CLAIMS

1. A three-dimensional living-body face detection method, comprising:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image; and

performing living-body detection based on the grayscale depth image and a living-body detection model;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

2. The method of claim 1, wherein the living-body detection model is obtained in the following manner:

acquiring multiple frames of depth images for a target training object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image sample; and

training based on the grayscale depth image sample and label data of the grayscale depth image sample to obtain the living-body detection model.

3. The method of claim 1, wherein the pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data comprises:

performing first ~~roughly~~ aligning on the multiple frames of depth images based on three-dimensional key facial points; and

performing second ~~finely~~ aligning on the ~~roughly~~ aligned depth images based on an iterative closest point (ICP) algorithm to obtain the point cloud data.

4. The method of any of claims 1 to 3, wherein before pre-aligning the multiple frames of depth images, the method further comprises:

bilaterally filtering each frame of depth image in the multiple frames of depth images.

~~5. The method of claim 1, wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:~~

~~determining an average depth of the face region according to three-dimensional key facial points in the point cloud data;~~

~~segmenting the face region, and deleting a foreground and a background in the point cloud data; and~~

~~normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.~~

~~6~~5. The method of claim ~~5~~1, wherein the preset value ranges are from 30 mm to 50 mm.

~~7~~6. The method of claim 2, wherein before the training based on the grayscale depth image sample to obtain the living-body detection model, the method further comprises:

performing data augmentation on the grayscale depth image sample, wherein the data augmentation comprises at least one of the following: a rotation operation, a shift operation, and a

zoom operation.

~~8~~7. The method of claim 1, wherein the living-body detection model is a model obtained by training based on a convolutional neural network structure.

~~9~~8. The method of claim 1, wherein the multiple frames of depth images are acquired based on an active binocular depth camera.

~~10~~9. A face authentication recognition method, comprising:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image;

performing living-body detection based on the grayscale depth image and a living-body detection model; and

determining whether the authentication recognition succeeds according to the living-body detection result;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~11~~10. A three-dimensional face detection apparatus, comprising:

an acquisition module configured to acquire multiple frames of depth images for a target detection object;

a first pre-processing module configured to pre-align the multiple frames of depth images to obtain pre-processed point cloud data;

a normalization module configured to normalize the point cloud data to obtain a grayscale depth image; and

a detection module configured to perform living-body detection based on the grayscale depth image and a living-body detection model;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~12~~11. A face authentication recognition apparatus, comprising:

an acquisition module configured to acquire multiple frames of depth images for a target detection object;

a first pre-processing module configured to pre-align the multiple frames of depth images to obtain pre-processed point cloud data;

a normalization module configured to normalize the point cloud data to obtain a grayscale depth image;

a detection module configured to perform living-body detection based on the grayscale depth image and a living-body detection model; and

a recognition module configured to determine whether the authentication recognition succeeds according to the living-body detection result;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~13~~12. An electronic device, comprising: a memory, a processor, and a computer program stored in the memory and executable on the processor, wherein the computer program is executed by the processor for:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image; and

performing living-body detection based on the grayscale depth image and a living-body detection model;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud

data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~14~~13. An electronic device, comprising: a memory, a processor, and a computer program stored in the memory and executable on the processor, wherein the computer program is executed by the processor for:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image;

performing living-body detection based on the grayscale depth image and a living-body detection model; and

determining whether the authentication recognition succeeds according to the living-body detection result;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~15~~14. A computer-readable storage medium storing one or more programs, wherein when

executed by a server comprising multiple applications, the one or more programs enable the server to perform the following operations:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image; and

performing living-body detection based on the grayscale depth image and a living-body detection model;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.

~~16~~15. A computer-readable storage medium storing one or more programs, wherein when executed by a server comprising multiple applications, the one or more programs enable the server to perform the following operations:

acquiring multiple frames of depth images for a target detection object;

pre-aligning the multiple frames of depth images to obtain pre-processed point cloud data;

normalizing the point cloud data to obtain a grayscale depth image;

performing living-body detection based on the grayscale depth image and a living-body detection model; and

determining whether the authentication recognition succeeds according to the living-body detection result;

wherein the normalizing the point cloud data to obtain a grayscale depth image comprises:

determining an average depth of a face region according to three-dimensional key facial points in the point cloud data;

segmenting the face region, and deleting a foreground and a background in the point cloud data; and

normalizing the point cloud data from which the foreground and background have been deleted to preset value ranges before and after the average depth that take the average depth as the reference to obtain the grayscale depth image.