

PASSENGER CONVEYOR HANDRAIL INSPECTION APPARATUS, PASSENGER
CONVEYOR HANDRAIL INSPECTION METHOD, AND PASSENGER CONVEYOR
HANDRAIL INSPECTION PROGRAM

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001]

The present invention relates to a passenger conveyor handrail inspection apparatus, a passenger conveyor handrail inspection method and a passenger conveyor handrail inspection program. Particularly, it relates to image processing in an apparatus using radiation for diagnosing internal deterioration of a handrail.

2. Description of the Background Art

[0002]

In a passenger conveyor such as an escalator, steps on which passengers stand are linked to each other annularly and driven rotationally. In order to prevent the passengers from falling, handrails on which the passengers can put their hands are provided to be driven rotationally in connection with the steps. Each handrail is constituted by a plurality of components, including a cover of a resin material such as

urethane or rubber provided in the surface of the handrail and a component called a tension member provided internally in the handrail for retaining strength.

[0003]

As the aforementioned tension member, there are some members using a plurality of steel cords arranged in parallel. When the steel cords are broken or twisted, the strength of the handrail is lowered. In inspection of the handrail, it is therefore necessary to inspect whether the steel cords are normal or not. As a handrail inspection apparatus, there has been known an apparatus which includes a radiation generator and a fluorescent portion and which performs inspection based on a through-transmission image generated by transmission through the handrail.

[0004]

As the aforementioned inspection apparatus based on a through-transmission image, there has been known an apparatus in which a radiation generator and a fluorescent portion are disposed to put a handrail therebetween, the handrail is irradiated with radiation, and the fluorescent portion emitting light on receipt of the radiation transmitted through the handrail is photographed to generate a through-transmission

image (e.g. JP-A-2003-048683). When the apparatus disclosed in JP-A-2003-048683 is used, it is possible to find out abnormality in the moving handrail by visual observation of the through-transmission image reflected on the fluorescent portion.

[0006]

The technique disclosed in JP-A-2003-048683 has the following disadvantages. One of the disadvantages is that since a person observing the through-transmission image determines whether it is good or bad, the determination cannot be made quantitatively to thereby lead to a variation in the result of the determination. The other disadvantage is that the condition of rubber or the like around steel cords buried in the moving handrail is not known though the condition of the steel cords themselves is reflected in the through-transmission image.

SUMMARY OF THE INVENTION

[0007]

The invention has been developed in consideration of the aforementioned problems. An object of the invention is to provide a passenger conveyor handrail inspection apparatus, a passenger conveyor handrail inspection method and a passenger

conveyor handrail inspection program, in which deterioration including deterioration around a tension member can be determined and the deterioration can be determined easily.

[0008]

In order to attain the aforementioned object, according to an aspect of the invention, there is provided a passenger conveyor handrail inspection apparatus for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, including: an image acquisition portion which acquires the through-transmission image generated with information indicating luminance as each pixel; a color conversion portion which converts each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, and generates a colored image from the color information; and a deterioration determination portion which determines deterioration of the handrail based on color of each pixel forming the generated colored image. Thus, it is possible to provide a passenger conveyor handrail inspection apparatus, in which deterioration including deterioration around a tension member can be determined and

the deterioration can be determined easily.

[0009]

Preferably, the deterioration determination portion compares the newly generated colored image with a colored image which has been set as a subject for determination of the deterioration of the handrail, and determines the deterioration of the handrail based on a difference between the colored images. Thus, it is possible to determine deterioration with age.

[0010]

Preferably, the passenger conveyor handrail inspection apparatus further includes a storage portion which stores the generated colored image in order to set the generated colored image as a subject for the comparison. Thus, it is possible to easily acquire images for determining the deterioration with age.

[0011]

Preferably, the passenger conveyor handrail inspection apparatus includes: a tension member recognition portion which recognizes a tension member contained in the handrail in the acquired through-transmission image; and a luminance adjustment portion which adjusts luminance of the through-transmission image as a whole based on luminance of

the recognized tension member; wherein: the color conversion portion generates the colored image based on the through-transmission image whose luminance has been adjusted. Thus, it is possible to cancel errors in luminance among the images caused by differences in photographing conditions or the like.

[0012]

Preferably, the tension member recognition portion recognizes a low-luminance portion as the tension member in the generated through-transmission image. Thus, it is possible to recognize the tension member easily.

[0013]

Preferably, the tension member recognition portion recognizes the tension member based on a predetermined arrangement pattern of the tension member. Thus, it is possible to recognize the tension member easily.

[0014]

Preferably, the passenger conveyor handrail inspection apparatus further includes a tension member deterioration determination portion which recognizes the tension member contained in the handrail in the acquired through-transmission image and determines deterioration of the tension member. Thus,

it is possible to determine deterioration of the tension member itself and determine total deterioration.

[0015]

Preferably, the passenger conveyor handrail inspection apparatus further includes a display processing portion which generates and outputs display information for displaying the generated colored image based on the generated colored image. Thus, it is possible to allow a user to visually recognize the through-transmission image.

[0016]

According to another aspect of the invention, there is provided a passenger conveyor handrail inspection method for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, including the steps of: acquiring the through-transmission image generated with information indicating luminance as each pixel, and storing the acquired through-transmission image into a storage medium; converting each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, generating a colored image from the color information, and storing the

generated colored image into a storage medium; and determining deterioration of the handrail based on color of each pixel forming the generated colored image, and outputting information indicating a result of the determination.

[0017]

According to a further aspect of the invention, there is provided a passenger conveyor handrail inspection program for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, the program making an information processing apparatus execute the steps of: acquiring the through-transmission image generated with information indicating luminance as each pixel, and storing the acquired through-transmission image into a storage medium; converting each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, generating a colored image from the color information, and storing the generated colored image into a storage medium; and determining deterioration of the handrail based on color of each pixel forming the generated colored image, and outputting information indicating a result of the determination.

[0018]

According to the invention, it is possible to provide a passenger conveyor handrail inspection apparatus, a passenger conveyor handrail inspection method and a passenger conveyor handrail inspection program, in which deterioration including deterioration around a tension member can be determined and the deterioration can be determined easily.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Fig. 1 is a view schematically showing the overall configuration of a passenger conveyor handrail inspection apparatus according to an embodiment of the invention;

Fig. 2 is a block diagram showing the hardware configuration of a PC according to the embodiment of the invention;

Fig. 3 is a block diagram showing the functional configuration of the PC according to the embodiment of the invention;

Fig. 4 is a flow chart showing the operation of the PC according to the embodiment of the invention;

Fig. 5 is a view showing a color conversion table according to the embodiment of the invention; and

Fig. 6 is view schematically showing a colored image according to the embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020]

An embodiment of the invention will be described in detail below with reference to the drawings. In the embodiment, description will be made on a handrail inspection apparatus, in which a handrail to be inspected is photographed with X-rays, and an image generated by the X-ray photographing is colored in accordance with luminance of the image so as to make it easy to confirm the image.

[0021]

Fig. 1 is a view schematically showing the configuration of a handrail inspection apparatus according to the embodiment and the positional relation between the handrail inspection apparatus and a handrail 2. As shown in Fig. 1, the handrail inspection apparatus according to the embodiment includes a radiation generator 1, an optical receiver 3, a video capture 4, a PC (Personal Computer) 5 and an optical mouse 6 for odometry. In addition, the optical receiver 3 includes a scintillator 3a, a reflector 3b and a camera 3c.

[0022]

The radiation generator 1 is arranged to irradiate the handrail 2 with radiation for transmission through the handrail 2. An X-ray source is used as the radiation generator 1 in the embodiment. The radiation generator 1 and the optical receiver 3 are set to put the handrail 2 therebetween. The set of the radiation generator 1 and the optical receiver 3 and the handrail 2 are moved relatively to each other so as to perform inspection all over the handrail 2.

[0023]

When the set of the radiation generator 1 and the optical receiver 3 and the handrail 2 are moved relatively to each other, the set of the radiation generator 1 and the optical receiver 3 may be moved relatively to the handrail 2 or the handrail 2 may be moved relatively to the set of the radiation generator 1 and the optical receiver 3.

[0024]

In the optical receiver 3, the scintillator 3a is disposed so as to be opposed to the radiation generator 1 through the handrail 2. X-rays radiated from the radiation generator 1 are transmitted through the handrail 2 and reach the scintillator 3a. The scintillator 3a emits luminescence on receipt of the X-rays. The luminescence emitted from the scintillator 3a is

reflected by the reflector 3b and guided to the camera 3c. Thus, a through-transmission image of the handrail 2 is picked up by the camera 3c, and the through-transmission image is generated in the optical receiver 3.

[0025]

The video capture 4 applies digital conversion to the through-transmission image generated by the optical receiver 3 and generates digital data of the through-transmission image (hereinafter referred to as digital image data). The digital image data generated by the video capture 4 are supplied to the PC 5 and stored therein. Thus, the digital image data of the through-transmission image generated with information indicating the luminescence intensity of the scintillator 3a, that is, information indicating the luminance as each pixel, are generated and stored in the PC 5.

[0026]

The optical mouse 6 for odometry reads the surface of the handrail 2 in accordance with the relative movement between the set of the radiation generator 1 and the optical receiver 3 and the handrail 2 and supplies a result of the reading to the PC 5. Thus, the PC 5 acquires the result of the reading by the optical mouse 6 for odometry and stores the result of

the reading into a storage medium. In accordance with the result of the reading, the PC 5 recognizes the relative movement distance between the set of the radiation generator 1 and the optical receiver 3 and the handrail 2.

[0027]

Based on the information stored thus in the PC 5, processing for inspecting the handrail 2 according to the embodiment is executed in the PC 5. Here, the hardware configuration of the PC 5 will be described with reference to Fig. 2. As shown in Fig. 2, the PC 5 according to the embodiment includes a configuration similar to that of a general server or PC etc. That is, in the PC 5 according to the embodiment, a CPU (Central Processing Unit) 10, a RAM (Random Access Memory) 20, a ROM (Read Only Memory) 30, an HDD (Hard Disk Drive) 40 and an I/F 50 are connected through a bus 80. In addition, an LCD (Liquid Crystal Display) 60 and an operation portion 70 are connected to the I/F 50.

[0028]

The CPU 10 is a computing unit, which controls the operation of the PC 5 as a whole. The RAM 20 is a volatile storage medium from/into which information can be read/written at a high speed. The RAM 20 is used as a work area when the

CPU 10 processes information. The ROM 30 is a read-only nonvolatile storage medium, in which a program such as firmware is stored. The HDD 40 is a nonvolatile storage medium from/into which information can be read/written. An OS (Operating System), various control programs, application programs, etc. are stored in the HDD 40.

[0029]

The I/F 50 connects various hardware, networks, etc. with the bus 80 and controls the various hardware, the networks, etc. The LCD 60 is a visual user interface on which the user can confirm the condition of the PC 5. The operation portion 70 is a user interface such as a keyboard, a mouse, a touch panel, various buttons, etc. by which the user can input information into the PC 5.

[0030]

In the hardware configuration, a program stored in the ROM 30, the HDD 40 or a not-shown storage medium such as an optical disk is read into the RAM 20 and operates under the control of the CPU 10. In this manner, a software control portion is formed. A functional block for implementing functions of the PC 5 according to the embodiment is constituted by the combination of the hardware and the software control portion

configured thus.

[0031]

Next, the functional configuration of the PC 5 according to the embodiment will be described with reference to Fig. 3. As shown in Fig. 3, the PC 5 according to the embodiment includes an image data input portion 21, a steel cord deterioration determination portion 22, a steel cord pattern recognition portion 23, an image luminance calculation portion 24, a coloring processing portion 25, an image comparison portion 26, an image database 27, a deterioration determination portion 28 and a total deterioration determination portion 29 in order to implement functions as a handrail inspection apparatus.

[0032]

The respective functions shown in Fig. 3 are implemented by the CPU 10 for performing arithmetic operation in accordance with a program for implementing the functions, a storage unit such as the HDD 40, a dedicated integrated circuit, etc. Processing based on the respective functions of the PC 5 shown in Fig. 3 will be described with reference to a flow chart of Fig. 4. First, the image data input portion 21 serves as an image acquisition portion. Thus, digital image data stored in the PC 5 are read by the image data input portion 21.

[0033]

When digital image data are read by the image data input portion 21, the steel cord pattern recognition portion 23 recognizes a portion corresponding to the steel cords out of the digital image data, and the image luminance calculation portion 24 corrects the luminance of the image as a whole based on the luminance of the portion corresponding to the steel cords in order to normalize the luminance of the image as a whole (S401). That is, the steel cord pattern recognition portion 23 serves as a tension member recognition portion while the image luminance calculation portion 24 serves as a luminance adjustment portion.

[0034]

In the embodiment, X-rays radiated by the radiation generator 1 are not transmitted through the portion corresponding to the steel cords. Accordingly, the portion corresponding to the steel cords in the digital image data is the lowest luminance portion. The image luminance calculation portion 24 according to the embodiment divides the luminance of the digital image data as a whole by the luminance of the portion corresponding to the steel cords, so as to correct the luminance on the basis of a fixed criterion. Thus, the luminance

of the digital image data can be compared with that of another different digital image data.

[0035]

Specifically, there is a possibility that different digital image data have different scales of luminance due to difference in photographing conditions, difference in conversion conditions for digital image conversion, or the like. However, in the condition that the luminance of the portion corresponding to the steel cords is the lowest and the same in any image, different digital images can be compared with each other by the aforementioned calculation of luminance.

[0036]

In order to make it easy to identify the portion where the steel cords are reflected in the digital image data, the steel cord pattern recognition portion 23 stores the pattern of a correct array of steel cords and recognizes the portion corresponding to the steel cords in accordance with the pattern. In addition, since the portion corresponding to the steel cords is a low-luminance portion as described above, the steel cord pattern recognition portion 23 may recognize a low-luminance portion as the portion corresponding to the steel cords in the digital image data. Examples of the aforementioned method for

determining a low-luminance portion include a method for extracting a portion whose luminance is not higher than a predetermined threshold, a method for extracting a portion whose luminance is the lowest on a scale, etc.

[0037]

When the luminance of the image data is normalized by the image luminance calculation portion 24, the coloring processing portion 25 then performs a coloring process for converting each pixel forming the digital image data into a color corresponding to the luminance of the pixel (S402). That is, the coloring processing portion 25 serves as a color conversion portion. Fig. 5 is a view showing a color conversion table to be referred to by the coloring processing portion 25 when the coloring processing portion 25 performs the coloring process. As shown in Fig. 5, the range of luminance after normalization is segmented into some stages in the color conversion table, and the stages are associated with colors respectively. While referring to the color conversion table shown in Fig. 5, the coloring processing portion 25 converts each pixel forming the normalized digital image data into color information so as to generate a colored image.

[0038]

Such conversion into color information in accordance with the luminance of each pixel based on the color conversion table is one of the essences of the embodiment. The significance of the color conversion process will be described below. Typically, the surroundings of the steel cords inside the handrail 2 are fixed by rubber. When the binding of the steel cords is loosened due to deterioration of the rubber, the steel cords come into contact with one another to cause friction wear among the steel cords. It has been known that the steel cords are disconnected with the progress of the friction wear. In order to avoid such disconnection in advance, it is effective to grasp the deterioration of the rubber.

[0039]

When the rubber deteriorates, the amount of X-rays transmitted through the rubber changes to thereby change the luminance of a portion corresponding to the deteriorated portion in image data generated as a result. For example, when the thickness of a certain portion is reduced, the amount of X-rays transmitted through the thin portion increases to increase the luminance of the portion consequently. It is therefore possible to determine the condition of the deterioration of the rubber when increase in the luminance of the portion than

that in the result of the previous measurement is checked.

[0040]

Fig. 6 is a view showing an example of digital image data P subjected to a coloring process. The hatched portion in Fig. 6 is a portion colored in chromatic color. In addition, the black-line portion in Fig. 6 is a portion which is also black in an actual colored image and where the steel cords are reflected.

[0041]

As shown in Fig. 6, the condition of each portion can be determined more obviously at a glance by display in which the luminance of each pixel is converted into color information than display only with contrast as in the original digital image data. Thus, the possibility of making wrong determination is low even if the determination is made based on visual observation. In the digital image data P shown in Fig. 6, there is a red portion in a third-layer portion from the bottom of an enlarged view P_1 . It is therefore possible to confirm the progress of deterioration of the rubber.

[0042]

When the coloring process is completed, the image comparison portion 26 then selects and reads colored image data

generated in the previous inspection (hereinafter referred to as comparative image data) from the image database 27 serving as a storage portion (S403). The image comparison portion 26 superimposes the digital image data which have been just subjected to the coloring process and generated this time (hereinafter referred to as image data to be inspected) on the comparative image data for the sake of comparison (S404). The digital image data stored in the image database 27 are digital image data subjected to the coloring process by the coloring processing portion 25 and generated in the inspection which has been already executed in the handrail inspection apparatus.

[0043]

In S404, the image comparison portion 26 determines the change of color between the comparative image data and the image data to be inspected. That is, the image comparison portion 26 calculates a difference in the area of each color composing pixels between the comparative image data and the image data to be inspected. In other words, the image comparison portion 26 counts pixels forming the comparative image data and pixels forming the image data to be inspected for each color shown in Fig. 5, and calculates a difference in the number of pixels for each color to generate a result of image comparison. That

is, in the embodiment, it is not necessary to compare pixels of the image data to be inspected and pixels of the comparative image data in one to one correspondence, so that it is possible to simplify the process. The comparison is not limited to the aforementioned manner but may be performed in one to one correspondence between the pixels of the image data to be inspected and the pixels of the comparative image data.

[0044]

When the result of comparison between the digital image data is generated as described above by the image comparison portion 26, the deterioration determination portion 28 compares the difference in the number of pixels for each color as the result of comparison with a predetermined threshold (S405), so as to determine whether deterioration of the handrail is confirmed in the image data to be inspected or not. In S405, the deterioration determination portion 28 determines whether deterioration of the handrail is confirmed or not based on whether the aforementioned difference in the number of pixels for each color is higher than the predetermined threshold or not. That is, in the embodiment, the image comparison portion 26 and the deterioration determination portion 28 work together to serve as a deterioration determination portion.

[0045]

When the difference in the number of pixels for each color is higher than the threshold as a result of the determination in S405 (Yes in S405), the total deterioration determination portion 29 concludes that there is deterioration in a portion other than the portion corresponding to the steel cords, such as a rubber portion of the handrail (S406).

[0046]

On the contrary, when the difference in the number of pixels for each color is not higher than the threshold (No in S405), the steel cord deterioration determination portion 22 then determines deterioration of the steel cords themselves (S407). That is, the steel cord deterioration determination portion 22 serves as a tension member deterioration determination portion. In S407, the steel cord deterioration determination portion 22 recognizes the low-luminance portion as the portion corresponding to the steel cords in the digital image data read by the image data input portion 21, and determines whether the portion recognized as the steel cords agrees with the predetermined number of steel cords or not and whether disconnection or deflection occurs in the steel cords or not.

[0047]

As a specific example of the determination in S407, assume that nine steel cords are used in the handrail. In this case, the steel cords are regarded as deteriorated when eight of the steel cords cannot be distinguished clearly as the low-luminance portion in the image.

[0048]

When there is deterioration as a result of the determination in S407 (Yes in S408), the total deterioration determination portion 29 concludes that deterioration occurs in the steel cords (S409). On the contrary, when there is no deterioration as a result of the determination in S407 (No in S408), the total deterioration determination portion 29 concludes that deterioration does not occur in the handrail (S410), and the process is terminated.

[0049]

When deterioration of the handrail is determined thus, the total deterioration determination portion 29 generates and outputs display information for displaying the generated colored image on the LCD 60. In this manner, the colored image of the handrail determined as deteriorated is displayed on the LCD 60 so that a user can confirm the image. That is, the total deterioration determination portion 29 serves as a display

processing portion.

[0050]

As described above, in the passenger conveyor handrail inspection apparatus according to the embodiment, luminance of a through-transmission image is converted into color information so that deterioration can be determined easily. In addition, change in the luminance of the through-transmission image chiefly appears in an elastic body such as rubber forming the handrail. It is therefore possible to determine deterioration including deterioration in the surroundings of steel cords serving as a tension member.

[0051]

That is, in the passenger conveyor handrail inspection apparatus according to the embodiment, deterioration in the handrail can be grasped multi-directionally based on determination of deterioration in the steel cords themselves and determination of deterioration in the rubber around the steel cords. Accordingly, it is possible to provide a method very effective in optimizing the period of inspection.

[0052]

The aforementioned embodiment has been described in the case where digital image data generated as image data to be

inspected and subjected to inspection are stored in the image database 27 and used as comparative image data in subsequent inspection, by way of example. However, the invention is not limited to the case where the image data which have been inspected previously are used as comparative image data, but configuration may be made so that image data generated separately as comparative image data, are used each time.

[0053]

On the other hand, when the image data to be inspected which have been used in previous inspection are used as comparative image data, deterioration with age can be determined. In addition, when an image database is provided, the aforementioned comparative image data can be acquired easily.

[0054]

In addition, the aforementioned embodiment has been described in the case where determination based on color is performed and steel cords are then determined when a difference beyond a threshold is not confirmed, by way of example. However, the determination based on color and the determination of the steel cords may be executed in parallel from the start.

What is claimed is:

1. A passenger conveyor handrail inspection apparatus for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, comprising:

an image acquisition portion which acquires the through-transmission image generated with information indicating luminance as each pixel;

a color conversion portion which converts each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, and generates a colored image from the color information; and

a deterioration determination portion which determines deterioration of the handrail based on color of each pixel forming the generated colored image.

2. A passenger conveyor handrail inspection apparatus according to Claim 1, wherein:

the deterioration determination portion compares the newly generated colored image with a colored image which has been set as a subject for determination of the deterioration of the handrail, and determines the deterioration of the handrail

based on a difference between the colored images.

3. A passenger conveyor handrail inspection apparatus according to Claim 2, further comprising:

a storage portion which stores the generated colored images in order to set the colored image as a subject for the comparison.

4. A passenger conveyor handrail inspection apparatus according to any one of Claims 1 through 3, further comprising:

a tension member recognition portion which recognizes a tension member contained in the handrail in the acquired through-transmission image; and

a luminance adjustment portion which adjusts luminance of the through-transmission image as a whole based on luminance of the recognized tension member; wherein:

the color conversion portion generates the colored image based on the through-transmission image whose luminance has been adjusted.

5. A passenger conveyor handrail inspection apparatus according to Claim 4, wherein:

the tension member recognition portion recognizes a low-luminance portion as the tension member in the generated through-transmission image.

6. A passenger conveyor handrail inspection apparatus according to Claim 4, wherein:

the tension member recognition portion recognizes the tension member based on a predetermined arrangement pattern of the tension member.

7. A passenger conveyor handrail inspection apparatus according to any one of Claims 1 through 6, further comprising:

a tension member deterioration determination portion which recognizes the tension member contained in the handrail in the acquired through-transmission image and determines deterioration of the tension member.

8. A passenger conveyor handrail inspection apparatus according to any one of Claims 1 through 7, further comprising:

a display processing portion which generates and outputs display information for displaying the generated colored image based on the generated colored image.

9. A passenger conveyor handrail inspection method for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, comprising the steps of:

acquiring the through-transmission image generated with information indicating luminance as each pixel, and storing

the acquired through-transmission image into a storage medium;

converting each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, generating a colored image from the color information, and storing the generated colored image into a storage medium; and

determining deterioration of the handrail based on color of each pixel forming the generated colored image, and outputting information indicating a result of the determination.

10. A passenger conveyor handrail inspection program for inspecting a passenger conveyor handrail based on a through-transmission image generated by transmission through the handrail, the program making an information processing apparatus execute the steps of:

acquiring the through-transmission image generated with information indicating luminance as each pixel, and storing the acquired through-transmission image into a storage medium;

converting each pixel forming the acquired through-transmission image into color information based on a color conversion table in which luminance and color are associated with each other, generating a colored image from

the color information, and storing the generated colored image into a storage medium; and

determining deterioration of the handrail based on color of each pixel forming the generated colored image, and outputting information indicating a result of the determination.