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United States Patent Application**20190287303****Kind Code****A1****Falstrup; David ; et al.****September 19, 2019****LAYERED PANORAMAS FOR VIRTUAL REALITY (VR)****Abstract**

A method for the production of immersive virtual reality experiences designed for viewing in virtual reality head-mounted displays (HMD). This unique layered panorama process is a cubic or spherical mapped content method for presentation of pre-rendered images viewed from a fixed point of view in a head mounted display for virtual reality (VR) applications, a method that by mapping/layering all visual elements onto a mono or stereoscopic spherical or cubic panorama surface creates a seamless visual integration.

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Family ID: **67905905**Appl. No.: **16/431664**Filed: **June 4, 2019****Related U.S. Patent Documents**

<u>Application Number</u>	<u>Filing Date</u>	<u>Patent Number</u>
15223638	Jul 29, 2016	10311636
16431664		
62270537	Dec 21, 2015	

Current U.S. Class:**1/1****Current CPC Class:**

H04N 13/239 20180501; H04N 13/117 20180501; G06F 3/04845 20130101; H04N 5/2251 20130101; G06F 3/0485 20130101;

take photos for both left camera and right camera and save to output files; c. creating panoramic photo: (i) mask the car vehicle including the car vehicle under carriage, tires, and antennas, (ii) mask out the vehicle windows for all photos and save as separate files, (iii) select a paintbrush and begin painting out irregularities of the cars' vehicle's shadow, (iv) save and upload output files; and d. final inspection including: (i) check to see if the camera reflection is visible and if so, remove reflection, (ii) apply the adjustment layers to the images and save and upload output files.

4. The method for creating layered stereoscopic panoramic photography in accordance with claim 3, further comprising: said panoramic images are obtained from a 35 mm camera.

5. The method for creating layered stereoscopic panoramic photography in accordance with claim 3, further comprising: said 35 mm camera is controlled by a rig.

6. A method for creating layered stereoscopic panoramic photography of a vehicle used in conjunction with graphic user interface elements, the method comprising: a. creating a first left panoramic layer using six stereo left images of a virtual showroom to form a left cube having portions of the virtual showroom on a left front face, a left right face, a left left face, a left back face, a left top face, and a left bottom face; b. creating a first right panoramic layer using six stereo right images of a virtual showroom to form a right cube having portions of the virtual showroom on a right front face, a right right face, a right left face, a right back face, a right top face, and a right bottom face; c. creating a second left panoramic layer of an interior of a said vehicle using a set of left images with a camera at a given height, lighting at a given intensity, and lens at a given diameter; d. creating a second right panoramic layer of said interior of said vehicle using a set of right images with said camera at a given height, lighting at a given intensity, and lens at a given diameter; e. using at least two left panoramic layers, align said at least two left panoramic layers on said left front face of said left cube; and f. using at least two right panoramic layers, align said at least two right panoramic layers on said right front face of said right cube.

7. The method for creating layered stereoscopic panoramic photography in accordance with claim 6, further comprising: said virtual showroom contains a horizon wall, a turntable and a ramp.

8. The method for creating layered stereoscopic panoramic photography in accordance with claim 6, further comprising: said panoramic images are obtained from a 35 mm camera.

9. The method for creating layered stereoscopic panoramic photography in accordance with claim 8, further comprising: said 35 mm camera is controlled by a rig.

10. The method for creating layered stereoscopic panoramic photography in accordance with claim 6, further comprising: creating a third left panoramic layer of an exterior of a said vehicle by taking a plurality of photos of said vehicle as it rotates a selected degrees using panoramic images with said camera at a given height, lighting at a given intensity, and lens at a given diameter.

11. The method for creating layered stereoscopic panoramic photography in accordance with claim 6, further comprising: creating a third right panoramic layer of said exterior of a said vehicle by taking a plurality of photos of said vehicle as it rotates by said selected degrees using panoramic images with said camera at a given height, lighting at a given intensity, and lens at a given diameter.

12. The method for creating layered stereoscopic panoramic photography of claim 10 wherein the plurality of photos is 36 photos.

13. The method for creating layered stereoscopic panoramic photography of claim 11 wherein the plurality of photos is 36 photos.

Description

substantially the same as the effect from placement of 3D objects in a 3D scene at varying distances from the user. Likewise, objects can appear to move in the apparent 3D space by creating animated frame sequences for left and right eye, warped appropriately to fit the background scene. Images may be layered on top of each other, with frame transparency and each are able to appear to be at different distances, with corresponding different left-right eye separation.

[0009] The present invention also includes a useful, novel, and non-obvious method for layering three dimensional (3D) elements and two dimensional (2D) elements on to panoramic photography for interaction by a user within a virtual reality head mounted display. These elements can be layered in both interior panoramas of a car or vehicle (Car and vehicle will be used interchangeably throughout this patent application) and exterior panoramas of a vehicle. In use, three-dimensional automotive vehicle images provide a 360 degree view of an entire exterior or interior of an automotive vehicle with selectable elements super imposed within this virtual reality powered by a virtual reality head mounted display.

[0010] It is an object of the present invention to create stereoscopic panoramic photographic images of an entire automotive exterior and interior that has selectable elements or objects layered within the virtual reality.

[0011] It is a further object of the present invention to create the visual images on digital photography mediums which are enabled to be transferred via computer applications to be used in conjunction with a smartphone or other portable electronic device which is configured to be used in conjunction with viewing through a virtual reality head-mounted display.

[0012] It is a further object of the present invention to create a stereoscopic automotive exterior panoramic photographic image which is achieved through having a separate set of photographs when viewed by a person through a person's right eye and subsequently viewed by the same person when viewed through the person's left eye, to combine the two separate images into a final assembled and stitched together three-dimensional 360 degree image.

[0013] It is a further object of the present invention to create the stereoscopic automotive selectable elements within the exterior or interior panoramic photographic images to be used for viewing in virtual reality head-mounted displays.

[0014] It is still a further object of the present invention to create the finished completed three-dimensional 360 degree automotive exterior content through several steps which are integrated with each other to create the final product. The sub-components of the special steps include:

[0015] 1. Creation of stereoscopic panoramic photography of automotive interiors, achieved through selection of special lensing, cameras and use of images of each eye to combine together interocular separation by creating photographs as viewed from a right eye of a human person and a second set of photographs as viewed from a left eye of a human person and combining the photographs taken as viewed from the right eye of the person and the photographs taken as viewed from the left eye of the person and combining them through the present invention interocular separation to create a final optimal-interocular display image of the entire vehicle exterior for subsequent transfer to a computer medium for incorporation into a computer software application downloadable to a portable electronic device such as a smartphone. The smartphone is used in conjunction with a virtual reality display through a head mounted display which is a headset with a pair of spaced apart arms respectively worn over the person's right and left ear or banded to encircle the back of a person's head with the smartphone working in conjunction and communicating through blue tooth or cable with the virtual reality display. The downloaded images in the smartphone are viewed through the headset with various activation members such as buttons on the headset pressed or otherwise activated by the person's fingers. The person looks at the removably attached smartphone through ocular viewing members such as lenses in the headset to view the entire virtual images of the exterior of the vehicle or close-up views of selected areas of the exterior of the vehicle such as the steering wheel, the dashboard consol with instruments, one or both front seats, one or both rear seats or an entire rear seat if the rear seat is not separate bucket seats, etc.

[0049] Although specific embodiments of the present invention will now be described with reference to the drawings, it should be understood that such embodiments are by way of example only and merely illustrative of but a small number of the many possible specific embodiments which can represent applications of the principles of the present invention. Various changes and modifications obvious to one skilled in the art to which the present invention pertains are deemed to be within the spirit, scope and contemplation of the present invention as further defined in the appended claims.

[0050] I. Equipment Required for Utilization of the Present Invention Method and Corresponding Apparatus

[0051] The following is a list of photographic equipment and related accessories which is the preferred equipment for use with the present invention. It is within the spirit and scope of the present invention to use similar, comparable or substitute equipment known to one skilled in the art as opposed to using the specific equipment and items set forth below. It will be appreciated that this is simply a recitation of the best method known to the inventors at the time this patent application was filed and is not intended to limit the course and scope of the specific equipment to achieve the new, novel and non-obvious results of the present invention.

[0052] Referring to FIG. 1 and to FIG. 2A, FIG. 2B and FIG. 2C, there is illustrated both in the assembled condition and in the exploded component condition, the assembled view of the single camera stereo panoramic rig 10. The components include a 35 mm. single lens reflex (SLR) camera 20 (for example, Canon 5d Mark 3). Camera 20 includes a full frame sensor. The camera preferably also has 20 mega pixels or higher with an auto exposure bracket feature. It will be appreciated that the present invention incorporates two duplicate single lens reflex cameras for use as will be described.

[0053] The present invention stereo panoramic rig includes a custom fit "Arca-Swiss" compatible L-shaped camera mount bracket 30. The custom fit keeps the camera from twisting on the head.

[0054] Further referring to FIG. 1 and FIG. 2A, there is illustrated the "Arca-Swiss" compatible plate with 90 degree clamp 40, allowing for the camera to slide left and right. Also illustrated are hex screws 50 (see FIG. 2B) for mounting the "Arca-Swiss" compatible clamp to the rotator base (see FIG. 2A). The equipment further includes an "Arca-Swiss" compatible clamp 60 (see FIG. 2A).

[0055] Referring to FIG. 1 and FIG. 2B, the equipment for the single camera stereo panoramic rig further comprises a large rotating panoramic base with adjustable degree increments 70. The rig also includes a threaded hex screw 80 for attaching the panoramic base 70 to the horizontal arm 90. The horizontal arm 90 includes a distal end 92 where a vertical "Arca-Swiss" compatible end clamp 94 is affixed to allow vertical arm attachments.

[0056] At the distal end 92 of the horizontal arm 90 and attached through the "Arca-Swiss" compatible end clamp 94 is a proximal end 96 of a vertical "Arca-Swiss" compatible plate 100. Affixed at the distal end 98 of the vertical "Arca-Swiss" compatible plate 100 is an "Arca-Swiss" compatible clamp 110. As part of the attachment mechanism there is included a hex screw 120 for mounting the "Arca-Swiss" compatible clamp to a small rotating panoramic base with adjustable degree increments 130.

[0057] Referring to FIG. 2D, there is shown two cameras 20 side by side to shoot left eye images and right eye images through horizon wall hole 262 (also shown in FIG. 3).

[0058] In addition to the above specific apparatus, the present invention also utilizes the following additional equipment for performing the novel method to be hereinafter described:

[0059] a. A shutter release cable with extension to enable remote releasing of the camera.

[0060] b. (6-8) 1,000 Watt Fresnel lights and (2-4) 2,000 Watt or comparable lighting kit utilizing these lights.

[0061] c. Diffusion and/or minus green gels.

[0062] d. A computer with Adobe Bridge, Photoshop, PTGui software, EOS Canon capture software, and Unity or other comparable software.

[0063] e. Stage including: stage wall, grey horizon wall, turntable, and ramp.

[0064] II. Initial Steps to Create the Appropriate Lighting and Corresponding Setup for Appropriate Photography for Use in the Present Invention

[0065] The following detailed description is written in narrative form in order to better explain how the present invention is implemented and to explain all the detail components in a manner that is understandable to a reader.

[0066] Referring to FIG. 3, Stage wall 280 is a generally rectangular wall with curved corners: lower left corner 282, upper left corner 284, upper right corner 286, and lower right corner 288. Enclosed within stage wall 280 is an elliptical shaped grey artificial horizon wall 260 that surrounds the stage and is almost entirely enclosed except for horizon wall hole 262 that allows left camera 240 and right camera 250 to unobstructedly shoot the car 230 as it rotates on turntable 200. Horizon wall 260 also has a hingably connected portion of the wall 264 that opens and closes to allow a car to enter and exit the stage area.

[0067] In between stage wall 280 and horizon wall 260 there are eight (8) spaced apart stage lights positioned around a portion of the area. Using the same coordinate system that will be used for the discussion of the turntable is defined to be left is equal to 0 degrees and 360 degrees, up is equal to 90 degrees, right is equal to 180 degrees, and down is equal to 270 degrees. Moving clockwise away from left camera 240 and around turntable 200, place the lights around horizon wall 260 at approximate locations and approximate positions:

[0068] 1. First stage light 202 with 1 kilowatt of power at approximate location 315 degrees and lamp positioned to illuminate stage wall (280) at 45 degrees.

[0069] 2. Second stage light 204 with 2 kilowatts of power at approximate location 360 degrees and lamp positioned to illuminate horizon wall (260) at 225 degrees.

[0070] 3. Third stage light 206 with 1 kilowatt of power at approximate location 45 degrees and lamp positioned to illuminate stage wall (280) at 315 degrees.

[0071] 4. Fourth stage light 208 with 1 kilowatt of power at approximate location 60 degrees and lamp positioned to illuminate stage wall (280) at 315 degrees.

[0072] 5. Fifth stage light 210 with 1 kilowatt of power at approximate location 130 degrees and lamp positioned to illuminate stage wall (280) at 210 degrees.

[0073] 6. Sixth stage light 212 with 1 kilowatt of power at approximate location 150 degrees and lamp positioned to illuminate stage wall (280) at 220 degrees.

[0074] 7. Seventh stage light 214 with 2 kilowatts of power at approximate location 180 degrees and lamp positioned to illuminate horizon wall (280) at 300 degrees.

[0075] 8. Eighth stage light 216 with 1 kilowatt of power at approximate location 200 degrees and lamp positioned to illuminate stage wall (280) at 135 degrees.

[0076] II. Positioning of Vehicle on Turntable

[0077] It has been discovered that the appropriate number of images for a vehicle is typically 72 images. There are 36 images taken from the left eye view and 36 images taken from the right eye view.

from outside the stage onto the car. Then, make sure the numbering chart in front of the table is set to the correct number. If the car was leaking exhaust onto the table while aligning it, now is the time to use the mop stored at the rear of the table to mop up any puddles or moisture from the table.

[0095] Overhead

[0096] Before you start the spin, you must take an overhead shot of the car following these steps:

[0097] 1) Place a grey card on the table floor on the driver side facing upward

[0098] 2) Turn off the overhead light switches found on the computer station side of the stage and make sure no lights are flaring in the overhead camera

[0099] 3) Go back to the computer and open the EOS Utility program

[0100] 4) Release the shutter from the EOS Utility control panel

[0101] 5) Preview of the image captured and save it to the server in the correct vif folder->Exterior Stills->Edited folder under the correct vif name. Turn the overhead lights back on and remove the grey card from the table floor.

[0102] Again, double check the car and make sure everything looks okay. Now begin the spin. Spin Vehicle and shoot photo images.

[0103] Go to the EOS Utility program and reset the file numbering back to 1. Then double-check that the images will be sent to the correct folder destination. Do this for both right and left cameras.

[0104] Remove any images accumulated in the destination folder(s) during the setup so the folder is empty. Place the car key on the workstation counter during the spin to prevent lights on the car from flashing during the spin.

[0105] 1. At the Kuper based computer station go to the e Vox Axis Control screen and make sure the table is set to 0 degrees.

[0106] 2. Monitor the spin from the computer and by cursory inspection to ensure that the turntable moves five (5) degrees for each frame.

[0107] 3. Once the spin has completed, upload the spin images to the server under the correct car file number in its specified spin folder. There should be 72 frames from each spin camera and 144 total per vehicle.

[0108] a) Exterior spins should be delivered in a set of 36 frames that start in the left position at Image "1 0".

[0109] b) Numbering should proceed in increments of 10 all the way up to 360 to allow for the full spin.

[0110] c) Both Left and Right images should be delivered in the same directory.

[0111] d) File naming format should be: [0112] {IMAGE_PREFIX}_{left/right}_{index}.png [0113] Example: CGL0000_BK_EXT_left_01 O.png

[0114] e) Folder naming convention should be: [0115] {IMAGE_PREFIX}_{Resolution}/ [0116] Example: CGL000_BK_1024/

[0117] f) Images should be delivered in a transparent .PNG format. (No Compression)

[0118] g) Requested image delivery resolutions are evolving, but currently 1024, 1280, and 2048 images are best.

[0119] h) Framing is very important, the most important thing is that all the cars that will appear in the same build are delivered at the same size relative to each other.

[0120] i) Each delivery should include a 128px (full frame) version of the "Left 240" image. This image should be called "Thumb.png" and placed in the root folder for that color.

[0121] j) The file prefix should not change delivery-to-delivery. Whichever prefix convention is used it should be locked and not change.

[0122] Resource

[0123] 1. Open the "vif_spin.quadrature.ost" folder on the desktop. [0124] Before spin is initiated, check the following folders for old files: [0125] 00_source, 01_composite, 02_shadow and 03_crop and make sure these folders are empty.

[0126] These folders should be empty of any previous project files.

[0127] 2. Then connect to the VIF server "vif xserve11 Network Drive. [0128] In the server, go to: [0129] Ol_active>AIOxxxx (Project Name)>spin>Ol_sps

[0130] There should be 36.tif files in this folder.

[0131] 3. Copy all 36.tif files into folder: vif_spin_post>Ol_composite" located on your desktop.

[0132] 4. Then, close the "vif_xserve>" folder.

[0133] Renaming Files

[0134] 1. Select all 36.tif files in the "vif_spin_post>Ol_composite" folder Right click and select the renaming utility "A Better Finder Rename".

[0135] 2. In the Rename Utility screen, scroll through the "Action:" drop down menu. Select "Produce numbered list".

[0136] Parameters:

[0137] Set the "Prefix:" to the current project number "AIOxxxx_spsco_" and the "Suffix:" to 11.tif".

[0138] Set the "Start With:" to "1 ", "Step Value:" to "1 ", and "Padding:" to "3".

[0139] Check the "Show full preview" box on to view the old name and the new name.

[0140] The new name preview is to the right. It should look like this: "AIOxxxx_spsco_001. tif"

[0141] 3. Select "OK"

[0142] 4. Select "Rename All"

[0143] The 36 frames are now ready for masking.

[0144] Alpha 1 Masking

[0193] 7. Go to your

[0194] "vif_spin_post>02_shadow"

[0195] located on your desktop. There will be two files in this folder. Open both frames and run action "man shadow fix start" on both files.

[0196] If shadows looks bad and spotty repeat Step 4: Adjusting Shadow. If the shadow looks good, continue.

[0197] 8. Delete both frames in the 02 shadow folder.

[0198] 9. Go to

[0199] File>Automate>Batch

[0200] Follow the settings:

[0201] Play: Set the "Set:" to "vif_spin_post.atn"

[0202] Set the "Action:" to "shadow"

[0203] Source: Folder

[0204] "Choose" your folder "vif_spin_post>01_composite"

[0205] Destination: None

[0206] Select OK.

[0207] Batching will begin.

[0208] Posting a Shadow

[0209] 1. When batching is complete, go to

[0210] "vif_spin post_>02_shadow"

[0211] Open the first frame.

[0212] There will be 36 frames in this folder.

[0213] 2. To fix each shadow open each frame individually and Run the "man_shadow_fix_start", the "lever" layer will be selected by the action.

[0214] 3. Select the paintbrush (100 soft brush preferred) with white as the foreground color and begin painting out irregularities of the cars' shadow.

[0215] 4. When finished with the "levels" layer", continue the process on the "shadow fix" layer. Select the "shadow fix" layer and begin painting out irregularities of the car's shadow on the "shadow fix" layer.

[0216] Paint primarily around the undercarriage of the car and at the pinch points of the tires.

[0217] Be careful to do as little as possible to the main shadow itself to avoid continuity problems in other

[0241] Source: Folder

[0242] "Choose" your folder "vif_spin_post>03_shadow"

[0243] Destination: None

[0244] 7. Select Ok.

[0245] This will save a crop copy of all 36 frames into the "vif_spin_post>04_crop" folder

[0246] Final Inspection

[0247] Camera reflection:

[0248] 1. Open frames 1, 10, 19, and 28 in the "vif_spin_post>04_crop" folder located on your desktop.

[0249] Check to see if the camera reflection is visible. If so, use the clone stamp tool to remove reflection.

[0250] Blown out areas:

[0251] 2. Open frames 9, 11, 27, and 29.

[0252] 3. Check for blown out areas. If blown out areas found do the following:

[0253] Use the "alpha 1" mask to make a selection of the car.

[0254] Select the paint brush and set mode to "Darken" and the painting opacity to 15%.

[0255] Use quick strokes over the blown out areas to paint in a little detail.

[0256] Adding Adjustment Layers

[0257] 1. Go to

[0258] "vif_xserve:0 1_active:AILXXXXX:AILXXXXX_spin:AILXXXXX_00_spre:"

[0259] Download the xxxx.acv and xxxx.ahu to you spin resources folder

[0260] "Macintosh HD:Users:xxxxxx:Desktop:vif_spin_post:00_resources:"

[0261] 2. Once it is on the computer apply the adjustment layers to images

[0262] 3. Select the alpha 1 then go to layers/new adjustment layers/curves, the curves window should pop up.

[0263] 4. Then select load, locate for xxxx.acv and press ok to load the adjustment curves on to the image, do the same for huesat layer.

[0264] Output (This process creates the frame outputs)

[0265] 1. Go to

[0266] "File>Automate>Batch 11

[0267] Set to+

[0284] Local Position to the parent is (0, -0.03, 0)

[0285] Layermask excludes the "Right" layer.

[0286] The Right Eye camera has the following unique settings:

[0287] Local Position to the parent is (0, 0.03, 0)

[0288] Layermask excludes the "Left" layer.

[0289] Referring to FIG. 7, the Car spin panoramic images are placed onto the skybox 400 by having the car spin panoramic images line up with the front face of skybox 400. This ensures the images has the perfect amount of distortion and is scaled precisely on import.

[0290] Referring to FIGS. 7 and 9, once the car is lined up, a special Shutterbox script is synced to an invisible rotating "anchor" object that determines the current rotation of the car. Depending on the number of images available for the spin, the Shutterbox script seamlessly switches out the appropriate left and right images depending on what angle the anchor object is currently rotated to.

[0291] Referring to FIG. 8, beginning with either a stereoscopic panoramic interior photo of a car or a stereoscopic panoramic exterior photo of a car, selectable graphic user interface object will be superimposed as a layer on top of the panoramic car images.

[0292] Referring to FIG. 8, and by way of example, superimposed Graphic User interface (GUI) allows the user of the head mounted display to select the elements/objects (element and object will be used interchangeably). In FIG. 8, Graphic user interface steering wheel 934 can be selected by the user to switch the user from viewing the panoramas for the outside of the car to viewing the panoramas for the inside of the car.

[0293] Insertion of Graphic User Interface

[0294] Referring to FIG. 9, there is illustrated a shutterbox 900 which consists of the virtual showroom skybox 400, multiple graphic user interface objects (931, 932, 933, 934, 935, 936, 937, 938, and 940), car 230 (not shown), and a white box 920. White box 920 represents a car that can be selected by the user from third graphic user interface object 933. Third graphic user interface object 933 is just one of the 3D objects that have been layered into shutterbox 900 to allow a user to interact with virtual showroom skybox 400. Each graphic user interface selection object (first graphic user interface 931, second graphic user interface 932, third graphic user interface object 933, fourth graphic user interface object 934, fifth graphic user interface object 935, sixth graphic user interface object 936, seventh graphic user interface object 937, and eighth graphic user interface object 938) shown in FIG. 9 is an individually produced and layered graphic object. These Graphic User interface (GUI) objects can be but are not limited to photos, videos, text files, or user accessible libraries such as the car library.

[0295] In order for the user to be able to access each of the individual icons/graphic user interface elements, the user uses a mouse in the center of the image and by rotating the user's head down, left or right, the user can select the desired graphic user element as discussed below. Therefore, the movement of a persons head while weaning HMD functions as a mouse to point to the specific icons.

[0296] In FIG. 9, by example, first graphic user interface object 931 is an information or help file for the user. Second graphic user interface object 932 takes the user back to the initial page or home page. Third graphic user interface object 933 allows a user to select a different car to fit within white box 920. Fourth graphic user interface object 934 is an interface that allows the other objects to be viewed when selected. Fifth graphic user interface object 935 changes the view to the inside of the car. Sixth graphic user interface object 936 is a video. Seventh graphic user interface object 937 allows the user to view the headlights, and eighth graphic user

