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**Example 1:**

**Abstract:**

It is inter alia disclosed to determine a phase difference between a light signal transmitted by a time of flight camera system and a reflected light signal received by at least one pixel sensor of an array of pixel sensors in an image sensor of the time of flight camera system, wherein the reflected light signal received by the at least one pixel sensor is reflected from an object illuminated by the transmitted light signal (301); determine an amplitude of the reflected light signal received by the at least one pixel sensor (301); combine the amplitude and phase difference for the at least one pixel sensor into a combined signal parameter for the at least one pixel sensor (307); and de-noise the combined signal parameter for the at least one pixel sensor by filtering with a filter the combined parameter for the at least one pixel sensor (309).

**Claim:**

The invention claimed is:

1. A method comprising:

determining a phase difference between a light signal transmitted by a time of flight camera system and a reflected light signal received by at least one pixel sensor of an array of pixel sensors in an image sensor of the time of flight camera system, wherein the reflected light signal received by the at least one pixel sensor is reflected from an object illuminated by the transmitted light signal;

determining an amplitude of the reflected light signal received by the at least one pixel sensor;

de-noising at least one of the phase difference or the amplitude for the at least one pixel sensor by filtering the phase difference or the amplitude for the at least one pixel sensor;

following de-noising of at least one of the phase difference or the amplitude, combining the amplitude and phase difference for the at least one pixel sensor into a combined signal parameter for the at least one pixel sensor; and

de-noising the combined signal parameter for the at least one pixel sensor by filtering the combined parameter for the at least one pixel sensor to generate a de-noised combined signal parameter from which a distance map image that is less effected by noise is determinable by the time of flight camera system.

2. The method as claimed in claim 1, wherein the filtering further comprises:

filtering with a non-local spatial transform filter.

3. The method as claimed in claim 2, wherein the non-local spatial transform filter is a non-local means filter.

4. The method as claimed in claim 1, further comprising calculating a distance range to the object from the de-noised combined signal parameter for the at least one pixel sensor by:

determining the de-noised phase difference for the at least one pixel sensor from the de-noised combined signal parameter for the at least one pixel sensor; and

calculating the distance range to the object for the at least one pixel sensor using the de-noised phase difference for the at least one pixel sensor.

5. The method as claimed in claim 1, wherein the combined signal parameter is a complex signal parameter formed from combining the amplitude and phase difference for the at least one pixel sensor.

6. The method as claimed in claim 1, wherein the image sensor of the time of flight camera system is based at least in part on a photonic mixer device.

7. An apparatus comprising at least one processor and at least one memory including computer code for one or more programs, the at least one memory and the computer code configured with the at least one processor to cause the apparatus at least to:

determine a phase difference between a light signal transmitted by a time of flight camera system and a reflected light signal received by at least one pixel sensor of an array of pixel sensors in an image sensor of the time of flight camera system, wherein the reflected light signal received by the at least one pixel sensor is reflected from an object illuminated by the transmitted light signal;

determine an amplitude of the reflected light signal received by the at least one pixel sensor;

de-noise at least one of the phase difference or the amplitude for the at least one pixel sensor by filtering the phase difference or the amplitude for the at least one pixel sensor;

following de-noising of at least one of the phase difference or the amplitude, combine the amplitude and phase difference for the at least one pixel sensor into a combined signal parameter for the at least one pixel sensor; and

de-noise the combined signal parameter for the at least one pixel sensor by filtering the combined parameter for the at least one pixel sensor to generate a de-noised combined signal parameter from which a distance map image that is less effected by noise is determinable by the time of flight camera system.

8. The apparatus as claimed in claim 7, wherein filtering comprises filtering with a non-local spatial transform filter.

9. The apparatus as claimed in claim 8, wherein the non-local spatial transform filter is a non-local means filter.

10. The apparatus as claimed in claim 7, wherein the at least one memory and the computer code configured with the at least one processor is further configured to calculate a distance range to the object from the de-noised combined signal parameter for the at least one pixel sensor by being configured to:

determine the de-noised phase difference for the at least one pixel sensor from the de-noised combined signal parameter for the at least one pixel sensor, and

calculate the distance range to the object for the at least one pixel sensor using the de-noised phase difference for the at least one pixel sensor.

11. The apparatus as claimed in claim 7, wherein the combined signal parameter is a complex signal parameter formed from combining the amplitude and phase difference for the at least one pixel sensor.

12. The apparatus as claimed in claim 7, wherein the image sensor of the time of flight camera system is based at least in part on a photonic mixer device.

13. A computer program product comprising at least one computer-readable storage medium, the computer-readable storage medium comprising a set of instructions, which, when executed by one or more processors, causes an apparatus to:

determine a phase difference between a light signal transmitted by a time of flight camera system and a reflected light signal received by at least one pixel sensor of an array of pixel sensors in an image sensor of the time of flight camera system, wherein the reflected light signal received by the at least one pixel sensor is reflected from an object illuminated by the transmitted light signal;

determine an amplitude of the reflected light signal received by the at least one pixel sensor;

de-noise at least one of the phase difference or the amplitude for the at least one pixel sensor by filtering the phase difference or the amplitude for the at least one pixel sensor;

following de-noising of at least one of the phase difference or the amplitude, combine the amplitude and phase difference for the at least one pixel sensor into a combined signal parameter for the at least one pixel sensor; and

de-noise the combined signal parameter for the at least one pixel sensor by filtering the combined parameter for the at least one pixel sensor to generate a de-noised combined signal parameter from which a distance map image that is less effected by noise is determinable by the time of flight camera system.

14. The computer program product as claimed in claim 13, wherein the set of instructions when executed by the processor causes the apparatus to filter, further causes the apparatus to:

filter with a non-local spatial transform filter.

15. The computer program product as claimed in claim 14, wherein the non-local spatial transform filter is a non-local means filter.

16. The computer program product as claimed in claim 13, wherein the set of instructions when executed by the processor further causes the apparatus to calculate a distance range to the object from the de-noised combined signal parameter for the at least one pixel sensor by being caused to:

determine the de-noised phase difference for the at least one pixel sensor from the de-noised combined signal parameter for the at least one pixel sensor; and

calculate the distance range to the object for the at least one pixel sensor using the de-noised phase difference for the at least one pixel sensor.

17. The computer program product as claimed in claim 13, wherein the combined signal parameter is a complex signal parameter formed from combining the amplitude and phase difference for the at least one pixel sensor.

18. The computer program product as claimed in claim 13, wherein the image sensor of the time of flight camera system is based at least in part on a photonic mixer device.

**Token Generated**:

The disclosed method relates to determining phase difference and amplitude of a reflected light signal received by a pixel sensor in a time of flight camera system. The method includes combining the amplitude and phase difference into a combined signal parameter and then de-noising it. The de-noised signal parameter is used to generate a distance map image with less noise. The method also includes filtering the phase difference and amplitude using a non-local spatial transform filter. The apparatus and computer program product for implementing the method are also disclosed.

**Prompt Generated**:

The disclosed invention relates to a method and apparatus for processing signals in a time-of-flight camera system. The method involves determining the phase difference between a transmitted light signal and a reflected light signal received by at least one pixel sensor in an image sensor. The amplitude of the reflected light signal is also determined. The phase difference and amplitude are then combined into a combined signal parameter for the pixel sensor. To reduce noise, the combined signal parameter is filtered using a non-local spatial transform filter. The filtered parameter is used to generate a de-noised combined signal parameter, which can be used to determine a distance map image with reduced noise. The invention also includes an apparatus and a computer program product implementing the method.

**Example 2:**

**Abstract:**

A method, apparatus and computer program product are provided to adjust audio file playback in terms of volume and/or compression. By example, a method separates an audio file into tracks, each attributable to a different instrument. The method also determines the instrument for which the audio signals are dominant or loudest and accesses settings for the volume preference of the audio signals attributable to each different instrument. The method modifies the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest based on user input altering a volume at which the audio file is output without modification of the setting for the volume preference of the audio signals attributable to another instrument. The method also amplifies or attenuates audio signals based upon the modified setting.

**Claim:**

"That which is claimed:

1. A method comprising:

separating an audio file into a plurality of tracks, each track comprises audio signals attributable to a different respective instrument;

determining the instrument for which the audio signals are dominant or loudest from among the tracks into which the audio file is separated;

dependent upon a determination of the instrument for which the audio signals are dominant or loudest during or after provision of user input to alter a volume at which the audio file is output, modifying a setting for a volume preference of the audio signals attributable to the instrument that is dominant or loudest based on the user input altering the volume at which the audio file is output without modification of the setting for the volume preference of the audio signals attributable to another instrument; and

amplifying or attenuating audio signals based upon the setting for the volume preference, as modified.

2. A method according to claim 1 wherein modifying the setting comprises modifying the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest in accordance with a direct relationship with respect to the user input.

3. A method according to claim 1 wherein modifying the setting comprises modifying the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest by a fixed amount in response to the user input.

4. A method according to claim 1 wherein amplifying or attenuating the audio signals comprises amplifying or attenuating the audio signals representative of the instrument for which the audio signals were dominant or loudest without amplifying or attenuating the audio signals representative of the another instrument.

5. A method according to claim 1 wherein the audio file comprises a plurality of segments such that the plurality of tracks each correspondingly include a plurality of track segments, wherein determining the instrument for which the audio signals are dominant or loudest, modifying the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest and amplifying or attenuating the audio signals are repeated for the plurality of segments of the audio file.

6. An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to:

separate an audio file into a plurality of tracks, each track comprises audio signals attributable to a different respective instrument;

determine the instrument for which the audio signals are dominant or loudest from among the tracks into which the audio file is separated;

dependent upon a determination of the instrument for which the audio signals are dominant or loudest during or after provision of user input to alter a volume at which the audio file is output, modify a setting for a volume preference of the audio signals attributable to the instrument that is dominant or loudest based on the user input altering the volume at which the audio file is output without modification of the setting for the volume preference of the audio signals attributable to another instrument; and

amplify or attenuate audio signals based upon the setting for the volume preference, as modified.

7. An apparatus according to claim 6 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to modify the setting by modifying the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest in accordance with a direct relationship with respect to the user input.

8. An apparatus according to claim 6 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to modify the setting by modifying the setting for the volume preference of the audio signals attributable to the instrument that is dominant or loudest by a fixed amount in response to the user input.

9. An apparatus according to claim 6 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to amplify or attenuate the audio signals by amplifying or attenuating the audio signals representative of the instrument for which the audio signals were dominant or loudest without amplifying or attenuating the audio signals representative of the another instrument.

10. An apparatus according to claim 6 wherein the audio file comprises a plurality of segments such that the plurality of tracks each correspondingly include a plurality of track segments, wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to repeatedly determine the instrument for which the audio signals are dominant or loudest, modify the setting for volume preference of the audio signals attributable to the instrument that is dominant or loudest and amplify or attenuate the audio signals for the plurality of segments of the audio file.

11. A method comprising:

separating an audio file into a plurality of tracks, each track comprises audio signals attributable to a different respective instrument;

determining the instrument for which the audio signals are dominant or loudest from among the tracks into which the audio file is separated;

determining a representation of a volume at which a user has previously output one or more audio files for which the audio signals attributable to the instrument are dominant or loudest; and

adjusting a volume at which the audio file is output based upon the representation of the volume at which the user has previously output one or more audio files for which the audio signals attributable to the instrument are dominant or loudest.

12. A method according to claim 11 wherein determining a representation of the volume comprises determining an average volume above an environment audio volume at which tracks representative of the respective instrument for which the audio signals that are dominant or loudest have been previously output.

13. A method according to claim 12 further comprising determining the environment audio volume, and wherein adjusting the volume comprises adjusting the volume at which the audio file is output such that the track representative of the respective instrument for which the audio signals are dominant or loudest has the average volume about the environment audio volume that is determined.

14. A method according to claim 13 wherein adjusting the volume comprises adjusting the volume of tracks representative of instruments other than the respective instrument for which the audio signals are dominant or loudest based upon the average volume above the environment audio volume at which tracks representative of the respective instrument for which the audio signals are dominant or loudest have been previously output.

15. A method according to claim 12 further comprising updating a database to store the average volume above the environment audio volume at which tracks representative of the respective instrument for which the audio signals are dominant or loudest have been previously output.

16. An apparatus comprising at least one processor and at least one memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to:

separate an audio file into a plurality of tracks, each track comprises audio signals attributable to a different respective instrument;

determine the instrument for which the audio signals are dominant or loudest from among the tracks into which the audio file is separated;

determine a representation of a volume at which a user has previously output one or more audio files for which the audio signals attributable to the instrument are dominant or loudest; and

adjust a volume at which the audio file is output based upon the representation of the volume at which the user has previously output one or more audio files for which the audio signals attributable to the instrument are dominant or loudest.

17. An apparatus according to claim 16 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to determine a representation of the volume by determining an average volume above an environment audio volume at which tracks representative of the respective instrument for which the audio signals that are dominant or loudest have been previously output.

18. An apparatus according to claim 17 wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to determine the environment audio volume, and wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to adjust the volume by adjusting the volume at which the audio file is output such that the track representative of the respective instrument for which the audio signals are dominant or loudest has the average volume about the environment audio volume that is determined.

19. An apparatus according to claim 18 wherein the at least one memory and the computer program code are configured to, with the at least one processor, cause the apparatus to adjust the volume by adjusting the volume of tracks representative of instruments other than the respective instrument for which the audio signals are dominant or loudest based upon the average volume above the environment audio volume at which tracks representative of the respective instrument for which the audio signals are dominant or loudest have been previously output.

20. An apparatus according to claim 17 wherein the at least one memory and the computer program code are further configured to, with the at least one processor, cause the apparatus to update a database to store the average volume above the environment audio volume at which tracks representative of the respective instrument for which the audio signals are dominant or loudest have been previously output."

**Token Generated:**

The present invention relates to adjusting audio file playback in terms of volume and/or compression. The method involves separating an audio file into tracks, each representing a different instrument. The dominant or loudest instrument is determined, and settings for volume preference are accessed for each instrument. The method then modifies the volume preference setting for the dominant instrument based on user input to alter the output volume. The audio signals are subsequently amplified or attenuated based on the modified setting. The invention also includes an apparatus and computer program product implementing the method. Additionally, there is a method for adjusting the volume at which an audio file is output based on the user's previous output levels for files with a dominant instrument. The apparatus and computer program product for this method are also provided.

**Prompt generated:**

The invention provides a method, apparatus, and computer program product for adjusting audio file playback in terms of volume and/or compression. The method involves separating an audio file into tracks corresponding to different instruments and determining the dominant or loudest instrument. The method then modifies the volume preference settings for the dominant instrument based on user input to adjust the output volume without modifying the settings for other instruments. The audio signals are amplified or attenuated based on the modified settings. The apparatus and computer program product implement the method, including features such as direct relationship modification, fixed amount modification, and segment-based processing. Another aspect of the invention involves adjusting the output volume based on a representation of the volume at which similar audio files have been previously output, with consideration given to the environment audio volume. The apparatus and computer program product also include features for updating a database with average volume information.

**Example 3:**

**Abstract:**

In accordance with an example embodiment a method, apparatus and a computer program product are provided. The method comprises partitioning an image into a plurality of super pixel cell areas and determining surface orientations for the plurality of super pixel cell areas. A surface orientation is determined for a super pixel cell area based on depth information associated with the image. The method further comprises receiving at least one virtual light source indication for modifying an illumination associated with the image. The illumination is modified by modifying brightness associated with one or more super pixel cell areas from among the plurality of super pixel cell areas based on the at least one virtual light source indication and surface orientations corresponding to the one or more super pixel cell areas from among the determined surface orientations for the plurality of super pixel cell areas.

**Claim:**

"We claim:

1. A method comprising:

partitioning an image into a plurality of super pixel cell areas;

determining surface orientations for the plurality of super pixel cell areas, wherein a surface orientation is determined for a super pixel cell area from among the plurality of super pixel cell areas based on depth information associated with the image;

receiving at least one virtual light source indication for modifying an illumination associated with the image; and

modifying the illumination associated with the image by modifying brightness associated with one or more super pixel cell areas from among the plurality of super pixel cell areas based on the at least one virtual light source indication and surface orientations corresponding to the one or more super pixel cell areas from among the determined surface orientations for the plurality of super pixel cell areas.

2. An apparatus comprising:

at least one processor; and

at least one memory comprising computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to at least perform:

partition an image into a plurality of super pixel cell areas;

determine surface orientations for the plurality of super pixel cell areas, wherein a surface orientation is determined for a super pixel cell area from among the plurality of super pixel cell areas based on depth information associated with the image;

receive at least one virtual light source indication for modifying an illumination associated with the image; and

modify the illumination associated with the image by modifying brightness associated with one or more super pixel cell areas from among the plurality of super pixel cell areas based on the at least one virtual light source indication and surface orientations corresponding to the one or more super pixel cell areas from among the determined surface orientations for the plurality of super pixel cell areas.

3. The apparatus as claimed in claim 2, wherein to determine the surface orientation for the super pixel cell area, the apparatus is further configured to:

assign normals for pixels corresponding to the super pixel cell area based on the depth information associated with the image, and

average the normals assigned to the pixels to generate an average normal, wherein the average normal is determined as the surface orientation for the super pixel cell area.

4. The apparatus as claimed in claim 3, wherein the apparatus is further configured to employ one or more filters for counteracting artefacts generated during the determination of the surface orientation for the super pixel cell area.

5. The apparatus as claimed in claim 3, wherein the apparatus is further configured to generate at least a coarse estimate of one of a depth map and disparity map for the image for generating the depth information associated with the image.

6. The apparatus as claimed in claim 2, wherein to receive the at least one virtual light source indication, the apparatus is further configured to receive at least one vector, wherein a vector from among the at least one vector is indicative of a virtual light source direction.

7. The apparatus as claimed in claim 2, wherein to receive the at least one virtual light source indication, the apparatus is further configured to receive at least one virtual light source position, wherein a virtual light source position from among the at least one virtual light source position comprises one of two-dimensional positional information and three-dimensional positional information corresponding to a virtual light source.

8. The apparatus as claimed in claim 7, wherein the apparatus is further configured to:

compute at least one vector from the at least one virtual light source position, wherein a vector from among the at least one vector is indicative of a virtual light source direction.

9. The apparatus as claimed in claim 6, wherein to modify brightness associated with the one or more super pixel cell areas, the apparatus is further configured to:

increase brightness of pixels included within a super pixel cell area from among the one or more super pixel cell areas if a corresponding surface orientation is facing the virtual light source direction represented by the vector; and

decrease brightness of pixels included within a super pixel cell area from among the one or more super pixel cell areas if a corresponding surface orientation is facing in a different direction from the virtual light source direction represented by the vector.

10. The apparatus as claimed in claim 9, wherein an individual brightness of a pixel from among pixels included within the one or more super pixel cell areas is modified in proportion to current pixel brightness.

11. The apparatus as claimed in claim 10, wherein modification of the individual brightness of the pixel is further performed based on an original color of the pixel, a depth information associated with the pixel and at least one pre-determined factor associated with one or more virtual light sources corresponding to the at least one virtual light source indication, the at least one criteria comprising a color associated with each virtual light source from among the one or more virtual light sources and a power factor associated with the each virtual light source.

12. The apparatus as claimed in claim 11, wherein the apparatus is further configured to modify a color associated with one or more super pixel cell areas from among the plurality of super pixel cell areas based on the color associated with the each virtual light source from among the one or more virtual light sources.

13. The apparatus as claimed in claim 2, wherein the one or more super pixel cell areas correspond to one of an image foreground region and an image background region identified based on the depth information associated with the image.

14. The apparatus as claimed in claim 11, wherein to modify the illumination associated with the image, the apparatus is further configured to perform one of gradual attenuation and abrupt attenuation of the brightness associated with the one or more super pixel cell areas along the virtual light source direction represented by the vector.

15. The apparatus as claimed in claim 2, wherein to modify the brightness associated with the one or more super pixel cell areas, the apparatus is further configured to perform one of removing brightness and adding brightness from individual super pixel cell areas from among the one or more super pixel cell areas.

16. The apparatus as claimed in claim 2, wherein the apparatus is further configured to:

identify a plurality of non-overlapping regions in the image, each non-overlapping region from among the plurality of non-overlapping regions associated with substantially same color and comprising at least one super pixel cell area from among the plurality of super pixel cell areas, wherein the plurality of non-overlapping regions are associated with higher level of brightness than regions comprising remaining super pixel cell areas from among the plurality of super pixel cell areas;

compute region surface orientations for the plurality of non-overlapping regions, wherein a region surface orientation from among the region surface orientations corresponds to a surface orientation computed for a non-overlapping region from among the plurality of non-overlapping regions; and

determine a light source direction corresponding to a primary light source illuminating the image by computing a weighted average of the region surface orientations, wherein a direction corresponding to the weighted average of the region surface orientations is determined as the light source direction.

17. The apparatus as claimed in claim 16, wherein to compute a region surface orientation from among the region surface orientations, the apparatus is further configured to average surface orientations corresponding to the at least one super pixel cell area included within a corresponding non-overlapping region from among the plurality of non-overlapping regions.

18. The apparatus as claimed in claim 17, wherein the apparatus is further configured to:

compute depth estimates and brightness estimates for the plurality of non-overlapping regions, wherein a depth estimate from among the depth estimates and a brightness estimate from among the brightness estimates is computed for the each non-overlapping region; and

assign weights to the region surface orientations, wherein a weight is assigned to a region surface orientation from among the region surface orientations based on a depth estimate from among the depth estimates and a brightness estimate from among the brightness estimates computed for a corresponding non-overlapping region from among the plurality of non-overlapping regions, wherein the weighted average of the region surface orientations is computed based on the assigned weights.

19. The apparatus as claimed in claim 18, wherein the depth estimate for the each non-overlapping region corresponds to an average depth of the at least one super pixel cell area included within the each non-overlapping region, and, wherein the brightness estimate for the each non-overlapping region corresponds to brightness associated with a brightest super pixel cell area from among the at least one super pixel cell area included within the each non-overlapping region.

20. The apparatus as claimed in claim 2, wherein the image is one from among a stereo pair of images.

21. The apparatus as claimed in claim 2, wherein the apparatus is further configured to display the image subsequent to modifying the illumination associated with the image.

22. A computer program product comprising at least one non-transitory computer-readable storage medium, the one non-transitory computer-readable storage medium comprising a set of instructions, which, when executed by one or more processors, cause an apparatus to at least perform:

partition an image into a plurality of super pixel cell areas;

determine surface orientations for the plurality of super pixel cell areas, wherein a surface orientation is determined for a super pixel cell area from among the plurality of super pixel cell areas based on depth information associated with the image;

receive at least one virtual light source indication for modifying an illumination associated with the image; and

modify the illumination associated with the image by modifying brightness associated with one or more super pixel cell areas from among the plurality of super pixel cell areas based on the at least one virtual light source indication and surface orientations corresponding to the one or more super pixel cell areas from among the determined surface orientations for the plurality of super pixel cell areas."

**Token Generated:**

The example embodiment provides a method, apparatus, and computer program product for modifying the illumination of an image. The method includes partitioning the image into super pixel cell areas and determining surface orientations for each super pixel cell area based on depth information. The method also involves receiving indications of virtual light sources to modify the illumination and adjusting the brightness of the super pixel cell areas based on the virtual light sources and their respective surface orientations. The apparatus includes a processor and memory to perform the method, while the computer program product contains instructions to execute the method on a processor.

**Prompt generated:**

The invention describes a method, apparatus, and computer program for modifying the illumination of an image. The method involves partitioning the image into super pixel cell areas and determining surface orientations for each area based on depth information. Virtual light source indications are received to modify the illumination. The brightness of specific super pixel cell areas is modified based on the virtual light source indications and corresponding surface orientations. The apparatus includes a processor and memory configured to perform the method. The computer program product comprises computer-readable instructions to execute the method. Additional features include the assignment of normals, filters to counteract artifacts, generation of depth or disparity maps, and modification of color. The apparatus can identify image foreground and background regions, compute region surface orientations, and determine the primary light source direction. The computer program product is stored on a non-transitory computer-readable storage medium.