

WHAT IS CLAIMED IS:

1. A face recognition system, comprising:  
a camera configured to capture an input image of a subject purported to be a person;  
a memory storing a deep learning model configured to perform multi-task learning for a pair of tasks including a liveness detection task and a face recognition task;  
and  
a processor configured to apply the deep learning model to the input image to recognize an identity of the subject in the input image and a liveness of the subject, and wherein the liveness detection task is configured to evaluate a plurality of different distractor modalities corresponding to different physical spoofing materials to prevent face spoofing for the face recognition task.
2. The face recognition system of claim 1, wherein the different physical spoofing materials comprise spoofing materials selected from the group consisting of a 3D mask, a printed image, and an electronic display.
3. The face recognition system of claim 1, wherein the processor is further configured to perform data preprocessing on the input images selected from the group consisting of image contrast enhancements, data augmentation, and cropping.
4. The face recognition system of claim 1, wherein the processor is further configured to apply an image contrast enhancement to the input images by randomly

adding one or more Gaussian distributed instances to an original RGB value of the input images.

5. The face recognition system of claim 1, wherein the processor is further configured to apply an image contrast enhancement to the input images by adding one or more Gaussian distributed instances to a Hue, Saturation, and Value (HSV) domain and multiplying two or more coefficients in the HSV domain to further adjust the Saturation and the Value of the input images.

6. The face recognition system of claim 1, wherein the processor is further configured to perform random central cropping on the input images.

7. The face recognition system of claim 1, wherein the processor is further configured to perform a data augmentation process on the input images to augment data in the images and increase a generality of the deep learning model to the different distractor modalities.

8. The face recognition system of claim 1, wherein the deep learning model is forming to include a plurality of layers, and the processor is further configured to train the deep learning model by freezing each of the plurality of layers except a last fully connected layer therein, and performing multi-task training by combining the liveness detection task and the face recognition task, wherein during the multi-task training, all weights of the plurality of layers are unfrozen.

9. The face recognition system of claim 1, wherein the deep learning model is formed using an inception structure configured to multiply an output of a convolution layer of the deep learning model with input images to produce a new image having amplified extracted features relative to the at least one of the input images.

10. The face recognition system of claim 1, wherein the deep learning model is formed using a loss structure that includes a face liveness penalty and a face recognition penalty.

11. A computer-implemented method for liveness detection and face recognition, the method comprising:

capturing, by a camera, an input image of a subject purported to be a person;

storing, in a memory, a deep learning model configured to perform multi-task learning for a pair of tasks including a liveness detection task and a face recognition task; and

applying, by a processor, the deep learning model to the input image to recognize an identity of the subject in the input image and a liveness of the subject, and wherein the liveness detection task is configured to evaluate a plurality of different distractor modalities corresponding to different physical spoofing materials to prevent face spoofing for the face recognition task.

12. The computer-implemented method of claim 11, wherein the different physical spoofing materials comprise spoofing materials selected from the group consisting of a 3D mask, a printed image, and an electronic display.

13. The computer-implemented method of claim 11, further comprising performing data preprocessing on the input images selected from the group consisting of image contrast enhancements, data augmentation, and cropping.

14. The computer-implemented method of claim 11, further comprising applying an image contrast enhancement to the input images by randomly adding one or more Gaussian distributed instances to an original RGB value of the input images.

15. The computer-implemented method of claim 11, further comprising applying an image contrast enhancement to the input images by adding one or more Gaussian distributed instances to a Hue, Saturation, and Value (HSV) domain and multiplying two or more coefficients in the HSV domain to further adjust the Saturation and the Value of the input images.

16. The computer-implemented method of claim 11, further comprising performing a data augmentation process on the input images to augment data in the images and increase a generality of the deep learning model to the different distractor modalities.

17. The computer-implemented method of claim 11, wherein the deep learning model is formed to include a plurality of layers, and the method further comprises training the deep learning model by:

freezing each of the plurality of layers except a last fully connected layer therein; and performing multi-task training by combining the liveness detection task and the face recognition task, wherein during the multi-task training, all weights of the plurality of layers are unfrozen.

18. The computer-implemented method of claim 11, wherein the deep learning model is formed using an inception structure configured to multiply an output of a convolution layer of the deep learning model with at least one of the input images to produce a new image having amplified extracted features relative to the input images.

19. The computer-implemented method of claim 11, wherein the pair of tasks are performed for an electronic-payment process.

20. A computer program product for liveness detection and face recognition, the computer program product comprising a non-transitory computer readable storage medium having program instructions embodied therewith, the program instructions executable by a computer to cause the computer to perform a method comprising: capturing, by a camera, an input image of a subject purported to be a person;

storing, in a memory, a deep learning model configured to perform multi-task learning for a pair of tasks including a liveness detection task and a face recognition task; and applying, by a processor, the deep learning model to the input image to recognize an identity of the subject in the input image and a liveness of the subject, and wherein the liveness detection task is configured to evaluate a plurality of different distractor modalities corresponding to different physical spoofing materials to prevent face spoofing for the face recognition task.