CLAIMS

What is claimed is:

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~~ combining and transforming the first and second images, wherein combining the first and second images comprises aligning the first image and the second image, and wherein transforming the first and second images comprises filtering light from the first image which is not illumination of the first color and filtering light from the second image which is not illumination of the second color; 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.

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 values.

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 of the preceding claims 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 of the preceding claims 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 of the preceding claims wherein ~~determining the facial image is consistent with a 3D structure~~ filtering light from the first image which is not illumination of the first color and filtering light from the second image which is not illumination of the second color comprises:

~~aligning the first image and the second image~~performing pixel value comparison per each pair of color channel values of corresponding pixels of a first plurality of pixels comprising the first image and a second plurality of pixels comprising the second image; and

~~determining if the facial image is consistent with a 3D structure in response to a combination of the aligned first and second images~~computing a matrix of resultant pixel component values from the pixel value comparison of the corresponding pixels of the first plurality of pixels and the second plurality of pixels.

7. The method in accordance with Claim 6 wherein determining the facial image is consistent with a 3D structure ~~further~~ comprises determining the facial image

is consistent with a 3D structure in response to the matrix of resultant pixel component values~~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~~ any of the preceding claims wherein ~~determining 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 and filtering light from the second image which is not illumination of the second color comprises:

filtering out light from the first image which is illumination from light sources other than illumination from the first color; and

filtering light out from the second image which is illumination from light sources other than illumination from the second color.

9. The method in accordance with any of the preceding claims 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 a 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; 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~~ combining and transforming 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 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, wherein the processor combines the first and second images by aligning the first image and the second image, and wherein the processor transforms the first and second images by filtering light from the first image which is not illumination of the first color and filtering light from the second image which is not illumination of the second color.

11. The system in accordance with Claim 10 further comprising a memory for storing data, wherein the stored data comprises a stored image of the user to be authenticated, and wherein the processor determines the facial image matches the user

to be authenticated by comparing the combination of the first or the second image to the stored image of the user to be authenticated.

12. The system in accordance with Claim 11 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.

13. The system in accordance with any of Claims 10 to 12 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.

14. The system in accordance with any of Claims 10 to 13 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.

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

16. The system in accordance with either Claim 14 or Claim 15 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.

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

performing pixel value comparison per each pair of color channel values of corresponding pixels of a first plurality of pixels comprising the first image and a second plurality of pixels comprising the second image; and

computing a matrix of resultant pixel component values from the pixel value comparison of the corresponding pixels of the first plurality of pixels and the second plurality of pixels,

wherein the processor determines the facial image is consistent with a 3D structure in response to the matrix of resultant pixel component values.

18. The system in accordance with ~~Claim~~ any of Claims 10 to 17 wherein ~~determining the facial image is consistent with a 3D structure further comprises filtering~~ the processor filters light from the first image which is not illumination of the first color by filtering out light from the first image which is illumination from light sources other than illumination from the first color.

19. The system in accordance with ~~either Claim 17 or Claim~~ any of Claims 10 to 18 wherein ~~determining the facial image is consistent with a 3D structure further~~

~~comprises filtering~~ the processor filters light from the second image which is not illumination of the second color by filtering light out from the second image which is illumination from light sources other than illumination from the second color.

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

21. 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~~ combining and transforming the first and second images, wherein combining the first and second images comprises aligning the first image and the second image, and wherein transforming the first and second images comprises filtering light from the first image which is not illumination of the first color and filtering light from the second image which is not illumination of the second color; and

authenticate 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.

22. The computer readable medium in accordance with Claim 21 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.

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

performing pixel value comparison per each pair of color channel values of corresponding pixels of a first plurality of pixels comprising the first image and a second plurality of pixels comprising the second image; and

computing a matrix of resultant pixel component values from the pixel value comparison of the corresponding pixels of the first plurality of pixels and the second plurality of pixels.

24. The computer readable medium in accordance with ~~any of Claims 21 to~~ Claim 23 further storing instructions for the processing means to determine the facial image is consistent with a 3D structure in response to ~~filtering light from the first image which is not illumination of the first color~~the matrix of resultant pixel component values.

25. The computer readable medium in accordance with any of Claims 21 to 24 further storing instructions for the processing means to ~~determine 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~~filter light from the first image which is not illumination of the first color and filter light from the second image which is not illumination of the second color by:

filtering out light from the first image which is illumination from light sources other than illumination from the first color; and

filtering out light from the second image which is illumination from light sources other than illumination from the second color.