SUMMARY

[0009] According to a first aspect, a method for liveness detection authentication of a facial image is provided. The method includes acquiring a first image of the facial image illuminated with a first color, acquiring a second image of the facial image illuminated with a second color, and determining if the facial image is consistent with a three-dimensional (3D) structure in response to a combination of the first and second images. The method further includes determining the facial image matches a user to be authenticated by comparing the combination of the first and second images to an image of the user to be authenticated, the image of the user to be authenticated being stored in a memory; and authenticating the facial image if the facial image is consistent with a 3D structure and the facial image matches a face of a user to be authenticated.

[0010] According to a second aspect, a system in a device for liveness detection authentication of a facial image is provided. The system includes a multi-color illumination device, a camera, a memory and a processor. The multi-color illumination device provides illumination in a first direction and the camera acquires images in at least the first direction. The memory stores data, wherein the stored data comprises a stored image of a user to be authenticated. The processor is coupled to the multi-color illumination device and the camera, and the processor records a first image from the camera when the multi-color illumination device illuminates the facial image with a first color and records a second image from the camera when the multi-color illumination device illuminates the facial image with a second color. The processor analyzes a combination of the first and second images to determine if the facial image is consistent with a three-dimensional (3D) structure in response to the combination of the first and second images, determines the facial image matches the user to be authenticated by comparing the combination of the first and second images to the stored image of the user to be authenticated and authenticates the facial image if the facial image is consistent with the 3D structure and the facial image matches a face of the user to be authenticated.

[0011] And according to a third aspect, a computer

readable medium for performing liveness detection authentication of a facial image is provided. The computer readable medium has instructions stored thereon for a processing means to acquire a first image of the facial image illuminated with a first color, acquire a second image of the facial image illuminated with a second color, determine if the facial image is consistent with a three-dimensional (3D) structure in response to a combination of the first and second images, determine the facial image matches a user to be authenticated by comparing the combination of the first and second images to an image of the user to be authenticated, the image of the user to be authenticated being stored in a memory, and authenticate the facial image if the facial image is consistent

with the 3D structure and the facial image matches a face of the user to be authenticated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The accompanying figures, where like reference numerals refer to identical or functionally similar elements throughout the separate views and which together with the detailed description below are incorporated in and form part of the specification, serve to illustrate various example embodiments and to explain various principles and advantages in accordance with a present example embodiment.

[0013] FIG. 1 depicts a high-level block diagram of a system for liveness detection in accordance with present example embodiments.

[0014] FIG. 2 depicts a side planar view of an optimal camera-user arrangement for the system for liveness detection in accordance with the present example embodiments.

[0015] FIGs. 3A, 3B and 3C depict side planar views of operation of the system for liveness detection in accordance with the present example embodiments. FIG. 3A depicts traditional mobile phone camera positioning and FIGs. 3B and 3C depict artificially shifting a reference marker on a mobile phone screen in accordance with the present example embodiments.

[0016] FIG. 4 depicts a color wheel showing optimal chrominance transition for use in the system for liveness detection in accordance with the present example embodiments.

[0017] FIG. 5 depicts a graph of surface reflectance as related to angle of incidence.

[0018] FIGs. 6A and 6B, depict vectors perpendicular to the surface, to demonstrate how the relation depicted in FIG. 5 would cause dramatic difference in pattern of reflection between a facial image of a flat two-dimensional (2D) object and a three-dimensional (3D) object. FIG. 6A depicts perpendicular vectors for a 3D object such as a face and FIG. 6B depicts perpendicular vectors for a flat 2D surface.

[0019] FIG. 7 depicts a block diagram of a device having a system for liveness detection in accordance with the present example embodiments.

[0020] FIG. 8 depicts a method for liveness detection in accordance with the present example embodiments.

CLAIMS

1. A method for liveness detection authentication of a facial image comprising:

acquiring a first image of the facial image illuminated with a first color;

acquiring a second image of the facial image illuminated with a second color;

determining if the facial image is consistent with a three-dimensional (3D) structure in response to a combination of the first and second images;

determining the facial image matches a user to be authenticated by comparing the combination of the first and second images to an image of the user to be authenticated, the image of the user to be authenticated being stored in a memory; and

authenticating the facial image if the facial image is consistent with the 3D structure and the facial image matches a face of the user to be authenticated.

2. The method in accordance with Claim 1 wherein the first color has a first chrominance value and the second color has a second chrominance value.

3. The method in accordance with Claim 2 wherein the first and second chrominance values are selected to maximize a chrominance differential.

4. The method in accordance with any one of Claims 1 to 3 wherein a time that the facial image is illuminated with the first color and a time that the facial image is illuminated with the second color are randomly selected.

5. The method in accordance with any one of Claims 1 to 4 further comprising before the acquiring the first image the step of suggesting the user to adjust position of the camera in response to determining that the facial image and the lighting are not correct.

6. The method in accordance with any one of Claims 1 to 5 wherein the determining if the facial image is consistent with a 3D structure comprises:

aligning the first image and the second image; and

determining if the facial image is consistent with the 3D structure in response to a combination of the aligned first and second images.

7. The method in accordance with Claim 6 wherein the determining if the facial image is consistent with a 3D structure further comprises filtering light from the first image which is not illumination of the first color.

8. The method in accordance with either Claim 6 or Claim 7 wherein the determining if the facial image is consistent with a 3D structure further comprises filtering light from the second image which is not illumination of the second color.

9. The method in accordance with any one of Claims 1 to 8 wherein the acquiring the first image and the acquiring the second image comprise acquiring a first set of images, the first set of images comprising the first image and the second image, the method further comprising acquiring at least a further set of images including:

acquiring a first one of the further set of images of the facial image illuminated with a third color different from the first and second colors; and

acquiring a second one of the further set of images of the facial image illuminated with a fourth color, wherein the fourth color is different from the first, second and third colors, and wherein the third color and the fourth color are selected in response to chrominance differential between a chrominance value of the third color and a chrominance value of the fourth color, and

wherein the determining if the facial image is consistent with a 3D structure comprises determining if the facial image is consistent with the 3D structure in response to a combination of the first, second, third and fourth images.

10. A system in a device for liveness detection authentication of a facial image, the system comprising:

a multi-color illumination device for providing illumination in a first direction;

a camera for acquiring images in at least the first direction;

a memory for storing data, wherein the stored data comprises a stored image of a user to be authenticated; and

a processor coupled to the multi-color illumination device and the camera, the processor recording a first image from the camera when the multi-color illumination device illuminates the facial image with a first color and recording a second image from the camera when the multi-color illumination device illuminates the facial image with a second color, the processor analyzing a combination of the first and second images to determine if the facial image is consistent with a three-dimensional (3D) structure in response to a combination of the first and second images, the processor determining the facial image matches the user to be authenticated by comparing the combination of the first and second images to the stored image of the user to be authenticated, the processor authenticating the facial image if the facial image is consistent with the 3D structure and the facial image matches a face of the user to be authenticated.

11. The system in accordance with Claim 10 wherein the processor controls the multi-color illumination device to illuminate the face with the first color and the second color in response to selecting the first and second colors to maximize a chrominance differential between chrominance values of the first and second colors.

12. The system in accordance with Claim 10 or Claim 11 wherein the processor controls the multi-color illumination device to illuminate the face with the first color for a first time and controls the multi-color illumination device to illuminate the face with the second color for a second time, wherein the first time and the second time a randomly chosen by the processor.

13. The system in accordance with any one of Claims 10 to 12 wherein the multi-color illumination device comprises a display and wherein the processor provides reference marker information to the display to suggest the user adjust a position of the camera before the acquiring the first image in response to determining that the facial image and the lighting are not correct.

14. The system in accordance with Claim 13 wherein the reference marker information comprises an image of the user.

15. The system in accordance with either Claim 13 or Claim 14 wherein the processor moves the reference marker information on the display to suggest the user adjust a position of the camera by maintaining a position of the reference marker substantially in a center of the display.

16. The system in accordance with any one of Claims 10 to 15 wherein the processor determines the facial image is consistent with the 3D structure by aligning the first image and the second image and determining if the facial image is consistent with the 3D structure in response to a combination of the aligned first and second images.

17. The system in accordance with Claim 16 wherein the determining if the facial image is consistent with a 3D structure further comprises filtering light from the first image which is not illumination of the first color.

18. The system in accordance with either Claim 16 or Claim 17 wherein the determining if the facial image is consistent with a 3D structure further comprises filtering light from the second image which is not illumination of the second color.

19. The system in accordance with any one of Claims 10 to 18 wherein the device comprises a mobile phone.

20. Computer readable media for performing liveness detection authentication of a facial image, the computer readable medium storing instructions for a processing means to

acquire a first image of the facial image illuminated with a first color;

acquire a second image of the facial image illuminated with a second color;

determine if the facial image is consistent with a three-dimensional (3D) structure in response to a combination of the first and second images;

determine the facial image matches a user to be authenticated by comparing the combination of the first and second images to an image of the user to be authenticated, the image of the user to be authenticated being stored in a memory; and

authenticate the facial image if the facial image is consistent with the 3D structure and the facial image matches a face of the user to be authenticated.

21. The computer readable medium in accordance with Claim 20 further storing instructions for the processing means to provide visual instructions to suggest the user to adjust position of the camera before acquiring the first image in response to determining that the facial image and the lighting are not correct.

22. The computer readable medium in accordance with either Claim 20 or Claim 21 further storing instructions for the processing means to determine the facial image is consistent with the 3D structure in response to aligning the first image and the second image.

23. The computer readable medium in accordance with any one of Claims 20 to 22 further storing instructions for the processing means to determine the facial image is consistent with the 3D structure in response to filtering light from the first image which is not illumination of the first color.

24. The computer readable medium in accordance with any one of Claims 20 to 23 wherein the determining if the facial image is consistent with a 3D structure further comprises filtering light from the second image which is not illumination of the second color.