

[DESCRIPTION]

[Title of Invention] MOVING HANDRAIL DETERIORATION DIAGNOSIS DEVICE

[Technical Field]

[0001]

The present invention relates to a moving handrail deterioration diagnosis device for diagnosing damage in a moving handrail provided in a passenger conveyor such as an escalator or a moving walkway.

[Background Art]

[0002]

For example, an invention described in JP-A-2006-27889 (Patent Literature 1) has been known as this type technique. The invention described in Patent Literature 1 relates to a man-conveyor moving handrail inspection device including a shape acquisition unit which measures the shape of a back surface of a moving handrail and outputs a measured value of the back surface shape, a damaged portion extraction unit which extracts a damaged portion in the moving handrail based on the measured value of the back surface shape, and a damage degree determination unit which determines a damage degree based on a result of extraction of the damaged portion, in order to distinguish between abrasion in the back surface of the moving handrail caused by running of the moving handrail and occurrence of damage

in the back surface of the moving handrail caused by another factor than the running of the moving handrail; wherein: the damaged portion extraction unit includes a quadratic differential unit which applies a quadratic differential to the measured value of the back surface shape of the moving handrail and outputs a quadratic differential value, and the damage degree determination unit determines that a portion of the moving handrail is damaged when the quadratic differential value exceeding a threshold which is predetermined for the quadratic differential value is outputted.

[Citation List]

[Patent Literature]

[0003]

[Patent Literature 1] JP-A-2006-27889

[Summary of Invention]

[Technical Problem]

[0004]

In the aforementioned background-art technique, images of the shape of the back surface of the moving handrail are acquired by an optical shape measuring unit using a moving handrail inspection hole provided in advance in a skirt guard of the passenger conveyor. However, the moving handrail moves up/down and left/right in the imaging position when the passenger conveyor is operated. It is

therefore impossible to fix the relative position between the optical shape measuring unit and the moving handrail to always acquire images in the same relative position. In addition, when the moving handrail moves left/right, the imaging position relative to the moving handrail varies among images largely with respect to a central axis parallel to the moving direction of the moving handrail, or the moving handrail moves up/down. As a result, the distance between the optical shape measuring unit and the moving handrail changes, and the reduction scale differs from one taken image to another.

[0005]

When the distance or the reduction scale changes in this manner, the position of the central axis of the moving handrail parallel to the moving direction and the range of the imaged handrail within taken images vary largely among the taken images. As a result, the result of determination as to the deterioration state is affected. In addition, the large variation in the position of the central axis or the large difference among the taken images as to the range of the imaged handrail leads to difficulty to identify the position of deterioration.

[0006]

Further, when the deterioration state is determined from such a taken image by use of a computer program or the like, there arises

a variation in determination due to the imaging condition of the image. When the occurrence of the variation is avoided as much as possible, a complicated determination algorithm is required to change determination criteria in accordance with the imaging condition of the image.

[0007]

Therefore, an object of the invention is to prevent the variation of the imaging position of a camera as much as possible even if a moving handrail moves up/down and left/right when the moving handrail is imaged in the state where a passenger conveyor is operated for the purpose of deterioration diagnosis.

[Solution to Problem]

[0008]

In order to achieve the foregoing object, the invention provides a moving handrail deterioration diagnosis device in which an image of a recess portion bottom of a moving handrail of a passenger conveyor is taken by a camera in the state in which the moving handrail is operated and a deterioration state of the moving handrail is diagnosed from the image taken by the camera, the moving handrail deterioration diagnosis device being characterized by including: a camera mounting mechanism to which the camera is fixed and which is disposed within a recess portion of the moving handrail; a tracking

mechanism which allows the camera mounting mechanism to track the moving handrail along a longitudinal axis of the recess portion while touching the recession portion bottom and opposite side surfaces of the recess portion; and a mounting member which has one end attached to the camera mounting mechanism and the other end attached to a non-running part serving as a constituent part of the passenger conveyor so that the mounting member supports the camera mounting mechanism on the non-running part while allowing tracking operation of the camera mounting mechanism using the tracking mechanism.

[Advantageous Effects of Invention]

[0009]

According to the invention, it is possible to prevent the variation of the imaging position of the camera as much as possible even if the moving handrail moves up/down and left/right when the moving handrail is imaged in the state where the passenger conveyor is operated.

Other objects, configurations and effects will be made clear in the following description of an embodiment.

[Brief Description of Drawings]

[0010]

[Fig. 1] A perspective view showing the schematic configuration of an escalator as a passenger conveyor to which a moving handrail

deterioration diagnosis device according to an embodiment of the invention is attached.

[Fig. 2] A side view showing the schematic configuration of the escalator in Fig. 1.

[Fig. 3] A perspective view schematically showing the state in which the moving handrail deterioration diagnosis device according to the embodiment of the invention has been attached to the passenger conveyor.

[Fig. 4] A top view showing a camera and a camera mounting mechanism shown in Fig. 3.

[Fig. 5] A side view of the camera and the camera mounting mechanism, seen from the direction of the arrow B in Fig. 4.

[Fig. 6] A view showing the state in which the moving handrail deterioration diagnosis device in Fig. 3 has been attached to a recess portion of a moving handrail.

[Fig. 7] A front view of an arm type bracket according to the embodiment.

[Fig. 8] A top view showing a link part between a link portion and an arm portion in the arm type bracket shown in Fig. 7.

[Fig. 9] A top view showing a link part between a fixation portion and the arm portion in the arm type bracket shown in Fig. 7.

[Fig. 10] A left side view of the link portion in Fig. 7.

[Figs. 11A and 11B] Views each showing a state in which the fixation portion is fixed to a frame.

[Description of Embodiments]

[0011]

An embodiment of the invention will be described below with reference to the drawings.

[0012]

Fig. 1 is a perspective view showing the schematic configuration of an escalator as a passenger conveyor to which a moving handrail deterioration diagnosis device according to an embodiment of the invention is attached. Besides the escalator, a moving walkway etc. maybe another example of the passenger conveyor. This embodiment will be described while the escalator is used as an example.

[0013]

In Fig. 1, an escalator 100 has steps 101 on which passengers stand, and moving handrails 102 which move in the same direction as a travelling direction of the steps 101. The moving handrails 102 are provided on opposite, left and right sides of the steps 101 with respect to the travelling direction of the steps 101.

[0014]

Each moving handrail 102 is arranged to be endless so that the moving handrail 102 can circulate along a balustrade 103 provided on corresponding one of the opposite sides of the steps 101 and in parallel with the travelling direction of the steps 101. That is, the moving handrail 102 moves in the same direction as the travelling direction of the steps 101 when the moving handrail 102 is located on an upper side of the balustrade 103. Once the moving handrail 102 reaches an end portion of the balustrade 103, the moving handrail 102 moves down drawing an arc. The moving handrail 102 which has been turned upside down thus is pulled into a deck 104 provided with a skirt guard and so on. Then, the moving handrail 102 passing through the inside of the deck 104 reaches an opposite end portion of the balustrade 103. The moving handrail 102 which has been turned upside down gets out of the deck 104, moves upward drawing an arc, and returns to the upper side of the balustrade 103. Each moving handrail 102 circulates in this manner. In addition, a drive unit or the like for driving the moving handrails 102 is provided inside the deck 104.

[0015]

Fig. 2 is a view showing the schematic configuration of the escalator 100 in Fig. 1. Fig. 2 shows a state of the escalator 100, seen from side. The escalator 100 has a frame 105 which is buried

under an upper floor and a lower floor and built between the upper floor and the lower floor. A not-shown chain is wound around a sprocket 106 which is rotated by a not-shown drive unit provided under the upper floor and a driven sprocket 107 which is provided under the lower floor. The steps 101 shown in Fig. 1 are disposed endlessly on the chain.

[0016]

The moving handrails 102 are driven by a terminal gear 108 for driving the moving handrails as shown in Fig. 2. The terminal gear 108 is connected to the sprocket 106, which is rotated by the not-shown drive unit, through a chain 109 so that the terminal gear 108 can be rotated in sync with the sprocket 106. Thus, the moving handrails 102 and the steps 101 are driven at the same velocity and in the same direction upon reception of a driving force from the sprocket 106.

[0017]

A large number of various constituent parts of the escalator 100 are disposed inside the deck 104 and the frame 105. It is therefore difficult to have a space for mounting any device inside the deck 104. However, there is a moving handrail sagging portion A in which each of the moving handrails 102 is sagging as shown in Fig. 2. This moving handrail sagging portion A is supported on moving handrail

support guides 110 so that the sectionally concave moving handrail 102 is allowed to turn up its recess portion as a canvas surface of the moving handrails 102. The space is secured above the recess portion.

[0018]

For the escalator 100 configured thus, a moving handrail deterioration diagnosis device according to this embodiment is attached to the frame 105 which is a non-running part as a constituent part of the escalator 100. In the moving handrail sagging portion A in a return path side of each moving handrail 102 moving inside the deck 104 and the frame 105, the moving handrail deterioration diagnosis device carries out measurement for diagnosing deterioration in the moving handrail 102.

[0019]

Fig. 3 is a main portion perspective view of the escalator, showing the state in which the moving handrail deterioration diagnosis device according to the embodiment has been attached to the escalator 100. As shown in Fig. 3, a moving handrail deterioration diagnosis device 1 uses a camera 2 to take an image of the canvas surface in a recess portion 102h of one of the moving handrails 102 of the escalator 100 in the state where the moving handrail 102 is operated. The image taken by the camera 2 is sent to a data processing device 10.

The data processing device 10 diagnoses a deterioration state in the moving handrail 102 based on the image which is taken by the camera 2 and sent to the data processing device 10.

[0020]

Such a moving handrail deterioration diagnosis device 1 is provided with the camera 2 which takes an image of the state of the moving handrail 102, a camera mounting mechanism 3 to which the camera 2 is fixed and which is disposed within the recess portion 102h of the moving handrail 102, and an arm type bracket 4 serving as a mounting member and having one end attached to the camera mounting mechanism 3 and the other end attached to the frame 105.

[0021]

As shown in Fig. 3, in the moving handrail deterioration diagnosis device 1 according to the embodiment, the camera 2 of the moving handrail deterioration diagnosis device 1 is connected to the data processing device 10 such as a PC through a connection line so as to communicate with the data processing device 10 in diagnostic measurement so that imaging operation of the camera 2, storage of images taken by the camera 2, and so on, are carried out by the data processing device 10. Images are taken by the camera 2 which is placed on the canvas surface in a recess portion bottom 102a of the back of the moving handrail 102. For each image, the deterioration

and damage state in the canvas, that is, whether the canvas is deteriorated or normal is determined by software using a program in the data processing device 10.

[0022]

In the example shown in Fig. 3, the moving handrail deterioration diagnosis device 1 and the data processing device 10 are connected through a cable 10a so as to transmit data to each other. However, data may be transmitted by wireless. In addition, whether the moving handrail 102 is deteriorated or normal may be determined not by a program but by a maintainer who checks the taken images.

[0023]

Fig. 4 is a top view showing the camera and the camera mounting mechanism shown in Fig. 3. Fig. 5 is a side view of the camera and the camera mounting mechanism, seen from the direction of the arrow B in Fig. 4. Fig. 6 is a view showing the state in which the moving handrail deterioration diagnosis device in Fig. 3 has been attached to the recess portion of the moving handrail.

[0024]

In Figs. 4 to 6, the camera mounting mechanism 3 has first to fourth wheels 5a, 5b, 5c and 5d which roll on the recess portion bottom 102a of the moving handrail 102, first and second fixed guides

6a and 6b which are brought into contact with one recess-portion-side end portion (hereinafter referred to as first end portion) 102b of the moving handrail 102, and first and second movable guides 7a and 7b which are brought into pressure contact with the other recess-portion-side end portion (hereinafter referred to as second end portion) 102c of the moving handrail 102. These parts are fixed to a housing 8 of the camera mounting mechanism 3.

[0025]

The housing 8 is constituted by first and second wheel fixation brackets 8a and 8b each of which is formed out of a plate material and into an L-shape in section, a housing body 8c and a camera illumination device mounting member 8d. The first to fourth wheels 5a to 5d are arranged in such a manner that the first and third wheels 5a and 5c are linked with the second and fourth wheels 5b and 5d by axles respectively. Members supporting the axles are fixed to the first and second wheel fixation brackets 8a and 8b respectively. In the same manner, the first and second fixed guides 6a and 6b and the first and second movable guides 7a and 7b are fixed to the first and second wheel fixation brackets 8a and 8b respectively.

[0026]

The camera 2 is fixed to the housing body 8c through the camera illumination device mounting member 8d in the state in which an imaging

lens portion 2a of the camera 2 faces the recess portion bottom 102a of the moving handrail 102, as shown in Figs. 5 and 6. Further, an illumination device 9 formed annularly around the camera 2 is attached to the housing body 8c through the camera illumination device mounting member 8d, as shown in Fig. 4. In the illumination device 9, a large number of LED lights 9a are disposed annularly around the imaging lens portion 2a and along the illumination device 9.

[0027]

The first and second fixed guides 6a and 6b and the first and second movable guides 7a and 7b allow the camera mounting mechanism 3 to track the behavior of the moving handrail 102 in a left/right direction (direction of the arrow C) in Fig. 5 so as to prevent the position of the longitudinal axis (axis parallel to the arrow B in Fig. 4) X of the moving handrail 102 from differing largely from one taken image to another.

[0028]

The first and second fixed guides 6a and 6b include rollers whose shafts are fixed to the housing 8 so that the rollers can rotate in contact with the first end portion 102b of the moving handrail 102. The first and second movable guides 7a and 7b include first and second roller retention members 72a and 72b which have one ends fixed rotatably around first and second shafts 71a and 71b respectively

and the other end third and fourth shafts 71c and 71d are fixed to respectively, first and second rollers 73a and 73b which are held rotatably on the third and fourth shafts 71c and 71d respectively, and first and second springs 74a and 74b which provide forces to rotate the first and second rollers 73a and 73b around the first and second shafts 71a and 71b so as to draw fan-shapes in a direction away from the first and second fixed guides 6a and 6b respectively. The first fixed guide 6a, the first roller 73a of the first movable guide 7a, the second fixed guide 6b and the second roller 73b of the second movable guide 7b are parallel to the arrow B in Fig. 4. The first fixed guide 6a and the first roller 73a are disposed substantially symmetrically with respect to the axis X passing through the center between the first and second end portions 102b and 102c, and the second fixed guide 6b and the second roller 73b are disposed substantially symmetrically likewise.

[0029]

When the camera mounting mechanism 3 configured thus is mounted in the recess portion 102h of the moving handrail 102, the first and second fixed guides 6a and 6b are elastically pressed toward the first end portion 102b by the first spring, and the first and second movable guides 7a and 7b are elastically pressed toward the second end portion 102c by the second spring, as shown in Fig. 5.

Thus, when the moving handrail 102 moves, the first and second rollers 73a and 73b rotate in pressure contact with the second end portion 102c of the moving handrail 102. Due to this pressure force, the first and second movable guides 7a and 7b try to move the camera mounting mechanism 3 toward the first and second fixed guides 6a and 6b.

[0030]

However, the positions of the first and second fixed guides 6a and 6b in contact with the first end portion 102b of the moving handrail 102 are restricted so that the camera mounting mechanism 3 can be prevented from moving toward the first and second fixed guides 6a and 6b. As a result, the camera mounting mechanism 3 tracks the behavior of the moving handrail 102 in the left/right direction. Accordingly, there is no fear that an imaging field 2b based on the camera 2 moves largely out of the axis X of the moving handrail 102.

[0031]

In addition, as shown in Figs. 5 and 6, the first to fourth wheels 5a to 5d rolling on the recess portion bottom 102a of the moving handrail 102 always keep their contact with the recess portion bottom 102a of the moving handrail 102 due to the own weight of the camera 2 and the camera mounting mechanism 3, so that the camera mounting mechanism 3 can track the behavior of the moving handrail

102 in an up/down direction (up/down direction in Figs. 5 and 6) with respect to the axis X. Thus, the variation of the distance between the camera 2 and the recess portion bottom 102a of the moving handrail 102 is suppressed to prevent the range of the imaging field 2b from varying largely. That is, there is no fear that the reduction scale of taken images differs largely from one taken image to another. If the own weight of the camera 2 and the camera mounting mechanism 3 is too light to keep the state in which the first to fourth wheels 5a to 5d are always in contact with the recess portion bottom 102a of the moving handrail 102, a weight may be added to keep the contact state.

[0032]

In this manner, according to the embodiment, the camera mounting mechanism 3 tracks the up/down and left/right motion so that the relative position between the camera mounting mechanism 3 and the moving handrail 102, particularly the relative position between the both with respect to the axis X can be regulated to keep one and the same position as much as possible. It is therefore possible to always take images in a substantially constant range even when severe deterioration such as swelling, shrinkage or cracking occurs in the moving handrail 102. Thus, the accuracy of diagnosis using the images can be improved.

[0033]

In addition, the illumination device 9 is attached to the camera mounting mechanism 3 in the state where the relative positions among the camera 2, the illumination device 9 and an imaging portion where each image is taken by the camera 2 are fixed to one another. Accordingly, images can be always taken with substantially constant distances of the camera 2 and the illumination device 9 from the moving handrail 102 as a subject. As a result, luminance unevenness of the subject is suppressed so that deterioration can be determined with high accuracy.

[0034]

Fig. 7 is a front view of the arm type bracket 4. Fig. 8 is a top view showing a link part between a link portion 11 and an arm portion 13 in the arm type bracket 4. Fig. 9 is a top view showing a link part between a fixation portion 12 and the arm portion 13 in the arm type bracket 4.

[0035]

As shown in Fig. 7, the arm type bracket 4 is fundamentally constituted by the link portion 11, the fixation portion 12 and the arm portion 13. The link portion 11 is provided at one end of the arm portion 13, and the fixation portion 12 is provided at the other end of the arm portion 13. The arm portion 13 is attached to the

camera mounting mechanism 3 through the link portion 11, and attached to the frame 105 through the fixation portion.

[0036]

The arm portion 13 has first to third arms 16, 17 and 18. A first rotary portion 14 is provided on the link portion 11 side of the first arm 16, and a second rotary portion 15 is provided on the fixation portion 12 side of the third arm. The first arm 16 has one end connected to the link portion 11, and the other end connected to one end of the second arm 17. The second arm 17 has one end connected to the other end of the first arm 16, and the other end connected to one end of the third arm 18. The third arm has one end connected to the other end of the second arm 17, and the other end connected to the fixation portion 12.

[0037]

The second arm 17 is formed into a U-shape in section so that upper and lower portions of the U-shape can slide with upper and lower end portions of the first arm 16. In addition, a long hole 17a is formed in a longitudinal direction of the second arm 17. A screw 19 is inserted into a hole provided on the other end side of the first arm 16 and the long hole 17a provided in the second arm 17, and fastened together so that the first arm 16 and the second arm 17 can be fixed. When the screw 19 is loosened, the shaft of

the screw 19 moves along the long hole 17a. When the screw 19 is fastened, the relative position between the first arm 16 and the second arm 17 formed thus is fixed in that position. Thus, the length defined by the two arms, that is, the first arm 16 and the second arm 17, can be changed within the range of the long hole 17a.

[0038]

In the same manner, the third arm 18 is also formed into a U-shape in section so that upper and lower portions of the U-shape can slide with the upper and lower end portions of the second arm 17. In addition, a long hole 18a is formed in a longitudinal direction of the third arm 18. A screw 20 is inserted into a hole provided on the other end side of the second arm 17 and the long hole 18a provided in the third arm 18, and fastened together so that the second arm 17 and the third arm 18 can be fixed. Accordingly, the second arm 17 and the third arm 18 are fixed in the same manner as the first arm 16 and the second arm 17. That is, when the screw 20 is loosened, the shaft of the screw 20 moves along the long hole 18a. When the screw 20 is fastened, the relative position between the second arm 17 and the third arm 18 is fixed in that position. Thus, the length defined by the two arms, that is, the second arm 17 and the third arm 18, can be changed within the range of the long hole 18a.

[0039]

Since the first to third arms 16, 17 and 18 are configured thus, the length of the arm portion 13 can be changed within the range of the long holes 17a and 18a. Due to this configuration, the length of the arm portion 13 can be adjusted in accordance with various forms of escalators 100 so that the arm portion 13 can be attached thereto. Thus, the general versatility of the moving handrail deterioration diagnosis device 1 can be improved.

[0040]

In addition, one end side of the first rotary portion 14 is attached to one end side of the first arm 16 rotatably within a predetermined range with respect to a first shaft 14a provided perpendicularly to a side surface of the first arm 16, as shown by the arrow D in Fig. 7. The other end side of the first rotary portion 14 is attached to the link portion 11 rotatably within a predetermined range with respect to a second shaft 14b provided in parallel to the side surface of the first arm 16, as shown by the arrow E in Fig. 8. In this manner, the first and second shafts 14a and 14b are provided in directions perpendicular to each other in the first rotary portion 14. Thus, the arm portion 13 can rotate relatively to the link portion 11 within a predetermined range in a direction substantially perpendicular to a direction substantially parallel to the recess portion bottom 102a of the moving handrail 102, so

that the camera mounting mechanism 3 can track the inclination of the moving handrail 102 in the directions of two axes.

[0041]

In the same manner, one end side of the second rotary portion 15 is attached to the other end side of the third arm 18 rotatably within a predetermined range with respect to a third shaft 15a provided perpendicularly to a side surface of the third arm 18, as shown by the arrow F in Fig. 7. The other end side of the second rotary portion 15 is attached to the fixation portion 12 rotatably within a predetermined range with respect to a fourth shaft 15b provided in parallel to the side surface of the third arm 18, as shown by the arrow G in Fig. 9. In this manner, the third and fourth shafts 15a and 15b are provided in directions perpendicular to each other in the fixation portion 12. Thus, the arm portion 13 can track the fixation portion 12 in the directions of two axes.

[0042]

In this manner, the link part between the camera mounting mechanism 3 and the arm type bracket 4 moves up/down and left/right desirably, and the link part between the camera mounting mechanism 3 and the fixation portion 12 fixed to the frame 105 of the escalator 100 also moves up/down and left/right desirably. Thus, the workability is improved because the accuracy in mounting the moving

handrail deterioration diagnosis device 1 to the frame 105 does not have to be taken into great consideration.

[0043]

Fig. 10 is an enlarged left side view of the link portion 11 in Fig. 7. As shown in Fig. 10, the link portion 11 has first and second support plates 11a and 11b extending from a plate-like member 11c provided on the top. The first and second support plates 11a and 11b retain a side portion of the first or second wheel fixation bracket 8a or 8b slidably. In addition, a fixation pin 21 is provided in the link portion 11. A downward elastic force is given to the fixation pin 21 so that the tip of a shaft portion 21a of the fixation pin 21 can normally protrude from the lower surface of the plate-like member 11c of the link portion 11.

[0044]

As shown in Fig. 4, first and second insertion holes 22a and 22b into which the shaft portion 21a can be inserted are provided in the first and second wheel fixation brackets 8a and 8b respectively. For example, when the link portion 11 and the second wheel fixation bracket 8b are linked as shown in Fig. 6, the camera mounting mechanism 3 and the link portion 11 are linked in the following process.

[0045]

That is:

· The second wheel fixation bracket 8b is inserted into a space 11d between the plate-like member 11c and the first and second support plates 11a and 11b of the link portion 11.

[0046]

· A side portion of the second wheel fixation bracket 8b retained by the first and second support plates 11a and 11b is slid and inserted.

[0047]

· The fixation pin 21 is pulled up when the shaft portion 21a of the fixation pin 21 interferes with the end portion of the second wheel fixation bracket 8b.

[0048]

· In the state where the fixation pin 21 is pulled up, the second wheel fixation bracket 8b is further inserted, and the fixation pin 21 is released from being pulled up.

[0049]

· In the state where the fixation pin 21 is released from being pulled up, the second wheel fixation bracket 8b is further inserted. When the shaft portion 21a of the fixation pin 21 reaches the position of the second fixation pin insertion hole 22b of the second wheel fixation bracket 8b, the fixation pin 21 is inserted into the fixation pin insertion hole 22b due to elastic force so that the second wheel fixation bracket 8b is fixed to the link portion 11.

[0050]

Due to this fixation operation, the camera mounting mechanism 3 and the link portion 11 are completely linked.

[0051]

Linking with the link portion 11 in the same procedure may be applied not only to the second wheel fixation bracket 8b but also to the first wheel fixation bracket 8a. In this manner, the arm type bracket 4 can be fixed to each of the left and right ends of the camera mounting mechanism 3. Since the structure in which the wheel fixation bracket 8a or 8b is thus slid and fixed to the link portion 11 is used, the work of fixing the camera mounting mechanism 3 can be performed easily even in a narrow site, that is, inside the deck 104 of the escalator 100.

[0052]

Figs. 11A and 11B are views each showing a state in which the fixation portion 12 is fixed. Fig. 11A is a side view showing a state where the fixation portion 12 is fixed to a frame 105 of L-shaped steel. Fig. 11B is a side view showing a state where the fixation portion 12 is fixedly attached to a frame 105 of U-shaped steel.

[0053]

As shown in Figs. 11A and 11B, the fixation portion 12 is constituted by an arm portion link member 23, a fixation portion

body 24 and a fixation handle 25. The rotary portion 15 is fixed to the bottom of the arm portion link member 23. The fixation portion body 24 is formed into a U-shape in section. The fixation handle 25 has a screw shaft 26 inserted into one surface which faces the fixation portion body 24. The fixation handle 25 is rotated to move the screw shaft 26 forward and backward so that the frame 105 is input between the screw shaft 26 and the other opposed surface of the fixation portion body 24. Thus, the other end of the arm type bracket 4 is attached to the frame 105.

[0054]

The arm portion link member 23 and the fixation portion body 24 are rotatably linked with each other by a rotary shaft 27 which can be rotated or fixed by a screw. The fixation portion body 24 can rotate relatively to the arm portion link member 23 when the screw of the rotary shaft 27 is loosened. When the screw is fastened, the relative position between the fixation portion body 24 and the arm portion link member 23 is fixed.

[0055]

Various forms of steel materials such as I-shaped steel, L-shaped steel, H-shaped steel, U-shaped steel, etc. may be used as the frame 105 of the escalator 100. In the embodiment, in the fixation portion 12, while the posture of the arm portion link member

23 is kept, the posture of the fixation portion body 24 can be rotated at 90 degrees when the screw of the rotary shaft 27 is loosened. The position of the fixation portion 12 rotated and changed thus is fixed when the screw of the rotary shaft 27 is fastened. In this manner, the fixation portion 12 can be attached to the frame 105 in accordance with the shape of the steel material. It is therefore unnecessary to choose the shape of the steel material so that the moving handrail deterioration diagnosis device 1 can be formed to have excellent general versatility.

[0056]

When the camera mounting mechanism 3 moves to track the moving handrail 102 moving in the left/right direction and the up/down direction, the arm type bracket 4 configured thus tracks the motion in the up/down direction due to the rotating operations of the first rotary portion 14 and the second rotary portion 15 around the first shaft 14a and the third shaft 15a, and tracks the motion in the left/right direction due to the rotating operations of the first rotary portion 14 and the second rotary portion 15 around the second shaft 14b and the fourth shaft 15b. That is, the camera mounting mechanism 3 linked to the frame 105 through the arm type bracket 4 tracks the motion of the moving handrail 102. In other words, the arm type bracket 4 allowing the camera mounting mechanism 3 to

rotate in the left/right direction and rotate in the up/down direction relatively to the arm type bracket 4 links the camera mounting mechanism 3 to the frame 105 so that measurement can be carried out in a position along the axis X.

[0057]

As described above, in the moving handrail deterioration diagnosis device 1 according to the embodiment, the camera mounting mechanism 3 can move to track the up/down and left/right motion of the moving handrail 102 even when the handrail 102 is imaged in the state where the escalator 100 is operated. Thus, the imaging range where each image can be taken by the camera 2 is substantially constant so that a normal moving handrail and a deteriorated moving handrail can be compared in the same dimensions, the same reduction scale and the same imaging environment. Thus, the deterioration state can be determined easily.

[0058]

The moving handrail deterioration diagnosis device 1 configured thus is installed in the following procedure. Fundamentally, the moving handrail deterioration diagnosis device 1 in the embodiment is configured in such a manner that the camera mounting mechanism 3 to which the camera 2 is fixed is separated from the arm type bracket 4 in advance and the camera mounting mechanism

3 and the arm type bracket 4 are linked with each other as they are set.

[0059]

First, the camera mounting mechanism 3 to which the camera 2 has been fixed is put into the recess portion 102h of the moving handrail 102 which is the subject to be imaged, and the camera mounting mechanism 3 put in the recess portion 102h is placed on the moving handrail 102.

[0060]

In the state where the camera mounting mechanism 3 is put in the recess portion 102h of the moving handrail 102 which is the subject to be imaged, the camera mounting mechanism 3 is firmly retained by the first and second end portions 102b and 102c of the moving handrail 102 due to the elastic force with which the first and second fixed guides 6a and 6b and the first and second movable guides 7a and 7b are urged outward by the first and second springs 74a and 74b. Thus, the camera mounting mechanism 3 tracks the left/right motion of the moving handrail 102.

[0061]

When the shape of the moving handrail 102 swells or shrinks in the left/right direction, the first and second movable guides 7a and 7b urged by the first and second springs 74a and 74b are open

or close while drawing fan-shapes outward or inward so as to track the left/right motion of the moving handrail 102 without leaving the first and second end portions 102b and 102c of the moving handrail 102.

[0062]

In addition, the first to fourth wheels 5a to 5d catch the surface of the recess portion bottom 102a of the moving handrail 102 and track the up/down motion of the moving handrail 102. The first to fourth wheels 5a to 5d abut against the moving handrail 102 due to the own weight of the camera mounting mechanism 3 as described previously. When the own weight of the camera mounting mechanism 3 is light, configuration is made in such a manner that weights can be attached to the wheel fixation brackets 8a and 8b so that the first to fourth wheels 5a to 5d can always abut against the recess portion bottom 102a of the moving handrail 102.

[0063]

Next, the link portion 11 of the arm type bracket 4 and the camera mounting mechanism 3 are fixed and linked by the fixation pin 21. Then, in accordance with the positional relation between the moving handrail 102 on which the camera mounting mechanism 3 is placed and the frame 105 of the escalator 100, the first arm 16, the second arm 17 and the third arm 18 are slid and used in short

lengths when the moving handrail 102 and the frame 105 are close to each other, and the first arm 16, the second arm 17 and the third arm 18 are used in expanded lengths when the moving handrail 102 and the frame 105 are far from each other. The lengths are adjusted suitably in accordance with the situation. For example, in use, only the first arm 16 and the second arm 17 may be expanded while the third arm 18 is put on the second arm 17 in a shortened length and fastened by the screw 20.

[0064]

In this manner, the length of the arm portion 13 is adjusted in accordance with the positional relation between the moving handrail 102 and the frame 105, and the arm type bracket 4 is fixed to the frame 105 of the escalator 100 by the fixation portion 12 provided on the other end side of the arm type bracket 4.

[0065]

The inside of the deck 104 and the inside of the frame 105 where the moving handrail 102 of the escalator 100 circulates are very narrow sites. If mounting work is intended to be carried out with the camera 2, the arm type bracket 4, etc. being linked, the workability in the work of inserting or installing the moving handrail deterioration diagnosis device 1 into the escalator 100 will be poor and the mounting will be difficult. However, when configuration

is made so that the camera mounting mechanism 3 and the arm type bracket 4 separated in advance are linked as they are set in the escalator 100, it is easy to insert each member even in the narrow sites. Thus, the user-friendliness is improved, and the working efficiency is also improved.

[0066]

The moving handrail 102 as the subject to be diagnosed may have various forms in accordance with the installation state. For example, the moving handrail 102 may be located above the frame 105 or may be located under the frame 105. However, the first rotary portion 14 with the first arm 16 and the second rotary portion 15 with the third arm 18 rotate in the up/down directions (the direction of the arrow D and the direction of the arrow F) around the first and third shafts 14a and 15a, so that the camera mounting mechanism 3 can keep riding on the moving handrail 102. In addition, the first rotary portion 14 with the link portion 11 and the second rotary portion 15 with the fixation portion 12 rotate in the left/right directions (the direction of the arrow E and the direction of the arrow G) around the second and fourth shafts 14b and 15b no matter which side (the left or right) the frame 105 and the moving handrail 102 are located on. Thus, the camera mounting mechanism 3 can keep riding on the moving handrail 102.

[0067]

In this manner, the moving handrail deterioration diagnosis device 1 can be fixed to the frame 105 of the escalator 100 by the arm portion 13 in the state where the camera mounting mechanism 3 is placed on the moving handrail 102. Accordingly, as shown in Fig. 3, the moving handrail deterioration diagnosis device 1 can be installed even in a narrow space 120 among the moving handrail 102, the frame 105 and the moving handrail support guides 110. Images can be taken in the same dimensions, the same reduction scale and the same imaging environment even if the images are taken while the escalator 100 is operated or even if the moving handrail 102 moves up/down and left/right without interfering with movable regions of the steps 101.

[0068]

Although the case where the arm type bracket 4 is used as a mounting member by way of example has been described in the embodiment, the invention is not limited thereto. For example, the mounting member may be constituted by a string, a chain or the like if it is a member which can be disposed in a predetermined position of the escalator 100 in the state where the camera mounting mechanism 3 is placed on the inner surface of the recess portion 102h of the moving handrail 102 without interfering with the camera mounting

mechanism 3 moving to track the motion of the moving handrail 102.

[0069]

In addition, although the example in which the arm type bracket 4 is fixed to the frame 105 has been described in the embodiment, the member for fixing the other end side of the mounting member may be any member if it is a non-running member in the passenger conveyor and if it does not interfere with the drive of the passenger conveyor when the mounting member is attached thereto.

[0070]

Further, although an escalator is used in the embodiment by way of example, it is a matter of course that the invention can be applied to well known passenger conveyors in general, including moving walkways.

[0071]

As described above, according to the embodiment, the following effects can be obtained.

[0072]

1) The moving handrail deterioration diagnosis device 1 is attached to the frame 105 movably in the up/down and left/right directions. Accordingly, the workability can be improved because special adjustment is not required for installation.

[0073]

2) The moving handrail deterioration diagnosis device 1 tracks the up/down and left/right motion of the moving handrail 102. Accordingly, the imaging range of the camera 2 does not diverge largely from the axis X, but the distance between the imaging lens portion 2a of the camera 2 and the canvas in the bottom 102a (as the subject to be imaged) of the moving handrail 102 is kept substantially constant. As a result, a normal moving handrail and a deteriorated moving handrail can be compared in the same relative position between the camera and each moving handrail. Thus, it is possible to increase the accuracy of determination in deterioration diagnosis. On that occasion, the moving handrail 102 moves very slightly up/down and left/right during the operation of the escalator 100. However, the camera mounting mechanism 3 tracks the motion of the moving handrail 102 so that the canvas surface can be put in predetermined dimensions within the field angle range of the camera 2 in order to determine the deterioration. Thus, when the camera 2 is placed in a position where the center of the canvas surface coincides with the center of an image, images can be taken continuously on the same conditions. As a result, the accuracy of diagnosis can be improved.

[0074]

3) Since the camera 2 and the LED lights 9a of the illumination device 9 are attached to the camera mounting mechanism 3, the distances

among the camera 2, the LED lights 9a and the bottom 102a (as the subject to be imaged) of the moving handrail 102 are kept substantially constant. Thus, the luminance unevenness in each image taken by the camera 2 can be suppressed. As a result, the accuracy of determination in the deterioration diagnosis can be improved.

[0075]

4) It will go well if the camera mounting mechanism 3 is linked to the link portion 11 of the arm portion 13 fixed to the frame 105. Accordingly, the camera mounting mechanism 3 can be placed very easily even in a narrow site inside the deck 104 of the escalator 100.

[0076]

5) Images are taken in the state where the distance between the imaging position and the canvas is substantially constant. Accordingly, deterioration can be determined with high accuracy. It is therefore possible to set the replacement or inspection timing of the moving handrail 102 in a suitable period.

[0077]

Incidentally, for example, the passenger conveyor in the scope of claims corresponds to the escalator 100 in the embodiment; the moving handrail corresponds to the reference sign 102; the recess portion corresponds to the reference sign 102h; the recess portion bottom corresponds to the reference sign 102a; the camera corresponds

to the reference sign 2; the moving handrail deterioration diagnosis device corresponds to the moving handrail deterioration diagnosis device 1 (and the data processing device 10); the camera mounting mechanism corresponds to the reference sign 3; the axis corresponds to the reference sign X; the tracking mechanism corresponds to the first and second fixed guides 6a and 6b, the first and second movable guides 7a and 7b, and the first to fourth wheels 5a, 5b, 5c and 5d; the non-running part corresponds to the frame 105; the mounting member corresponds to the arm type bracket 4; the wheel corresponds to the first to fourth wheels 5a, 5b, 5c and 5d; the one recess-portion-side end portion corresponds to the first end portion 102b; the fixed guide corresponds to the reference signs 6a and 6b; the other recess-portion-side end portion corresponds to the second end portion 102c; the movable guide corresponds to the reference signs 7a and 7b; the illumination device corresponds to the reference sign 9; the inside of the body of the passenger conveyor corresponds to the narrow space 120 among the moving handrail 102, the frame 105 and the moving handrail support guides 110; the link portion corresponds to the reference sign 11; the fixation portion corresponds to the reference sign 12; the plurality of members correspond to the first to third arms 16, 17 and 18; and the fixation member corresponds to the screws 19 and 20.

[0078]

Further, the invention is not limited to the aforementioned embodiment, but various modifications can be made without departing from the gist of the invention. All the technical items included in the technical ideas stated in the scope of claims are subject matters of the invention. The aforementioned embodiment shows a preferred example. From the contents disclosed herein, those skilled in the art can implement various alternatives, revisions, modifications or improvements, which are included in the technical scope stated in the scope of the accompanying claims.

[Reference Signs List]

[0079]

- 1 moving handrail deterioration diagnosis device
- 2 camera
- 3 camera mounting mechanism
- 4 arm type bracket
- 5a, 5b, 5c and 5d first to fourth wheels
- 6a and 6b first and second fixed guides
- 7a and 7b first and second movable guides
- 9 illumination device
- 10 data processing device
- 11 link portion

12 fixation portion

16, 17 and 18 first to third arms

19, 20 screw

100 escalator

102 moving handrail

102a recess portion bottom

102b first end portion (one recess-portion-side end portion)

102c second end portion (the other recess-portion-side end portion)

102h recess portion

105 frame

110 moving handrail support guide

120 space

X axis

[CLAIMS]

[Claim 1]

A moving handrail deterioration diagnosis device in which an image of a recess portion bottom of a moving handrail of a passenger conveyor is taken by a camera in the state in which the moving handrail is operated and a deterioration state of the moving handrail is diagnosed from the image taken by the camera, the moving handrail deterioration diagnosis device being characterized by comprising:

a camera mounting mechanism to which the camera is fixed and which is disposed within a recess portion of the moving handrail;

a tracking mechanism which allows the camera mounting mechanism to track the moving handrail along a longitudinal axis of the recess portion while touching the recess portion bottom and opposite side surfaces of the recess portion; and

a mounting member which has one end attached to the camera mounting mechanism and the other end attached to a non-running part serving as a constituent part of the passenger conveyor so that the mounting member supports the camera mounting mechanism on the non-running part while allowing tracking operation of the camera mounting mechanism using the tracking mechanism.

[Claim 2]

A moving handrail deterioration diagnosis device according

to Claim 1, characterized in that: the tracking mechanism includes:

a wheel which rotates in contact with the recess portion bottom of the moving handrail;

a fixed guide which touches one recess-portion-side end portion of the moving handrail; and

a movable guide which touches the other recess-portion-side end portion of the moving handrail while elastic force is given to the movable guide.

[Claim 3]

A moving handrail deterioration diagnosis device according to Claim 1 or 2, further comprising:

an illumination device which emits light to an imaging portion where each image of the moving handrail is taken by the camera; characterized in that:

the illumination device is attached to the camera mounting mechanism so that a relative position between the camera with the illumination device and the imaging portion is set at a predetermined position.

[Claim 4]

A moving handrail deterioration diagnosis device according to any one of Claims 1 through 3, characterized in that: the mounting member includes:

a link portion which can engage in link operation for linking the camera mounting mechanism therewith inside a body of the passenger conveyor; and

a fixation portion which is attached to the non-running part.

[Claim 5]

A moving handrail deterioration diagnosis device according to any one of Claims 1 through 3, characterized in that: the mounting member includes:

a plurality of members which are divided so as to be slidable longitudinally; and

a fixation member which fixes adjacent ones with each other in a desired sliding position.

[Claim 6]

A moving handrail deterioration diagnosis device according to Claim 4, characterized in that:

the link portion allows the linked camera mounting mechanism to rotate in a left/right direction and rotate in an up/down direction; and

the fixation portion allows the mounting member to rotate in the left/right direction and rotate in the up/down direction relatively to the non-running part.