METHODS AND SYSTEMS FOR DETECTING SPOOFING OF FACIAL RECOGNITION IN CONNECTION WITH MOBILE DEVICES

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application No. 62/817,554, filed March 12, 2019, which application is incorporated herein by reference in its entirety.

BACKGROUND

[0002] "Spoofing" a security system is generally defined as an act of masquerading as an authenticated user, by submitting false data. In this case, methods of liveness detection may be employed to determine whether a biometric modality, such as a face, a palm (palm print), a finger (fingerprint), or an ear, carries the unique structural qualities of the original three-dimensional biometric modality, or is a two-dimensional replicate.

SUMMARY

[0003] In one aspect, disclosed herein are computer-implemented methods for detecting spoofing of biometric identity recognition using the camera of a mobile device, the method comprising: (a) recording, by a camera, a user's face image or set of images at a first distance; (b) processing the user's face image or set of images at the first distance with algorithms to generate a first data representation of the user's image or set of images; (c) processing the first data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera; (d) changing the distance between the user's face and the camera, wherein changing the distance comprises increasing the distance between the user's face and the camera, decreasing the distance between the user's face and the camera, changing the orientation of the camera in relation to the user's face, changing the orientation of the user's face in relation to the camera, or any combination thereof; (e) recording, by the camera, the user's face image or set of images at a second distance; (f) processing the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images; (g) comparing the second data representation with the predictive model generated from the first data representation to determine if they match; and (h) comparing an additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and (i) validating an identity recognition match if the second data

representation matches the predictive model generated from the first data representation. In some embodiments, the method further comprises rejecting the identity recognition match if, after comparing the second data representation with the predictive model generated from the first data representation, the second data representation

comprises comparing the (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the second data representation, and the first data representation. In some embodiments, the method further comprises validating an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation; and (II) the motion and/or location data recorded continuously or at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

[0004] In another aspect, disclosed herein are computer-implemented systems comprising a computing device comprising at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the computing device to create an application for detecting spoofing of biometric identity recognition using the camera of a mobile device, the application comprising: (a) a software module configured to record a user's face image or set of images at a first distance; (b) a software module configured to process the user's face image or set of images at the first distance with algorithms to generate a first data representation of the user's image or set of images; (c) a software module configured to process the first data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera; (d) a software module configured to change the distance between the user's face and the camera, wherein changing the distance comprises increasing the distance between the user's face and the camera, decreasing the distance between the user's face and the camera, changing the orientation of the camera in relation to the user's face, changing the orientation of the user's face in relation to the camera, or any combination thereof; (e) a software module configured to record the user's face image or set of images at a second distance; (f) a software module configured to process the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images; (g) a software module configured to compare the second data representation with the predictive model generated from the first data representation to determine if they match; and (h) a software module configured to compare additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and (i) a software module configured to validate an identity recognition match if the second data representation matches the predictive model generated from the first data representation. In some

embodiments, the system further comprises a software module configured to reject the identity recognition match if, after the software module configured to compare the second data representation with the predictive model generated from the first data representation, the second data representation does not match the predictive model generated from

camera, or any combination thereof; (e) a software module configured to record the user's face image or set of images at a second distance; (f) a software module configured to process the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images; (g) a software module configured to compare the second data representation with the predictive model generated from the first data representation to determine if they match; and (h) a software module configured to compare additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and (i) a software module configured to validate an identity recognition match if the second data representation matches the predictive model generated from the first data representation. In some embodiments, the media further comprises a software module configured to reject the identity recognition match if, after the software module configured to compare the second data representation with the predictive model generated from the first data representation, the second data representation does not match the predictive model generated from the first data representation. In some embodiments, the media further comprising a software module configured to capture one or more additional data representations from the user's face image or set of images from the first or second distance, and compare the captured one or more additional data representations with the predictive model generated from the first data representation to determine if they match if, after comparing the second data representation with the predictive model generated from the first data representation, the second data representation does not match the predictive model generated from the first data representation. In some embodiments, the media further comprising a software module configured to validate an additional data representation identity recognition match if the one or more additional data representations match the predictive model generated from the first data representation. In some embodiments, the media further comprising a software module configured to reject an additional data representation identity recognition match if the one or more additional data representations does not match the predictive model generated from the first data representation. In some embodiments, the media further comprising a software module configured to compare additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation. In some embodiments, additional data comprises a name, password, identity number, address, geo-location, device ID, unique data characteristic of the user's software environment on the mobile device, other biometric data,

predictive models of user data or biometric data, other data, or any combination thereof. In some embodiments, the media further comprises: (a) a software module configured to process the second data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between

CLAIMS

WHAT IS CLAIMED IS:

1. A computer-implemented method for detecting spoofing of biometric identity recognition using the camera of a mobile device, the method comprising:
    a) recording, by a camera, a user's face image or set of images at a first distance;
    b) processing the user's face image or set of images at the first distance with algorithms to generate a first data representation of the user's image or set of images;
    c) processing the first data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;
    d) changing the distance between the user's face and the camera, wherein changing the distance comprises increasing the distance between the user's face and the camera, decreasing the distance between the user's face and the camera, changing the orientation of the camera in relation to the user's face, changing the orientation of the user's face in relation to the camera, or any combination thereof;
    e) recording, by the camera, the user's face image or set of images at a second distance;
    f) processing the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images;
    g) comparing the second data representation with the predictive model generated from the first data representation to determine if they match;
    h) comparing an additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and
    i) validating an identity recognition match if the second data representation matches the predictive model generated from the first data representation.
2. The method of claim 1, further comprising rejecting the identity recognition match if, after comparing the second data representation with the predictive model generated from the first data

representation, the second data representation does not match the predictive model generated from the first data representation.

3. The method of claim 1, the method further comprising validating an additional data representation identity recognition match if the one or more additional data representations match the predictive model generated from the first data representation.

4. The method of claim 1, further comprising rejecting an additional data representation identity recognition match if the one or more additional data representations does not match the predictive model generated from the first data representation.

5. The method of claim 1, wherein additional data comprises a name, password, identity number, address, geo-location, device ID, unique data characteristic of the user's software environment on the mobile device, other biometric data, predictive models of user data or biometric data, other data, or any combination thereof.

6. The method of claim 1, further comprising:

   a) processing the second data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;

   b) comparing the first data representation with the predictive model generated from the second data representation to determine if they match; and

   c) validating an identity recognition match if the first data representation matches the predictive model generated from the second data representation.

7. The method of claim 6, wherein the comparison of a predictive model to a data representation comprises configuring a matching architecture.

8. The method of claim 6, wherein the comparison of a predictive model to a data representation comprises comparing a predictive model generated from a first data representation with a second data representation, comparing a predictive model generated from a second data representation with a first data representation, or any combination thereof.

9. The method of claim 7, wherein the configuration of matching architecture changes upon successive matching exercises, or changes upon certain successive matching exercise and not others, wherein changes may be randomized between matching exercises, or be based on non-randomized determinate data or protocols, or which may not change.

10. The method of claim 9, wherein changes to the configuration of matching architecture are based on changes being randomized between matching exercises, changes being based on non-randomized determinate data or protocols, or any combination thereof.

11. The method of claim 7, wherein the configuration of matching architecture does not change.

12. The method of claim 1, wherein a guided user interface is used to capture the first and/or second data representations.

13. The method of claim 12, wherein information captured from the guided user interface is used in matching exercises.

14. The method of claim 1, the method further comprising:

    a) recording, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) recording, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) comparing the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the first data representation, and the second data representation; and

    d) validating an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

15. The method of claim 14, wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation.

16. The method of claim 15, further comprising comparing (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the first data representation, and the second data representation.

17. The method of claim 16, further comprising validating an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation; and (II) the motion and/or location data recorded continuously or at a plurality of

intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

18. The method of claim 6, further comprising:

    a) recording, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) recording, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) comparing the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the second data representation, and the first data representation; and

    d) validating an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

19. The method of claim 18, wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation.

20. The method of claim 19, further comprising comparing the (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the second data representation, and the first data representation.

21. The method of claim 20, further comprising validating an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation; and (II) the motion and/or location data recorded continuously or at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

22. A computer-implemented system comprising a computing device comprising at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the computing device to create an application for detecting spoofing of biometric identity recognition using the camera of a mobile device, the application comprising:

a) a software module configured to record a user's face image or set of images at a first distance;

b) a software module configured to process the user's face image or set of images at the first distance with algorithms to generate a first data representation of the user's image or set of images;

c) a software module configured to process the first data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;

d) a software module configured to change the distance between the user's face and the camera, wherein changing the distance comprises increasing the distance between the user's face and the camera, decreasing the distance between the user's face and the camera, changing the orientation of the camera in relation to the user's face, changing the orientation of the user's face in relation to the camera, or any combination thereof;

e) a software module configured to record the user's face image or set of images at a second distance;

f) a software module configured to process the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images;

g) a software module configured to compare the second data representation with the predictive model generated from the first data representation to determine if they match;

h) a software module configured to compare additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and

i) a software module configured to validate an identity recognition match if the second data representation matches the predictive model generated from the first data representation.

23. The system of claim 22, further comprising a software module configured to reject the identity recognition match if, after the software module configured to compare the second data representation with the predictive model generated from the first data representation, the second data representation does not match the predictive model generated from the first data representation.

24. The system of claim 22, further comprising a software module configured to validate an additional data representation identity recognition match if the one or more additional data representations match the predictive model generated from the first data representation.

25. The system of claim 22, further comprising a software module configured to reject an additional data representation identity recognition match if the one or more additional data representations does not match the predictive model generated from the first data representation.

26. The system of claim 22, wherein additional data comprises a name, password, identity number, address, geo-location, device ID, unique data characteristic of the user's software environment on the mobile device, other biometric data, predictive models of user data or biometric data, other data, or any combination thereof.

27. The system of claim 22, wherein the system further comprises:

    a) a software module configured to process the second data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;

    b) a software module configured to compare the first data representation with the predictive model generated from the second data representation to determine if they match; and

    c) a software module configured to validate an identity recognition match if the first data representation matches the predictive model generated from the second data representation.

28. The system of claim 27, wherein the software module configured to compare the first data representation with the predictive model generated from the second data representation comprises a matching architecture configuration.

29. The system of claim 27, wherein any software module configured to compare a predictive model to a data representation comprises comparing a predictive model generated from a first data representation with a second data representation, comparing a predictive model generated from a second data representation with a first data representation, or any combination thereof.

30. The system of claim 28, wherein the configuration of matching architecture changes upon successive matching exercises, or changes upon certain successive matching exercise and not others, wherein changes may be randomized between matching exercises, or be based on non-randomized determinate data or protocols, or which may not change.

31. The system of claim 30, wherein changes to the configuration of matching architecture are based on changes being randomized between matching exercises, changes being based on non-randomized determinate data or protocols, or any combination thereof.

32. The system of claim 28, wherein the matching architecture configuration does not change.

33. The system of claim 22, wherein the system further comprises a guided user interface used to capture the first and/or second data representations.

34. The system of claim 33, wherein information captured from the guided user interface is used in matching exercises.

35. The system of claim 22, the system further comprising:

    a) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) a software module configured to compare the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the first data representation, and the second data representation; and

    d) a software module configured to validate an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

36. The system of claim 35,wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation

37. The system of claim 36, further comprising a software module configured to compare (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the first data representation, and the second data representation.

38. The system of claim 37, further comprising a software module configured to validate an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation; and (II) the motion and/or location data recorded continuously or at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

39. The system of claim 27, the system further comprising:

    a) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) a software module configured to compare the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the second data representation, and the first data representation; and

    d) a software module configured to validate an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

40. The system of claim 39, wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation.

41. The system of claim 40, further comprising a software module configured to compare the (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the second data representation, and the first data representation.

42. The system of claim 41, further comprising a software module configured to validate an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation; and (II) the motion and/or location data recorded continuously or

at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

43. A non-transitory computer-readable storage media encoded with a computer program including instructions executable by one or more processors to create an application for detecting spoofing of biometric identity recognition using the camera of a mobile device, the application comprising:

a) a software module configured to record a user's face image or set of images at a first distance;

b) a software module configured to process the user's face image or set of images at the first distance with algorithms to generate a first data representation of the user's image or set of images;

c) a software module configured to process the first data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;

d) a software module configured to change the distance between the user's face and the camera, wherein changing the distance comprises increasing the distance between the user's face and the camera, decreasing the distance between the user's face and the camera, changing the orientation of the camera in relation to the user's face, changing the orientation of the user's face in relation to the camera, or any combination thereof;

e) a software module configured to record the user's face image or set of images at a second distance;

f) a software module configured to process the user's face image or set of images at the second distance with algorithms to generate a second data representation of the user's second image or set of images;

g) a software module configured to compare the second data representation with the predictive model generated from the first data representation to determine if they match;

h) a software module configured to compare additional data to determine if the user presenting the face image or set of images at the first distance is a match to the user presenting the face image or set of images at the second distance if the second data representation does not match the predictive model generated from the first data representation; and

i) a software module configured to validate an identity recognition match if the second data representation matches the predictive model generated from the first data representation.

44. The media of claim 43, further comprising a software module configured to reject the identity recognition match if, after the software module configured to compare the second data representation with the predictive model generated from the first data representation, the second data representation does not match the predictive model generated from the first data representation.

45. The media of claim 43, further comprising a software module configured to validate an additional data representation identity recognition match if the one or more additional data representations match the predictive model generated from the first data representation.

46. The media of claim 43, further comprising a software module configured to reject an additional data representation identity recognition match if the one or more additional data representations does not match the predictive model generated from the first data representation.

47. The media of claim 43, wherein additional data comprises a name, password, identity number, address, geo-location, device ID, unique data characteristic of the user's software environment on the mobile device, other biometric data, predictive models of user data or biometric data, other data, or any combination thereof.

48. The media of claim 43, wherein the media further comprises:

    a) a software module configured to process the second data representation into a predictive model that estimates the data representations of the user's face image or set of images at other distances or orientations between the user's face and the camera;

    b) a software module configured to compare the first data representation with the predictive model generated from the second data representation to determine if they match; and

    c) a software module configured to validate an identity recognition match if the first data representation matches the predictive model generated from the second data representation.

49. The media of claim 48, wherein the software module configured to compare the first data representation with the predictive model generated from the second data representation comprises a matching architecture configuration.

50. The media of claim 48, wherein a software module configured to compare a predictive model to a data representation comprises comparing a predictive model generated from a first data representation with a second data representation, comparing a predictive model generated from a second data representation with a first data representation, or any combination thereof.

51. The media of claim 49, wherein the configuration of matching architecture changes upon successive matching exercises, or changes upon certain successive matching exercise and not others, wherein changes may be randomized between matching exercises, or be based on non-randomized determinate data or protocols, or which may not change.

52. The media of claim 51, wherein changes to the configuration of matching architecture are based on changes being randomized between matching exercises, changes being based on non-randomized determinate data or protocols, or any combination thereof.

53. The media of claim 49, wherein the configuration of matching architecture does not change.

54. The media of claim 43, wherein the media further comprises a guided user interface used to capture the first and/or second data representations.

55. The media of claim 54, wherein information captured from the guided user interface is used in matching exercises.

56. The media of claim 43, the media further comprising:

    a) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) a software module configured to compare the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the first data representation, and the second data representation; and

    d) a software module configured to validate an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

57. The media of claim 56,wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation.

58. The media of claim 57, further comprising a software module configured to compare (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation with (II) the predictive model generated from the first data representation, and the second data representation.

59. The media of claim 58, further comprising a software module configured to validate an identity recognition match if (I) the second data representation matches the predictive model generated from the first data representation; and (II) the motion and/or location data recorded continuously or at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

60. The media of claim 48, the media further comprising:

    a) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the first distance;

    b) a software module configured to record, from one or more sensors on the mobile device, motion and/or location data at the time the user's face image or set of images is recorded by the camera at the second distance;

    c) a software module configured to compare the motion and/or location data recorded at the first distance and motion and/or location data from the second distance with the predictive model generated from the second data representation, and the first data representation; and

    d) a software module configured to validate an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation predictive modeling; and (II) the motion and/or location data match the expected motion and/or location data attributing to the position of the mobile device to the user's face.

61. The media of claim 60, wherein the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data representation.

62. The media of claim 61, further comprising a software module configured to compare the (I) the motion and/or location data is recorded continuously or at a plurality of intervals between the time of recording of the first data representation and the time of recording of the second data

representation with (II) the predictive model generated from the second data representation, and the first data representation.

63. The media of claim 62, further comprising a software module configured to validate an identity recognition match if (I) the first data representation matches the predictive model generated from the second data representation; and (II) the motion and/or location data recorded continuously or at a plurality of intervals match the expected motion and/or location data attributing to the position of the mobile device to the user's face.