

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

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PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43bis.1)

Date of mailing
(day/month/year)

23 JUL 2018

Applicant's or agent's file reference
10141/005405-WOO

FOR FURTHER ACTION

See paragraph 2 below

International application No.

PCT/US 18/31368

International filing date (day/month/year)

07 May 2018 (07.05.2018)

Priority date (day/month/year)

11 May 2017 (11.05.2017)

International Patent Classification (IPC) or both national classification and IPC

IPC(8) - H04L 29/06 (2018.01)

CPC - H04L 63/0861, H04L 63/0823, H04L 67/06, G06F 21/32, G06F 21/35, H04L 9/3268, H04L 63/0428,
H04L 63/0815, H04L 63/102, H04L 9/3231, G06F 21/6218

Applicant VERIDIUM IP LIMITED

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 43bis.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 66.1bis(b) that written opinions of this International Searching Authority will not be so considered.

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

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

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Date of completion of this opinion

06 July 2018

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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 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-24	YES
	Claims	None	NO
Inventive step (IS)	Claims	4-5, 7, 11, 16-17, 19, 23	YES
	Claims	1-3, 6, 8-10, 12-15, 18, 20-22, 24	NO
Industrial applicability (IA)	Claims	1-24	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1 and 13 lack an inventive step under PCT Article 33(3) as being obvious over the document entitled "Vein Patterns as Bio-Metric Identifier using Euclidean Distance" by Aeri et al. (hereinafter 'Aeri'). in view of US 2016/0373440 A1 (Hoyos Labs IP Ltd.).

Regarding claim 1, Aeri teaches a computer implemented method for matching an biometric input record with at least one stored encrypted biometric record, without data decryption of the input and the at least one stored record, the method comprising (Abstract - a new approach for biometric authentication; vein.fs pattern based biometric authentication that can be used for ascertaining the biometric identity of person under scanner): providing an initial biometric vector to a machine learning algorithm, wherein the machine learning algorithm translates the initial biometric vector to a Euclidean measurable feature vector (Abstract; page 2, col 1; page 3, col 1 - thinned image pattern is now examined for intersections extractions; inter-distance between intersections. The inter-distance between intersections of vein patterns are stored in a data base; central pixel is the pixel under scanner and the coordinates of the central pixel are taken as the intersection points. Following images show the intersections obtained in a template image; inter-distances between intersections are computed by the following formula: Say (x1,y1) and (x2,y2) are coordinates of two intersections; All processes are carried out in a machine learning techniques); storing the Euclidian measurable feature vector in a storage with other Euclidian measurable feature vectors (Abstract; page 3, col 1; page 3, col 2 - inter-distance between intersections. The inter-distance between intersections of vein patterns are stored in a data base; The inter-distances are now stored in a data base along with veins pattern attributes like name and physical identity); receiving, from a mobile computing device, a current biometric vector representing the biometric input record (page 1, col 2- customer.fs mobile device, important information may get corrupted so that easy methods are adapted and implemented to avoid such types of leakage. Biometric methods such as.h Real Time Recognition system.h using finger vein is adapted in this paper which provide high level of accuracy to avoid chances of leakage of important personal information; test vein pattern is brought under test); providing a current biometric vector to the machine learning algorithm, wherein the machine learning algorithm translates the current biometric vector to a current Euclidian measurable feature vector (page 3, col 1; page 3, col 2 - when a test vein pattern is examined, same steps are repeated and inter-distances are computed.); conducting a search of at least some of the stored Euclidian measurable feature vectors in a portion of the data storage using the current Euclidian measurable feature vector, wherein the biometric input record is matched with at least one biometric record in encrypted space as a function of an absolute distance computed between the current Euclidian measurable feature vector and a calculation of each of the respective Euclidian measurable feature vectors in the portion of the storage (page 3, col 1; page 3, col 2 - the Euclidean distances between test pattern and data base patterns are computed by using the following formula: $ED = \sqrt{(DT-Ddb)^2}$ Where Dt and Ddb are the test and data base vein pattern inter-distances. Sort the ED vector for minimum ED. The vein pattern in data base with minimum ED is the equivalent vein pattern to test vein image; flow chart). Aeri does not teach encrypted biometric input record; The machine learning algorithm is a neural network; receiving the current biometric vector over a data communication network. However, Hoyos Labs IP Ltd. teaches encrypted biometric input record (para [0004]- authentication request is processed that is subsequently received that includes an encrypted partial second biometric vector and that is associated with a user of the user computing device); utilizing a neural network for processing the biometric data (para [0103]-[0104]- neural network can be applied for fingerprint matching); receiving the current biometric vector over a data communication network (para [0039], [0109] - BOPS server 102 that can receive via one or more data communication networks from a client device 104 a biometric vector, referred to herein, generally, as the initial biometric vector ("IBV"); a software application ("MCA") executing on a mobile computing device 104 provides for acquisition of an initial biometric vector (IBV)). It would have been obvious to one of ordinary skill in the art to combine the fingerprint matching taught by Aeri with the finger print acquisition and transmission taught by Hoyos Labs IP Ltd. Since doing so would provide relatively strong protection of biometric data transmission and secure the privacy of the user.

--- (See Continuation in Supplemental Box) ---

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box V.2. Citations and Explanations.

Regarding claim 13, Aeri teaches a computer implemented system for matching a biometric input record with at least one stored biometric record, the system comprising (Abstract - a new approach for biometric authentication; vein.fs pattern based biometric authentication that can be used for ascertaining the biometric identity of person under scanner): providing an initial biometric vector to a machine learning algorithm, wherein the machine learning algorithm translates the initial biometric vector to a Euclidian measurable feature vector (Abstract; page 2, col 1; page 3, col 1 - thinned image pattern is now examined for intersections extractions; inter-distance between intersections. The inter-distance between intersections of vein patterns are stored in a data base; central pixel is the pixel under scanner and the coordinates of the central pixel are taken as the intersection points. Following images show the intersections obtained in a template image; inter-distances between intersections are computed by the following formula: Say (x1,y1) and (x2,y2) are coordinates of two intersections; All processes are carried out in a machine learning techniques); storing the Euclidian measurable feature vector in a storage with other Euclidian measurable feature vectors (Abstract; page 3, col 1; page 3, col 2 - inter-distance between intersections. The inter-distance between intersections of vein patterns are stored in a data base; The inter-distances are now stored in a data base along with veins pattern attributes like name and physical identity); receiving, from a mobile computing device, a current biometric vector representing the biometric input record (page 1, col 2- customer.fs mobile device, important information may get corrupted so that easy methods are adapted and implemented to avoid such types of leakage. Biometric methods such as.h Real Time Recognition system.h using finger vein is adapted in this paper which provide high level of accuracy to avoid chances of leakage of important personal information; test vein pattern is brought under test); providing a current biometric vector to the machine learning algorithm, wherein the machine learning algorithm translates the current biometric vector to a current Euclidian measurable feature vector (page 3, col 1; page 3, col 2 - when a test vein pattern is examined, same steps are repeated and inter-distances are computed.); conducting a search of at least some of the stored Euclidian measurable feature vectors in a portion of the data storage using the current Euclidian measurable feature vector, wherein the biometric input record is matched with at least one biometric record in encrypted space as a function of an absolute distance computed between the current Euclidian measurable feature vector and a calculation of each of the respective Euclidian measurable feature vectors in the portion of the storage (page 3, col 1; page 3, col 2 - the Euclidean distances between test pattern and data base patterns are computed by using the following formula: $ED = \sqrt{(DT - Ddb)^2}$ Where Dt and Ddb are the test and data base vein pattern inter-distances. Sort the ED vector for minimum ED. The vein pattern in data base with minimum ED is the equivalent vein pattern to test vein image; flow chart). Aeri does not teach one or more processors and a computer-readable medium, wherein the one or more processors are configured to interact with the computer-readable medium in order to perform operations that include: encrypted biometric input record; matching an encrypted biometric input record with at least one stored encrypted biometric record, without data decryption of the input and the at least one stored record; The machine learning algorithm is a neural network; receiving the current biometric vector over a data communication network. However, Hoyos Labs IP Ltd. teaches one or more processors and a computer-readable medium, wherein the one or more processors are configured to interact with the computer-readable medium in order to perform operations that include (Claim 11- at least one processor operatively coupled to one or more non-transitory processor readable media; wherein the one or more processor readable media includes instructions for enabling the at least one processor): encrypted biometric input record (para [0004]- authentication request is processed that is subsequently received that includes an encrypted partial second biometric vector and that is associated with a user of the user computing device); matching an encrypted biometric input record with at least one stored encrypted biometric record, without data decryption of the input and the at least one stored record (claim 1; para [0066] - Matching operations can in an encrypted space; comparison of the encrypted partial initial biometric vector and the encrypted partial second biometric vector); utilizing a neural network for processing the biometric data (para [0103]-[0104]- neural network can be applied for fingerprint matching); receiving the current biometric vector over a data communication network (para [0039], [0109] - BOPS server 102 that can receive via one or more data communication networks from a client device 104 a biometric vector, referred to herein, generally, as the initial biometric vector ("IBV"); a software application ("MCA") executing on a mobile computing device 104 provides for acquisition of an initial biometric vector (IBV)). It would have been obvious to one of ordinary skill in the art to combine the fingerprint matching taught by Aeri with the finger print acquisition and transmission taught by Hoyos Labs IP Ltd. Since doing so would provide relatively strong protection of biometric data transmission and secure the privacy of the user.

Claims 2, 6, 14, 18 lack an inventive step under PCT Article 33(3) as being obvious over Aeri in view of Hoyos Labs IP Ltd. and further in view of US 5,161,204 A1 to Hutcheson et al. (hereinafter 'Hutcheson').

Regarding claim 2 and 14, neither Aeri nor Hoyos Labs IP Ltd. teaches classifying the Euclidian measurable feature vector and/or classifying the current Euclidian measurable feature vector, wherein the classifying is performed at least in part using one or more distance functions. However, Hutcheson teaches classifying the Euclidian measurable feature vector and/or classifying the current Euclidian measurable feature vector, wherein the classifying is performed at least in part using one or more distance functions (col 26, ln 15 to col 27, ln 25; col 32, ln 25-61). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of Hutcheson since doing so would improve the accuracy of the matching step.

Regarding claim 6 and 18, neither Aeri nor Hoyos Labs IP Ltd. teaches identifying, for each respective Euclidian measurable biometric vector, a plurality of floating point values; and using a bitmap to eliminate from an absolute distances calculation any of the plurality of values that are not present in every vector. However, Hutcheson teaches identifying, for each respective Euclidian measurable biometric vector, a plurality of floating point values (col 18, ln 18-45; col 25, ln 35 to col 26, ln 6); using a bitmap to eliminate from an absolute distances calculation any of the plurality of values that are not present in every vector (col 23, ln 35 to col 24, ln 20; col 26, ln 25-64). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of Hutcheson since doing so would improve the accuracy of the matching step.

--- (See Continuation in Supplemental Box) ---

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of:
Box V.2. Citations and Explanations.

Claims 8-10, 12, 20-22, 24 lack an inventive step under PCT Article 33(3) as being obvious over Aeri in view of Hoyos Labs IP Ltd. and further in view of US 2015/0278642 A1 (SUPERFISH LTD).

Regarding claim 8 and 20, neither Aeri nor Hoyos Labs IP Ltd. teaches the neural network is configured with a variety of convolutional layers, together with a rectifier (ReLU) and pooling nodes. However, SUPERFISH LTD teaches a neural network that is configured with a variety of convolutional layers, together with a rectifier (ReLU) and pooling nodes (para [0016]-[0019], [0021]-[0024]). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of SUPERFISH LTD since doing so would provide a fast and accurate processing of the biometric data.

Regarding claim 9 and 21, neither Aeri nor Hoyos Labs IP Ltd. teaches the neural network is configured to use pooling as a form of non-linear down-sampling, and further wherein one or more pooling nodes progressively reduce the spatial size of a represented Euclidean-measurable feature vector to reduce the amount of parameters and computation in the neural network. However, SUPERFISH LTD teaches the neural network is configured to use pooling as a form of non-linear down-sampling, and further wherein one or more pooling nodes progressively reduce the spatial size of a represented Euclidean-measurable feature vector to reduce the amount of parameters and computation in the neural network (para [0018], [0022]-[0025], [0033]-[0035]). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of SUPERFISH LTD since doing so would provide a fast and accurate processing of the biometric data.

Regarding claim 10 and 22, Aeri teaches computing, for each of a plurality of stored Euclidian measurable feature vectors, a relative position difference between an average face vector and the respective Euclidian measurable feature vector; squaring the relative position difference, summing the values, and calculating the square root (page 3, col 1- inter-distance between them is given by: $D = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$).

Regarding claim 12 and 24, Hoyos Labs IP Ltd. the neural network translates the initial biometric vector and the current biometric vector as a function of matrix multiplications, and uses a Euclidean distance algorithm based on a Euclidean cost function (para [0102]-[0105]). Neither Aeri nor Hoyos Labs IP Ltd. teaches respective layers of the neural network. However, SUPERFISH LTD teaches respective layers of the neural network (para [0016]-[0019], [0021]-[0024]). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of SUPERFISH LTD since doing so would provide a fast and accurate processing of the biometric data.

Claims 3, 15 lack an inventive step under PCT Article 33(3) as being obvious over Aeri in view of Hoyos Labs IP Ltd. and Hutcheson and further in view of US 2012/0314974 A1 (Yang).

Regarding claim 3 and 15, Hutcheson teaches the classifying the Euclidian measurable feature and/or the current Euclidian measurable feature vector returns floating point values (col 18, ln 18-45; col 25, ln 35 to col 26, ln 6). Neither Aeri nor Hoyos Labs IP Ltd. nor Hutcheson a Frobenius algorithm is utilized to compute an absolute distance between each floating point and its average. However, Yang teaches a Frobenius algorithm is utilized to compute an absolute distance between each floating point and its average (para [0117]-[0120], [0148]-[0152]). It would have been obvious to one of ordinary skill in the art to modify the combination of Aeri and Hoyos Labs IP Ltd. with those of Hutcheson and Yang since doing so would improve the accuracy of the matching step.

Claims 4-5, 7, 11, 16-17, 19, 23 meet the criteria set forth under PCT Article 33(2)-(3) because the prior art fails to disclose or fairly suggest the particular combination of elements recited in dependent claims 4-5, 7, 11, 16-17, 19, 23.

Regarding claim 4 and 16, none of the prior art discloses the search is conducted in Order $\log(n)$ time.

Regarding claim 5 and 17, none of the prior art discloses using a Frobenius algorithm to classify the Euclidian measurable biometric vectors, traversing a hierarchy of the classified Euclidian measurable biometric vectors in Order $\log(n)$ time and identifying that a respective Euclidian measurable biometric vector is the current Euclidian measurable feature vector.

Regarding claim 7 and 19, none of the prior art discloses identifying, for each respective Euclidian measurable biometric vector, a plurality of floating point values and defining a sliding scale of importance based on the number of vectors a respective one of the floating point value appears.

Regarding claim 11 and 23, none of the prior art discloses performance of the neural network is determined as a function of a cost function, in which a number of layers given as a spatial size of an output volume is computed as a function of an input volume size W , a kernel field size of layer neurons K , a stride with which the layers are applied S , and an amount of zero padding P used on a border.

Claims 1-24 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.