

DEMENTIA PATIENT TRACKING APPARATUS AND METHOD

【Technical Field】

[1] The present disclosure relates to an apparatus and method for classifying and tracking dementia patients.

【Background Art】

[2] Dementia is a syndrome in which there are deterioration in behavioral functions including memory due to various causes and it is difficult to maintain daily life. In particular, the "roaming" symptom of dementia patients is one of the biggest concerns in nursing. People with dementia not only roam around the house, but also go out and sometimes get lost. In a case where a person with dementia gets lost, if the person is not found early, the person may be at risk due to traffic accidents, malnutrition, and deterioration of health, and thus, it is necessary to be prepared for every possible accident or case.

【Disclosure】

【Technical Problem】

[3] The present disclosure provides a tracking apparatus and method that analyzes the presence or absence of dementia by analyzing the gait of a person using CCTV and track the location of a dementia patient by applying a re-recognition technology.

【Technical Solution】

[4] In an aspect, there is provided a tracking apparatus, and the tracking apparatus includes: an acquiring unit configured to acquire a moving picture in which a pedestrian is photographed; and a tracking unit configured to determine whether the pedestrian is a dementia patient, or track a specific pedestrian through analysis of the moving picture.

[5] In another aspect, there is provided a tracking method performed by a tracking apparatus, and the method includes: acquiring a moving picture in which a set area is

photographed; extracting a pedestrian included in the moving picture; forming skeleton of the pedestrian; measuring a stride length and a walking speed of the pedestrian through analysis of the skeleton; generating a spectrogram image including the stride length and the walking speed; and analyzing the spectrogram image using a discriminant model generated through a deep learning algorithm, and determining whether the pedestrian is with dementia.

[6] In yet another aspect, there is provided a tracking method performed by a tracking apparatus, and the method includes: acquiring a moving picture in which a set area is photographed; extracting an object image representing a pedestrian included in the moving picture; extracting a walking characteristic including a stride length and a walking speed of the pedestrian through analysis of the object image; generating a spectrogram image including the stride length and the walking speed; determining whether the pedestrian coincides with a specified pedestrian using the object image, the walking characteristic, and the spectrogram image; and displaying on a map a movement path of a candidate object corresponding to a pedestrian determined to coincide with the specific pedestrian.

【Advantageous Effects】

[7] The tracking apparatus of the present disclosure may determine whether a pedestrian is with dementia through analysis of a moving picture captured by a camera.

[8] In particular, the tracking apparatus of the present disclosure may determine whether the pedestrian is a dementia patient using a walking characteristic of the pedestrian included in the moving picture.

[9] In addition, the tracking apparatus of the present disclosure may provide a method for continuously tracking a dementia patient using a plurality of cameras installed at different places.

[10] The tracking apparatus of the present disclosure may communicate with the plurality of cameras, and may analyze moving pictures respectively received from the plurality of

cameras. The tracking apparatus can classify or specify a dementia patient through the analysis of the moving pictures. In addition, when the specific pedestrian is determined to be a dementia patient through analysis of a moving picture captured by a specific camera, the tracking apparatus may store a walking characteristic or a spectrogram of the specific pedestrian. The tracking apparatus can recognize a specific pedestrian identified as a dementia patient from a moving picture of another camera by comparing the walking characteristic or spectrogram of the pedestrian captured by another camera with a pre-stored one. When re-recognition of the specific pedestrian is completed in a different camera, the tracking apparatus may estimate or track a moving line of the specific pedestrian by taking into consideration location information of each camera, photographing time information, and a moving direction of the specific pedestrian in the moving picture.

[11] According to the tracking apparatus and the tracking method of the present disclosure, it is possible to early detect a dementia patient and automatically estimate the location of the dementia patient and at the same time. In doing this, the safety of dementia patients with roaming symptom can be secured.

【Description of Drawings】

[12] FIG. 1 is a schematic diagram illustrating a tracking apparatus of the present disclosure.

[13] FIG. 2 is a block diagram illustrating a tracking unit.

[14] FIG. 3 is a schematic diagram illustrating a first operation of the tracking unit.

[15] FIG. 4 is a schematic diagram illustrating a second operation of the tracking unit.

[16] FIG. 5 is a schematic diagram illustrating a tracking operation of a tracking unit.

[17] FIG. 6 is a flowchart illustrating a tracking method according to the present disclosure.

[18] FIG. 7 is a flowchart illustrating another tracking method of the present disclosure.

[19] FIG. 8 is a flowchart illustrating operations of a detector, a calculator, and a converter.

[20] FIG. 9 is a schematic diagram illustrating an operation of a detector.

- [21] FIG. 10 is a flowchart illustrating an operation of the determiner.
- [22] FIG. 11 is a schematic diagram illustrating an operation of the determiner.
- [23] FIG. 12 is a schematic diagram illustrating an operation of a tracker.
- [24] FIG. 13 is a schematic diagram illustrating another operation of the tracker.
- [25] FIG. 14 is a diagram illustrating a computing device according to an embodiment of the present disclosure.

【Mode for Disclosure】

[26] Embodiments of the present disclosure are described in detail herein with reference to the accompanying drawings so that this disclosure may be easily performed by one of ordinary skill in the art to which the present disclosure pertains. The present disclosure may, however, be embodied in many different forms and should not be construed as being limited to the embodiments set forth herein. In the drawings, parts irrelevant to the description are omitted for simplicity of explanation, and like numbers refer to like elements throughout.

[27] In the present specification, redundant description of the same constituent elements is omitted.

[28] Also, in the present specification, it is to be understood that when one component is referred to as being "connected" or "coupled" to another component, it may be connected or coupled directly to another component or be connected or coupled to another component with the other component intervening therebetween. On the other hand, in the present specification, it is to be understood that when one component is referred to as being "connected or coupled directly" to another component, it may be connected or coupled to another component without the other component intervening therebetween.

[29] It is also to be understood that the terminology used herein is only for the purpose of describing particular embodiments, and is not intended to be limiting of the present invention.

[30] In addition, in the present disclosure, singular forms are to include plural forms unless the context clearly indicates otherwise.

[31] In addition, it will be further understood that terms “comprises” or “have” used in the present specification specify the presence of stated features, numerals, steps, operations, components, parts, or a combination thereof, but do not preclude the presence or addition of one or more other features, numerals, steps, operations, components, parts, or a combination thereof.

[32] Also, as used herein, the term “and/or” includes any plurality of combinations of items or any of a plurality of listed items. In the present specification, ‘A or B’ may include ‘A’, ‘B’, or ‘A and B’.

[33] Also, in this specification, a detailed description of known functions and configurations will be omitted if it obscures the subject matter of the present disclosure.

[34] A tracking apparatus of the present disclosure may analyzes the gait of a pedestrian 90 using various cameras 10 such as a CCTV camera, a camera installed in a mobile communication terminal, and a portable camera to determine the presence or absence of dementia and may track a movement path of the pedestrian 90. Since dementia is accompanied by gait disorder due to neurological damage, the presence or absence of dementia may be estimated by analyzing the gait. Thereafter, a movement path of a pedestrian 90 determined to have dementia through re-recognition may be tracked.

[35] FIG. 1 is a schematic diagram illustrating a tracking apparatus of the present disclosure.

[36] The tracking apparatus shown in FIG. 1 may include an acquiring unit 110 and a tracking unit 130.

[37] A camera 10 for photographing a pedestrian 90 walking along a pedestrian path 80 and the like and generating a moving picture 20 may be provided.

[38] The acquiring unit 110 may communicate with a plurality of cameras 10 disposed at

different locations. The acquiring unit 110 may acquire the moving picture 20 in which the pedestrian 90 is photographed, through communication with the camera 10. As an example, the moving picture 20 acquired from the camera 10 may be photographed at a rate of several tens of frames per second.

[39] Each camera 10 may photograph a set location including the pedestrian path 80 on which the pedestrian 90 walks. As an example, the camera 10 may include a set area, a close circuit TV (CCTV) for photographing a set location, a camera of a mobile communication terminal, and a portable camera.

[40] The acquiring unit 110 may be provided with a communication module capable of performing wired and wireless communication with each camera 10. The plurality of cameras 10 may communicate with a server provided in a central control room. At this point, the acquiring unit 110 may be formed integrally with the server, or may receive the moving picture 20 photographed by each camera 10 from the server.

[41] Through analysis of the moving picture 20, the tracking unit 130 may determine whether the pedestrian 90 included in the moving picture 20 is a dementia patient or may track a specific pedestrian estimated as a dementia patient.

[42] The tracking unit 130 may analyze gait of the pedestrian 90 included in the moving picture 20 and determine whether the pedestrian 90 is with dementia using a result of the analysis of the gait.

[43] For example, through the analysis of the moving picture 20, the tracking unit 130 may analyze a walking characteristic of the pedestrian 90, for example, at least one of a stride length, a walking speed, an amount of change in stride length, and an amount of change in walking speed. The tracking unit 130 may determine whether the pedestrian 90 is with dementia by using at least one of: a stride length, a walking speed, an amount of change in stride length, and an amount of change in walking speed. In general, the gait of a dementia patient is different

from that of a normal person. As a result, the walking characteristic of the dementia patient and the walking characteristic of the normal person are also different, using which whether the pedestrian 90 is with dementia may be determined.

[44] For example, the tracking unit 130 may determine the pedestrian 90 as a dementia patient when the amount of change in stride length or the amount of change in walking speed satisfies a set value.

[45] The tracking unit 130 may determine whether the pedestrian 90 is with dementia through machine learning.

[46] For example, the tracking unit 130 may be provided with an extraction model 31, a classification model 32, and a discriminant model 33 which are generated through machine learning.

[47] The extraction model 31 may extract the pedestrian 90 in the moving picture 20 when the moving picture 20 is input.

[48] The classification model 32 may analyze joint key points of the pedestrian 90 extracted through the extraction model 31, and form the skeleton S of the pedestrian 90 using the key points.

[49] The discriminant model 33 may determine whether the pedestrian 90 is with dementia by using a walking characteristic including the stride length and walking speed of the pedestrian 90, which is calculated through the analysis of the skeleton S.

[50] The tracking unit 130 may track the dementia patient using at least one of: first location information including a location where the camera 10 is installed, second location information indicating a location at which the dementia patient is photographed by the camera 10, and information on a direction in which the pedestrian 90 moves in the moving picture 20.

[51] The tracking of the dementia patient may include identifying at least one of: whether the pedestrian 90 is with dementia, a location of the dementia patient, and a moving direction

of the dementia patient. Alternatively, the tracking of the dementia patient may include displaying, on a terminal of a manager, at least one of: information as to whether the pedestrian is with dementia, location information of the pedestrian, and a moving direction of the pedestrian. Alternatively, the tracking of the dementia patient may include displaying at least one of identified location information and moving direction information on a map.

[52] FIG. 2 is a block diagram illustrating the tracking unit 130. FIG. 3 is a schematic diagram illustrating a first operation of the tracking unit 130. FIG. 4 is a schematic diagram illustrating a second operation of the tracking unit 130.

[53] The tracking unit 130 may include a detector 131, a calculator 133, a converter 135, a determiner 137, and a tracker 139.

[54] In order to determine the presence of dementia based on gait, walking characteristics that constitute characteristics of the gait need be extracted from the pedestrian 90. Changes in gait such as a stride length and a walking speed appear due to aging and disease. In order to obtain such walking characteristics, it is necessary to detect and track a foot location of the pedestrian 90.

[55] In order to obtain the walking characteristics, the both feet must first be detected separately, and the detector 131 may use an object extraction model 31 to detect or sense and extract the pedestrian 90 in the moving picture 20 corresponding to an input image as shown in FIG. 3 or in each frame forming the moving picture 20.

[56] After extracting only an area of the pedestrian 90 from the moving picture 20 or the like, the detector 131 may form skeleton s using the classification model 32 capable of setting joint key points learned in advance (corresponding to a first operation of tracking unit 130).

[57] The detector 131 may measure a distance between the feet of the pedestrian 90 using the joint key points of the pedestrian 90 included in the moving picture 20. For example, the detector 131 may measure a distance (interval) between points 11 and 14 representing the

respective feet in the skeleton s of FIG. 3.

[58] The calculator 133 may calculate a stride length and a walking speed of the pedestrian 90 using the distance between the feet.

[59] The detector 131 may measure the distance between the feet once when the pedestrian 90 initially stands, and then may measure the distance between the feet only when the pedestrian 90 moves. The distance between the feet measured by the detector 131 may form a signal indicating a stride length and a walking speed. And, to order to measure a degree of movement of arms a and legs b, the detector 131 may measure initial location values of a point (2, 3, 4), a point (5, 6, 7), a point (9, 10, 11), and a point (12, 13, 14).

[60] The calculator 133 may also measure or calculate an amount of change in each of the points representing the arms a and the legs b only when a stride length value (a distance between the points 11 and 14) is measured. In other words, when the pedestrian 90 walks, the calculator 133 may extract or calculate a joint motion including an amount of change in arm joints and an amount of change in leg joints of the pedestrian 90.

[61] The converter 135 may generate one inspection signal by combining signals respectively indicating a stride length, a walking speed, and a joint motion acquired after the walking of the pedestrian 90 lasts continuously for a set time or longer. The corresponding inspection signal may be converted by the converter 135 into an image for determining dementia.

[62] For example, the converter 135 may use a short-time Fourier transform (STFT) algorithm to convert the inspection signal into a processing signal indicating an amount of change in stride length based on a change in time. The converter 135 may convert the processing signal into a spectrogram image including a stride length and a walking speed. As a result, the converter 135 may generate a spectrogram image h including the stride length and the walking speed (corresponding to a second operation of the tracking unit 130).

[63] The spectrogram is a tool for visualizing a walking characteristic i1 of the pedestrian 90 in the form of waves, and characteristics of a waveform and a spectrum may be combined.

[64] A change in the amplitude axis according to a change in the time axis may be seen in a waveform i2 and a change in the amplitude axis according to a change in the frequency axis may be seen in a spectrum i3, whereas a difference in amplitude according to a change in the time axis and the frequency axis may be expressed as a difference in print density or display color in the spectrogram image h.

[65] The determiner 137 may determine whether the pedestrian 90 is with dementia through analysis of the spectrogram image h.

[66] For example, through the analysis of the spectrogram image h, the determiner 137 may calculate a possibility that the pedestrian 90 is with dementia. The determiner 137 may determine the pedestrian 90 as a dementia patient when the possibility of dementia satisfies a set value. The determiner 137 may determine the pedestrian 90 as a normal person when the possibility of dementia does not satisfy the set value.

[67] Specifically, a deep learning algorithm may be installed in the determiner 137 in order to realize a gait-based dementia determining technology. The deep learning algorithm may analyze an extracted spectrogram image to calculate a possibility of a dementia patient or normal person. When an estimated possibility of dementia exceeds a predetermined value, dementia may be determined. A dementia discriminant model 33 based on a deep learning algorithm specialized for dementia patients may be installed in the determiner 137. The discriminant model 33 may be trained to determine whether dementia is present using a walking characteristic of a normal person and a dementia patient as an input dataset. For example, the discriminant model 33 may be trained to determine whether dementia is present using a spectrogram image, which has visualized a walking characteristic, as an input data set. The discriminant model 33 may be generated using a convolutional neural network for analysis

of the spectrogram image h. The discriminant model 33 may divide the spectrogram image h into set intervals in a time flow and analyze the walking characteristic based on a change in time. In doing so, the discriminant model 33 may analyze a change in stride length and a change in walking speed based on a change in time and may determine as to dementia. As a result, the determiner 137 may determine whether the pedestrian 90 is with dementia by analyzing an amount of change in stride length and an amount of change in walking speed of the pedestrian 90 through the analysis of the walking characteristic.

[68] FIG. 5 is a schematic diagram illustrating a tracking operation of the tracking unit 130.

[69] The tracking unit 130 may continuously track a specific pedestrian determined to be a dementia patient using object re-recognition.

[70] Object re-recognition is a technique for uniquely distinguishing objects by comparing objects photographed at various locations. In this case, an object may include the pedestrian 90 included in the moving picture 20.

[71] For the object re-recognition, it should be possible to re-identify the current object by extracting and comparing identification information (feature value), distinguished from that of other objects, from the current object. For the object re-recognition, it is preferable that the same identification information be obtained even if the photographing angle, location, and brightness are changed.

[72] Through the object re-recognition, the tracker 139 provided in the tracking unit 130 may search for an object image (the pedestrian 90 included in the moving picture 20) similar in appearance to a specific pedestrian identified as a dementia patient.

[73] The tracker 139 may extract a feature from the object image and compare a feature value (identification information) to find an object image most similar to the object to be found.

[74] Since identification information is extracted from a frame image of the moving picture 20, the search may be mainly performed on an object similar in appearance to the specific

pedestrian to be found. When recognizing an object, a feature model 34 generated through a convolutional neural network specialized in extracting identification information of an object may be installed in the tracker 139. In extracting features, a deep learning algorithm model may be configured to detect from a large part to a small part. Therefore, the recognition performance may be improved without extraction weights being biased to coats, pants, etc., which takes a high proportion of external appearance.

[75] In the case of the aforementioned object re-recognition, there are many problems because re-recognition is performed by analyzing only an object image. It is difficult to extract uniform feature values because changes occur in the object image due to the influence of a photographing environment, such as the angle, resolution, and brightness of a photographing device such as the camera 10. Therefore, in order to improve re-recognition accuracy, it is preferable to use data that is less affected by the photographing environment. In order to solve this problem, the tracker 139 may perform re-recognition using an element that is the least affected by the photographing environment. For example, the tracker 139 may perform re-recognition using a stride length characteristic and a spectrogram image. The stride length characteristic and the spectrogram image are data that are less affected by the photographing environment. These data may have already been acquired by the detector 131, the calculator 133, and the converter 135.

[76] According to the tracker 139 that performs re-recognition using the stride length characteristic and the spectrogram image, a specific pedestrian may be accurately recognized even if an observation location of the photographing device is changed.

[77] The tracker 139 may perform re-recognition using the object image and one or more elements. Using many elements improves recognition accuracy but slows down analysis. Accordingly, the tracker 139 may perform re-recognition using only some major elements. In this case, a deep learning algorithm configured to receive and process two or more data for re-

recognition may be used. As shown in FIG. 5, a convolutional neural network model that receives a plurality of data and extracts one feature value may be used. The tracker 139 may acquire a feature value of the pedestrian 90, which is clearly distinguished from other objects, using object image and element information. The tracker 139 may perform accurate re-recognition by additionally analyzing an element that is the least affected by the photographing environment, for example, a walking characteristic or a spectrogram image.

[78] In summary, the tracker 139 may determine whether the pedestrian 90 coincides with a specific pedestrian by analyzing the walking characteristic of the pedestrian 90, which includes a stride length and a walking speed of the pedestrian 90 and a spectrogram image h. In this case, the specific pedestrian may represent the pedestrian 90 who is determined or distinguished or estimated as a dementia patient.

[79] When the pedestrian 90 included in the moving picture 20 is determined as the specific pedestrian, the tracker 139 may track a moving line of the pedestrian 90 determined as the specific pedestrian. Tracking of the moving line may mean displaying per-time locations of the pedestrian 90 on the map or displaying a moving direction of the pedestrian 90 on the map.

[80] FIG. 6 is a flowchart illustrating a tracking method according to the present disclosure.

[81] The tracking method of FIG. 6 may be performed by the tracking apparatus of FIG. 1. The tracking method of FIG. 6 may refer to a method of determining whether the pedestrian 90 is a dementia patient.

[82] First, operation S510 of acquiring a moving picture 20 in which a set area is photographed may be performed. This operation may be performed by the acquiring unit 110.

[83] Operation S520 of extracting the pedestrian 90 included in the moving picture 20 may be performed. This operation may be performed by the detector 131.

[84] Operation S530 of forming skeleton of the pedestrian 90 may be performed. This operation may be performed by the detector 131.

[85] Operation S540 of measuring a stride length and a walking speed of the pedestrian 90 may be performed through analysis of the skeleton. This operation may be performed by the calculator 133.

[86] Operation S550 of generating a spectrogram image including the stride length and the walking speed may be performed. This operation may be performed by the converter 135.

[87] Operation S560 of analyzing the spectrogram image using the discriminant model 33 generated using a deep learning algorithm to determine whether the pedestrian 90 is with dementia may be performed. This operation may be performed by the determiner 137.

[88] FIG. 7 is a flowchart illustrating another tracking method of the present disclosure.

[89] The tracking method of FIG. 7 may be performed by the tracking apparatus of FIG. 1. The tracking method of FIG. 7 may refer to a method of tracking a moving line of a specific pedestrian.

[90] Operation S610 of acquiring a moving picture 20 in which a set area is photographed may be performed. This operation may be performed by the acquiring unit 110.

[91] Operation S620 of extracting an object image representing the pedestrian 90 included in the moving picture 20 may be performed. This operation may be performed by the detector 131.

[92] Operation S630 of extracting a walking characteristic including a stride length and a walking speed of the pedestrian 90 through analysis of the object image may be performed. This operation may be performed by the calculator 133.

[93] Operation S640 of generating a spectrogram image including the stride length and walking speed (S converter 135) may be performed in operation S640. This operation may be performed by the converter 135.

[94] Operation S650 of determining whether the pedestrian 90 coincides with a pre-acquired specific pedestrian using the object image, the walking characteristic, and the

spectrogram image may be performed. This operation may be performed by the tracker 139.

[95] Operation S660 of displaying on a map a movement path of an object candidate corresponding to the pedestrian 90 determined to coincide with the specific pedestrian may be performed. This operation may be performed by the tracker 139.

[96] In the process of determining whether the pedestrian 90 is a dementia patient and the process of tracking a moving line of the dementia patient, there are same operations performed by the detector 131, the calculator 133, and the converter 135 (operations S510, S520, S530, and S540 and operations S610, S620, S630, and S640). In doing so, the operations of the detector 131, the calculator 133, and the converter 135 in the dementia determining process and the moving line tracking process may be shared between the two processes.

[97] FIG. 8 is a flowchart illustrating operations of the detector 131, the calculator 133, and the converter 135. FIG. 9 is a schematic diagram illustrating operations of the detector 131.

[98] Identification information ID of a new moving picture 20 may be received through the acquiring unit 110 or a separate input unit in operation S561.

[99] The acquiring unit 110 may receive a file of the moving picture 20 from a database of the moving picture 20 with the received ID of the new moving picture 20 in operation S562.

[100] The detector 131 may read one frame from the moving picture 20 in operation S563.

[101] The detector 131 may input a frame to an object detection model corresponding to the extraction model 31, and may detect an object and receive coordinates and ID of the tracked object. The detector 131 may generate an object image by cutting out areas other than whole each detected object in a frame in operation S564.

[102] The detector 131 may input object images into a pose estimation model corresponding to the classification model 32 and extract the skeleton of the object in operation S565.

[103] The calculator 133 may measure an amount of change in stride length and an amount of change in limb movement at times when the object stops and starts to walk in operation

S566.

[104] The detector 131 may read a next frame from the moving picture 20 in operation S567.

[105] When the measurement is terminated in operation S567, the converter 135 may convert the amount of change in stride length and the amount of change in limb movement into a spectrogram image in operation S568.

[106] Object ID, image, detection time, and stride length information may be stored in an object database, and the converted spectrogram image and the stride length information may be stored in a pose database.

[107] The converter 135 transmits ID of detected objects to the determiner 137. The detector 131 may detect an object from an image and perform a task of acquiring a walking characteristic. The measured walking characteristic may be converted into a spectrogram image for use by the determiner 137. Through this process, the determiner 137 may analyze the walking characteristic to determine as to dementia.

[108] FIG. 10 is a flowchart illustrating the operation of the determiner 137. FIG. 11 is a schematic diagram illustrating the operation of the determiner 137.

[109] The determiner 137 may determine whether the pedestrian 90 is with dementia, based on a walking characteristic of an object corresponding to the pedestrian 90. The discriminant model 33 installed in the determiner 137 may determine whether the object is with dementia, by analyzing the amount of change in stride length and limb movement.

[110] A sequence of operations of the determiner 137 may be as follows.

[111] The determiner 137 may receive ID of an object that requires determination as to dementia in operation S571.

[112] The determiner 137 may receive a spectrogram image of the object from a pose database in operation S572.

[113] The determiner 137 may pre-process the spectrogram image before determining as to

dementia.

[114] The determiner 137 may input the pre-processed spectrogram image to the pre-trained discriminant model 33 and receive a return of whether or not dementia is present in operation S573.

[115] The determiner 137 may store a result of determination as to dementia in an object database in operation S574.

[116] The determiner 137 may transmit the result of determination as to dementia to the tracker 139. The determiner 137 may receive the spectrogram image as shown in FIG. 11 and determine as to dementia. Before the inputting of the spectrogram image into the discriminant model 33, a pre-processing process such as dividing the spectrogram image by size may be performed. Through the pre-processing process, a walking characteristic for each set time may be extracted and may be used as data for determination as to dementia.

[117] FIG. 12 is a schematic diagram illustrating an operation of the tracker 139.

[118] When the pedestrian 90 captured by the specific camera 10 is determined as a dementia patient and the corresponding specific pedestrian is out of view of the specific camera 10, the tracker 139 may perform re-recognition of the specific pedestrian.

[119] For example, the tracker 139 may compare objects detected from the moving picture 20 captured by the camera 10 within a set radius from a location where the specific pedestrian corresponding to a dementia patient is detected with the specific pedestrian.

[120] The tracker 139 may use two models in order to perform quick and accurate re-identification.

[121] For re-identification, the tracker 139 may use an object re-recognition model corresponding to the feature model 34 and an analysis model.

[122] The object recognition model may select a group of candidates similar in appearance to the specific pedestrian among numerous objects by comparing only object appearance

information. The analysis model may rearrange the ranking of the candidates in the candidate group by performing re-recognition one more time using more elements than the object re-recognition model. The analysis model may quickly and accurately find a dementia object (the specific pedestrian) among numerous objects using two models.

[123] The processing process of the object recognition model and the analysis model is as follows.

[124] The tracker 139 may receive entity ID of the specific pedestrian determined as a dementia patient in operation S581. In other words, when a dementia patient is determined in the moving picture 20 of the specific camera 10, identification information ID of the dementia patient may be propagated to the plurality of trackers 139.

[125] The tracker 139 may receive an image of a target, a detection time of the target, and ID of the moving picture 20 from the object database in operation S582.

[126] The tracker 139 may search a storage unit for an object included in a search range predefined by the detection time of the target and the ID of the moving picture 20, and may receive object ID, image, and stride length information in operation S582.

[127] The tracker 139 may receive a feature value returned by inputting the object image to a re-identification model in operation S583.

[128] The tracker 139 may generate a candidate group after selecting only N approximate object images by comparing with a feature value of the target using a similarity determining algorithm in operation S584.

[129] The tracker 139 may receive spectrogram images and stride length characteristic of the target and the candidate group from the pose database in operation S585.

[130] The tracker 139 may receive a feature value returned by inputting the spectrogram image, the object image, and the stride length characteristic to the analysis model in operation S586.

[131] The tracker 139 may compare feature values between the target and the candidate group and rearrange the ranking of candidates in the candidate group based on similarity in operation S587.

[132] The tracker 139 may transmit object ID, image, and ranking information of the target and the candidate group to a tracking model for tracking movement in operation S588. The disadvantage of the analysis model, which is low speed despite high re-recognition accuracy, can be compensated for through the object re-recognition model. Since the analysis model requires a lot of resources and time, the analysis model may be applied only to a selected candidate group. By allowing only high possibility objects to go through element analysis, work efficiency may be improved.

[133] FIG. 13 is a schematic diagram illustrating another operation of the tracker 139.

[134] The tracking model installed in the tracker 139 may display a movement path of a specific pedestrian corresponding to a dementia object on a map. A candidate group may be provided to a manager, and the manager may select a candidate object determined to be a dementia object from among candidates detected by each imaging device. When the selection is completed, the tracker 139 may track a moving line by displaying a movement path of the dementia object on the map.

[135] The tracking model of the tracker139 may receive object ID, image, and ranking information of the dementia object and the candidate group in operations S591 and S592. When the analysis model and the tracking model are both installed in the tracker 139, this process may be omitted and an output value from the analysis model may be input directly to the tracking model.

[136] A result of re-identification may be provided to a manager's terminal by the tracker139 in operation S593, and in this case, images of candidate objects for each imaging device may be displayed in order of ranking.

[137] The manager may select a candidate object image determined to be identical to the dementia object from among the images displayed for each channel in operation S594.

[138] When the selection of the manager is completed, the tracker 139 may receive detection time and photographing location information of the candidate object selected from the storage unit.

[139] The tracker 139 may mark a movement path of the selected candidate object on the map with the received detection time and the photographing location in operation S595. The manager may finally track a movement path by determining whether the object is identical to the dementia object. Using a deep learning model, tens of thousands of objects may be selected into dozens of candidates for each channel and provided to the manager. This allows the manager to quickly and accurately track a moving line of the dementia patient.

[140] FIG. 14 is a diagram illustrating a computing device according to an embodiment of the present disclosure. A computing device TN100 of FIG. 14 may be a device (e.g., a tracking apparatus, etc.) described herein.

[141] In the embodiment of FIG. 14, the computing device TN100 may include at least one processor TN110, a transceiving device TN120, and a memory TN130. Also, the computing device TN100 may further include a storage device TN140, an input interface device TN150, an output interface device TN160, and the like. Constituent elements included in the computing device TN100 may be connected by a bus TN170 to communicate with each other.

[142] The processor TN110 may execute a program command stored in at least one of the memory TN130 and the storage device TN140. The processor TN110 may refer to a central processing unit (CPU), a graphics processing unit (GPU), or a dedicated processor in which methods according to an embodiment of the present disclosure are performed. The processor TN110 may be configured to implement procedures, functions, and methods described in connection with an embodiment of the present disclosure. The processor TN110 may control

each constituent element of the computing device TN100.

[143] Each of the memory TN130 and the storage device TN140 may store various types of information related to the operation of the processor TN110. Each of the memory TN130 and the storage device TN140 may be configured as at least one of a volatile storage medium and a nonvolatile storage medium. For example, the memory TN130 may include at least one of a read only memory (ROM) and a random access memory (RAM).

[144] The transceiving device TN120 may transmit or receive a wired signal or a wireless signal. The transceiving device TN120 may be connected to a network to perform communication.

[145] The exemplary embodiments of the present disclosure are not only embodied by the above-mentioned method and apparatus. Alternatively, the above-mentioned exemplary embodiments may be embodied by a program performing functions that correspond to the configuration of the exemplary embodiments of the present invention, or a recording medium on which the program is recorded. These embodiments can be easily devised from the description of the above-mentioned exemplary embodiments by those skilled in the art to which the present invention pertains.

[146] Although the embodiments of the present disclosure have been described in detail above, the scope of the present disclosure is not limited thereto, and various modifications and improvements by those skilled in the art using the basic concept of the present disclosure as defined in the following claims are also present.

CLAIMS

1. A tracking apparatus comprising:
an acquiring unit configured to acquire a moving picture in which a pedestrian is photographed; and
a tracking unit configured to determine whether the pedestrian is a dementia patient, or track a specific pedestrian through analysis of the moving picture.
2. The tracking apparatus of claim 1,
wherein the tracking unit analyzes gait of the pedestrian included in the moving picture, and determines whether the pedestrian is with dementia using a result of analysis of the gait.
3. The tracking apparatus of claim 1, wherein:
a camera for photographing the pedestrian and generating the moving picture is provided, and
the tracking unit tracks a dementia patient using at least one of: first location information including a location where the camera is installed, second location information indicating a location photographed by the camera, and information on a moving direction in which the pedestrian moves in the moving picture.
4. The tracking apparatus of claim 1, wherein:
an extraction model, a classification model, and a discriminant model generated through machine learning are provided in the tracking unit,
the extraction model extracts the pedestrian included in the moving picture when the moving picture is input,

the classification model analyzes joint key points of the pedestrian extracted through the extraction model and forms skeleton of the pedestrian using the key points, and

the discriminant model determines whether the pedestrian is with dementia using a walking characteristic including a stride length and a walking speed of the pedestrian, which are calculated through analysis of the skeleton.

5. The tracking apparatus of claim 1, wherein:

the tracking unit measures a distance between feet of the pedestrian using joint key points of the pedestrian included in the moving picture,

the tracking unit calculates a stride length and a walking speed of the pedestrian using the distance,

the tracking unit extracts a joint motion including an amount of change in arm joints and an amount of change in leg joints of the pedestrian when the pedestrian walks,

the tracking unit generates one inspection signal by combining signals respectively representing the stride length, the walking speed, and the joint motion acquired after the walking of the pedestrian lasts continuously for a set time or longer,

the tracking unit uses a short-time Fourier transform (STFT) algorithm to convert the inspection signal into a processing signal indicating an amount of change in stride length based on a change in time,

the tracking unit converts the processing signal into a spectrogram image including the stride length and the walking speed,

the tracking unit calculates a possibility that the pedestrian is with dementia through analysis of the spectrogram image, and

the tracking unit determines the pedestrian as a patient with dementia when the possibility of dementia satisfies a set value, and the tracking unit determines the pedestrian as

a normal person when the possibility of dementia does not satisfy the set value.

6. The tracking apparatus of claim 5, wherein:

the tracking unit inputs the spectrogram image to a discriminant model generated using a convolutional neural network,

the discriminant model divides the spectrogram image into set intervals in a time flow and analyzes a walking characteristic based on a change in time, and

the discriminant model determines whether the pedestrian is with dementia by analyzing an amount of change in stride length and an amount of change in walking speed of the pedestrian through analysis of the walking characteristic.

7. The tracking apparatus of claim 1, wherein:

the tracking unit measures a distance between feet of the pedestrian using joint key points of the pedestrian included in the moving picture,

the tracking unit calculates a stride length and a walking speed of the pedestrian using the distance,

the tracking unit extracts a joint motion including an amount of change in arm joints and an amount of change in leg joints of the pedestrian when the pedestrian walks,

the tracking unit generates one inspection signal by combining signals respectively representing the stride length, the walking speed, and the joint motion acquired after the walking of the pedestrian lasts continuously for a set time or longer,

the tracking unit uses a short-time Fourier transform (STFT) algorithm to convert the inspection signal into a processing signal indicating an amount of change in stride length based on a change in change,

the tracking unit converts the processing signal into a spectrogram image including the

stride length and the walking speed,

the tracking unit determines whether the pedestrian is the specific pedestrian by using a walking characteristic of the pedestrian, including a stride length and a walking speed, and the spectrogram image, and

the tracking unit tracks a moving line of the pedestrian when it is determined that the pedestrian is the specific pedestrian.

8. The tracking apparatus of claim 1, wherein:

a detector, a calculator, a converter, a determiner, a tracker are provided,

the detector measures a distance between feet of the pedestrian using joint key points of the pedestrian included in the moving picture,

the calculator calculates a stride length and a walking speed of the pedestrian using the distance,

the converter generates a spectrogram image including the stride length and the walking speed,

the determiner determines whether the pedestrian is with dementia through analysis of the spectrogram image, and

the tracker determines whether the pedestrian coincides with the specific pedestrian through analysis of the spectrogram image, and tracks a moving line of the pedestrian determined as the specific pedestrian.

9. A tracking method performed by a tracking apparatus, the method comprising:

acquiring a moving picture in which a set area is photographed;

extracting a pedestrian included in the moving picture;

forming skeleton of the pedestrian;

measuring a stride length and a walking speed of the pedestrian through analysis of the skeleton;

generating a spectrogram image including the stride length and the walking speed; and

analyzing the spectrogram image using a discriminant model generated through a deep learning algorithm, and determining whether the pedestrian is with dementia.

10. A tracking method performed by a tracking apparatus, the method comprising:

acquiring a moving picture in which a set area is photographed;

extracting an object image representing a pedestrian included in the moving picture;

extracting a walking characteristic including a stride length and a walking speed of the pedestrian through analysis of the object image;

generating a spectrogram image including the stride length and the walking speed;

determining whether the pedestrian coincides with a specified pedestrian using the object image, the walking characteristic, and the spectrogram image; and

displaying on a map a movement path of a candidate object corresponding to a pedestrian determined to coincide with the specific pedestrian.