

One of the challenges of Image-based point cloud compression techniques is that a point cloud may not be suitable for projection onto images, especially when the point distribution follows a surface with many folds (concave/convex regions, like in clothing) or when the point distribution does not follow a surface at all (like in fur or hair). In these situations, image-based point cloud compression techniques suffer from low compression efficiency (many small projections are required, reducing the efficiency of the 2D video compression) or bad quality (due to the difficulty of projecting the point cloud onto a surface).

One of the approaches used in the state of the art to alleviate this problem consists in projecting multiple geometry and texture information onto a same spatial location (pixel) of an image. This means that several depth and/or texture images are generated per 3D point of the point cloud.

This is the case, for example, of the point cloud encoder as defined in ISO/IEC JTC1/SC29 WG1 1/N 17248, Macau, China, October 2017 (TMC2) in which two depth images (representative of the geometry of the point cloud) and two texture images (representative of the color/texture of the point cloud) are encoded.

Compressing efficiently texture images obtained by projecting points of a point cloud onto a projection plane is an issue.

4. Summary.

The following presents a simplified summary of the present embodiments in order to provide a basic understanding of some aspects of the present embodiments. This summary is not an extensive overview of the present embodiments. It is not intended to identify key or critical elements of the present embodiments. The following summary merely presents some aspects of the present embodiments in a simplified form as a prelude to the more detailed description provided below.

~~According to a first aspect, there is provided a method including encoding a point cloud in a bitstream, wherein encoding the point cloud includes: encoding color information data representative of a first texture image from which at least one point of the point cloud is colorized, encoding an information representative of a texture interpolation coding mode, wherein the texture interpolation coding mode indicates that the bitstream contains color information data representative of the first texture image, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information.~~

According to a first aspect, there is provided a method including encoding a point cloud in a bitstream, wherein encoding the point cloud includes: encoding color information data representative of a first texture image from which at least one point of the point cloud is colored when decoding the point cloud, encoding the point cloud in the bitstream wherein the coded point cloud includes colorized 3D points and non-colorized 3D points, colorized 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud, non-colorized 3D points being 3D points of the point cloud having no color value assigned from color information data encoded in the bitstream, encoding an information representative of a texture interpolation coding mode, the texture interpolation coding mode indicating whether texture interpolation has to be done for non-colorized 3D points of the point cloud when decoding the point cloud, wherein texture interpolation for non-colorized 3D points is a function of colorized 3D points of the point cloud neighboring in the point cloud the non-colorized 3D points.

~~According to a second aspect, there is provided an apparatus including one or more processors configured for encoding a point cloud in a bitstream, wherein encoding the point cloud includes: encoding color information data representative of a first texture image from which at least one point of the point cloud is colored, encoding an information representative of a texture interpolation coding mode, wherein the texture interpolation coding mode indicates that the bitstream contains color information data representative of the first texture image, and that texture interpolation has to be done on at least one other point of the point cloud that is not colored from said color information.~~

According to a second aspect, there is provided an apparatus including one or more processors configured for encoding a point cloud in a bitstream, wherein encoding the point cloud includes: encoding color information data representative of a first texture image from which at least one point of the point cloud is colored when decoding the point cloud, encoding the point cloud in the bitstream wherein the coded point cloud includes colorized 3D points and non-colorized 3D points, colorized 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud, non-colorized 3D points being 3D points of the point cloud having no color value assigned from color information data encoded in the bitstream, encoding an information representative of a texture interpolation coding mode, the texture interpolation coding mode indicating whether texture interpolation has to be done for non-colorized 3D points of the point cloud when decoding the point cloud, wherein texture interpolation for non-colorized 3D points is a function of colorized 3D points of the point cloud neighboring in the point cloud the non-colorized 3D points.

~~According to a third aspect, there is provided a method including reconstructing a point cloud from a bitstream, wherein reconstructing the point cloud includes: decoding from the bitstream, an information representative of a texture interpolation coding mode, wherein the texture interpolation coding mode indicates that the bitstream contains color information data representative of a first texture image and that texture interpolation has to be done for at least one point of the point cloud that is not colorized from said color information, reconstructing said first texture image from said color information data, assigning colors to at least one point of the reconstructed point cloud that is not colorized from said color information data.~~

According to a third aspect, there is provided a method including decoding a first texture image from color information data decoded from a bitstream, decoding a point cloud from the bitstream, the decoded point cloud including colorized 3D points and non-colorized 3D points, colorized 3D points being 3D points of the decoded point cloud whose color value is assigned from the decoded first texture image, non-colorized 3D points being 3D points of the decoded point cloud having no color value assigned from color information data decoded from the bitstream, decoding from the bitstream, an information representative of a texture interpolation coding mode, the texture interpolation coding mode indicating whether texture interpolation has to be done for the non-colorized 3D points of the point cloud, responsive to a determination that the texture interpolation coding mode indicates that texture interpolation has to be done for the non-colorized 3D points of the point cloud, assigning a color value to at least one non-colorized 3D point as a function of colorized 3D points of the decoded point cloud neighboring in the point cloud the at least one non-colorized 3D point.

~~According to a fourth aspect, there is provided an apparatus including one or more processors configured for reconstructing a point cloud from a bitstream, wherein reconstructing the point cloud includes: decoding from the bitstream, an information representative of a texture interpolation coding mode, wherein the texture interpolation coding mode indicates that the bitstream contains color information data representative of a first texture image and that texture interpolation has to be done for at least one point of the point cloud that is not colorized from said color information, reconstructing said first texture image from said color information data, assigning colors to at least one point of the reconstructed point cloud that is not colorized from said color information data.~~

According to a fourth aspect, there is provided an apparatus including one or more processors configured for: decoding a first texture image from color information data decoded from a bitstream, decoding a point cloud from the bitstream, the decoded point cloud including colorized 3D points and non-colorized 3D points, colorized 3D points being 3D points of the decoded point cloud whose color value is assigned from the decoded first texture image, non-

colorized 3D points being 3D points of the decoded point cloud having no color value assigned from color information data decoded from the bitstream, decoding from the bitstream, an information representative of a texture interpolation coding mode, the texture interpolation coding mode indicating whether texture interpolation has to be done for the non-colored 3D points of the point cloud, responsive to a determination that the texture interpolation coding mode indicates that texture interpolation has to be done for the non-colored 3D points of the point cloud, assigning a color value to at least one non-colored 3D point as a function of colorized 3D points of the decoded point cloud neighboring in the point cloud the at least one non-colored 3D point.

~~According to a fifth aspect, there is provided a signal carrying a bitstream including color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information.~~

According to a fifth aspect, there is provided a signal carrying a bitstream including data representative of a point cloud and color information representative of a first texture image from which at least one point of the point cloud is colorized when decoding the point cloud, the point cloud including colorized 3D points and non-colored 3D points, colorized 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud, non-colored 3D points being 3D points of the point cloud having no color value assigned from color information data decoded from the bitstream, the bitstream also including an information representative of a texture interpolation coding mode indicating whether texture interpolation has to be done for non-colored 3D points of the point cloud when decoding the point cloud, wherein texture interpolation for the non-colored 3D points of the point cloud is a function of colorized 3D points of the point cloud neighboring in the point cloud the non-colored 3D points.

According to a sixth aspect, there is provided a computer program product including instructions which, when the program is executed by one or more processors, causes the one or more processors to carry out the above method.

According to a seventh aspect, there is provided a non-transitory computer-readable medium including instructions for causing one or more processors to carry out the above method.

~~According to an eighth aspect, there is provided a device including: an accessing unit configured to access data including a bitstream including color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information; and a transmitter configured to transmit the data including the bitstream.~~

According to an eighth aspect, there is provided a device including: an accessing unit configured to access data including the above signal; and a transmitter configured to transmit the data including the signal.

~~According to a ninth aspect, there is provided a method including: accessing data including a bitstream including color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information; and transmitting data including the bitstream.~~

According to a ninth aspect, there is provided a method including: accessing data including the above; and transmitting data including the signal.

~~According to a tenth aspect, there is provided a non-transitory computer-readable medium including instructions for causing one or more processors to perform: accessing data including a bitstream including color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information; and transmitting data including the bitstream.~~

According to a tenth aspect, there is provided a non-transitory computer-readable medium including instructions for causing one or more processors to perform: accessing data including the above signal; and transmitting data including the signal.

The present embodiments relate to a method for generating and encoding in a bitstream an interpolation texture coding mode indicating that the bitstream contains color

information data representative of a texture image and that texture interpolation has to be done on point of a reconstructed point cloud that are not colorized from said color information data.

The present embodiments also relate to a method comprising checking if a contains an interpolation texture coding mode indicating that a bitstream contains color information data representative of a texture image and that texture interpolation has to be done on point of a reconstructed point cloud that are not colorized from said color information data, reconstructing a first texture image from said color information data and, and assigning colors are to points of the reconstructed point cloud that are not colorized from said color information data.

The specific nature of the present embodiments as well as other aspects, advantages, features and uses of the present embodiments will become evident from the following description of examples taken in conjunction with the accompanying drawings.

5. Brief Description of Drawings.

In the drawings, examples of the present embodiments are illustrated.

It shows:

- **Fig. 1** shows an overview of the TMC2 encoder;
- **Fig. 2** illustrates depth values associated with points of a point cloud;
- **Fig. 3** shows an overview of the TMC2 decoder;
- **Fig. 4** shows examples of decoded texture images;
- **Fig. 5** shows a difference between two texture images;
- **Fig. 6** shows an example of the proposed texture encoding in a path for generating texture;
- **Fig. 7** shows an example of the proposed texture decoding in a path for reconstructing/decoding texture of a point cloud; and
- **Fig. 8** illustrates a block diagram of an example of a system in which various aspects and embodiments are implemented.

CLAIMS

1. A method comprising encoding a point cloud in a bitstream, wherein encoding the point cloud comprises:

5 - encoding color information data representative of a first texture image from which at least one point of the point cloud is colored when decoding the point cloud,

- encoding the point cloud in the bitstream wherein the coded point cloud comprises colored 3D points and non-colored 3D points,

10 colored 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud,

non-colored 3D points being 3D points of the point cloud having no color value assigned from color information data encoded in the
15 bitstream,

 - encoding an information representative of a texture interpolation coding mode, ~~wherein the texture interpolation coding mode indicates whether that the bitstream contains color information data representative of the first texture image, and that texture interpolation has to be done for non-~~
20 ~~colored 3D points on at least one other point of the point cloud that is not colored from said color information~~ when decoding the point cloud, wherein texture interpolation for non-colored 3D points is a function of colored 3D points of the point cloud neighboring in the point cloud the non-colored 3D points.

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2. An apparatus comprising one or more processors configured for encoding a point cloud in a bitstream, wherein encoding the point cloud comprises:

 - encoding color information data representative of a first texture image from which at least one point of the point cloud is colored when decoding the
30 point cloud,

- encoding the point cloud in the bitstream wherein the coded point cloud comprises colored 3D points and non-colored 3D points,

colorized 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud.

5 non-colorized 3D points being 3D points of the point cloud having no color value assigned from color information data encoded in the bitstream,

- encoding an information representative of a texture interpolation coding mode, ~~wherein the texture interpolation coding mode indicates~~ing whether ~~that the bitstream contains color information data representative of the first texture image, and that texture interpolation has to be done~~ for non-colorized 3D points on at least one other point of the point cloud when decoding the point cloud, wherein texture interpolation for non-colorized 3D points is a function of colorized 3D points of the point cloud neighboring in the point cloud the non-colorized 3D points~~that is not colorized from said color~~
15 information.

3. A method comprising ~~reconstructing a point cloud from a bitstream, wherein reconstructing the point cloud comprises:~~

20 - decoding a first texture image from color information data decoded from a bitstream,

- decoding a point cloud from the bitstream, the decoded point cloud comprising colorized 3D points and non-colorized 3D points,

colorized 3D points being 3D points of the decoded point cloud whose color value is assigned from the decoded first texture image,

25 non-colorized 3D points being 3D points of the decoded point cloud having no color value assigned from color information data decoded from the bitstream,

- decoding from the bitstream, an information representative of a texture interpolation coding mode, ~~wherein the texture interpolation coding mode indicates~~es whether ~~that the bitstream contains color information data representative of a first texture image and that texture interpolation has to be~~
30 that the bitstream contains color information data representative of a first texture image and that texture interpolation has to be

- done for the non-colored 3D points ~~at least one point of the point cloud that is not colored from said color information,~~
- ~~-reconstructing said first texture image from said color information data,~~
 - responsive to a determination that the texture interpolation coding
- 5 mode indicates that texture interpolation has to be done for the non-colored
3D points of the point cloud, assigning a colors value to at least one non-
colored 3D point as a function of colored 3D points of the decoded point
cloud neighboring in the point cloud the at least one non-colored 3D point of
the reconstructed point cloud that is not colored from said color information
 10 data.
4. An apparatus comprising one or more processors configured for
~~reconstructing a point cloud from a bitstream, wherein reconstructing the point~~
~~cloud comprises:~~
- 15 ~~- decoding a first texture image from color information data decoded~~
~~from a bitstream,~~
 - ~~- decoding a point cloud from the bitstream, the decoded point cloud~~
~~comprising colored 3D points and non-colored 3D points,~~
~~colored 3D points being 3D points of the decoded point cloud~~
 20 ~~whose color value is assigned from the decoded first texture image,~~
~~non-colored 3D points being 3D points of the decoded point~~
~~cloud having no color value assigned from color information data~~
~~decoded from the bitstream,~~
 - ~~- decoding from the bitstream, an information representative of a texture~~
- 25 ~~interpolation coding mode, wherein the texture interpolation coding mode~~
~~indicatinges whether that the bitstream contains color information data~~
~~representative of a first texture image and that texture interpolation has to be~~
~~done for the non-colored 3D points at least one point of the point cloud that~~
~~is not colored from said color information,~~
- 30 ~~-reconstructing said first texture image from said color information data,~~
 - responsive to a determination that the texture interpolation coding
mode indicates that texture interpolation has to be done for the non-colored

3D points of the point cloud, ~~assigning a colors value~~ to at least one non-
colorized 3D point as a function of colorized 3D points of the decoded point
cloud neighboring in the point cloud the at least one non-colorized 3D
point~~point of the reconstructed point cloud that is not colorized from said color~~
 5 ~~information data.~~

5. ~~The method of claim 3, wherein the method further comprises or the~~
~~apparatus of claim 4 wherein the one or more processors is further configured~~
~~for colorizing at least one point of the point cloud from said first texture image.~~

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~~6~~5. The method of any one of claims 1, ~~3~~ or ~~5~~3 or the apparatus of any one of
 claims 2 ~~or~~, 4 ~~or~~ 5, wherein said ~~interpolation-texture~~ interpolation coding mode
 indicates which texture interpolation to be used.

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~~7~~6. The method of any one of claims 1, 3 or ~~5-6~~ or the apparatus of any one of
 claims 2, 4 or ~~5-6~~, wherein the ~~interpolation-texture~~ interpolation coding mode
 indicates that an ~~interpolation-texture~~ interpolation process has to be done to
 reconstruct a second texture image.

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~~8~~. The method of any one of claims 1, ~~3~~ or ~~5-7~~ or the apparatus of any one of
 claims 2, 4 or ~~5-7~~, wherein ~~assigning colors to at least one point of the~~
~~reconstructed point cloud that is not colorized from said color information data~~
~~is a function of already colorized neighbors points of the point of the point~~
 25 ~~cloud.~~

~~9~~7. The method of any one of claims 1, 3 or ~~5-6~~8 or the apparatus of any one
 of claims 2, 4 or ~~5-6~~8, wherein said ~~an interpolation-texture~~ interpolation coding
 30 mode is transmitted as an image or a metadata.

408. A signal carrying a bitstream comprising data representative of a point cloud and color information representative of a first texture image from which at least one point of the point cloud is coloredwhen decoding the point cloud, the point cloud comprising colorized 3D points and non-colorized 3D points,
- 5 points,
- colorized 3D points being 3D points of the point cloud whose color value is assigned from the first texture image when decoding the point cloud,
- non-colorized 3D points being 3D points of the point cloud having
- 10 no color value assigned from color information data decoded from the bitstream,
- ~~and the bitstream also comprising an information representative of a interpolation-texture interpolation coding mode indicating that whether the bitstream contains color information representative of the first texture image~~
- 15 ~~from which at least one point of a point cloud is colored, and that texture interpolation has to be done for non-colorized 3D points on at least one other point of the point cloud—~~when decoding the point cloud, wherein texture interpolation for the non-colorized 3D points of the point cloud is a function of colorized 3D points of the point cloud neighboring in the point cloud the non-
- 20 colorized 3D points ~~that is not colorized from said color information.~~

419. A computer program product including instructions which, when the program is executed by one or more processors, causes the one or more processors to carry out the method of any one of claims 1, 3 or 5-97.

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4210. A non-transitory computer-readable medium including instructions for causing one or more processors to carry out the method of any one of claims 1, 3 or 5-97.

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1311. A device comprising:

- an accessing unit configured to access data including a signal according to claim 8 ~~bitstream comprising color information representative of a first texture image from which at least one point of the point cloud is colorized,~~
- 5 and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information; and
- 10 - a transmitter configured to transmit the data including the ~~bitstream~~signal.

124. A method comprising:

- accessing data including a signal according to claim 8 ~~bitstream comprising color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one~~
- 15 other point of the point cloud that is not colorized from said color information; and
- 20 - transmitting data including the ~~bitstream~~signal.

4513. A non-transitory computer-readable medium including instructions for causing one or more processors to perform:

- accessing data including a ~~bitstream comprising color information representative of a first texture image from which at least one point of the point cloud is colorized, and an interpolation texture coding mode indicating that the bitstream contains color information representative of the first texture image~~
- 30 from which at least one point of a point cloud is colorized, and that texture interpolation has to be done on at least one other point of the point cloud that is not colorized from said color information
- signal according to claim 8; and
- transmitting data including the ~~bitstream~~signal.