PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:
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INVITATION TO PAY ADDITIONAL FEES
AND, WHERE APPLICABLE, PROTEST FEE

(PCT Article 17(3)(a) and Rule 40.1 and 40.2(e))

Applicant's or agent's file reference 0059-714WO1	Date of mailing *(day/month/year)* 13 July 2020 (13-07-2020) **PAYMENT DUE** within **ONE MONTH** from the above date of mailing
International application No. PCT/US2020/030723	International filing date *(day/month/year)* 30 April 2020 (30-04-2020)
Applicant GOOGLE LLC	

1. This International Searching Authority

(i) considers that there are 3 *(number of)* inventions claimed in the international application covered by the claims indicated on an extra sheet:

(ii) therefore considers that **the international application does not comply with the requirements of unity of invention** (Rules 13.1, 13.2 and 13.3) for the reasons indicated on an extra sheet:

(iii) [X] has carried out a partial international search (see Annex) [ ] will establish the international search report on those parts of the international application which relate to the invention first mentioned in claims Nos.:

see extra sheet

(iv) will establish the international search report on the other parts of the international application only if, and to the extent to which, additional fees are paid.

2. Consequently, the applicant is hereby **invited to pay,** within the time limit indicated above, the amount indicated below:

EUR 1.775,00	x	2	=	EUR 3.550,00
Fee per additional invention		number of additional inventions		currency/total amount of additional fees

3. The applicant is informed that, according to Rule 40.2(c), **the payment of any additional fee may be made under protest,** i.e., a reasoned statement to the effect that the international application complies with the requirement of unity of invention or that the amount of the required additional fee is excessive, where applicable, subject to the payment of a protest fee.

Where the applicant pays additional fees under protest, the applicant is hereby invited, within the time limit indicated above, to pay a protest fee (Rule 40.2(e)) in the amount of EUR 910,00 *(currency/amount)*

Where the applicant has not, within the time limit indicated above, paid the required protest fee, the protest will be considered not to have been made and the International Searching Authority will so declare.

4. [ ] Claim(s) Nos. _____ have been found to be unsearchable under Article 17(2)(b) because of defects under Article 17(2)(a) and therefore have not been included with any invention.

Name and mailing address of the International Searching Authority	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk Tel. (+31-70) 340-2040 Fax: (+31-70) 340-3016	CUNNINGHAM, Julie Tel: +49 (0)30 25901-515

Form PCT/ISA/206 (April 2005)

Registered Mail

INVITATION TO PAY ADDITIONAL FEES

International application No.
PCT/US2020/030723

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6, 8, 9, 11-17, 19, 20

   modification of the pose of an object in an image

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2. claim: 7

   improvement of the appearance of an object in a warped image

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3. claims: 10, 18

   selection of a reference image

The reasons for which the application is not considered to comply with the requirements of unity of invention are specified in the annexed provisional opinion accompanying the partial search results (EPO Form 1707).

Annex to Form PCT/ISA/206
COMMUNICATION RELATING TO THE RESULTS OF THE PARTIAL INTERNATIONAL SEARCH

International Application No
PCT/US2020/030723

1. The present communication is an Annex to the invitation to pay additional fees (Form PCT/ISA/206). It shows the results of the international search established on the parts of the international application which relate to the invention first mentioned in claims Nos.:
see 'Invitation to pay additional fees'
2. This communication is not the international search report which will be established according to Article 18 and Rule 43.

3. If the applicant does not pay any additional search fees, the information appearing in this communication will be considered as the result of the international search and will be included as such in the international search report.

4. If the applicant pays additional fees, the international search report will contain both the information appearing in this communication and the results of the international search on other parts of the international application for which such fees will have been paid.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	RICARDO MARTIN-BRUALLA ET AL: "LookinGood : Enhancing Performance Capture with Real-time Neural Re-Rendering", 20181204; 1077952576 - 1077952576, vol. 37, no. 6, 255, 4 December 2018 (2018-12-04), pages 1-14, XP058422640, ACM Transactions on Graphics DOI: 10.1145/3272127.3275099 ISBN: 978-1-4503-6008-1	1-4,6,8, 9,11-13, 15-17, 19,20
Y	abstract section 2 "related work", sub-section "learning based methods", paragraphs 1 to 4, page 3 section 3.1 "learning to enhance reconstructions", paragraphs 1 and 3, page 4 section 3.2 "image enhancement", paragraphs 1 to 5, page 4 sub-section "stereo loss", page 5 section 4 "evaluation", paragraphs 1 and 2, page 7 - single camera dataset section 4.1 "volumetric capture", paragraphs 1 and 2 sub-section "full body capture (multi-view)", paragraph3, page 8 - viewpoint changes section 4.2 "qualitative results", sub-section "upper body results (single view)", page 8 section 4.2 "qualitative results", -/--	5,14

[X] Further documents are listed in the continuation of box C.

[ ] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	sub-section "viewpoint robustness", page 8 section 4.3 "ablation study", sub-section "segmentation mask", page 9 section 5 "real-time free viewpoint neural re-rendering", page 9 section 6 "discussion, limitations and future work", last paragraph, page 12 figures 1,3,4,5,7,8,12,17 -----	
Y	BALAKRISHNAN GUHA ET AL: "Synthesizing Images of Humans in Unseen Poses", 2018 IEEE/CVF CONFERENCE ON COMPUTER VISION AND PATTERN RECOGNITION, IEEE, 18 June 2018 (2018-06-18), pages 8340-8348, XP033473757, DOI: 10.1109/CVPR.2018.00870 [retrieved on 2018-12-14] section 1 "introduction", paragraphs 1 to 3, page 8340 section 3 "method", paragraphs 1 to 3, pages 8341 to 8342 section 3.1 "pose representation" section 3.2 "source image segmentation", paragraphs 1 and 3 section 3.3 "foreground spatial transformation" section 3.4 "foreground synthesis" section 3.6 "foreground/backgroudn compositing" figures 1,2,3,4,5 -----	5,14
A	PAPANDREOU GEORGE ET AL: "Towards Accurate Multi-person Pose Estimation in the Wild", IEEE COMPUTER SOCIETY CONFERENCE ON COMPUTER VISION AND PATTERN RECOGNITION. PROCEEDINGS, IEEE COMPUTER SOCIETY, US, 21 July 2017 (2017-07-21), pages 3711-3719, XP033249721, ISSN: 1063-6919, DOI: 10.1109/CVPR.2017.395 [retrieved on 2017-11-06] abstract section 1 "introduction", paragraph 4 section 3.2 "person pose estimation", paragraph 1 sub-section "OKS-based non maximum suppression" - object keypoint similarity based filtering of candidate poses figures 1,3,4 ----- -/--	5,14

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
T	Rohit Pandey ET AL: "Volumetric Capture of Humans With a Single RGBD Camera via Semi-Parametric Learning", 2019 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), 29 May 2019 (2019-05-29), pages 1-13, XP055707462, DOI: 10.1109/CVPR.2019.00994 ISBN: 978-1-7281-3293-8 Retrieved from the Internet: URL:https://arxiv.org/pdf/1905.12162v1.pdf [retrieved on 2020-06-22] the whole document -----	1-20

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Application no:
Demande nº:
Anmelde-Nr: PCT/US2020/030723

DISCLAIMER

The attached provisional opinion on the patentability of the first invention searched serves only as information.
A reply addressing the points raised in the opinion is **not** required and will **not** be taken into account when issuing the final search report and opinion on patentability.

AVERTISSEMENT

L'avis provisoire ci-joint sur la brevetabilité de la première invention recherchée ne sert qu'à titre d'information.
Une réponse abordant les points soulevés dans l'avis n'est **pas** nécessaire et ne sera **pas** prise en compte lors de l'établissement du rapport final de la recherche et de l'avis sur la brevetabilité.

DISCLAIMER

Die beigefügte vorläufige Stellungnahme zur Patentierbarkeit der ersten geprüften Erfindung dient lediglich zur Information.
Eine Antwort auf die erhobenen Punkte in der Stellungnahme ist **nicht** erforderlich und bleibt bei der Erstellung des endgültigen Recherchenberichts und der Stellungnahme zur Patentierbarkeit **unberücksichtigt**.

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

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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.

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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.

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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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