

NETWORK TRAINING METHOD AND APPARATUS, PERSON RE-IDENTIFICATION METHOD AND APPARATUS, STORAGE MEDIUM, AND COMPUTER PROGRAM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The disclosure is based on and claims priority to Chinese patent application No. 202010864291.4, filed on August 25, 2020, the disclosure of which is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The disclosure relates to the technical field of computer, and particularly to a network training method and apparatus, a person re-identification method and apparatus, a storage medium, and a computer program.

BACKGROUND

[0003] Person re-identification, also called as person re-recognition, is a technique that uses computer vision technique to determine whether a specific person is present in an image or video sequence. At present, the person re-identification technique has been widely applied to many fields and industries such as intelligent video detection and intelligent security. Since the person re-identification technique involves private data concerning human face, a human body, a personal identity and the like in the process of processing an image or a video frame sequence, there is an urgent need for a person re-identification method that can avoid leakage of private data.

SUMMARY

[0004] Embodiments of the disclosure provide technical solutions of a network training method and apparatus, a person re-identification method and apparatus, a storage medium, and a computer program.

[0005] According to an aspect of the embodiments of the disclosure, a network training method is provided. The method is applied to a cloud server. The cloud server includes a first person re-identification network. The method includes: sending a first network parameter corresponding to the first person re-identification network to a plurality of edge servers; receiving second network parameters returned by the plurality of edge servers, where for any edge server of the plurality of edge servers, the edge server includes a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have the same network structure, the second network parameter is obtained after the edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; and updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

[0006] In a possible implementation, the operation of updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating may include: receiving weights corresponding to the second network parameters returned by the plurality of edge servers, where for any edge server, the weight corresponding to the second network parameter is determined by the edge server according to the second person re-

identification network before training and the second person re-identification network after training; performing, according to the weights corresponding to the second network parameters returned by the plurality of edge servers, weighted averaging on the second network parameters returned by the plurality of edge servers to obtain the first network parameter after updating; and updating the first person re-identification network according to the first network parameter after updating to obtain the first person re-identification network after updating.

[0007] In a possible implementation, the method may further include: sending a shared image data set to the plurality of edge servers; receiving pseudo labels returned by the plurality of edge servers, where for any edge server, the pseudo label is generated by the edge server according to the shared image data set and the second person re-identification network after training; and training the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training.

[0008] In a possible implementation, the operation of training the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training may include: determining an average pseudo label according to the pseudo labels returned by the plurality of edge servers; and training the first person re-identification network after updating according to the shared image data set and the average pseudo label to obtain the first person re-identification network after training.

[0009] According to an aspect of the embodiments of the disclosure, a network training method is provided. The method is applied to an edge server. The edge server includes a second person re-identification network, an identity classification network and a local image data set. The method includes: receiving a first network parameter corresponding to a first person re-identification network sent by a cloud server, where the first person re-identification network and the second person re-identification network have the same network structure; training the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, where the second person re-identification network corresponds to a second network parameter; and sending the second network parameter to the cloud server.

[0010] In a possible implementation, the operation of training the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training may include: training the second person re-identification network and the identity classification network according to the local image data set and the first network parameter to obtain the second person re-identification network after training and the identity classification network after training.

[0011] In a possible implementation, the method may further include: storing the identity classification network after training in the edge server.

[0012] In a possible implementation, the local image data set may include image data corresponding to a plurality of identities; and dimensionality of the identity classification network may be related to a quantity of the plurality of identities.

[0013] In a possible implementation, the method further includes: receiving a shared image data set sent by the cloud server; generating a pseudo label according to the shared image data set and the second person re-identification network after training; and sending the pseudo label to the cloud server.

[0014] In a possible implementation, the method further includes: determining a first eigenvector according to the second person re-identification network before training and the local image data set, and determining a second eigenvector according to the second person

re-identification network after training and the local image data set; determining a cosine distance between the first eigenvector and the second eigenvector; determining a weight corresponding to the second network parameter according to the cosine distance; and sending the weight corresponding to the second network parameter to the cloud server.

[0015] In a possible implementation, the edge server may be an image acquisition device; and the local image data set may be obtained from acquisition of the image acquisition device.

[0016] In a possible implementation, the edge server may be connected to at least one image acquisition device, the edge server and the at least one image acquisition device may be located in the same geographical area; the local image data set may be acquired by the edge server from the at least one image acquisition device.

[0017] According to an aspect of the embodiments of the disclosure, a person re-identification method is provided, which includes: performing, by using a target person re-identification network, person re-identification processing on at least one frame of to-be-identified image acquired in a target geographical area to determine a person re-identification result, where the target person re-identification network is obtained by training with the above-mentioned network training method.

[0018] In a possible implementation, the target person re-identification network is a first person re-identification network after updating or a first person re-identification network after training.

[0019] In a possible implementation, the target geographical area includes an edge server; and in a case that the edge server includes a second person re-identification network after training, the target person re-identification network is the second person re-identification network after training.

[0020] According to an aspect of the embodiments of the disclosure, a network training apparatus is provided. The network training apparatus is applied to a cloud server. The cloud server includes a first person re-identification network. The apparatus includes: a sending part, configured to send a first network parameter corresponding to the first person re-identification network to a plurality of edge servers; a reception part, configured to receive second network parameters returned by the plurality of edge servers, where for any edge server, the edge server includes a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have the same network structure, and the second network parameter is obtained after the edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; and an updating part, configured to update the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

[0021] According to an aspect of the embodiments of the disclosure, a network training apparatus is provided. The apparatus is applied to an edge server. The edge server includes a second person re-identification network, an identity classification network and a local image data set. The apparatus includes: a reception part, configured to receive a first network parameter corresponding to a first person re-identification network sent by a cloud server, where the first person re-identification network and the second person re-identification network have the same network structure; a network training part, configured to train the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, where the second person re-identification network corresponds to a second network parameter; and a sending part, configured to send the second network parameter to the cloud server.

[0022] According to an aspect of the embodiments of the disclosure, a person re-

identification apparatus is provided, which includes: a person re-identification portion, configured to: perform, by using a target person re-identification network, person re-identification processing on at least one frame of to-be-identified image acquired in a target geographical area to determine a person re-identification result, where the target person re-identification network is obtained through training by using the above-mentioned network training method.

[0023] According to an aspect of the embodiments of the disclosure, an electronic device is provided, which includes: a processor; and a memory, configured to store instructions executable by the processor, where the processor is configured to invoke the instructions stored in the memory to perform the above-mentioned method.

[0024] According to an aspect of the embodiments of the disclosure, a computer-readable storage medium is provided, which stores computer program instructions thereon, where the computer program instructions are executed by a processor to implement the above-mentioned method.

[0025] According to an aspect of the embodiments of the disclosure, a computer program is provided, including computer-readable codes, where when the computer-readable codes are run on an electronic device, a processor in the electronic device implements the above-mentioned method.

[0026] In the embodiments of the disclosure, in a cloud server including a first person re-identification network, a first network parameter corresponding to the first person re-identification network is sent to a plurality of edge servers; second network parameters returned by the plurality of edge servers are received, where for any edge server, the edge server includes a second person re-identification network having the same network structure as the first person re-identification network, an identity classification network and a local image data set, the second network parameter is obtained after the edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; the first person re-identification network is updated according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating. The cloud server and the plurality of edge servers jointly train a person re-identification network. In a training process, the image data set is still stored in the edge servers, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0027] It should be understood that the foregoing general description and the following detailed description are only exemplary and explanatory rather than to limit the embodiments of the disclosure. Other features and aspects of the embodiments of the disclosure will become clear in light of the following detailed description of exemplary embodiments with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The accompanying drawings are incorporated in the specification and constitute a part of the specification. These accompanying drawings show embodiments conforming to the disclosure, and are used together with the specification to describe the technical solutions of the embodiments of the disclosure.

[0029] FIG. 1 is a flowchart of a network training method according to an embodiment of the disclosure;

[0030] FIG. 2 is an exemplary structural diagram of network training according to an embodiment of the disclosure;

[0031] FIG. 3 is a flowchart of a network training method according to an embodiment of the disclosure;

[0032] FIG. 4 is an exemplary schematic diagram of determining a weight of a second

network parameter according to an embodiment of the disclosure;

[0033] FIG. 5 is a structural network diagram of a cloud server and an edge server according to an embodiment of the disclosure;

[0034] FIG. 6 is a structural network diagram of a cloud server, an edge server and a terminal device according to an embodiment of the disclosure;

[0035] FIG. 7 is an exemplary structural diagram of network training according to an embodiment of the disclosure;

[0036] FIG. 8 is a block diagram of a network training apparatus according to an embodiment of the disclosure;

[0037] FIG. 9 is a block diagram of a network training apparatus according to an embodiment of the disclosure;

[0038] FIG. 10 is a block diagram of an electronic device according to an embodiment of the disclosure; and

[0039] FIG. 11 is a block diagram of an electronic device according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0040] Various exemplary embodiments, features, and aspects of the disclosure will be described below in detail with reference to the accompanying drawings. In the accompanying drawings, the same reference sign represents the same or similar components. Although various aspects of the embodiments are shown in the accompanying drawings, it is not necessary to draw the accompanying drawings in scale unless specifically noted.

[0041] The word "exemplary" used herein exclusively means "used as an example, embodiment or illustration". Any embodiment described herein as "exemplary" does not need to be construed as superior as or better than other embodiments.

[0042] The term "and/or" in this specification describes only an association relationship for describing associated objects and represents that three relationships may exist. For example, A and/or B may represent the following three cases: only A exists, both A and B exist, and only B exists. In addition, the term "at least one" herein means any one of a plurality or any combination of at least two of a plurality, for example, including at least one of A, B, or C, and may mean including any one or more elements selected from the group consisting of A, B, and C.

[0043] In addition, numerous specific details are given in the specific implementations below to better describe the embodiments of the disclosure. It should be understood by those skilled in the art that the embodiments of the disclosure can still be implemented without certain specific details. In some examples, methods, means, components, and circuits known to those skilled in the art are not described in detail in order to highlight the main idea of the embodiments of the disclosure.

[0044] FIG. 1 is a flowchart of a network training method according to an embodiment of the disclosure. The network training method may be performed by a cloud server. The cloud server includes a first person re-identification network. In some possible implementations, the network training method may be implemented by the cloud server by invoking computer-readable instructions stored in a memory. As shown in FIG. 1, the method may include the following operations.

[0045] At S11, a first network parameter corresponding to the first person re-identification network is sent to a plurality of edge servers.

[0046] At S12, second network parameters returned by the plurality of edge servers are received, where for any edge server, the edge server includes a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have

the same network structure, the second network parameter is obtained after the edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter.

[0047] At S13, the first person re-identification network is updated according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

[0048] The cloud server and the plurality of edge servers jointly train a person re-identification network. In a training process, the image data set is still stored in the edge servers, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained. In addition, because the image data set does not need to be uploaded to the cloud server, communication bandwidth can be effectively saved.

[0049] When the cloud server and the plurality of edge servers jointly train a person re-identification network, the cloud server and the plurality of edge servers may jointly perform network training based on a federated learning algorithm. For example, a plurality of communities jointly trains one person re-identification network. One edge server is disposed in each community. Through the federated learning algorithm, an image data set (an image data set acquired by an image acquisition device disposed inside or near a community) is still stored in a community (a local edge server) and does not need to be uploaded to another community (another edge server), thereby protecting data privacy.

[0050] During actual applications, because local image data sets in different edge servers have different data amounts, the different edge servers have heterogeneous data. In a conventional federated learning algorithm, when the plurality of edge servers are used to perform network training, weights of the second network parameters obtained through network training in the edge servers are set according to data amounts in the different edge servers. However, the data amount cannot directly reflect a training effect of network training. Therefore, when the cloud server updates the first person re-identification network by using the weights of the second network parameters obtained based on a weight determination method in the edge servers, the accuracy of the updated first person re-identification network is relatively low.

[0051] In a possible implementation, the operation of updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the updated first person re-identification network includes: weights corresponding to the second network parameters returned by the plurality of edge servers are received, where for any edge server, the weight corresponding to the second network parameter is determined by the edge server according to the second person re-identification network before training and the second person re-identification network after training; weighted averaging is performed on the second network parameters returned by the plurality of edge servers according to the weights corresponding to the second network parameters returned by the plurality of edge servers to obtain the first network parameter after updating; and updating the first person re-identification network according to the first network parameter after updating to obtain the first person re-identification network after updating.

[0052] The weights of the second network parameters sent by the edge servers are determined by the edge servers according to the second person re-identification networks before training and the second person re-identification networks after training. That is, the weights of the second network parameters are determined according to training effects of the edge servers. Therefore, the cloud server performs weighted averaging on the second network parameters returned by the plurality of edge servers according to the weights corresponding to the second network parameters returned by the edge servers to obtain the first network parameter after updating with relatively high accuracy, and the first person re-identification network is updated according to the first network parameter after updating,

thereby effectively improving the accuracy of the first person re-identification network after updating.

[0053] During actual applications, because local image data sets in different edge servers are acquired in different scenarios (illumination, and angle), the different edge servers have heterogeneous data. As a result, the performance of the second person re-identification networks after training, which is obtained after the edge servers perform training according to the local image data set, the identity classification network and the first network parameter, is higher than the performance of the first person re-identification network after updating, which is obtained after the cloud server and the plurality of edge servers jointly perform training. Therefore, based on a knowledge distillation algorithm, the second person re-identification networks after training in the edge servers may be used as teacher networks, and the updated first person re-identification network in the cloud server may be used as a student network. The student network is trained by using the teacher networks (the second person re-identification network after updating is used to train the first person re-identification network after updating), thereby improving the stability and convergence of a training process of the first person re-identification network.

[0054] In a possible implementation, the method further includes: a shared image data set is sent to the plurality of edge servers; pseudo labels returned by the plurality of edge servers are received, where for any edge server, the pseudo label is generated by the edge server according to the shared image data set and the second person re-identification network after training; and the first person re-identification network after updating is trained according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training.

[0055] The cloud server receives the pseudo label returned by each edge server. Because the pseudo label is generated by the edge server according to the shared image data set and the second person re-identification network after training, the pseudo label may be used for representing a network characteristic of the second person re-identification network after training. Therefore, the training of the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers is equivalent to integrating network characteristics of the edge servers to train the first person re-identification network after updating, so that the stability and convergence of a training process of the first person re-identification network can be effectively improved. The shared image data set is an image data set that can be used by both the cloud server and the edge server to perform network training.

[0056] FIG. 2 is an exemplary structural diagram of network training according to an embodiment of the disclosure. As shown in FIG. 2, the second person re-identification networks after training in the plurality of edge servers form a teacher network 1, a teacher network 2, ..., and a teacher network N , where N is a quantity of the plurality of edge servers, and $N > 1$. The first person re-identification network after updating in the cloud server forms a student network. The teacher network 1 generates a pseudo label l_1 by using the shared image data set, and sends the pseudo label l_1 to the cloud server; the teacher network 2 generates a pseudo label l_2 by using the shared image data set, and sends the pseudo label l_2 to the cloud server; ...; and the teacher network N generates a pseudo label l_N by using the shared image data set, and sends the pseudo label l_N to the cloud server. The cloud server trains the student network (the updated first person re-identification network) according to the pseudo label l_1 , the pseudo label l_2 , ..., and the pseudo label l_N , and the shared image data set to obtain the first person re-identification network after training.

[0057] In a possible implementation, the operation of training the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training includes: an average pseudo label is determined according to the

pseudo labels returned by the plurality of edge servers; and the updated first person re-identification network after updating is trained according to the shared image data set and the average pseudo label to obtain the first person re-identification network after training.

[0058] For example, the cloud server and N ($N > 1$) edge servers jointly train the first person re-identification network, and the cloud server receives a pseudo label l_i returned by an i^{th} ($1 \leq i \leq N$) edge server, where the pseudo label l_i is generated by the i^{th} edge server according to the shared image data set and the second person re-identification network after training in the i^{th} edge server. The cloud server determines an average pseudo label l according to the pseudo labels returned by the N edge servers by using the following formula (1):

$$l = \frac{1}{N} \sum_{1 \leq i \leq N} l_i \quad (1).$$

The cloud server trains the updated first person re-identification network according to the shared image data set and the average pseudo label l to obtain the first person re-identification network after training.

[0059] In the embodiment of the disclosure, in a cloud server including a first person re-identification network, a first network parameter corresponding to the first person re-identification network is sent to a plurality of edge servers; second network parameters returned by the plurality of edge servers are received, where for any edge server, the edge server includes a second person re-identification network having the same network structure as the first person re-identification network, an identity classification network and a local image data set, the second network parameter is obtained after the edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; the first person re-identification network is updated according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating. The cloud server and the plurality of edge servers jointly train a person re-identification network. In a training process, the image data set is still stored in the edge servers, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0060] FIG. 3 is a flowchart of a network training method according to an embodiment of the disclosure. The network training method may be performed by an edge server. The edge server includes a second person re-identification network, an identity classification network and a local image data set. In some possible implementations, the network training method may be implemented by the edge server by invoking computer-readable instructions stored in a memory. As shown in FIG. 3, the method may include the following steps.

[0061] At S31, a first network parameter corresponding to a first person re-identification network sent by a cloud server is received, where the first person re-identification network and the second person re-identification network have the same network structure.

[0062] At S32, the second person re-identification network is trained according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, where the second person re-identification network corresponds to a second network parameter.

[0063] At S33, the second network parameter is sent to the cloud server.

[0064] The edge server and the cloud server jointly train a person re-identification network. In a training process, an image data set is still stored in the edge server, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0065] In a possible implementation, the edge server is an image acquisition device; and the local image data set is obtained according to acquisition of the image acquisition device.

[0066] In a case that the edge server is an image acquisition device (for example, an

intelligent camera) that directly communicates with the cloud server, the image acquisition device needs to have particular computing power, storage capacity and communication capability. The image acquisition device acquires images to obtain the local image data set, and periodically deletes and clears invalid image data (for example, image data with a caching duration exceeding a preset threshold) in the local image data set, to reduce storage pressure. The image acquisition device receives the first network parameter corresponding to the first person re-identification network sent by the cloud server, trains the second person re-identification network according to the local image data set and the first network parameter to obtain the second person re-identification network after training corresponding to the second network parameter, and further sends the second network parameter to the cloud server.

[0067] In a possible implementation, the edge server is connected to at least one image acquisition device, and the edge server and the at least one image acquisition device are located in the same geographical area; and the local image data set is acquired by the edge server from the at least one image acquisition device.

[0068] In a case that at least one image acquisition device is disposed in the same geographical area, one edge server may be disposed in the geographical area. In this case, the at least one image acquisition device does not need to have storage capacity and computing power. The edge server is connected to the image acquisition device, and acquires images from the image acquisition device to build the local image data set. The edge server receives the first network parameter corresponding to the first person re-identification network sent by the cloud server, trains the second person re-identification network according to the local image data set and the first network parameter to obtain the second person re-identification network after training corresponding to the second network parameter, and further sends the second network parameter to the cloud server.

[0069] In a possible implementation, the operation of training the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training includes: the second person re-identification network and the identity classification network are trained according to the local image data set and the first network parameter to obtain the second person re-identification network after training and the identity classification network after training.

[0070] In a possible implementation, the local image data set includes image data corresponding to a plurality of identities; and dimensionality of the identity classification network is related to the quantity of the plurality of identities.

[0071] The person re-identification network after training is a network used for performing identity identification on images. Therefore, in a process of training a person re-identification network, the local image data set including image data corresponding to a plurality of identities and the identity classification network need to be used. The dimensionality of the identity classification network is related to a quantity of the plurality of identities included in the local image data set. For example, the local image data set includes image data corresponding to 100 identities, and the dimensionality of the identity classification network is 100. That is, the identity classification network includes 100 different identity classes.

[0072] The edge server builds a local second person re-identification network and the identity classification network into a combined network, and trains the combined network by using the first network parameter received from the cloud server and the local image data set to obtain the combined network after training. The combined network after training includes the second person re-identification network after training and the identity classification network after training. The second person re-identification network after training corresponds to the second network parameter. The edge server sends the second

network parameter to the cloud server. Because the first person re-identification network and the second person re-identification network have the same network structure, the first person re-identification network may be updated by using the second network parameter.

[0073] In a possible implementation, the method further includes: the identity classification network after training is stored in the edge server.

[0074] A classifier network does not need to be used in an actual process of performing person re-identification by the first person re-identification network obtained through training in the cloud server. Therefore, to save communication bandwidth and ensure consistent network structures in the cloud server and the edge server in a joint training process based on a federated learning algorithm, the edge server only sends the second network parameter corresponding to the second person re-identification network after training to the cloud server, and the identity classification network after training is locally stored in the edge server.

[0075] In a possible implementation, the method further includes: a shared image data set sent by the cloud server is received; a pseudo label is generated according to the shared image data set and the second person re-identification network after training; and the pseudo label is sent to the cloud server.

[0076] The foregoing FIG. 2 is still used as an example. As shown in FIG. 2, the edge server receives the shared image data set sent by the cloud server, generates a pseudo label by using the shared image data set and the local second person re-identification network after training, and sends the pseudo label to the cloud server. Because the pseudo label may be used for representing a network characteristic of the second person re-identification network after training, the cloud server performs network training on the first person re-identification network after updating in the cloud server according to the pseudo label to obtain the first person re-identification network after training, so that the network performance of the first person re-identification network after training is closer to the network performance of the second person re-identification network after training in the edge server, thereby effectively improving the stability and convergence of a training process of the first person re-identification network.

[0077] In a possible implementation, the method further includes: a first eigenvector is determined according to the second person re-identification network before training and the local image data set, and a second eigenvector is determined according to the second person re-identification network after training and the local image data set; a cosine distance between the first eigenvector and the second eigenvector is determined; a weight corresponding to the second network parameter is determined according to the cosine distance; and the weight corresponding to the second network parameter is sent to the cloud server.

[0078] FIG. 4 is an exemplary schematic diagram of determining a weight of a second network parameter according to an embodiment of the disclosure. As shown in FIG. 4, the edge server generates a first eigenvector f_1 according to the second person re-identification network before training and the local image data set. The edge server performs network training according to the first network parameter received from the cloud server to obtain the second person re-identification network after training. The edge server generates a second eigenvector f_2 according to the second person re-identification network after training and the local image data set. The edge server determines a cosine distance $\text{cosine_distance}(f_1, f_2)$ between the first eigenvector f_1 and the second eigenvector f_2 . The edge server determines a weight of the second network parameter corresponding to the second person re-identification network after training according to the cosine distance $\text{cosine_distance}(f_1, f_2)$. A larger cosine distance $\text{cosine_distance}(f_1, f_2)$ represents a larger change generated in current network training, a better training effect, and a larger weight allocated. A smaller cosine distance $\text{cosine_distance}(f_1, f_2)$ is smaller represents a

smaller change generated in current network training, a worse training effect, and a smaller weight allocated. The edge server sends the determined weight corresponding to the second network parameter to the cloud server. Because the weight of the second network parameter is determined according to a network training effect in the edge server, after the cloud server updates the first person re-identification network based on the weight, the accuracy of the first person re-identification network after updating can be effectively improved.

[0079] In a possible implementation, the entire local image data set or part of the local image data set may be used for determining the first eigenvector f_1 and the second eigenvector f_2 . This is not specifically limited in the disclosure.

[0080] In the embodiment of the disclosure, in an edge server including a second person re-identification network, an identity classification network and a local image data set, a first network parameter corresponding to a first person re-identification network sent by a cloud server is received, where the first person re-identification network and the second person re-identification network have the same network structure; the second person re-identification network is trained according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training corresponding to the second network parameter; and the second network parameter is sent to the cloud server. The edge server and the cloud server jointly train a person re-identification network. In a training process, the image data set is still stored in the edge server, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0081] In a possible implementation, when a cloud server and a plurality of edge servers jointly train a person re-identification network, the plurality of edge servers may all be image acquisition devices (for example, intelligent cameras) that directly communicate with the cloud server. FIG. 5 is a structural network diagram of a cloud server and an edge server according to an embodiment of the disclosure. As shown in FIG. 5, five edge servers connected to the cloud server are image acquisition devices (an image acquisition device 1, an image acquisition device 2, an image acquisition device 3, an image acquisition device 4 and an image acquisition device 5). In such a network structure, each image acquisition devices need to have particular computing power, storage capacity, and communication capability. Each image acquisition device acquires images to obtain the local image data set, and periodically deletes and clears invalid image data (for example, image data with a caching duration exceeding a preset threshold) in the local image data set, so as to reduce storage pressure. The cloud server and the five image acquisition devices used as the edge servers jointly train a person re-identification network. In a training process, the image data set is still locally stored in the image acquisition devices, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0082] In a possible implementation, when the cloud server and the plurality of edge servers jointly train a person re-identification network, the plurality of edge servers may all be edge servers each being connected to at least one image acquisition device. Each edge server and the at least one image acquisition device connected to the edge server are located in the same geographical area. FIG. 6 is a structural network diagram of a cloud server, an edge server and a terminal device according to an embodiment of the disclosure. As shown in FIG. 6, the cloud server directly communicates with an edge server A and an edge server B. The edge server A is connected to a terminal device 1 and a terminal device 2. The terminal device 1 and the terminal device 2 are image acquisition devices (an image acquisition device 1 and an image acquisition device 2, for example, the image acquisition devices are cameras). The edge server A, the image acquisition device 1 and the image acquisition device 2 are disposed in the same geographical area (for example, in the same

community or the same company). The edge server A acquires images from the image acquisition device 1 and the image acquisition device 2 respectively to build the local image data set. The edge server B is connected to a terminal device 3, a terminal device 4 and a terminal device 5. The terminal device 3, the terminal device 4 and the terminal device 5 are image acquisition devices (an image acquisition device 3, an image acquisition device 4 and an image acquisition device 5, for example, the image acquisition devices are cameras). The edge server B, the image acquisition device 3, the image acquisition device 4 and the image acquisition device 5 are disposed in the same geographical area (for example, the same community or the same company). The edge server B acquires images from the image acquisition device 3, the image acquisition device 4 and the image acquisition device 5 respectively to build the local image data set. The cloud server and the two edge servers (the edge server A and the edge server B) train a person re-identification network. In a training process, the image data set is still locally stored in the edge servers, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network is effectively trained.

[0083] As can be known according to the foregoing description, the disclosure provides two training architectures which combine federated learning and person re-identification: a cloud-edge architecture and a terminal-edge-cloud architecture.

[0084] Cloud-edge architecture: A cloud server directly communicates with an intelligent camera. A cloud coordinates a plurality of intelligent cameras to simultaneously perform training. The intelligent cameras cache pictures at an edge, and periodically perform deletion and clearing to reduce storage pressure of an edge server. In such architecture, the intelligent cameras need to have particular computing power, storage capacity, and communication capability.

[0085] Terminal-edge-cloud architecture: An edge gateway (that is, the above-mentioned edge server) is connected to a plurality of intelligent cameras. A cloud server is connected to a plurality of edge gateways. Pictures for person re-identification training are transmitted from the intelligent cameras to the edge gateways, and are cached in the edge gateways. The edge gateways and the cloud server perform training of federated learning. In this process, data is still kept in the edge gateways, and data privacy can still be protected. In a typical application scenario, for example, a plurality of communities jointly train one person re-identification model, each community has one edge gateway connected to the plurality of intelligent cameras. In a federated learning manner, data is still kept in the community but is not transmitted to another community or the cloud server, thereby protecting data privacy.

[0086] In a possible implementation, when the cloud server and the plurality of edge servers jointly train a person re-identification network, some of the plurality of edge servers may be image acquisition devices (for example, intelligent cameras) that directly communicate with the cloud server, and some of the plurality of edge servers may be edge servers connected to at least one image acquisition device. This is not specifically limited in the embodiments of the disclosure.

[0087] FIG. 7 is an exemplary structural diagram of network training according to an embodiment of the disclosure. As shown in FIG. 7, a cloud server may communicate with a plurality of edge servers (an edge server 1, an edge server 2, ..., an edge server N), and a first person re-identification network included in the cloud server and second person re-identification networks included in the edge servers have the same network structure. Each edge server further includes a local image data set and an identity classification network. The cloud server sends a first network parameter corresponding to the first person re-identification network to the plurality of edge servers. After receiving the first network parameter, each edge server trains the second person re-identification network by using the local image data set and an identity classification network to obtain a second person re-identification network after training corresponding to a second network parameter and the

identity classification network after training. To ensure that the cloud server and the edge servers jointly train consistent network structures, the edge servers only send the second network parameters corresponding to the second person re-identification networks after training to the cloud server. The cloud server updates the first person re-identification network according to the received second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating. The first network parameter after updating corresponding to the first person re-identification network is sent to the plurality of edge servers to perform cyclic training. The training ends when the identification accuracy of the first person re-identification network after updating in the cloud server reaches a threshold or the quantity of times of cyclic training reaches a preset quantity of times.

[0088] A universal federated learning algorithm (i.e., Federated Averaging, FedAvg) requires that models (person re-identification deep learning models, that is, the person re-identification networks) of a plurality of parties for synchronization should be identical. A classifier layer (that is, the identity classification network) of a person re-identification deep learning model depends on the quantity of different people included in data of each party. Therefore, classifier layers of models of a plurality of parties that participate in training may be different. As a result, models of a plurality of parties that participate in federated learning may be different. Therefore, the federated learning algorithm FedAvg is inapplicable to the foregoing application scenario. As can be known according to the foregoing content, because the federated learning algorithm is improved in the disclosure, that is, it is allowed that some of models of the plurality of parties that participate in federated learning are different, federated learning can be better applied to training of person re-identification.

[0089] Because local image data sets in different edge servers have different data amounts, the different edge servers have heterogeneous data. When the plurality of edge servers jointly train the first person re-identification network, to reduce the impact of data heterogeneity on the accuracy of the first person re-identification network after updating, weights of the second network parameters corresponding to the second person re-identification networks after training may be determined in the edge servers by using a weight determination method based on a training effect, so that after the cloud server updates the first person re-identification network by combining the second network parameters returned by the edge servers, the first person re-identification network after updating with relatively high accuracy is obtained. Specific steps of the weight determination method based on a training effect have been described in related parts in the foregoing embodiments, and will not be repeated here.

[0090] Because local image data sets in different edge servers are acquired in different scenarios (illumination, and angle), the different edge servers have heterogeneous data, so that the performance of the second person re-identification networks after training, which are obtained after the edge servers perform training according to the local image data sets and the first network parameter, is better than the performance of the first person re-identification network after updating which is obtained after the cloud server and the plurality of edge servers jointly perform training. To improve the stability and convergence of a training process of the first person re-identification network, the first person re-identification network after updating in the cloud server may be trained by using a knowledge distillation algorithm and based on the second person re-identification networks after updating in the edge servers and a shared image data set, thereby effectively improving the stability and convergence of the training process of the first person re-identification network. A specific training process based on the knowledge distillation algorithm has been described in related parts in the foregoing embodiments, and will not be repeated here.

[0091] As can be known based on the foregoing content, the disclosure proposes to use a knowledge distillation method. Local models of the plurality of parties that participate in

federated learning are used as teacher models, and a model of a cloud server is used as a student model. Knowledge of the teacher models is better transferred to the student model by using the knowledge distillation method, thereby improving the stability and convergence of model training.

[0092] In a process of training a person re-identification network based on the network structure shown in FIG. 7, the weight determination method based on a training effect and the network training based on a knowledge distillation algorithm may be separately used or may be used in combination. This is not specifically limited in the embodiments of the disclosure.

[0093] In an application scenario, for example, in a case that a plurality of companies or institutions need to jointly train a person re-identification network to improve the robustness of the person re-identification network after training, to avoid the problem of data privacy leakage when data of a plurality of parties is gathered in the same server, the person re-identification network may be jointly trained based on the network structure shown in FIG. 7. The plurality of companies or institutions is used as edge servers. The plurality of companies or institutions directly communicates with the same cloud server. In a training process, data is still stored locally and does not need to be uploaded to the cloud server, so that data privacy of the plurality of companies or institutions can be protected while the person re-identification network is obtained through effective training in the cloud server.

[0094] In an application scenario, for example, a company A provides a training service of a person re-identification network to a company B. If image data of image acquisition devices (for example, intelligent cameras) of the company B is uploaded to the company A, the problem of data privacy leakage may occur. In this case, the company A may jointly train the person re-identification network based on the network structure shown in FIG. 7. The company A may be used as a cloud server. The image acquisition devices in the company B may be used as a plurality of edge servers. In a training process, data is still locally stored in the company B and does not need to be uploaded to the company A, so that data privacy of the company A can be protected while the person re-identification network is obtained through effective training in the company B.

[0095] An embodiment of the disclosure further provides a person re-identification method. The person re-identification method may be performed by a terminal device or other processing device. The terminal device may be an image acquisition device (for example, an intelligent camera), User Equipment (UE), a mobile device, a user terminal, a terminal, a cellular phone, a cordless phone, a Personal Digital Assistant (PDA), a handheld device, a computing device, an in-vehicle device, a wearable device, or the like. The other processing device may be a server, a cloud server, or the like. In some possible implementations, the person re-identification method may be implemented by a processor by invoking computer-readable instructions stored in a memory. The method may include the following operations.

[0096] Person re-identification processing is performed on at least one frame of to-be-identified image acquired in a target geographical area by using a target person re-identification network to determine person re-identification result, where the target person re-identification network is obtained by training with the network training method in the foregoing embodiments.

[0097] The target person re-identification network may perform person re-identification processing on at least one frame of to-be-identified image in the target geographical area to determine whether there is a characteristic person in the at least one frame of to-be-identified image.

[0098] In a possible implementation, the target person re-identification network is a first person re-identification network after updating or a first person re-identification network after training.

[0099] The first person re-identification network after updating or the first person re-identification network after training in the cloud server has universality, that is, is applicable to any application scenario. Therefore, the updated first person re-identification network or the first person re-identification network after training in the cloud server may be used to implement person re-identification on the at least one frame of to-be-identified image acquired in the target geographical area, to obtain a person re-identification result.

[00100] In a possible implementation, the target geographical area includes an edge server, and in a case that the edge server includes a second person re-identification network after training, the target person re-identification network is the second person re-identification network after training.

[00101] As can be known in combination with the embodiments of the network training method of a cloud server and an edge server, because local image data sets in different edge servers are acquired in different scenarios (illumination, and angle), the different edge servers have heterogeneous data. The second person re-identification networks after training obtained through training according to the local image data sets in different edge servers are personalized and better adapt to local scenarios, so that the performance of the second person re-identification networks in the edge servers after training is better than the performance of the first person re-identification network after updating obtained through joint training by the cloud server and the plurality of edge servers. Therefore, in a case that the target geographical area includes an edge server and the edge server includes the second person re-identification network after training, person re-identification may be performed on at least one frame of to-be-identified image by using the second person re-identification network after training that better adapts to a local scenario of the target geographical area, thereby improving the accuracy of a processing result.

[00102] In the disclosure, after one deployment, further training and iteration may be performed according to data generated in the edge server, so that low-cost continuous update and iteration of a model can be implemented.

[00103] It may be understood that each of the foregoing method embodiments mentioned in the embodiments of the disclosure may be combined with each other to form a combined embodiment without violating the logic of the principle, and the embodiments of the disclosure are not described again for brevity. It may be understood by those skilled in the art that in the foregoing method of a specific implementation, the specific order of execution of the steps should be determined by their functions and possible internal logic.

[00104] In addition, an embodiment of the disclosure further provides a network training apparatus, a person re-identification apparatus, an electronic device, a computer-readable storage medium, and a program. All the foregoing may be configured to implement any network training/person re-identification method provided in the embodiments of the disclosure. For corresponding technical solutions and descriptions, reference may be made to corresponding records in the method part, and details are not described again.

[00105] FIG. 8 is a block diagram of a network training apparatus according to an embodiment of the disclosure. The network training apparatus is applied to a cloud server. The cloud server includes a first person re-identification network. As shown in FIG. 8, the apparatus 80 includes a sending part 81, a reception part 82 and an updating part 83.

[00106] The sending part 81 is configured to send a first network parameter corresponding to the first person re-identification network to a plurality of edge servers.

[00107] The reception part 82 is configured to receive second network parameters returned by the plurality of edge servers, where for any edge server, the edge server includes a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have the same network structure, the second network parameter is obtained after the edge server trains the second person re-identification network according

to the local image data set, the identity classification network and the first network parameter; and

[00108] The updating part 83 is configured to update the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

[00109] In a possible implementation, the updating part 83 includes a reception sub-part, a first updating sub-part and a second updating sub-part.

[00110] The reception sub-part is configured to receive weights corresponding to the second network parameters returned by the plurality of edge servers, where for any edge server, the weight corresponding to the second network parameter is determined by the edge server according to the second person re-identification network before training and the second person re-identification network after training.

[00111] The first updating sub-part is configured to perform, according to the weights corresponding to the second network parameters returned by the plurality of edge servers, weighted averaging on the second network parameters returned by the plurality of edge servers to obtain the first network parameter after updating.

[00112] The second updating sub-part is configured to update the first person re-identification network according to the first network parameter after updating to obtain the first person re-identification network after updating.

[00113] In a possible implementation, the sending part 81 is further configured to send a shared image data set to the plurality of edge servers.

[00114] The reception part 82 is further configured to receive pseudo labels returned by the plurality of edge servers, where for any edge server, the pseudo label is generated by the edge server according to the shared image data set and the second person re-identification network after training.

[00115] The apparatus 80 further includes a network training part.

[00116] The network training part is configured to train the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training.

[00117] In a possible implementation, the network training part is further configured to: determine an average pseudo label according to the pseudo labels returned by the plurality of edge servers; and train the first person re-identification network after updating according to the shared image data set and the average pseudo label to obtain the first person re-identification network after training.

[00118] FIG. 9 is a block diagram of a network training apparatus according to an embodiment of the disclosure. The network training apparatus is applied to an edge server. The edge server includes a second person re-identification network, an identity classification network and a local image data set. As shown in FIG. 9, an apparatus 90 includes a reception part 91, a network training part 92 and a sending part 93.

[00119] The reception part 91 is configured to receive a first network parameter corresponding to a first person re-identification network sent by a cloud server, where the first person re-identification network and the second person re-identification network have the same network structure.

[00120] The network training part 92 is configured to train the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, where the second person re-identification network corresponds to a second network parameter.

[00121] The sending part 93 is configured to send the second network parameter to the cloud server.

[00122] In a possible implementation, the network training part 92 is further configured to train the second person re-identification network and the identity classification network according to the local image data set and the first network parameter to obtain the second person re-identification network after training and the identity classification network after training.

[00123] In a possible implementation, the apparatus 90 further includes a storage part.

[00124] The storage portion is configured to store the identity classification network after training in the edge server.

[00125] In a possible implementation, the local image data set includes image data corresponding to a plurality of identities; and a dimensionality of the identity classification network is related to a quantity of the plurality of identities.

[00126] In a possible first implementation, the reception part 91 is further configured to receive a shared image data set sent by the cloud server.

[00127] The apparatus 90 further includes a pseudo label generation part.

[00128] The pseudo label generation portion is configured to generate a pseudo label according to the shared image data set and the second person re-identification network after training.

[00129] The sending part 93 is further configured to send the pseudo label to the cloud server.

[00130] In a possible implementation, the apparatus 90 further includes a first determination part, a second determination part and a third determination part.

[00131] The first determination part is configured to determine a first eigenvector according to the second person re-identification network before training and the local image data set, and determine a second eigenvector according to the second person re-identification network after training and the local image data set.

[00132] The second determination part is configured to determine a cosine distance between the first eigenvector and the second eigenvector.

[00133] The third determination part is configured to determine a weight corresponding to the second network parameter according to the cosine distance.

[00134] The sending part 93 is further configured to send the weight corresponding to the second network parameter to the cloud server.

[00135] In a possible implementation, the edge server is an image acquisition device; and the local image data set is obtained from acquisition of the image acquisition device.

[00136] In a possible implementation, the edge server is connected to at least one image acquisition device, the edge server and the at least one image acquisition device are located in the same geographical area; the local image data set is acquired by the edge server from the at least one image acquisition device.

[00137] An embodiment of the disclosure further provides a person re-identification apparatus, including: a person re-identification portion, configured to: perform, by using a target person re-identification network, person re-identification processing on at least one frame of to-be-identified image acquired in a target geographical area, and determine a person re-identification result, where the target person re-identification network is obtained through training by using the foregoing network training method.

[00138] In a possible implementation, the target person re-identification network is an updated first person re-identification network or a trained first person re-identification network.

[00139] In a possible implementation, the target geographical area includes an edge server, and in a case that the edge server includes a second person re-identification network after training, the target person re-identification network is the second person re-identification network after training.

[00140] In some embodiments, the network training/person re-identification apparatus

provided in the embodiments of the disclosure has functions or contain parts that can be configured to perform the methods described in the method embodiments above. For the specific implementation thereof, reference may be made to the description of the method embodiments above and details are not be described herein again for brevity.

[00141] In this and other embodiments of the disclosure, a "part" may be a part of a circuit, a part of a processor, a part of a program or software, or the like, or certainly may be a unit or may be modular or non-modular.

[00142] An embodiment of the disclosure further provides a computer-readable storage medium is provided, storing computer program instructions, where the computer program instructions are executed by a processor to implement the foregoing method. The computer-readable storage medium may be a non-volatile computer-readable storage medium.

[00143] An embodiment of the disclosure further provides an electronic device, including: a processor; and a memory, configured to store instructions executable by the processor, where the processor is configured to invoke the instructions stored in the memory to perform the foregoing method.

[00144] An embodiment of the disclosure further provides a computer program product, including a computer-readable code, where when the computer-readable code is run on a device, a processor in the device executes instructions for implementing the network training/person re-identification method provided in any foregoing embodiment.

[00145] An embodiment of the disclosure further provides another computer program product, configured to store computer-readable instructions, where the instructions, when being executed, cause a computer to perform the operations in the network training/person re-identification method provided in any foregoing embodiment.

[00146] The electronic device may be provided as a terminal, a server or a device in other forms.

[00147] FIG. 10 is a block diagram of an electronic device according to an embodiment of the disclosure. As shown in FIG. 10, an electronic device 800 may be a terminal such as an image acquisition device (for example, an intelligent camera), a mobile phone, a computer, a digital broadcast terminal, a message transceiver device, a game console, a tablet device, medical equipment, fitness equipment, or a PDA.

[00148] Referring to FIG. 10, the electronic device 800 may include one or more of the following components: a processing component 802, a memory 804, a power component 806, a multimedia component 808, an audio component 810, an input/output (I/O) interface 812, a sensor component 814, and a communication component 816.

[00149] The processing component 802 typically controls overall operations of the electronic device 800, such as the operations associated with display, telephone calls, data communications, camera operations, and recording operations. The processing component 802 may include one or more processors 820 to execute instructions to perform all or part of the steps in the above described methods. Moreover, the processing component 802 may include one or more modules which facilitate the interaction between the processing component 802 and other components. For instance, the processing component 802 may include a multimedia module to facilitate the interaction between the multimedia component 808 and the processing component 802.

[00150] The memory 804 is configured to store various types of data to support the operation of the electronic device 800. Examples of such data include instructions for any applications or methods operated on the electronic device 800, contact data, phonebook data, messages, pictures, video, and the like. The memory 804 may be implemented using any type of volatile or non-volatile memory devices, or a combination thereof, such as a Static Random Access Memory (SRAM), an Electrically Erasable Programmable Read-Only Memory (EEPROM), an Erasable Programmable Read-Only Memory (EPROM), a Programmable Read-Only Memory (PROM), a Read-Only Memory (ROM), a magnetic

memory, a flash memory, a magnetic disk or an optical disc.

[00151] The power component 806 provides power to various components of the electronic device 800. The power component 806 may include a power management system, one or more power sources, and any other components associated with the generation, management, and distribution of power in the electronic device 800.

[00152] The multimedia component 808 includes a screen providing an output interface between the electronic device 800 and the user. In some embodiments, the screen may include a Liquid Crystal Display (LCD) and a Touch Panel (TP). If the screen includes the TP, the screen may be implemented as a touch screen to receive input signals from the user. The TP includes one or more touch sensors to sense touches, slips, and gestures on the TP. The touch sensors may not only sense a boundary of a touch or slip action, but also sense a period of time and a pressure associated with the touch or slip action. In some embodiments, the multimedia component 808 includes a front-facing camera and/or a rear-facing camera. The front-facing camera and the rear-facing camera may receive external multimedia data while the electronic device 800 is in an operation mode, such as a photographing mode or a video mode. Each of the front-facing camera and the rear-facing camera may be a fixed optical lens system or have focus and optical zoom capability.

[00153] The audio component 810 is configured to output and/or input audio signals. For example, the audio component 810 includes a microphone ("MIC") configured to receive an external audio signal when the electronic device 800 is in an operation mode, such as a call mode, a recording mode, and a voice recognition mode. The received audio signal may be further stored in the memory 804 or transmitted via the communication component 816. In some embodiments, the audio component 810 further includes a speaker to output audio signals.

[00154] The I/O interface 812 provides an interface between the processing component 802 and peripheral interface modules, such as a keyboard, a click wheel, buttons, and the like. The buttons may include, but are not limited to, a home button, a volume button, a starting button, and a locking button.

[00155] The sensor component 814 includes one or more sensors to provide status assessments of various aspects of the electronic device 800. For instance, the sensor component 814 may detect an open/closed state of the device 800, relative positioning of components, for example, the display and the keypad, of the electronic device 800, a change in position of the electronic device 800 or a component of the electronic device 800, a presence or absence of user contact with the electronic device 800, an orientation or an acceleration/deceleration of the electronic device 800, and a change in temperature of the electronic device 800. The sensor component 814 may include a proximity sensor configured to detect the presence of nearby objects without any physical contact. The sensor component 814 may also include a light sensor, such as a Complementary Metal-Oxide-Semiconductor (CMOS) or a Charge-Coupled Device (CCD) image sensor, for use in imaging applications. In some embodiments, the sensor component 814 may also include an accelerometer sensor, a gyroscope sensor, a magnetic sensor, a pressure sensor, or a temperature sensor.

[00156] The communication component 816 is configured to facilitate wired or wireless communication between the electronic device 800 and other devices. The electronic device 800 can access a wireless network based on a communication standard such as a wireless network (Wi-Fi), the second-generation mobile communication technology (2G), the third-generation mobile communication technology (3G) or a combination thereof. In an exemplary embodiment, the communication component 816 receives a broadcast signal or broadcast associated information from an external broadcast management system via a broadcast channel. In an exemplary embodiment, the communication component 816 further includes a Near Field Communication (NFC) module to facilitate short-range

communications. For example, the NFC module may be implemented based on a Radio Frequency Identification (RFID) technology, an Infrared Data Association (IrDA) technology, an Ultra-Wideband (UWB) technology, a Bluetooth (BT) technology, and other technologies.

[00157] In an exemplary embodiment, the electronic device 800 may be implemented with one or more Application-Specific Integrated Circuits (ASICs), Digital Signal Processors (DSPs), Digital Signal Processing Devices (DSPDs), Programmable Logic Devices (PLDs), Field Programmable Gate Arrays (FPGAs), controllers, micro-controllers, microprocessors, or other electronic components, for performing the foregoing method.

[00158] In an exemplary embodiment, a volatile computer-readable storage medium is further provided, for example, a memory 804 including computer program instructions, and the computer program instructions are executable by the processor 820 of the electronic device 800 to complete the foregoing method.

[00159] FIG. 11 is a block diagram of an electronic device according to an embodiment of the disclosure. As shown in FIG. 11, an electronic device 1900 may be provided as a server. Referring to FIG. 11, the electronic device 1900 includes a processing component 1922, which further includes one or more processors, and memory resources represented by a memory 1932 for storing instructions, such as an application, that may be executed by the processing component 1922. The application stored in memory 1932 may include one or more modules each corresponding to a set of instructions. In addition, the processing component 1922 is configured to execute the instructions to perform the foregoing method.

[00160] The electronic device 1900 may further include a power component 1926 configured to perform power management of the electronic device 1900, a wired or wireless network interface 1950 configured to connect the electronic device 1900 to a network, and an I/O interface 1958. The electronic device 1900 may operate an operating system stored in the memory 1932, for example, a Microsoft server operating system (Windows ServerTM), a graphical user interface-based operating system introduced by Apple (Mac OS XTM), a multi-user multi-process computer operating system (UnixTM), a free and open source Unix-like operating system (LinuxTM), an open source Unix-like operating system (FreeBSDTM) or the like.

[00161] In an exemplary embodiment, a volatile computer-readable storage medium is further provided, for example, a memory 1932 including computer program instructions. The computer program instructions are executable by the processing component 1922 of the electronic device 1900 to complete the foregoing method.

[00162] The embodiments of the disclosure may be a system, a method and/or a computer program product. The computer program product may include a computer-readable storage medium containing computer-readable program instructions for enabling a processor to implement aspects of the embodiments of the disclosure.

[00163] The computer-readable storage medium may be a tangible device that may hold and store instructions used by an instruction execution device. The computer-readable storage medium may be, for example, but not limited to, an electrical storage device, a magnetic storage device, an optical storage device, an electromagnetic storage device, a semiconductor storage device, or any suitable combination of the above. More specific examples of the computer-readable storage medium (a non-exhaustive list) include: a portable computer disk, a hard disk, a Random Access Memory (RAM), a ROM, an EPROM (or a flash memory), a Static Random Memory Reader (SRAM), a portable Compact-Disc Read-Only Memory (CD-ROM), a Digital Versatile Disc (DVD), a memory stick, a floppy disk, a mechanical coding device, such as punched cards or raised structures in a recess with instructions stored thereon, and any suitable combination of the above. The computer-readable storage medium used herein is not to be interpreted as a transient signal per se, such as a radio wave or another freely propagating electromagnetic wave, an

electromagnetic wave propagating through a waveguide or another transmission medium (for example, a light pulse through a fiber optic cable), or an electrical signal transmitted through a wire.

[00164] The computer-readable program instructions described herein may be downloaded from the computer-readable storage medium to individual computing/processing devices or to an external computer or an external storage device via a network such as the Internet, a Local Area Network (LAN), a Wide Area Network (WAN) and/or a wireless network. The network may include a copper transmission cable, fiber optic transmission, wireless transmission, a router, a firewall, a switch, a gateway computer, and/or an edge server. A network adapter or network interface in each computing/processing device receives computer-readable program instructions from the network and forwards the computer-readable program instructions for storage in computer-readable storage media in the respective computing/processing devices.

[00165] The computer program instructions used for performing the operations in the embodiments of the disclosure may be assembly instructions, Instruction Set Architecture (ISA) instructions, machine instructions, machine-related instructions, microcode, firmware instructions, state setting data, or source or object code written in any combination of one or more programming languages, including object-oriented programming languages such as Smalltalk and C++, and conventional procedural programming languages such as "C" or the like. The computer-readable program instructions may be executed entirely on the user's computer, partially on the user's computer, as a stand-alone software package, partially on the user's computer and partially on a remote computer, or entirely on a remote computer or server. In the case of a remote computer, the remote computer may be connected to the user's computer via any type of network, including a LAN or a WAN, or may be connected to an external computer (for example, using an Internet service provider to connect via the Internet). In some embodiments, aspects of the embodiments of the disclosure are implemented by using the state information of computer-readable program instructions to personalize an electronic circuit such as a programmable logic circuit, an FPGA, or a Programmable Logic Array (PLA), which can execute the computer-readable program instructions.

[00166] Aspects of the embodiments of the disclosure are described herein with reference to flowcharts and/or block diagrams of methods, apparatuses (systems), and computer program products according to the embodiments of the disclosure. It should be understood that each box of the flowchart and/or block diagram and the combination of boxes in the flowchart and/or block diagram may be implemented by the computer-readable program instructions.

[00167] These computer-readable program instructions may be provided to a processor of a general-purpose computer, a special purpose computer, or other programmable data processing apparatus, thereby producing a machine such that these instructions, when executed through the processor of the computer or the other programmable data processing apparatus, produce an apparatus that implements the function/action specified in one or more boxes in the flowchart and/or block diagram. It is also possible to store these computer-readable program instructions in a computer-readable storage medium that cause the computer, other programmable data processing apparatus, and/or other device to operate in a particular manner, whereby the computer-readable medium on which the instructions are stored then includes an article of manufacture that includes instructions for implementing aspects of the functions/actions specified in one or more boxes in a flowchart and/or block diagram.

[00168] Computer-readable program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other device such that a series of operational steps are executed on the computer, other programmable data processing

apparatus, or other device to produce a computer-implemented process such that the instructions executed on the computer, the other programmable data processing apparatus, or other device implement the function/action specified in one or more boxes in the flowchart and/or block diagram.

5 [00169] The flowcharts and block diagrams in the accompanying drawings show the possible architectures, functions, and operations of the systems, the methods, and the computer program products according to a plurality of embodiments of the disclosure. In this regard, each block in the flowcharts or block diagrams can represent a part of a module, a program segment or an instruction, and the part of the module, the
10 program segment or the instruction contains one or more executable instructions for implementing the defined logical functions. In some implementations as alternatives, the functions labeled in the blocks can occur in an order different from the order labeled in the accompanying drawings. For example, two consecutive blocks can be substantially executed in parallel in fact, and they sometimes can also be executed in a reverse order, which is
15 defined by the referred functions. It should also be noted that each block in the block diagrams and/or the flowcharts and the combination of the blocks in the block diagrams and/or the flowcharts can be implemented by a dedicated system based on hardware for executing the defined functions or actions, or can be implemented by a combination of the dedicated hardware and computer instructions.

20 [00170] The computer program product may be specifically implemented through hardware, software, or a combination thereof. In an optional embodiment, the computer program product is specifically embodied as a computer storage medium, and in another optional embodiment, the computer program product is specifically embodied as a software product, for example, a Software Development Kit (SDK).

25 [00171] Embodiments of the disclosure have been described above, and the foregoing description is exemplary, not exhaustive, and is not limited to the disclosed embodiments. Without departing from the scope and spirit of the illustrated embodiments, many modifications and changes will be apparent to a person of ordinary skill in the art. The terminology used herein has been selected to best explain the principles, practical
30 applications, or improvements to the technology in the marketplace of each embodiment, or to enable others of ordinary skill in the art to understand the various embodiments disclosed herein.

INDUSTRIAL APPLICABILITY

35 [00172] Embodiments of the disclosure provide a network training method and apparatus, a person re-identification method and apparatus, a storage medium, and a computer program. A cloud server includes a first person re-identification network. The method includes: sending a first network parameter corresponding to the first person re-identification network to a plurality of edge servers; receiving second network parameters
40 returned by the plurality of edge servers, where for any edge server, the edge server includes a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have the same network structure, and the second network parameter is obtained after the edge server trains the second person re-identification network according
45 to the local image data set, the identity classification network and the first network parameter; and updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating. The cloud server and the plurality of edge servers jointly train a person re-identification network. In a training process, the image data set is
50 still stored in the edge servers, and the image data set does not need to be uploaded to the cloud server, so that data privacy can be protected while the person re-identification network

is effectively trained.

CLAIMS

1. A network training method, wherein the method is applied to a cloud server, the cloud server comprises a first person re-identification network, the method comprises:

 sending a first network parameter corresponding to the first person re-identification network to a plurality of edge servers;

 receiving second network parameters returned by the plurality of edge servers, wherein for each edge server of the plurality of edge servers, the each edge server comprises a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have a same network structure, the second network parameter is obtained after the each edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; and

 updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

2. The method according to claim 1, wherein updating the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating comprises:

 receiving weights corresponding to the second network parameters returned by the plurality of edge servers, wherein for the each edge server, the weight corresponding to the second network parameter is determined by the each edge server according to the second person re-identification network before training and the second person re-identification network after training;

 performing, according to the weights corresponding to the second network parameters returned by the plurality of edge servers, weighted averaging on the second network parameters returned by the plurality of edge servers to obtain the first network parameter after updating; and

 updating the first person re-identification network according to the first network parameter after updating to obtain the first person re-identification network after updating.

3. The method according to claim 1 or 2, wherein the method further comprises:

 sending a shared image data set to the plurality of edge servers;

 receiving pseudo labels returned by the plurality of edge servers, wherein for the each edge server, the pseudo label is generated by the each edge server according to the shared image data set and the second person re-identification network after training; and

 training the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training.

4. The method according to claim 3, wherein training the first person re-identification network after updating according to the shared image data set and the pseudo labels returned by the plurality of edge servers to obtain the first person re-identification network after training comprises:

 determining an average pseudo label according to the pseudo labels returned by the

plurality of edge servers; and

training the first person re-identification network after updating according to the shared image data set and the average pseudo label to obtain the first person re-identification network after training.

5. A network training method, wherein the method is applied to an edge server, the edge server comprises a second person re-identification network, an identity classification network and a local image data set, the method comprises:

receiving a first network parameter corresponding to a first person re-identification network sent by a cloud server, wherein the first person re-identification network and the second person re-identification network have a same network structure;

training the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, wherein the second person re-identification network corresponds to a second network parameter; and

sending the second network parameter to the cloud server.

6. The method according to claim 5, wherein training the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training comprises:

training the second person re-identification network and the identity classification network according to the local image data set and the first network parameter to obtain the second person re-identification network after training and the identity classification network after training.

7. The method according to claim 6, wherein the method further comprises:

storing the identity classification network after training in the edge server.

8. The method according to claim 6 or 7, wherein the local image data set comprises image data corresponding to a plurality of identities; and dimensionality of the identity classification network is related to a quantity of the plurality of identities.

9. The method according to any one of claims 5 to 8, wherein the method further comprises:

receiving a shared image data set sent by the cloud server;

generating a pseudo label according to the shared image data set and the second person re-identification network after training; and

sending the pseudo label to the cloud server.

10. The method according to any one of claims 5 to 9, wherein the method further comprises:

determining a first eigenvector according to the second person re-identification network before training and the local image data set, and determining a second eigenvector according to the second person re-identification network after training and the local image data set;

determining a cosine distance between the first eigenvector and the second eigenvector;

determining a weight corresponding to the second network parameter according to the cosine distance; and

sending the weight corresponding to the second network parameter to the cloud server.

11. The method according to any one of claims 5 to 10, wherein the edge server is an image acquisition device; and the local image data set is obtained from acquisition of the image acquisition device.

12. The method according to any one of claims 5 to 10, wherein the edge server is connected to at least one image acquisition device, the edge server and the at least one image acquisition device are located in a same geographical area; the local image data set is acquired by the edge server from the at least one image acquisition device.

13. A person re-identification method, comprising:

performing, by using a target person re-identification network, person re-identification processing on at least one frame of to-be-identified image acquired in a target geographical area to determine a person re-identification result, wherein the target person re-identification network is obtained by training with the network training method according to any one of claims 1 to 12.

14. The method according to claim 13, wherein the target person re-identification network is a first person re-identification network after updating or a first person re-identification network after training.

15. The method according to claim 13, wherein the target geographical area comprises an edge server; and in a case that the edge server comprises a second person re-identification network after training, the target person re-identification network is the second person re-identification network after training.

16. A network training apparatus, wherein the apparatus is applied to a cloud server, the cloud server comprises a first person re-identification network, the apparatus comprises:

a sending part, configured to send a first network parameter corresponding to the first person re-identification network to a plurality of edge servers;

a reception part, configured to receive second network parameters returned by the plurality of edge servers, wherein for each edge server of the plurality of edge servers, the each edge server comprises a second person re-identification network, an identity classification network and a local image data set, the second person re-identification network and the first person re-identification network have a same network structure, the second network parameter is obtained after the each edge server trains the second person re-identification network according to the local image data set, the identity classification network and the first network parameter; and

an updating part, configured to update the first person re-identification network according to the second network parameters returned by the plurality of edge servers to obtain the first person re-identification network after updating.

17. A network training apparatus, wherein the apparatus is applied to an edge server, the edge server comprises a second person re-identification network, an identity classification network and a local image data set, the apparatus comprises:

a reception part, configured to receive a first network parameter corresponding to a first person re-identification network sent by a cloud server, wherein the first person re-identification network and the second person re-identification network have a same network

structure;

a network training part, configured to train the second person re-identification network according to the local image data set, the identity classification network and the first network parameter to obtain the second person re-identification network after training, wherein the second person re-identification network corresponds to a second network parameter; and

a sending part, configured to send the second network parameter to the cloud server.

18. A person re-identification apparatus, comprising:

a person re-identification part, configured to perform, by using a target person re-identification network, person re-identification processing on at least one frame of to-be-identified image acquired in a target geographical area to determine a person re-identification result, wherein the target person re-identification network is obtained by training with the network training method according to any one of claims 1 to 12.

19. An electronic device, comprising:

a processor; and

a memory, configured to store instructions executable by the processor, wherein the processor is configured to invoke the instructions stored in the memory to perform the method according to any one of claims 1 to 15.

20. A computer-readable storage medium, storing computer program instructions thereon, wherein a processor is configured to execute the computer program instructions to implement the method according to any one of claims 1 to 15.

21. A computer program, comprising computer-readable codes, wherein when the computer-readable codes are run on an electronic device, a processor in the electronic device implements the method according to any one of claims 1 to 15.