

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

PCT

**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**
(PCT Rule 43*bis*.1)

To:

see form PCT/ISA/220

Date of mailing
(day/month/year) see form PCT/ISA/210 (second sheet)

Applicant's or agent's file reference
see form PCT/ISA/220

FOR FURTHER ACTION
See paragraph 2 below

International application No.
PCT/US2020/030723

International filing date (day/month/year)
30.04.2020

Priority date (day/month/year)
30.04.2019

International Patent Classification (IPC) or both national classification and IPC
INV. G06T19/00

Applicant
GOOGLE LLC

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application


2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

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see form
PCT/ISA/210

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - the international application in the language in which it was filed.
 - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non obvious), or to be industrially applicable have not been examined in respect of

the entire international application

claims Nos. 7, 10, 18

because:

the said international application, or the said claims Nos. relate to the following subject matter which does not require an international search (*specify*):

the description, claims or drawings (*indicate particular elements below*) or said claims Nos. are so unclear that no meaningful opinion could be formed (*specify*):

the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed (*specify*):

no international search report has been established for the whole application or for said claims Nos. 7, 10, 18

a meaningful opinion could not be formed without the sequence listing; the applicant did not, within the prescribed time limit:

furnish a sequence listing in the form of an Annex C/ST.25 text file, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.

furnish a sequence listing on paper or in the form of an image file complying with the standard provided for in Annex C of the Administrative Instructions, and such listing was not available to the International Searching Authority in the form and manner acceptable to it; or the sequence listing furnished did not comply with the standard provided for in Annex C of the Administrative Instructions.

pay the required late furnishing fee for the furnishing of a sequence listing in response to an invitation under Rule 13ter.1(a) or (b).

See Supplemental Box for further details

Box No. IV Lack of unity of invention

1. In response to the invitation (Form PCT/ISA/206) to pay additional fees, the applicant has, within the applicable time limit:
- paid additional fees
 - paid additional fees under protest and, where applicable, the protest fee
 - paid additional fees under protest but the applicable protest fee was not paid
 - not paid additional fees
2. This Authority found that the requirement of unity of invention is not complied with and chose not to invite the applicant to pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rule 13.1, 13.2 and 13.3 is
- complied with
 - not complied with for the following reasons:
see separate sheet
4. Consequently, this report has been established in respect of the following parts of the international application:
- all parts.
 - the parts relating to claims Nos. 1-6, 8, 9, 11-17, 19, 20

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>5, 14</u>
	No: Claims	<u>1-4, 6, 8, 9, 11-13, 15-17, 19, 20</u>
Inventive step (IS)	Yes: Claims	
	No: Claims	<u>1-6, 8, 9, 11-17, 19, 20</u>
Industrial applicability (IA)	Yes: Claims	<u>1-6, 8, 9, 11-17, 19, 20</u>
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item IV

Lack of unity of invention

1 This Authority considers that the application does not meet the requirements of unity of invention and that there are 3 inventions covered by the claims indicated as follows:

claims: 1 to 5, 6, 8, 9, 11 to 17, 19, and 20,

directed to the **modification of the pose of an object in an image;**

claim: 7

directed to the **improvement of the appearance of an object in a warped image;**

claims: 10 and 18

directed to the **selection of a reference image.**

1.1 The reasons for which the inventions are not so linked as to form a single general inventive concept, as required by Rule 13.1 PCT, are as follows:

1.2 The features of independent claims 1, 12, and 20 are known from MARTIN-BRUALLA ET AL: "LookinGood: Enhancing Performance Capture with Real-time Neural Re-Rendering", 4 December 2018, pages 1-14, XP058422640 (henceforth referred to as D1), see section "Re Item V" hereafter..

1.3 From the comparison of the subject-matter of claims 1 to 5, 6, 8, 9, 11 to 17, 19, and 20 (1st invention) with the method disclosed in document D1, the following features can be seen as representing the contribution over the prior art:

(i) determining a target pose of the object by mapping two dimensional keypoints to corresponding three dimensional points of depth data*;

(*see observations under Article 6 PCT hereafter)

(ii) generating the second image by warping the object in the at least one calibration image using a convolutional neural network that takes the at least one calibration image and the target pose of the object as input.

From these special technical features, the objective problem to be solved can be seen as:

how to modify the pose of an object in an image (1st problem).

- 1.4 From the comparison of the subject-matter of claim 7 (2nd invention) with the method disclosed in document D1, the following features can be seen as representing the contribution over the prior art:

(iii) the object in the aligned calibration image is warped using a second pass of a CNN trained by minimizing at least two loss.

From these special technical features, the objective problem to be solved can be seen as:

how to improve the appearance of an object in a warped image (2nd problem).

- 1.5 From the comparison of the subject-matter of claims 10 and 18 (3rd invention) with the method disclosed in document D1, the following features can be seen as representing the contribution over the prior art:

(iv) generating a similarity score for each of the at least one calibration image based on a target pose;

(v) selecting the at least one calibration image from the at least one calibration image based on the similarity score.

From these special technical features, the objective problem to be solved can be seen as:

how to select a reference image (3rd problem).

- 1.6 The above analysis shows that the special technical features of the three inventions are not the same and are not similar.
- 1.7 Furthermore, a pair-wise comparison of the three objective problems, each seen in the light of the description and the drawings of the present application, indicates that these problems are not related, so that the special technical features of the 3 inventions have no correspondence with each other.
- 1.8 Hence, the claims comprise neither the same, nor corresponding special technical features, so the technical relationship between the subject matter of the claims required by Rule 13.2 PCT is lacking and the claims are not so linked as to form a single general inventive concept as required by Rule 13.1 PCT.

Consequently the application does not meet the requirement for unity of invention.

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Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

- D1 MARTIN-BRUALLA ET AL: "LookinGood: Enhancing Performance Capture with Real-time Neural Re-Rendering", 4 December 2018, pages 1-14, XP058422640
- D2 BALAKRISHNAN GUHA ET AL: "Synthesizing Images of Humans in Unseen Poses", 18 June 2018, pages 8340-8348, XP033473757

2 Notwithstanding the observations under Article 6 PCT hereafter (see section Re Item VIII), the subject-matter of claim 1 to 4, 6, 8, 9, 11 to 13, 15 to 17, 19, and 20 is not new in the sense of Article 33(2) PCT, and the criteria of Article 33(1) PCT are therefore not met.

2.1 Independent claims 1

D1 discloses receiving a first image including color data and depth data;

D1: figure 1, upper row (single view), input RGB and depth data; figure 5, input color image; figure 7, upper rows, input image;

determining a viewpoint associated with an augmented reality and/or virtual reality display displaying a second image;

D1: figure 1, output image and legend : "re-rendering novel viewpoints" - it is implicit that the novel new point is associated with the AR/VR device and the output image is displayed by the device; section 3.3, last paragraph, page 7; figure 7, upper rows, prediction image; figure 8, "viewpoint changes"; section 4.2 "qualitative results", sub-section "viewpoint robustness", page 8 - unseen camera poses; section 5 "real-time free viewpoint neural re-rendering", page 9;

receiving at least one calibration image including an object in the first image, the object being in a different pose as compared to a pose of the object in the first image;

D1: section 3.1 "learning to enhance reconstructions", paragraphs 1 and 3, page 4; section 4 "evaluation", paragraphs 1 and 2, page 7; figure 7, unseen sequences; it is noted additionally that the apparent pose of an object is de facto changed when object is seen from a different point of view.

generating the second image based on the first image, the viewpoint and the at least one calibration image.

D1: section 5 "real-time free viewpoint neural re-rendering", page 9.

The subject-matter of claim 1 is therefore not new within the meaning of Article 33(2) PCT.

2.2 Independent claims 12 and 20

The subject-matter of independent claims 12 and 20 corresponds in terms of other categories to that of independent claim 1. The objection raised in respect of this latter claim therefore also apply, mutatis mutandis, to claims 12 and 20 which therefore are also considered not new within the meaning of Article 33(2) PCT.

2.3 Claims 2 and 13

D1 discloses the first image is received from a single camera configured to capture the color data as red, green, blue data and at least one of capture the depth data and generate the depth data based on the color data.

D1: figure 1.

The subject-matter of claims 2 and 13 is therefore not new within the meaning of Article 33(2) PCT.

2.4 Claim 3

D1 discloses the viewpoint associated with the AR and/or VR display is different than a viewpoint associated with the first image.

D1: figure 1, output image and legend : "re-rendering novel viewpoints" - it is implicit that the novel new point is associated with the AR/VR device and the output image is displayed by the device; section 3.3, last paragraph, page 7; figure 7, upper rows, prediction image; figure 8, "viewpoint changes"; section 4.2 "qualitative results", sub-section "viewpoint robustness", page 8 - unseen camera poses; section 5 "real-time free viewpoint neural re-rendering", page 9.

The subject-matter of claim 3 is therefore not new within the meaning of Article 33(2) PCT.

2.5 Claim 4

D1 discloses the at least one calibration image is a silhouette image of the object.

D1: figure 5; (section 3.2 "image enhancement", paragraphs 1 to 5, page 4).

The subject-matter of claim 4 is therefore not new within the meaning of Article 33(2) PCT.

2.6 Claims 6 and 15

D1 discloses the generating of the second image includes, generating at least one part-mask in a first pass of a convolutional neural network having the at least one calibration image as an input, generating at least one part-image in the first pass of the convolutional neural network, and generating the second image a second pass of the convolutional neural network having the at least one part-mask and the at least one part-image as input.

D1: figure 5; section 3.2 "image enhancement", paragraphs 1 to 5, page 4; section 4.3 "ablation study", sub-section "segmentation mask", page 9.

The subject-matter of claims 6 and 15 is therefore not new within the meaning of Article 33(2) PCT.

2.7 Claims 8 and 16

D1 discloses the second image is blended using a neural network to generate missing portions of the second image.

D1: section 4.2 "qualitative results", sub-section "upper body results (single view)", page 8; figure 7.

The subject-matter of claims 8 and 16 is therefore not new within the meaning of Article 33(2) PCT.

2.8 Claims 9 and 17

D1 discloses the second image is a silhouette image of the object, the method further comprising merging the second image with a background image.

D1: figure 5, output color image; figure 7, color image is merged with a black background image.

The subject-matter of claims 9 and 17 is therefore not new within the meaning of Article 33(2) PCT.

2.9 Claims 11 and 19

D1 discloses a pre-processing stage in which a plurality of images are captured while the pose of the object is changed;

D1: section 3.1 "learning to enhance reconstructions", paragraphs 1 and 3, page 4; section 4 "evaluation", paragraphs 1 and 2, page 7 - single camera dataset; section 4.1 "volumetric capture", paragraphs 1 and 2;

storing the plurality of images as the at least one calibration image;

D1: The storage of the captured images, e.g. in a memory space of the disclosed system, is implicit from the passages cited wrt. the previous feature; see as well footnote 1 on page 8;

capturing an image, during a communications event, the image including the object in a new pose,

D1: figure 1, upper row (single view), input RGB and depth data; figure 5, input color image; figure 7, upper rows, input image; a communication event is a technical requirement of the disclosed method, e.g. a communication of data between the AR/VR device and a camera and/or a main processing unit;

adding the image to the stored plurality of images.

D1: The storage of the captured image, e.g. in a memory space of the disclosed system, is also implicit since it is a technical requirement.

The subject-matter of claims 11 and 19 is therefore not new within the meaning of Article 33(2) PCT.

3 Notwithstanding the observations under Article 6 PCT hereafter (see section Re Item VIII), the subject-matter of claims 5 and 14 does not involve an inventive step in the sense of Article 33(3) PCT, and the criteria of Article 33(1) PCT are therefore not met.

D1 is regarded as being the prior art closest to the subject-matter of claims 5 and 14, and discloses a method from which the subject-matter of claim 5 differs in that the generating of the second image includes:

(i) determining a target pose of the object by mapping two dimensional keypoints to corresponding three dimensional points of depth data*;

(*see observations under Article 6 PCT hereafter)

and (ii) generating the second image by warping the object in the at least one calibration image using a convolutional neural network that takes the at least one calibration image and the target pose of the object as input.

The technical effect of distinguishing feature (i) and (ii) is that the pose of the object is determined from key points detected in a colored depthmap re-rendered from the viewpoint (see description par. [0038],[0042]), and the determined pose is used to warp the calibration image.

The problem to be solved by the present invention may therefore be regarded as **how to modify the pose of an object in an image** (problem 1).

The solution proposed in claim 5 of the present application cannot be considered to involve an inventive step (Article 33(3) PCT).

Feature (i) is described in document D2 (see passages indicated in the International Search Report) as providing the same advantages as in the present application. The skilled person would therefore regard it as a normal development option to include this feature in the method described in D1 in order to solve the problem posed.

In view of the above reasoning, the skilled person would regard it a normal design procedure to combine all the features set out in claim 5.

The same reasoning applies, mutatis, mutandis, to the subject-matter of corresponding claim 14.

The subject-matter of claims 5 and 14 is therefore not inventive step in the sense of Article 33(3) PCT.

Re Item VIII

Certain observations on the international application

4 The application does not meet the requirements of Article 6 PCT, because claims 1, 4, 5, 6, 9, 12, 14, 17, and 20 are not clear.

4.1 Independent claims 1, 12 and 20

The above claims do not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined. The claims attempt to define the subject-matter in terms of the result to be achieved, namely

"generating the second image base on the first image, the viewpoint, and the at least one calibration image",

which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

4.2 Claims 4, 6, 9, 17

The terms "silhouette image", "part image", and "part mask" used in the above claims have no well-recognized meaning and leaves the reader in doubt as to the meaning of the technical feature to which they refer, thereby rendering the definition of the subject-matter of said claims unclear, Article 6 PCT.

Furthermore, the technical features distinguishing one of the above terms from another (or for variants such as "silhouette mask") appear doubtful in view of the disclosure of the invention (see e.g. par. [0057],[0060],[0063],[0068],[0099]) which, as a whole, suggests to the reader that the above terms may in fact refer to equivalent features expressed in a different terminology. This renders the definition of the subject-matter of said claims further unclear, Article 6 PCT.

4.3 Claims 5 and 14

In the above claims, the statement "associated with the at least one calibration image " is unclear and leaves the reader in doubt as to the meaning of the technical feature to which it refers, thereby rendering the definition of the subject-matter of said claim unclear, Article 6 PCT.

Furthermore, the detailed disclosure of the invention indicates that the pose of the object is determined from key points detected *in a colored depthmap re-rendered from the viewpoint* (see description par. [0038],[0042]), is presently understood as an image of a category different from a calibration image. For this reason, the above claims are not supported by the description as required by Article 6 PCT.

4.4 Claim 6

The above claim does not meet the requirements of Article 6 PCT because the matter for which protection is sought is not clearly defined, for the following reasons.

4.4.1 The claim attempts to define the subject-matter in terms of the result to be achieved, namely

"generating the second image [in] a second pass of the convolutional neural network having the at least one part-mask and the at least one part-image as input"

which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

- 4.4.2 Additionally, the definition of the generating steps does not enable the skilled person to determine which technical features are necessary to perform the stated "generating the second image".

More specifically, it is unclear, even in view of the whole application, how a *same convolutional neural network* can be used i) in a first pass to generate the claimed "part-mask" and "part-image", and ii) in a second pass to generate the second image. This contradicts the conventional knowledge about trained neural networks which are known to be trained for highly specific tasks, with corresponding specific inputs and outputs. This contradiction leads to doubt concerning the technical features of the claimed convolutional neural network itself, thereby rendering the definition of the subject-matter of claim 6 unclear, Article 6 PCT.

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