

APPARATUS FOR DIAGNOSING DETERIORATION OF MOVING HANDRAIL IN PASSENGER CONVEYOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to an apparatus for diagnosing deterioration of a moving handrail of a passenger conveyor, which is used for diagnosing deterioration of a moving handrail provided in a passenger conveyor such as a moving handrail in an escalator and which is provided with a camera for photographing the surface or inside of the moving handrail.

2. Description of the Background Art

[0002]

JP-A-6-300713 or JP-A-2010-82689 has heretofore disclosed an apparatus which is provided with a camera for photographing the surface or inside of a subject to be diagnosed so that deterioration of the subject can be diagnosed based on images taken by the camera though the subject is not a moving handrail of a passenger conveyor.

[0003]

The background-art technique disclosed in JP-A-6-300713

is a defective condition inspection system which includes: a transducer for scanning the surface of a subject to be diagnosed with a contact-type sensor and detecting a stereoscopic defect in the surface of the subject; and a CCD camera and so on for detecting an internal defect of the subject.

[0004]

In addition, the background-art technique disclosed in JP-A-2010-82689 is a plate brick replacement determination apparatus which is provided with two CCD cameras which photograph a sliding surface of a subject to be diagnosed, so that irregularities in the surface of the subject can be determined based on three-dimensional coordinate values.

SUMMARY OF THE INVENTION

[0006]

It has been found out from recent studies that there is a close correlation between the degree of a change of a color tone in the surface of a moving handrail of a passenger conveyor and the progress of deterioration on the back side in a position where the color tone changes or in the inside of the moving handrail when the color tone of the surface of the moving handrail changes as compared with that when the moving handrail was new. According to the aforementioned background-art techniques

disclosed in JP-A-6-300713 and JP-A-2010-82689, indeed the irregularities of the surface of a subject to be diagnosed can be detected or the depth of a damage thereof can be measured, but there is no consideration about diagnosis of deterioration of the subject based on the change of the color tone in the surface of the subject.

[0007]

The present invention has been developed in consideration of the aforementioned actual circumstances in the background art. An object of the invention is to provide an apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor, by which deterioration of the moving handrail based on a change of a color tone in the surface of the moving handrail can be diagnosed.

[0008]

In order to attain the aforementioned object, an apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to the invention includes: a first camera which takes an image of a surface of the moving handrail in a state in which the moving handrail is moving due to running of the passenger conveyor; an image import portion to which the image taken by the first camera is imported; a control unit

which performs signal processing on the taken image imported to the image import portion and diagnoses deterioration of the moving handrail based on the image taken by the first camera; a radiation unit which includes a second camera connected to the image import portion and taking a radiographic image of the moving handrail; and a drive control portion which is connected to the control unit and drives the radiation unit; wherein: the control unit extracts a deviation between a color tone of the surface of the moving handrail obtained from the image taken by the first camera and a predetermined color tone of a surface of a new moving handrail, and performs arithmetic operation for identifying a position of the moving handrail in the image taken by the first camera when the extracted deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, and as soon as the identified position of the moving handrail reaches a position where the radiation unit is placed, the control unit outputs a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail, and performs control of processing for displaying the radiographic image taken by the second camera.

[0009]

According to the invention configured thus, an image of the surface of the moving handrail which is being moved due to the running of the passenger conveyor is taken by the first camera in order to diagnose deterioration of the moving handrail. The taken image is imported to the image import portion, and further transmitted from the image import portion to the control unit. The control unit extracts a deviation between the color tone of the surface of the moving handrail obtained from the image taken by the first camera and the predetermined color tone of the surface of the new moving handrail. The control unit performs arithmetic operation for identifying the position of the moving handrail in the image taken by the first camera when the extracted deviation exceeds a predetermined threshold. In this arithmetic operation, for example, a joint portion of the moving handrail formed to be endless is set as a reference position, and a distance from the reference position is obtained so as to identify the position of deterioration in the moving handrail.

[0010]

In the aforementioned state, as soon as the identified position of the moving handrail which is moving reaches a position where the radiation unit is placed, the control unit

outputs a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail. In this manner, radiation is emitted from the radiation unit to the moving handrail in the position where the moving handrail is regarded as deteriorated, so that a radiographic image of the moving handrail can be taken by the second camera. The radiographic image taken by the second camera is transmitted to the control unit through the image import portion. Processing for displaying the radiographic image is controlled by the control unit. Thus, the radiographic image in the position where the moving handrail is deteriorated can be grasped so that the deterioration of the moving handrail can be diagnosed accurately. That is, the invention can diagnose deterioration of the moving handrail based on the change of the color tone in the surface of the moving handrail.

[0011]

In addition, according to the invention, the control unit includes a 3D image synthesizing unit which synthesizes a 3D image of the moving handrail from images taken by the first camera and imported to the image import portion.

[0012]

In addition, according to the invention, the control unit

includes a deepest concave portion extracting unit which extracts a deepest concave portion in the surface of the moving handrail based on the 3D image synthesized by the 3D image synthesizing unit, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when a cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration.

[0013]

In addition, according to the invention, the control unit extracts a deepest concave portion color tone deviation which is a deviation between a color tone of the deepest concave portion and the predetermined color tone of the surface of the new moving handrail when the cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit is smaller than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail

when the deepest concave portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration.

[0014]

In addition, according to the invention, the control unit includes a highest convex portion extracting unit which extracts a highest convex portion in the surface of the moving handrail when the deepest concave portion color tone deviation is not larger than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when a swelling amount of the highest convex portion extracted by the highest convex portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration.

[0015]

Further, according to the invention, the control unit extracts a highest convex portion color tone deviation which is a deviation between a color tone of the highest convex portion and the predetermined color tone of the surface of the new moving handrail when the swelling amount of the highest convex portion

extracted by the highest convex portion extracting unit is smaller than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when the highest convex portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration.

[0016]

An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to configuration of the invention includes: a first camera which takes an image of a surface of the moving handrail; an image import portion to which the image taken by the first camera is imported; a control unit which performs signal processing on the taken image imported to the image import portion; a radiation unit which includes a second camera connected to the image import portion and taking a radiographic image of the moving handrail; and a drive control portion which is connected to the control unit and drives the radiation unit. Further, according to configuration of the invention, the control unit extracts a deviation between a color tone of the surface of the moving

handrail obtained from the image taken by the first camera and a predetermined color tone of a surface of a new moving handrail, and performs arithmetic operation for identifying a position of the moving handrail in the image taken by the first camera when the extracted deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, and as soon as the identified position of the moving handrail reaches a position where the radiation unit is placed, the control unit outputs a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail, and performs control of processing for displaying the radiographic image taken by the second camera. With this configuration, the invention can diagnose deterioration of the moving handrail based on the change of the color tone in the surface of the moving handrail. Thus, according to the invention, deterioration of the moving handrail can be diagnosed with higher accuracy than in the background art and the moving handrail can be inspected and replaced at a proper time so that a highly reliable apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017]

Fig. 1 is a view showing the configuration of an apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to an embodiment of the invention; and

Fig. 2 is a flow chart showing the procedure of processing to be executed by a personal computer provided in the apparatus according to the embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0018]

An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to an embodiment of the invention will be described below with reference to the drawings.

[0019]

In the embodiment, as shown in Fig. 1, the apparatus has a plurality of first cameras 2 and 3 for taking images of the surface of a moving handrail 1 in a state in which the moving handrail 1 is moving due to the running of the passenger conveyor, an image import portion 9 to which the images taken by the first cameras 2 and 3 are imported, and a control unit such as a personal computer 10 for performing signal processing on the taken images imported to the image import portion 9. A monitor 11 for

displaying images in accordance with display processing control performed by the personal computer 10 is connected to the personal computer 10.

[0020]

In addition, the apparatus according to the embodiment has a radiation unit 8 and a drive control portion 12. The radiation unit 8 has a second camera 7 connected to the image import portion 9 and taking a radiographic image of the moving handrail 1. The drive control portion 12 is connected to the personal computer 10 and drives the radiation unit 8.

[0021]

The radiation unit 8 has a radiation generator 4, a fluorescent screen (scintillator) 5 and a reflecting mirror 6. The radiation generator 4 is disposed on a back surface side of the moving handrail 1 and emits radiation, that is, X-rays. The fluorescent screen 5 is disposed on a front surface side of the moving handrail 1 and irradiated with the radiation which is emitted by the radiation generator 4 and transmitted through the moving handrail 1. The reflecting mirror 6 reflects a radiographic image of the fluorescent screen 5. The radiographic image reflected by the reflecting mirror 6 is taken by the second camera 7. The radiation unit 8 as a whole is

covered with a shield portion 8a. By the shield portion 8a, the radiation, that is, the X-rays, is prevented from leaking to the outside.

[0022]

The personal computer 10 fundamentally serves as follows. That is, the personal computer 10 extracts a deviation between a color tone in the surface of the moving handrail 1 obtained from each of the images taken by the first cameras 2 and 3 and a predetermined color tone in a surface of a new moving handrail 1. When the extracted deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs arithmetic operation for identifying the position of the moving handrail 1 in each of the images taken by the first cameras 2 and 3. As soon as the identified position of the moving handrail 1 reaches a position where the radiation unit 8 is placed, the personal computer 10 outputs a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1, and performs control of processing for displaying the radiographic image taken by the second camera 7. The personal computer 10 includes a 3D image synthesizing unit for synthesizing a 3D

image of the moving handrail 1 from the images taken by the first cameras 2 and 3 and imported to the image import portion 9.

[0023]

In addition, the personal computer 10 includes a deepest concave portion extracting unit for extracting a deepest concave portion in the surface of the moving handrail 1 based on the 3D image synthesized by the 3D image synthesizing unit. When a cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs control of processing for outputting a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1.

[0024]

In addition, the personal computer 10 extracts a deepest concave portion color tone deviation which is a deviation between a color tone of the deepest concave portion extracted by the deepest concave portion extracting unit and the predetermined color tone of the surface of the new moving handrail when the cutting amount of the deepest concave portion is smaller than

the predetermined threshold. When the deepest concave portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs control of processing for outputting a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1.

[0025]

In addition, the personal computer 10 includes a highest convex portion extracting unit which extracts a highest convex portion in the surface of the moving handrail 1 when the deepest concave portion color tone deviation is not larger than the predetermined threshold. When a swelling amount of the highest convex portion extracted by the highest convex portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs control of processing for outputting a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1.

[0026]

Further, the personal computer 10 extracts a highest

convex portion color tone deviation which is a deviation between a color tone of the highest convex portion extracted by the highest convex portion extracting unit and the predetermined color tone of the surface of the new moving handrail when the swelling amount of the highest convex portion is smaller than the aforementioned predetermined threshold. When the highest convex portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs control of processing for outputting a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1.

[0027]

The control of processing by which the embodiment configured thus is characterized will be described below.

[0028]

That is, images of the surface of the moving handrail 1 in a state in which the moving handrail 1 is moving due to the running of the passenger conveyor are taken by the first cameras 2 and 3 in order to diagnose deterioration of the moving handrail 1. The taken images are imported to the image import portion 9 and further transmitted from the image import portion

9 to the personal computer 10. The personal computer 10 extracts a deviation between a color tone in the surface of the moving handrail 1 chiefly obtained from the images taken by the first cameras 2 and 3 and a predetermined color tone in the surface of a new moving handrail. When the extracted deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, the personal computer 10 performs arithmetic operation for identifying the position of the moving handrail 1 in the images taken by the first cameras 2 and 3 at that time. In this arithmetic operation, for example, a joint portion of the moving handrail 1 formed to be endless is set as a reference position, and a distance from the reference position is obtained so as to identify the position of deterioration in the moving handrail 1.

[0029]

In the aforementioned state, as soon as the identified position of the moving handrail 1 which is moving reaches a position where the radiation unit 8 is placed, the personal computer 10 outputs a driving signal to the drive control portion 12 for the radiation unit 8 so as to allow the radiation to be transmitted through the moving handrail 1. Thus, in the identified position of the moving handrail 1 regarded as

occurrence of deterioration, the radiation, that is, the X-rays, is emitted from the radiation unit 8 toward the moving handrail 1, so that a radiographic image of the moving handrail 1 is taken by the second camera 7. The radiographic image taken by the second camera 7 is transmitted to the personal computer 10 through the image import portion 9. Processing for displaying the radiographic image is controlled by the personal computer 10 so that the radiographic image is displayed on the monitor 11.

[0030]

The control of processing by which the embodiment is characterized has been described above. The details of control including various kinds of processings to be performed by the personal computer 10 will be described below with reference to Fig. 2.

[0031]

Based on the taken images transmitted from the first cameras 2 and 3 through the image import portion 9, the personal computer 10 integrates and synthesizes movie frames of the first cameras 2 and 3 using the 3D image synthesizing unit so as to synthesize a 3D image of the moving handrail 1 (Step S1).

[0032]

Next, the personal computer 10 uses the deepest concave portion extracting unit to perform processing for extracting a deepest concave portion in the aforementioned 3D image by comparison between one section of the 3D image and another (Step S2).

[0033]

Next, the personal computer 10 calculates a cutting amount of the extracted deepest concave portion, which indicates the depth of the extracted deepest concave portion from the average coordinates of all the sections, and determines whether or not the cutting amount is at least a predetermined threshold which is a value regarded as occurrence of deterioration (Step S3).

[0034]

When the determination concludes that the cutting amount is not smaller than the threshold, the personal computer 10 obtains the distance of the deepest concave portion, for example, from the joint portion of the moving handrail 1 so as to identify the position of the deepest concave portion (Step S10). Next, the personal computer 10 sets a deterioration flag in the identified position of the deepest concave portion (Step S11).

[0035]

When the position of the deterioration flag reaches the

position where the radiation unit 8 is placed in accordance with the movement of the moving handrail 1, the personal computer 10 outputs a driving signal to the drive control portion 12 so as to emit the radiation, that is, the X-rays from the radiation generator 4 of the radiation unit 8 toward the moving handrail 1. The radiation transmitted through the moving handrail 1 moves via the fluorescent screen 5 and the reflecting mirror 6 and is photographed as a radiographic image by the second camera 7. The radiographic image is transmitted to the personal computer 10 through the image import portion 9. Processing for displaying the radiographic image is controlled by the personal computer 10 so that the radiographic image is displayed on the monitor 11 (Step S12).

[0036]

When the determination in Step S3 concludes that the cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit of the personal computer 10 is smaller than the predetermined threshold, the personal computer 10 extracts a deepest concave portion color tone deviation which is a deviation between a color tone of the deepest concave portion and the predetermined color tone of the surface of the new moving handrail 1 (Step S4).

[0037]

Next, the personal computer 10 determines whether or not the extracted deepest concave portion color tone deviation is at most a predetermined threshold which is a value regarded as occurrence of deterioration (Step S5).

[0038]

When the determination in Step S5 concludes that the deepest concave portion color tone deviation exceeds the threshold, processing in the aforementioned Steps S10, S11 and S12 is performed so that the radiographic image is displayed on the monitor 11.

[0039]

On the other hand, when the determination in Step S5 concludes that the deepest concave portion color tone deviation is not larger than the threshold, the personal computer 10 uses the highest convex portion extracting unit to perform processing for extracting a highest convex portion in the aforementioned 3D image by comparison between one section of the 3D image and another (Step S6).

[0040]

Next, the personal computer 10 calculates a swelling amount of the extracted highest convex portion, which indicates

the height of the extracted highest convex portion from the average coordinates of all the sections, and determines whether or not the swelling amount is at least a predetermined threshold which is a value regarded as occurrence of deterioration (Step S7).

[0041]

When the determination in Step S7 concludes that the swelling amount is not smaller than the threshold, the personal computer 10 identifies the position of the highest convex portion (Step S10). Processing in the aforementioned Steps S11 and S12 is performed so that the radiographic image is displayed on the monitor 11.

[0042]

On the other hand, when the determination in Step S7 concludes that the swelling amount of the highest convex portion is smaller than the threshold, the personal computer 10 extracts a highest convex portion color tone deviation which is a deviation between a color tone of the highest convex portion and the predetermined color tone of the surface of the new moving handrail (Step S8).

[0043]

Next, the personal computer 10 determines whether or not

the extracted highest convex portion color tone deviation is at most a predetermined threshold which is a value regarded as occurrence of deterioration (Step S9).

[0044]

When the determination in Step S9 concludes that the highest convex portion color tone deviation exceeds the threshold, processing in the aforementioned Steps S10, S11 and S12 is performed so that the radiographic image is displayed on the monitor 11.

[0045]

On the other hand, when the determination in Step S9 concludes that the highest convex portion color tone deviation is not larger than the threshold, the moving handrail 1 is diagnosed as not deteriorated, and the diagnosis of deterioration in the moving handrail 1 is terminated.

[0046]

According to the embodiment in which deterioration in the moving handrail 1 is diagnosed in the aforementioned configuration, it is possible to perform not only the diagnosis of deterioration of the moving handrail 1 based on the cutting amount of the moving handrail 1 and the diagnosis of deterioration of the moving handrail 1 based on the swelling

amount of the moving handrail 1 but also the diagnosis of deterioration of the moving handrail 1 based on the change of the color tone in the surface of the moving handrail 1. According to the embodiment, it is therefore possible to perform the diagnosis of deterioration of the moving handrail 1 with high accuracy and perform inspection and replacement of the moving handrail 1 at a proper time. Thus, it is possible to provide a highly reliable apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor.

[0047]

In addition, the area to perform the diagnosis of deterioration using X-rays can be narrowed in accordance with the change of the color tone in the surface of the moving handrail 1. It is therefore possible to improve the safety of a worker handling the X-rays and it is also possible to reduce the running cost. Further, the place where the diagnosis of deterioration should be performed based on X-ray images is identified. It is therefore possible to make determination with higher accuracy than in the procedure in which X-ray images of the whole moving handrail are taken and a position of deterioration is identified from the huge volume of X-ray images for the sake of the diagnosis of deterioration.

What is claimed is:

1. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor, comprising:

a first camera which takes an image of a surface of the moving handrail in a state in which the moving handrail is moving due to running of the passenger conveyor;

an image import portion to which the image taken by the first camera is imported;

a control unit which performs signal processing on the taken image imported to the image import portion and diagnoses deterioration of the moving handrail based on the image taken by the first camera;

a radiation unit which includes a second camera connected to the image import portion and taking a radiographic image of the moving handrail; and

a drive control portion which is connected to the control unit and drives the radiation unit; wherein:

the control unit extracts a deviation between a color tone of the surface of the moving handrail obtained from the image taken by the first camera and a predetermined color tone of a surface of a new moving handrail, and performs arithmetic operation for identifying a position of the moving handrail

in the image taken by the first camera when the extracted deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration, and as soon as the identified position of the moving handrail reaches a position where the radiation unit is placed, the control unit outputs a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail, and performs control of processing for displaying the radiographic image taken by the second camera.

2. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to Claim 1, wherein:

the control unit includes a 3D image synthesizing unit which synthesizes a 3D image of the moving handrail from images taken by the first camera and imported to the image import portion.

3. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to Claim 2, wherein:

the control unit includes a deepest concave portion extracting unit which extracts a deepest concave portion in the surface of the moving handrail based on the 3D image synthesized by the 3D image synthesizing unit, and the control unit performs control of processing for outputting a driving

signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when a cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration.

4. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to Claim 3, wherein:

the control unit extracts a deepest concave portion color tone deviation which is a deviation between a color tone of the deepest concave portion and the predetermined color tone of the surface of the new moving handrail when the cutting amount of the deepest concave portion extracted by the deepest concave portion extracting unit is smaller than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when the deepest concave portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration.

5. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to Claim 4, wherein:

the control unit includes a highest convex portion extracting unit which extracts a highest convex portion in the surface of the moving handrail when the deepest concave portion color tone deviation is not larger than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted through the moving handrail when a swelling amount of the highest convex portion extracted by the highest convex portion extracting unit is not smaller than a predetermined threshold which is a value regarded as occurrence of deterioration.

6. An apparatus for diagnosing deterioration of a moving handrail in a passenger conveyor according to Claim 5, wherein:

the control unit extracts a highest convex portion color tone deviation which is a deviation between a color tone of the highest convex portion and the predetermined color tone of the surface of the new moving handrail when the swelling amount of the highest convex portion extracted by the highest convex portion extracting unit is smaller than the predetermined threshold, and the control unit performs control of processing for outputting a driving signal to the drive control portion for the radiation unit so as to allow radiation to be transmitted

through the moving handrail when the highest convex portion color tone deviation exceeds a predetermined threshold which is a value regarded as occurrence of deterioration.