VERIFICATION OF TRANSLATION

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declare that I am well acquainted with both the Japanese and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of Japanese Patent Laid-open Publication No. 2000-242773, published September 8, 2000.

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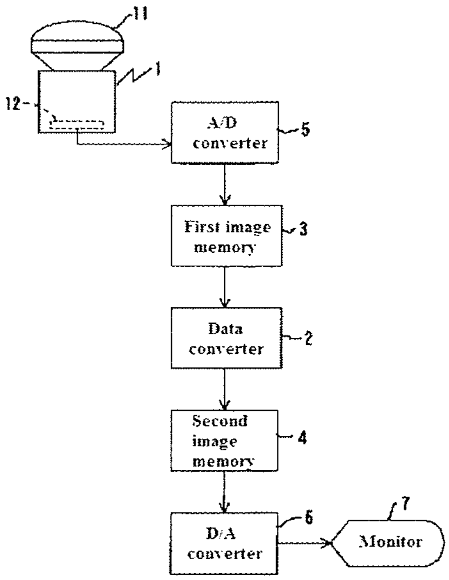
(54) [TITLE OF INVENTION]

IMAGE DATA CONVERSION DEVICE

(57) [ABSTRACT]

[PROBLEM] To convert image capture data of a full surrounding area obtained by a fish-eye lens such that distortion can be corrected and the image capture data can be displayed as a seamless single image.

[MEANS FOR SOLVING THE PROBLEM] With respect to a region for a portion of circular image data obtained by image capture using a fish-eye lens, a point (g(Θ)•cosψ, g(Θ)•sinψ) in the region on a planar Cartesian coordinate system whose origin point is a center of the circular image (where Θ is a parameter fulfilling $0 < \Theta < \pi/2$; g(Θ) is a function fulfilling g(0) = 0 and monotonically increasing in the range of Θ; and ψ is an angle formed by a line segment and a coordinate axis on the planar Cartesian coordinate system, the line segment linking the origin point of the planar Cartesian coordinate system and the point on the circular image) is converted into a point (R, ψ, R/tanΘ) on a cylindrical coordinate system where R is a constant.



[SCOPE OF THE CLAIMS]

[CLAIM 1] An image data conversion device wherein, with respect to a region for a portion of circular image data obtained by image capture using a fish-eye lens, a point $(g(\Theta)\cdot\cos\psi, g(\Theta)\cdot\sin\psi)$ in the region on a planar Cartesian coordinate system whose origin point is a center of the circular image (where Θ is a parameter fulfilling $0 < \Theta < \pi/2$; $g(\Theta)$ is a function fulfilling $g(0) = 0$ and monotonically increasing in the range of Θ; and ψ is an angle formed by a line segment and a coordinate axis on the planar Cartesian coordinate system, the line segment linking the origin point of the planar Cartesian coordinate system and the point on the circular image) is converted into a point $(R, \psi, R/\tan\Theta)$ on a cylindrical coordinate system where R is a constant.

[CLAIM 2] The image data conversion device according to claim 1, wherein the fish-eye lens has a property in which $h = g(\theta)$ (h being an image height and θ being a field angle).

[CLAIM 3] The image data conversion device according to claim 2, wherein the function $g(\theta)$ is $g(\theta) = 2f\cdot\tan(\theta/2)$ (f being a focal distance).

[CLAIM 4] The image data conversion device according to claim 2, wherein the function $g(\theta)$ is $g(\theta) = f\cdot\theta$ (f being a focal distance).

[CLAIM 5] A computer-readable storage medium storing a program executing operations of the image data conversion device according to any one of claims 1 to 4 on the computer.

[CLAIM 6] An image capture system comprising:

the fish-eye lens;

a conversion means converting an image obtained by the fish-eye lens into the image data;

the image data conversion device according to any one of claims 1 to 4; and

a display means displaying the image data on the cylindrical coordinate plane by projecting the image data onto a plane, the image data on the cylindrical coordinate plane having been converted by the image data conversion device.

[CLAIM 7] An image data conversion method wherein, with respect to a region for a portion of circular image data obtained by image capture using a fish-eye lens, a point $(g(\Theta)\cdot\cos\psi, g(\Theta)\cdot\sin\psi)$ in the region on a planar Cartesian coordinate system whose origin point is a center of the circular image (where Θ is a parameter fulfilling $0 < \Theta < \pi/2$; $g(\Theta)$ is a function fulfilling $g(0) = 0$ and monotonically increasing in the range of Θ; and ψ is an angle formed by a line segment and a coordinate axis on the planar Cartesian coordinate system, the line segment linking the origin point of the planar Cartesian coordinate system and the point on the circular image) is converted into a point $(R, \psi, R/\tan\Theta)$ on a cylindrical coordinate system where R is a constant.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field of the Invention] The present invention relates to an image data conversion device and, specifically, relates to a device converting image data having a circular shape and obtained by image capture with a fish-eye lens into planar image data in which distortion is corrected and wide area display is possible.

[0002]

[Prior Art] Conventionally, in an in-store surveillance camera, a traffic regulating camera, and the like, in order to monitor a status of a surrounding area, a camera having a field of view that is limited to a forward view is typically rotated by a drive device such as a motor. However, when such a camera having a limited field of view is rotated, a rotation driver becomes necessary, and thus the device becomes complex. In addition, the camera must be rotated when a specific target is to be captured and so when the target is moving, it may not be possible to capture the target due to limitations of rotation speed. Furthermore, a plurality of directions cannot be imaged simultaneously, constantly resulting in blind spots in a monitored area, and therefore such a camera cannot be said to be sufficient for a monitoring function and the like.

[0003] Japanese Patent Publication No. H06-501585 suggests, as a technology resolving such problems, converting image data having a circular shape into a planar image, the image data being obtained by capturing an image of all orientations forward of a fish-eye lens. A simple description of the technology follows. The circular image data obtained by the fish-eye lens can include an image of all orientations, but the image becomes more distorted further toward an outer periphery. This distortion can be largely removed when the circular image data is translated onto a hemisphere surface, but image data translated to the hemisphere surface cannot be displayed on a planar monitor. In the above technology, the portion of the image data translated to the hemisphere surface is further projected onto a planar surface, thereby enabling the image data to be displayed by conversion into a plane. By using such a method, a device can be simplified by making a rotation driver mechanism unnecessary, and switching a display direction simply becomes a matter of control during data processing, and thus can also be sped up remarkably.

[0004]

[Problem to Be Solved by the Invention] However, even when circular image data obtained in this way by the fish-eye lens is configured to be converted directly into planar image data, an entire hemisphere surface cannot be projected onto a single planar surface with adequate distortion correction, and therefore the image obtained relates only to a specific direction. Accordingly, blind spots occur on a display screen even though the full surrounding area is captured by the fish-eye lens. In addition, as a method to eliminate blind spots, a method performing planar image conversion for a plurality of directions simultaneously and performing simultaneous display can be considered. However, in such a case, seams between images are not continuous and a plurality of different image conversions must be performed.

[0005] In order to resolve these problems, the present invention has as an object to convert image capture data of a full surrounding area obtained by a fish-eye lens such that distortion can be corrected and the image capture data can be displayed as a seamless single image.

[0006]

[Means for Solving the Problems] In order to resolve the above-noted problems, with respect to a region for a portion of circular image data obtained by image capture using a fish-eye lens, an image data conversion device according to the present invention converts a point ($g(\Theta)\cdot\cos\psi$, $g(\Theta)\cdot\sin\psi$) in the region on a planar Cartesian coordinate system whose origin point is a center of the circular image (where Θ is a parameter fulfilling $0 < \Theta < \pi/2$; $g(\Theta)$ is a function fulfilling $g(0) = 0$ and monotonically increasing in the range of Θ; and ψ is an angle formed by a line segment and a coordinate axis on the planar Cartesian coordinate system, the line segment linking the origin point of the planar Cartesian coordinate system and the point on the circular image) into a point (R, ψ, $R/\tan\Theta$) on a cylindrical coordinate system where R is a constant. Moreover, what is referred to as a fish-eye lens in the present invention includes not only what is typically called a fish-eye lens, having a viewing angle of substantially 180°, but also includes what is typically called a wide-angle lens, having a narrower viewing angle.

[0007] Moreover, the conversion is sufficient when a conversion is performed that, as a result, satisfies the above-noted relationship and the process of the conversion is not discussed. In other words, the above-noted formula need not be applied directly, and cases are also included where conversion is performed using a table showing correspondence between pre-conversion pixels and post-conversion pixels. In addition, the planar Cartesian coordinate system and the cylindrical coordinate system are mutually independent and directions of the coordinates can be defined as desired. In addition, the cylindrical coordinate

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