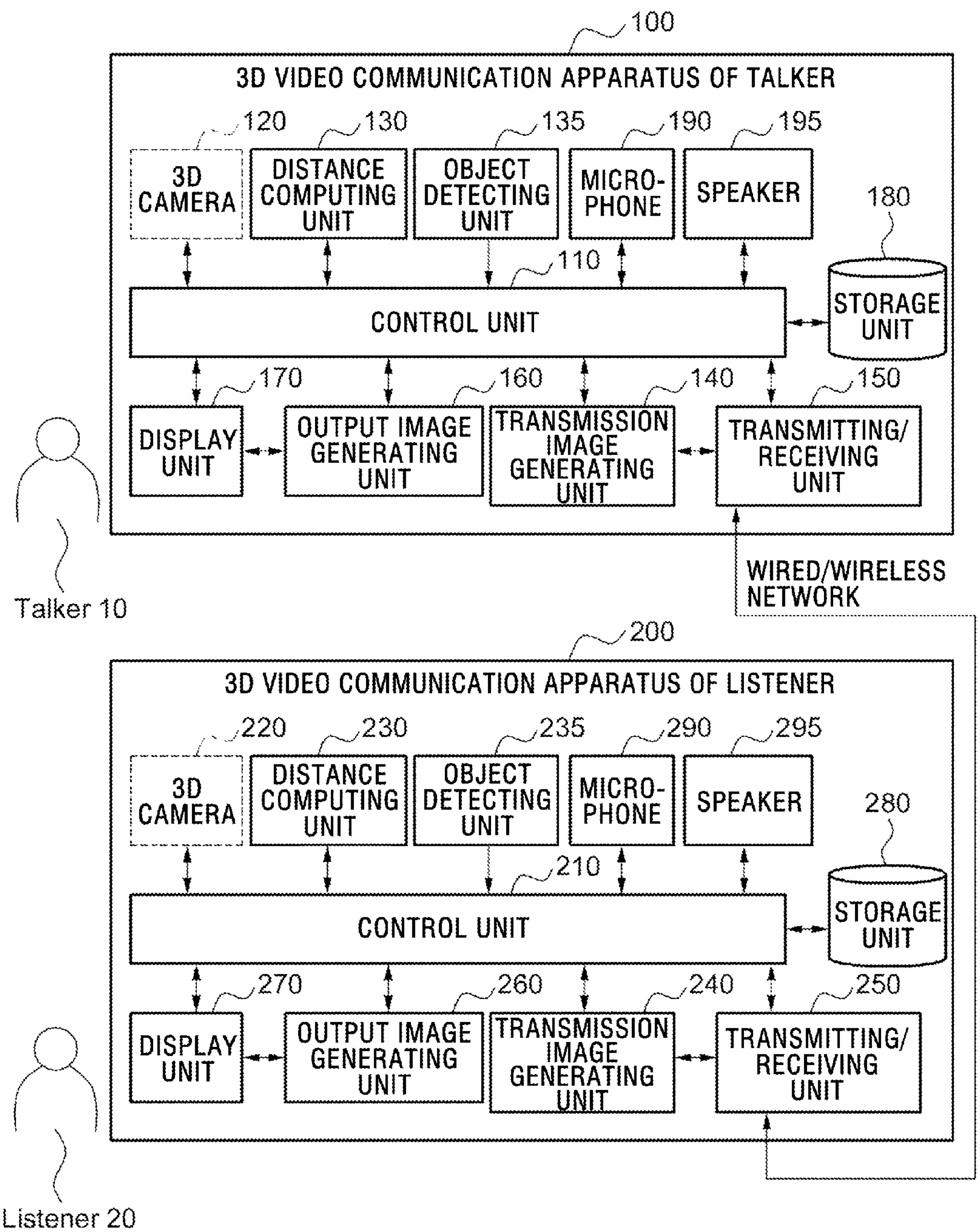

100
3D VIDEO COMMUNICATION APPARATUS OF TALKER
120
3D CAMERA
130
DISTANCE COMPUTING UNIT
135
OBJECT DETECTING UNIT
190
MICRO-PHONE
195
SPEAKER
180
STORAGE UNIT
110
CONTROL UNIT
170
DISPLAY UNIT
160
OUTPUT IMAGE GENERATING UNIT
140
TRANSMISSION IMAGE GENERATING UNIT
150
TRANSMITTING/ RECEIVING UNIT
Talker 10
WIRED/WIRELESS NETWORK
200
3D VIDEO COMMUNICATION APPARATUS OF LISTENER
220
3D CAMERA
230
DISTANCE COMPUTING UNIT
235
OBJECT DETECTING UNIT
290
MICRO-PHONE
295
SPEAKER
280
STORAGE UNIT
210
CONTROL UNIT
270
DISPLAY UNIT
260
OUTPUT IMAGE GENERATING UNIT
240
TRANSMISSION IMAGE GENERATING UNIT
250
TRANSMITTING/ RECEIVING UNIT
Listener 20

FIG. 2

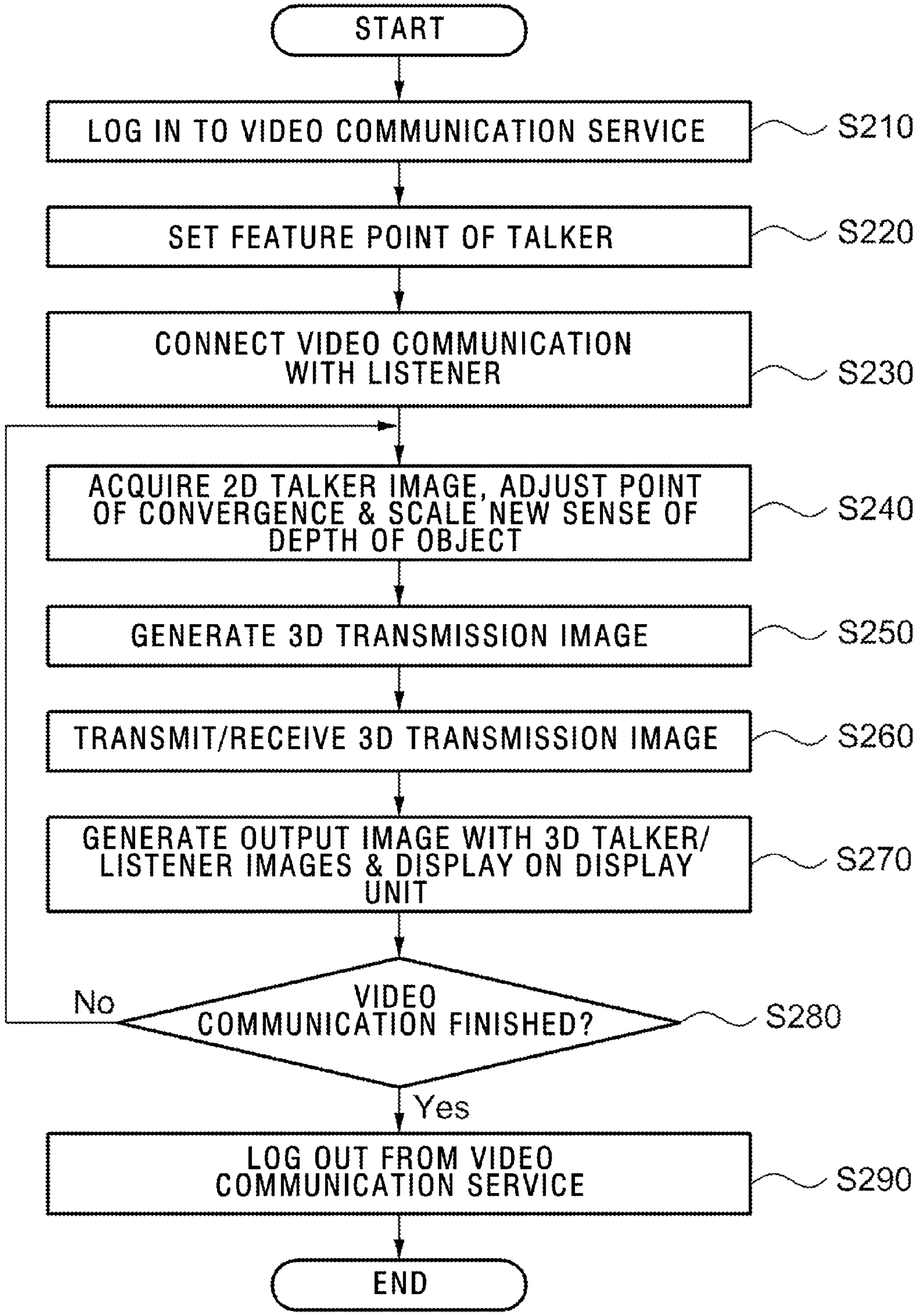

START
LOG IN TO VIDEO COMMUNICATION SERVICE
S210
SET FEATURE POINT OF TALKER
S220
CONNECT VIDEO COMMUNICATION WITH LISTENER
S230
ACQUIRE 2D TALKER IMAGE, ADJUST POINT OF CONVERGENCE & SCALE NEW SENSE OF DEPTH OF OBJECT
S240
GENERATE 3D TRANSMISSION IMAGE
S250
TRANSMIT/RECEIVE 3D TRANSMISSION IMAGE
S260
GENERATE OUTPUT IMAGE WITH 3D TALKER/ LISTENER IMAGES & DISPLAY ON DISPLAY UNIT
S270
VIDEO COMMUNICATION FINISHED?
S280
No
Yes
LOG OUT FROM VIDEO COMMUNICATION SERVICE
S290
END

FIG. 3

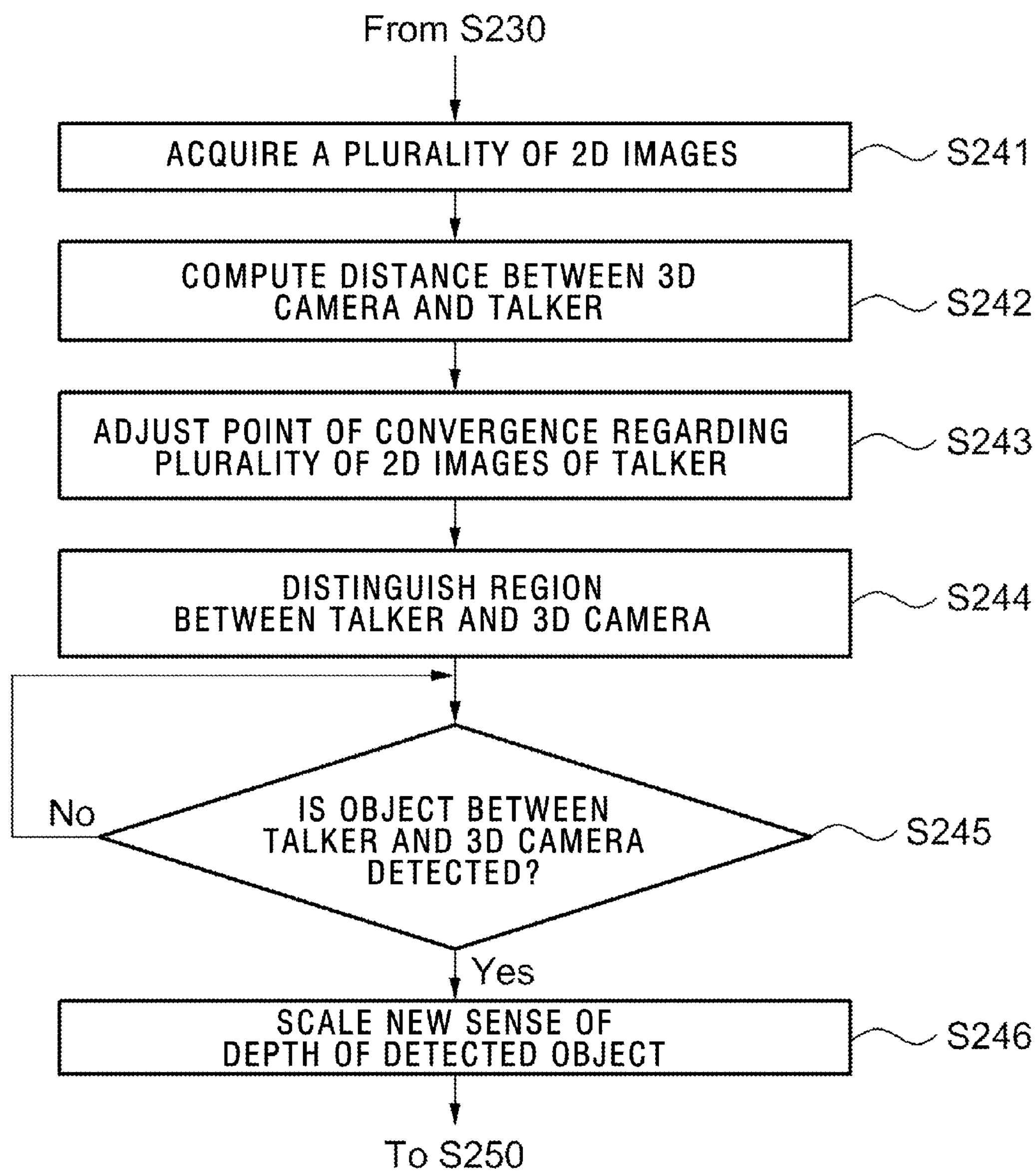
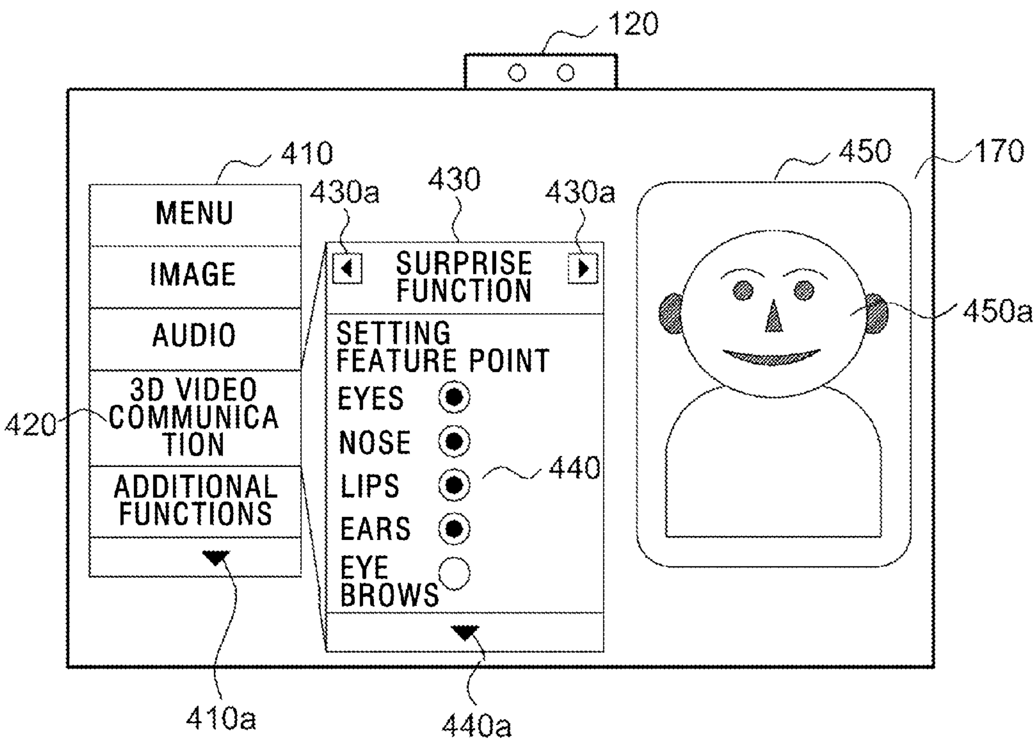
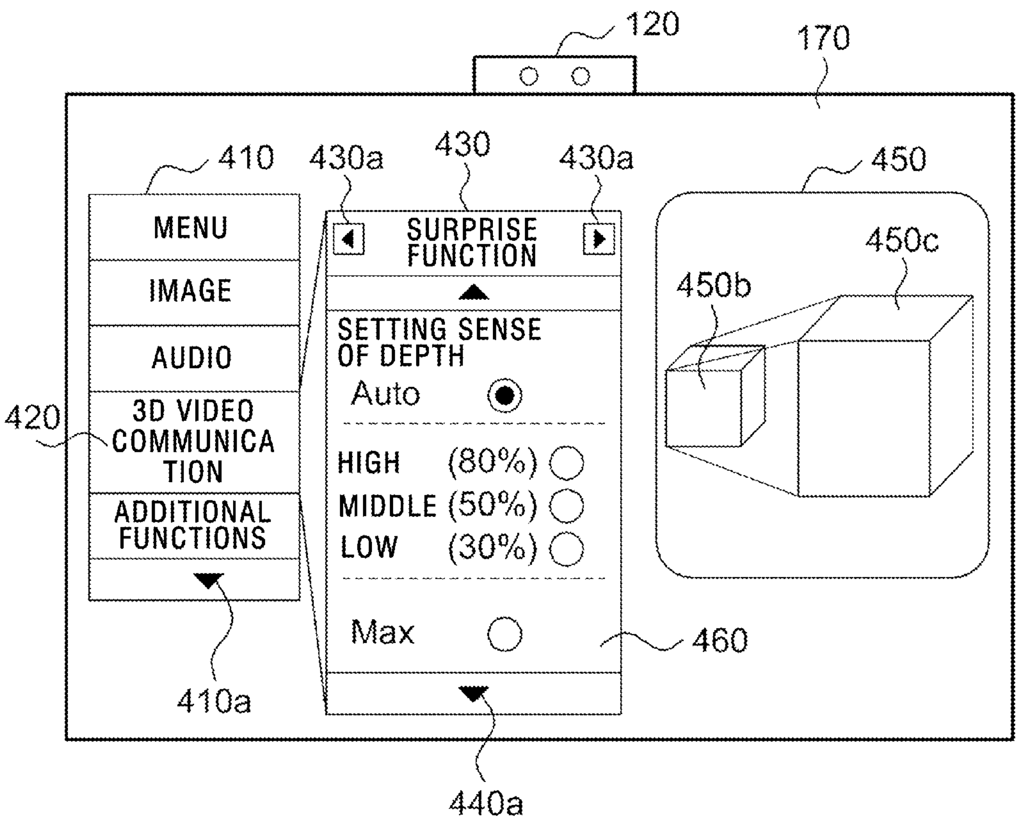

From S230
ACQUIRE A PLURALITY OF 2D IMAGES
S241
COMPUTE DISTANCE BETWEEN 3D CAMERA AND TALKER
S242
ADJUST POINT OF CONVERGENCE REGARDING PLURALITY OF 2D IMAGES OF TALKER
S243
DISTINGUISH REGION BETWEEN TALKER AND 3D CAMERA
S244
IS OBJECT BETWEEN TALKER AND 3D CAMERA DETECTED?
S245
No
Yes
SCALE NEW SENSE OF DEPTH OF DETECTED OBJECT
S246
To S250

FIG. 4A



120
410
430a
430
430a
450
170
MENU
IMAGE
AUDIO
3D VIDEO COMMUNICATION
ADDITIONAL FUNCTIONS
420
SURPRISE FUNCTION
SETTING FEATURE POINT
EYES
NOSE
LIPS
EARS
EYE BROWS
440
450a
410a
440a

FIG. 4B



120
170
410
430a
430
430a
450
MENU
SURPRISE FUNCTION
IMAGE
450c
450b
AUDIO
SETTING SENSE OF DEPTH
Auto
420
3D VIDEO COMMUNICATION
HIGH (80%)
MIDDLE (50%)
LOW (30%)
ADDITIONAL FUNCTIONS
Max
460
410a
440a

FIG. 5

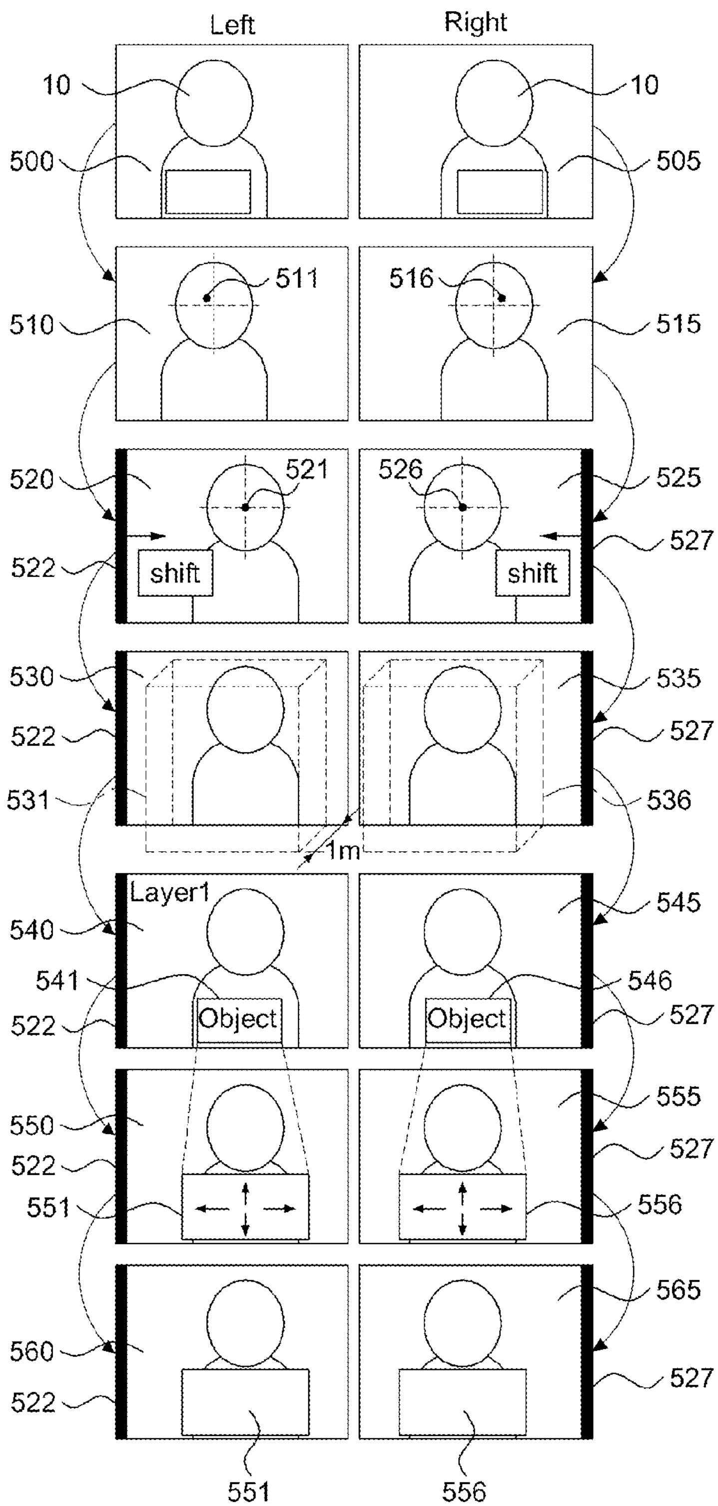

Left
Right
10
10
500
505
511
516
510
515
520
521
526
525
522
527
shift
shift
530
535
522
527
531
536
1m
Layer1
540
545
541
546
522
527
Object
Object
550
555
522
527
551
556
560
565
522
527
551
556

FIG. 6

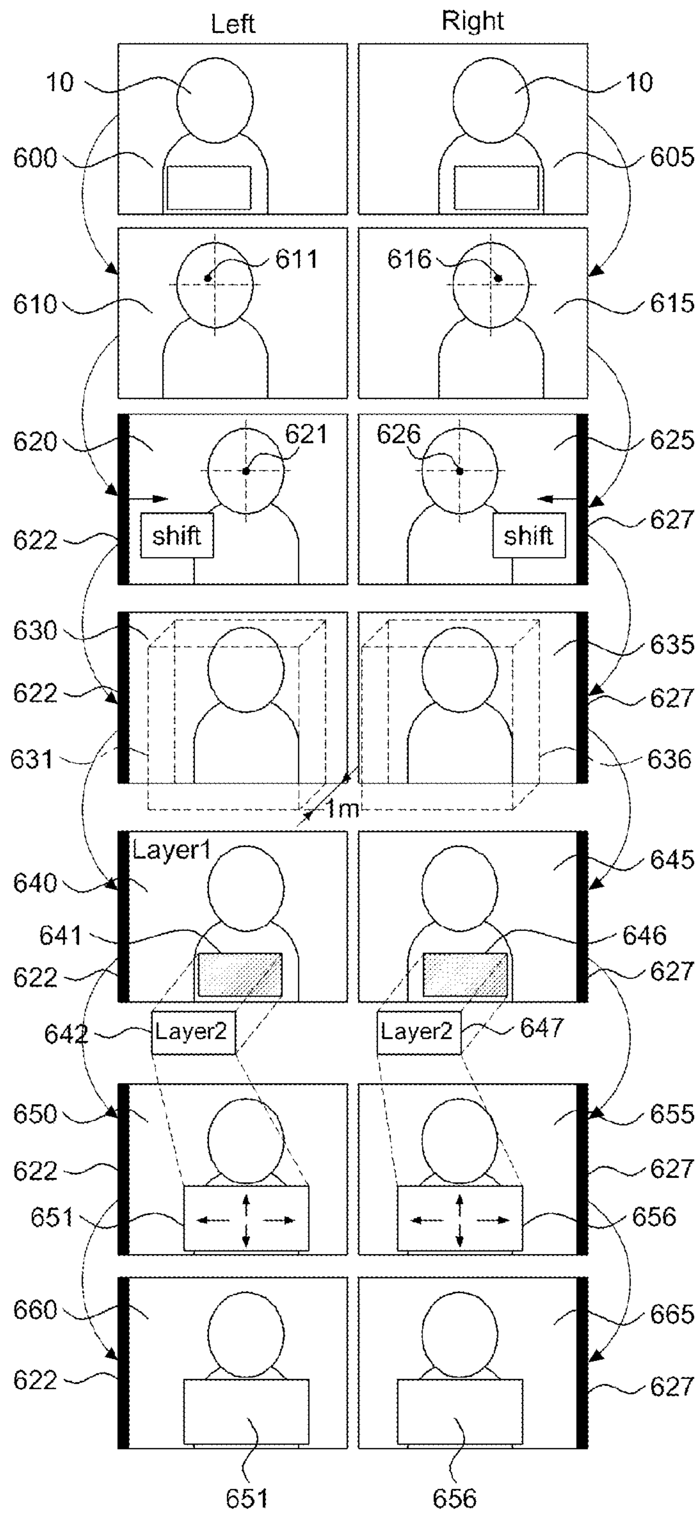
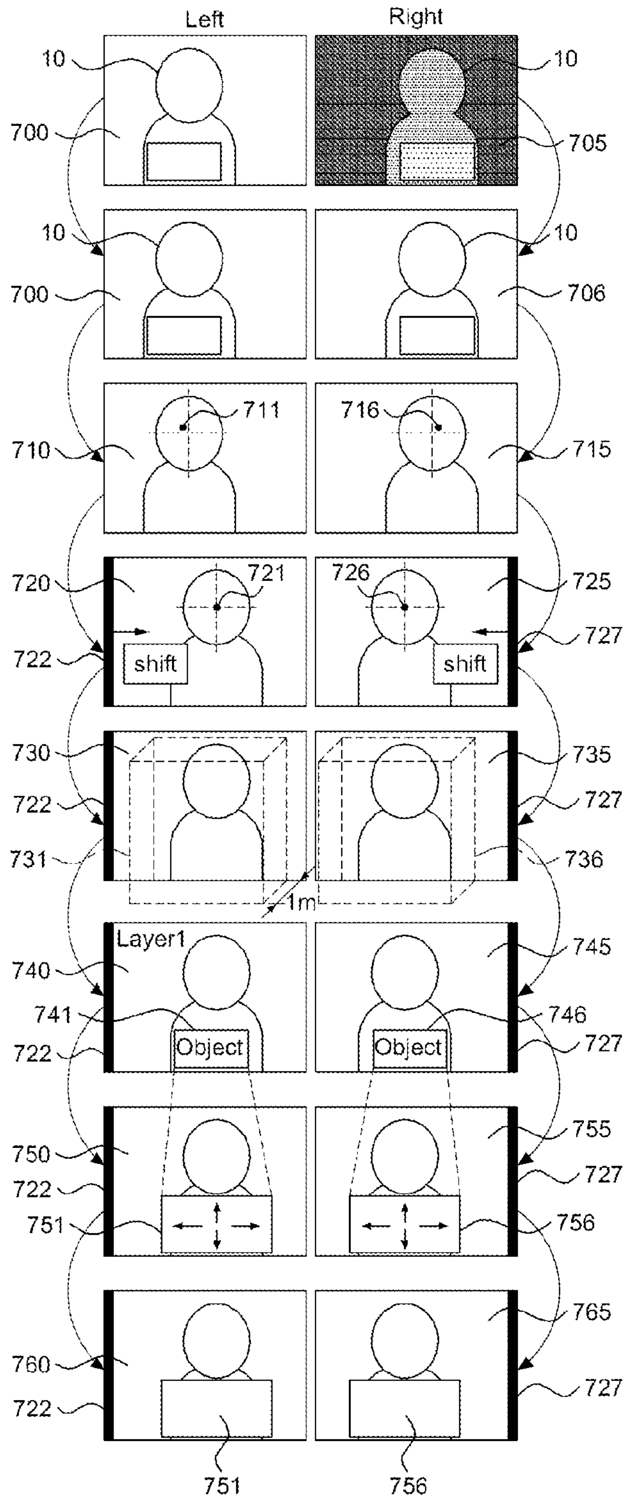

Left
Right
10
10
600
605
610
611
616
615
620
621
626
625
622
shift
shift
627
630
635
622
627
631
636
1m
Layer1
640
645
641
646
622
627
642
Layer2
Layer2
647
650
655
622
627
651
656
660
665
622
627
651
656

FIG. 7



Left
Right
10
700
705
706
710
711
716
715
720
721
726
725
722
727
shift
730
735
731
736
1m
Layer1
740
745
741
746
Object
750
755
751
756
760
765

FIG. 8A

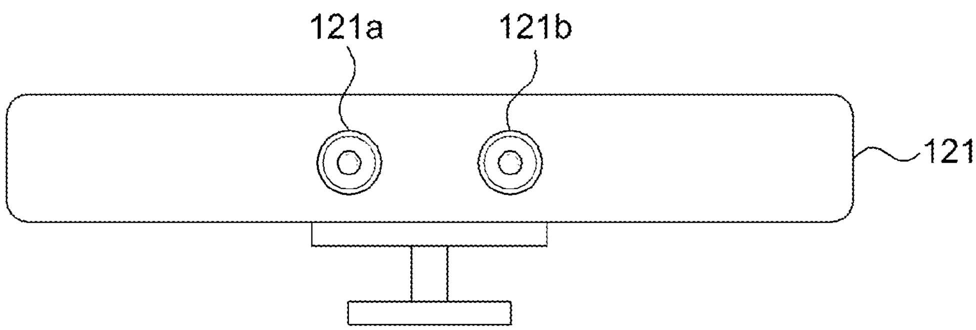


FIG. 8B

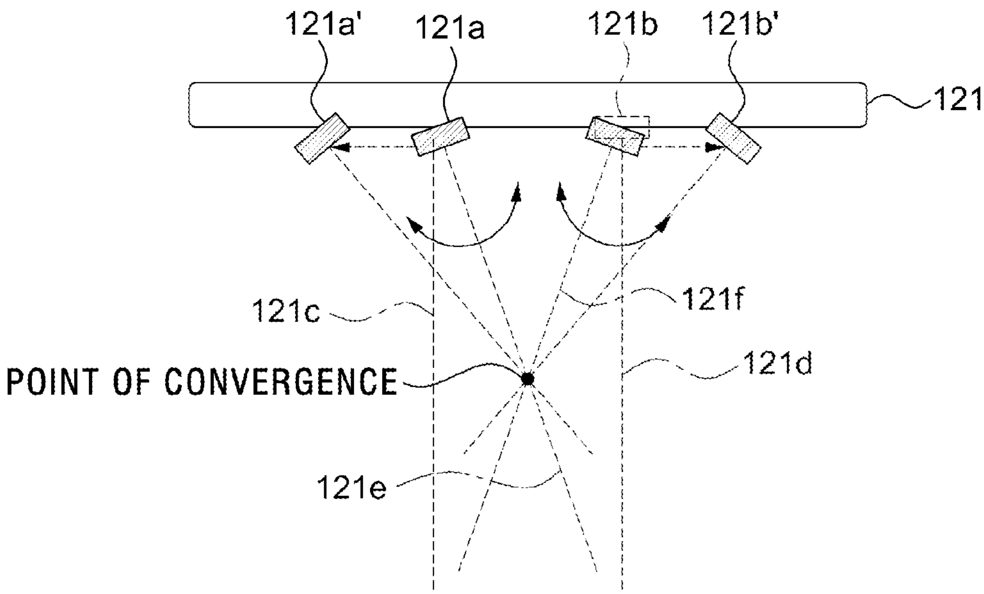

121a'
121a
121b
121b'
121
121c
121f
POINT OF CONVERGENCE
121d
121e

FIG. 8C

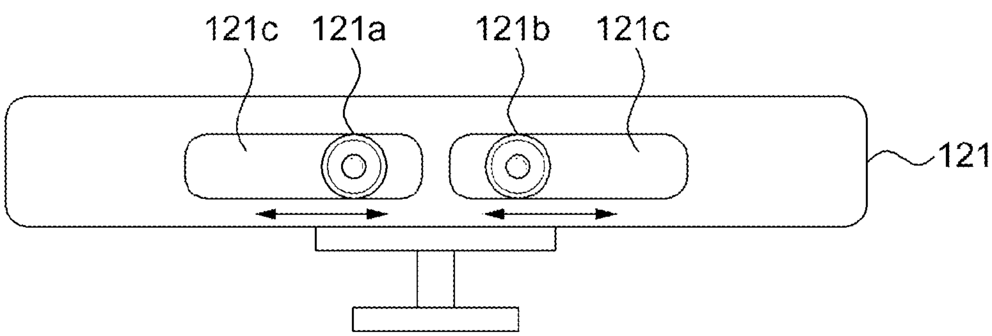


FIG. 8D

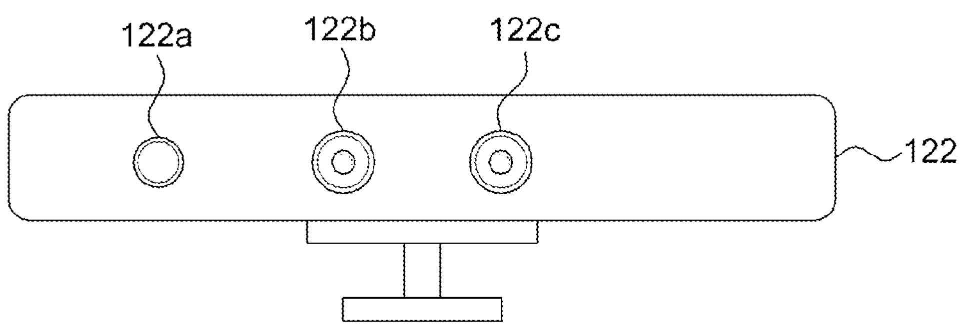
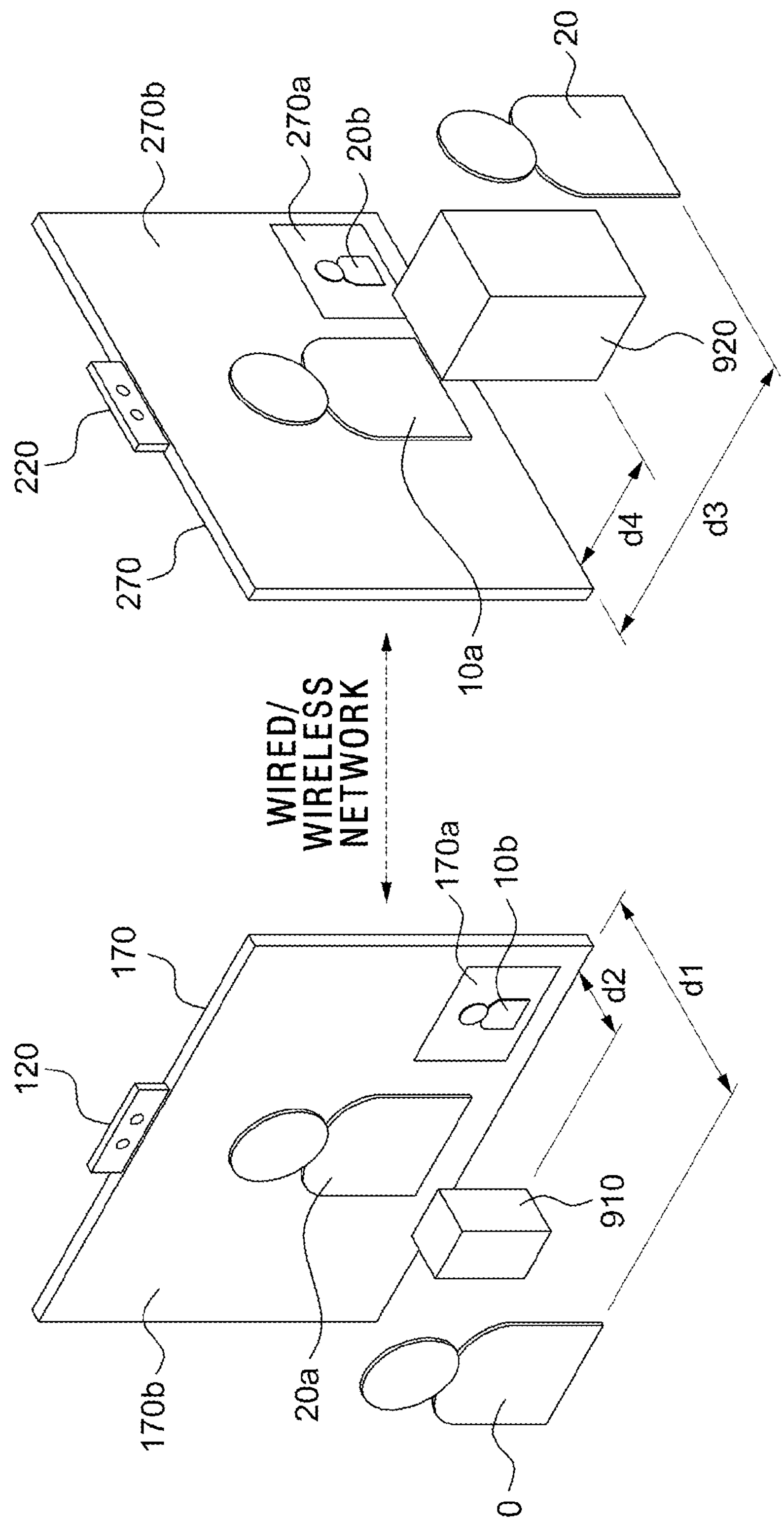


FIG. 9


270b
270a
20b
20
220
270
10a
920
d4
d3
WIRED/
WIRELESS
NETWORK
120
170
170a
10b
d2
d1
910
170b
20a
10

3D VIDEO COMMUNICATION APPARATUS AND METHOD FOR VIDEO PROCESSING OF 3D VIDEO COMMUNICATION APPARATUS

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority from Korean Patent Application No. 10-2010-0109849, filed Nov. 5, 2010, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field

Apparatuses and methods consistent with exemplary embodiments relate to three dimensional (3D) video communication apparatus and method for video processing thereof.

2. Description of the Related Art

A video communication apparatus enables video communication between a talker and a listener using a camera, a microphone or a speaker.

For example, a video communication apparatus with one camera can provide two dimensional (2D) video communication between a talker and a listener. A video communication apparatus using a plurality of cameras can provide 3D video communication using a plurality of videos, for example, left-side videos and right-side videos.

A video communication apparatus generates the sense of depth of a 3D video using captured left-side video and right-side video. The implementation of the 3D video can generally be categorized into glasses type and non-glasses type.

The glasses type generally includes passive type, active type and anaglyph type. The non-glasses type generally includes lenticular type and parallax barrier type.

SUMMARY

Exemplary embodiments may address at least the above problems and/or disadvantages and other disadvantages not described above. Also, exemplary embodiments are not required to overcome the disadvantages described above, and an exemplary embodiment of the present inventive concept may not overcome any of the problems described above.

According to an aspect an exemplary embodiment, there is provided a video communication method of a (3D video communication apparatus connectable to a 3D camera may be provided, which may include acquiring a plurality of 2D images corresponding to a talker using the 3D camera, adjusting a point of convergence of the plurality of 2D images using a preset feature point of the talker, detecting an object located between the talker and the 3D camera using the acquired plurality of 2D images, scaling an original sense of depth of the detected object to a new sense of depth, and generating a 3D talker image including the object with the new sense of depth and transmitting the 3D talker image to a 3D video communication apparatus of a listener.

According to another aspect of an exemplary embodiment, the video communication method may additionally include setting the feature point of the talker, wherein the feature point may include at least one of eyes, nose, lips, ears and eyebrows of the talker.

According to another aspect of an exemplary embodiment, the video communication method may additionally include receiving a 3D listener image from the 3D video communication apparatus of the listener, and displaying the 3D listener image or the 3D talker image on a display unit.

According to another aspect of an exemplary embodiment, the 3D camera may be a stereoscopic camera or a depth camera unit.

According to another aspect of an exemplary embodiment, the video communication method may additionally include computing a distance between the 3D camera and the talker, wherein the distance may be computed using disparity or depth information of the plurality of 2D images.

According to another aspect of an exemplary embodiment, the 3D talker image may be displayed on a reference plane of a display unit of the 3D video communication apparatus of the listener, and an object having the new sense of depth may be displayed on a front side of the reference plane (+z axis direction) distinguishably from the 3D talker image.

According to another aspect of an exemplary embodiment, an object having the new sense of depth is displayed on a reference plane of the display unit of the 3D video communication apparatus of the listener, and the 3D talker image is displayed on a back side of the reference plane (−z axis direction) distinguishably from the object with the adjusted sense of depth.

According to another aspect of an exemplary embodiment, the adjusting may include adjusting by shifting a left-side image and a right-side image acquired from the stereoscopic camera or the depth camera unit using the preset feature point, or rotating at least one of light axes of a left-side camera and a right-side camera of the stereoscopic camera.

According to another aspect of an exemplary embodiment, the scaling may include enlarging or shifting the detected object of a left-side image and the detected object of a right-side image acquired from the stereoscopic camera or the depth camera unit, or adjusting at least one distance from among a light axis of a left-side camera and a light axis of a right-side camera of the stereoscopic camera.

According to another aspect of an exemplary embodiment, the scaling may include enlarging, by adding a predetermined ratio corresponding to a size of the detected object of a left-side image and a size of the detected object of a right-side image acquired at the stereoscopic camera or the depth camera unit, or enlarging the detected object of the left-side image and the detected object of the right-side image to a predetermined size.

According to another aspect of an exemplary embodiment, the 3D camera may be integrally formed in the 3D video communication apparatus.

According to another aspect of an exemplary embodiment, there is provided a video communication method of a 3D video communication apparatus connectable to a 3D camera, which may include acquiring a plurality of 2D images corresponding to a talker using the 3D camera, generating a first 3D talker image by adjusting a point of convergence of the plurality of 2D images using a preset feature point of the talker, detecting an object located between the talker and the 3D camera, scaling an original sense of depth of the detected object to a new sense of depth, transmitting a second 3D talker image containing the object with the new sense of depth to a 3D video communication apparatus of a listener, and receiving a 3D listener image from the 3D video communication apparatus of the listener and displaying a first 3D talker image or the 3D listener image containing the object with the original sense of depth on the display unit.

According to another aspect of an exemplary embodiment, the video communication method may additionally include computing a distance between the 3D camera and the talker.

According to another exemplary embodiment, a video communication method of a 3D video communication apparatus connectable to a 3D camera may be provided, which may include acquiring a plurality of 2D images corresponding to a talker using the 3D camera, adjusting a point of convergence of the plurality of 2D images using a preset feature point of the talker, distinguishing between a first region corresponding to the talker and a second region between the talker and the 3D camera, detecting an object located between the talker and the 3D camera, scaling an original sense of depth of the detected object to a new sense of depth, and generating a 3D talker image including the object with the new sense of depth.

According to another aspect of an exemplary embodiment, the detecting the object between the talker and the 3D camera may include dividing the detected object into separate layers.

According to another aspect of an exemplary embodiment, the video processing method may additionally include transmitting the 3D talker image to a 3D video communication apparatus of a listener, and receiving a 3D listener image from the 3D video communication apparatus of the listener, wherein the received 3D listener image or the 3D talker image is displayed on the display unit.

According to another aspect of an exemplary embodiment, the 3D talker image may be displayed on a reference plane of a display unit of the 3D video communication apparatus and the object with the new sense of depth may be displayed on a front side of the reference plane (+z axis direction) distinguishably from the 3D talker image, or the object with the new sense of depth may be displayed on the reference plane of the display unit, and the 3D talker image may be displayed on a back side of the reference plane (−z axis direction) distinguishably from the object with the new sense of depth.

According to another aspect of an exemplary embodiment, the video processing method may additionally include computing a distance between the 3D camera and the talker.

According to another aspect of an exemplary embodiment, the 3D camera may be a stereoscopic camera or a depth camera unit.

According to another aspect of an exemplary embodiment, there is provided a 3D video communication apparatus including a display unit which displays a 3D image, which may include a storage unit, and a control unit which controls the 3D camera and the storage unit, wherein the control unit adjusts a point of convergence of a plurality of 2D images using a preset feature point of a talker, detects an object located between the talker and the 3D camera, scales an original sense of depth of the detected object to a new sense of depth, and generates a 3D talker image including the object with the new sense of depth from the plurality of 2D images.

According to another aspect of an exemplary embodiment, the 3D video communication apparatus may additionally include a transmitting/receiving unit which transmits the 3D talker image to a 3D video communication apparatus of a listener at video communication with the talker and receives a 3D listener image from the 3D video communication apparatus of the listener, wherein the display unit displays the 3D talker image or the received 3D listener image.

According to another aspect of an exemplary embodiment, the display unit may display a user interface (UI) screen to set a feature point of the talker and the feature point may be inputted using the UI screen.

According to another aspect of an exemplary embodiment, the control unit may compute a distance between the 3D camera and the talker using the plurality of 2D images and detect the object using the computed distance.

According to another aspect of an exemplary embodiment, there is provided a 3D video communication apparatus including a display unit which displays a 3D image, which may include a 3D camera which acquires a plurality of 2D images corresponding to a talker, a storage unit, and a control unit which controls the 3D camera and the storage unit, wherein the control unit adjusts a point of convergence of the plurality of 2D images using the preset feature point of the talker, distinguishes between a first region corresponding to the talker and a second region between the talker and the 3D camera, detects the object in the second region, scales an original sense of depth of the detected object to a new sense of depth, and generates a 3D talker image including the object with the new sense of depth from the plurality of 2D images.

According to another aspect of an exemplary embodiment, the 3D video communication apparatus may additionally include a transmitting/receiving unit which transmits the 3D talker image to a 3D video communication apparatus of a listener at video communication with the talker, and receives a 3D listener image from the 3D video communication apparatus of the listener, wherein the display unit displays the 3D talker image or the 3D listener image.

According to another aspect of an exemplary embodiment, the control unit may compute a distance between the 3D camera and the talker using the plurality of 2D images and detect the object using the computed distance.

According to another aspect of an exemplary embodiment, the 3D talker image may be displayed on a reference plane of a display unit of the 3D video communication apparatus of the talker, and the object with the new sense of depth may be displayed on a front side (+z axis direction) of the reference plane distinguishably from the 3D talker image, or the object with the new sense of depth may be displayed on the reference plane of the display unit and the 3D talker image may be displayed on a back side of the reference plane (−z axis direction) distinguishably from the object with the new sense of depth.

A 3D video communication apparatus, which generates a 3D talker image containing an object with a new sense of depth located between a talker and a 3D camera, and transmits the generated 3D talker image to provide a differentiated 3D video effect to a listener in front of the 3D video communication apparatus of the listener, and a video control method thereof are provided.

A 3D video communication apparatus, which may selectively display first to third 3D talker images generated at a 3D video communication apparatus of a talker, on a display of the 3D video communication apparatus of the talker, and a video control method thereof are provided.

A 3D video communication apparatus, which can selectively transmit second and third 3D talker images generated at a 3D video communication apparatus of a talker, to display on a display unit of a 3D video communication apparatus of a listener, and a video control method thereof are provided.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and/or other aspects will become more apparent by describing certain exemplary embodiments, with reference to the accompanying drawings, in which:

FIG. **1** is a block diagram of a 3D video communication apparatus according to an exemplary embodiment;

FIG. **2** is a flowchart provided to explain a method for controlling video on a 3D video communication apparatus according to an exemplary embodiment;

FIG. **3** is a flowchart provided to explain in detail an operation performed at operation S**230** of FIG. **2** according to an exemplary embodiment;

FIGS. **4**A and **4**B are views illustrating user interface screens of a 3D video communication apparatus according to an exemplary embodiment;

FIG. **5** illustrates a processing method of a stereoscopic camera of a 3D video communication apparatus according to an exemplary embodiment;

FIG. **6** illustrates a processing method of a stereoscopic camera of a 3D video communication apparatus according to an exemplary embodiment;

FIG. **7** illustrates a processing method of a depth camera unit a 3D video communication apparatus according to an exemplary embodiment;

FIGS. **8**A to **8**D illustrates a 3D camera according to an exemplary embodiment; and

FIG. **9** illustrates an example of displaying a result of video processing of a 3D video communication apparatus at a talker side on a 3D video communication apparatus at a listener side, according to an exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Certain exemplary embodiments are described in greater detail below with reference to the accompanying drawings.

In the following description, like drawing reference numerals are used for the like elements, even in different drawings. The matters defined in the description, such as detailed construction and elements, are provided to assist in a comprehensive understanding of exemplary embodiments. However, exemplary embodiments can be carried out without those specifically defined matters. Also, well-known functions or constructions are not described in detail since they would obscure the invention with unnecessary detail.

FIG. **1** is a block diagram of a 3D video communication apparatus or 3D video communication system according to an exemplary embodiment.

Referring to FIG. **1**, the 3D video communication apparatus **100**, **200** according to an exemplary embodiment can connect to a wired or wireless network. The 3D video communication apparatus **100** on the talker's side is connectable to the 3D video communication apparatus **200** over wired/wireless network.

The 3D video communication apparatus encompasses the 3D video communication apparatus **100** on the talker's side and the 3D video communication apparatus **200** on the listener's side.

The 3D video communication apparatus **100** may be connected to at least one computer (not illustrated) including a server, at least one image forming apparatus (not illustrated) and/or at least one portable apparatus (not illustrated) over wired/wireless network.

The image forming apparatus (not illustrated) may include a variety of apparatuses including a copier, a printer, a facsimile, a scanner, or a multi-function peripheral (MFP) that outputs image data. The MFP may have a plurality of functions including copying, printing, scanning, fax transmission, e-mail transmission, or file transmission.

The portable apparatus (not illustrated) may include a mobile phone, a smartphone, a digital camera, an e-book reader, a tablet PC or a portable storage medium such as USB memory or memory card, but not limited thereto.

The external apparatus may include a computer including a server, an image forming apparatus, or a portable apparatus.

The server may include a web server that supports web service or a data server that stores data.

The 3D video communication apparatus **100** may include a control unit **110**, a 3D camera **120**, a distance computing unit **130**, an object detecting unit **135**, a transmission image generating unit **140**, a transmitting/receiving unit **150**, an output image generating unit **160**, a display unit **170**, a storage unit **180**, a microphone **190**, and a speaker **195**.

The control unit **110** may include a CPU (not illustrated), a ROM having recorded thereon a control program, and a RAM (not illustrated) used to memorize input data or used as an operation-related memory area. The CPU, the ROM and the RAM may be interconnected with each other via an internal bus.

The control unit **110** may control the storage unit **180**, the 3D camera **120**, the distance computing unit **130**, the object detecting unit **135**, the display unit **140**, the output image generating unit **150**, the transmission image generating unit **160**, the transmitting/receiving unit **170**, the microphone **190**, and the speaker **195**.

The 3D camera **120** may capture a plurality of first 2D images, including first left-side images **500**, **600**, **700** and first right-side images **505**, **605**, **706**, corresponding to a talker **10** to implement a 3D communication.

The a plurality of captured 2D images **500**, **505**, **600**, **605**, **700**, **705** may refer to one dimensional (1D) and 2D images.

The talker **10** herein may include the talker **10** himself positioned opposite to the 3D camera **120** or the background surrounding the talker **10**. The talker **10** alone, or the background alone without the talker therein, or both the talker **10** and the background may be positioned opposite the 3D camera **120**.

The term "capture" or "acquire" of the 3D camera **120** herein may refer to the same meaning.

The first 2D image captured through the 3D camera **120** may be stored at the storage unit **180** according to the control by the control unit **110**.

The 3D camera **120** may capture a plurality of 2D images successively according to the 3D video communication between the talker **10** and the listener **20**, and the plurality of successively-captured 2D images may be stored at the storage unit **180**.

The 3D camera **120** according to an exemplary embodiment may be positioned on an upper portion of the display unit **170**, or in other places depending on applications.

The 3D camera **120** according to an aspect of an exemplary embodiment is described below with reference to FIGS. **8**A to **8**D.

FIGS. **8**A to **8**D are views illustrating the 3D camera **120** according to an aspect of an exemplary embodiment.

Referring to FIGS. **8**A to **8**D, the 3D camera may be a stereoscopic camera **121** including a left-side camera **121***a* which captures first left-side images **500**, **600** of the talker **10**, and a right-side camera **121***b* which captures first right-side images **505**, **605** of the talker **10**.

The 3D camera may also include a depth camera unit **122** which includes an infrared (IR) sensor **122***a*, a depth camera **122***b* which acquires depth information using a time for an infrared ray emitted from the IR sensor **122***a* to touch and reflect from the talker **10** and be received back, and a camera **122***c* to capture the first 2D image **700** of the talker **10**.

The depth camera unit **122** may detect the shape of the talker **10** using the received reflected light. The depth camera unit **122** may compute a distance from the depth camera unit **122** to the talker **10** using the time of flight (TOF) of the IR light emitted from the IR sensor **122***a* and reflected at the talker **10** and received at the depth camera **122***b*.

The received reflected light may be passed through a filter (not illustrated) or a beam splitter (not illustrated) and sensed at the depth camera **122***b* as the grayscale data which corresponds to the distance to the talker **10**.

The sensed grayscale data may be converted into depth information and stored at the storage unit **180** as the 2D image **705**.

The 2D image **705** corresponding to the depth information appears brighter if it is closer to the depth camera **122***b* or darker if farther from the depth camera **122***b*.

An object positioned between the talker **10** and the depth camera **122***b*, for example, a hand of the talker **10**, a gift box, or the like, may appear brighter than the talker **10**.

The gift box laid on the hand of the talker **10** may appear darker than the talker **10**, if the gift box is behind the talker **10**, that is, for example, between the talker **10** and the background.

The 3D camera **120** refers to a camera which is capable of capturing the first 2D image corresponding to the talker **10**. Any camera other than the stereoscopic camera **121** or the depth camera unit **122** may be implemented as the 3D camera **120** as long as the camera is capable of capturing a plurality of 2D images corresponding to the talker **10**.

The 3D camera **120** may be separately provided and connected to the 3D video communication apparatus **100** via wired/wireless network, or formed as all-in-one unit.

The distance computing unit **130** may compute a distance between the 3D camera **120** and the talker **10** using the first 2D image captured through the 3D camera **120**.

With respect to the stereoscopic camera **121**, the distance computing unit **130** may compute the distance from the stereoscopic camera **121** to the talker **10** using disparity between the first left-side images **500**, **600** captured through the left-side camera **121***a* and the first right-side images **505**, **605** captured through the right-side camera **121***b*.

The distance using disparity between the first left-side images **500**, **600** and the first right-side images **505**, **605** may be computed using a variety of known algorithms.

With respect to the depth camera unit **122**, the distance computing unit **130** may compute distance from the depth camera unit **122** to the talker **10** using TOF of a IR light emitted from the IR sensor **122***a* and reflected and received at the depth camera **122***b*.

The distance computing unit **130** may additionally compute distance to the talker **10** from the 3D camera which captures the first 2D image corresponding to the talker **10**, in addition to computing distance from the stereoscopic camera **121** or the depth camera unit **122** to the talker **10**.

The object detecting unit **135** may distinguish between a first region that corresponds to the talker **10** and a second region **531**, **536**, **631**, **636**, **731**, **736** that includes a predetermined distance between the talker **10** and the 3D camera **120**, and detect an object **541**, **546**, **641**, **646**, **741**, **746** located within the second region **531**, **536**, **631**, **636**, **731**, **736**.

For example, the predetermined distance may be 1 m. The predetermined distance may vary depending on the setting of the 3D video communication apparatus.

The distinguished second region that includes the predetermined distance may refer to the 3D region (corresponding to x, y and z axes) that corresponds to a plurality of 2D images **530**, **535**, **630**, **635**, **730**, **735**.

The distinguished second region may include a plurality of regions, and at least one from among the second regions may be varied depending on the setting of the 3D communication apparatus.

In an exemplary embodiment, the object detecting unit **135** may detect an object **541**, **546** located in the second region at 1 m distance from the talker **10** to the direction of the 3D camera **120**.

With respect to the stereoscopic camera **121**, the object detecting unit **135** may detect the object **541**, **546**, **641**, **646** located in the second area **531**, **536**, **631**, **636** at 1 m distance based on the left-side images **530**, **630** and the right-side images **535**, **635**.

In another exemplary embodiment, layers may be divided from an object which is detected from the corresponding region.

Referring to FIG. **6**, the 3D video communication apparatus **100** may detect an object **641**, **646** located within the second region **631**, **636** from first layers of a plurality of 2D images **640**, **645** with adjusted points of convergence. Further, the 3D video communication apparatus **100** may generate second layers corresponding to the detected object **641**, **646**.

Higher efficiency of video processing may be obtained, by adjusting the sense of depth of the object **642**, **647** that corresponds to the second layers. The embodiment in which separate layers are generated may be appropriately applicable to a rather complex object.

With respect to the depth camera unit **122**, the object detecting unit **135** may detect the object **741**, **746** located in the second region **731**, **736** at 1 m distance between the talker **10** and the depth camera unit **122** of the plurality of 2D images **730**, **735**.

The types and sizes of the objects **541**, **546**, **641**, **646**, **741**, **746** detected at the object detecting unit **135** may vary according to the setting of the 3D video communication apparatus **100**.

If the 3D camera **120** does not detect a plurality of objects, objects of the target may be designated by setting the 3D video communication apparatus **100** accordingly.

The transmission image generating unit **140** may generate second 2D images **520**, **525**, **620**, **625**, **720**, **725** by adjusting point of convergence with respect to the first 2D image or adjust the point of convergence, and generate third 2D images **560**, **565**, **660**, **665**, **760**, **765**, **10***a* by carrying out adjustment of sense of depth.

The second 2D images may correspond to the first 3D talker images. Also, the third 2D images may correspond to the second 3D talker images.

The generated third 3D talker images may be transmitted to the 3D video communication apparatus **200** of the listener **20** via the transmitting/receiving unit **150** of the 3D video communication apparatus **100** of the talker **10**.

The point of convergence may be adjusted as predetermined feature points **511**, **516**, **611**, **616**, **711**, **716** may be detected from the first 2D image, and a plurality of 2D images **510**, **515**, **610**, **615**, **710**, **715** is shifted using the detected feature points **511**, **516**, **611**, **616**, **711**, **716**.

Reference numerals **520**, **525** of FIG. **5**, **620**, **625** of FIG. **6**, and **720**, **725** of FIG. **7** may refer to the second 2D images.

The empty regions **522**, **527**, **622**, **627**, **722**, **727** may appear in black.

The point of convergence adjustment is described below with reference to FIG. **8**B.

Referring to FIG. **8**B, the first left-side images **500**, **600** and the first right-side images **505**, **605** may be captured using a light axis **121***c* of the left-side camera **121***a* and a light axis **121***d* of the right-side camera **121***b* of the stereoscopic camera **121**.

The preset feature points **511**, **516**, **611**, **616** are detected from the first 2D images, and the point of convergence may be adjusted using the detected feature points **511**, **516**, **611**, **616**.

Regarding hardware, a driving unit (not illustrated) may be implemented, which may include a motor (not illustrated) and a gear train (not illustrated) to rotate the light axes corresponding to the left-side camera **121***a* and the right-side camera **121***b*.

The control unit **110** may adjust the point of convergence by rotating at least one of the light axis **121***c* of the left-side camera **121***a* and the light axis **121***d* of the right-side camera **121***b* to a position of new light axes **121***e*, **121***f*. For example, only the light axis **121***c* of the left-side camera **121***a* may be rotated. Further, both the light axis **121***c* of the left-side camera **121***a* and the light axis **121***d* of the right-side camera **121***b* may be rotated together.

The sense of depth of the left-side image of the left-side camera **121***a* and that of the right-side image of the right-side camera **121***b* may be adjusted within an adjustment limit **121***c*(for example, left-side camera **121***a* may be moved to **121***a*', right-side camera may be moved to **121***b*') as movable by the left-side and right-side cameras **121***a*, **121***b*.

If a distance between the left-side and right-side cameras **121***a*, **121***b* increases, the disparity increases accordingly. If the distance between the left-side and right-side cameras **121***a*, **121***b* decreases, the disparity decreases accordingly.

Referring back to FIG. **1**, the second 2D image may be stored at the storage unit **180** according to the control of the control unit **110**.

In another exemplary embodiment, the transmission image generating unit **140** may generate the second 2D image and the generated second 2D image may be the first 3D talker image displayed on the display unit **170** of the 3D video communication apparatus **100**.

The transmission image generating unit **140** may adjust the original sense of depth of the object **541**, **546**, **641**, **646**, **741**, **746** detected by the object detecting unit **135** with a new sense of depth.

Regarding the adjustment the sense of depth, the transmission image generating unit **140** may enlarge the detected object **541**, **546**, **641**, **646**, **741**, **746** to a new size or shift the detected object **541**, **546**, **641**, **646**, **741**, **746**.

Accordingly, the objects **541**, **546**, **641**, **646**, **741**, **746** included in the plurality of 2D images may be enlarged or shifted in at least one direction, as for example, in direction of +x axis, −x axis, +y axis, −y axis with respect to the center of the objects.

In yet another exemplary embodiment, if layers are divided, the transmission image generating unit **140** may maintain the original sense of depth with respect to a plurality of 2D images **640**, **645** corresponding to the first layers, and adjust to the new sense of depth regarding the objects **642**, **647** corresponding to the second layers. The detected objects **641**, **646** may be increased to a new size or shifted.

The adjustment of the sense of depth is described below with reference to FIGS. **8**B and **8**C.

Referring to FIG. **8**C, in the stereoscopic camera **121**, interocular distance (ID) between the left-side camera **121***a* and the right-side camera **121***b* may be adjusted according to the control of the control unit **110**. Accordingly, the sense of depth of the left-side image of the left-side camera **121***a* and the right-side image of the right-side camera **121***b* may be adjusted within an adjustment limit **121***c* as movable by the left-side camera **121***a* and the right-side camera **121***b*.

A driving unit (not illustrated) may be implemented, which may include a motor (not illustrated) and a gear train (not illustrated) to adjust a distance between the left-side and right-side cameras **121***a*, **121***b*.

If a distance between the left-side and right-side cameras **121***a*, **121***b* increases, the disparity increases accordingly. If the distance between the left-side and right-side cameras **121***a*, **121***b* decreases, the disparity decreases accordingly.

Regarding the depth camera unit **122**, the transmission image generating unit **140** may carry out adjustment of point of convergence and sense of feeling **760**, **765** using a plurality of 2D images **700**, **706** in a similar manner as implemented in the example of the stereoscopic camera **121**.

The third 2D image may be stored at the storage unit **180** according to the control of the control unit **110**.

The stored third 2D image may be transmitted to the 3D video communication apparatus **200** via the transmitting/receiving unit **150**.

The 3D video communication apparatus **200** of the listener **20** may generate an output image **10***a*, **20***a* at the output image generating unit **260** based on the received second 3D talker image and the 3D talker image which is generated by capturing at the 3D camera **220**, and display the output image on the display unit **270**.

The transmission image generating unit **140** may generate a third 3D talker image by using the second 3D talker image, and transmit the generated third 3D talker image to the transmitting/receiving unit **250** of the 3D video communication apparatus **200** via the transmitting/receiving unit **150**. The generated third 3D talker image **10***a* may be stored at the storage unit **180** according to the control of the control unit **110**.

The third 3D talker image may confirm to the specification (e.g., size, resolution, contrast ratio of the display unit **270**) as supported by the 3D video communication apparatus **200** of the listener **20** using wired/wireless network.

The third 3D talker image may be generated in accordance with the confirmed specification of the 3D video communication apparatus **200** of the listener **20**.

The output image generating unit **260** of the 3D video communication apparatus **200** of the listener **20** may directly display the received third 3D talker image differently from the current format on the display unit **270** (e.g., the output image may be generated as a plurality of 2D output images).

The output image generating unit **260** may generate output image of the second 3D talker image using the current format, while the third 3D talker image may be displayed directly on the display unit **170**, **270** as the output image **10***a*.

The second and third 3D talker images generated at the output image generating unit **160** may be displayed on the reference plane of the display unit **270** of the 3D video communication apparatus, and the object **920** with a new sense of depth may be displayed distinguishably from the reference plane in a direction of the listener **20** (i.e., +z axis direction) with respect to the reference plane of the front-display unit **270**.

The output image generating unit **260** may display the object **920** having a new sense of depth on the reference plane of the display unit **270** of the 3D video communication apparatus **200** of the listener **20**, while displaying the 3D talker image distinguishably from the reference plane in a direction opposite to the listener **20** (i.e., −z axis direction) with respect to the reference plane of the back-display unit **270**.

Depending on the setting of the 3D video communication apparatus, the transmitting/receiving unit **150** may selectively transmit the stored second or third 3D talker image or voice to the transmitting/receiving unit **250** of the 3D video communication apparatus **200** of the listener **20** using wired/wireless network.

The transmitting/receiving unit **150** may encode the second or third 3D talker image or voice into a transmission format corresponding to the wired/wireless network before transmitting the same.

Depending on the setting of the 3D communication apparatus, the transmitting/receiving unit **150** may transmit the stored second or third 3D talker image or voice to the transmitting/receiving unit of a plurality of 3D video communication apparatuses of the listeners. Accordingly, one talker may communicate with a plurality of listeners by a 3D video communication.

Depending on the setting of the 3D video communication apparatus **200** of the listener **20**, the transmitting/receiving unit **150** may receive second and third 3D listener image and voice corresponding to the second and third 3D talker image. The transmitting/receiving unit **150** may decode the encoded second or third 3D talker image or voice in the transmission format corresponding to the wired/wireless network into the second or third 3D talker image or voice.

The decoded second or third 3D talker image or voice may be stored at the storage unit **180**.

The transmitting/receiving unit **150** may transmit the first 3D image stored at the storage unit **180**, or the generated first to third 3D talker images to an external apparatus using wired/wireless network according to the control of the control unit **110**. The received second and third 3D listener image may also be transmitted to the external apparatus.

If the first 2D image or the generated first to third 3D talker images are transmitted to a computer or portable apparatus that includes server, the transmitted images may be stored at the storage unit of the computer or the portable apparatus, and displayed on the display unit.

The first 2D image or the generated first to third 3D talker images may be edited using 2D or 3D editing program of the computer or portable apparatus that includes server.

Further, if the first 2D image, or the generated first and second 3D talker images, or the received first and second 3D listener images are transmitted to an image forming apparatus, the transmitted images may be printed out on a recording medium supported by the image forming apparatus.

The output image generating unit **160** may generate output images **10***a*, **20***a* to be displayed on the display unit **170**. The output images **10***a*, **20***a* may include the first to third 3D talker images generated at the transmission image generating unit **140** or the second or third 3D listener image received at the transmitting/receiving unit **150**.

The output image generating unit **160** may display the second or third 3D talker image and the received second or third 3D listener image as the output images **10***a*, **20***a* on the display unit **170**, in accordance with the size of the display unit **170**, size (horizontal×vertical) of the talker display region **170***a* and size (horizontal×vertical) of the listener display region **170***b* of the display unit **170**, and the position of display.

Depending on the setting of the 3D video communication apparatus, the output image generating unit **160** may generate a new output image **10***a* or **20***a* in accordance with the size and position of display of the display unit **170**, or the size of the talker display region **170***a* and position of display.

The output image generating unit **160** may cause the third 3D talker image and the third 3D listener image stored at the storage unit **180** to be displayed on the display unit **170** as an output image. The output image may be converted to conform to the size of the display unit **170**, the size of the talker display region **170***a* or listener display region **170***b*, and the position of display.

In another exemplary embodiment, the output image generating unit **160** may generate an output image **10***b* by using the second 2D image (i.e., first 3D talker image) and display the generated image on the talker display region **170***a* of the display unit **170**.

The output image **20***b* corresponding to the second and third 3D listener images may be displayed on the listener display region **170***b*.

The output image generating unit **160** may generate a 3D image **10***a*, **20***a* that corresponds to the glasses type or non-glasses type as supported by the 3D video communication apparatus **100**.

In an exemplary embodiment, the transmission image generating unit **140** and the output image generating unit **160** may be implemented as one single image generating unit (not illustrated). The image generating unit (not illustrated) may generate first to third 3D talker images. The generated first to third 3D talker images or received second and third 3D listener images may be generated as the output images **10***a*, **10***b* or output image **20***a* to be displayed on the display unit **170**.

The display unit **170** may display at least one of the talker display region **170***a* and the listener display region **170***b*. For example, the display unit **170** may display only the talker display region **170***a*, or only the listener display region **170***b*, or both the talker and listener display regions **170***a*, **170***b*.

The size, such as the size ratio %, and the position, such as upper, lower, left, right direction, of the talker or listener display region **170***a*, **170***b* displayed on the display unit **170** may be set using 3D video communication item **420** on a menu **410** of the 3D video communication apparatus **100**.

The display unit **170** may display 3D images **10***a*, **10***b*, **20***a* corresponding to the glasses or non-glasses type as supported by the 3D video communication apparatus **100**.

The setting may be applied using remote controller (not illustrated) or if the display unit **170** is implemented as a touch screen, using touch input.

The storage unit **180** may store first to third 2D images according to the control of the control unit **110**. Further, the storage unit **180** may store the first to third 3D talker images which are generated at the transmission image generating unit **140**.

The storage unit **180** may store the output images **10***a*, **10***b*, **20***a* displayed on the display unit **170** of the 3D video communication apparatus **100**.

The storage unit **180** may be integrated with the 3D video communication apparatus **100** or provided separately. Further, the storage unit **180** may include a nonvolatile memory, a volatile memory, a HDD or solid state drive (SSD).

The storage unit or storage unit **180** may include ROM (not illustrated) or RAM (not illustrated) built in the storage unit **180** or the control unit **110**.

The microphone **190** receives voice of the talker **10** or voice from the background.

The 3D video communication apparatus **100** may include at least one microphone **190** and the direction of the microphone **190** may change in accordance with the location of the talker **10** who is moving.

The speaker **195** may output the voice of the talker **10** or the voice of the listener **20** in sync with the output images **10***a*, **20***a*, **20***b* displayed on the display unit **270**. The 3D video communication apparatus **100** may include at least one speaker **195** and provide the talker **10** with various 3D sound according to the number or positions of the speakers **195**.

If the 3D video communication apparatus **200** of the listener **20** displays the object **920** of the output image **10***a* having adjusted sense of depth, the speaker **295** may provide the corresponding audio such as music, thunder, or honking which is distinguished from the voice of the talker **10**.

At least one of the 3D camera **120** and the display unit **170** may be separately provided from the 3D video communication apparatus **100**, and the separate 3D camera **120** or the display unit **170** may be connected to the 3D video communication apparatus **100** by wired/wireless network.

If at least one of the 3D camera **120** and the display unit **170** is separately provided, the 3D video communication apparatus **100** may include the control unit **110**, the storage unit **180**, the distance computing unit **130**, the object detecting unit **135**, the transmission image generating unit **140**, the transmitting/receiving unit **150**, the output image generating unit **160**, the microphone **290**, and the speaker **295**.

The 3D video communication apparatus **200** may include the control unit **210**, the 3D camera **220**, the distance computing unit **230**, the object detecting unit **235**, the transmission image generating unit **240**, the transmitting/receiving unit **250**, the output image generating unit **260**, the display unit **270**, the storage unit **280**, the microphone **290** and the speaker **295**.

The functions and structures of the components **210** to **295** of the 3D video communication apparatus **200** are similar to those of the components **110** to **195** of the 3D video communication apparatus **100** of the talker **10**.

The 3D camera **220** of the 3D video communication apparatus **200** may capture a plurality of 2D images corresponding to the listener **20**. The distance computing unit **230** may compute a distance from the 3D camera **220** to the listener **20** based on the plurality of captured 2D images.

Further, the 3D video communication apparatus **200** may detect an object located between the listener **20** and the 3D camera **220** by the object detecting unit **235** using the computed distance.

The 3D video communication apparatus **200** may adjust the point of convergence and sense of depth of the detected object and generate first to third 3D listener images at the output image generating unit **260**.

Further, the 3D video communication apparatus **200** may receive the voice of the listener **20** or the sound from the background through the microphone **290**.

The transmitting/receiving unit **250** may transmit the generated second or third 3D listener image or the voice of the listener to the 3D video communication apparatus **100** of the talker **10**. Further, the transmitting/receiving unit **250** may receive the second or third 3D talker image or the voice of the talker **10** from the 3D video communication apparatus **100** of the talker **10**.

The second or third 3D talker image or the voice of the talker **10** received from the 3D video communication apparatus **100** of the talker **10** may be stored at the storage unit **280**.

The output image generating unit **260** may generate the received second 3D talker image into an output image and display the generated output image on the display unit **270**. Further, the second 3D talker image may directly displayed on the display unit **270**.

The output image generating unit **260** may generate the first to third 3D listener images into an output image and display the generated output image on the display unit **270**. That is, The display unit **270** may display at least one of the talker display region **270***a* and the listener display region **270***b*. For example, the display unit **270** may display only the talker display region **270***a*, or only the listener display region **270***b*, or both the talker and listener display regions **270***a*, **270***b*.

If the second or third 3D talker image including an object with adjusted sense of depth is displayed on the display unit **270**, the 3D audio effect distinguished from the listener **20** may be provided.

The speaker **295** may output the voice of the talker **10** or the listener **20** in sync with the output image **10***a*, **20***a*, **20***b* displayed on the display unit **270**.

FIG. **2** is a flowchart provided to explain a video control method of a 3D video communication apparatus according to an exemplary embodiment.

At operation S**210**, the 3D video communication apparatus logs on to a 3D video communication service in accordance with the intention of the talker **10**.

The talker **10** may log into the 3D video communication service by inputting his ID and password on a login screen displayed on the display unit **170**.

The 3D video communication apparatus may provide the talker **10** with a user interface screen corresponding to the video communication service through the display unit **170**.

When successfully completing login, the talker **10** may setup a setting for 3D video communication using the user interface screen (not illustrated) corresponding to the video communication service displayed on the display unit **170**.

At operation S**220**, the 3D video communication apparatus sets the feature points of the talker **10**.

FIGS. **4**A and **4**B are views illustrating an example of the user interface screen for setting the 3D video communication apparatus according to an aspect of an exemplary embodiment.

Referring to FIG. **4**A, the display unit **170** of the 3D video communication apparatus **100** may display a menu **410** for the setting.

The menu **410** may include items such as image, audio, 3D video communication, or additional functions, and may display the additional items of the menu **410** in response to selection on a direction key **410***a*.

The items on the menu **410** may vary depending on the functions supported by the 3D video communication apparatus **100**.

If the 3D video communication **420** is selected from the menu **410**, a surprise function menu **430** is displayed, and a setting feature point screen **440** is displayed. An additional item of 2D video communication **420** may be added by selecting the direction key **430***a*.

At least one of the targets for the feature points, i.e., at least one of the eyes, nose, lips, ears and eyebrows may be selected on the displayed setting feature point screen **440**. For example, only the eyes, or both the eyes and nose, or all of the eyes, nose, lips, ears and eyebrows may be selected.

However, the type and number of the feature points are not limited to the eyes, nose, lips, ears or eyebrows. Accordingly, any feature point that can be set at the 3D video communication apparatus is applicable.

The selected feature point may be displayed on a preview **450***a* on a preview region **450** for observation by the talker **10**.

By using the feature point setting **440**, it is possible to adjust the point of convergence regarding the first 2D image which is captured through the 3D camera **120**.

If the direction key **440***a* is selected from the displayed setting feature point screen **440**, a screen for a sense of depth setting **460** may be displayed.

The target of the sense of depth setting screen **460** may be at least one object **910** located between the talker **10** and the 3D camera **120**.

In an exemplary embodiment, the talker **10** or the listener **20** may provide distinguishable 3D video effect by the object **920** which is displayed on the display unit **170**, **270** with a new sense of depth.

The selectable items on the sense of depth setting screen **460** may include Auto, High (80%), Middle (50%), Low (30%) or Max.

For Auto, the sense of depth may be set using at least one of the distance between the object **910** and the 3D camera **120**, and the size of the object **910**.

The values 80%, 50%, 30% set for High, Middle and Low may be set with reference to the maximum sense of depth (e.g., Max supported by the 3D video communication apparatus **100**) and may vary depending on setting.

Max may be set at the maximum sense of depth as supported by the 3D video communication apparatus **100** and may vary depending on setting.

The selected sense of depth may be displayed on the preview region **450** illustrating the original sense of depth **450***b* of the object **910** and the new sense of depth **450***c* of the object **910** before and after the adjustment of the sense of depth.

The talker **10** may view the preview region **450** and add changes as necessary.

Referring to FIG. **2**, at operation S**230**, the talker **10** connects to the counterpart of the video communication, i.e., to the listener **20** for the 3D video communication using the 3D video communication apparatus **100**.

The talker **10** may select at least one listener **20** from a phonebook displayed on the display unit **170**.

The talker may also attempt the 3D video communication with the listener **20** by directly inputting a telephone number using a telephone key displayed on the display unit **170** by, for example, inputting a telephone number through a remote controller (not illustrated) or touching the telephone number on the display unit **170** if the display unit **170** has a touchscreen.

The talker **10** may have 3D video communication with a plurality of listeners **20**.

The talker **10** may connect to a plurality of listeners **20** for 3D video communication by selecting the listeners, based on a phonebook selection or directly inputting telephone numbers on the display unit **170**.

During the 3D video communication with one listener **20**, the talker **10** may attempt 3D video communication with a second listener by selecting the second listener in the phonebook or directly inputting telephone number on the display unit **170**.

If the talker **10** is connected to a plurality of listeners **20**, the output images corresponding to the talker **10** or the plurality of listeners **20** may appear on the display unit **170**.

If the video communication is connected between the talker **10** and the listener **20**, the 3D video communication begins.

Referring to FIG. **2**, at operation S**240**, the transmission image generating unit **140** may adjust a point of convergence with respect to the first 2D image which is captured through the 3D camera **120**.

The transmission image generating unit **140** may adjust a new sense of depth with respect to an object detected by the object detecting unit **135**.

The operation S**240** of FIG. **2** is described in greater detail below with reference to the flowchart of FIG. **3**.

FIG. **3** is a flowchart illustrating in detail the process performed at operation S**240** of FIG. **2** according to an aspect of an exemplary embodiment.

The operations S**241** to S**246** of FIG. **3** are described below with reference to FIGS. **5** to **7**.

FIGS. **5** to **7** are views illustrating a video processing method of a stereoscopic camera and a depth camera unit of a 3D video communication apparatus according to an aspect of an exemplary embodiment.

Referring to FIG. **5**, the left-side images **500** to **560** and the right-side images **505** to **565** of the stereoscopic camera **121** are illustrated. The images **510**, **520**, **530**, **540**, **550**, and **560** correspond to the first left-side image **500**. The images **515**, **525**, **535**, **545**, **555**, and **565** correspond to the first right-side image **505**. The images are divided into left-side and right-side images in order to explain the process of FIG. **5**.

The same may apply to the first 2D images **600**, **605** of FIG. **6** and the first 2D images **700**, **706** of FIG. **7**.

Referring to FIG. **3**, at operation S**241**, the 3D video communication apparatus captures first 2D image using the 3D camera **120**.

For the stereoscopic camera **121**, the first 2D image may include the first left-side image **500**, **600** of the left-side camera **121***a* and the first right-side image **505**, **605** of the right-side camera **121***b* each corresponding to the talker **10**.

For the depth camera unit **122**, the first 2D image may include a left-side image **700** corresponding to the camera **122***c* which captures the talker **10** and a right-side image **706** corresponding to an imaginary 2D image **705** which is generated using the left-side image **700** and depth information acquired from the depth camera **122***b*.

The 3D camera **120** may successively capture a plurality of the first 2D images for the 3D video communication.

At operation S**242** of FIG. **3**, a distance from the 3D camera **120** to the talker **10** is computed using the 3D video communication apparatus.

With respect to the stereoscopic camera **121**, the distance computing unit **130** may compute the distance from the stereoscopic camera **121** to the talker **10** using disparity between the first left-side images **500**, **600** and the first right-side images **505**, **605**, by using the preset feature points **511**, **516**, **611**, **616** of the talker **10**.

The distance using disparity between the left-side images and the right-side images may be computed using a variety of known algorithms.

With respect to the depth camera unit **122**, the distance computing unit **130** may compute distance from the depth camera **122***b* to the talker **10** using TOF of an IR light emitted from the IR sensor **122***a* and reflected and received at the depth camera **122***b*.

The computed distance from the depth camera **122***b* to the talker **10** may be stored at the storage unit **180** as a separate lookup table. For example, the talker **10** may be recorded as being distanced from the depth camera unit **122** by 2 m and the object may be recorded as being distanced from the depth camera unit **122** by 1.5 m.

At operation S**243** of FIG. **3**, the 3D video communication apparatus adjusts point of convergence using the first 2D image corresponding to the talker **10**.

With respect to the stereoscopic camera **121**, for the adjustment of a point of convergence, the preset feature points **511**, **516**, **611**, **616** may be detected from the left-side images **510**, **610** and the right-side images **515**, **615**, and at least one of the left-side images **510**, **610** and the right-side images **515**, **615** may be shifted using the detected feature points **511**, **516**, **611**, **616** to thus adjust the points of convergence. The direction of shift may include at least one of upward, downward, rightward and leftward directions.

If the left-side images **510**, **610** and the right-side images **515**, **615** are shifted, empty areas **522**, **527** may appear in black.

With respect to the depth camera unit **122**, similarly to the stereoscopic camera **121**, for the adjustment of point of convergence, the preset features **711**, **716** may be detected from the left-side image **710** and the right-side image **715**, and at least one of the left-side and right-side images **710**, **715** is shifted using the detected feature point **711**, **716** to thus adjust the point of convergence **721**, **726**.

If the left-side and right-side images **710**, **716** are shifted, empty areas **722**, **727** may appear in black.

The adjustment of point of convergence is described below with reference to FIG. **8**B.

Referring to FIG. **8**B, the first left-side and right-side images **500**, **505** may be captured using light axes **121***c*, **121***d* of the left-side and right-side cameras **121***a*, **121***b* of the stereoscopic camera **121**, respectively.

The feature points **511**, **611** of the left-side images **510**, **610** and the feature points **516**, **616** of the right-side images **515**, **615** may be detected and the point of convergence may be adjusted in hardware manner using the detected feature points **511**, **516**, **611**, **616**.

Regarding hardware, a driving unit (not illustrated) may be implemented, which may include a motor (not illustrated) and a gear train (not illustrated) to shift the light axes corresponding to the left-side camera **121***a* and the right-side camera **121***b*.

For the adjustment of a point of convergence, the control unit **110** may adjust the light axes **121***c*, **121***d* to new light axes **121***e*, **121***f* according to an angle determined for adjustment of the point of convergence.

At operation S**244** of FIG. **3**, the 3D video communication apparatus distinguishes between the distance from the talker **10** to the 3D camera **120**, and a region of a predetermined distance, respectively.

The object detecting unit **135** may distinguish between a first region corresponding to the talker **10** and a second region **531**, **536**, **631**, **636**, **731**, **736** including the predetermined distance from the talker **10** to the direction of the 3D camera **120**, respectively.

The predetermined distance may be 1 m, for example. Further, the predetermined distance may vary depending on the setting of the 3D video communication apparatus.

The second region that includes the predetermined distance may be a 3D region (corresponding to x, y and z axes) included into a plurality of 2D images **530**, **535**, **630**, **635**, **730**, **735**.

The distinguished second region may include a plurality of second regions, and may vary depending on the setting of the 3D video communication apparatus **100**.

The operation S**244** to distinguish the areas of the stereoscopic camera **121** and the depth camera unit **122** may be substantially similar to each other.

At operation S**245** of FIG. **3**, the 3D video communication apparatus detects an object located at a distance between the talker **10** and the 3D camera **120**.

By using the object detecting unit **135**, it is possible to detect the objects **541**, **546**, **641**, **646**, **741**, **746** included in the second regions **531**, **536**, **631**, **636**, **731**, **736**.

The type, size or number of objects which may be detected by using the object detecting unit **135** is not limited.

A plurality of objects may be detected in the distinguished second regions **531**, **536**, **631**, **636**, **731**, **736** and the target object for detection may be designated by setting the 3D video communication apparatus accordingly.

The operation S**235** to detect the object by the stereoscopic camera **121** and by the depth camera unit **122** may be substantially similar to each other.

In another exemplary embodiment, the 3D video communication apparatus may divide layers with respect to the object detected in the distinguished region.

Referring to FIG. **6**, the 3D video communication apparatus **100** may detect the objects **641**, **646** located within the second regions **631**, **636**. The 3D video communication apparatus **100** may generate second layers **642**, **647** corresponding to the detected objects **641**, **646**.

By adjusting a sense of depth of the objects **642**, **647** corresponding to the second layers, a higher efficiency of video processing may be obtained. As explained above, an embodiment of generating a separate layer may be suitable for an example of a rather complex object.

At operation S**246** of FIG. **3**, the 3D video communication apparatus adjusts the original sense of depth of the objects **541**, **546**, **641**, **646**, **741**, **746** to new senses of depth.

Regarding the adjustment of the sense of depth, the transmission image generating unit **140** may shift or enlarge the detected objects **541**, **546**, **641**, **646**, **741**, **746** to new sizes.

The objects **551**, **556**, **651**, **656**, **751**, **756** included in the left-side and right-side images **550**, **650**, **750**, and **555**, **655**, **755** may be enlarged in at least one direction (e.g., +x, −x, +y, −y axes with respect to the object), or shifted in at least one direction.

A third 2D image **560**, **565**, **660**, **665**, **760**, **765** may be generated when the adjustment of the sense of depth is completed.

The third 2D left-side and right-side images **560**, **660**, **750** and **565**, **665**, **765** with the adjusted sense of depth may be generated by overwriting with the result of the new sense of depth adjustment regarding the first 2D left-side and right-side images **500**, **600**, **700** and **505**, **605**, **705** captured through the 3D camera **120** or saving the result of the new sense of depth adjustment with new names.

The difference of the adjustment of the sense of depth may be confirmed by comparing the object of the third 2D image with the object of the second 2D image.

The difference of the adjustment of the sense of depth provides the listener **20** at video communication using the 3D video communication apparatus **200** with a differentiated 3D video effect.

Hardware is described below with reference to FIGS. **8**B and **8**C.

Referring to FIGS. **8**B and **8**C, for the stereoscopic camera **121**, interocular distance (ID) between the left-side camera **121***a* and the right-side camera **121***b* may be adjusted according to the control of the control unit **110**.

The sense of depth of the left-side image of the left-side camera **121***a* and that of the right-side image of the right-side camera **121***b* may be adjusted within an adjustment limit **121***c* as movable by the left-side and right-side cameras **121***a*, **121***b*.

Regarding hardware, a driving unit (not illustrated) may be implemented, which may include a motor (not illustrated) and a gear train (not illustrated) to adjust the distance between the left-side camera **121***a* and the right-side camera **121***b*.

If a distance between the left-side and right-side cameras **121***a*, **121***b* increases, the disparity increases accordingly. If the distance between the left-side and right-side cameras **121***a*, **121***b* decreases, the disparity decreases accordingly.

In other exemplary embodiments, the transmission image generating unit **140** maintains the original sense of depth for the first layers, and adjusts to a new sense of depth regarding objects **642**, **647** corresponding to the second layers.

Adjustment of the sense of depth may include shifting or enlarging of the detected objects **641**, **646**.

The operation S**250** of FIG. **2** proceeds when the operation S**236** to adjust the sense of depth is competed.

Accordingly, at operation S**250** of FIG. **2**, the 3D video communication apparatus generates a 3D transmission image.

The second or third 3D talker image may be transmitted to the 3D video communication apparatus **200** of the listener **20** via the transmitting/receiving unit **150**.

The third 3D talker image **10***a* may be directly displayed on the display unit **270** of the 3D video communication apparatus **200** of the listener **20**.

At operation S**260** of FIG. **2**, the 3D video communication apparatus transmits the 3D talker transmission image and receives 3D listener image.

Depending on a setting of the 3D video communication apparatus, the second or third 3D talker image and voice of the talker **10** may be converted into a transmission format corresponding to wired/wireless network and selectively transmitted to the transmitting/receiving unit **250** of the 3D video communication apparatus **200** of the listener **20**.

Depending on a setting of the 3D video communication apparatus, the transmitting/receiving unit **150** may receive from the transmitting/receiving unit **250** of the 3D video communication apparatus **200** of the listener **20** the second 3D listener image (not illustrated) corresponding to the second 3D talker image or the third 3D listener image **20***a* corresponding to the third 3D talker image, and the voice of the listener **20**.

The transmitting/receiving unit **150** may decode the second or third 3D talker image or voice, which was converted into a transmission format corresponding to the wired/wireless network, into second or third 3D listener image or voice.

The decoded second or third 3D talker image or voice may be stored at the storage unit **180**.

The transmitting/receiving unit **150** may transmit the first 2D image stored at the storage unit **180** or generated first to third 3D talker images to an external apparatus (not illustrated) using wired/wireless network.

The received second 3D listener image (not illustrated) or the third 3D listener image **20***a*, and the voice of the listener **20** may be stored at the storage unit **180** according to the control of the control unit **110**.

At operation S**270** of FIG. **2**, the 3D video communication apparatus may generate an output image and display it on the display unit **170**.

The output image generating unit **160** may generate output images **10***a*, **10***b*, **20***a* to be displayed on the display unit **170**.

The output images **10***a*, **10***b*, **20***a* may include the first and third 3D talker images generated at the transmission image generating unit **140** or the second and third 3D listener images received at the transmitting/receiving unit **150**.

Depending on a setting of the 3D video communication apparatus, the output image generating unit **160** may display the first and second 3D talker images and the received first and second 3D listener images as the output images **10***a*, **20***a* in accordance with the size of the display unit **170**, size (horizontal×vertical) and location of the talker display region **170***a* and size (horizontal×vertical) and location of the listener display region **170***b* of the display unit **170**.

Since the second 3D talker image or the second 3D listener image has already been generated as the output image, the above image may be displayed on the display unit **170** in accordance with the size of the display unit **170**, size (horizontal×vertical) and location of the talker display region **170***a* and size (horizontal×vertical) and location of the listener display region.

In another exemplary embodiment, the output image generating unit **160** may generate the output image **10***b* using the second 2D image (i.e., first 3D talker image) and display the generated image **10***b* on the listener display region **170***a*.

At operation S**280** of FIG. **2**, the 3D video communication apparatus determines if the video communication is finished.

Determining if the video communication of the 3D video communication apparatuses **100**, **200** is finished may be performed by receiving an input corresponding to ending of video communication by the talker **10** or the listener **20**. Alternatively, whether the video communication is finished may be determined based on a disconnection state of wired/wireless network between the 3D video communication apparatus **100** of the talker **10** and the 3D video communication apparatus **200** of the listener **20**.

If the 3D video communication apparatuses **100**, **200** receive an input corresponding to an ending of the video communication from the talker **10** or the listener **20**, the 3D video communication apparatuses **100**, **200** may notify the same to the counterpart 3D video communication apparatuses **100**, **200**.

If the video communication is not finished, the operation proceeds to operation S**240** to continue video communication. If the video communication is finished, the process proceeds to operation S**290**.

At operation S**290** of FIG. **2**, the 3D video communication apparatus logs out from the video communication service.

The 3D video communication apparatus **100** receives a talker's logout input regarding the video communication service and accordingly logs out and finishes the operation.

FIG. **9** illustrates an example of displaying the result of video processing at the 3D video communication apparatus of the talker **10** on the 3D video communication apparatus of the listener **20**, according to an exemplary embodiment.

Referring to FIG. **9**, the 3D video communication apparatus **100** for 3D video communication may capture the first 2D image of the talker **10** using the 3D camera **120**.

Using the captured first 2D image, the 3D video communication apparatus **100** of the talker **10** may carry out a video processing including adjustment of point of convergence or sense of depth regarding an object **910** located (at a distance (d**1**-d**2**) between the talker **10** and the 3D camera **120**.

Although the display unit **170** shows the listener display region **170***b* larger than the talker display region **170***a*, the size or the location of the talker or listener display region **170***a*, **170***b* may vary depending on setting.

The transmitting/receiving unit **150** of the 3D video communication apparatus **100** of the talker **10** transmits the second or third 3D talker image to the transmitting/receiving unit **250** of the 3D video communication apparatus **200** using the wired/wireless network, and the 3D video communication apparatus of the listener **20** may store the received second and third 3D talker images at the storage unit **280**.

The 3D video communication apparatus **200** of the listener **20** may display the output image **10***a* generated using the second 3D talker image or the third 3D talker image **10***a*.

In the output image **10***a* displayed on the display unit **270**, the object **920** with the adjusted sense of depth may provide the feeling as if the object **920** is located before the listener **20** at a distance (d**3**-d**4**) between the listener **20** and the 3D camera **220**.

In the 3D video communication apparatus **200** of the listener, the distance (d**4**) between the 3D camera **220** and the object **920** is generated by the adjustment of the depth of the 3D video communication apparatus **100** of the talker **10**.

The distance (d**3**-d**4**) between the object **920** and the listener **20** is decreased to be narrower than the distance (d**1**-d**2**) between the object **910** and the talker **10**, and thus it may be felt as if the object is closer to the listener **20**.

The listener **20** may feel strong differentiated 3D video effect due to the object **920** with the new sense of depth (d**4**) displayed on the display unit **270** of the 3D video communication apparatus **200** of the listener **20**.

The 3D video communication apparatus **200** of the listener **20** may compute a distance (d**3**) between the listener **20** and the 3D camera **220**. The distance (d**3**) between the listener **20** and the 3D camera **220** may be substantially identical to or smaller than the distance (d**4**) between the object **920** with the adjusted sense of depth and the 3D camera **220**.

In the above example, the 3D video communication apparatus **200** of the listener **20** may notify the listener **20** to increase the distance (d**3**) to the 3D camera **220** through the display unit **270** or the speaker **295**.

Further, the output image **10***a* may be displayed on a reference plane of the display unit **270** of the 3D video communication apparatus **200** of the listener **20**, and the object **920** with the new sense of depth may be displayed on a front side with reference to the reference plane (i.e., in a direction of the listener **20** on the reference plane of the display unit **270** (+z axis direction)) distinguishably from the 3D talker image **10***a*.

Further, the object **920** with the adjusted new sense of depth may be displayed on the reference plane of the display unit **270** of the 3D video communication apparatus **200** of the listener **20**, and the output image **10***a* may be displayed on a back side of the reference plane (i.e., direction opposite to the listener **10** on the reference plane of the display unit **270** (−z axis direction)) distinguishably from the 3D talker image **10***a*.

Methods according to exemplary embodiments may be implemented in the form of program commands to be executed through a variety of computing means and recorded on a computer-readable medium. The computer-readable medium may include program command, data file, or data structure singularly or in combination. The program command recorded on said medium may be designed and constructed specifically for the embodiment, or those which are known and available among those skilled in the computer software area.

The foregoing exemplary embodiments and advantages are merely exemplary and are not to be construed as limiting. The present teaching can be readily applied to other types of apparatuses. Also, the description of the exemplary embodiments is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

What is claimed is:

1. A three dimensional (3D) video communication method comprising:
- acquiring a plurality of two dimensional (2D) images corresponding to a talker, by using a 3D camera;
- detecting an object located between the talker and the 3D camera using the acquired plurality of 2D images;
- scaling an original sense of depth of the detected object to a new sense of depth relative to the talker; and
- generating a 3D talker image including the object with the new sense of depth relative to the talker and transmitting the 3D talker image to a 3D video communication apparatus of a listener.

2. The 3D video communication method of claim **1**, further comprising
- setting the feature point of the talker, wherein the feature point comprises at least one of eyes, nose, lips, ears, and eyebrows of the talker.

3. The 3D video communication method of claim **1**, further comprising:
- receiving a 3D listener image from the 3D video communication apparatus of the listener; and
- displaying the 3D listener image or the 3D talker image on a display unit.

4. The 3D video communication method of claim **1**, wherein the 3D camera comprises at least one of a stereoscopic camera and a depth camera unit.

5. The 3D video communication method of claim **1**, further comprising computing a distance between the 3D camera and the talker, by using disparity or depth information of the plurality of 2D images.

6. The 3D video communication method of claim **1**, further comprising:
- displaying the 3D talker image on a reference plane of a display unit of the 3D video communication apparatus of the listener; and
- displaying the object having the new sense of depth on a front side of the reference plane in a positive z axis direction distinguishably from the 3D talker image.

7. The 3D video communication method of claim **1**, further comprising:
- displaying the object having the new sense of depth on a reference plane of a display unit of the 3D video communication apparatus of the listener; and
- displaying the 3D talker image on a back side of the reference plane in a negative z axis direction distinguishably from the object with the new sense of depth.

8. The 3D video communication method of claim **1**, wherein the adjusting comprises:
- shifting a left-side image and a right-side image acquired from one of a stereoscopic camera and a depth camera unit using the feature point, or
- rotating at least one of a light axis of a left-side camera and a light axis of a right-side camera of the stereoscopic camera.

9. The 3D video communication method of claim **1**, wherein the scaling comprises:
- enlarging or shifting the object detected in a left-side image and the object detected in a right-side image acquired from one of a stereoscopic camera and a depth camera unit, or
- adjusting at least one distance among a light axis of a left-side camera and a light axis of a right-side camera of the stereoscopic camera.

10. The 3D video communication method of claim **1**, wherein the scaling comprises enlarging, by adding a predetermined ratio corresponding to a size of the object detected in a left-side image and a size of the object detected in a right-side image acquired by one of a stereoscopic camera and a depth camera unit, or
- enlarging the detected object of the left-side image and the detected object of the right-side image to a predetermined size.

11. The 3D video communication method of claim **1**, wherein the 3D camera is integrally formed in a 3D video communication apparatus of the talker.

12. The 3D video communication method of claim **1**, further comprising
- adjusting a point of convergence of the plurality of 2D images using a feature point of the talker.

13. A three dimensional (3D) video communication method comprising:
- acquiring a plurality of two dimensional (2D) images corresponding to a talker, by using a 3D camera;
- detecting an object located between the talker and the 3D camera;
- scaling an original sense of depth of the detected object to a new sense of depth relative to the talker;
- transmitting a second 3D talker image containing the object with the new sense of depth relative to the talker to a 3D video communication apparatus of a listener; and
- receiving a 3D listener image from the 3D video communication apparatus of the listener and displaying the first 3D talker image or the 3D listener image containing the object with the original sense of depth on a display unit.

14. The 3D video communication method of claim 13, further comprising computing a distance between the 3D camera and the talker.

15. The 3D video communication method of claim 13, further comprising

generating a first 3D talker image by adjusting a point of convergence of the plurality of 2D images using a feature point of the talker.

16. A three dimensional (3D) video communication method comprising:

acquiring a plurality of two dimensional (2D) images corresponding to a talker, by using a 3D camera;

distinguishing between a first region corresponding to the talker and a second region between the talker and the 3D camera;

detecting an object located between the talker and the 3D camera in the second region;

scaling an original sense of depth of the detected object to a new sense of depth relative to the talker; and

generating a 3D talker image including the object with the new sense of depth relative to the talker.

17. The 3D video communication method of claim 16, wherein the detecting the object between the talker and the 3D camera comprises dividing the detected object into separate layers.

18. The 3D video communication method of claim 16, further comprising:

transmitting the 3D talker image to a 3D video communication apparatus of a listener;

receiving a 3D listener image from the 3D video communication apparatus of the listener; and

displaying the received 3D listener image or the 3D talker image on a display unit.

19. The 3D video communication method of claim 18, further comprising:

displaying the 3D talker image on a reference plane of the display unit, and displaying the object with the new sense of depth on a front side of the reference plane in a positive z axis direction distinguishably from the 3D talker image, or

displaying the object with the new sense of depth on the reference plane of the display unit, and displaying the 3D talker image on a back side of the reference plane in a negative z axis direction distinguishably from the object with the new sense of depth.

20. The 3D video communication method of claim 16, further comprising computing a distance between the 3D camera and the talker.

21. The 3D video communication method of claim 16, wherein the 3D camera comprises at least one of a stereoscopic camera and a depth camera unit.

22. The 3D video communication method of claim 16, further comprising

adjusting a point of convergence of the plurality of 2D images using a feature point of the talker.

23. A three dimensional (3D) video communication system comprising a display unit which displays a 3D image, the 3D video communication system comprising:

a storage unit; and

a control unit which controls the 3D camera and the storage unit, wherein the control unit, detects an object located between the talker and the 3D camera, scales an original sense of depth of the detected object to a new sense of depth relative to the talker, and generates a 3D talker image including the object with the new sense of depth relative to the talker from the plurality of 2D images.

24. The 3D video communication system of claim 23, further comprising:

a transmitting/receiving unit which transmits the 3D talker image to a 3D video communication apparatus of a listener during video communication with the listener, and receives a 3D listener image from the 3D video communication apparatus of the listener,

wherein the display unit displays the 3D talker image or the received 3D listener image.

25. The 3D video communication system of claim 23, wherein the display unit displays a user interface (UI) screen to set a feature point of the talker and the feature point is inputted using the UI screen.

26. The 3D video communication system of claim 23, wherein the control unit computes a distance between the 3D camera and the talker using the plurality of 2D images and detects the object using the computed distance.

27. The 3D video communication system of claim 23,

wherein the control unit adjusts a point of convergence of a plurality of two dimensional (2D) images using a feature point of a talker.

28. A three dimensional (3D) video communication system comprising a display unit which displays a 3D image, the 3D video communication system comprising:

a 3D camera which acquires a plurality of two dimensional (2D) images corresponding to a talker;

a storage unit; and

a control unit which controls the 3D camera and the storage unit, wherein the control unit distinguishes between a first region corresponding to the talker and a second region between the talker and the 3D camera, detects the object in the second region, scales an original sense of depth of the detected object to a new sense of depth relative to the talker, and generates a 3D talker image including the object with the new sense of depth relative to the talker from the plurality of 2D images.

29. The 3D video communication system of claim 28, further comprising:

a transmitting/receiving unit which transmits the 3D talker image to a 3D video communication apparatus of a listener during video communication with the listener, and receives a 3D listener image from the 3D video communication apparatus of the listener,

wherein the display unit displays the 3D talker image or the 3D listener image.

30. The 3D video communication system of claim 28, wherein the control unit computes a distance between the 3D camera and the talker using the plurality of 2D images and detects the object using the computed distance.

31. The 3D video communication system of claim 28,

wherein the control unit adjusts a point of convergence of the plurality of 2D images using the feature point of the talker.

32. A three dimensional (3D) video communication system comprising a display unit which displays a 3D image, the 3D video communication system comprising:

a transmitting/receiving unit which receives a 3D talker image including a first object with an adjusted sense of depth;

a storage unit which stores the 3D talker image including the first object with the adjusted sense of depth;

a control unit which controls the transmitting/receiving unit and the storage unit, and

a 3D camera which acquires a plurality of two dimensional (2D) images corresponding to a listener;

wherein the control unit:

controls generating an output image by using the 3D talker image including the first object with the stored adjusted sense of depth relative to the talker, and controls displaying the generated output image on the display unit;

adjusts a point of convergence of the plurality of 2D images using a feature point of the listener,

detects a second object located between the listener and the 3D camera using the acquired plurality of 2D images,

scales an original sense of depth of the detected second object into a new sense of depth relative to the listener,

generates a 3D listener image including the second object with the new sense of depth relative to the listener from a plurality of 2D images, and

transmits the generated 3D listener image to a 3D video communication of a talker using the transmitting/receiving unit.

33. The 3D video communication system of claim **32**, wherein:

the 3D talker image is displayed on a reference plane of the display unit of a 3D video communication apparatus of the listener and the first object with the adjusted sense of depth is displayed on a front side of the reference plane in a positive z axis direction distinguishably from the 3D talker image, or

the first object with the adjusted sense of depth is displayed on the reference plane of the display unit, and the 3D talker image is displayed on a back side of the reference plane in a negative z axis direction distinguishably from the first object with the adjusted sense of depth.

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