Title: IMAGE AND SOUND RECORDING DEVICE FOR VEHICLE

Abstract: Provided is an apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, which includes an image photographing portion photographing an outside image out of a window and outputting an analog image signal, a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal, an image analysis portion analyzing the digital image signal and extracting an image property related to weather, an event detection portion detecting an event during operation of the vehicle, a control portion controlling operation of a wiper of the vehicle by comparing an extracted image property with a predetermined critical value and controlling monitored image and sound to be stored when the event is detected by the event detection portion, an image compression portion compressing the digital image signal and outputting a compressed digital image data, and a storing portion storing the compressed image data.
Description

IMAGE AND SOUND RECORDING DEVICE FOR VEHICLE

Technical Field

[1] The present invention relates to an apparatus for recording image and sound for a vehicle, and more particularly, to an apparatus for recording image and sound for a vehicle which can provide information relating to the running of the vehicle when a vehicle accident occurs and simultaneously control convenience equipments in the vehicle by using a camera installed in the vehicle.

Background Art

[2] Technologies for vehicle safety operation supporting apparatuses have been developed which can store image and sound using an image recording apparatus such as a camera and a sound recording apparatus such as a microphone which are installed in the vehicle and simultaneously secure the stored image and sound information as evidence material about a situation before and after an accident, when an even such as an accident, a fire, or other emergency situations occurring to the vehicle is recognized.

Disclosure of Invention

Technical Problem

[3] Korean Patent No. 10-0369743 discloses an apparatus for recording image for a vehicle which comprises a camera installed at a predetermined position in the vehicle and photographing the surrounding of the vehicle, an encoding portion converting an image signal transmitted from the camera to a digital image signal, a control portion receiving the digital image signal transmitted from the encoding portion, performing a predetermined control operation, and transmitting a controlled image signal to a storing portion and an output portion, the storing portion storing the image signal transmitted from the control portion and a data signal transmitted from a real time switch in units of memory blocks, an operation panel provided at the front side of the apparatus for recording image for a vehicle and generating a predetermined operation signal according to a user's operation instruction, the real time switch generating a data signal about the current date and time and transmitting the same to the control portion, an outside display device incorporated in the output portion and displaying the image signal of the camera transmitted from the control portion and the data signal transmitted from the real time switch so as to be visually recognized, an outside output
port incorporated in the output portion and transmitting the data stored in the storing portion to outside devices, and a second storing portion having two units of storing blocks and, when the user operates a storing button 2 provided on the operation panel, sequentially transmitting and storing from the latest time recording data to the earliest time recording data among the data stored in the storing portion with respect to the time point when the second button 2 is operated according to a control signal of the control portion and storing in real time the data transmitted from the camera and the real time switch under the control of the control portion from the time point when the storing button 2 is operated in the second block.

However, since the above conventional apparatus for recording image for a vehicle is only used for verifying an accident dispute after an accident occurs and becomes useless if an event does not occurs, the user is highly likely to feel an operational efficiency of the apparatus very low so that it is difficult for an automobile industry to actively employ the apparatus.

In the meantime, PCT Publication No. WO 99/47396 discloses an apparatus for automatically operating a wiper by sensing rain. According to the publication, to detect an environmental factor affecting a visual range, the apparatus includes at least one transmitter using an electromagnetic wave (optical wave) and at least one receiver. Simultaneously, a measuring circuit between the transmitter and the receiver is installed on a window. When a layer in the window is generated to propagation of a wave between the transmitter and the receiver, for example, the window is wet by rainfall, an output signal transmitted by the transmitter is affected to be changed. The output signal is used for the control of a wiper blade apparatus.

Korean Patent No. 10-0410936 discloses an apparatus and method for controlling illumination for a vehicle according to surrounding illuminance. According to the patent, the amount of light input is measured by an optical sensor around a vehicle so that illumination of a head light, a tail light, an instrument panel light, etc. is automatically controlled.

However, according to the above conventional convenience equipment control method, since an additional apparatus needs to be installed when the apparatus is not already installed in a vehicle, a portion for sensing rain and a portion for sensing the light amount are separated provided, and in particular, an additional convenience equipment controller is required even when a camera is installed in a vehicle to secure operation information, an efficiency of the apparatus is low.

**Technical Solution**
To solve the above and/or other problems, the present invention provides an apparatus for recording image and sound for a vehicle which can record and check operation information regarding a vehicle accident by installing an image photographing portion in the vehicle and simultaneously control various convenience equipments installed in the vehicle.

The present invention provides an apparatus for recording image and sound for a vehicle which can record and check operation information regarding a vehicle accident by installing an image photographing portion in the vehicle and simultaneously has an image correction function to improve visibility of image photographed by an image photographing portion installed in the vehicle.

According to an aspect of the present invention, in an apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, the apparatus comprises an image photographing portion photographing an outside image out of a window and outputting an analog image signal, a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal, an image analysis portion analyzing the digital image signal and extracting an image property related to weather, an event detection portion detecting an event during operation of the vehicle, a control portion controlling operation of a wiper of the vehicle by comparing an extracted image property with a predetermined critical value and controlling monitored image and sound to be stored when the event is detected by the event detection portion, an image compression portion compressing the digital image signal and outputting a compressed digital image data, and a storing portion storing the compressed image data.

The image property comprises at least sharpness of an image, the image analysis portion comprises a sharpness analysis portion which analyzes the sharpness of the image based on an energy amount of a high frequency component of the image, and the control portion comprises a wiper operation control portion which determines whether to operate the wiper based on the analyzed sharpness.

According to another aspect of the present invention, in an apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, the apparatus comprises an image photographing portion photographing an outside image out of a window and outputting an analog image signal, a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal, an
image analysis portion analyzing the digital image signal and extracting an image property related to brightness outside the window, an event detection portion detecting an event during operation of the vehicle, a control portion controlling operation of an illumination apparatus of the vehicle by comparing an extracted image property with a predetermined critical value and controlling monitored image and sound to be stored when the event is detected by the event detection portion, an image compression portion compressing the digital image signal and outputting a compressed digital image data, and a storing portion storing the compressed image data.

The image property comprises brightness of the image, the image analysis portion comprises at least one brightness analysis portion which analyzes the brightness of the image by analyzing a gray level of each of pixels forming the image, and the control portion comprises at least one light operation control portion which determines whether to operate a light or a tail light based on the analyzed brightness.

According to another aspect of the present invention, in an apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, the apparatus comprises an image photographing portion photographing an outside image cut of a window and outputting an analog image signal, a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal, an image correction portion receiving the digital image signal, performing image correction including at least one of contrast stretching and histogram equalization, and outputting a corrected digital image signal, an event detection portion detecting an event during operation of the vehicle, a control portion controlling monitored image and sound to be stored when the event is detected by the event detection portion, an image compression portion compressing the corrected digital image signal and outputting a compressed digital image data, and a storing portion storing the compressed image data.

**Advantageous Effects**

The apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can control various convenient equipments installed in a vehicle such as the wiper or the light, by installing the image photographing portion in the vehicle. Also, the apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can improve visibility of a photographed
image through the image correction, by installing the image photographing portion in the vehicle.

Description of Drawings

[17] FIG. 1 is a block diagram of an apparatus for recording image and sound for a vehicle according to an embodiment of the present invention;

[18] FIG. 2 is a flow chart for explaining major steps of an operation performed in the apparatus of FIG. 1;

[19] FIGS. 3, 4, 5, and 6 are graphs illustrating a step of analyzing brightness and contrast of an image in an image analysis portion;

[20] FIG. 7 is a view illustrating an example of the operation of the image analysis portion; and

[21] FIG. 8 is a view illustrating an example of the operation of the image correction portion.

[22] FIG. 9 is a view for explaining an embodiment of operating a wiper by analyzing distortion of an image when it rains lightly.

Best Mode

[23] Referring to FIG. 1, an apparatus for recording image and sound for a vehicle according to an embodiment of the present invention is installed in a vehicle, monitors outside image and sound, and stores monitored image and sound when an event occurs. The apparatus for recording image and sound for a vehicle includes an image photographing portion 102 such as a camera photographing outside image out of a window and outputting an analog image signal, a decoding portion 104 decoding the photographed outside analog image signal and outputting a digital image signal, and an image analysis portion 106 extracting an image property related to weather and/or brightness out of the window by analyzing the digital image signal. The image photographing portion 102 is installed inside the vehicle, preferably at an inner surface of a front glass window of the vehicle.

[24] In the present embodiment, the image analysis portion 106 includes a sharpness analysis portion 108 and a brightness analysis portion 110. Also, the apparatus for recording image and sound for a vehicle includes a sound collecting portion 142 such as a microphone collecting outside sound, an A/D converting portion 144 converting an analog sound signal to a digital sound signal, and a sound compression portion 146 compressing a digital sound signal.

[25] The apparatus for recording image and sound for a vehicle includes a vehicle operation information I/F portion 150 inputting vehicle operation information such as
speeds, time, and directions, an event detection portion 152 detecting an event during
the operation of a vehicle, an automatic wiper operation switch 154, an auto light
operation switch 156, and a control key 158 used when a user changes a set value.

[26] The apparatus for recording image and sound for a vehicle includes a control
portion 16, an image restoration portion 172, a sound restoration portion 180, and a D/
A converting portion 182. The control portion 16 includes a wiper operation control
portion 162, a light operation control portion 164, and an emergency situation in-
formation storing/reproduction control portion 168. Also, the apparatus for recording
image and sound for a vehicle includes a multiplexing portion (MUX) 174 and an
encoding portion 176.

[27] The operation and effect of the apparatus for recording image and sound for a
vehicle configured as above will be described below.

[28] When the automatic wiper operation switch 154 is turned on, the wiper operation
control portion 162 of the control portion 16 is enabled. Also, when the auto light
operation switch 156 is turned on, the light operation control portion 164 of the control
portion 16 is enabled. Next, the image photographing portion 104 photographs an
outside image out of a window and outputs an analog image signal. The decoding
portion 104 decodes a photographed outside analog image signal, that is, a camera
image and converts the decoded signal to a digital image signal. The image analysis
portion 106 analyzes the digital image signal and extracts an image property related to
weather and brightness outside the window.

[29] In the present embodiment, the brightness analysis portion 110 of the image
analysis portion 106 analyzes brightness and contrast of an image (S204) and
determines whether the brightness and the contrast is less than a predetermined value
(S206). When the brightness and the contrast is determined to be less than the pre-
determined value, the image is corrected (S208).

[30] The brightness analysis portion 110 of the image analysis portion 106 analyzes the
brightness and contrast of the properties of an image in the following method. A pixel
can be indicated with values of R, G, and B having different sizes, which can be
presented in a gray level. For example, assuming that an overall screen is made of k
numbers of pixels, $r_k$ is the k-th pixel of a gray level, $n$ is a total number of the pixels in
an image, and $n_k$ is the number of pixels of the k-th gray level, a probability $p(r_k)$ that a
pixel having a gray level $r_k$ is generated can be presented as follows.

$$p(r_k) = n_k / n \quad [\text{Equation 1}]$$

[31] FIGS. 3, 4, 5, and 6 are graphs for explaining an example of a step of analyzing

[32]
brightness and contrast of an image by the image analysis portion 106. Referring to FIGS. 3 through 6, the image analysis portion 105 of the apparatus for recording image and sound for a vehicle according to an embodiment of the present invention analyzes a gray level distribution of an image in a histogram method. That is, a dark image such as an image photographed in the night is disposed in an area where a gray level is low, as shown in FIG. 4, while a bright image such as an image photographed during the day time is distributed in an area where a gray level is high, as shown in FIG. 3. Also, an image having a low contrast is concentrated in an area having a particular gray level distribution, as shown in FIG. 5, while an image having a high contrast is disposed in a wide area across the entire gray level distribution, as shown in FIG. 6. That is, by analyzing the brightness and contrast of an image photographed by an image photographing portion, lights such as a head light, a tail light, an instrument panel light, etc. can be controlled.

[33] Also, the sharpness analysis portion 108 of the image analysis portion 106 analyzes sharpness of an image (S210). The wiper operation control portion 162 of the control portion 16 determines whether an analyzed sharpness is less than a predetermined critical value (S212). When the sharpness is determined to be less than the critical value in the step 162, the wiper operation control portion 162 outputs a wiper operation command (S214).

[34] The brightness analysis portion 110 of the image analysis portion 106 analyzes the brightness of an image (S220). Also, the brightness of an image obtained in the step S204 can be used. Further, both the brightness and contrast can be used. The light operation control portion 164 of the control portion 16 determines whether the brightness of an image is less than a predetermined critical value (S222). When the brightness of an image is determined to be less than the critical value in the step S222, the light operation control portion 164 outputs a light operation command (S224).

[35] The sharpness of an image decreases when it is foggy, which is less than a case of raining. Also, the brightness of an image tends to be darker compared to a normal state, which is less than a case of being in the night.

[36] A fog light can be automatically operated using such property of an image. The light operation control portion 164 determines whether the sharpness value and the brightness value analyzed by the sharpness analysis portion 108 and the brightness analysis portion 110 of the image analysis portion 106 are within a predetermined range (S230). When the sharpness value and the brightness value are determined to be within the range, the light operation control portion 164 outputs a fog light operation.
command (S232).

[37] FIG. 7 is a view illustrating an example of the operation of the image analysis portion 106. Referring to FIG. 7, an image outside a window photographed through the window shows a wide difference in a sharpness property such as a distribution of an energy amount of a high frequency component between a state of being wet by rain and a state of not being wet. Thus, whether it rains can be recognized by analyzing the sharpness property of an image such as an energy amount of a high frequency component. When the sharpness value is less than a predetermined value, a wiper is controlled to be operated. Thus, by detecting raining, the wiper can be automatically operated.

[38] Also, in the dark night, the brightness value and the contrast value analyzed by the image analysis portion 106 are low. In this case, when the values are less than a predetermined critical value, a light operation command is output.

[39] Thus, it can be seen whether it is dark or bright by analyzing the brightness and the contrast of an image so that a light such as a head light, a tail light, an instrument panel light, etc. can be automatically operated according to a range of the brightness and the contrast of an image. For example, it is possible that the tail light and an instrument panel light are first operated according to a degree of being dark and then the head light is controlled to be operated.

[40] The sharpness and the brightness can be measured by the image analysis portion 106 in a variety of methods. Here, the descriptions on a unit and detailed values thereof will be omitted herein because they are meaningless. The image correction portion 120 corrects the original image to an image having relatively higher brightness and contrast through an image enhancement such as contrast stretching or histogram equalization.

[41] FIG. 8 is a view illustrating an example of the operation of the image correction portion 120. Referring to FIG. 8, the emergency situation information storing/reproduction control portion 168 of the control portion 16 stores an image photographed by the image photographing portion 102 in a memory at ordinary times. The photographed images are continuously recorded in a memory in a round-robin method and can overwrite the memory. A non-volatile memory such as a flash memory is preferably used in a method of storing images in a memory. The non-volatile memory includes a memory stick, a multimedia card (MMC), a security digital (SD) card, and a compact flash memory which are inserted in a memory slot.

[42] In the apparatus for recording image and sound for a vehicle according to the
present invention, the multiplexing portion (MUX) 174 performs multiplexing to selectively monitor an image currently being photographed or an image restored by the image restoration portion 172 according to a user's selection. The encoding portion 176 can monitor the image currently being photographed, an image having been image-corrected, or a reproduced image through a monitor (not shown) by performing TV-encoding and outputting a video signal. The sound restoration portion 180 collects the compressed sound stored in the memory or through a memory slot 184 and restores the sound under the control of the emergency situation information storing/reproduction control portion 168. The D/A converting portion 182 converts a restored digital sound data to an analog sound signal so that the sound stored in an accident or emergency situation can be monitored with the image.

[43] When an event is detected, the apparatus for recording image and sound for a vehicle according to the present invention configured as above controls to compress and store monitored image and sound and simultaneously compares the image properties extracted from the image such as sharpness and/or brightness of the image with a predetermined critical value to control the operation of a wiper, a light or a fog light of the vehicle.

[44] Thus, when an event generated in an accident or emergency situation, for example, when an impact sensor for an airbag operates or an emergency button for a vehicle is pressed, an event signal is output from the event detection portion 152 and input to the control portion 16. The emergency situation information storing/reproduction control portion 168 of the control portion 16 safely protects accident and emergency situation information by write-protecting a portion from a current address to a memory address prior to a particular time.

[45] In the emergency situation information storing/reproduction control portion 168, information can be inserted in a data area such as a closed caption (CC) or a user data on a stream of a compressed image and stored by using the vehicle operation information such as speed, time and direction of a vehicle input through the vehicle operation information I/F portion 150 while the image compression portion 130 and the sound compression portion 146 compress image and sound.

[46] The image compression portion 130 compresses the digital image signal and outputs a compressed digital image data, and stores the compressed image data in a storing portion such as the memory or the memory slot 184. The memory and memory slot 184 is independently formed to be easily attached/detached.

[47] The apparatus for recording image and sound for a vehicle according to the present
invention improves visibility of an image photographed in an inferior environment such as night time and having a low visibility, through image correction.

[48] A corrected image signal is input to the image compression portion 130 where an image is compressed based on a compression technique such as MPEG, and compressed therein. The control portion 16 inserts various information, for example, information on speed, operation time, and direction, received from the vehicle operation information I/F portion 150 in the memory or the memory slot 184 to be stored therein.

[49] When apparatus for recording image and sound for a vehicle according to the present invention works without problems after an accident or emergency situation occurs, the compressed image and sound can be continuously overwritten in the round-robin method using the remaining memory area except for the write-protected memory area.

[50] Although in the above embodiment an example of controlling a wiper, a light, and a fog light by analyzing sharpness and brightness, lights of a vehicle such as a tail light or an instrument panel light can be automatically controlled by appropriately selecting the critical value.

[51] In the apparatus for recording image and sound for a vehicle according to the present invention, an image obtained through a camera installed in a vehicle is converted to a digital signal by a decoder and a converted digital signal is input to an image analyzer. The image analyzer extracts sharpness information and brightness information by analyzing the input image signal and controls the wiper and the light using the extracted sharpness information and the brightness information. An output signal is displayed on a driver's display via the MUX and the encoder, which assists safe driving. To improve performance, an ultraviolet/infrared filter can be used.

[52] The apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can control various convenient equipments installed in a vehicle such as the wiper or the light, by installing the image photographing portion in the vehicle. Also, the apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can improve visibility of a photographed image through the image correction, by installing the image photographing portion in the vehicle.

[53] In the meantime, although there is a change in sharpness when it rains heavily, if it
rains lightly, since the change in sharpness is small, raining may not be appropriately recognized. When it rains lightly, raining can be appropriately recognized by analyzing distortion of an image such as a waterdrop pattern. To this end, in another embodiment of the present invention, the sharpness analysis portion analyzes the distortion of an image with the analysis of sharpness. FIG. 9 is a view for explaining an embodiment of operating a wiper by analyzing distortion of an image when it rains lightly. As shown in FIG. 9, a rate of recognition when it rains lightly can be increased by operating a wiper by analyzing the distortion of an image such as a waterdrop pattern. Since it is difficult to directly analyze the distortion of an image without a reference image, an image (b) distorted by the waterdrop pattern is compared and analyzed with respect to an image (a) after the wiper is operated.

**Industrial Applicability**

As described above, the apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can control various convenient equipments installed in a vehicle such as the wiper or the light, by installing the image photographing portion in the vehicle. Also, the apparatus for recording image and sound for a vehicle according to the present invention enables recording and checking the operation information about a vehicle accident and simultaneously can improve visibility of a photographed image through the image correction, by installing the image photographing portion in the vehicle.
Claims

1. An apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, the apparatus comprising:
an image photographing portion photographing an outside image out of a window and outputting an analog image signal;
a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal;
an image analysis portion analyzing the digital image signal and extracting an image property related to weather;
an event detection portion detecting an event during operation of the vehicle;
a control portion controlling operation of a wiper of the vehicle by comparing an extracted image property with a predetermined critical value and controlling monitored image and sound to be stored when the event is detected by the event detection portion;
an image compression portion compressing the digital image signal and outputting a compressed digital image data; and
a storing portion storing the compressed image data.

2. The apparatus of claim 1, wherein the image property comprises at least sharpness of an image, the image analysis portion comprises a sharpness analysis portion which analyzes the sharpness of the image based on an energy amount of a high frequency component of the image, and the control portion comprises a wiper operation control portion which determines whether to operate the wiper based on the analyzed sharpness.

3. An apparatus for recording image and sound for a vehicle installed in the vehicle to monitor outside image and sound and storing monitored image and sound when an event is generated, the apparatus comprising:
an image photographing portion photographing an outside image out of a window and outputting an analog image signal;
a decoding portion decoding a photographed outside analog image signal and outputting a digital image signal;
an image analysis portion analyzing the digital image signal and extracting an image property related to brightness outside the window;
an event detection portion detecting an event during operation of the vehicle;
a control portion controlling operation of an illumination apparatus of the vehicle
by comparing an extracted image property with a predetermined critical value
and controlling monitored image and sound to be stored when the event is
detected by the event detection portion;
an image compression portion compressing the digital image signal and
outputting a compressed digital image data; and
a storing portion storing the compressed image data.

4. The apparatus of claim 3, wherein the image property comprises brightness of
the image, the image analysis portion comprises at least one brightness analysis
portion which analyzes the brightness of the image by analyzing a gray level of
each of pixels forming the image, and the control portion comprises at least one
light operation control portion which determines whether to operate a light or a
tail light based on the analyzed brightness.

5. An apparatus for recording image and sound for a vehicle installed in the
vehicle to monitor outside image and sound and storing monitored image and
sound when an event is generated, the apparatus comprising:
an image photographing portion photographing an outside image out of a
window and outputting an analog image signal;
a decoding portion decoding a photographed outside analog image signal and
outputting a digital image signal;
an image correction portion receiving the digital image signal, performing image
correction including at least one of contrast stretching and histogram
equalization, and outputting a corrected digital image signal;
an event detection portion detecting an event during operation of the vehicle;
a control portion controlling monitored image and sound to be stored when the
event is detected by the event detection portion;
an image compression portion compressing the corrected digital image signal
and outputting a compressed digital image data; and
a storing portion storing the compressed image data.
[Fig. 2]

START

S202 DECODE CAMERA IMAGE AND CONVERT IT TO DIGITAL IMAGE SIGNAL

S204 ANALYZE BRIGHTNESS AND CONTRAST OF IMAGE

S206 ARE BRIGHTNESS AND CONTRAST LESS THAN PREDETERMINED VALUE?

S208 CORRECT IMAGE

S210 ANALYZE SHARPNESS OF IMAGE

S212 IS SHARPNESS LESS THAN PREDETERMINED VALUE?

S214 OUTPUT WIPER OPERATION COMMAND

S220 ANALYZE BRIGHTNESS OF IMAGE

S222 IS BRIGHTNESS LESS THAN PREDETERMINED VALUE?

S224 OUTPUT LIGHT OPERATION COMMAND

S230 ARE BRIGHTNESS SHARPNESS WITHIN PREDETERMINED VALUE?

S232 OUTPUT FOG LIGHT OPERATION COMMAND

END

[Fig. 3]

BRIGHT IMAGE

P(r_x)

r_x
DARK IMAGE

LOW CONTRAST IMAGE

HIGH CONTRAST IMAGE
[Fig. 7]

(a) FOOGY IMAGE

(b) DARK IMAGE

(c) AFTER WIPER OPERATES

(d) WET-B-RAIN STATE

IMAGE

DISTRIBUTION OF ENERGY AMOUNT OF HIGH FREQUENCY COMPONENT

DISTRIBUTION OF PROBABILITY OF GENERATION OF EACH GRAY LEVEL

[Fig. 8]

$P(r_x)$

$P(r_k)$

CORRECTION

Histogram Equalization
(a) AFTER THE WIPER OPERATED  (b) DISTORTED BY THE WATERDROP PATTERN
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H04N 5/76

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 H04N 5/76

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Patents and applications for inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tbody>
<tr>
<td>Y</td>
<td>US 6141611 A (Phoenix Group, Inc.) 31 OCT. 2000</td>
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<td>KR 10-1999-0069303 A (Sung-ho, Sung) 06 SEP. 1999</td>
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☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search
10 OCTOBER 2005 (10.10.2005)

Date of mailing of the international search report
10 OCTOBER 2005 (10.10.2005)

Name and mailing address of the ISA/KR
Korean Intellectual Property Office
920 Dunsan-dong, Seo-gu, Daejeon 302-701, Republic of Korea
Facsimile No. 82-42-472-7140

Authorized officer
LEE, Seung Han
Telephone No. 82-42-481-5761

Form PCT/ISA/210 (second sheet) (January 2004)