

METHOD AND APPARATUS FOR IMAGE GENERATION, COMPUTER DEVICE, AND STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION(S)

[1] This application claims priority to and the benefit of Chinese Application Patent Serial No. 201910420187.3, entitled “METHOD FOR TRAINING IMAGE GENERATION MODEL, METHOD AND APPARATUS FOR IMAGE GENERATION, DEVICE, AND STORAGE MEDIUM” and filed on May 20, 2019, the entire disclosure of which is hereby incorporated by reference.

TECHNICAL FIELD

[2] This disclosure relates to the technical field of image processing, and more particularly to a method and apparatus for image generation, a computer device, and a storage medium.

BACKGROUND

[3] At present, different modal images are usually collected with an image collecting device. As an example, magnetic resonance imaging (MRI) generally includes three types of modal images, namely T1-weighted imaging, T2-weighted imaging, and an MRI T2-weighted fluid-attenuated inversion recovery (T2-FLAIR) image. Different modal images contain different kinds of information and are applicable to different scenarios. For example, T1-weighted imaging is used to observe anatomical structures, and T2-weighted imaging is used to observe tissue lesions. However, in order to collect different modal images, it is currently necessary to set corresponding scanning parameters on the image collecting device (such as a magnetic resonance imager) and undergo a long period of scanning or further undergo relevant image processing to obtain different modal images. Therefore, there is a need to improve generation efficiency of different modal images.

SUMMARY

[4] Implementations provide a method and apparatus for image generation, a computer device, and a storage medium, which is conducive to generation efficiency and accuracy rate of modal images.

[5] In a first aspect, a method for image generation is provided. The method includes the following. A target image collected by an image collecting device and a first modal image corresponding to the target image are obtained. The first modal image is inputted into a pre-trained image generation model, where the image generation model includes at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image. An image collection instruction is sent to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction. The collected second modal image is obtained and the generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved.

[6] In a second aspect, an apparatus for image generation is further provided. The apparatus includes an image obtaining unit, an image inputting unit, an instruction sending unit, an obtaining-and-verifying unit, and an image saving unit. The image obtaining unit is configured to obtain a target image collected by an image collecting device and a first modal image corresponding to the target image. The image inputting unit is configured to input the first modal image into a pre-trained image generation model, where the image generation model includes at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image. The instruction sending unit is configured to send an image collection instruction to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction. The obtaining-and-verifying unit is configured to obtain the collected second modal image and verify the generated second modal image according to the collected second modal image. The image saving unit is configured to save the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

[7] In a third aspect, a computer device is further provided. The computer device includes a memory and a processor. The memory is configured to store computer programs. The processor is configured to execute the computer programs to perform the method for image generation described above.

[8] In a fourth aspect, a computer readable storage medium is further provided. The computer readable storage medium is configured to store computer programs which, when executed by a processor, are operable with the processor to perform the method for image generation described above.

[9] Implementations provide a method and apparatus for image generation, a computer device, and a storage medium. The target image and the first modal image corresponding to the target image are obtained. The second modal image is generated according to the first modal image with aid of the image generation model, and the third modal image is generated according to the second modal image. The generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved. If the above method is adopted, it is possible to improve generation efficiency and accuracy rate of various modal images.

BRIEF DESCRIPTION OF THE DRAWINGS

[10] In order to describe technical solutions of implementations more clearly, the following will give a brief introduction to the accompanying drawings used for describing implementations. Apparently, the following accompanying drawings are merely some implementations of the disclosure. Based on these drawings, those of ordinary skill in the art can also obtain other drawings without creative efforts.

[11] FIG. 1 is a schematic diagram illustrating an application scenario of a method for image generation according to implementations.

[12] FIG. 2 is a schematic flowchart of a method for training an image generation model according to implementations.

[13] FIG. 3 is a schematic flowchart of a method for image generation according to implementations.

[14] FIG. 4 is a schematic flowchart of sub-steps of the method in FIG. 3.

[15] FIG. 5 is a schematic flowchart of sub-steps of the method in FIG. 3.

[16] FIG. 6 is a schematic flowchart of a method for image generation according to other implementations.

[17] FIG. 7 is a schematic block diagram of an apparatus for training an image generation model according to implementations.

[18] FIG. 8 is a schematic block diagram of an apparatus for image generation according to implementations.

[19] FIG. 9 is a schematic block diagram of a computer device according to implementations.

DETAILED DESCRIPTION

[20] Technical solutions of implementations will be described clearly and completely with reference to the accompanying drawings in implementations of the disclosure. Apparently, the implementations described herein are merely some implementations, rather than all implementations, of the disclosure. All other implementations obtained based on the implementations described herein by those of ordinary skill in the art without creative efforts shall fall within the protection scope of the disclosure.

[21] The flowchart in the accompanying drawings is for illustrative purpose only, and does not necessarily include all contents and operations/steps, nor does it have to be executed in the described order. For example, some operations/steps can also be broken down, combined, or partially combined, and therefore an actual order of execution may be modified according to actual needs.

[22] Implementations provide a method and apparatus for image generation, a computer device, and a storage medium. The method is applicable to a terminal or a server for cooperating with an image collecting device to generate multiple types of modal images.

[23] The terminal may be an electronic device such as a mobile phone, a tablet PC, a notebook computer, a desktop computer, a personal digital assistant (PDA), a wearable device, etc. The server may be a separate server, or may be a server cluster.

[24] The following will describe in detail implementations with reference to the accompanying drawings. The implementations hereinafter described and features therein can be combined with each other without conflict.

[25] FIG. 1 is a schematic diagram illustrating an application scenario of a method for image generation according to implementations. As illustrated in FIG. 1, in the application scenario, a server and an image collecting device are included. The server may also be a terminal. The image collecting device is a camera device that can collect multiple types of modal images. The image collecting device may be, for example, a magnetic resonance imager, a computed tomography (CT) scanner, a transmission electron microscope, a camera device, or the like.

[26] The server executes the method for image generation and interacts with the image collecting device, to generate quickly and accurately multiple types of modal images. This can shorten user's wait time and thus improve user experience. On the other hand, usage of

the image collecting device can be reduced, which is possible to prolong a service life of the image collecting device.

[27] In the following, the magnetic resonance imager is adopted as the image collecting device. In addition, other image collecting devices shall also fall within the protection scope of the disclosure as long as they can generate multiple types of modal images or images similar to multi-modal images. As an example, the transmission electron microscope can obtain images from various scanning angles (that is, different modal images) by scanning at various preset scanning angles. Therefore, the transmission electron microscope can also be applied to the method for image generation.

[28] FIG. 2 is a schematic flowchart of a method for training an image generation model according to implementations. As illustrated in FIG. 2, the method includes operations at blocks S101 to S103.

[29] At block S101, an image dataset is obtained, where the image dataset includes multiple target images and a first modal image, a second modal image, and a third modal image corresponding to each of the multiple target images.

[30] The image dataset is a sample dataset. The sample dataset includes multiple target images, where each of the multiple target images corresponds to at least the first modal image, the second modal image, and the third modal image. The sample dataset is used for model training.

[31] As an example, the image dataset is an MRI image dataset. The MRI image dataset includes multiple MRI images, where each of the multiple MRI images corresponds to multiple modal images, that is, the first modal image, the second modal image, and the third modal image. The first modal image corresponds to T1-weighted imaging, the second modal image corresponds to T2-weighted imaging, and the third modal image corresponds to a T2-FLAIR image, where the T2-FLAIR image is an MRI fluid-attenuated inversion recovery image. Different modal images contain different kinds of image information and have different functions. For example, the T1-weighted imaging is mainly used to observe anatomical structures. The T2-weighted imaging is mainly used to observe lesions. In the T2-FLAIR image, tissue inhibition technology is adopted to remove tissues that are rich in moisture, such that lesions can be more prominent.

[32] At block S102, a preset generative adversarial network (GAN) is extracted.

[33] The preset GAN includes at least a first generator, a first discriminator, a second generator, and a second discriminator. The first generator is used for generating a second modal image according to the first modal image. The first discriminator is used for

determining whether the generated second modal image or the second modal image in the image dataset is inputted. The second generator is used for generating a third modal image according to the generated second modal image. The second discriminator is used for determining whether the generated third modal image or the third modal image in the image dataset is inputted.

[34] The GAN includes two networks, where one of the two networks serves as a generator and the other serves as a discriminator. The two networks are trained simultaneously and contest with each other based on a minimax algorithm. The generator during training is used to fool the discriminator to generate an authentic image (that is, an image that is generated to be exactly the same as the original), and the discriminator gradually learns not to be deceived by the generator during training.

[35] The GAN is different from a traditional probabilistic generation model in that the GAN avoids a learning mechanism of a Markov chain. While the traditional probabilistic generative model usually requires Markov chain sampling and inference, the GAN avoids such a computationally complex process and directly performs sampling and inference instead, which can improve efficiency and therefore can be widely used in various scenarios.

[36] The GAN performs, through a neural network, inverse transform sampling of a probability distribution on a random variable that obeys a Gaussian distribution or a uniform distribution from 0 to 1, to obtain a generated probability distribution. The GAN as well as a common probability generator is trained such that the generated probability distribution is as close to a probability distribution of real data as possible, so as to mimic real data. However, in practice, it is impossible to accurately know a distribution of real data, and the only way is to obtain as many samples as possible from the real world and use a distribution of samples to represent the distribution of real data. Through continuous training of a network, parameters of the network can be constantly optimized, such that the generated probability distribution is as close to the probability distribution of real data as possible.

[37] For a loss function during training, a traditional generator usually optimizes likelihood of data. However, the GAN adopts a completely different method, in which a discriminator that is also composed of a neural network is introduced. During training, a generator continuously generates new data, and the discriminator constantly determines whether the generated data resembles the real data. The two networks are simultaneously optimized and finally balanced at a Nash equilibrium point. Therefore, the generator is intended to learn as much as possible the probability distribution of real data, and the discriminator is intended to determine whether input data obtained by itself comes from real

data or output data from the generator. The two networks are constantly optimized in the adversarial training. When the performance of the discriminator is adequate (that is, good enough), if data generated by the generator can still cause the discriminator to confusion, the generator can be considered to be optimal.

[38] The GAN provided herein includes at least two generators and two discriminators, that is, the first generator, the second generator, the first discriminator, and the second discriminator. The first generator is used to generate the second modal image. The second generator is used to generate the third modal image.

[39] It should be noted that, according to implementations, a network structure of the GAN has been modified, in which a dropout mechanism is introduced to replace general noise, thereby increasing model training speed and improving model generation efficiency.

[40] At block S103, adversarial training is performed on the GAN according to the multiple target images and the first modal image, the second modal image, and the third modal image corresponding to each of the multiple target images, and the trained GAN is saved as the image generation model.

[41] The first modal image corresponding to each of the multiple target images in the image dataset is taken as an input of the first generator, an image outputted by the first generator and the second modal image in the image dataset are taken as an input of the first discriminator, the image outputted by the first generator is taken as an input of the second generator, and an image outputted by the second generator and the third modal image in the image dataset are taken as an input of the second discriminator, so as to perform adversarial training. Adversarial training is performed in a chained manner until the first discriminator is unable to determine whether the image outputted by the first generator or the second modal image in the image dataset is inputted and the second discriminator is unable to determine whether the image outputted by the second generator or the third modal image in the image dataset is inputted. Then the trained first generator and the trained second generator are saved.

[42] In some examples, the GAN can further include a third generator and a third discriminator. The target image can be taken as an input of the third generator, and an image outputted by the third generator and the first modal image in the image dataset can be taken as an input of the third discriminator, until the third discriminator is unable to determine whether the image outputted by the third generator or the first modal image in the image dataset is inputted. Then the trained first generator and the trained second generator can be saved.

[43] FIG. 3 is a schematic flowchart of a method for image generation according to

implementations. As illustrated in FIG. 3, the method includes operations at blocks S201 to S205.

[44] At block S201, a target image collected by an image collecting device and a first modal image corresponding to the target image are obtained.

[45] The target image collected by the image collecting device is obtained, and the first modal image corresponding to the target image is obtained. The first modal image is a modal image that contains various kinds of information and is collected according to different collection parameters. The first modal image may be, for example, one of T1-weighted imaging, T2-weighted imaging, and a T2-FLAIR image.

[46] The target image collected by the image collecting device can be obtained as follows. The target image is received from the image collecting device, where the target image is an image of the target object collected by the image collecting device, and the target object may be, for example, a person, an animal, a tissue, scenery, or the like.

[47] In some examples, the target image collected by the image collecting device can be obtained as follows. The target image collected by the image collecting device within a preset time period is obtained. For example, the image collecting device begins to collect the image of the target object (that is, the target image). In this situation, the preset time period starts from when the image collecting device begins to collect the target image. The preset time period refers to a time period from when the image collecting device begins to collect the target image to when the image collecting device completes collecting the target image, and the preset time period does not include a time period in which other modal images are collected. As such, it is possible to shorten a collection time of the image collecting device and on the other hand, reduce loss of the image collecting device.

[48] In some implementations, in order to obtain quickly and accurately the first modal image corresponding to the target image, thereby improving generation efficiency of modal images, the first modal image corresponding to the target image can be obtained as follows. The target image is inputted into a pre-trained image generation model to generate the first modal image corresponding to the target image.

[49] For example, the target image is inputted into a third generator of the pre-trained image generation model to generate the first modal image corresponding to the target image.

[50] In some implementations, in order to obtain quickly and accurately the first modal image corresponding to the target image, thereby improving generation efficiency of modal images, a manner of obtaining a modal image is further provided. As illustrated in FIG. 4, the first modal image corresponding to the target image can be obtained as follows.

[51] At block S201a, an object type of the target object in the target image is obtained and a collection parameter of the object type is determined, where different object types correspond to different collection parameters.

[52] At block S201b, the collection parameter is sent to the image collecting device, such that the image collecting device collects the first modal image corresponding to the target image according to the collection parameter.

[53] At block S201c, the first modal image is received from the image collecting device.

[54] The object type of the target object may be, for example, a person, an animal, a tissue, or scenery. As an example, in MRI, the object type can be a person or an animal. The object type can also be subdivided. For example, in terms of a person, the object type can be subdivided into different body parts such as head, arm, hand, leg, foot, etc. Different object types correspond to different collection parameters. The collection parameter may include, for example, a collection time, a scanning frequency, a scanning speed, and the like. The object type of the target object in the target image is obtained through image recognition of the target object and the collection parameter of the obtained object type is determined. The collection parameter is sent to the image collecting device. The image collecting device collects the first modal image corresponding to the target image according to the collection parameter and sends the collected first modal image to a server. The server receives the first modal image from the image collecting device.

[55] At block S202, the first modal image is inputted into the pre-trained image generation model.

[56] The pre-trained image generation model adopts an image generation model that has been trained in the above method for training an image generation model. The image generation model includes at least a first generator and a second generator. The first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator of the image generation model. The second generator generates a third modal image according to the generated second modal image.

[57] At block S203, an image collection instruction is sent to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction.

[58] The server sends the image collection instruction to the image collecting device (such as a magnetic resonance imager). The image collection instruction is used for instructing the image collecting device to collect the second modal image. Upon receiving the

image collection instruction, the image collecting device collects the second modal image according to the image collection instruction and sends the collected second modal image to the server.

[59] At block S204, the collected second modal image is obtained and the generated second modal image is verified according to the collected second modal image.

[60] The server receives the second modal image collected by the image collecting device and verifies the generated second modal image according to the collected second modal image. The generated second modal image can be verified as follows. A degree of similarity between the generated second modal image and the collected second modal image is calculated. The generated second modal image is verified according to the degree of similarity. If the degree of similarity is greater than 90%, the verification succeeds.

[61] In some implementations, a manner of verifying a modal image is further provided. As illustrated in FIG. 5, the generated second modal image can be verified according to the collected second modal image as follows.

[62] At block S204a, a modal parameter of the collected second modal image and a modal parameter of the generated second modal image are extracted.

[63] At block S204b, the verification is determined to succeed when the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image.

[64] The modal parameter refers to parameter information of a modal image, such as transverse relaxation time or longitudinal relaxation time. Matching of modal parameters includes determining whether the modal parameter of one modal image is the same as or close to that of the other modal image. For example, the two modal images have the same transverse relaxation time or a difference therebetween in terms of transverse relaxation time is less than 0.01s (second). If the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image, the verification is determined to succeed. In this way, verification efficiency of modal images can be improved, thereby improving generation efficiency of modal images.

[65] In some implementations, the generated second modal image can be verified according to the collected second modal image as follows. The collected second modal image is inputted into the image generation model, such that a discriminator of the image generation model verifies the generated second modal image according to the collected second modal image and outputs a result of successful verification when the discriminator is unable to determine whether the collected second modal image or the generated second modal image is

inputted.

[66] At block S205, when the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved.

[67] The generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, and the generated second modal image and the generated third modal image that are obtained based on the image generation model are saved. As such, various modal images corresponding to the target image can be obtained, thereby improving generation efficiency of modal images and accuracy rate of modal images.

[68] According to the above method for image generation, the target image and the first modal image corresponding to the target image are obtained. The second modal image is generated according to the first modal image with aid of the image generation model, and the third modal image is generated according to the second modal image. The generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved. If the above method is adopted, it is possible to improve generation efficiency and accuracy rate of various modal images.

[69] FIG. 6 is a schematic flowchart of a method for image generation according to other implementations. As illustrated in FIG. 6, the method includes operations at blocks S301 to S307.

[70] At block S301, a target image collected by an image collecting device and a first modal image corresponding to the target image are obtained.

[71] The target image collected by the image collecting device is obtained, and the first modal image corresponding to the target image is obtained. The first modal image is a modal image that contains various kinds of information and is collected according to different collection parameters, for example, T1-weighted imaging.

[72] At block S302, the first modal image is inputted into a pre-trained image generation model.

[73] A first generator of the image generation model generates a second modal image according to the first modal image and inputs the generated second modal image into a second generator of the image generation model. The second generator generates a third modal image according to the generated second modal image.

[74] At block S303, an image collection instruction is sent to the image collecting device, such that the image collecting device collects a second modal image according to the

image collection instruction.

[75] A server sends the image collection instruction to the image collecting device. The image collection instruction is used for instructing the image collecting device to collect the second modal image. Upon receiving the image collection instruction, the image collecting device collects the second modal image according to the image collection instruction and sends the collected second modal image to the server.

[76] At block S304, the collected second modal image is obtained and the generated second modal image is verified according to the collected second modal image.

[77] The server receives the second modal image collected by the image collecting device and verifies, according to the collected second modal image, the second modal image generated by the image generation model. By verifying the second modal image (that is, verifying the generated second modal image according to the collected second modal image), it is possible to ensure accuracy of the first modal image and the third modal image at the same time, thereby improving accuracy of modal images.

[78] At block S305, when the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved.

[79] The generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, and the generated second modal image and the generated third modal image that are obtained based on the image generation model are saved.

[80] At block S306, when the verification fails, the collected second modal image is inputted into the second generator, such that the second generator generates a third modal image according to the collected second modal image.

[81] The generated second modal image is verified according to the collected second modal image. When the verification fails, the collected second modal image is inputted into the second generator, such that the second generator generates the third modal image according to the collected second modal image.

[82] At block S307, the first modal image, the collected second modal image, and the generated third modal image are saved.

[83] The first modal image, the second modal image collected by the image collecting device, and the third modal image, which is generated by the image generation model according to the collected second modal image, are saved. As such, various modal images corresponding to the target image can be obtained, thereby improving generation efficiency of modal images and accuracy rate of multiple types of modal images.

[84] According to the above method for image generation, the target image and the first modal image corresponding to the target image are obtained. The second modal image is generated according to the first modal image with aid of the image generation model, and the third modal image is generated according to the second modal image. The generated second modal image is verified according to the collected second modal image. When the verification succeeds, the first modal image, the generated second modal image, and the generated third modal image are saved. If the above method is adopted, it is possible to improve generation efficiency and accuracy rate of various modal images.

[85] FIG. 7 is a schematic block diagram of an apparatus for training an image generation model according to implementations. The apparatus for training an image generation model is configured to perform the above method for training an image generation model. The apparatus for training an image generation model can be configured on a server.

[86] As illustrated in FIG. 7, the apparatus for training an image generation model 400 includes a dataset obtaining unit 401, a network extracting 402, and a training-and-saving unit 403.

[87] The dataset obtaining unit 401 is configured to obtain an image dataset, where the image dataset includes multiple target images and a first modal image, a second modal image, and a third modal image corresponding to each of the multiple target images. The network extracting unit 402 is configured to extract a preset GAN, where the GAN includes at least a first generator, a first discriminator, a second generator, and a second discriminator, the first generator is used for generating a second modal image according to the first modal image, the first discriminator is used for determining whether the generated second modal image or the second modal image in the image dataset is inputted, the second generator is used for generating a third modal image according to the generated second modal image, and the second discriminator is used for determining whether the generated third modal image or the third modal image in the image dataset is inputted. The training-and-saving unit 403 is configured to perform adversarial training on the GAN according to the multiple target images and the first modal image, the second modal image, and the third modal image corresponding to each of the multiple target images, and save the trained GAN as the image generation model.

[88] FIG. 8 is a schematic block diagram of an apparatus for image generation according to implementations. The apparatus for image generation is configured to perform the above method for image generation. The apparatus for image generation can be configured on a server or a terminal.

[89] As illustrated in FIG. 8, the apparatus for image generation 500 includes an image obtaining unit 501, an image inputting unit 502, an instruction sending unit 503, an obtaining-and-verifying unit 504, an image saving unit 505, an image generating unit 506, and a collecting-and-saving unit 507.

[90] The image obtaining unit 501 is configured to obtain a target image collected by an image collecting device and a first modal image corresponding to the target image.

[91] In some examples, the image obtaining unit 501 is configured to input the target image into a pre-trained image generation model to generate the first modal image corresponding to the target image.

[92] In some examples, the image obtaining unit 501 includes a type obtaining sub-unit 5011, a parameter sending sub-unit 5012, and an image receiving sub-unit 5033. The type obtaining sub-unit 5011 is configured to obtain an object type of a target object in the target image and determine a collection parameter of the object type, where different object types correspond to different collection parameters. The parameter sending sub-unit 5012 is configured to send the collection parameter to the image collecting device, such that the image collecting device collects the first modal image corresponding to the target image according to the collection parameter. The image receiving sub-unit 5033 is configured to receive the first modal image from the image collecting device.

[93] The image inputting unit 502 is configured to input the first modal image into the pre-trained image generation model.

[94] The image generation model includes at least a first generator and a second generator. The first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator. The second generator generates a third modal image according to the generated second modal image.

[95] The instruction sending unit 503 is configured to send an image collection instruction to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction.

[96] The obtaining-and-verifying unit 504 is configured to obtain the collected second modal image and verify the generated second modal image according to the collected second modal image.

[97] In some examples, the obtaining-and-verifying unit 504 includes a parameter extracting sub-unit 5041 and a matching-and-verifying sub-unit 5042. The parameter extracting sub-unit 5041 is configured to extract a modal parameter of the collected second modal image and a modal parameter of the generated second modal image. The matching-

and-verifying sub-unit 5042 is configured to determine that the verification succeeds when the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image.

[98] In some examples, the obtaining-and-verifying unit 504 is configured to input the collected second modal image into the image generation model, such that a discriminator of the image generation model verifies the generated second modal image according to the collected second modal image and outputs a result of successful verification when the discriminator is unable to determine whether the collected second modal image or the generated second modal image is inputted.

[99] The image saving unit 505 is configured to save the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

[100] The image generating unit 506 is configured to input the collected second modal image into the second generator when the verification fails, such that the second generator generates a third modal image according to the collected second modal image.

[101] The collecting-and-saving unit 507 is configured to save the first modal image, the collected second modal image, and the generated third modal image.

[102] It should be noted that, those skilled in the art can understand clearly that for the sake of convenience and simplicity of description, for details of the working process of each of the above apparatuses or units, reference can be made to the related part in the foregoing method implementations, which will not be repeated herein.

[103] The apparatus for image generation or the apparatus for training an image generation model described above can be implemented in the form of computer programs. The computer programs can be run on a computer device illustrated in FIG. 9.

[104] FIG. 9 is a schematic block diagram of a computer device according to implementations. The computer device can be a terminal.

[105] As illustrated in FIG. 9, the computer device includes a processor, a memory, and a network interface that are connected via a system bus. The memory can include a non-volatile storage medium and an internal memory.

[106] The non-volatile storage medium can be configured to store an operating system and computer programs. The computer programs include program instructions which, when executed, are operable with the processor to perform the method for image generation described in any one of the foregoing implementations or to perform the method for training an image generation model.

[107] The processor is configured to provide computing and control capabilities and supports running of the entire computer device.

[108] The internal memory provides an environment for running of the computer programs in the non-volatile storage medium. The computer programs, when executed by the processor, are operable with the processor to perform the method for image generation described in any one of the foregoing implementations or to perform the method for training an image generation model.

[109] The network interface is configured for network communication, for example, sending assigned tasks. It can be understood by those skilled in the art that, the structure illustrated in FIG. 9 is merely a block diagram of a partial structure related to the solution of implementations and does not constitute any limitation to the computer device to which the solution of implementations is applied. The computer device may include more components or fewer components than illustrated, or some components may be combined, or a different component arrangement may be adopted.

[110] The processor may be a central processing unit (CPU). The processor may also be a general-purpose processor, a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), or other programmable logic devices, discrete gates or transistor logic devices, discrete hardware components. The general purpose processor may be a microprocessor, or the processor may be any conventional processor or the like.

[111] Implementations further provide a computer readable storage medium. The computer readable storage medium is configured to store computer programs. The computer programs include program instructions which, when executed by a processor, are operable with the processor to perform the method for image generation described in any one of the foregoing implementations or to perform the method for training an image generation model.

[112] The computer readable storage medium may be an internal storage unit of the computer device described in the foregoing implementation, such as a hard disk or memory of the computer device. The computer readable storage medium may also be an external storage device of the computer device, such as a plug-in hard disk, a smart media card (SMC), a secure digital (SD) card, a flash card, or the like equipped on the computer device.

[113] While the disclosure has been described in connection with certain embodiments, it is to be understood that the disclosure is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the scope of the appended claims, which scope is to be accorded the broadest

interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

What is claimed is:

1. A method for image generation, comprising:

obtaining a target image collected by an image collecting device and a first modal image corresponding to the target image;

inputting the first modal image into a pre-trained image generation model, wherein the image generation model comprises at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image;

sending an image collection instruction to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction;

obtaining the collected second modal image and verifying the generated second modal image according to the collected second modal image; and

saving the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

2. The method of claim 1, further comprising:

obtaining an image dataset, wherein the image dataset comprises a plurality of target images and a first modal image, a second modal image, and a third modal image corresponding to each of the plurality of target images;

extracting a preset generative adversarial network (GAN), wherein the GAN comprises at least a first generator, a first discriminator, a second generator, and a second discriminator, the first generator is used for generating a second modal image according to the first modal image, the first discriminator is used for determining whether the generated second modal image or the second modal image in the image dataset is inputted, the second generator is used for generating a third modal image according to the generated second modal image, and the second discriminator is used for determining whether the generated third modal image or the third modal image in the image dataset is inputted; and

performing adversarial training on the GAN according to the plurality of target images and the first modal image, the second modal image, and the third modal image corresponding to each of the plurality of target images, and saving the trained GAN as the image generation model.

3. The method of claim 1, wherein obtaining the first modal image corresponding to the target image comprises:

inputting the target image into the pre-trained image generation model to generate the first modal image corresponding to the target image.

4. The method of claim 1, wherein the target image contains a target object, and obtaining the first modal image corresponding to the target image comprises:

obtaining an object type of the target object in the target image and determining a collection parameter of the object type, wherein different object types correspond to different collection parameters;

sending the collection parameter to the image collecting device, such that the image collecting device collects the first modal image corresponding to the target image according to the collection parameter; and

receiving the first modal image from the image collecting device.

5. The method of claim 1, wherein verifying the generated second modal image according to the collected second modal image comprises:

extracting a modal parameter of the collected second modal image and a modal parameter of the generated second modal image; and

determining that the verification succeeds when the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image.

6. The method of claim 1, wherein verifying the generated second modal image according to the collected second modal image comprises:

inputting the collected second modal image into the image generation model, such that a discriminator of the image generation model outputs a result of successful verification when the discriminator is unable to determine whether the collected second modal image or the generated second modal image is inputted.

7. The method of any of claims 1 to 6, further comprising:

after inputting the collected second modal image into the image generation model,

inputting the collected second modal image into the second generator when the verification fails, such that the second generator generates a third modal image

according to the collected second modal image; and

saving the first modal image, the collected second modal image, and the generated third modal image.

8. An apparatus for image generation, comprising:

an image obtaining unit configured to obtain a target image collected by an image collecting device and a first modal image corresponding to the target image;

an image inputting unit configured to input the first modal image into a pre-trained image generation model, wherein the image generation model comprises at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image;

an instruction sending unit configured to send an image collection instruction to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction;

an obtaining-and-verifying unit configured to obtain the collected second modal image and verify the generated second modal image according to the collected second modal image; and

an image saving unit configured to save the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

9. A computer device, comprising

a memory configured to store computer programs; and

a processor configured to execute the computer programs to:

obtain a target image collected by an image collecting device and a first modal image corresponding to the target image;

input the first modal image into a pre-trained image generation model, wherein the image generation model comprises at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image;

send an image collection instruction to the image collecting device, such that

the image collecting device collects a second modal image according to the image collection instruction;

obtain the collected second modal image and verify the generated second modal image according to the collected second modal image; and

save the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

10. The computer device of claim 9, wherein in terms of obtaining the first modal image corresponding to the target image, the processor is configured to execute the computer programs to:

input the target image into the pre-trained image generation model to generate the first modal image corresponding to the target image.

11. The computer device of claim 9, wherein the target image comprises a target object, and in terms of obtaining the first modal image corresponding to the target image, the processor is configured to execute the computer programs to:

obtain an object type of the target object in the target image and determine a collection parameter of the object type, wherein different object types correspond to different collection parameters;

send the collection parameter to the image collecting device, such that the image collecting device collects the first modal image corresponding to the target image according to the collection parameter; and

receive the first modal image from the image collecting device.

12. The computer device of claim 9, wherein in terms of verifying the generated second modal image according to the collected second modal image, the processor is configured to execute the computer programs to:

extract a modal parameter of the collected second modal image and a modal parameter of the generated second modal image; and

determine that the verification succeeds when the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image.

13. The computer device of claim 9, wherein in terms of verifying the generated second modal image according to the collected second modal image, the processor is configured to

execute the computer programs to:

input the collected second modal image into the image generation model, such that a discriminator of the image generation model outputs a result of successful verification when the discriminator is unable to determine whether the collected second modal image or the generated second modal image is inputted.

14. The computer device of any of claims 9 to 13, wherein the processor is further configured to execute the computer programs to:

after inputting the collected second modal image into the image generation model,
input the collected second modal image into the second generator when the verification fails, such that the second generator generates a third modal image according to the collected second modal image; and
save the first modal image, the collected second modal image, and the generated third modal image.

15. A computer readable storage medium configured to store computer programs which, when executed by a processor, are operable with the processor to:

obtain a target image collected by an image collecting device and a first modal image corresponding to the target image;
input the first modal image into a pre-trained image generation model, wherein the image generation model comprises at least a first generator and a second generator, the first generator generates a second modal image according to the first modal image and inputs the generated second modal image into the second generator, and the second generator generates a third modal image according to the generated second modal image;
send an image collection instruction to the image collecting device, such that the image collecting device collects a second modal image according to the image collection instruction;
obtain the collected second modal image and verify the generated second modal image according to the collected second modal image; and
save the first modal image, the generated second modal image, and the generated third modal image, when the verification succeeds.

16. The computer readable storage medium of claim 15, wherein in terms of obtaining the

first modal image corresponding to the target image, the computer programs are operable with the processor to:

input the target image into the pre-trained image generation model to generate the first modal image corresponding to the target image.

17. The computer readable storage medium of claim 15, wherein the target image comprises a target object, and in terms of obtaining the first modal image corresponding to the target image, the computer programs are operable with the processor to:

obtain an object type of the target object in the target image and determine a collection parameter of the object type, wherein different object types correspond to different collection parameters;

send the collection parameter to the image collecting device, such that the image collecting device collects the first modal image corresponding to the target image according to the collection parameter; and

receive the first modal image from the image collecting device.

18. The computer readable storage medium of claim 15, wherein in terms of verifying the generated second modal image according to the collected second modal image, the computer programs are operable with the processor to:

extract a modal parameter of the collected second modal image and a modal parameter of the generated second modal image; and

determine that the verification succeeds when the modal parameter of the collected second modal image matches the modal parameter of the generated second modal image.

19. The computer readable storage medium of claim 15, wherein in terms of verifying the generated second modal image according to the collected second modal image, the computer programs are operable with the processor to:

input the collected second modal image into the image generation model, such that a discriminator of the image generation model outputs a result of successful verification when the discriminator is unable to determine whether the collected second modal image or the generated second modal image is inputted.

20. The computer readable storage medium of any of claims 15 to 19, wherein the computer programs are further operable with the processor to:

after inputting the collected second modal image into the image generation model,
input the collected second modal image into the second generator when the
verification fails, such that the second generator generates a third modal image
according to the collected second modal image; and
save the first modal image, the collected second modal image, and the generated third modal
image.