

least a portion of the eye in the image of the facial region, wherein the at least a portion of the eye comprises a scleral region of the eye; defining a plurality of periocular image regions within the image each excluding the ocular image region and including at least a portion of the area surrounding the eye in the image of the facial region, wherein each of the periocular image regions is sized differently from the ocular image region; calculating one or more biometric match scores based on the ocular image region and at least one of the periocular regions; and designating the image of the facial region as authentic or not authentic based on the one or more biometric match scores. Defining a particular one of the periocular image regions comprises: calculating a region height by multiplying a height of the ocular image region including the scleral region with a first numerical factor; calculating a region width by multiplying a width of the ocular image region including the scleral region with a second numerical factor; setting a height of the particular periocular image region equal to the calculated region height; and setting a width of the particular periocular image region equal to the calculated region width.

[0005] There is also disclosed a system comprising at least one memory for storing computer-executable instructions, and at least one processing unit for executing the instructions stored on the at least one memory. Execution of the instructions programs the at least one processing unit to perform operations as described above.

[0006] In another aspect, a computer-implemented method comprises the steps of: receiving an image of a facial region of a user, the facial region including an eye and an area surrounding the eye; processing the image to define an ocular image region including at least a portion of the eye in the image of the facial region; defining a plurality of periocular image regions each including at least a portion of the area surrounding the eye in the image of the facial region, wherein the periocular regions are defined based on dimensions of the defined ocular region; calculating one or more biometric match scores based on the ocular image region and at least one of the periocular regions; and designating the image of the facial region as authentic or not authentic based on the one or more biometric match scores.

[0007] In one implementation, the plurality of periocular image regions comprises at least four periocular image regions. The at least four periocular image regions can comprise a periocular image region disposed below the ocular image region, a periocular image region

CLAIMS

1. A computer-implemented method comprising:
 - receiving an image of a facial region of a user, the facial region including an eye and an area surrounding the eye;
 - processing the image to define an ocular image region including at least a portion of the eye in the image of the facial region, wherein the at least a portion of the eye comprises a scleral region of the eye;
 - defining a plurality of periocular image regions within the image each excluding the ocular image region and including at least a portion of the area surrounding the eye in the image of the facial region, wherein each of the periocular image regions is sized differently from the ocular image region, and wherein defining a particular one of the periocular image regions comprises:
 - calculating a region height by multiplying a height of the ocular image region including the scleral region with a first numerical factor;
 - calculating a region width by multiplying a width of the ocular image region including the scleral region with a second numerical factor;
 - setting a height of the particular periocular image region equal to the calculated region height; and
 - setting a width of the particular periocular image region equal to the calculated region width;
 - calculating one or more biometric match scores based on the ocular image region and at least one of the periocular regions; and
 - designating the image of the facial region as authentic or not authentic based on the one or more biometric match scores.
2. The method of claim 1, wherein the plurality of periocular image regions comprises at least four periocular image regions.
3. The method of claim 2, wherein the at least four periocular image regions comprise a lower periocular image region disposed below the ocular image region, a right periocular image

region disposed to a right of the ocular image region, a periocular image region disposed to a left of the ocular image region, and a periocular image region disposed above the ocular image region.

4. The method of claim 1, wherein defining the plurality of periocular image regions comprises defining a right periocular image region disposed to the right of the ocular image region, the right periocular image region having a width in a range of 10% to 80% of a width of the ocular image region and a height in a range of 120% to 550% of a height of the ocular image region.

5. The method of claim 1, wherein defining the plurality of periocular image regions comprises defining a left periocular image region disposed to a left of the ocular image region, the left periocular image region having a width in a range of 10% to 50% of a width of the ocular image region and a height in a range of 120% to 550% of a height of the ocular image region.

6. The method of claim 1, wherein calculating the one or more biometric match scores comprises:

calculating a first biometric match score based on the ocular image region and an ocular enrollment template; and

in response to determining that the first biometric match score does not meet a first match threshold, calculating a second biometric match score based on the ocular image region, a first one of the periocular image regions, the ocular enrollment template, and a periocular enrollment template.

7. The method of claim 6, wherein calculating the one or more biometric match scores further comprises, in response to determining that the second biometric match score does not meet a second match threshold, calculating one or more further biometric match scores by iteratively including additional ones of the periocular image regions in calculating the further biometric match scores until either a particular further biometric match score meets a corresponding match threshold or no further periocular image regions are available for inclusion.

8. The method of claim 7, wherein the plurality of periocular image regions are ranked based at least on discriminative power and/or quality, and wherein the additional periocular image regions are iteratively included based on the respective rankings of the additional periocular image regions.

9. The method of claim 7, further comprising dividing one or more of the plurality of periocular image regions into sub-regions based on one or more facial features derived from the periocular image regions, wherein the additional periocular image regions are iteratively included based on cluster importance or the respective rankings of the additional periocular image regions.

10. The method of claim 1, wherein calculating the one or more biometric match scores comprises:

- identifying a first set of pairs of matched points based on the ocular image region and an enrollment template; and

- identifying a second set of pairs of matched points based on at least one of the periocular image regions and the enrollment template.

11. The method of claim 10, wherein calculating the one or more biometric match scores further comprises:

- determining one or more inlier matched points by inputting a combination of the first and second sets of pairs of matched points into an outlier detection algorithm;

- determining that a number of the inlier matched points that correspond to the ocular image region meets a minimum ocular inlier count; and

- calculating one of the biometric match scores based at least in part on the inlier matched points.

12. The method of claim 11, wherein the minimum ocular inlier count is equal to 3.

13. The method of claim 10, wherein calculating the one or more biometric match scores further comprises:

determining one or more first inlier matched points by inputting the first set of pairs of matched points into an outlier detection algorithm;

determining one or more second inlier matched points by inputting the second set of pairs of matched points into the outlier detection algorithm; and

calculating one of the biometric match scores based at least in part on an output of the outlier detection algorithm using a combination of the first and second inlier matched points as input.

14. The method of claim 13, wherein calculating the one or more biometric match scores further comprises determining that a number of inlier matched points, obtained from the output of the outlier detection algorithm, that correspond to the ocular image region meets a minimum ocular inlier count.

15. The method of claim 14, wherein the minimum ocular inlier count is equal to 3.

16. A system comprising:

at least one memory for storing computer-executable instructions; and

at least one processing unit for executing the instructions stored on the at least one memory, wherein execution of the instructions programs the at least one processing unit to perform operations comprising:

receiving an image of a facial region of a user, the facial region including an eye and an area surrounding the eye;

processing the image to define an ocular image region including at least a portion of the eye in the image of the facial region, wherein the at least a portion of the eye comprises a scleral region of the eye;

defining a plurality of periocular image regions within the image each excluding the ocular image region and including at least a portion of the area surrounding the eye in the image of the facial region, wherein each of the periocular image regions is sized differently from the ocular image region, and wherein defining a particular one of the periocular image regions comprises:

calculating a region height by multiplying a height of the ocular image region including the scleral region with a first numerical factor;
calculating a region width by multiplying a width of the ocular image region including the scleral region with a second numerical factor;
setting a height of the particular periocular image region equal to the calculated region height; and
setting a width of the particular periocular image region equal to the calculated region width;
calculating one or more biometric match scores based on the ocular image region and at least one of the periocular regions; and
designating the image of the facial region as authentic or not authentic based on the one or more biometric match scores.

17. The system of claim 16, wherein the plurality of periocular image regions comprises at least four periocular image regions.

18. The system of claim 17, wherein the at least four periocular image regions comprise a lower periocular image region disposed below the ocular image region, a right periocular image region disposed to a right of the ocular image region, a periocular image region disposed to a left of the ocular image region, and a periocular image region disposed above the ocular image region.

19. The system of claim 16, wherein defining the plurality of periocular image regions comprises defining a right periocular image region disposed to a right of the ocular image region, the right periocular image region having a width in a range of 10% to 80% of a width of the ocular image region and a height in a range of 120% to 550% of a height of the ocular image region.

20. The system of claim 16, wherein defining the plurality of periocular image regions comprises defining a left periocular image region disposed to a left of the ocular image region, the left periocular image region having a width in a range of 10% to 50% of a width of the ocular

image region and a height in a range of 120% to 550% of a height of the ocular image region.

21. The system of claim 16, wherein calculating the one or more biometric match scores comprises:

calculating a first biometric match score based on the ocular image region and an ocular enrollment template; and

in response to determining that the first biometric match score does not meet a first match threshold, calculating a second biometric match score based on the ocular image region, a first one of the periocular image regions, the ocular enrollment template, and a periocular enrollment template.

22. The system of claim 21, wherein calculating the one or more biometric match scores further comprises, in response to determining that the second biometric match score does not meet a second match threshold, calculating one or more further biometric match scores by iteratively including additional ones of the periocular image regions in calculating the further biometric match scores until either a particular further biometric match score meets a corresponding match threshold or no further periocular image regions are available for inclusion.

23. The system of claim 22, wherein the plurality of periocular image regions are ranked based at least on discriminative power and/or quality, and wherein the additional periocular image regions are iteratively included based on the respective rankings of the additional periocular image regions.

24. The system of claim 22, wherein the operations further comprise dividing one or more of the plurality of periocular image regions into sub-regions based on one or more facial features derived from the periocular image regions, wherein the additional periocular image regions are iteratively included based on cluster importance or the respective rankings of the additional periocular image regions.

25. The system of claim 16, wherein calculating the one or more biometric match scores comprises:

identifying a first set of pairs of matched points based on the ocular image region and an enrollment template; and

identifying a second set of pairs of matched points based on at least one of the periocular image regions and the enrollment template.

26. The system of claim 25, wherein calculating the one or more biometric match scores further comprises:

determining one or more inlier matched points by inputting a combination of the first and second sets of pairs of matched points into an outlier detection algorithm;

determining that a number of the inlier matched points that correspond to the ocular image region meets a minimum ocular inlier count; and

calculating one of the biometric match scores based at least in part on the inlier matched points.