US 20110246329A1

(19) United States

(12) Patent Application Publication

Geisner et al.

(10) Pub. No.: US 2011/0246329 A1

(43) Pub. Date: Oct. 6, 2011

(54) **MOTION-BASED INTERACTIVE SHOPPING ENVIRONMENT**

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(21) Appl. No.: **12/752,917**

(22) Filed: **Apr. 1, 2010**

Publication Classification

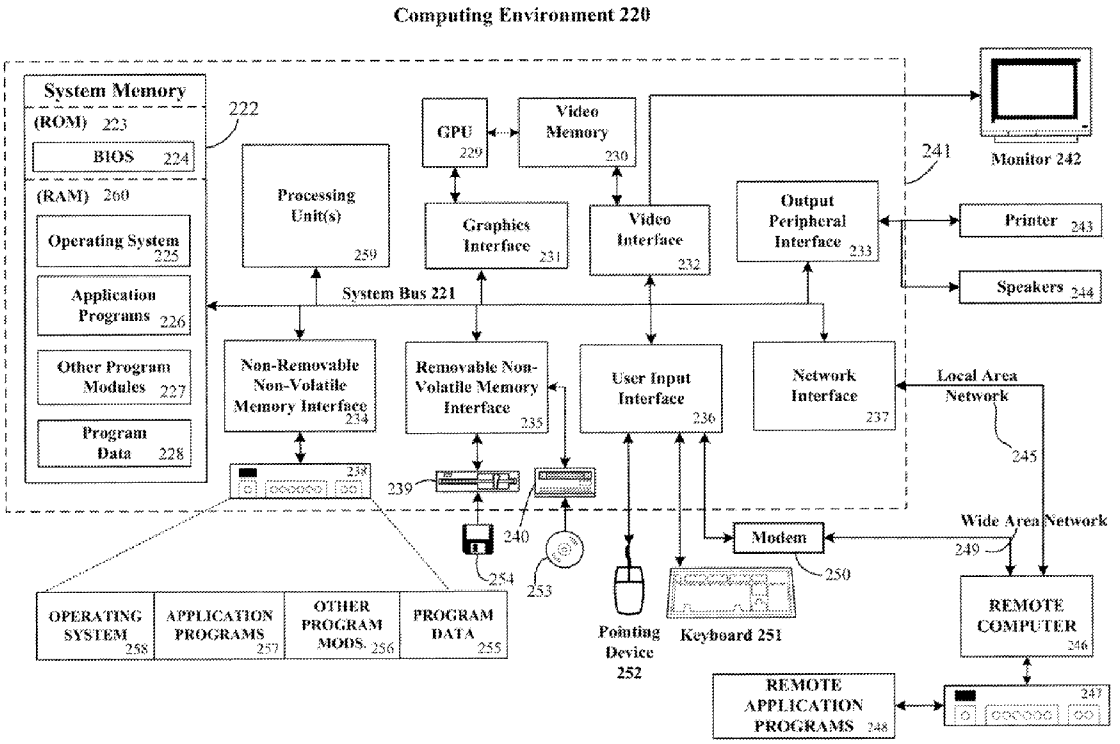
(51) **Int. Cl.**

G06Q 30/00	(2006.01)
G06F 3/048	(2006.01)
G06Q 50/00	(2006.01)

(52) **U.S. Cl.** **705/27.1**; 715/757

(57) **ABSTRACT**

An on-screen shopping application which reacts to a human target user's motions to provide a shopping experience to the user is provided. A tracking system captures user motions and executes a shopping application allowing a user to manipulate an on-screen representation the user. The on-screen representation has a likeness of the user or another individual and movements of the user in the on-screen interface allows the user to interact with virtual articles that represent real-world articles. User movements which are recognized as article manipulation or transaction control gestures are translated into commands for the shopping application.



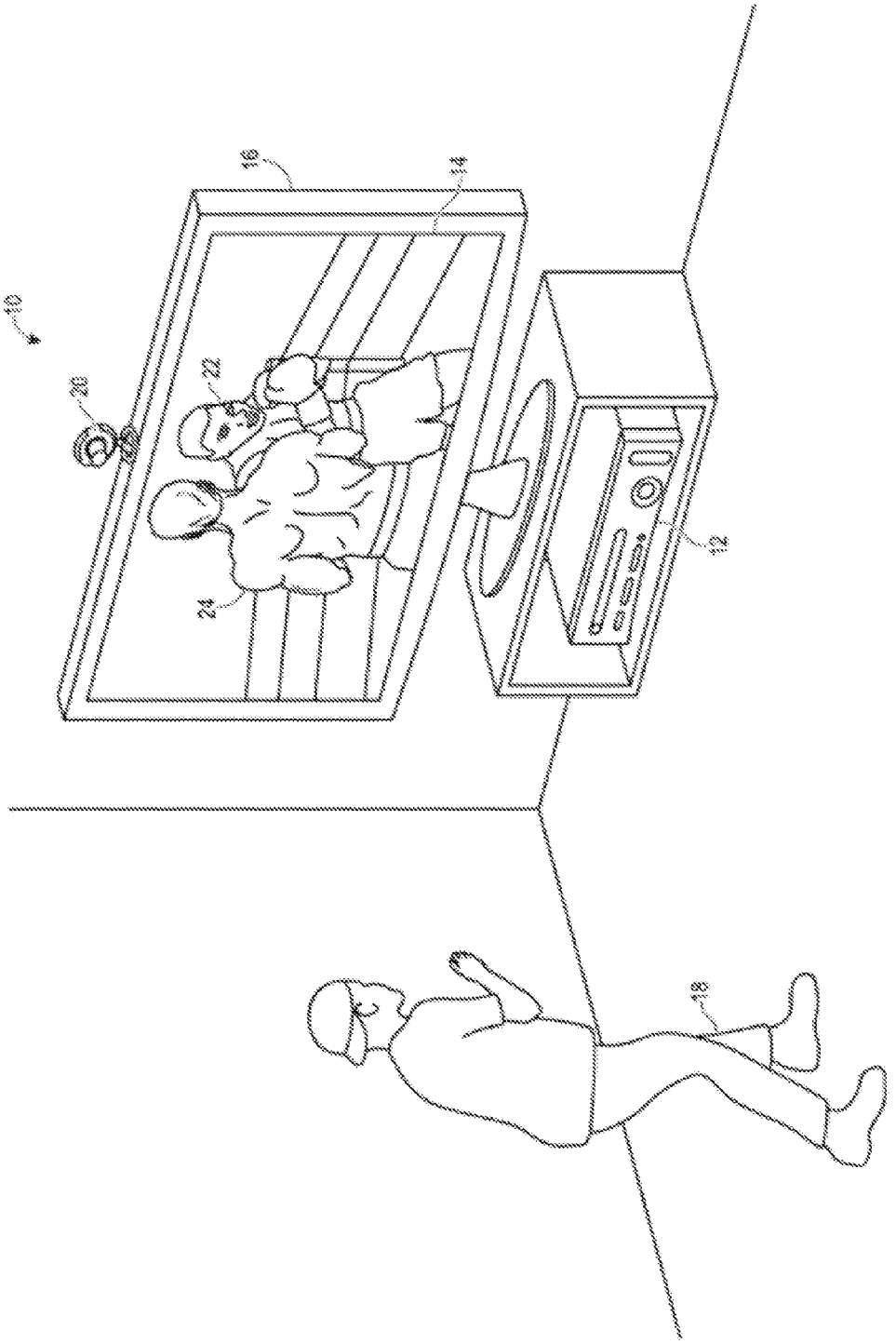


FIG. 1

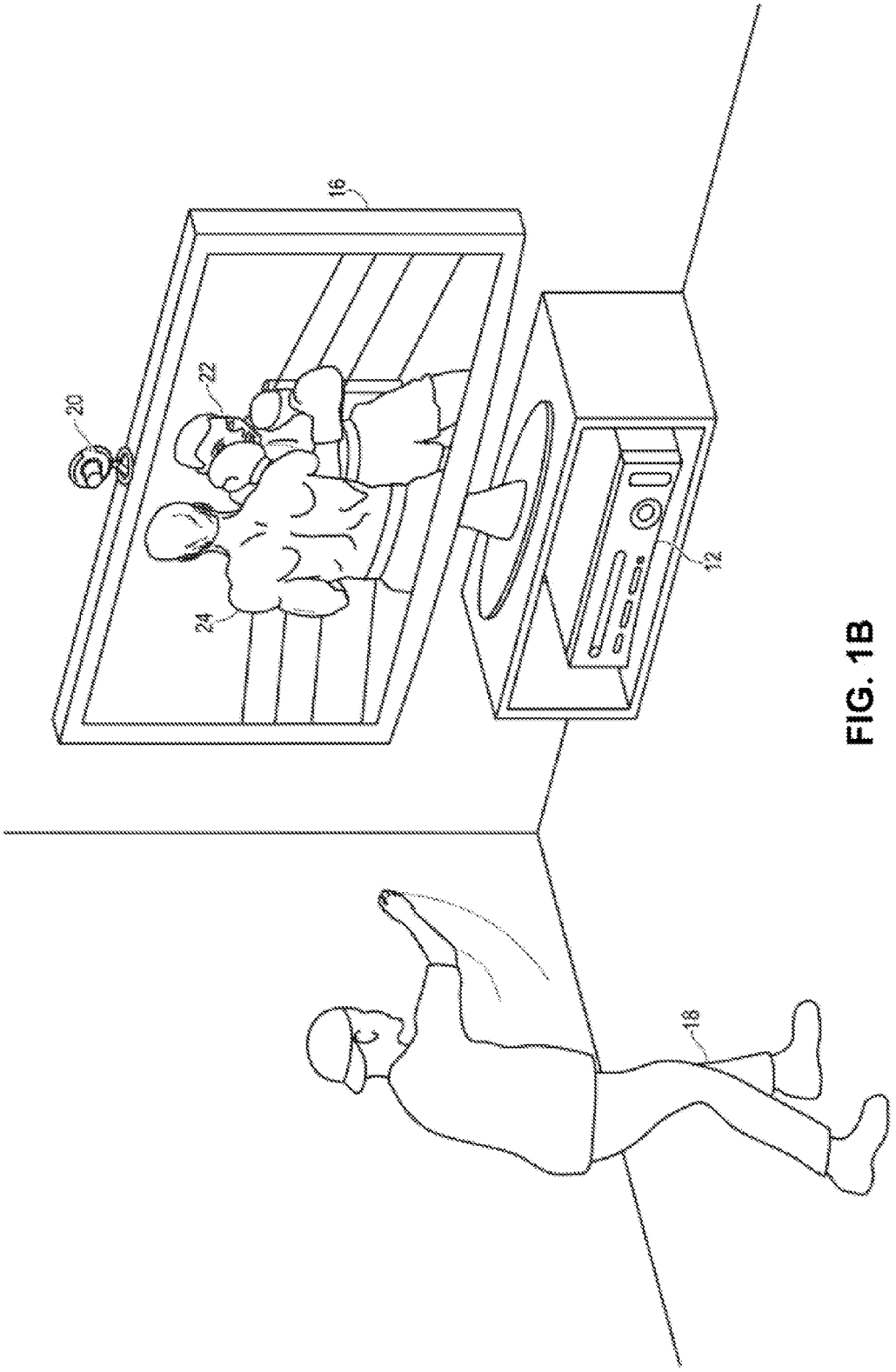


FIG. 1B

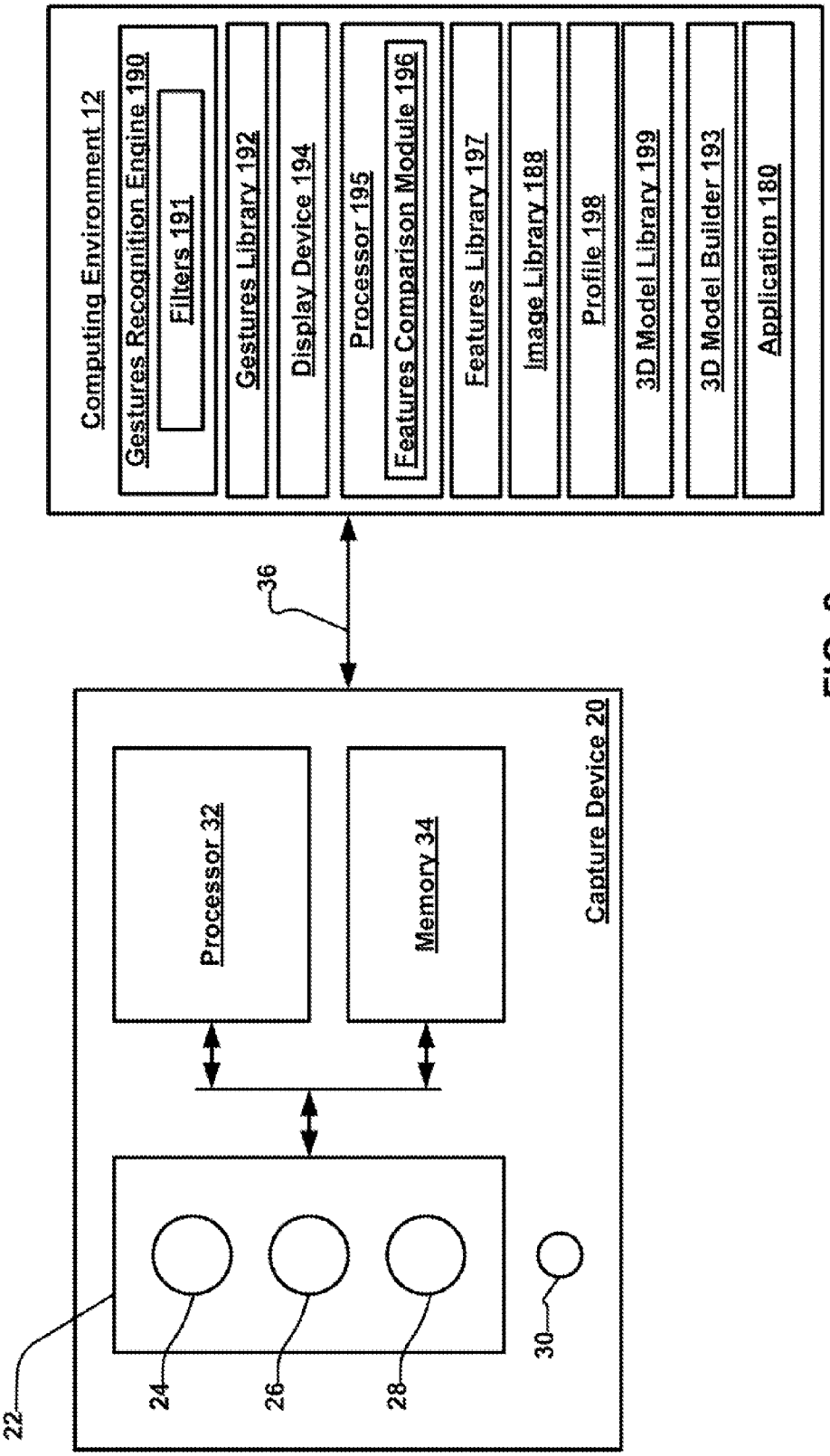

Computing Environment 12
Gestures Recognition Engine 190
Filters 191
Gestures Library 192
Display Device 194
Processor 195
Features Comparison Module 196
Features Library 197
Image Library 188
Profile 198
3D Model Library 199
3D Model Builder 193
Application 180
36
Capture Device 20
Processor 32
Memory 34
22
24
26
28
30

FIG. 2

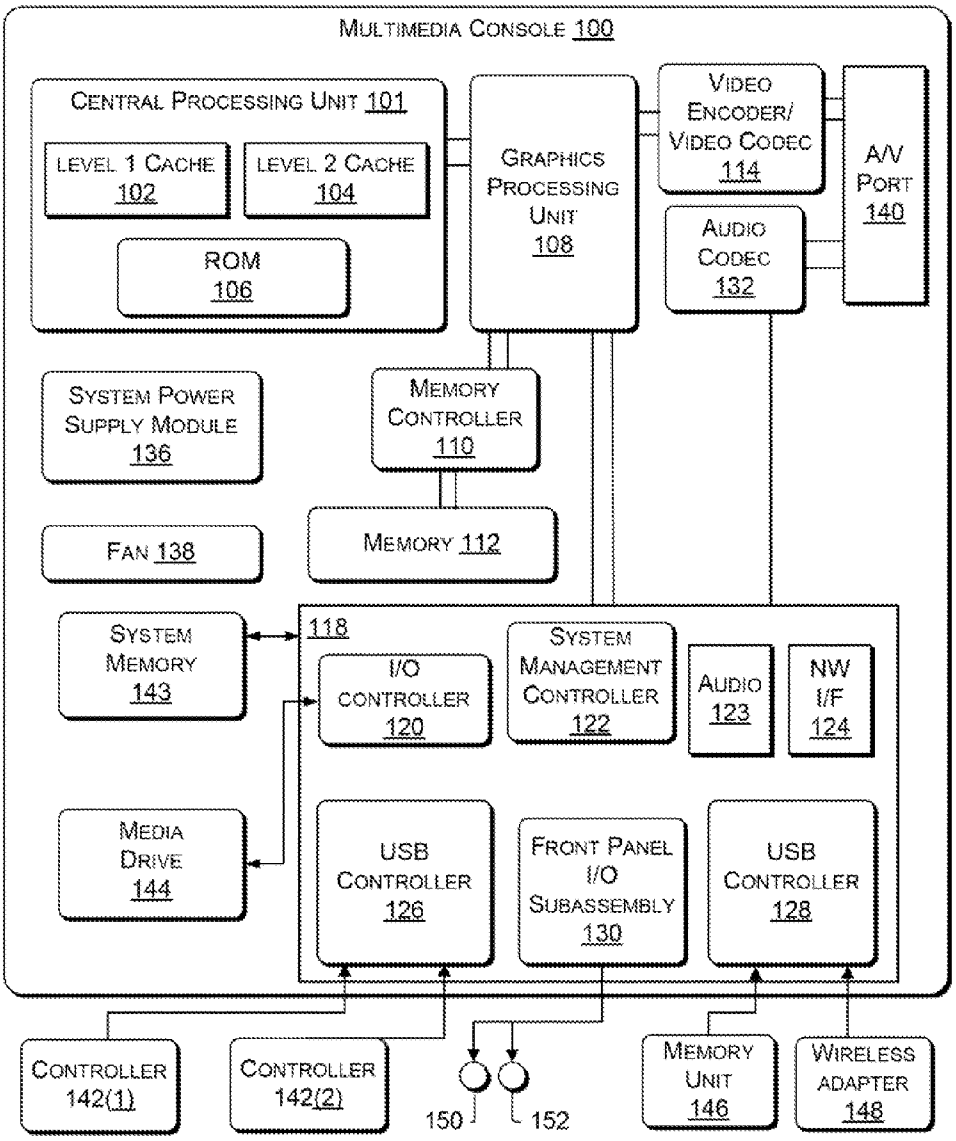

MULTIMEDIA CONSOLE 100
CENTRAL PROCESSING UNIT 101
LEVEL 1 CACHE 102
LEVEL 2 CACHE 104
ROM 106
GRAPHICS PROCESSING UNIT 108
VIDEO ENCODER/ VIDEO CODEC 114
A/V PORT 140
AUDIO CODEC 132
SYSTEM POWER SUPPLY MODULE 136
MEMORY CONTROLLER 110
MEMORY 112
FAN 138
118
SYSTEM MEMORY 143
I/O CONTROLLER 120
SYSTEM MANAGEMENT CONTROLLER 122
AUDIO 123
NW I/F 124
MEDIA DRIVE 144
USB CONTROLLER 126
FRONT PANEL I/O SUBASSEMBLY 130
USB CONTROLLER 128
CONTROLLER 142(1)
CONTROLLER 142(2)
150
152
MEMORY UNIT 146
WIRELESS ADAPTER 148

FIG. 3

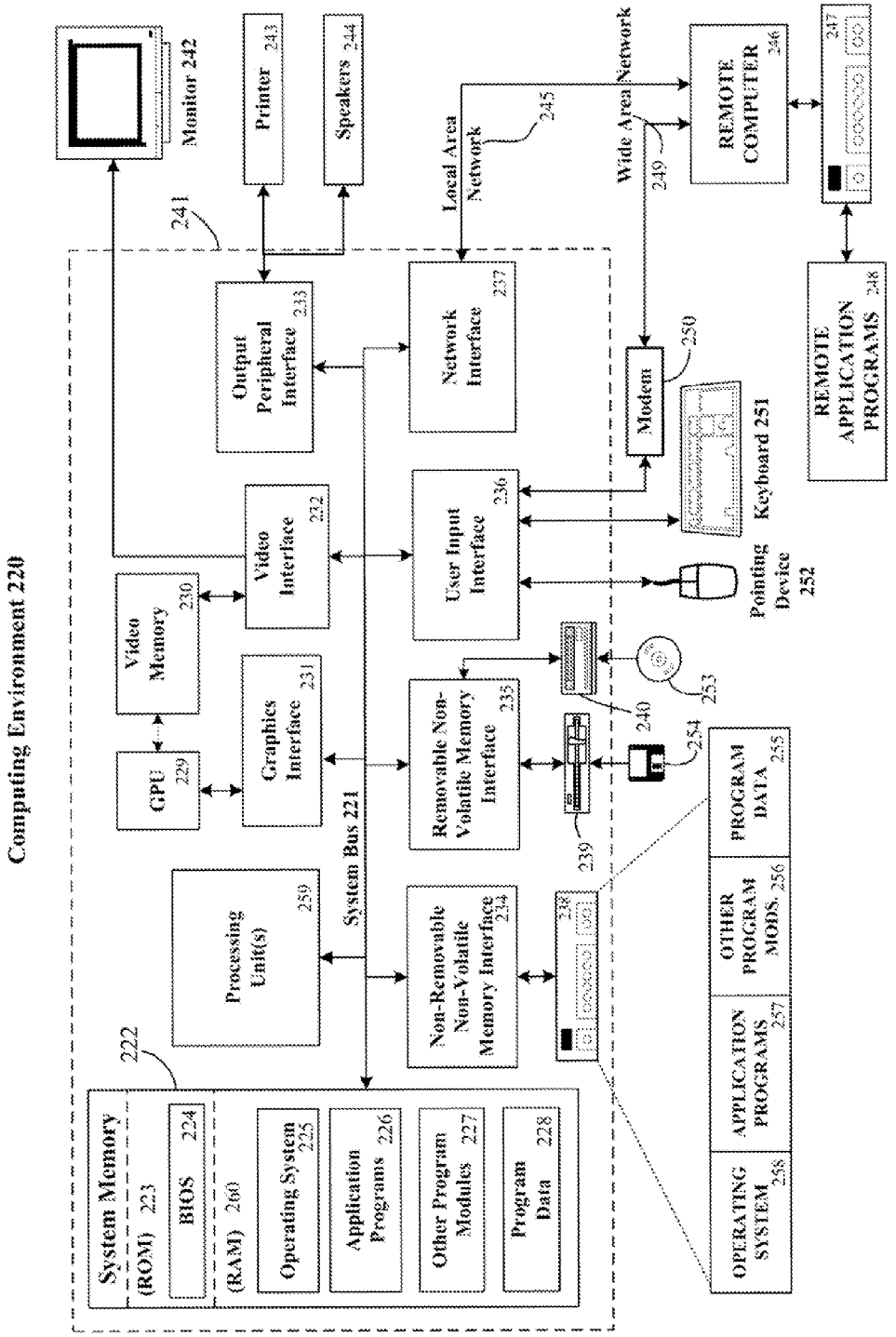

Computing Environment 220
Monitor 242
Printer 243
Speakers 244
241
Local Area Network
245
Wide Area Network
249
REMOTE COMPUTER 246
247
Output Peripheral Interface 233
Network Interface 237
Modem 250
REMOTE APPLICATION PROGRAMS 248
Video Interface 232
User Input Interface 236
Keyboard 251
Pointing Device 252
Video Memory 230
Graphics Interface 231
GPU 229
Removable Non-Volatile Memory Interface 235
240
253
254
239
PROGRAM DATA 255
OTHER PROGRAM MODS. 256
APPLICATION PROGRAMS 257
OPERATING SYSTEM 258
Processing Unit(s) 259
System Bus 221
Non-Removable Non-Volatile Memory Interface 234
238
222
System Memory
(ROM) 223
BIOS 224
(RAM) 260
Operating System 225
Application Programs 226
Other Program Modules 227
Program Data 228

FIG. 4

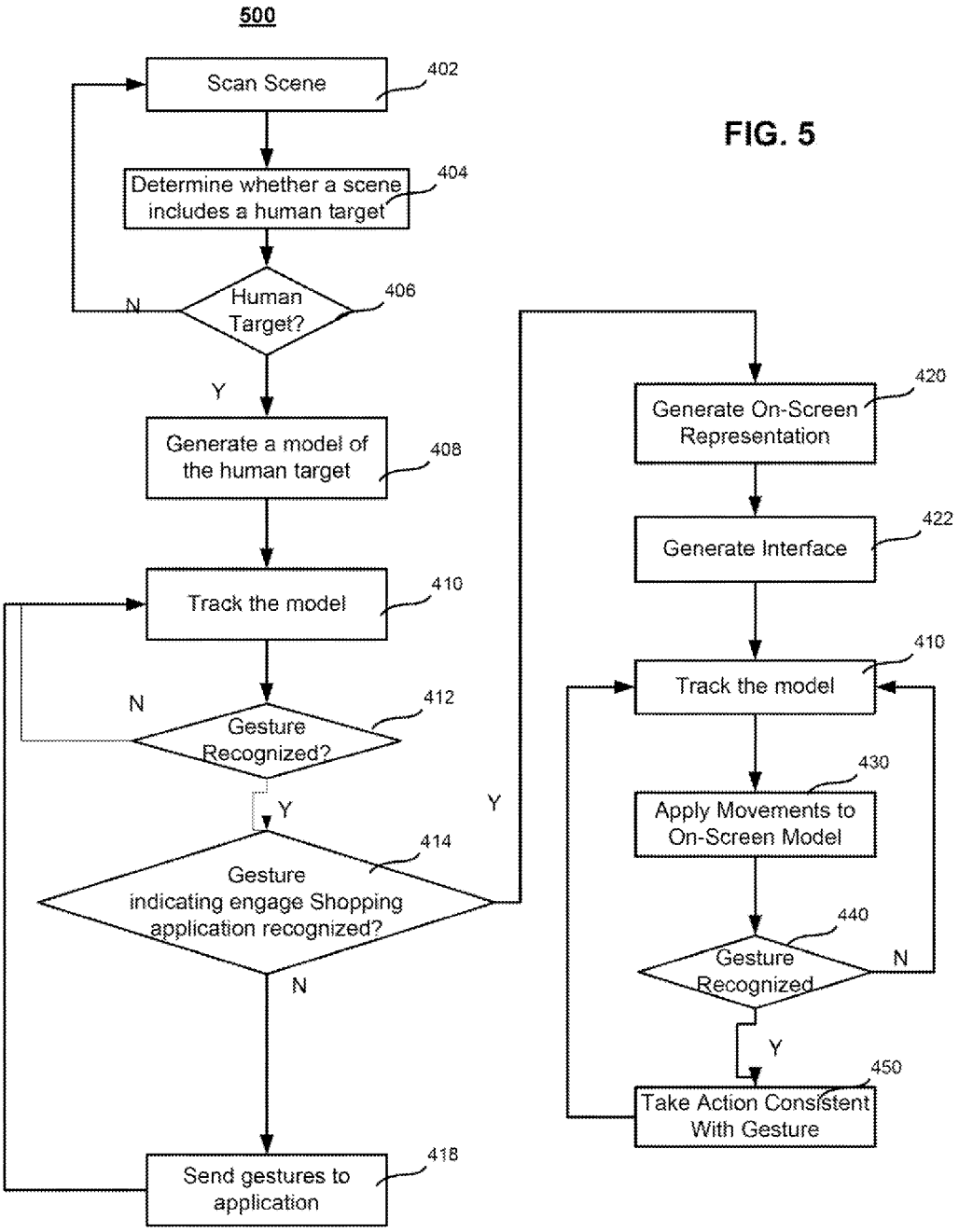
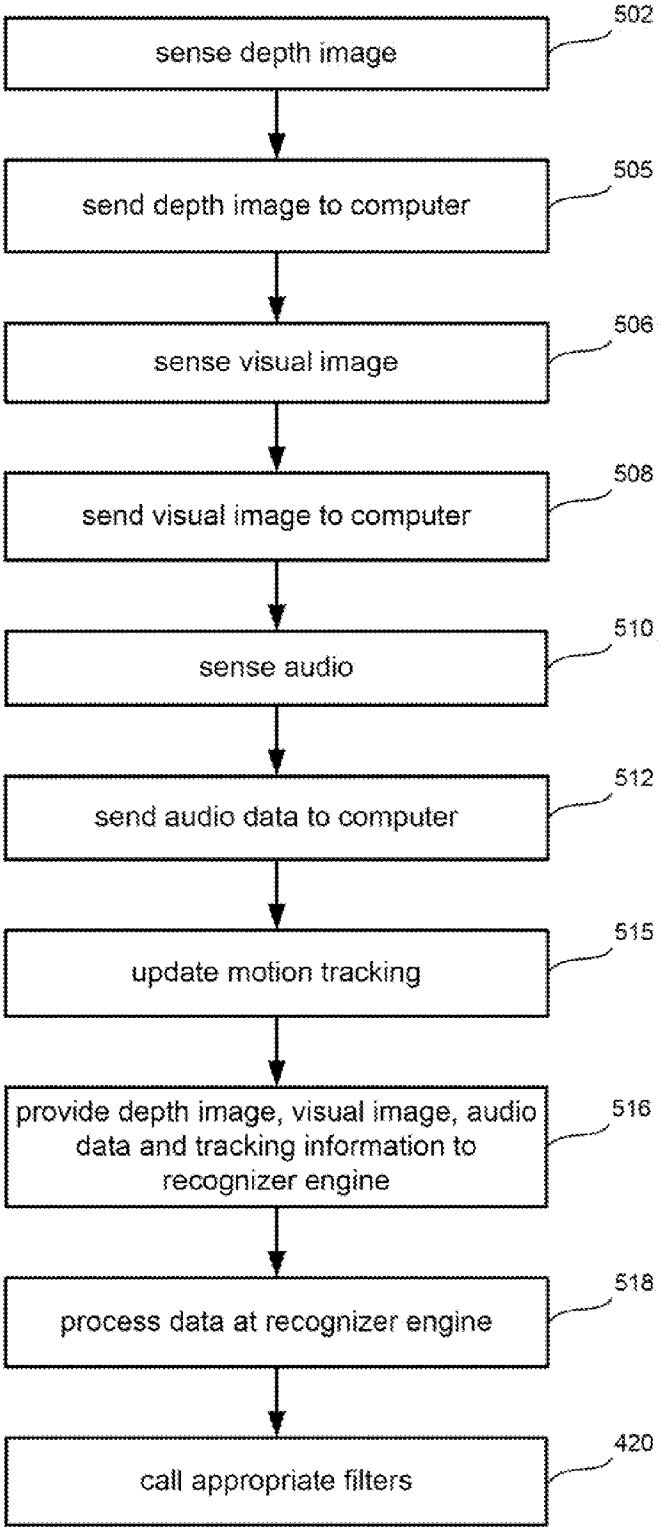

500
Scan Scene
402
Determine whether a scene includes a human target
404
Human Target?
406
N
Y
Generate a model of the human target
408
Track the model
410
N
Gesture Recognized?
412
Y
Gesture indicating engage Shopping application recognized?
414
Y
N
Send gestures to application
418
Generate On-Screen Representation
420
Generate Interface
422
Track the model
410
Apply Movements to On-Screen Model
430
Gesture Recognized
440
N
Y
Take Action Consistent With Gesture
450

FIG. 5

FIG. 6


sense depth image
502
send depth image to computer
505
sense visual image
506
send visual image to computer
508
sense audio
510
send audio data to computer
512
update motion tracking
515
provide depth image, visual image, audio data and tracking information to recognizer engine
516
process data at recognizer engine
518
call appropriate filters
420

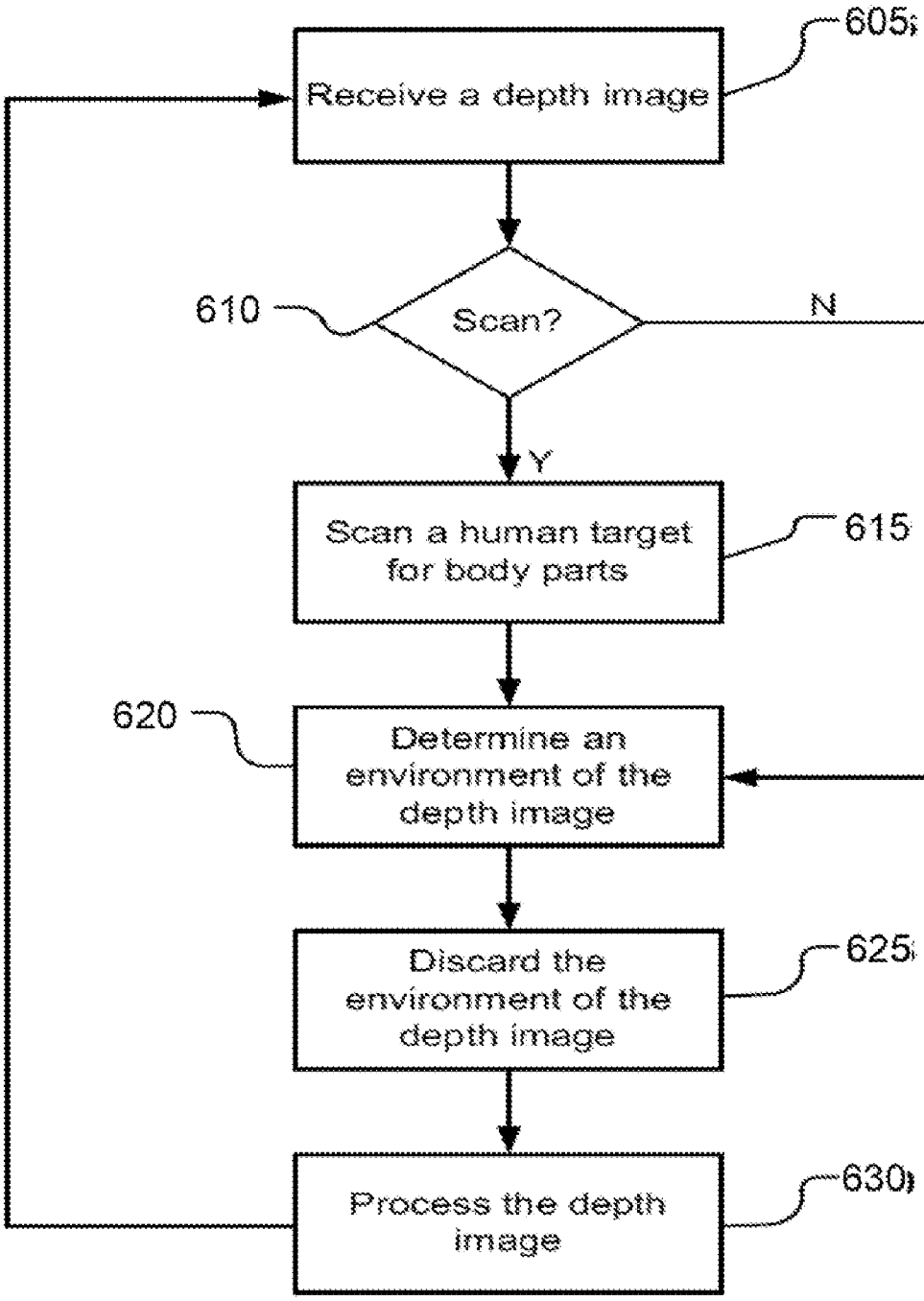

605
Receive a depth image
610
Scan?
N
Y
Scan a human target for body parts
615
620
Determine an environment of the depth image
Discard the environment of the depth image
625
Process the depth image
630

FIG. 7

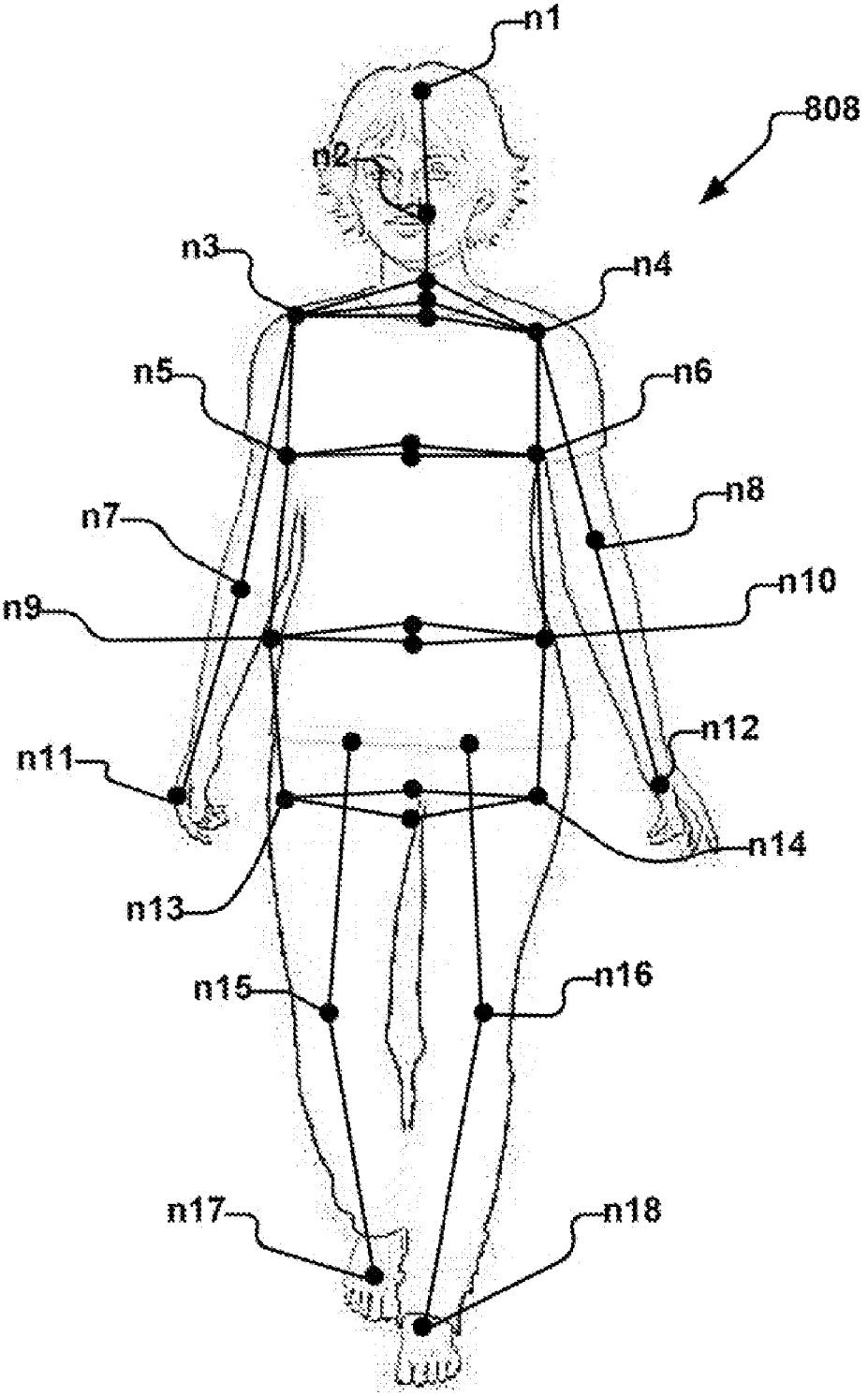


FIG. 8

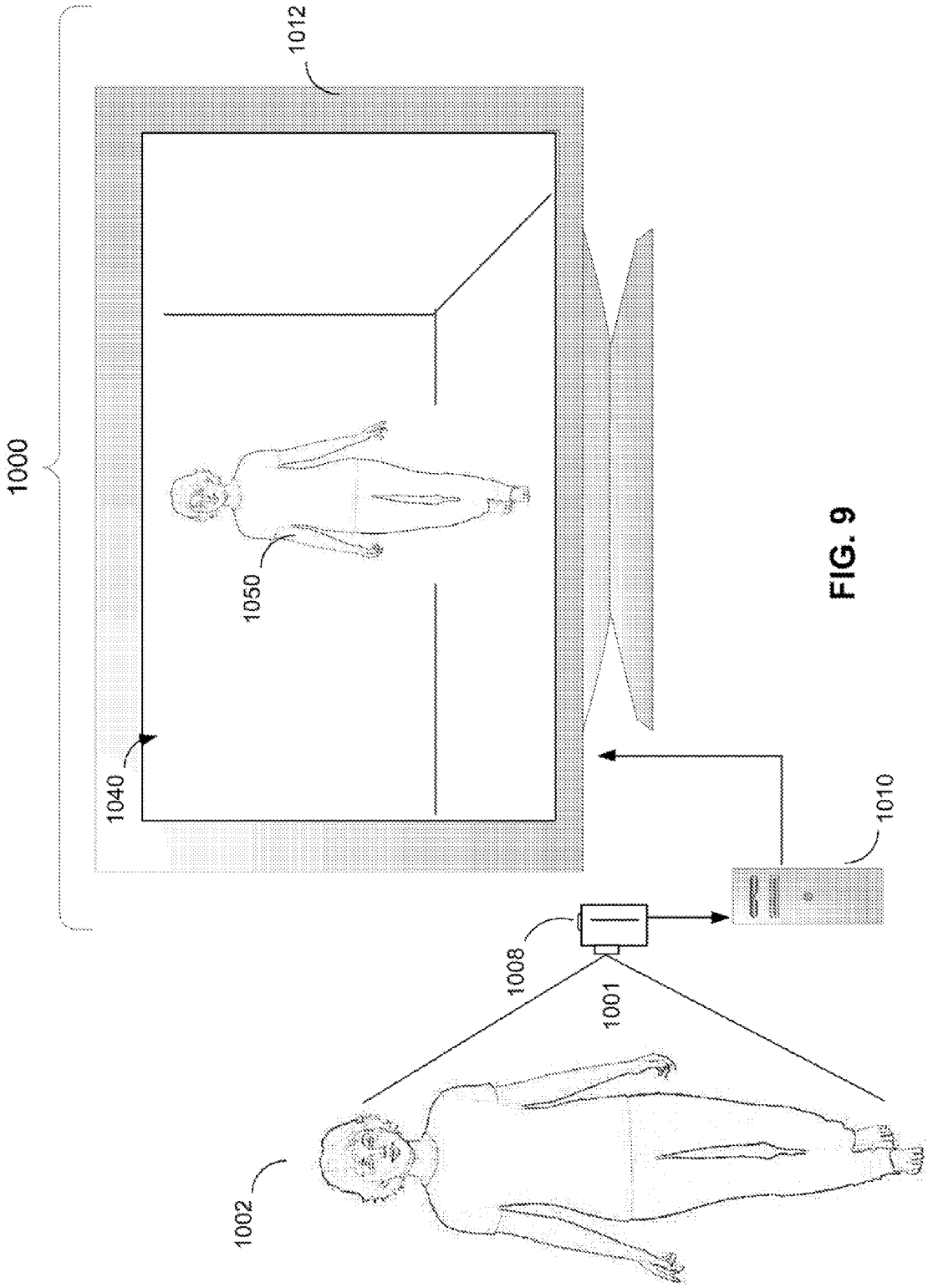


FIG. 9

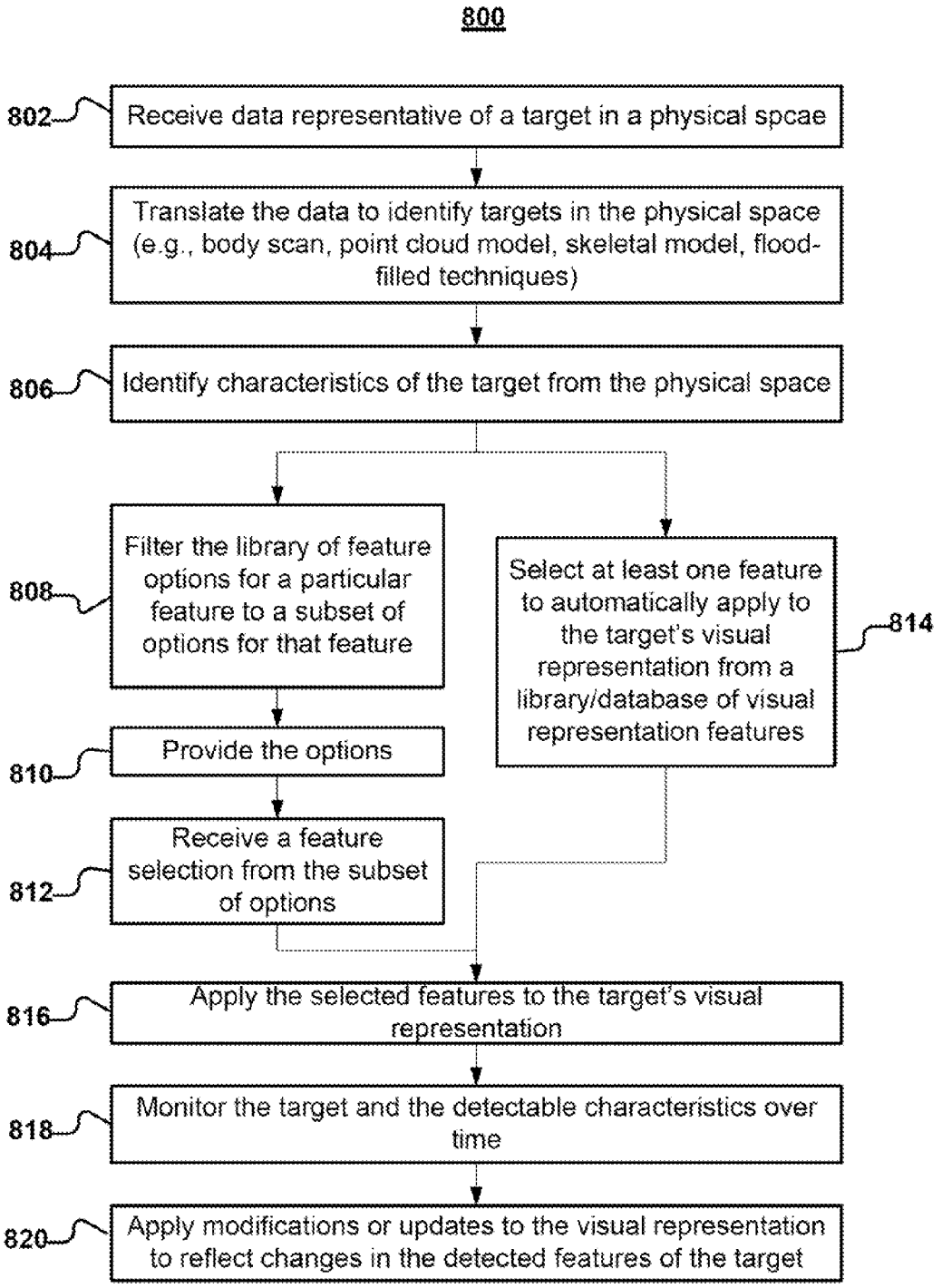

800
802
Receive data representative of a target in a physical spcae
804
Translate the data to identify targets in the physical space (e.g., body scan, point cloud model, skeletal model, flood-filled techniques)
806
Identify characteristics of the target from the physical space
808
Filter the library of feature options for a particular feature to a subset of options for that feature
814
Select at least one feature to automatically apply to the target's visual representation from a library/database of visual representation features
810
Provide the options
812
Receive a feature selection from the subset of options
816
Apply the selected features to the target's visual representation
818
Monitor the target and the detectable characteristics over time
820
Apply modifications or updates to the visual representation to reflect changes in the detected features of the target

FIG. 10

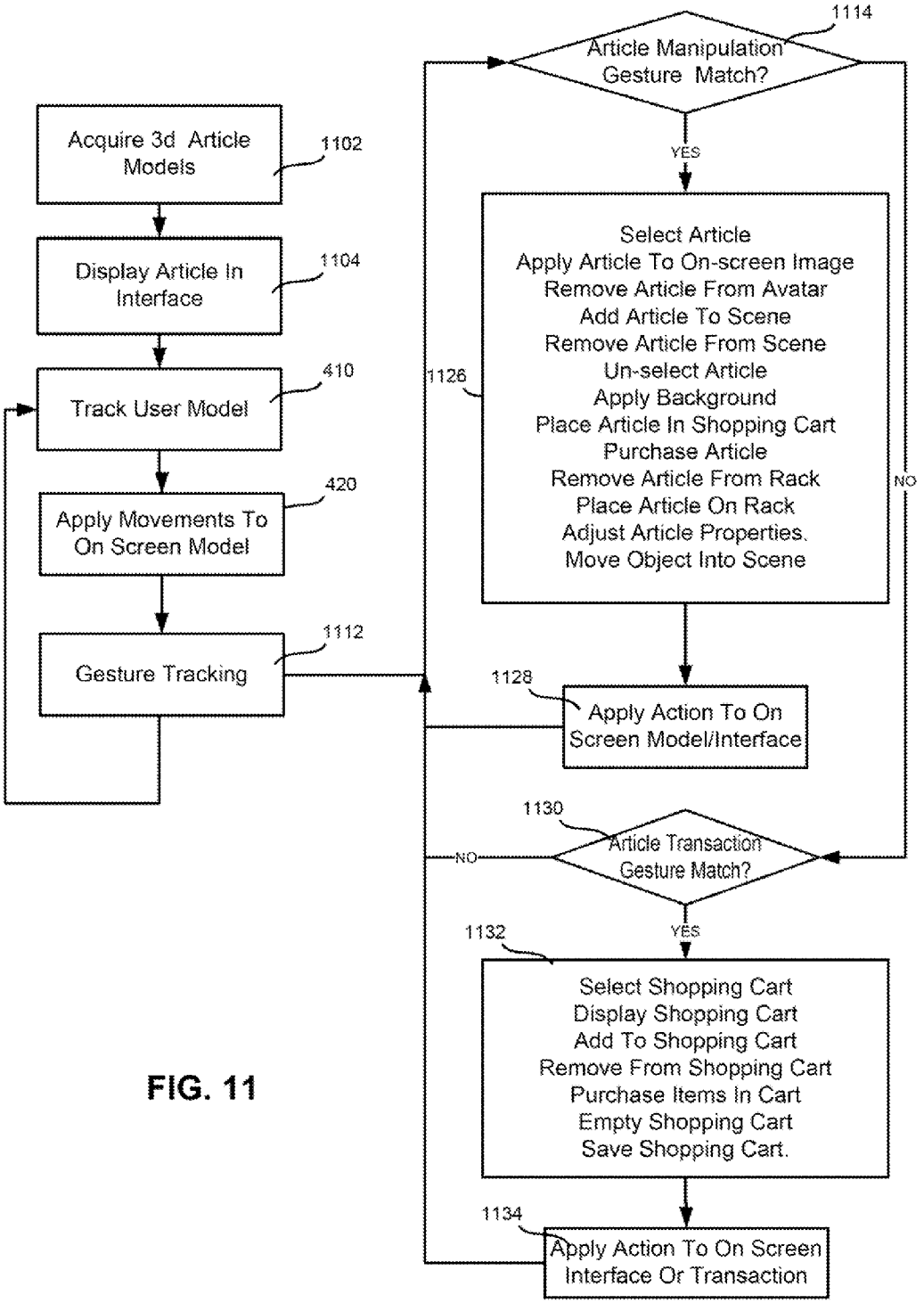

Acquire 3d Article Models
1102
Display Article In Interface
1104
Track User Model
410
Apply Movements To On Screen Model
420
Gesture Tracking
1112
Article Manipulation Gesture Match?
1114
YES
NO
Select Article
Apply Article To On-screen Image
Remove Article From Avatar
Add Article To Scene
Remove Article From Scene
Un-select Article
Apply Background
Place Article In Shopping Cart
Purchase Article
Remove Article From Rack
Place Article On Rack
Adjust Article Properties.
Move Object Into Scene
1126
1128
Apply Action To On Screen Model/Interface
1130
Article Transaction Gesture Match?
NO
YES
1132
Select Shopping Cart
Display Shopping Cart
Add To Shopping Cart
Remove From Shopping Cart
Purchase Items In Cart
Empty Shopping Cart
Save Shopping Cart.
1134
Apply Action To On Screen Interface Or Transaction

FIG. 11

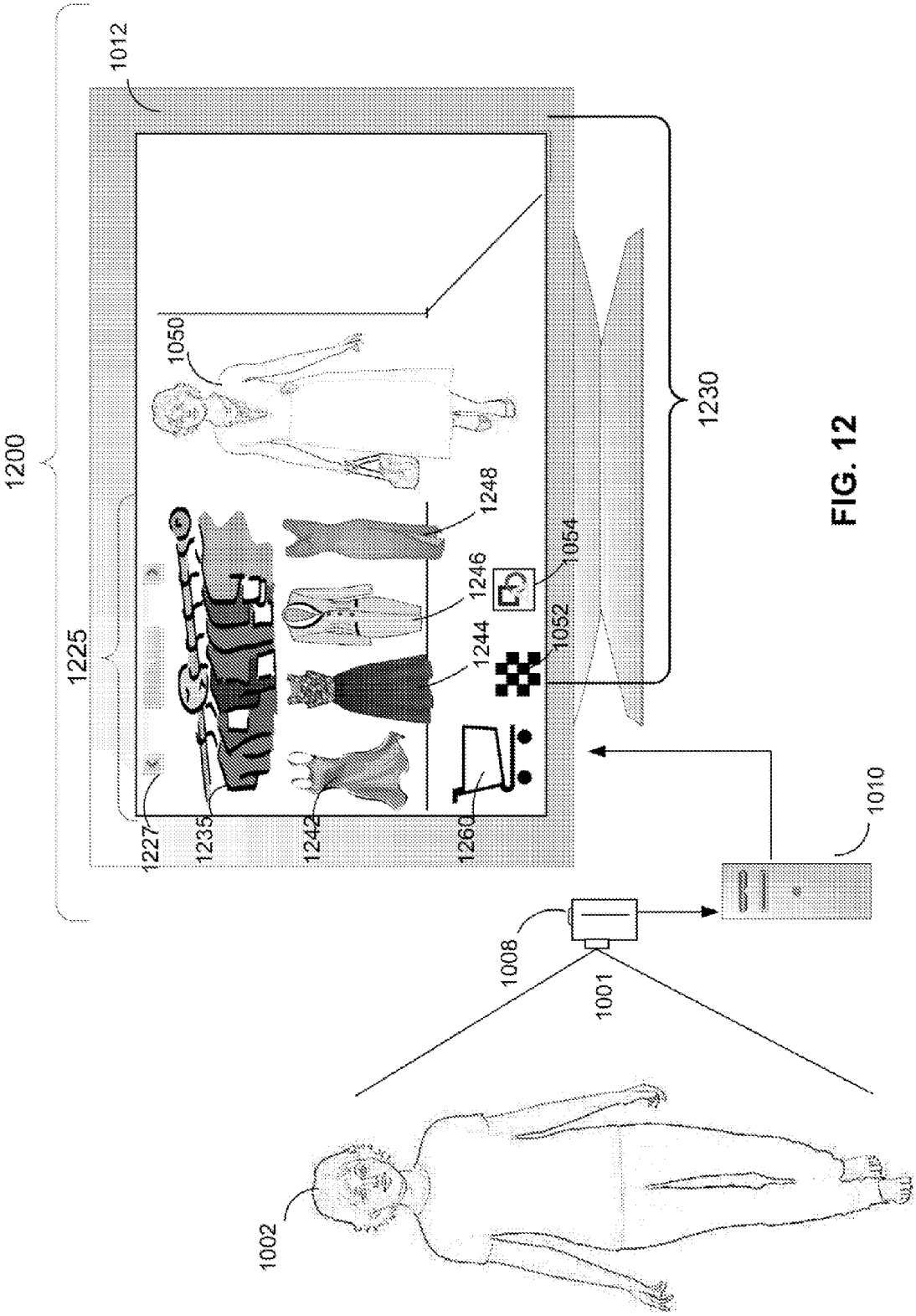

1200
1012
1225
1050
1230
1248
1246
1054
1244
1052
1227
1235
1242
1260
1010
1008
1001
1002

FIG. 12

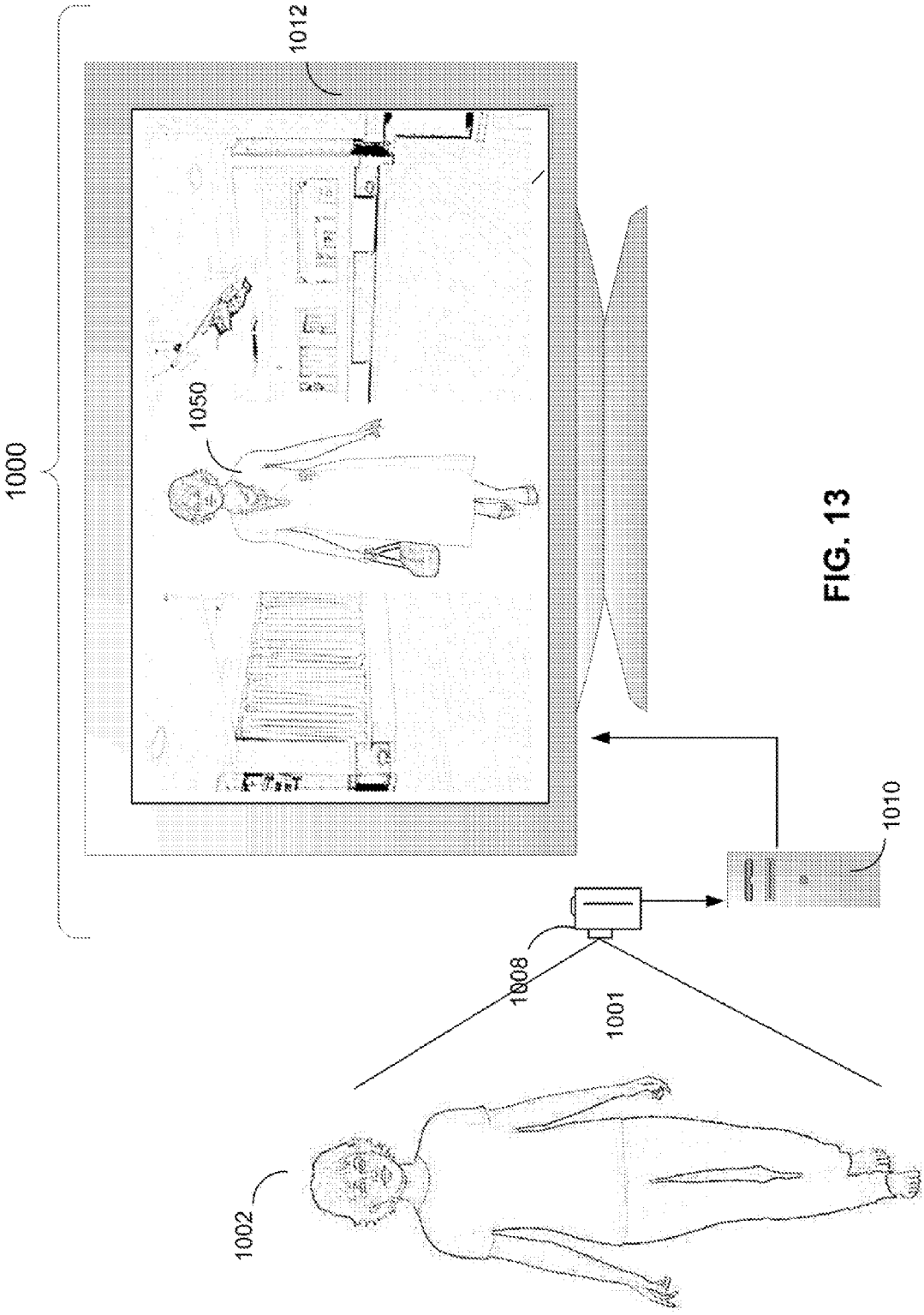


FIG. 13

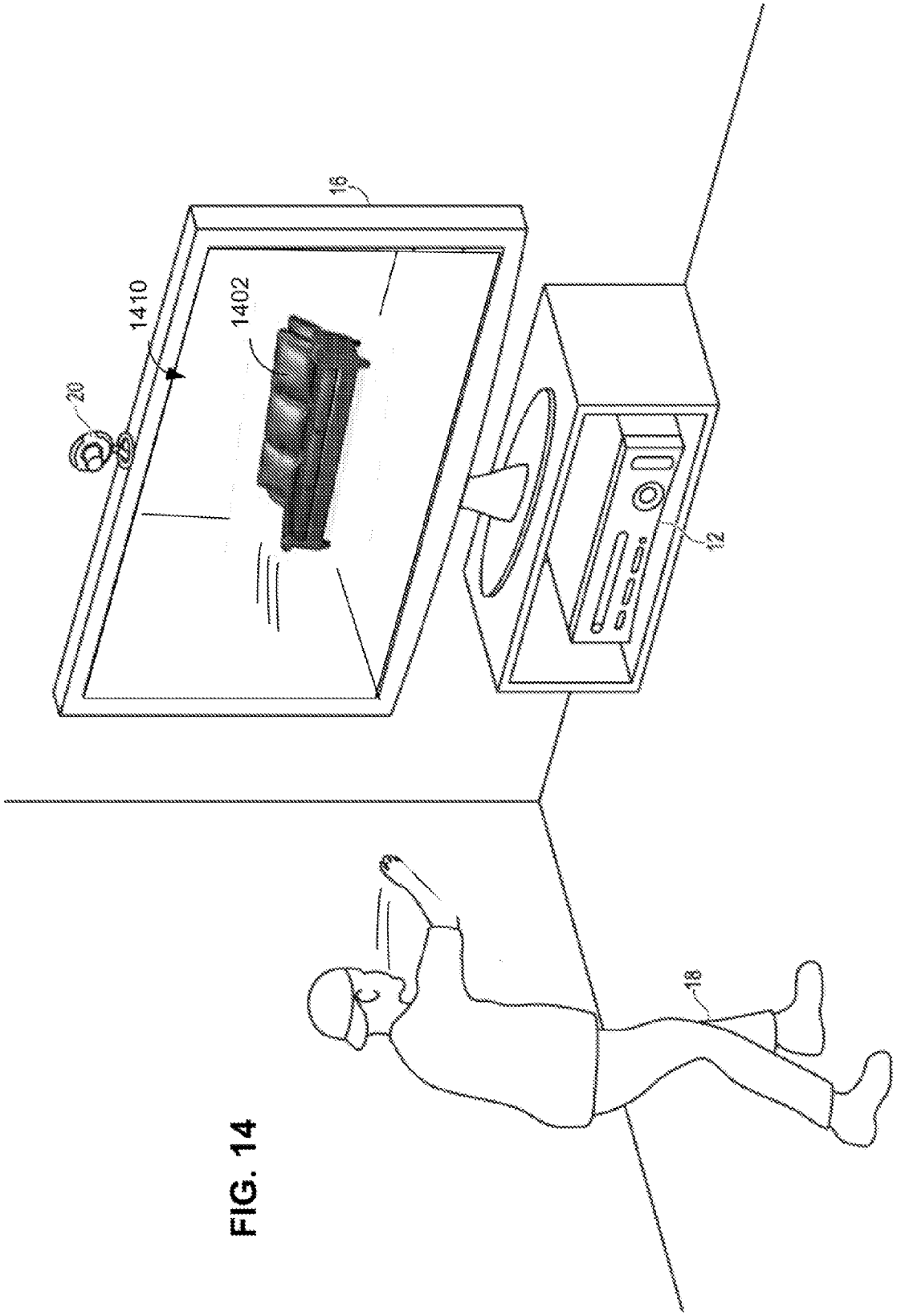


FIG. 14

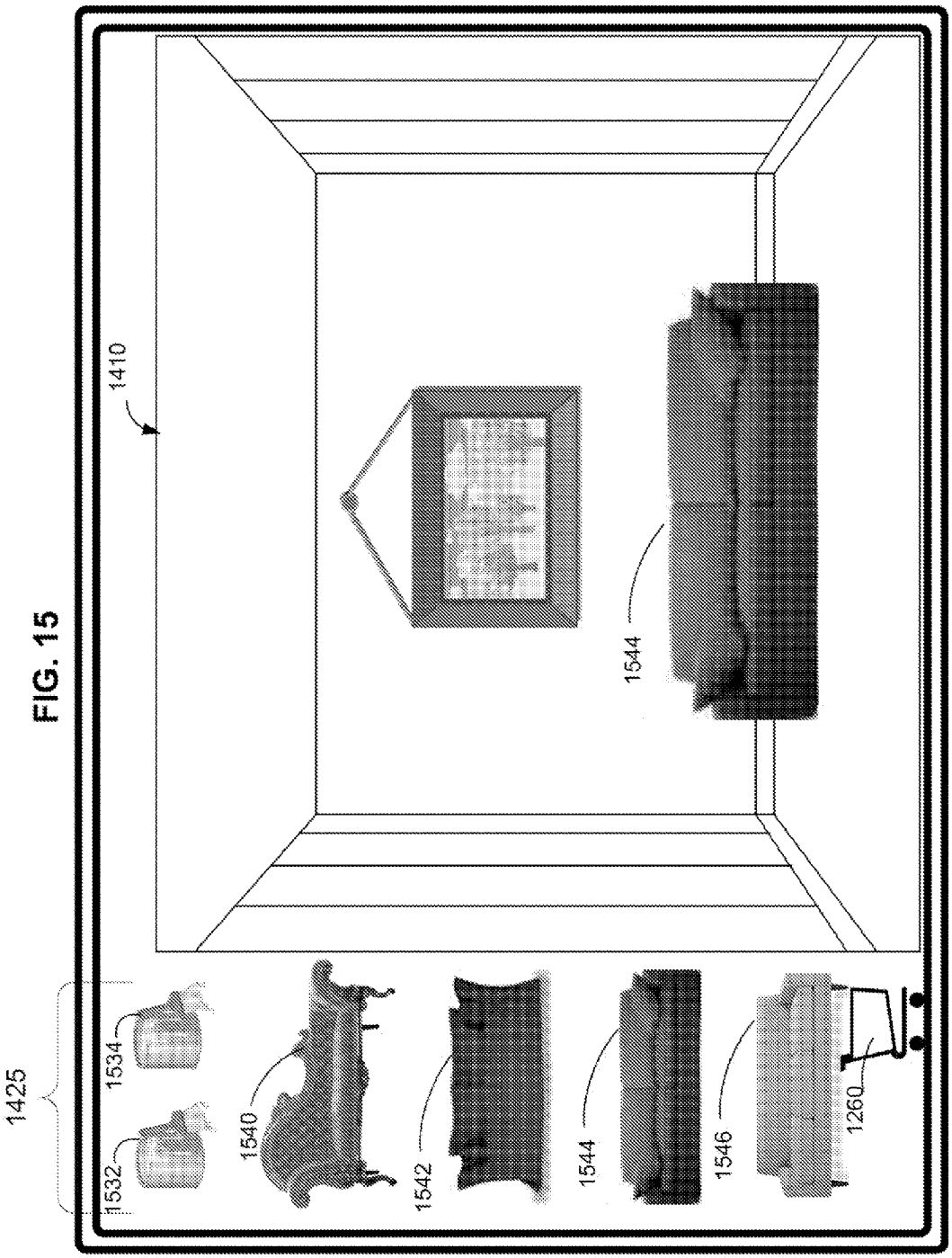


FIG. 15

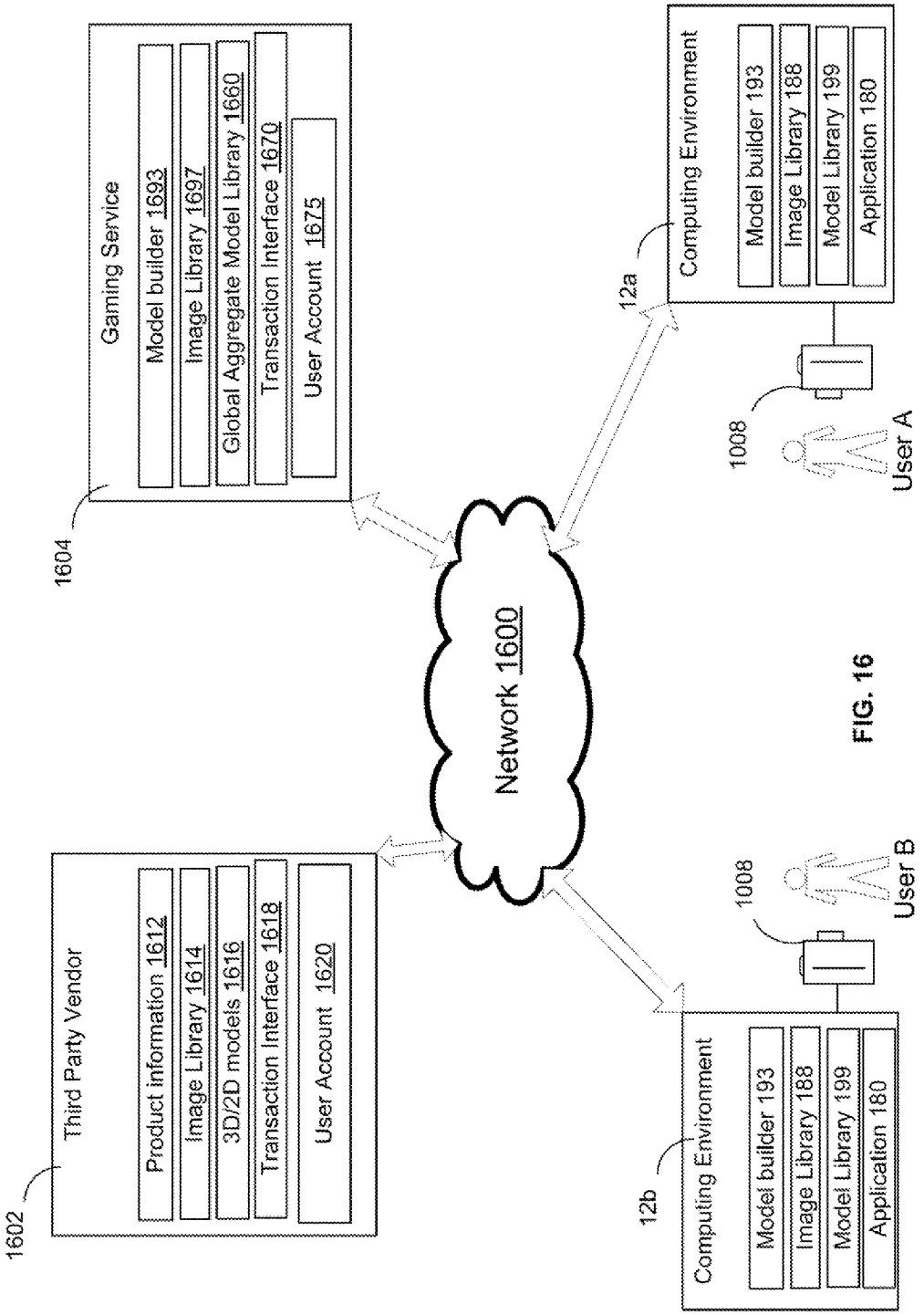

Gaming Service
Model builder 1693
Image Library 1697
Global Aggregate Model Library 1660
Transaction Interface 1670
User Account 1675
1604
Computing Environment
Model builder 193
Image Library 188
Model Library 199
Application 180
12a
1008
User A
Network 1600
Third Party Vendor
Product information 1612
Image Library 1614
3D/2D models 1616
Transaction Interface 1618
User Account 1620
1602
Computing Environment
Model builder 193
Image Library 188
Model Library 199
Application 180
12b
1008
User B

FIG. 16

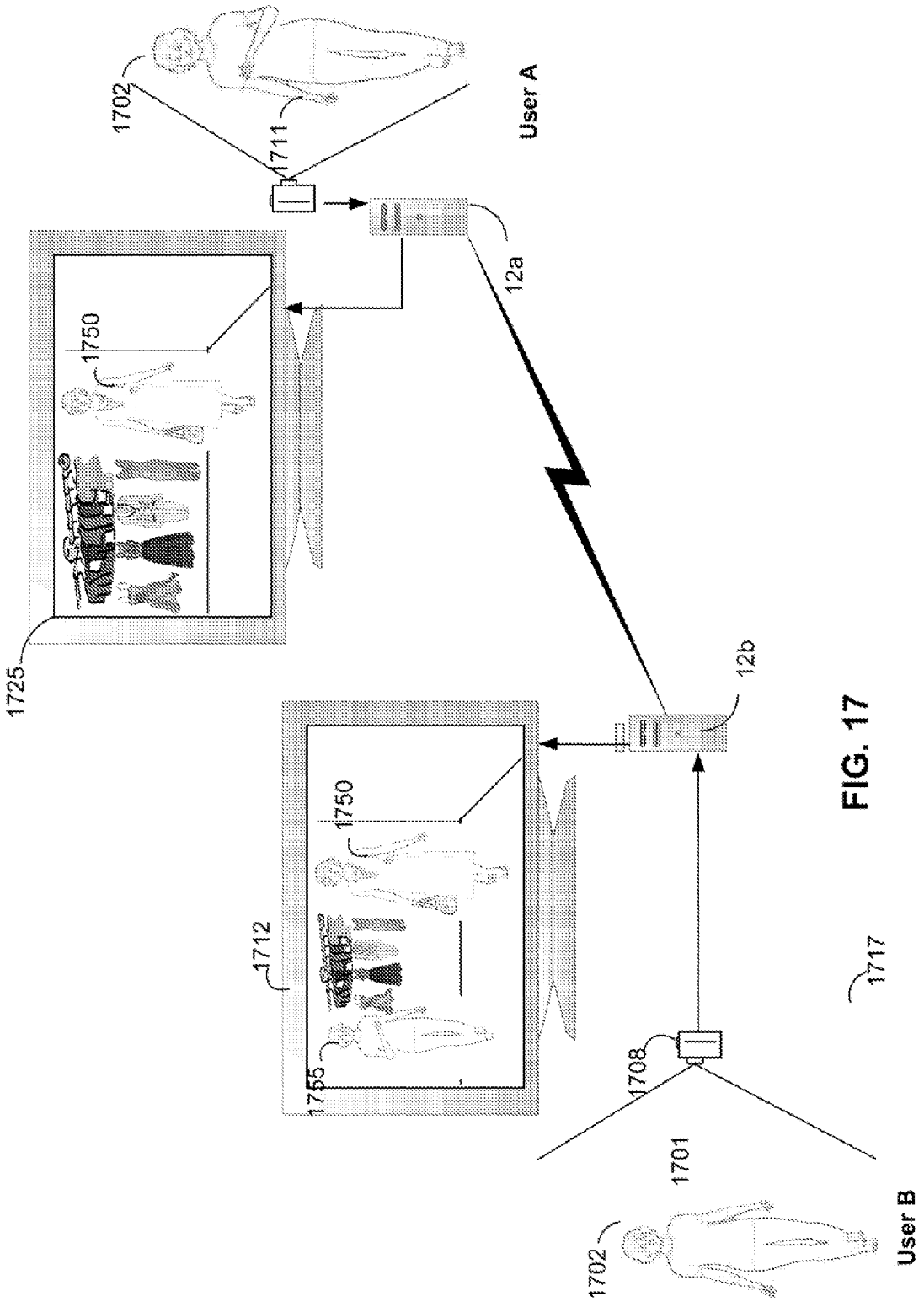

1702
1711
User A
12a
1750
1725
12b
1750
1712
1755
1708
1717
1701
1702
User B

FIG. 17

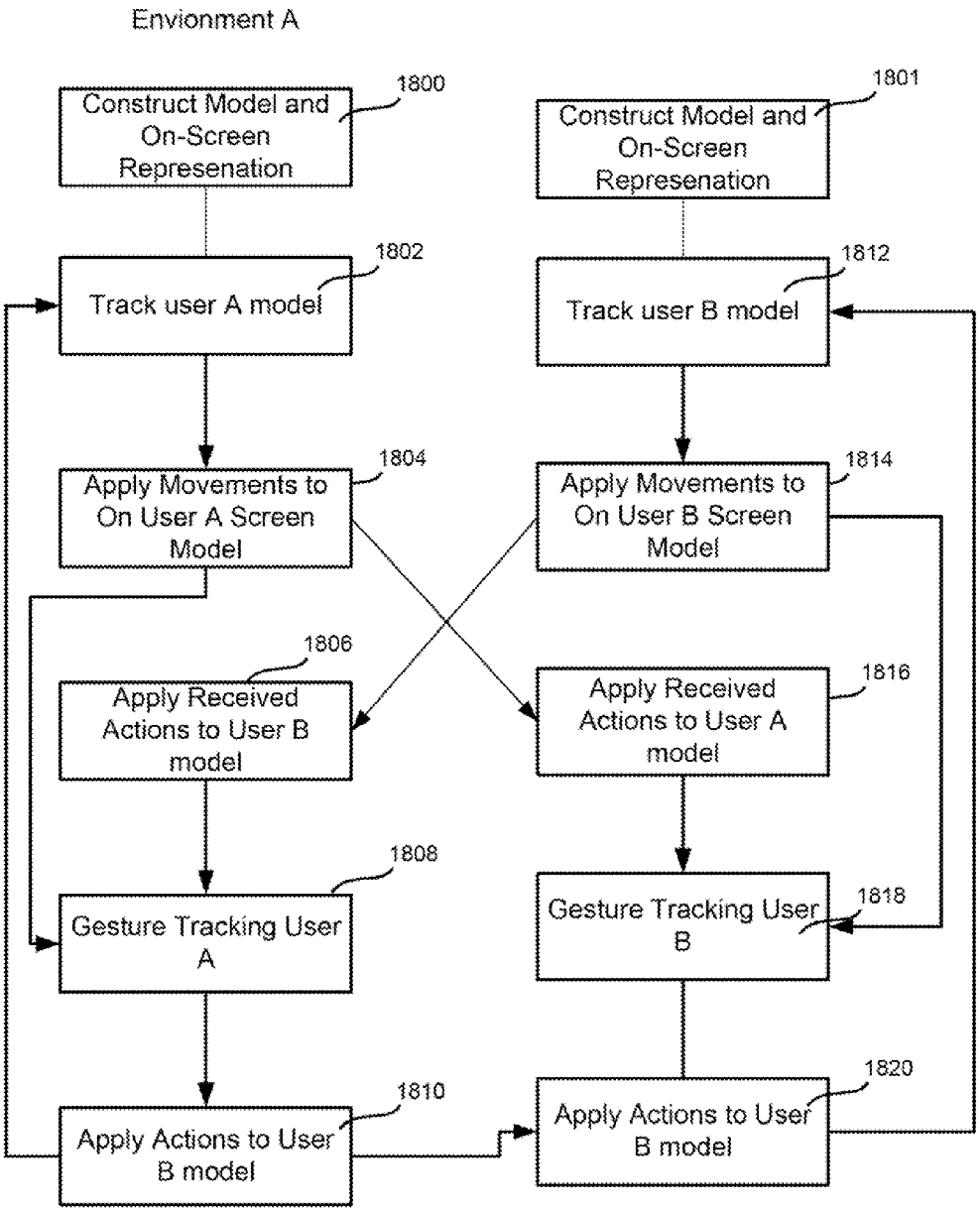

Envionment A
Construct Model and On-Screen Represenation
1800
Construct Model and On-Screen Represenation
1801
Track user A model
1802
Track user B model
1812
Apply Movements to On User A Screen Model
1804
Apply Movements to On User B Screen Model
1814
Apply Received Actions to User B model
1806
Apply Received Actions to User A model
1816
Gesture Tracking User A
1808
Gesture Tracking User B
1818
Apply Actions to User B model
1810
Apply Actions to User B model
1820

FIG. 18

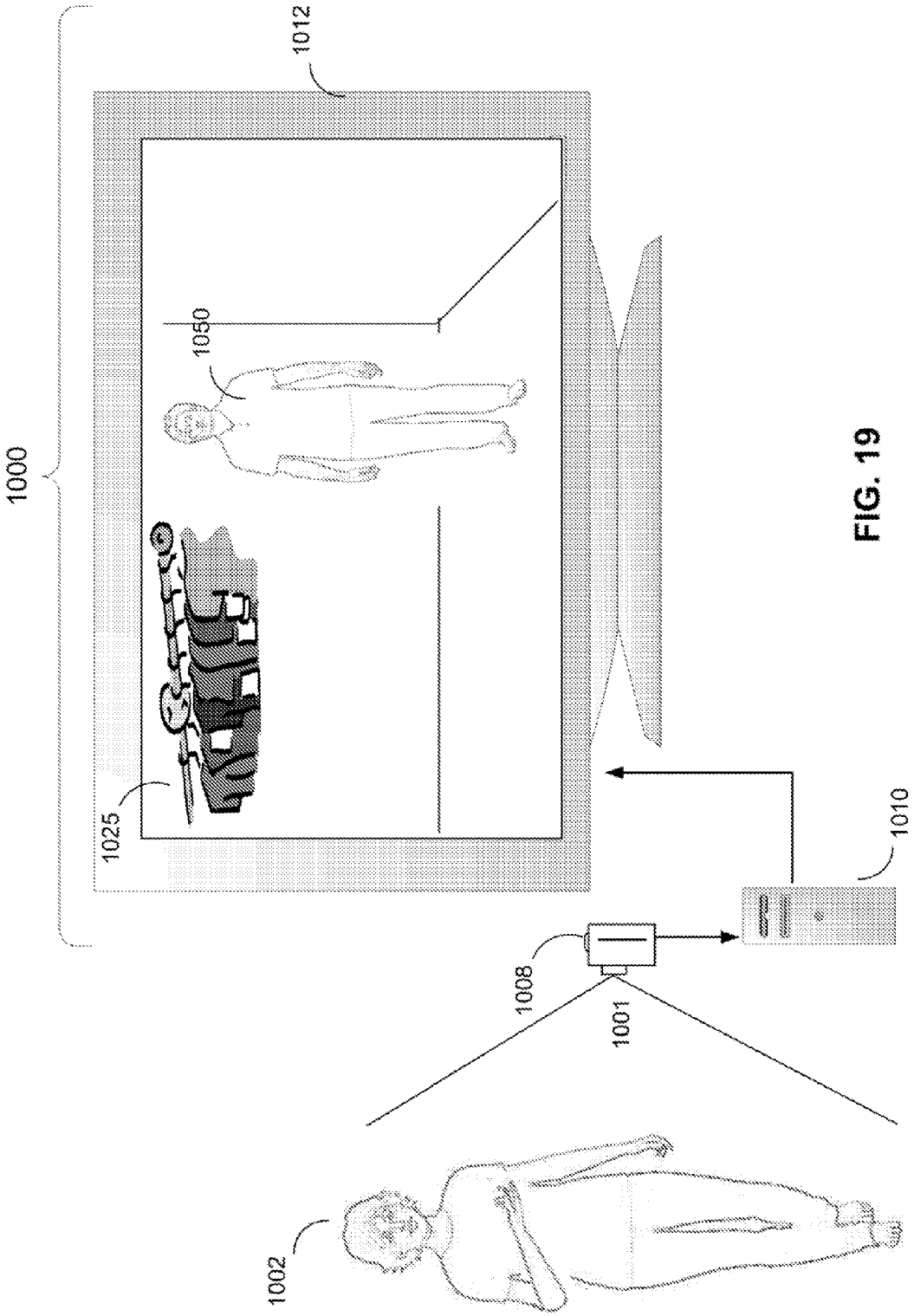


FIG. 19

MOTION-BASED INTERACTIVE SHOPPING ENVIRONMENT

BACKGROUND

[0001] On-line shopping has become increasingly popular, but suffers from the fact that users may not be aware of how a particular article will work for them. Users may not be aware how an article of clothing fits them or how a piece of furniture will appear in their home. Some attempts to solve this problem include the use of virtual models which are built from a library of stock model parts.

[0002] Current solutions to assist a user in determining how articles will work for their particular needs are limited.

SUMMARY

[0003] An on-screen shopping application which reacts to a human target user's motions to provide a shopping experience to the user is provided. A tracking system is used to track user motions and execute a shopping application. An on-screen representation of a human target user, representative of the likeness of the user or another individual, is presented on a display device. Movements of the human target user are tracked and displayed on the display device. An on-screen interface allows the user to interact with virtual articles that represent real-world articles available to the user. User movements which are recognized as article manipulation or transaction control gestures are translated into commands for the shopping application.

[0004] In one aspect, the application comprises a computer implemented method wherein a scene including a human target user is captured using a capture device which is part of the tracking system. A representation of the scene and the human target is rendered on a display device. An interface is presented allowing the human target to select and position one or more of a plurality of virtual articles representing real articles available for purchase in the representation on the display device. User movements are tracked in the scene and the movements applied to the representation of the human target. Movements are applied to at least one of the virtual articles in the representation when the motions of the human target in the scene indicate an article manipulation gesture. User movements are applied to a purchasing interface when the motions of the human target in the scene indicate an transaction manipulation gesture

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] FIGS. **1**A and **1**B illustrate an example embodiment of a tracking system with a user playing a game.

[0006] FIG. **2** illustrates an example embodiment of a capture device that may be used as part of the tracking system.

[0007] FIG. **3** depicts an example of a processing device that may be used to track motion and execute and application based on the tracked motion.

[0008] FIG. **4** illustrates a second example embodiment of a computing system that may be used to track motion and update an application based on the tracked motion.

[0009] FIG. **5** is a flowchart illustrating a method which may be implemented by the devices illustrated in FIGS. **1-4** to execute an application.

[0010] FIG. **6** is a flow chart describing one embodiment for automatically sensing one or more physical properties of an environment.

[0011] FIG. **7** is a flowchart illustrating selection of a human target within a scene.

[0012] FIG. **8** illustrates an example embodiment of a skeletal model **808** representing a scanned human target used to track a human target in a scene.

[0013] FIG. **9** illustrates a user **1002** and an on-screen representation of the user **1050** provided by system **20**.

[0014] FIG. **10** is a flowchart illustrating a method for creating an on-screen representation of a human target.

[0015] FIG. **11** is a flowchart illustrating a method performed by a computer to implement an on-screen shopping application.

[0016] FIG. **12** is a representation of an on-screen representation of a user and a user interface.

[0017] FIG. **13** is a representation of an on-screen representation of a human target user in a virtual background.

[0018] FIG. **14** is an example embodiment of a tracking system implementing a shopping application using virtual articles.

[0019] FIG. **15** is a representation of an on-screen interface without a human target in a virtual scene.

[0020] FIG. **16** is a block diagram depicting various tracking systems connected via a network with on-line retailers and a gaming service.

[0021] FIG. **17** is a block diagram depicting various tracking systems connected via a network.

[0022] FIG. **18** is a flowchart illustrating how two users on different systems may interact using in an on-screen shopping application.

[0023] FIG. **19** illustrates a human target user and an on-screen representation of another human target user.

DETAILED DESCRIPTION

[0024] Technology is provided wherein a computing system runs an on-screen shopping application which reacts to a human target user's motions to provide a shopping experience to the user. A tracking system is used to track user motions and execute a shopping application. An on-screen representation of a human target user, representative of the likeness of the user or another individual, is presented on a display device. Movements of the human target user are tracked and displayed on the display device. An on-screen interface allows the user to interact with virtual articles that represent real-world articles available to the user. User movements which are recognized as article manipulation or transaction control gestures are translated into commands for the shopping application.

[0025] In one embodiment, the shopping solution provided herein utilizes a system **10** which tracks user movements and presents an on-screen representation of a user (and/or other users), and allows interaction by one or more movements of the human target, or tracked, user.

[0026] FIGS. **1**A and **1**B illustrate an example embodiment of a system **10** which can be used with the present technology. One use of the exemplary tracking system **10** is where a user **18** plays a game. In FIG. **1** the example is the user playing a boxing game. In an example embodiment, the system **10** may be used to recognize, analyze, and/or track a human target such as the user **18** or other objects within range of tracking system **10**.

[0027] As shown in FIG. **1**, tracking system **10** may include a computing system **12**. The computing system **12** may be a computer, a gaming system or console, or the like. According to an example embodiment, the computing system **12** may

include hardware components and/or software components such that computing system **12** may be used to execute applications such as gaming applications, non-gaming applications, or the like. In one embodiment, computing system **12** may include a processor such as a standardized processor, a specialized processor, a microprocessor, or the like that may execute instructions stored on a processor readable storage device for performing the processes described herein.

[0028] As shown in FIG. **1**A, tracking system **10** may further include a capture device **20**. The capture device **20** may be, for example, a camera that may be used to visually monitor one or more users, such as the user **18**, such that gestures and/or movements performed by the one or more users may be captured, analyzed, and tracked to perform one or more controls or actions within the application and/or animate an avatar or on-screen character, as will be described in more detail below.

[0029] According to one embodiment, the tracking system **10** may be connected to an audio/visual device **16** such as a television, a monitor, a high-definition television (HDTV), or the like that may provide game or application visuals and/or audio to a user such as the user **18**. For example, the computing system **12** may include a video adapter such as a graphics card and/or an audio adapter such as a sound card that may provide audio/visual signals associated with the game application, non-game application, or the like. The audio/visual device **16** may receive the audio/visual signals from the computing system **12** and may then output the game or application visuals and/or audio associated with the audio/visual signals to the user **18**. According to one embodiment, the audio/visual device **16** may be connected to the computing system **12** via, for example, an S-Video cable, a coaxial cable, an HDMI cable, a DVI cable, a VGA cable, component video cable, or the like.

[0030] As shown in FIGS. **1**A and **1**B, the tracking system **10** may be used to recognize, analyze, and/or track a human target such as the user **18**. For example, the user **18** may be tracked using the capture device **20** such that the gestures and/or movements of user **18** may be captured to animate an avatar or on-screen character and/or may be interpreted as controls that may be used to affect the application being executed by computer environment **12**. Thus, according to one embodiment, the user **18** may move his or her body to control the application and/or animate the avatar or on-screen character. Similarly, tracking system **10** may be used to recognize, analyze, and/or track persons who are watching user **18** play the game so that movement by those persons watching user **18** play the game will control movement avatars in the audience at the boxing game displayed on audio/visual device **16**.

[0031] In the example depicted in FIGS. **1**A and **1**B, the application executing on the computing system **10** may be a boxing game that the user **18** is playing. For example, the computing system **12** may use the audio/visual device **16** to provide a visual representation of a boxing opponent **22** to the user **18**. The computing system **12** may also use the audio/visual device **16** to provide a visual representation of a user avatar **24** that the user **18** may control with his or her movements. For example, as shown in FIG. **1**B, the user **18** may throw a punch in physical space to cause the user avatar **24** to throw a punch in game space. Thus, according to an example embodiment, the computer system **12** and the capture device **20** recognize and analyze the punch of the user **18** in physical space such that the punch may be interpreted as a game control of the user avatar **24** in game space and/or the motion of the punch may be used to animate the user avatar **24** in game space.

[0032] In example embodiments, the human target such as the user **18** may have an object. In such embodiments, the user of an electronic game may be holding the object such that the motions of the user and the object may be used to adjust and/or control parameters of the game. Objects not held by the user can also be tracked, such as objects thrown, pushed or rolled by the user (or a different user) as well as self propelled objects. In addition to boxing, other games can also be implemented.

[0033] According to other example embodiments, the tracking system **10** may further be used to interpret target movements as operating system and/or application controls that are outside the realm of games. For example, virtually any controllable aspect of an operating system and/or application may be controlled by movements of the target such as the user **18**.

[0034] FIG. **2** illustrates an example embodiment of a capture device **20** that may be used for target recognition, analysis, and tracking in a scene, where the target can be a user or an object. According to an example embodiment, the capture device **20** may be configured to capture video with depth information including a depth image that may include depth values via any suitable technique including, for example, time-of-flight, structured light, stereo image, or the like. According to one embodiment, the capture device **20** may organize the calculated depth information into "Z layers," or layers that may be perpendicular to a Z axis extending from the depth camera along its line of sight.

[0035] As shown in FIG. **2**, the capture device **20** may include an image camera component **22**. According to an example embodiment, the image camera component **22** may be a depth camera that may capture the depth image of a scene. The depth image may include a two-dimensional (2-D) pixel area of the captured scene where each pixel in the 2-D pixel area may represent a depth value such as a length or distance in, for example, centimeters, millimeters, or the like of an object in the captured scene from the camera.

[0036] As shown in FIG. **2**, according to an example embodiment, the image camera component **22** may include an IR light component **24**, a three-dimensional (3-D) camera **26**, and an RGB camera **28** that may be used to capture the depth image of a scene. Each of these components is focused on a scene. For example, in time-of-flight analysis, the IR light component **24** of the capture device **20** may emit an infrared light onto the scene and may then use sensors (not shown) to detect the backscattered light from the surface of one or more targets and objects in the scene using, for example, the 3-D camera **26** and/or the RGB camera **28**. In some embodiments, pulsed infrared light may be used such that the time between an outgoing light pulse and a corresponding incoming light pulse may be measured and used to determine a physical distance from the capture device **20** to a particular location on the targets or objects in the scene. Additionally, in other example embodiments, the phase of the outgoing light wave may be compared to the phase of the incoming light wave to determine a phase shift. The phase shift may then be used to determine a physical distance from the capture device **20** to a particular location on the targets or objects.

[0037] According to another example embodiment, time-of-flight analysis may be used to indirectly determine a physi-

cal distance from the capture device **20** to a particular location on the targets or objects by analyzing the intensity of the reflected beam of light over time via various techniques including, for example, shuttered light pulse imaging.

[0038] In another example embodiment, the capture device **20** may use a structured light to capture depth information. In such an analysis, patterned light (i.e., light displayed as a known pattern such as grid pattern or a stripe pattern) may be projected onto the scene via, for example, the IR light component **24**. Upon striking the surface of one or more targets or objects in the scene, the pattern may become deformed in response. Such a deformation of the pattern may be captured by, for example, the 3-D camera **26** and/or the RGB camera **28** and may then be analyzed to determine a physical distance from the capture device **20** to a particular location on the targets or objects.

[0039] According to another embodiment, the capture device **20** may include two or more physically separated cameras that may view a scene from different angles, to obtain visual stereo data that may be resolved to generate depth information.

[0040] In another example embodiment, the capture device **20** may use point cloud data and target digitization techniques to detect features of the user.

[0041] The capture device **20** may further include a microphone **30**, or an array of microphones. The microphone **30** may include a transducer or sensor that may receive and convert sound into an electrical signal. According to one embodiment, the microphone **30** may be used to reduce feedback between the capture device **20** and the computing environment **12** in the target recognition, analysis, and tracking system **10**. Additionally, the microphone **30** may be used to receive audio signals that may also be provided by the user to control applications such as game applications, non-game applications, or the like that may be executed by the computing environment **12**.

[0042] In an example embodiment, the capture device **20** may further include a processor **32** that may be in operative communication with the image camera component **22**. The processor **32** may include a standardized processor, a specialized processor, a microprocessor, or the like that may execute instructions that may include instructions for receiving the depth image, determining whether a suitable target may be included in the depth image, converting the suitable target into a skeletal representation or model of the target, or any other suitable instruction.

[0043] The capture device **20** may further include a memory component **34** that may store the instructions that may be executed by the processor **32**, images or frames of images captured by the 3-d camera **26** or RGB camera **28**, or any other suitable information, images, or the like. According to an example embodiment, the memory component **34** may include random access memory (RAM), read only memory (ROM), cache, Flash memory, a hard disk, or any other suitable storage component. As shown in FIG. **2**, in one embodiment, the memory component **34** may be a separate component in communication with the image capture component **22** and the processor **32**. According to another embodiment, the memory component **34** may be integrated into the processor **32** and/or the image capture component **22**.

[0044] As shown in FIG. **2**, the capture device **20** may be in communication with the computing environment **12** via a communication link **36**. The communication link **36** may be a wired connection including, for example, a USB connection, a Firewire connection, an Ethernet cable connection, or the like and/or a wireless connection such as a wireless 802.11b, g, a, or n connection. According to one embodiment, the computing environment **12** may provide a clock to the capture device **20** that may be used to determine when to capture, for example, a scene via the communication link **36**.

[0045] Additionally, the capture device **20** may provide the depth information and images captured by, for example, the 3-D camera **26** and/or the RGB camera **28**, and a skeletal model that may be generated by the capture device **20** to the computing environment **12** via the communication link **36**. The computing environment **12** may then use the skeletal model, depth information, and captured images to, for example, control an application such as a game or word processor. For example, as shown, in FIG. **2**, the computing environment **12** may include a gestures library **192**.

[0046] Computing environment **12** may include a gesture recognition engine **190** including gesture filters **191**, a gestures library **192**, a display device **194**, a processor **195** including a feature comparison model **196**, a features library **197**, an image library **188**, user profile information **198**, a 3-D model library **198**, a 3-D model builder **193** and one or more applications **180**. In the present example, application **180** is an interactive shopping application.

[0047] Processor **195** can execute instructions for receiving data of a scene, wherein the data includes data representative of the target in a physical space. The instructions comprise instructions for detecting at least one target feature from the data, and comparing the at least one detected target feature to visual representation feature options from the features library **195**. The visual representation feature options may comprise selectable options configured for application to the visual representation. Further instructions provide for selecting a visual representation feature from the visual representation feature options, applying the visual representation feature to the visual representation of the target, and rendering the visual representation. The visual representation may be auto-generated from the comparison of the at least one detected feature to the visual representation feature options such that the selection of the visual representation feature is performed without manual selection by a user.

[0048] The selection of the visual representation feature may comprise selecting the visual representation feature that is similar to the detected target feature. The visual representation feature may be at least one of a facial feature, a body part, a color, a size, a height, a width, a shape, an accessory, or a clothing item. The instructions may provide for generating a subset of visual representation feature options, from the visual representation feature options, for the visual representation feature, and providing the generated subset of feature options for user selection of the visual representation feature to apply to the visual representation. The generated subset of visual representation feature options may comprise multiple visual representation feature options that are similar to the detected target feature. The instructions may provide for receiving a user selection of a visual representation feature from the generated subset of feature options, wherein selecting the visual representation feature from the visual representation feature options comprises selecting the visual representation feature that corresponds to the user selection. The visual representation, having the visual representation feature, may be rendered in real time. Furthermore, the instructions may provide for monitoring the target and detecting a change in the detected target feature, and updating the visual

representation of the target by updating the visual representation feature applied to the visual representation, in real time, based on the change in the detected target feature.

[0049] As shown, in FIG. **2**, the computing environment **12** may include a gestures library **192** and a gestures recognition engine **190**. The gestures recognition engine **190** may include a collection of gesture filters **191**. A filter may comprise code and associated data that can recognize gestures or otherwise process depth, RGB, or skeletal data. Each filter **191** may comprise information defining a gesture along with parameters, or metadata, for that gesture. For instance, a throw, which comprises motion of one of the hands from behind the rear of the body to past the front of the body, may be implemented as a gesture filter **191** comprising information representing the movement of one of the hands of the user from behind the rear of the body to past the front of the body, as that movement would be captured by a depth camera. Parameters may then be set for that gesture. Where the gesture is a throw, a parameter may be a threshold velocity that the hand has to reach, a distance the hand must travel (either absolute, or relative to the size of the user as a whole), and a confidence rating by the recognizer engine that the gesture occurred. These parameters for the gesture may vary between applications, between contexts of a single application, or within one context of one application over time.

[0050] While it is contemplated that the gestures recognition engine **190** may include a collection of gesture filters **191**, where a filter may comprise code or otherwise represent a component for processing depth, RGB, or skeletal data, the use of a filter is not intended to limit the analysis to a filter. The filter is a representation of an example component or section of code that analyzes data of a scene received by a system, and comparing that data to base information that represents a gesture. As a result of the analysis, the system may produce an output corresponding to whether the input data corresponds to the gesture. The base information representing the gesture may be adjusted to correspond to the recurring feature in the history of data representative of the user's capture motion. The base information, for example, may be part of a gesture filter as described above. But, any suitable manner for analyzing the input data and gesture data is contemplated.

[0051] In an example embodiment, a gesture may be recognized as a trigger for the entry into a modification mode, where a user can modify the visual representation auto-generated by the system. For example, a gesture filter **191** may comprise information for recognizing a modification trigger gesture. If the modification trigger gesture is recognized, the application may go into a modification mode. The modification trigger gesture may vary between applications, between systems, between users, or the like. For example, the same gesture in a tennis gaming application may not be the same modification trigger gesture in a bowling game application. Consider an example modification trigger gesture that comprises a user motioning the user's right hand, presented in front of the user's body, with the pointer finger pointing upward and moving in a circular motion. The parameters set for the modification trigger gesture may be used to identify that the user's hand is in front of the user's body, the user's pointer finger is pointed in an upward motion, and identifying that the pointer finger is moving in a circular motion.

[0052] Certain gestures may be identified as a request to enter into a modification mode, where if an application is currently executing, the modification mode interrupts the current state of the application and enters into a modification mode. The modification mode may cause the application to pause, where the application can be resumed at the pause point when the user leaves the modification mode. Alternately, the modification mode may not result in a pause to the application, and the application may continue to execute while the user makes modifications.

[0053] The data captured by the cameras **26**, **28** and device **20** in the form of the skeletal model and movements associated with it may be compared to the gesture filters **191** in the gestures library **192** to identify when a user (as represented by the skeletal model) has performed one or more gestures. Thus, inputs to a filter such as filter **191** may comprise things such as joint data about a user's joint position, like angles formed by the bones that meet at the joint, RGB color data from the scene, and the rate of change of an aspect of the user. As mentioned, parameters may be set for the gesture. Outputs from a filter **191** may comprise things such as the confidence that a given gesture is being made, the speed at which a gesture motion is made, and a time at which the gesture occurs.

[0054] The computing environment **12** may include a processor **195** that can process the depth image to determine what targets are in a scene, such as a user **18** or an object in the room. This can be done, for instance, by grouping together of pixels of the depth image that share a similar distance value. The image may also be parsed to produce a skeletal representation of the user, where features, such as joints and tissues that run between joints are identified. There exist skeletal mapping techniques to capture a person with a depth camera and from that determine various spots on that user's skeleton, joints of the hand, wrists, elbows, knees, nose, ankles, shoulders, and where the pelvis meets the spine. Other techniques include transforming the image into a body model representation of the person and transforming the image into a mesh model representation of the person.

[0055] In an embodiment, the processing is performed on the capture device **20**, and the raw image data of depth and color (where the capture device **20** comprises a 3-D camera **26**) values are transmitted to the computing environment **12** via link **36**. In another embodiment, the processing is performed by a processor **32** coupled to the camera **402** and then the parsed image data is sent to the computing environment **12**. In still another embodiment, both the raw image data and the parsed image data are sent to the computing environment **12**. The computing environment **12** may receive the parsed image data but it may still receive the raw data for executing the current process or application. For instance, if an image of the scene is transmitted across a computer network to another user, the computing environment **12** may transmit the raw data for processing by another computing environment.

[0056] The processor may have a features comparison module **196**. The features comparison module **196** may compare the detected features of a target to the options in the features library **197**. The features library **197** may provide visual representation feature options, such as color options, facial feature options, body type options, size options, etc, and the options may vary for human and non-human targets. The library may be a catalog, a database, memory, or the like, that stores the features for the visual representation. The library may an organized or unorganized collection of features options. The system or user may add features to the catalog. For example, an application may have a pre-packaged set of feature options or the system may have a default number of available features. Additional feature options may

be added to or updated in the features library **197**. For example, the user may purchase additional feature options in a virtual marketplace, a user may gift feature options to another user, or the system may generate feature options by taking a snapshot of the user's detected features.

[0057] The image library **188** may be a collection of images retrieved by the capture device **20** including particular features of users who interact with the capture device. Images may be used to render on-screen scenes in accordance with the discussion below. The image library **188** may also store images scanned by the capture device of articles in the scene.

[0058] The features comparison module **196** may make feature selections, such as from the catalog of feature options, that most closely resemble the detected features of the target. The system may auto-generate a virtual object that has the detected features. For example, consider the detection of a red, two-seater couch in the physical space. The system may identify the features from the features library **197** that, alone or in combination, resemble the detected target features of the couch In an example embodiment, the selection from the features library **197** may be as simple as selecting a virtual target that has at least one feature of the physical target. For example, the features library **197** may have numerous feature options for furniture and may include a virtual image or depiction of a red, two-seater couch. Such features may be pre-packaged and provided with an application or with the system. In another example, the system may take a snapshot of the physical couch and create a cartoon or virtual image that takes the shape of the physical couch. Thus, the feature selected may be from a snapshot of the physical couch previously taken by the system and added to the features library **197**.

[0059] The system may adjust the color, positioning, or scale of a selected feature based on the detected target features and store this information in a 3-D model library **199**. For example, the system may select a feature or combine several features from the features library **197** that resemble the features of the detected target. The system may add features to a selected feature or virtual image to more fully resemble the detected target. In the example of the detected couch, the system may perform a feature look-up in the features library **197** and identify a virtual frame for a couch having at least one feature that resembles a feature of the physical couch. For example, the system may initially select a virtual couch that resembles the detected physical couch in shape. If a virtual two-seater couch is an available feature option, the system may select the virtual two-seater. Colors may be feature options selectable by the system. In this example, if a red couch is specifically not an option in the features library **197**, the system may select a color from the features library **197** and apply it to the virtual frame selected. The system may select an existing color in the features library **197** that resembles the detected red color of the physical couch, or the system may take a snapshot of the color of the physical couch and add it to the features library as a feature option. The system may apply the selected red color feature to the virtual couch image.

[0060] Physical models may be components of the selected target. In general, modeling of cloth and garments worn by virtual models is performed by first attaching the cloth to a mesh to the body surface by defining attachment data of the garment mesh to the surface of the online representation. Cloth deformation makes use of shape of the underlying skin of a virtual model, or in this case the virtual representation. Each vertex of a garment mesh is associated with a triangle, edge, or vertex of a skin mesh.

[0061] Hence, for a garment, in one embodiment, a 3-D model includes a mesh of information use to determine how to apply the garment to a human model. Body deformation provides resizing of the cloth or garment model. Physics-based models have been developed that are able to simulate the dynamics of cloth independent of its use whether it's clothing or other situations such as furniture or tablecloths. Such models integrate complex clothing detection and simulate physical behavior of the garments. Any of these modeling techniques may be utilized to generate a three-dimensional article model for use in the application. One popular way of modeling the mechanics of clothes are spring-mass particle systems. They are composed of 3-D punctual masses, connected to their neighbors by springs. The mechanical behaviors of clothes are simulated by competing forces applied on each mass given their position and velocity. There are different ways to complete the numerical integration. Garments interact with objects in their environment either with the body that wears them or with other garment pieces. Dealing with collisions involves two types of problems, collision detection and collision response. A shopping application **180** will use this information stored in the 3-D model to find the geometrical contacts between the objects and integrate the resulting reaction and friction effects in a mechanical simulation presented on the display **194**.

[0062] In another example, the target is a human user and the system detects the user's features, such as eye color, size, and shape, hair color, type, and length, etc. The system may compare the detected features to a catalog of feature options and apply selected features to the visual representation. As described above, the system may combine features and alter those features. For example, the features may be altered by applying a color, positioning, or scaling to the target. The features may be altered by the selection of additional features from the features library **197**, such as a color, or by using image data from a snapshot of the target. For example, an application may provide a generic set of solid color pants, t-shirts, and shoe types in the features library **197**. The system may select from the generic clothing features but alter the selected clothing features by applying colors to the clothing to reflect the colors of the target's clothing detected by the system.

[0063] The 3-D model library storing features and models of elements used in an on-screen interface by a user. The 3-D model library may include physical models of articles formed in conjunction with the disclosure in U.S. patent application No (virtual object manipulation). Additional meta-data may be associated with each model to provide, for example, information on how the article interacts with other articles. For example, a 3-D model of a lamp may record the type light the lamp provides and the coverage of the light.

[0064] The computing environment **12** may use a 3-D Model Builder **193** to create 3-D models from scanned scene information available from the image library and the capture device.

[0065] In another example, the system may identify a subset of features in the features library **197** that resemble the user's features and provide the subset from which the user may choose. Thus, the number of options provided to the user for a particular feature may be intelligently filtered to make it easier for the user to customize the visual representation.

[0066] The computing environment **12** may use the gestures library **192** to interpret movements of the skeletal model and to control an application based on the movements. Filters may be modular or interchangeable so that a first filter may be replaced with a second filter that has the same number and types of inputs and outputs as the first filter without altering any other aspect of the recognizer engine architecture. For instance, there may be a first filter for driving that takes as input skeletal data and outputs a confidence that the gesture associated with the filter is occurring and an angle of steering. Where one wishes to substitute this first driving filter with a second driving filter—perhaps because the second driving filter is more efficient and requires fewer processing resources—one may do so by simply replacing the first filter with the second filter so long as the second filter has those same inputs and outputs—one input of skeletal data type, and two outputs of confidence type and angle type.

[0067] A filter need not have a parameter. For instance, a "user height" filter that returns the user's height may not allow for any parameters that may be tuned. An alternate "user height" filter may have tunable parameters—such as to whether to account for a user's footwear, hairstyle, headwear and posture in determining the user's height.

[0068] Inputs to a filter may comprise things such as joint data about a user's joint position, like angles formed by the bones that meet at the joint, RGB color data from the scene, and the rate of change of an aspect of the user. Outputs from a filter may comprise things such as the confidence that a given gesture is being made, the speed at which a gesture motion is made, and a time at which a gesture motion is made.

[0069] Gesture recognizer engine **190** provides functionality to the filters. In one embodiment, the functionality that the recognizer engine **190** implements includes an input-over-time archive that tracks recognized gestures and other input, a Hidden Markov Model implementation (where the modeled system is assumed to be a Markov process—one where a present state encapsulates any past state information necessary to determine a future state, so no other past state information must be maintained for this purpose—with unknown parameters, and hidden parameters are determined from the observable data), as well as other functionality required to solve particular instances of gesture recognition.

[0070] Filters **191** are loaded and implemented on top of recognizer engine **190** and can utilize services provided by recognizer engine **190**. Application **180** may use the filters **191** provided by the recognizer engine **190**, or it may provide its own filters which plugs into recognizer engine **190**. In one embodiment, all filters have a common interface to enable this plug-in characteristic. Further, all filters may utilize parameters, so a single gesture tool below may be used to debug and tune the entire filter system.

[0071] More information about recognizer engine **190** can be found in U.S. patent application Ser. No. 12/422,661, "Gesture Recognizer System Architecture," filed on Apr. 13, 2009, incorporated herein by reference in its entirety. More information about recognizing gestures can be found in U.S. patent application Ser. No. 12/391,150, "Standard Gestures," filed on Feb. 23, 2009; and U.S. patent application Ser. No. 12/474,655, "Gesture Tool" filed on May 29, 2009. Both of which are incorporated by reference herein in their entirety.

[0072] The computing environment **12** can model and display a representation of a human target user, or a representation of another individual for whom a 3D model is stored, such as in the form of an avatar or a pointer on a display, such as in a display device **193**. Display device **193** may include a computer monitor, a television screen, or any suitable display device. For example, a camera-controlled computer system may capture user image data and display user feedback on a television screen that maps to the user's gestures. The user feedback may be displayed as an avatar or other on screen representation of the user, on the screen such as shown in FIGS. **1**A and **1**B. The avatar's motion can be controlled directly by mapping the avatar's movement to those of the user's movements. The user's gestures may be interpreted control certain aspects of the application.

[0073] According to an example embodiment, the target may be a human target in any position such as standing or sitting, a human target with an object, two or more human targets, one or more appendages of one or more human targets or the like that may be scanned, tracked, modeled and/or evaluated to generate a virtual screen, compare the user to one or more stored profiles and/or to store profile information **198** about the target in a computing environment such as computing environment **12**. The profile information **198** may be in the form of user profiles, personal profiles, application profiles, system profiles, or any other suitable method for storing data for later access. The profile information **198** may be accessible via an application or be available system-wide, for example. The profile information **198** may include lookup tables for loading specific user profile information. The virtual screen may interact with an application that may be executed by the computing environment **12** described above with respect to FIGS. **1**A-**1**B.

[0074] The system may render a visual representation of a human target, such as a user, by auto-generating the visual representation based on information stored in the user's profile. According to example embodiments, lookup tables may include user specific profile information. In one embodiment, the computing environment such as computing environment **12** may include stored profile data **198** about one or more users in lookup tables. The stored profile data **198** may include, among other things the targets scanned or estimated body size, skeletal models, body models, voice samples or passwords, the target's gender, the targets age, previous gestures, target limitations and standard usage by the target of the system, such as, for example a tendency to sit, left or right handedness, or a tendency to stand very near the capture device. This information may be used to determine if there is a match between a target in a capture scene and one or more user profiles **198**, which, in one embodiment, may allow the system to adapt the virtual screen to the user, or to adapt other elements of the computing or gaming experience according to the profile **198**.

[0075] Previously selected features for the target's visual representation may be stored in a profile. For example, a user-specific profile may store the features selected and applied to auto-generate the user's visual representation. A location-specific profile may store features selected and applied to auto-generate and display a virtual scene that resembles the physical space. For example, virtual objects that correspond to objects in the physical space, such as furniture in the room, may be generated by selecting from options in the features library **197**. Colors may be detected and available colors may be selected from the features library **197**. Upon recognition or initialization by the system, the location-specific profile may be loaded, displaying the furniture and colors that correspond to the location.

[0076] One or more personal profiles **198** may be stored in computer environment **12** and used in a number of user sessions, or one or more personal profiles may be created for a single session only.

[0077] The gestures library **192**, gestures recognition engine **190**, features library **197**, features comparer **196** and profile **198** may be implemented in hardware, software or a combination of both. For example, the gestures library **192**, and gestures recognition engine **190**. may be implemented as software that executes on a processor, such as processor **195**, of the computing environment **12** (or on processing unit **101** of FIG. **3** or processing unit **259** of FIG. **4**). The gestures library and filter parameters may be tuned for an application or a context of an application by a gesture tool. A context may be a cultural context, and it may be an environmental context.

[0078] It is emphasized that the block diagram depicted in FIGS. **3**-**4** described below are exemplary and not intended to imply a specific implementation. Thus, the processor **195** FIG. **2**, the processing unit **101** of FIG. **3**, and the processing unit **259** of FIG. **4**, can be implemented as a single processor or multiple processors. Multiple processors can be distributed or centrally located. For example, the gestures library **192** may be implemented as software that executes on the processor **32** of the capture device or it may be implemented as software that executes on the processor **195** in the computing environment **12**. Any combination of processors that are suitable for performing the techniques disclosed herein are contemplated. Multiple processors can communicate wirelessly, via hard wire, or a combination thereof.

[0079] Furthermore, as used herein, a computing environment **12** may refer to a single computing device or to a computing system. The computing environment may include non-computing components. The computing environment may include a display device, such as display device **194** shown in FIG. **2**. A display device may be an entity separate but coupled to the computing environment or the display device may be the computing device that processes and displays, for example. Thus, a computing system, computing device, computing environment, computer, processor, or other computing component may be used interchangeably.

[0080] FIG. **3** illustrates an example embodiment of a computing system that may be the computing system **12** shown in FIGS. **1**A-**2** used to track motion and/or animate (or otherwise update) an avatar or other on-screen object displayed by an application. The computing system such as the computing system **12** described above with respect to FIGS. **1**A-**2** may be a multimedia console **100**, such as a gaming console. As shown in FIG. **3**, the multimedia console **100** has a central processing unit (CPU) **101** having a level 1 cache **102**, a level 2 cache **104**, and a flash ROM (Read Only Memory) **106**. The level 1 cache **102** and a level 2 cache **104** temporarily store data and hence reduce the number of memory access cycles, thereby improving processing speed and throughput. The CPU **101** may be provided having more than one core, and thus, additional level 1 and level 2 caches **102** and **104**. The flash ROM **106** may store executable code that is loaded during an initial phase of a boot process when the multimedia console **100** is powered on.

[0081] A graphics processing unit (GPU) **108** and a video encoder/video codec (coder/decoder) **114** form a video processing pipeline for high speed and high resolution graphics processing. Data is carried from the graphics processing unit **108** to the video encoder/video codec **114** via a bus. The video processing pipeline outputs data to an A/V (audio/video) port **140** for transmission to a television or other display. A memory controller **110** is connected to the GPU **108** to facilitate processor access to various types of memory **112**, such as, but not limited to, a RAM (Random Access Memory).

[0082] The multimedia console **100** includes an I/O controller **120**, a system management controller **122**, an audio processing unit **123**, a network interface controller **124**, a first USB host controller **126**, a second USB controller **128** and a front panel I/O subassembly **130** that are preferably implemented on a module **118**. The USB controllers **126** and **128** serve as hosts for peripheral controllers **142**(**1**)-**142**(**2**), a wireless adapter **148**, and an external memory device **146** (e.g., flash memory, external CD/DVD ROM drive, removable media, etc.). The network interface **124** and/or wireless adapter **148** provide access to a network (e.g., the Internet, home network, etc.) and may be any of a wide variety of various wired or wireless adapter components including an Ethernet card, a modem, a Bluetooth module, a cable modem, and the like.

[0083] System memory **143** is provided to store application data that is loaded during the boot process. A media drive **144** is provided and may comprise a DVD/CD drive, Blu-Ray drive, hard disk drive, or other removable media drive, etc. The media drive **144** may be internal or external to the multimedia console **100**. Application data may be accessed via the media drive **144** for execution, playback, etc. by the multimedia console **100**. The media drive **144** is connected to the I/O controller **120** via a bus, such as a Serial ATA bus or other high speed connection (e.g., IEEE 1394).

[0084] The system management controller **122** provides a variety of service functions related to assuring availability of the multimedia console **100**. The audio processing unit **123** and an audio codec **132** form a corresponding audio processing pipeline with high fidelity and stereo processing. Audio data is carried between the audio processing unit **123** and the audio codec **132** via a communication link. The audio processing pipeline outputs data to the A/V port **140** for reproduction by an external audio user or device having audio capabilities.

[0085] The front panel I/O subassembly **130** supports the functionality of the power button **150** and the eject button **152**, as well as any LEDs (light emitting diodes) or other indicators exposed on the outer surface of the multimedia console **100**. A system power supply module **136** provides power to the components of the multimedia console **100**. A fan **138** cools the circuitry within the multimedia console **100**.

[0086] The CPU **101**, GPU **108**, memory controller **110**, and various other components within the multimedia console **100** are interconnected via one or more buses, including serial and parallel buses, a memory bus, a peripheral bus, and a processor or local bus using any of a variety of bus architectures. By way of example, such architectures can include a Peripheral Component Interconnects (PCI) bus, PCI-Express bus, etc.

[0087] When the multimedia console **100** is powered on, application data may be loaded from the system memory **143** into memory **112** and/or caches **102**, **104** and executed on the CPU **101**. The application may present a graphical user interface that provides a consistent user experience when navigating to different media types available on the multimedia console **100**. In operation, applications and/or other media contained within the media drive **144** may be launched or played from the media drive **144** to provide additional functionalities to the multimedia console **100**.

[0088] The multimedia console **100** may be operated as a standalone system by simply connecting the system to a television or other display. In this standalone mode, the multimedia console **100** allows one or more users to interact with the system, watch movies, or listen to music. However, with the integration of broadband connectivity made available through the network interface **124** or the wireless adapter **148**, the multimedia console **100** may further be operated as a participant in a larger network community.

[0089] When the multimedia console **100** is powered ON, a set amount of hardware resources are reserved for system use by the multimedia console operating system. These resources may include a reservation of memory (e.g., 16 MB), CPU and GPU cycles (e.g., 5%), networking bandwidth (e.g., 8 kbs), etc. Because these resources are reserved at system boot time, the reserved resources do not exist from the application's view.

[0090] In particular, the memory reservation preferably is large enough to contain the launch kernel, concurrent system applications and drivers. The CPU reservation is preferably constant such that if the reserved CPU usage is not used by the system applications, an idle thread will consume any unused cycles.

[0091] With regard to the GPU reservation, lightweight messages generated by the system applications (e.g., pop ups) are displayed by using a GPU interrupt to schedule code to render popup into an overlay. The amount of memory required for an overlay depends on the overlay area size and the overlay preferably scales with screen resolution. Where a full user interface is used by the concurrent system application, it is preferable to use a resolution independent of application resolution. A scaler may be used to set this resolution such that the need to change frequency and cause a TV resynch is eliminated.

[0092] After the multimedia console **100** boots and system resources are reserved, concurrent system applications execute to provide system functionalities. The system functionalities are encapsulated in a set of system applications that execute within the reserved system resources described above. The operating system kernel identifies threads that are system application threads versus gaming application threads. The system applications are preferably scheduled to run on the CPU **101** at predetermined times and intervals in order to provide a consistent system resource view to the application. The scheduling is to minimize cache disruption for the gaming application running on the console.

[0093] When a concurrent system application requires audio, audio processing is scheduled asynchronously to the gaming application due to time sensitivity. A multimedia console application manager (described below) controls the gaming application audio level (e.g., mute, attenuate) when system applications are active.

[0094] Input devices (e.g., controllers **142**(**1**) and **142**(**2**)) are shared by gaming applications and system applications. The input devices are not reserved resources, but are to be switched between system applications and the gaming application such that each will have a focus of the device. The application manager preferably controls the switching of input stream, without knowledge the gaming application's knowledge and a driver maintains state information regarding focus switches. The cameras **26**, **28** and capture device **20** may define additional input devices for the console **100** via USB controller **126** or other interface.

[0095] FIG. **4** illustrates another example embodiment of a computing system **220** that may be used to implement the computing system **12** shown in FIGS. **1**A-**2** to track motion and/or animate (or otherwise update) an avatar or other on-screen object displayed by an application. The computing system environment **220** is only one example of a suitable computing system and is not intended to suggest any limitation as to the scope of use or functionality of the presently disclosed subject matter. Neither should the computing system **220** be interpreted as having any dependency or requirement relating to any one or combination of components illustrated in the exemplary operating system **220**. In some embodiments the various depicted computing elements may include circuitry configured to instantiate specific aspects of the present disclosure. For example, the term circuitry used in the disclosure can include specialized hardware components configured to perform function(s) by firmware or switches. In other examples embodiments the term circuitry can include a general purpose processing unit, memory, etc., configured by software instructions that embody logic operable to perform function(s). In example embodiments where circuitry includes a combination of hardware and software, an implementer may write source code embodying logic and the source code can be compiled into machine readable code that can be processed by the general purpose processing unit. Since one skilled in the art can appreciate that the state of the art has evolved to a point where there is little difference between hardware, software, or a combination of hardware/software, the selection of hardware versus software to effectuate specific functions is a design choice left to an implementer. More specifically, one of skill in the art can appreciate that a software process can be transformed into an equivalent hardware structure, and a hardware structure can itself be transformed into an equivalent software process. Thus, the selection of a hardware implementation versus a software implementation is one of design choice and left to the implementer.

[0096] Computing system **220** comprises a computer **241**, which typically includes a variety of computer readable media. Computer readable media can be any available media that can be accessed by computer **241** and includes both volatile and nonvolatile media, removable and non-removable media. The system memory **222** includes computer storage media in the form of volatile and/or nonvolatile memory such as read only memory (ROM) **223** and random access memory (RAM) **260**. A basic input/output system **224** (BIOS), containing the basic routines that help to transfer information between elements within computer **241**, such as during start-up, is typically stored in ROM **223**. RAM **260** typically contains data and/or program modules that are immediately accessible to and/or presently being operated on by processing unit **259**. By way of example, and not limitation, FIG. **4** illustrates operating system **225**, application programs **226**, other program modules **227**, and program data **228**.

[0097] The computer **241** may also include other removable/non-removable, volatile/nonvolatile computer storage media. By way of example only, FIG. **4** illustrates a hard disk drive **238** that reads from or writes to non-removable, nonvolatile magnetic media, a magnetic disk drive **239** that reads from or writes to a removable, nonvolatile magnetic disk **254**, and an optical disk drive **240** that reads from or writes to a removable, nonvolatile optical disk **253** such as a CD ROM or other optical media. Other removable/non-removable, vola-

tile/nonvolatile computer storage media that can be used in the exemplary operating environment include, but are not limited to, magnetic tape cassettes, flash memory cards, digital versatile disks, digital video tape, solid state RAM, solid state ROM, and the like. The hard disk drive **238** is typically connected to the system bus **221** through an non-removable memory interface such as interface **234**, and magnetic disk drive **239** and optical disk drive **240** are typically connected to the system bus **221** by a removable memory interface, such as interface **235**.

[0098] The drives and their associated computer storage media discussed above and illustrated in FIG. **4**, provide storage of computer readable instructions, data structures, program modules and other data for the computer **241**. In FIG. **4**, for example, hard disk drive **238** is illustrated as storing operating system **258**, application programs **257**, other program modules **256**, and program data **255**. Note that these components can either be the same as or different from operating system **225**, application programs **226**, other program modules **227**, and program data **228**. Operating system **258**, application programs **257**, other program modules **256**, and program data **255** are given different numbers here to illustrate that, at a minimum, they are different copies. A user may enter commands and information into the computer **241** through input devices such as a keyboard **251** and pointing device **252**, commonly referred to as a mouse, trackball or touch pad. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, or the like. These and other input devices are often connected to the processing unit **259** through a user input interface **236** that is coupled to the system bus, but may be connected by other interface and bus structures, such as a parallel port, game port or a universal serial bus (USB). The cameras **26**, **28** and capture device **20** may define additional input devices for the console **100** that connect via user input interface **236**. A monitor **242** or other type of display device is also connected to the system bus **221** via an interface, such as a video interface **232**. In addition to the monitor, computers may also include other peripheral output devices such as speakers **244** and printer **243**, which may be connected through a output peripheral interface **233**. Capture Device **20** may connect to computing system **220** via output peripheral interface **233**, network interface **237**, or other interface.

[0099] The computer **241** may operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **246**. The remote computer **246** may be a personal computer, a server, a router, a network PC, a peer device or other common network node, and typically includes many or all of the elements described above relative to the computer **241**, although only a memory storage device **247** has been illustrated in FIG. **4**. The logical connections depicted include a local area network (LAN) **245** and a wide area network (WAN) **249**, but may also include other networks. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets and the Internet.

[0100] When used in a LAN networking environment, the computer **241** is connected to the LAN **245** through a network interface or adapter **237**. When used in a WAN networking environment, the computer **241** typically includes a modem **250** or other means for establishing communications over the WAN **249**, such as the Internet. The modem **250**, which may be internal or external, may be connected to the system bus **221** via the user input interface **236**, or other appropriate mechanism. In a networked environment, program modules depicted relative to the computer **241**, or portions thereof, may be stored in the remote memory storage device. By way of example, and not limitation, FIG. **5** illustrates application programs **248** as residing on memory device **247**. It will be appreciated that the network connections shown are exemplary and other means of establishing a communications link between the computers may be used.

[0101] Either of the systems of FIG. **3** or **4**, or a different computing system, can be used to implement Computing System **12** of FIG. **2**. As explained above, computing system **12** determines the motions of the users and employs those detected motions to control a video game or other application. For example, a user's motions can be used to control an avatar and/or object in a video game. In some embodiments, the system can simultaneously track multiple users and allow the motion of multiple users to control or effect the application.

[0102] The system will use the RGB images and depth images to track a user's movements. For example, the system will track a skeleton of a person using a depth images. There are many methods that can be used to track the skeleton of a person using depth images. One suitable example of tracking a skeleton using depth images is provided in U.S. patent application Ser. No. 12/603,437, "Pose Tracking Pipeline," filed on Oct. 21, 2009. (hereinafter referred to as the '437 application), incorporated herein by reference in its entirety. The process of the '437 application includes acquiring a depth image, down sampling the data, removing and/or smoothing high variance noisy data, identifying and removing the background, and assigning each of the foreground pixels to different parts of the body. Based on those steps, the system will fit a model with the data and create a skeleton. The skeleton will include a set of joints and connections between the joints.

[0103] In one embodiment, in order for a user's motion to be used to control an application the user must first be enrolled or bound to the application. In one embodiment, each user will be asked to identify himself or herself by standing in front of the system so that depth images and/or visual images can be obtained from multiple angles for that user. For example, the user may be asked to stand in front of the camera, turn around, and make various poses while depth images and visual images are obtained. After the system obtains enough depth and/or visual images, the system will create a set of identifying data from the images that uniquely identifies the user. The system will create a unique identification and associate that unique identification with on-screen representation (e.g., avatar) or other object in the game/application. After a user is enrolled in (or bound to) the application, the system will track the motion of that user while the user is actively engaged with the application (e.g., playing the game or using the application). However, in the past, other people in the room who are not actively engaged with the application, (e.g., not bound to application, bound to application but not playing current game, or bound to application but currently not having a turn to play) do not have a way to interact with the application.

[0104] FIG. **5** is a flow chart illustrating a general method to provide an independent motion tracking based shopping application in accordance with the present technology.

[0105] In FIG. **5**, a scene is scanned at **402** in accordance with the discussion herein using the capture system illustrated in FIG. **2** and the process described below at FIG. **6**. At step **404**, the system time determines whether the scene includes a

human target. Selection of a human target within a scene is discussed below with respect to FIG. **7**. At step **406**, scanning is continuous until a human target is found. Once a human target is detected at **406**, a model of the human target is generated at **408**. A model of the target is illustrated in FIG. **8**. At step **410**, the model is continuously tracked.

[0106] Suitable tracking technology is also disclosed in U.S. patent application Ser. No. 12/475,308, "Device for Identifying and Tracking Multiple Humans Over Time," filed on May 29, 2009, incorporated herein by reference in its entirety; U.S. patent application Ser. No. 12/696,282, "Visual Based Identity Tracking," filed on Jan. 29, 2010, incorporated herein by reference in its entirety; U.S. patent application Ser. No. 12/641,788, "Motion Detection Using Depth Images," filed on Dec. 18, 2009, incorporated herein by reference in its entirety; and U.S. patent application Ser. No. 12/575,388, "Human Tracking System," filed on Oct. 7, 2009, incorporated herein by reference in its entirety.

[0107] Movements of the model are presented to the system which waits for a gesture or other indication indicating that the user wishes to engage or otherwise perform an action on system **10**. If the gesture is recognized at **412**, a determination is made as to whether or not the gesture indicates the user wishes to engage in a shopping application at **414**. If not, another application may be engaged at **418** and application gestures beyond that point tracked at step **410** are sent to the engaged application at **418**. Other applications at **418** may include video games such as those illustrated in FIG. **1**A or **1**B as well as administrative tasks available to users of system **10**.

[0108] Techniques for gesture recognition are disclosed in U.S. patent application Ser. No. 12/422,661, "Gesture Recognizer System Architecture," filed on Apr. 13, 2009; U.S. patent application Ser. No. 12/391,150, "Standard Gestures," filed on Feb. 23, 2009; and U.S. patent application Ser. No. 12/474,655, "Gesture Tool" filed on May 29, 2009, all of which are incorporated by reference herein in their entirety.

[0109] If the shopping application is engaged at **414**, an on-screen representation of the human target is generated at **420**. At **422**, a shopping interface is generated on the display **16**. The shopping interface may comprise any variety of interface designed to allow the user to manipulate a series of virtual articles presented in the interface through movements captured by the system **10**. The virtual articles presented represent real-world articles that a user may acquire through vendors, or which the user may already own and which the user wishes to have presented in the on-screen representation. For example, a user may wish to shop for a new item to match to a user's existing inventory of items. Representations of both items may be presented.

[0110] The model of the human target is continuously tracked at **410** and movements of the human target model are applied to the on-screen model at **430**. This is discussed below with respect to FIGS. **6** and **11**, and performed in accordance with the teachings of U.S. application Ser. Nos. 12/475,308, 12/696,282, 12/641,788, and 12/575,388.

[0111] If a user performs a gesture and the gesture is recognized at **440**, action consistent with the gesture within the shopping application is applied at **450**. As discussed below, shopping applications gestures can comprise two general types of gestures: an article manipulation gesture or a transaction manipulation gesture. An article manipulation gesture may comprise, for example, any of a number of shopping consistent actions consistent with the interface presented to the user. If the user is presented a selection of virtual articles comprising clotting and an on-screen representation of themselves, article manipulation actions may comprise actions such as selecting clothes, putting on clothes, taking off clothes, adjusting clothes, changing backgrounds, changing accessories, moving room elements within a scene, placing items within a scene, placing the on-screen representation with a variety of backgrounds in particular clothing, and the like. A transaction gesture may comprise a gesture used to facilitate a transaction such as movement of an article into a shopping cart, removing an article from a shopping cart, entry of financial information and the like.

[0112] FIG. **6** is a flow chart describing one embodiment for automatically sensing one or more physical properties of an environment, including properties of one or more entities not actively engaged with the application and users who are actively engaged. The process of FIG. **6** is one example implementation of step **402** of FIG. **5**. In step **502**, capture device **20** will sense a depth image. In step **504**, that depth image will be sent to computing system **12**. In step **506**, capture device **20** will sense a visual image. In step **508**, that visual image will be sent to computing system **12**. In step **510**, capture device **20** will sense audio data. In step **512**, that audio data will be sent to computing system **12**. In step **514**, depth image processing and skeleton tracking **50** will update the motion tracking based on the depth image, visual image and/or audio data. In step **516**, the depth image, visual image and/or audio data, as well as tracking information, will be provided to recognizer engine **54**. In step **518**, recognizer engine **54** will process the received data and then call the appropriate one or more filters in step **520**.

[0113] As noted above, FIG. **5** includes a step of identifying a gesture at steps **412** and **440**. In one example, for each action that an application wishes to detect, there will be a separate gesture filter in filter set **191**. In other implementations, one filter can determine more than one gesture or action. The recognition engine **190** will receive data throughout the performance of an application. Each filter that is employed will register with recognition engine **190**, including indicating which data it is looking for. When recognition engine **190** sees that the data for a particular filter is available, recognition engine **190** will call the appropriate filter **191**. It is possible that many filters are called concurrently or in an overlapping manner. Each of the filters that are called by recognition engine **190** to look for a specific set of one or more gestures or actions will automatically identify an action or condition based on the physical properties sensed. When a filter determines that a specific gesture or action it is looking for has occurred, the filter may report that information to an application.

[0114] FIG. **7** depicts a flow diagram of an example method for processing depth information in accordance with steps **404** and **406** of FIG. **6** including, for example, segmenting a human target from an environment in depth image that may be captured by a capture device. In an example embodiment, the example method **600** may take the form of program code (i.e., instructions) that may be executed by, for example, the capture device **20** and/or the computing environment **12** of system **1010**. The method of determining whether a human is in the scene is disclosed in U.S. patent application Ser. No. 12/475,094 entitled "Environment And/Or Target Segmentation", filed 29 May 2009 and hereby fully incorporated herein by reference.

[0115] According to one embodiment, at **605**, a depth image may be received. The capture device **20** may capture or

observe a scene that may include one or more targets or objects. In an example embodiment, the capture device **20** may be a depth camera configured to obtain a depth image of the scene using any suitable technique such as time-of-flight analysis, structured light analysis, stereo vision analysis, or the like. The depth image may be a plurality of observed pixels where each observed pixel has an observed depth value. The depth image may include a two-dimensional (2-D) pixel area of the captured scene where each pixel in the 2-D pixel area may have a depth value such as a length or distance in, for example, centimeters, millimeters, or the like of an object in the captured scene from the capture device.

[0116] The depth image may include one or more human targets corresponding to, one or more users and one or more non-human targets such as a wall, a table, a monitor, a couch, a ceiling or the like in the captured scene. At **615**, a human target in a depth image may be scanned for one or more body parts. In one embodiment, system **10** may determine whether a human target in the depth image may have been previously scanned, at **610**, before the human target may be scanned at **615**. For example, the capture device may capture a scene in frames. Each frame may include a depth image. The depth image of each frame may be analyzed to determine whether the depth image may include a human target as described above. The depth image of each frame may further be analyzed to determine whether the human target may have been previously scanned for one or more body parts. For example, at **610**, system **10** may determine whether a human target in the depth image received, at **605**, corresponds to a human target previously scanned at **615**. In one embodiment, at **610**, if the human target may not correspond to a human target previously scanned, the human target may then be scanned at **615**.

[0117] At **620**, an environment of the depth image may be determined. For example, the depth image may be a plurality of observed pixels in a two-dimensional (2-D) pixel area where each observed pixel has an observed depth value. In one embodiment, system **10** may determine whether one or more of the pixels in the depth image may be associated with the human target or environment of the depth image. In an example embodiment, the system may determine the environment of the depth image by initially defining a bounding box around each foreground object such as each human target in the depth image received at **605**. The bounding box may be defined by the centroid and/or measurements determined based on, for example, the scan at **615**. After defining the bounding box for each human target, the pixels in the depth image outside the bounding box may be identified as environment.

[0118] The system may further determine the environment of a depth image by flood filling one or more pixels associated with the a human target such as the human target at **620**. For example, system **20** may detect edges of, for example, the foreground object such as the human target by comparing various depth values of nearby pixels such that the pixels within the edges of the human target may be flood filled. In addition, system **20** may detect edges of the foreground object such as the human target by comparing various depth values of nearby pixels that may be within the bounding box. According to an example embodiment, system **10** may detect the edges of a human target by analyzing various pixels within, for example, the bounding box using a predetermined edge tolerance. One body part of the human target (such as user **1002** in FIG. **9**) may be separated from another body part of the human body. For example, an infrared shadow may be cast by a body part such that the body part may be separated from another body part of the human target. In another example embodiment, a body part such as a head may be separated from a torso of the human target by, for example, facial hair, various articles of clothing, or the like.

[0119] Additionally, as described above, the body parts that may be separated by, for example, facial hair, various articles of clothing, or the like by invalid depth values. At **620**, system **10** may use depth history data to determine the environment or the non-human target pixels of the depth image. At **625**, the environment of the depth image may be removed or discarded. For example, upon flood filling the pixels associated with the human target by determining whether pixels may be associated with the human target as described above, the target recognition, analysis and tracking system may discard the pixels that may not be associated with the flood filled human target. Thus, in one embodiment, at **625**, the target recognition analysis and tracking system may discard or remove the pixels associated with the environment of the depth image based on the flood filled human target such that the human target including the pixels and depth values associated therewith may be isolated in the depth image. According to an example embodiment, system **10** may discard the pixels associated with the environment by assigning them, for example, an invalid depth value such as a depth value of zero.

[0120] The depth image with the isolated human target may be processed at **630**. In one embodiment, system **10** may process the depth image with the isolated human target such that a model of the human target in the captured scene may be generated.

[0121] For example, according to an example embodiment, a model such as a skeletal model, a mesh human model, or the like of a user such as the user **18** described with respect to FIG. **8**.

[0122] The visual appearance of an on-screen character may then be changed in response to changes to the model being tracked. For example, a user such as the user **18** described above with respect to FIGS. **1**A and **1**B playing an electronic game on a gaming console may be tracked by the gaming console as described herein. In particular, a body model such as a skeletal model may be used to model the target game player, and the body model may be used to render an on-screen player avatar. As the game player straightens one arm, the gaming console may track this motion, then in response to the tracked motion, adjust the body model accordingly. The gaming console may also apply one or more constraints to movements of the body model. Upon making such adjustments and applying such constraints, the gaming console may display the adjusted player avatar.

[0123] FIG. **8** illustrates an example embodiment of a skeletal model **808** representing a scanned human target used to track a user, such as user **18** or **1002**. The model is shown relative to the user **1002**. According to an example embodiment, the skeletal model **808** may include one or more data structures that may represent the human target **18** or **1002** as a three-dimensional model. Each body part may be characterized as a mathematical vector defining joints and bones of the skeletal model **808**.

[0124] As shown in FIG. **8**, the skeletal model **808** may include one or more joints n**1**-n**18**. According to an example embodiment, each of the joints n**1**-n**18** may enable one or more body parts defined there between to move relative to one or more other body parts. For example, a model representing

a human target may include a plurality of rigid and/or deformable body parts that may be defined by one or more structural members such as "bones" with the joints n**1**-n**18** located at the intersection of adjacent bones. The joints n**1**-n**18** may enable various body parts associated with the bones and joints n**1**-n**18** to move independently of each other. For example, the bone defined between the joints n**7** and n**11**, shown in FIG. **9**, corresponds to a forearm that may be moved independent of, for example, the bone defined between joints n**15** and n**17** that corresponds to a calf.

[0125] **Each of the joints represents a place in the skeleton where the skeleton can pivot in the x, y, z directions or a place of interest on the body. Other methods for tracking can also be used. Suitable tracking technology is disclosed the teachings of U.S. patent application Ser. Nos. 12/475,308, 12/696,282, 12/641,788, and 12/575,388, cited above.

[0126] FIG. **9** illustrates a user **1002** and an on-screen representation of the user **1050** provided by system **20**. Through moving her body, a user **1002** may create gestures. A gesture comprises a motion or pose by a user that may be captured as image data and parsed for meaning.

[0127] A user's gestures may be used for input in a general computing context. For instance, various motions of the hands or other body parts may correspond to common system wide tasks such as navigate up or down in a hierarchical list, open a file, close a file, and save a file. For instance, a user may hold his hand with the fingers pointing up and the palm facing the capture device **20**. He may then close his fingers towards the palm to make a fist, and this could be a gesture that indicates that the focused window in a window-based user-interface computing environment should be closed. Gestures may also be used in a video-game-specific context, depending on the game. For instance, with a driving game, various motions of the hands and feet may correspond to steering a vehicle in a direction, shifting gears, accelerating, and braking. Thus, a gesture may indicate a wide variety of motions that map to a displayed user representation, and in a wide variety of applications, such as video games, text editors, word processing, data management, etc.

[0128] An application may set values for parameters associated with various transition points to identify the points at which to use pre-canned animations. Transition points may be defined by various parameters, such as the identification of a particular gesture, a velocity, an angle of a target or object, or any combination thereof. If a transition point is defined at least in part by the identification of a particular gesture, then properly identifying gestures assists to increase the confidence level that the parameters of a transition point have been met.

[0129] FIGS. **9** and **10** illustrate the creation of an on screen representation **1050** of a user **1002**. The techniques for generating an on-screen representation are disclosed in U.S. patent application Ser. No. 12/511,850, entitled Auto Generating a Visual Representation, filed 29 Jul. 2009, fully incorporated herein by reference. The on-screen representation may be auto-generated by the system to provide a visual representation of a target that has features resembling the detected features of the target. Alternately, the system may provide a subset of selectable features from which the user may choose. The system may select the features based on the detected features of the target and apply the selections to the visual representation of the target. Thus, auto-generation techniques may remove a large amount of the effort from a user. For example, the system can make selections, on behalf of the user, and apply them to the user's visual representation.

[0130] As shown in FIG. **9**, the system renders a visual representation **1050** on a display **1000** that corresponds to the user **1002** in the physical space **1001**. In this example, the system auto-generated the on-screen representation **1050** by detecting features of the user **1002**, comparing the detected features to a library of feature options, or imaging information in an imaging library, selecting the feature options that resemble the detected features of the user **1002**, and automatically applying them to the user's on-screen representation **1050**. The auto-generation of the on-screen representation removes work from the user **1002** and creates an experience for the user **1002** as they are transported into the game or application experience.

[0131] By tracking the model generated at step **408**, system **20** can display the on-screen representation in real time and update the feature selections applied to the on-screen representation in real time. The system may track the user in the physical space over time and apply modifications or update the features applied to the on-screen representation, also in real time. For example, the system may track a user and identify that the user has removed a sweatshirt. The system may identify the user's body movements and recognize a change in the user's clothing type and color. The system may use any of the user's identified characteristics to assist in the feature selection process and/or updated the features selected from the features library and applied to the visual representation.

[0132] Image data and/or depth information may be used in to identify target features. Such target features for a human target may include, for example, height and/or arm length and may be obtained based on, for example, a body scan, a skeletal model, the extent of a user **1002** on a pixel area or any other suitable process or data. Using for example, the depth values in a plurality of observed pixels that are associated with a human target and the extent of one or more aspects of the human target such as the height, the width of the head, or the width of the shoulders, or the like, the size of the human target may be determined. The camera **1008** may process the image data and use it to determine the shape, colors, and size of various parts of the user, including the user's hair, clothing, etc. The detected features may be compared to a catalog of feature options for application to a visual representation, such as the visual representation feature options in the features library **197**.

[0133] In another example embodiment, the system can identify characteristics of the user and use the identified characteristics to select features for the visual representation, the system may use target digitization techniques. The techniques comprise identifying surfaces, textures, and object dimensions from unorganized point clouds derived from a capture device, such as a depth sensing device. Employing target digitization may comprise surface extraction, identifying points in a point cloud, labeling surface normals, computing object properties, tracking changes in object properties over time, and increasing confidence in the object boundaries and identity as additional frames are captured. For example, a point cloud of data points related to objects in a physical space may be received or observed. The point cloud may then be analyzed to determine whether the point cloud includes an object. A collection of point clouds may be identified as an

object and fused together to represent a single object. A surface of the point clouds may be extracted from the object identified.

[0134] Any known technique or technique disclosed herein that provides the ability to scan a known/unknown object, scan a human, and scan background aspects in a scene (e.g., floors, walls) may be used to detect features of a target in the physical space. The scan data for each, which may include a combination of depth and RGB data, may be used to create a three-dimensional model of the object. The RGB data is applied to the corresponding area of the model. Temporal tracking, from frame to frame, can increase confidence and adapt the object data in real-time. Thus, the object properties and tracking of changes in the object properties over time may be used to reliably track objects that change in position and orientation from frame to frame in real time. The capture device captures data at interactive rates, increasing the fidelity of the data and allowing the disclosed techniques to process the raw depth data, digitize the objects in the scene, extract the surface and texture of the object, and perform any of these techniques in real-time such that the display can provide a real-time depiction of the scene.

[0135] Camera recognition technology can be used to determine which elements in the features library **197** most closely resemble characteristics of the user **602**. The system may use facial recognition and/or body recognition techniques to detect features of the user **1002**. For example, the system may detect features of the user based on the generation of the models from the image data, point cloud data, depth data, or the like. A facial scan may take place and the system may process the data captured with respect to the user's facial features and RGB data. In an example embodiment, based on the location of five key data points (i.e., eyes, corner points of the mouth, and nose), the system suggests a facial recommendation for a player. The facial recommendation may include at least one selected facial feature, an entire set of facial features, or it may be a narrowed subset of options for facial features from the features library **197**. The system may perform body recognition techniques, identifying various body parts/types from a body scan. For example, a body scan of the user may provide a suggestion for the user's height. For any of these scans, the user may be prompted to stand in the physical space in a position that provides for the best scan results.

[0136] Other features may be detected from the captured data. For example, the system may detect color data and clothing data by analyzing the user and/or the model of the user.

[0137] The system may detect at least one of the user's features and select a feature from the features library **197** that is representative of the detected feature. The system may automatically apply the selected feature to the user's visual representation **1050**. Thus, the user's visual representation **1050** has the likeness of the user as selected by the system.

[0138] FIG. **10** shows an example method of providing feature selections to a user. The provision of feature selections may be provided by a display of the visual representation with the features applied or a subset of the library of features with a narrowed down subset of options from which the user may choose. For example, at **802**, the system receives data from a physical space that includes a target, such as a user or a non-human object.

[0139] As described above, at **802** a capture device can capture data of a scene, such as the depth image of the scene and scan targets in the scene. At **804**, the system may determine whether one or more targets in the scene corresponds to a human target such as a user. For example, to determine whether a target or object in the scene corresponds to a human target, each of the targets may be flood filled and compared to a pattern of a human body model. Each target or object that matches the human body model may then be scanned to generate a skeletal model associated therewith. For example, a target identified as a human may be scanned to generate a skeletal model associated therewith. The skeletal model may then be provided to the computing environment for tracking the skeletal model and rendering a visual representation associated with the skeletal model. At **804**, the system may translate the captured data to identify the features of the targets in the physical space by using any suitable technique, such as a body scan, point cloud models, skeletal models, flood-filled techniques, or the like.

[0140] At **806**, the system may detect characteristics of the target and compare them to feature options, such as feature options in a features library. The feature options may be a collection of options for various features for the target. For example, feature options for a user may include eyebrow options, hair options, nose options, etc. Feature options for furniture in a room may include size options, shape options, hardware options, etc.

[0141] In an example embodiment, the system may detect several features available for application to the visual representation that resemble the user's detected features. Thus, at **806**, the system may detect a feature of the user compare the detected feature to the features library **197** for application to the user's visual representation, and, at **810**, the system may select a subset of the feature options based on the detected feature. The system may select the subset as those features by comparing the similarities of the features in the features library **197** to the detected characteristics of the user. Sometimes, a feature will be very similar, but the system may still provide the user a subset of options to choose from at **810**. In this manner, the user can select a feature from the subset that is at least similar to the user's corresponding characteristic, but can select a more flattering feature from that subset, for example. The system may receive the user's selection from the subset of options at **812**. Thus, the user does not have to filter an entire library of options for the particular feature for features that are similar to the user. The system can filter the library of options and provide the user a subset of features from which to choose.

[0142] The system may auto-generate a visual representation of the user at **814**. Thus, upon comparison of the target's detected features to the options in the features library, the system may auto-generate a visual representation of the target by automatically selecting the features to apply to the visual representation. The target is effortlessly transported into the system or software experience when the system automatically renders a visual representation that corresponds to the user, having automatically selected features from the features library that resemble the detected features of the target.

[0143] The visual representation may have a combination of automatically selected features and features selected by the user based on the subset of options provided by the system. Thus, the visual representation may be partially generated and partially customized by the user.

[0144] The selections made by the system and/or the user may be applied to the target's visual representation at **816**. The system may render the visual representation to the user. At **818**, the system may continue to monitor the target in the

physical space, tracking the detectable features of the target over time. Modifications to the target's visual representation may be made in real time to reflect any changes to the target's detected features. For example, if the target is a user and the user takes off a sweatshirt in the physical space, the system may detect a new shirt style and/or color, and automatically select an option from the features library that closely resembles the user's shirt.

[0145] The selected option may be applied to the user's visual representation in real time. Thus, the processing in the preceding steps may be performed in real time such that the display corresponds to the physical space in real time. In this manner, an object, a user, or motion in the physical space may be translated for display in real time such that the user may interact with an executing application in real time.

[0146] The user's detected features, the selected features by the system, and any selected features by the user may become part of a profile, at **822**. The profile may be specific to a particular physical space or a user, for example. Avatar data, including features of the user, may become part of the user's profile. A profile may be accessed upon entry of a user into a capture scene. If a profile matches a user based on a password, selection by the user, body size, voice recognition or the like, then the profile may be used in the determination of the user's visual representation. History data for a user may be monitored, storing information to the user's profile. For example, the system may detect features specific to the user, such as the user's facial features, body types, etc. The system may select the features that resemble the detected features for application to the target's visual representation and for storage in the target profile.

[0147] Elements of the on-screen representation and the skeletal model, when combined, provide a 3-D model of the user which can be used when applying articles such as clothing to the user. In order to provide an accurate virtual representation of how an article will interact with the user, sizing information for the user to allow connection of a model of a garment is maintained with the 3-D model.

[0148] As noted above, the detection, imaging and tracking components of system **20** may be utilized in an on-line presentation and shopping application. The presentation and shopping application **180** provides a user with a realistic idea of how articles presented in an on-screen representation will appear relative to the user or a scene that the user specifies.

[0149] FIG. **11** illustrates a process performed by a presentation and shopping application in accordance with the present technology.

[0150] At step **1102**, three dimensional article models are acquired by the system **20**. Articles are virtual elements used in the shopping application which represent real-world goods be available from online or retail vendors. Article models may be acquired from a variety of sources. Retailers wishing to present articles for sale using the shopping application may create their own article models consistent with one or more standards for three dimensional models. Model specifications may fit any number of known standards for creating and storing three dimensional models of articles used within a rendered scene. Vendors may provide pricing and transaction information associated with the article model.

[0151] At **1104**, the article is displayed in an application interface. Exemplary interfaces are shown in FIGS. **12-19**. Next, at steps **410** and **420**, the user model is tracked and movements applied to the on-screen model, respectively. Steps **410** and **420** are equivalent to those set forth above with respect to FIG. **5**.

[0152] At **1112**, the gesture recognition engine **192** monitors the scene information for gestures within the movements of the user model at **410** which might indicate that the user intends an action to take place. One type of action may comprise an article manipulation gesture, where a user wishes to move an article within the scene relative to the on-screen model. If an article manipulation gesture is found, a gesture match at **1114** occurs, and any one of a number of gestures such as those illustrated in FIG. **11** may occur.

[0153] Step **1126** illustrates a small set of possible gestures representing an action which may occur in an shopping application **180**. These actions may include, for example, an action to: select article, apply article to on-screen image, remove article from avatar, add article to scene, remove article from scene, un-select article, apply background, remove article from rack, place article on rack, adjust article properties, and move object into scene. The aforementioned gestures should not be construed as limiting but are exemplary of the type of gestures a user may need in a shopping application when manipulating an article.

[0154] Selecting an article may comprise a gesture indicating that that the user intends to select an article in the interface. An interface for the application may be presented in a display, as shown below at FIG. **12**. Selection can be of an article in a rendered scene or in the interface selection portion of the scene. Such a gesture may comprise, for example, a motion to grab a virtual garment by moving to position the on-screen representation of the user's hand over the garment and closing one's hand. A gesture applying an article to an on-screen image may comprise moving a selected garment from a rack of hanging virtual clothes, and placing the garment on top of the on-screen representation. Conversely, a gesture may comprise removing an article. A gesture may indicate the user wishes to adjust the clothing. For example, the user may wish to raise the user's collar, roll up the user's pants, roll up the user's sleeves, or the like. Any of these types of gestures may result in the adjustment of the clothing in the interface at **1128**. Alternatively, the user may wish to place themselves in a different physical background at **1128**. A gesture such as selecting a background tile from the interface and applying the background tile into the user's screen will result in applying or removing a background at **1128**. Any other of a number of types of actions at **1126** may result in a corresponding action **1128** within the interface.

[0155] Another general type of gesture which may be initiated by a user is a transaction gesture. A transaction gesture may be used by the user to initiate a purchase, return or other type of transaction on a real-world article represented by the virtual article in the interface. if an article transaction gesture is recognized at **1130**, any of a number of actions may occur at **1132**, including an action to: select shopping cart, display shopping cart, add to shopping cart, remove from shopping cart, purchase items in cart, empty shopping cart, save shopping cart, purchase an item from the interface, add funding information, retrieve stored funding information, or any other transaction related action. When the action occurs at **1132**, a representation of the action may be rendered in the display at **1134**. Rendering a transaction action in the display may take any number of known forms used to conduct computer based purchase transactions.

[0156] FIG. **12** illustrates an exemplary interface **1200** which is rendered by the system based on a human model **1002**. The interface **1200** may include a control or selection portion **1225** and a rendered scene **1230**. In one embodiment, control elements, such as a scroll bar **1227**, a garment rack with selectable garments **1235**, and a shopping cart **1260** may be provided in the selection portion **1225** of a rendered scene. Actions of the human model **1002** are transferred to the on-screen representation **1050**. The interface may include, for example, virtual articles comprising a virtual rack of clothes **1040**, and/or individual garments **1042**, **1044**, **1046**, **1048**, and a series of backgrounds **1052**, **1054**, any number of which may be provided to the user. The user **1002** facing the screen **1200** can reach up, grasp the garment from a rack, place it in an array of garments **1060** and/or place the garment onto the virtual model **1050**. As indicated in FIG. **12**, the appearance of the virtual model **1050** will mimic the size of the user **1002** with the appropriate clothing articles attached.

[0157] In using the interface **1200**, a user **1002** may make appropriate gestures to select garments from a garment rack **1235**, place them in a holding area (garments **1242**, **1244**, **1246** and **1248**) and move the garments onto the virtual model **1050**. A user **1002** may use a scroll interface **1227** to move through garments on a virtual rack **1235**. A user may select to put garments into a virtual shopping cart **1260** which a user may then purchase using a transaction interface (not shown). Purchasing items using the system may comprise using a purchasing interface provided by system **20** which a user **1002** may interact with using gestures, or may comprise being provided with a vendor specific interface through, for example, a browser window presented in the interface **1200**.

[0158] A user may select one or more of the background icons **1052**, **1054** to provide a scene specific background behind the virtual representation **1050** of user **1002**. FIG. **13** illustrates the application of a background to the scene illustrated in FIG. **12**. In the application of FIG. **13**, other elements of the interface have been removed, but it in other applications the elements of the interface **1025** may remain. When the background is applied to the scene, the selection portions of the interface may by removed. Alternatively, the selection portions may be displayed. When the selection portions are not displayed. Application of a background **1052**, **1054** allows the user to determine how a particular article will appear in a particular situation.

[0159] Backgrounds **1052**, **1054** may comprise scanned scenes stored by the user using the capture device **20**, or stock scenes provided by retailers or third parties. In one embodiment, the interface presents the user in the scene presented to the capture device. Other stored scenes may be utilized and selected by the user in the interface.

[0160] Other interface elements may be provided to allow the user to change the appearance of the on-screen representation. For example, lighting controls may allow a user to change the type and position of lighting sources on a scene. Certain articles, such as lamps, may include, in metadata associated with the model, information to allow the system to generate a light source from the article to allow a user to determine how source light from the lamp will change the appearance of a scene. Each of the elements may be represented within the interface by suitable on-screen controls.

[0161] Another interface element may include user sizing controls. Sizing controls may be applied to articles (such as clothing) or to the representation of the tracked human model of the user. For example, a user may wish to determine how her appearance may change with a gain or loss of weight. Sizing controls may also allow selection of different sizes of articles, allowing a user to determine if a small or medium size article fits the on-screen representation better.

[0162] FIG. **14** illustrates an alternative use of the shopping application or in a user **18** can place physical object, such as a couch **1402**, within a scene **1410** on a display **16**. In different embodiments, different types of virtual articles other than clothing or furniture may be presented in by the shopping application **180**.

[0163] FIG. **15** is an enlarged view of an exemplary scene **1410** provided with an interface **1425** suitable for use with a shopping application used in a room modeling application. Interface **1525** includes, for example, a number of articles (in this example chairs) **1540**, **1542**, **1544** and **1546** as well as a number of paint colors **1532** and **1534** which can be applied to a scene **1410**.

[0164] Scene **1410** may be a representation of a user's room or the scene scanned by the capture device **20** (or another background selected by the user). Elements within the scene which are determined to be objects can be removed from the scene, or can be replaced in the scene by other objects through motions of the user. For example, if a user **1002** reaches on an article such as article **1544** and grasps the article and moves it into the scene, the user can position the article within the scene **1410** at a desired location by grasping the article with a hand closing motion, and releasing the article with a hand opening motion. Similarly, the user can paint the room by grasping one of the two icons **1532** and **1534**, and applying that to the scene **1550**. Any number of different types of articles may be provided from third-party vendors.

[0165] Scene **1410** may be created by scanning the user's environment (such as area **1001** in FIG. **9**). Scene **1410** will maintain the perspective of the room as well as sizing information to allow articles presented therein to have the proper size in relation to the scene. Gestures specific to a presentation and shopping application may be used. For example, if an article is a rug and the user wishes to place a rug under the chair, as opposed to in front a chair, a specific gesture allows for positioning of the rug relative to the chair **1544**.

[0166] In another alternative, the shopping application **180** may provide an interactive experience between two users (User A, User B) using different systems **20** or two users in a scene using a direct connection between two computing environments **12**A and **12**B or a networked connection between the devices.

[0167] FIG. **16** illustrates an overview of interconnected systems which may be used to provide services to a shopping application on one or more computing commuting environments **12**A and **12**B. Computing environments **12**A and **12**B may be coupled to a gaming service **1604** and one or more third-party vendor sites **1602** via a network **1600**. A subset of elements equivalent to those illustrated with respect to each computing environment **12** shown in FIG. **2** are shown in FIG. **16** for illustration only. However, it should be understood that other elements **190**, **191**, **192**, **194**, **195**, **196**, **198** may be provided on environments **12**A and **12**B.

[0168] The third-party vendor sites may comprise vendors having articles for sale to users and who interact directly with computing environments **12**A, **12**B or interact with gaming service **1604** to allow users operating shopping application **180** to purchase goods using application **180**. In one embodiment, vendors **1602** can supply 3-D models, or 2-D product information on articles available from the vendors directly to

the computing environments **12**A, **12**B. Metadata attached to the models or information may include sizing information, pricing information and purchase terms. Application **180** may support interfacing directly with product information **1612**, an image library **1614**, models **1616** and a transaction interface **1618** provided by vendor **1602**.

[0169] Gaming service **1604** may include a global aggregate library of 3-D models gathered from a variety of different vendors **1602** allowing users to access an aggregated set of available items via a single service. Likewise, article models may be provided to the gaming service **1604** which can store 3-D models that may be aggregated by the gaming service **1604** for use on a plurality of computing environments **12**. A gaming service may provide its own 3-D models, or 3-D models may be generated by the computing environment itself. In addition, gaming service **1604** may maintain user account information **1675** including financial payment information to allow users to purchase items directly from the gaming service or where the service **1604** acts as an intermediary between the user and vendors **1602**. A transaction interface **1670** in the gaming service communicates via network **1600** with a transaction interface **1618** to enable purchases by users to vendors through the gaming service **1604**.

[0170] Alternatively, vendors maintain user account information **1620** to allow computing environments **12**A and **12**B to couple to the vendor directly and initiate purchase transactions with the vendor directly.

[0171] In another alternative, two users can communicate and collaborate via a networked environment in the shopping application **180**. As illustrated in FIGS. **17** an **18**, two users A and B using different computing environments, each executing an application **180** can interact allowing, for example, user A to apply changes to the on-screen representation of user B. In FIG. **17**, an on-screen representation **1750** of user B (**1702**) is generated and represented in a display **1712** along with an on-screen representation **1755** of user A (**1704**). User A, interacting with computing environment **12**A, may interact with interface **1725** to select articles to be applied to the on-screen representation **1750** of user B, which are then displayed to user B in her interface **1712**. Movements of user B within her environment **1701** are displayed to user B such that both users view the same scene. Should user B wish to change the scene, her actions are transmitted back to the display **1722** of User A.

[0172] This process is illustrated in FIG. **18**. FIG. **18** illustrates the process of the application **180** operating on two different processing devices **12**A and **12**B. Respective on-screen models for User A and user B are generated at **1800** and **1801**, respectively. At step **1802**, actions of User A are tracked at applied to the on-screen model of user A at **1804**. These actions are transmitted to computing environment **12**B and applied to an the on-screen model of User A at **1816**. Likewise, movements of user B are tracked at **1812**, applied to the on-screen representation of User B at **1814** and transmitted to computing environment **12**A to be applied to the on-screen representation of User B at **1806**. Respective gestures of each user are detected at **1808** and **1818**. In this example, actions of user A at **1810** are applied to the User B model and sent to computing environment **12**B to be applied to the on-screen representation of the user B model at **1820**. However, in alternative embodiments, gestures of user A can likewise be applied to user B.

[0173] As noted above, on-screen representations of humans can be provided and likewise, on-screen representations of articles utilized in the method of FIG. **18**.

[0174] In this manner the respective users can alter each other's interfaces, models, rendered scene or any element of the on-screen display. In alternative embodiments, two users represented in FIGS. **17** and **18** may be connected directly through a network, connected through the internet directly, or connected through an intermediary service such as the gaming service **1604**. Any of a number of different types of applications can be used in accordance with the present technology. The technology allows for the personal adaptation of the virtual environment to the user's existing environment in appearance.

[0175] Gestures do not have to be drag and drop. They could be more organic to what the user is doing, such as, for example, putting on clothes, or remove clothes. Virtual objects are not limited to clothes that include make-up and other objects.

[0176] In addition, suggestion logic may be employed to scan the user's appearance and suggest additional types of virtual objects which can be related to real physical objects which are available by a user. The system can be utilized in home or in a store. Meta data can be attached to the object to help in elemental determinations, such as whether the object fits tightly, or fits loosely. In addition, objects can be overlaid on other objects to determine, for example, how an object fits in a room, or how a shirt interacts with an existing pair of pants. Real time data can be extracted to 3-D in real time or a picture can be cut from the scene and manipulated within the scene.

[0177] The system may recommend clothing for the user based on the identity of these user characteristics. The clothing recommendations may be based on clothing in the user's closet or from clothing available for purchase in the virtual world marketplace. For example, a user may have a personal closet with a repository of items owned and associated with a particular visual representation. The personal closet may comprise an interface for allowing the user to view and modify clothing and other items that are applied to the user's visual representation. For example, accessories, shoes, etc, may be modified. A user's gender may be determined based on the captured data or as a result of accessing a profile associated with the user.

[0178] Another alternative user of the technology allows a user to interact with an on-screen representation of another user or avatar. As illustrated in FIG. **19**, a user **1902** may have an on-screen representation **1950** which represents a different individual. In the example shown in FIG. **19**, a female user **1902** may interact with a male on-screen representation. The on-screen representation may be provided from stored profile information of other users or from a library of models. Actions of the user **1902** can be mimicked by the on-screen representation or the model may be posed by the user **1902** based on gestures performed by the user **1902**.

[0179] Although the subject matter has been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims. It is intended that the scope of the technology be defined by the claims appended hereto.

What is claimed is:

1. A computer implemented method, comprising:

capturing a scene using a capture device, the scene including a human target;

rendering a representation of the scene and the human target on a display device;

presenting an interface allowing the human target to select and position one or more of a plurality of virtual articles representing real articles available for purchase in the representation on the display device;

tracking movements of the human target in the scene;

applying the movements of the human target to the representation of the human target;

applying the movements of the human target to at least one of the virtual articles in the representation when the movements of the human target in the scene indicate an article manipulation gesture; and

applying the movements of the human target to a purchasing interface when the movements of the human target in the scene indicate an transaction manipulation gesture

2. The computer implemented method of claim 1 wherein the step of applying movements of the human target includes positioning at least one of the virtual articles on the representation of the human target responsive to the article manipulation gesture.

3. The computer implemented method of claim 2 wherein positioning the virtual article on the representation of the human target includes applying the movements of the human target to the representation of the human target and the model on the representation.

4. The computer implemented method of claim 1 wherein the step of applying movements of the human target includes selecting the virtual article, positioning the virtual article at a location within the scene and releasing the virtual article within the scene.

5. The computer implemented method of claim 4 wherein positioning comprises rendering the virtual article in a representation maintaining proportions of the virtual article to the representation of the human target and the scene.

6. The computer implemented method of claim 1 further including providing a purchasing interface allowing the human target to purchase a real world article corresponding to a virtual article rendered in the display.

7. The computer implemented method of claim 1 further including the step of receiving three dimensional models of virtual articles for inclusion in the representation of the scene from third party vendors.

8. The computer implemented method of claim 1 further including generating three dimensional models of virtual articles from captured information in the scene.

9. The computer implemented method of claim 1 further including generating a representation of the human target by gathering image information and depth information, and building a mesh model of the body of the human target.

10. The computer implemented method of claim 9 wherein the representation of the human target is of a different individual than the human target.

11. A computer implemented method allowing a user to perform a purchase transaction, comprising:

rendering a representation a human target user in a scene on a display device;

presenting a plurality of one or more virtual articles in the scene on the display device, the virtual articles corresponding to real world articles;

tracking movements of the human target user in the scene and applying said movements to the representation of the human target and one or more virtual articles in the representation;

recognizing at least one article manipulation gesture of the human target, the article manipulation gesture indicating an instruction to manipulate at least one virtual article relative to the representation of the human target;

applying the article manipulation gesture to the representation;

recognizing at least one transaction manipulation gesture, the transaction manipulation gesture comprising an instruction to perform a transaction relative to an article corresponding to the virtual article selected by the human target user; and

applying the at least one transaction manipulation gesture.

12. The computer implemented method of claim 11 further including capturing movements of a human target using a first capture device and first processing device, and performing said rendering and presenting steps on a second processing device.

13. The computer implemented method of claim 12 wherein the first processing device and second processing device are coupled by a network.

14. The computer implemented method of claim 13 wherein the first and second processing devices are coupled to a vendor via the network, and the method further includes the step of:

providing a purchasing interface, the purchasing interface responsive to the transaction gesture which initiates a purchase of a real world article corresponding to the virtual article with the vendor.

15. The computer implemented method of claim 14 further including the step of receiving three dimensional models of virtual articles for inclusion in the representation of the scene from third party vendors.

16. The computer implemented method of claim 15 further including generating a representation of the human target by gathering image information and depth information, and building a mesh model of the body of the human target.

17. A computer implemented method, comprising:

capturing a scene using a capture device, the scene including a human target;

rendering a representation of the human target on a display device;

presenting an interface allowing the human target to manipulate virtual articles available for purchase relative to the representation on the display device;

reproducing movements of the human target in the scene;

recognizing at least one article manipulation gestures of the human target;

applying the article manipulation gesture to the representation to manipulate at least one article relative to the representation of the human target;

recognizing at least one transaction manipulation gesture; and

applying the at least one transaction manipulation gesture to a purchase transaction relative to a real world article corresponding to the virtual article.

18. The method of claim **17** further including providing a purchasing interface, the purchasing interface responsive to a transaction gesture which initiates a purchase of a real world article corresponding to the virtual article with the vendor.

19. The method of claim **17** wherein a manipulation gesture comprises an action to: select article, apply article to on-screen image, remove article from avatar, add article to scene, remove article from scene, un-select article, apply background, place article in shopping cart, purchase article, remove article from rack, place article on rack, adjust article properties, and move object into scene.

20. The method of claim **17** wherein a transaction gesture comprises an action to: select shopping cart, display shopping cart, add to shopping cart, remove from shopping cart, purchase items in cart, empty shopping cart, save shopping cart.

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