PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	28 NOV 2018

Applicant's or agent's file reference	FOR FURTHER ACTION
33705-41234/WO	See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 18/49264	31 August 2018 (31.08.2018)	01 September 2017 (01.09.2017)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H04N 7/18 (2018.01)
CPC - G06K 9/00288, G06K 9/00268, H04N 7/181, H04N 21/44008, G06K 9/0077

Applicant PERCIPIENT.AI INC

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 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.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	01 November 2018	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

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Box No. I Basis of this 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 43*bis*.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 13*ter*.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 13*ter*.1(a)).

☐ on paper or in the form of an image file (Rule 13*ter*.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:

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

1. Statement

Novelty (N)	Claims	1-35	YES
	Claims	None	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-35	NO
Industrial applicability (IA)	Claims	1-35	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-2, 4-5, 7-9, 13, 17-22, 28, 32 lack an inventive step under PCT Article 33(3) as being obvious over US 9,275,269 B1 to Orbeus, Inc. (hereinafter, 'Orbeus') in view of US 8,437,504 B2 (Sugai).

As per claim 1, Orbeus discloses a method for identifying individuals within a video, the method comprising:
accessing, from computer memory, a video describing the movement of one or more unidentified individuals over a period of time and comprising one or more frames ("As an additional example, the computer 102 requests a video clip, containing a set (meaning one or more) of frames or still images, from the web server 114", col 8, ln 4-22);

dividing the video into a set of segments, wherein each segment describes a part of a
frame of the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 32-37);

determining, for each match, a confidence level describing the accuracy of the match between the unidentified individual and the target individual, wherein the confidence level is related to the distance between a feature vector of the face of the target individual and a feature vector of the face of the unidentified individual ("At 1308, for each facial feature in the detected face, the Software application calculates a matching score for each position (m, n) using the facial feature probability and each of the convolution values of the corresponding LBP feature templates", col 11, ln 25-38);

and generating a report of search results indicating that the unidentified individual within the video matched a target individual, the confidence level assigned to that match, and a notification indicating where in the video the target individual appeared in the video ("Additionally, at 218, the soft ware application labels the final feature by associating the final feature with a label identifying the face in the input image. In one implementation, the association is represented by a record in a table with a relational database.", col 12, ln 65- col 13, ln 2; col 13, ln 20-27).

However, Orbeus does not disclose adjusting, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame; responsive to the detection algorithm detecting a face, adjusting, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual.

However, Sugai does disclose adjusting, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame ("When the human figure is detected by the characteristic object detecting unit 308, the characteristic region setting unit 309 sets the detected region as a characteristic region 404. When the control unit 303 receives the characteristic region 404 which is set by the characteristic region setting unit 309, the control unit 303 controls the timing generator 302 So as to read out the characteristic region 404 in the resolution C.", col 6, ln 59-66, col 7, ln 43-49);

responsive to the detection algorithm detecting a face, adjusting, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual ("When the humane characteristic feature identifying unit 314 cannot achieve identification of the human characteristic feature, the humane characteristic feature identifying unit 314 can instruct the control unit 303 to read out the characteristic image 405 in a higher resolution (resolution D).", col 7, ln 15-19, col 13, ln 20-27).

It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus with the adjusting pixel resolutions taught by Sugai since such would allow for ensuring the resolution of extracted features are such that a match can be made between a target face and an unidentified face.

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Box V.2 Citations and Explanations

As per claim 2, Orbeus in view of Sugai discloses the method of claim 1. Sugai further discloses wherein the video further includes one or more unidentified objects, the video file describing, for each object, the one or more of the following: a position of the object; a movement of the object; and an orientation of the object ("The distance calculating unit 313 calculates a distance from the monitoring system to the imaging point from the coordinate positions in the images of the regions of the partial images 402 and 403 selected in the partial image region 55 selecting unit 305.", col 4, ln 49-56).

As per claim 4, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses further comprising: dividing the video into a set of frames, wherein each frame corresponds to a range of timestamps from the period of time during which the video was recorded([where dividing a video into a sequence of frames includes the corresponding time sequence a frame is associated with] "At 1102, the application further selects a set of representing frames or all frames from the video clip to derive a model. At 1104, the Software application performs a process, such as the process 200, to detect a face and derive a final feature of the face from a first frame, for example, such as the first or second frame of the selected set of frames.", col 18, ln 35-41); and dividing each frame into a set of segments, wherein each segment includes a portion of data stored within the frame within the processing capacity of the detection algorithm and the recognition algorithm ("Additionally, at 1104, the server application identifies the facial area or window within the first frame that contains the detected face. For example, the facial window is in a rectangular or square shape.", col 18, ln 42-44).

As per claim 5, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein a segment represents a static image representing a portion of data stored by the video ("At 1102, the application further selects a set of representing frames or all frames from the video clip to derive a model.", col 18, ln 35-37).

As per claim 7, Orbeus in view of Sugai discloses the method of claim 1. Sugai further discloses wherein adjusting the pixel resolution of the segment to the detection resolution comprises: accessing, from computer memory, a pixel resolution within the processing capacity of the detection algorithm ("When the human figure is detected by the characteristic object detecting unit 108, the characteristic region setting unit 109 sets the region including the above described change pixel region as a characteristic region 203. The characteristic region setting unit 109 outputs the characteristic region 203 and resolution C to the control unit 103.", col 4, ln 32-38); and assigning the accessed pixel resolution as the detection resolution ("When the human figure is detected by the characteristic object detecting unit 108, the characteristic region setting unit 109 sets the region including the above described change pixel region as a characteristic region 203. The characteristic region setting unit 109 outputs the characteristic region 203 and resolution C to the control unit 103.", col 4, ln 32-38).

As per claim 8, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein the detection algorithm is a neural network ("Weights for the layers and neurons of the multi-layer deep belief network are trained from training facial images. As end of the deep learning process, a kernel function is derived.", col 14, ln 42-44).

As per claim 9, Orbeus in view of Sugai discloses the method of claim 1. Sugai discloses wherein adjusting the pixel resolution of the segment to the recognition resolution comprises: accessing, from computer memory, a pixel resolution within the processing capacity of the recognition algorithm ("As the resolution of the partial image, the optimal resolution can be automatically set in accordance with the position of the partial image selecting region which is selected. Further, if the human characteristic feature is insufficiently identified in the characteristic image which is read out in the resolution C, the characteristic image can be read out in the resolution D (the resolution C is smaller than the resolution D). As above, only a necessary region is read out in a higher resolution when necessary, and therefore, the readout data amount can be reduced.", col 7, ln 31-40); assigning the accessed pixel resolution as the recognition resolution (col 7, ln 31-40);; and increasing the pixel resolution for the segment from the detection resolution of the segment to the recognition resolution col 7, ln 31-40).

As per claim 13, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein matching the face of the unidentified individual to a target individual comprises: extracting, for each segment, a feature vector describing at least one physical feature of the face of each unidentified individual within the segment ("For each of the facial feature parts, at 210, the software application extracts a set of image features, such as LBP or HOG features.", col 11, ln 54-56; "For each facial feature part, at 212, the software application concatenates the set of image features into a Subpart feature. For example, the set of image features is concatenated into an Mx1 or 1xM vector, where M is the number of image features in the set.", col 12, ln 5-9); wherein the feature vector is extracted by a neural network ("Weights for the layers and neurons of the multi-layer deep belief network are trained from training facial images. As end of the deep learning process, a kernel function is derived.", col 14, ln 42-44).

As per claim 17, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein matching an unidentified individual to a target individual comprises: determining a distance between the feature vector describing the face of each target individual and the extracted feature vector of each unidentified individual in a segment ("For example, the nearest matches are selected based on the image feature distances between the final feature of the retrieved image and the final features retrieved at 504. In one implementation, the image feature distances are ranked from the Smallest to the largest; and the K faces corresponding to the first K. Smallest image feature distances.", col 16, ln 42-48); and ranking each match based on the determined distance ("For example, the nearest matches are selected based on the image feature distances between the final feature of the retrieved image and the final features retrieved at 504. In one implementation, the image feature distances are ranked from the Smallest to the largest; and the K faces corresponding to the first K. Smallest image feature distances.", col 16, ln 42-48).

As per claim 18, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein the distance comprises a Euclidean distance or a Hamming distance ("In other words, an image feature distance. Such as Euclidean distance, measures how close one facial image matches to another predetermined facial image.", col 14, ln 9-11).

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Box V.2 Citations and Explanations

As per claim 19, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses comparing, for each match, the determined distance between the feature vector of the target individual and the extracted feature vector of the unidentified individual to a threshold distance ("In Such a case, in a further implementation, the highest score is compared to a predetermined threshold. If the highest score is below the threshold, at 414, the software application indicates that the face in the retrieved image is not recognized.", col 15, ln 33 -37); and determining, responsive to the comparison between the threshold distance and the determined distance, the confidence level for the match ("In one implementation, the image feature distances are ranked from the Smallest to the largest; and the K faces corresponding to the first K. Smallest image feature distances.", col 16, ln 45-60).

As per claim 20, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein the confidence level for a match is inversely related to the determined distance between the feature vector of the face of the target individual and the extracted feature vector of the unidentified individual ("In one implementation, the image feature distances are ranked from the Smallest to the largest; and the K faces corresponding to the first K. Smallest image feature distances.", col 16, ln 45-60).

As per claim 21, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein the confidence level is a quantitative measurement or a qualitative measurement, the qualitative measurement comprising a verbal value and the quantitative measurement comprising a numerical value ("In Such a case, in a further implementation, the highest score is compared to a predetermined threshold. If the highest score is below the threshold, at 414, the software application indicates that the face in the retrieved image is not recognized.", col 15, ln 33-37).

As per claim 22, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses wherein the report presented through a user device further comprises: the confidence level for each segment of the video ("As an additional example, the computer 102 requests a video clip, containing a set (meaning one or more) of frames or still images, from the web server 114.", col 8, ln 20-22; "At 412, the software application labels the face and the retrieved image with the label associated with the model with highest score.", col 15, ln 20-22);
the confidence level for each match ("Server computer, and retrieving a set of models from a database. The method further includes extracting a final feature from the image wherein the final feature is extracted by the client computer or the server computer, and applying each model in the set of models on the final feature to generate a set of comparison scores.", col 5, ln 15-20); and one or notifications indicating when a target individual appears in the video. ("At 412, the software application labels the face and the retrieved image with the label associated with the model with highest score.", col 15, ln 20-22).

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As per claim 28, Orbeus discloses a non-transitory computer readable storage medium comprising stored program code executable by at least one processor, the program code when executed causes the processor to:
access, from computer memory ("The computer 102 comprises one or more processors. Such as, for example, any of the variants of the Intel Xeon family of processors, or any of the variants of the AMD Opteron family of processors. In addition, the computer 102 includes one or more network interfaces, such as, for example, a Gigabit Ethernet interface, Some amount of memory, and some amount of storage. Such as a hard drive. ", col 7, ln 43-50); a video describing the movement of one or more unidentified individuals over a period of time and comprising one or more frames ("As an additional example, the computer 102 requests a video clip, containing a set (meaning one or more) of frames or still images, from the web server 114", col 8, ln 4-22); divide the video into a set of segments, wherein each segment describes a part of a frame of the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 32-37);

determine, for each match, a confidence level describing the accuracy of the match between the unidentified individual and the target individual, wherein the confidence level is related to the distance between a feature vector of the face of the target individual and a feature vector of the face of the unidentified individual ("At 1308, for each facial feature in the detected face, the Software application calculates a matching score for each position (m, n) using the facial feature probability and each of the convolution values of the corresponding LBP feature templates", col 11, ln 25-38); and generate a report of search results indicating that the unidentified individual within the video matched a target individual, the confidence level assigned to that match,
and a notification indicating where in the video the target individual appeared in the video ("Additionally, at 218, the soft ware application labels the final feature by associating the final feature with a label identifying the face in the input image. In one implementation, the association is represented by a record in a table with a relational database.", col 12, ln 65- col 13, ln 2; col 13, ln 20-27).

However, Orbeus does not disclose adjust, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame;
responsive to the detection algorithm detecting a face, adjust, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual.

However, Sugai does disclose adjust, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame ("When the human figure is detected by the characteristic object detecting unit 308, the characteristic region setting unit 309 sets the detected region as a characteristic region 404. When the control unit 303 receives the characteristic region 404 which is set by the characteristic region setting unit 309, the control unit 303 controls the timing generator 302 So as to read out the characteristic region 404 in the resolution C.", col 6, ln 59-66, col 7, ln 43-49);
responsive to the detection algorithm detecting a face, adjust, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual ("When the humane characteristic feature identifying unit 314 cannot achieve identification of the human characteristic feature, the humane characteristic feature identifying unit 314 can instruct the control unit 303 to read out the characteristic image 405 in a higher resolution (resolution D).", col 7, ln 15-19, col 13, ln 20-27).

It would have been obvious to one of ordinary skill in the art to combine the computer readable medium taught by Orbeus with the adjusting pixel resolutions taught by Sugai since such would allow for ensuring the resolution of extracted features are such that a match can be made between a target face and an unidentified face.

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As per claim 32, Orbeus discloses a system comprising:
a processor ("The computer 102 comprises one or more processors. Such as, for example, any of the variants of the Intel Xeon family of processors, or any of the variants of the AMD Opteron family of processors.", col 8, ln 44-47); a sensor assembly ("Image recognition is a process, performed by computers, to analyze and understand an image (such as a photo or video clip). Images are generally produced by sensors, including light sensitive cameras ", col 1, ln 39-42); communicatively coupled to the processor, recording sensor data and storing the sensor data in computer memory ("The system 100 includes a facial recognition server computer 102 coupled to a data base 104 which stores images, image features, recognition facial models (or models for short), and labels, col 8, ln 38-41);
and
a non-transitory computer readable storage medium comprising stored program code executable by at least one processor, the program code when executed causes the processor to: access, from computer memory ("The computer 102 comprises one or more processors. Such as, for example, any of the variants of the Intel Xeon family of processors, or any of the variants of the AMD Opteron family of processors. In addition, the computer 102 includes one or more network interfaces, such as, for example, a Gigabit Ethernet interface, Some amount of memory, and some amount of storage. Such as a hard drive. ", col 7, ln 43-50); a video describing the movement of one or more unidentified individuals over a period of time and comprising one or more frames ("As an additional example, the computer 102 requests a video clip, containing a set (meaning one or more) of frames or still images, from the web server 114", col 8, ln 4-22);
divide the video into a set of segments, wherein each segment describes a part of a frame of the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 32-37);

determine, for each match, a confidence level describing the accuracy of the match between the unidentified individual and the target individual, wherein the confidence level is related to the distance between a feature vector of the face of the target individual and a feature vector of the face of the unidentified individual ("At 1308, for each facial feature in the detected face, the Software application calculates a matching score for each position (m, n) using the facial feature probability and each of the convolution values of the corresponding LBP feature templates", col 11, ln 25-38); and generate a report of search results indicating that the unidentified individual within the video matched a target individual, the confidence level assigned to that match, and a notification indicating where in the video the target individual appeared in the video ("Additionally, at 218, the soft ware application labels the final feature by associating the final feature with a label identifying the face in the input image. In one implementation, the association is represented by a record in a table with a relational database.", col 12, ln 65- col 13, ln 2; col 13, ln 20-27).

However, Orbeus does not disclose adjust, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame; responsive to the detection algorithm detecting a face, adjust, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual.

However, Sugai does disclose adjust, for each segment, a pixel resolution of the segment to a detection resolution such that a detection algorithm detects a face of one more unidentified individuals within the segment, wherein at the detection resolution a size of the face in the segment increases relative to the size of the face in the frame ("When the human figure is detected by the characteristic object detecting unit 308, the characteristic region setting unit 309 sets the detected region as a characteristic region 404. When the control unit 303 receives the characteristic region 404 which is set by the characteristic region setting unit 309, the control unit 303 controls the timing generator 302 So as to read out the characteristic region 404 in the resolution C.", col 6, ln 59-66, col 7, ln 43-49); responsive to the detection algorithm detecting a face, adjust, for each segment, the pixel resolution of the segment from the detection resolution to a recognition resolution such that a recognition resolution matches the face of the unidentified individual to a target individual ("When the humane characteristic feature identifying unit 314 cannot achieve identification of the human characteristic feature, the humane characteristic feature identifying unit 314 can instruct the control unit 303 to read out the characteristic image 405 in a higher resolution (resolution D).", col 7, ln 15-19, col 13, ln 20-27).

It would have been obvious to one of ordinary skill in the art to combine the computer readable medium taught by Orbeus with the adjusting pixel resolutions taught by Sugai since such would allow for ensuring the resolution of extracted features are such that a match can be made between a target face and an unidentified face.

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Claims, 3, 11-12, 16, 30 and 35 lack an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and further in view of US 7,689,011 B2 to Luo et al. (hereinafter, 'Luo').

As per claim 3, Orbeus in view of Sugai discloses the method of claim 2. However, Orbeus in view of Sugai does not disclose wherein each object is associated with a class, the class representing a group of objects with at least one shared feature. However, Luo does disclose wherein each object is associated with a class, the class representing a group of objects with at least one shared feature ("In some embodiments, the members of the matching face class correspond to ones of the candidate images that have distance feature vectors that are below a threshold distance, whereas the members of the non-matching face class are at or above the threshold distance. In some embodiments, the candidate images are classified by a binary classifier, which maps each distance feature vector to one of the matching face class and the non-matching face class.", col 10, ln 29-36). It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the class taught by Luo, since such would allow for faster filtering of potentially relevant faces.

As per claim 11, Orbeus in view of Sugai discloses the method of claim 1. However, Orbeus in view of Sugai does not disclose wherein adjusting the pixel resolution of the segment to the recognition resolution comprises: identifying a face within a bounding box based on one or more colors of pixels representing physical features of the face; for each remaining pixel of the bounding box, contrasting the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face; and extracting the feature vector from the focused image of the face.

However, Luo does disclose wherein adjusting the pixel resolution of the segment to the recognition resolution comprises: identifying a face within a bounding box based on one or more colors of pixels representing physical features of the face ("In some embodiments, each of the auxiliary identification regions is represented by a set of low-level image features (e.g., color features, texture features, shape and layout features)...", col 5, ln 64-67);
for each remaining pixel of the bounding box, contrasting the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face ("The color normalization processing component 82 color normalizes the auxiliary identification region and passes a color-normalized version 83 of the auxiliary identification region to the feature extraction processing component 16.", col 8, ln 40-44); and extracting the feature vector from the focused image of the face ("The color normalization processing component 82 passes the color-normalized auxiliary identification region 83 to the feature extraction processing component 16, which calculates features from the normalized auxiliary identification region in accordance with one or more of the auxiliary identification feature extraction methods described above.", col 9, ln 29-34).

It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the class of Luo so that color normalization occurs, since such would allow for ensuring all colors are evaluated equally across the spectrum to ensure the correct facial feature is extracted.

As per claim 12, Orbeus in view of Sugai and Luo disclose the method of claim 11. Sugai further discloses Removing pixels from the environment surrounding the face from the bounding box ([disclosing reading out only relevant pixels from a selected area] "The characteristic region image read out unit 110 reads out the characteristic image 204 in the resolution C from the imaging device 101, and stores the characteristic image 204 in the image storage unit 111. The image display unit 112 displays the characteristic image 204 in the image storage unit 111. At this time, the characteristic image 204 is set independently from the partial image 202 So as to include the characteristic object.", col 4, ln 19-53).

As per claim 16, Orbeus in view of Sugai discloses the method of claim 1. However, Orbeus in view of Sugai does not disclose receiving, from a user device, a query to identify one or more target individuals, the query comprising the feature vector describing physical features of the face of the target individual; and
executing a search, within each segment of the video, an unidentified individual matching each target individual of the query.

However, Luo does disclose receiving, from a user device, a query to identify one or more target individuals, the query comprising the feature vector describing physical features of the face of the target individual ("A respective distance feature vector is deter mined between the query image and each of the candidate images in the collection based on the features of the query image and the corresponding features of the candidate images (FIG.9, block 102).", col 10, ln 20-25); and Executing a search, within each segment of the video, an unidentified individual matching each target individual of the query ("The candidate images are ranked based on the computed similarity measures (FIG. 8, block 94). The candidate images typically are ranked in order from the candidate image most similar to the query image to the candidate image least similar to the query image.", col 10, ln 4-8).

It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the class of Luo since such would allow for allowing multiple image features to lead to a matching target image.

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As per claim 30, Orbeus in view of Sugai discloses the non-transitory computer readable storage medium of claim 28. However, Orbeus in view of Sugai does not disclose stored program code that when executed causes the processor to: identify a face within a bounding box based on one or more colors of pixels representing physical features of the face; for each remaining pixel of the bounding box, contrast the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face; and extract the feature vector from the focused image of the face.

However, Luo does disclose stored program code that when executed causes the processor to: identify a face within a bounding box based on one or more colors of pixels representing physical features of the face ("In some embodiments, each of the auxiliary identification regions is represented by a set of low-level image features (e.g., color features, texture features, shape and layout features)...", col 5, ln 64 -67); for each remaining pixel of the bounding box, contrast the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face ("The color normalization processing component 82 color normalizes the auxiliary identification region and passes a color-normalized version 83 of the aux auxiliary identification region to the feature extraction processing component 16.", col 8, ln 40-44); and extract the feature vector from the focused image of the face ("The color normalization processing component 82 passes the color-normalized auxiliary identification region 83 to the feature extraction processing component 16, which calculates features from the normalized auxiliary identification region in accordance with one or more of the auxiliary identification feature extraction methods described above.", col 9, ln 29-34). It would have been obvious to one of ordinary skill in the art to combine the computer readable medium taught by Orbeus and Sugai with the class of Luo so that color normalization occurs, since such would allow for ensuring all colors are evaluated equally across the spectrum to ensure the correct facial feature is extracted.

As per claim 35, Orbeus in view of Sugai discloses the system of claim 32. However, Orbeus in view of Sugai does not disclose wherein the stored program code further comprises program code that when executed causes the processor to: identify a face within a bounding box based on one or more colors of pixels representing physical features of the face; for each remaining pixel of the bounding box, contrast the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face; and extract the feature vector from the focused image of the face. However, Luo does disclose stored program code that when executed causes the processor to: identify a face within a bounding box based on one or more colors of pixels representing physical features of the face ("In some embodiments, each of the auxiliary identification regions is represented by a set of low-level image features (e.g., color features, texture features, shape and layout features)...", col 5, ln 64-67); for each remaining pixel of the bounding box, contrast the environment surrounding the face by normalizing the color of each remaining pixel of the bounding box sharing a row and column, the contrast focusing an image of the face ("The color normalization processing component 82 color normalizes the auxiliary identification region and passes a color-normalized version 83 of the aux auxiliary identification region to the feature extraction processing component 16.", col 8, ln 40-44); and extract the feature vector from the focused image of the face ("The color normalization processing component 82 passes the color-normalized auxiliary identification region 83 to the feature extraction processing component 16, which calculates features from the normalized auxiliary identification region in accordance with one or more of the auxiliary identification feature extraction methods described above.", col 9, ln 29-34). It would have been obvious to one of ordinary skill in the art to combine the computer readable medium taught by Orbeus and Sugai with the class of Luo so that color normalization occurs, since such would allow for ensuring all colors are evaluated equally across the spectrum to ensure the correct facial feature is extracted.

Claims 6, 29 and 33 lack an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and further in view of US 2011/0128288 A1 to Petrou et al. (hereinafter, 'Petrou').

As per claim 6, Orbeus in view of Sugai discloses the method of claim 1. Orbeus further discloses generating, by the detection algorithm, a bounding box encompassing the detected face, wherein the bounding box demarcates the detected face from a surrounding environment recorded by the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 34-38).

However, Orbeus in view of Sugai does not discloses wherein adjusting the pixel resolution of the segment to the detection resolution comprises: decreasing the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution; at the detection resolution, detecting, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face. However, Petrou does disclose wherein adjusting the pixel resolution of the segment to the detection resolution comprises: decreasing the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution ("However, a user may not be interested in all of the entities in the original image 1602. Therefore, as shown in FIGS. 17A-B and 18 the user can select a particular entity or a region of interest within the image. As explained in more detail below, the region of inter est has a second resolution, which is Smaller than the resolution of the entire original image 1602.", para [0167]); at the detection resolution, detecting, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face ("For example, a face recognition search system 112-A will access a facial image database 114-A to look for facial matches to the image query. As will be explained in more detail with regard to FIG. 9, if the visual query contains a face, the facial recognition search system 112-A will return one or more search results (e.g., names, matching faces, etc.) from the facial image database 114-A.", para [0043]). It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the lesser resolution taught by Petrou, since such would allow for a less hardware intensive search.

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As per claim 29, Orbeus in view of Sugai discloses the non-transitory computer readable storage medium of claim 28. Orbeus further discloses and generate, by the detection algorithm, a bounding box encompassing the detected face, wherein the bounding box demarcates the detected face from a surrounding environment recorded by the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 34-38). However, Orbeus in view of Sugai does not disclose further comprising stored program code that when executed causes the processor to: decrease the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution; at the detection resolution, detect, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face; and generate, by the detection algorithm, a bounding box encompassing the detected face, wherein the bounding box demarcates the detected face from a surrounding environment recorded by the video. However, Petrou does disclose further comprising stored program code that when executed causes the processor to: decrease the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution ("However, a user may not be interested in all of the entities in the original image 1602. Therefore, as shown in FIGS. 17A-B and 18 the user can select a particular entity or a region of interest within the image. As explained in more detail below, the region of inter est has a second resolution, which is Smaller than the resolution of the entire original image 1602.", para [0167]); at the detection resolution, detect, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face ("For example, a face recognition search system 112-A will access a facial image database 114-A to look for facial matches to the image query. As will be explained in more detail with regard to FIG. 9, if the visual query contains a face, the facial recognition search system 112-A will return one or more search results (e.g., names, matching faces, etc.) from the facial image database 114-A.", para [0043]). It would have been obvious to one of ordinary skill in the art to combine the computer readable media aught by Orbeus and Sugai with the lesser resolution taught by Petrou, since such would allow for a less hardware intensive search.

As per claim 33, Orbeus in view of Sugai discloses the system of claim 32. Orbeus further discloses and
generate, by the detection algorithm, a bounding box encompassing the detected face, wherein the bounding box demarcates the detected face from a surrounding environment recorded by the video ("In one implementation, the facial portion (also referred to herein as a facial window) is a rectangular area. In a further implementation, the facial window has a fixed size, such as 100x100 pixels, for different faces of different people.", col 10, ln 34-38). However, Orbeus does not disclose wherein the stored program code further comprises program code that when executed causes the processor to: decrease the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution; the detection resolution, detect, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face. However, Petrou does disclose further comprising stored program code that when executed causes the processor to: decrease the pixel resolution for the segment from an original pixel resolution of the video to the detection resolution ("However, a user may not be interested in all of the entities in the original image 1602. Therefore, as shown in FIGS. 17A-B and 18 the user can select a particular entity or a region of interest within the image. As explained in more detail below, the region of inter est has a second resolution, which is Smaller than the resolution of the entire original image 1602.", para [0167]); at the detection resolution, detect, by the detection algorithm, a face of an unidentified individual based on one or more physical features of the face ("For example, a face recognition search system 112-A will access a facial image database 114-A to look for facial matches to the image query. As will be explained in more detail with regard to FIG. 9, if the visual query contains a face, the facial recognition search system 112-A will return one or more search results (e.g., names, matching faces, etc.) from the facial image database 114-A.", para [0043]). It would have been obvious to one of ordinary skill in the art to combine the computer readable media taught by Orbeus and Sugai with the lesser resolution taught by Petrou, since such would allow for a less hardware intensive search.

Claims 10 and 34 lacks an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and in further view of US 2010/0287053 A1 to Ganong et al. (hereinafter Ganong).

As per claims 10, neither Orbeus nor Sugai teach wherein adjusting the pixel resolution of the segment to the recognition resolution comprises: identifying, by the recognition algorithm, the corners of the bounding box surrounding a detected face, wherein the corners of the bounding box correspond to a group of pixels of the segment; mapping the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution; generating a bounding box by connecting the mapped group of pixels at the recognition resolution; and applying the recognition algorithm to match a face within the bounding box to a target individual.
However, Ganong, in an analogous art, teaches adjusting the pixel resolution of the segment to the recognition resolution comprises: identifying, by the recognition algorithm, the corners of the bounding box surrounding a detected face, wherein the corners of the bounding box correspond to a group of pixels of the segment (para [0082]-[0085]); mapping the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution (para[0082]-[0085], [0124], [0130], [0133]-[0139]); generating a bounding box by connecting the mapped group of pixels at the recognition resolution (para[0082]-[0085], [0133]-[0139]); and applying the recognition algorithm to match a face within the bounding box to a target individual (para[0082]-[0085], [0133]-[0139]). It would have been obvious to one of ordinary skill in the art to have modified the system by including adjusting the pixel resolution of the segment to the recognition resolution comprises: identifying, by the recognition algorithm, the corners of the bounding box surrounding a detected face, wherein the corners of the bounding box correspond to a group of pixels of the segment; mapping the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution; generating a bounding box by connecting the mapped group of pixels at the recognition resolution; and applying the recognition algorithm to match a face within the bounding box to a target individual as taught by Ganong for identifying faces in digital photos (Ganong, para [0012]).

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As per claim 34, neither Orbeus nor Sugai wherein the stored program code further comprises program code that when executed causes the processor to: identify, by the recognition algorithm, the comers of the bounding box surrounding a detected face, wherein the comers of the bounding box correspond to a group of pixels of the segment; map the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution; generate a bounding box by connecting the mapped group of pixels at the recognition resolution; and apply the recognition algorithm to match a face within the bounding box to a target individual. However, Ganong, in an analogous art, teaches wherein the stored program code further comprises program code that when executed causes the processor to: identify, by the recognition algorithm, the comers of the bounding box surrounding a detected face, wherein the comers of the bounding box correspond to a group of pixels of the segment (para[0082]-[0085]); map the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution (para[0082]-[0085], [0124], [0130], [0133]-[0139]); generate a bounding box by connecting the mapped group of pixels at the recognition resolution (para[0082]-[0085], [0133]-[0139]); and apply the recognition algorithm to match a face within the bounding box to a target individual (para [0082]-[0085], [0133]-[0139]). It would have been obvious to one of ordinary skill in the art to have modified the system by including wherein the stored program code further comprises program code that when executed causes the processor to: identify, by the recognition algorithm, the comers of the bounding box surrounding a detected face, wherein the comers of the bounding box correspond to a group of of pixels of the segment; map the group of pixels associated with each comer of the bounding box at the detection resolution to a corresponding group of pixels within the segment at the recognition resolution; generate a bounding box by connecting the mapped group of pixels at the recognition resolution; and apply the recognition algorithm to match a face within the bounding box to a target individual as taught by Ganong for identifying faces in digital photos (Ganong, para [0012]).

Claims 14-15 lack an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and further in view of US 7,295,687 B2 to Kee et al. (hereinafter, 'Kee').

As per claim 14, Orbeus in view of Sugai discloses the method of claim 13. Orbeus further discloses wherein extracting a feature vector comprises: extracting image data describing the physical features of the face of the unidentified individual from the segment of the video ("For each of the facial feature parts, at 210, the software application extracts a set of image features, such as LBP or HOG features.", col 11, ln 54-56); providing the extracted image data as input to a neural network comprising a plurality of layers ("Weights for the layers and neurons of the multi-layer deep belief network are trained from training facial images. As end of the deep learning process, a kernel function is derived.", col 14, ln 42-44).

However, Orbeus in view of Sugai does not disclose extracting the feature vector representing the face based upon an output of a hidden layer of the neural network. However, Kee does disclose extracting the feature vector representing the face based upon an output of a hidden layer of the neural network ("In the present embodiment learniing 40 persons with 5 face images for each person stored in the Olivetti DB, 60 neurons are used in the hidden layer.", col 7, ln 26-28). It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the hidden layer taught by Kee, since such would allow for a more efficient determination of facial recognition.

As per claim 15, Orbeus in view of Sugai and Kee discloses the method of claim 14. Orbeus further discloses wherein physical features of a face comprise one or more of the following: a piece of eyewear; facial hair; a piece of headwear; illumination of the face based on the orientation of the face relative to a light source; and a facial expression on the face ("In a further implementation, at 2904, the server software application performs facial recognition to recognize faces and determine facial expressions of individuals within each photo. In one implementation, different facial images (such as Smile, angry, etc.) are viewed as different types of scenes.", col 29, ln 13-17).

Claims 23-25 lack an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and in further view of US 2016/0063335 A1 to NOKIA TECHNOLOGIES OY (hereinafter Nokia).

As per claim 23, neither Orbeus nor Sugai teach further comprising: detecting, within a plurality of segments, an unidentified individuals, wherein the detections access the extracted feature vector for the face of the unidentified individual for each segment of the plurality; determining, for each pair of consecutive segments, a distance between the extracted feature vectors; responsive to determining the distance to be within a threshold distance, generating, for each pair of consecutive segments, a representative feature vector by aggregating the feature vectors from the pair of segments; and clustering, across any segment of the video, representative feature vectors determined to be within a threshold distance.
However, Nokia, in an analogous art, teaches detecting, within a plurality of segments, an unidentified individuals, wherein the detections access the extracted feature vector for the face of the unidentified individual for each segment of the plurality (para [0041]-[0047]); determining, for each pair of consecutive segments, a distance between the extracted feature vectors (para [0064]-[0069]; abstract); responsive to determining the distance to be within a threshold distance, generating, for each pair of consecutive segments, a representative feature vector by aggregating the feature vectors from the pair of segments (para [0064]-[0069]; abstract); and clustering, across any segment of the video, representative feature vectors determined to be within a threshold distance (para [0042]-[0045], [0064]-[0069]; abstract).
It would have been obvious to one of ordinary skill in the art to have modified the system of Orbeus and Sugai detecting, within a plurality of segments, an unidentified individuals, wherein the detections access the extracted feature vector for the face of the unidentified individual for each segment of the plurality; determining, for each pair of consecutive segments, a distance between the extracted feature vectors; responsive to determining the distance to be within a threshold distance, generating, for each pair of consecutive segments, a representative feature vector by aggregating the feature vectors from the pair of segments; and clustering, across any segment of the video, representative feature vectors determined to be within a threshold distance by including as taught by Nokia because the modification would improve the face recognition accuracy (Nokia, para [0003]).

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As per claim 24, Nokia teaches wherein the representative feature vector is extracted based on a computation of the mean of the detected feature vectors (para [0041]-[0047]).

As per claim 25, Nokia teaches wherein each cluster is assigned a confidence level describing the distance between the tracks of the cluster (para [0042]-[0045], [0064]-[0069]; abstract).

Claims 26-27 lack an inventive step under PCT Article 33(3) as being obvious over Orbeus in view of Sugai and further in view of US 9,373,024 B2 to AT&T Intellectual Property I, L. P. (hereinafter, 'AT&T').

As per claim 26, Orbeus in view of Sugai discloses the method of claim 1. However, Orbeus in view of Sugai does not disclose identifying, from the one or more segments of the video, segments in which an unidentified individual was present with a second individual; incrementing, for each combination of unidentified individuals and second individuals, the number of segments in which both individuals are present; and assigning a label to each combination based on the incremented number of segments, the label describing a strength of the relationship between the individuals of the combination.

However, AT&T does disclose identifying, from the one or more segments of the video ("It should be noted that an image may be one of a sequence of images in a video. Thus, Video can be analyzed as described herein similar to images but on a frame by frame or scene by scene basis.", col 3, ln 10-13); segments in which an unidentified individual was present with a second individual ("In another embodiment, information from event data could be stored in database 20 and used to estimate social relation ships between people from many images. As different people are identified using the content of images and event data about those people and images are stored, the system can begin to estimate social relationships between individuals.", col 8, ln 20-25); incrementing, for each combination of unidentified individuals and second individuals, the number of segments in which both individuals are present ("These relationships would have stronger or weaker computed links based on the co-occurrence of people (420 of FIG. 4) and event data from the corresponding images that they were identified in. For example, as Zoe Ellen and Nathanial Jackson appeared in more images together in different locations, the strength of a computed a social link could be incremented and the system might propose that Zoe and Nathanial are friends or are related.", col 8, ln 25-33); and assigning a label to each combination based on the incremented number of segments, the label describing a strength of the relationship between the individuals of the combination ("These relationships would have stronger or weaker computed links based on the co-occurrence of people (420 of FIG. 4) and event data from the corresponding images that they were identified in. For example, as Zoe Ellen and Nathanial Jack son appeared in more images together in different locations, the strength of a computed a social link could be incremented and the system might propose that Zoe and Nathanial are friends or are related.", col 8, ln 25-33).It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the relationship indicator taught by AT&T, since such would allow for future indexing for easier facial recognition.

As per claim 27, Orbeus in view of Sugai discloses the method of claim 1. However, Orbeus in view of Sugai does not disclose identifying, from the one or more segments of the video, segments in which an unidentified individual was present with a second individual; accessing, for each of the segments, the confidence level of the match for the unidentified individual; and assigning a label to each combination based on the confidence level of each match within each segment, the label describing the strength of the relationship between the individuals of the combination.
However, At&T does disclose identifying, from the one or more segments of the video ("It should be noted that an image may be one of a sequence of images in a video. Thus, Video can be analyzed as described herein similar to images but on a frame by frame or scene by scene basis.", col 3, ln 10-13); segments in which an unidentified individual was present with a second individual ("In another embodiment, information from event data could be stored in database 20 and used to estimate social relation ships between people from many images. As different people are identified using the content of images and event data about those people and images are stored, the system can begin to estimate social relationships between individuals.", col 8, ln 20-25); accessing, for each of the segments, the confidence level of the match for the unidentified individual ("It should be noted that the determinations in the steps of FIG. 3, as well as determinations of other types of content shown in an image, may not result in accurate identifications. To account for this potential inaccuracy, a level of confidence concerning the accuracy of a determination can be generated and associated with each determination.", col 4, ln 31-36); and assigning a label to each combination based on the confidence level of each match within each segment, the label describing the strength of the relationship between the individuals of the combination ("It should be noted that the determinations in the steps of FIG. 3, as well as determinations of other types of content shown in an image, may not result in accurate identifications. To account for this potential inaccuracy, a level of confidence concerning the accuracy of a determination can be generated and associated with each determination.", col 4, ln 31-36). It would have been obvious to one of ordinary skill in the art to combine the method taught by Orbeus and Sugai with the relationship indicator taught by AT&T, since such would allow for future indexing for easier facial recognition.

Claims 1-35 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.