

a mechanism for detecting a distance between the imaging device and the flying object, such as a device or program which calculates the distance between a stereo camera or stereo image and a subject to be captured, resulting in an increase in the cost of equipment.

[0008]

Additionally, regarding the method for detecting a bird by using the particle image velocimetry, PTL 3 does not show how a bird is detected from the motion of particles in images. Thus, the method for detecting a bird by using the particle image velocimetry cannot be achieved.

Another problem is that not only birds but also airplanes are captured at an airport. When detecting a bird from the motion of particles in images, a misjudgment may occur due to the failure in distinguishing between a bird and an airplane.

[0009]

Embodiments of the present invention provide a bird detection device, a bird detection system, a bird detection method, and a program, all of which provide solutions to the above-described problems.

[Solution to Problem]

[0010]

According to a first aspect of the present invention, there is provided a bird detection device including: a captured image acquisition unit which obtains a captured image; a bird candidate image extraction unit which extracts a bird candidate image, which is a candidate for a bird image, from the captured image; a bird detection determination unit which determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image, a drive unit causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and a difference extraction unit detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images, wherein the bird detection determination unit determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

[0011]

According to a second aspect of the present invention, there is provided a bird detection system including: an image capturing device which takes a captured image; and a bird detection device, wherein the bird detection device includes: a captured image acquisition unit which obtains a captured image; a bird candidate image extraction unit which extracts a bird candidate image, which is a candidate for a bird image, from the captured image; a bird detection determination unit which determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image, a drive unit causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and a difference extraction unit detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images, wherein the bird detection determination unit determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

[0012]

According to a third aspect of the present invention,, there is provided a method for detecting a bird, the method being implemented by a bird detection device and including: a captured image acquisition step which obtains a captured image; a bird candidate image extraction step which extracts a bird candidate image, which is a candidate for a bird image, from the captured image; a bird detection determination step which determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image, a driving step for causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and a difference extraction step for detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images, wherein the bird detection determination step determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

[0013]

According to a fourth aspect of the present invention, there is provided a program for causing a computer as a bird detection device to execute: a captured image acquisition step which obtains a captured image; a bird candidate image extraction step which extracts a bird candidate image, which is a candidate for a bird image, from the captured image; a bird detection determination step which determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image, a driving step for causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and a difference extraction step for detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images, wherein the bird detection determination step determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

[Advantageous Effect of Invention]

[0014]

According to embodiments of the present invention, birds can be detected more accurately without the need for a mechanism for detecting a distance to a flying object.

[Brief Description of Drawings]

[0015]

Fig. 1 is a schematic block diagram illustrating a functional configuration of a bird detection system according to one exemplary embodiment of the present invention.

Fig. 2 is an explanatory diagram illustrating swiveling of an image capturing unit 121 according to the exemplary embodiment.

Fig. 3 is an explanatory diagram illustrating relationships between images obtained by a difference extraction unit 114 according to the exemplary embodiment.

Fig. 4 is an explanatory diagram illustrating an example mask for removing an isolated point used by a filter processing unit 115 according to the exemplary embodiment.

Fig. 5 is an explanatory diagram illustrating learning of distinction reference data performed by a bird shape

CLAIMS

1. A bird detection device comprising:
 - a captured image acquisition unit that obtains a captured image;
 - a bird candidate image extraction unit that extracts a bird candidate image, the bird candidate image being a candidate for a bird image, from the captured image;
 - a bird detection determination unit that determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image,
 - a drive unit causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and
 - a difference extraction unit detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images,
 - wherein the bird detection determination unit determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.
2. The bird detection device according to claim 1, further comprising:
 - an alarm notification unit that outputs an alarm notifying that a bird has been detected,
 - wherein the alarm notification unit outputs the alarm when the bird detection determination unit detects a bird.
3. The bird detection device according to claim 1 or 2,
 - wherein the bird candidate image extraction unit comprises:

a difference extraction unit that extracts a difference between a first captured image and a second captured image that was earlier obtained to obtain a first differential image, as well as extracting a difference between the second captured image and a third image that had been earlier obtained to obtain a second differential image, and obtains an image of a product of the first differential image and the second differential image; and

a bird shape determination unit which extracts the bird candidate image based on the image of the product obtained by the difference extraction unit.

4. A bird detection system comprising:

an image capturing device which takes a captured image;
and

a bird detection device,

wherein the bird detection device comprises:

a captured image acquisition unit that obtains a captured image;

a bird candidate image extraction unit that extracts a bird candidate image, the bird candidate image being a candidate for a bird image, from the captured image;

a bird detection determination unit that determines whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image,

a drive unit causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and

a difference extraction unit detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images,

wherein the bird detection determination unit determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

5. A method for detecting a bird implemented by a bird detection device, the method comprising:

a captured image acquisition step for obtaining a captured image;

a bird candidate image extraction step for extracting a bird candidate image, the bird candidate image being a candidate for a bird image, from the captured image;

a bird detection determination step for determining whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image,

a driving step for causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and

a difference extraction step for detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images,

wherein the bird detection determination step determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.

6. A program for causing a computer as a bird detection device to execute:

a captured image acquisition step for obtaining a captured image;

a bird candidate image extraction step for extracting a bird candidate image, the bird candidate image being a candidate for a bird image, from the captured image; and

a bird detection determination step for determining whether a bird has been detected, based on a time required for the bird candidate image to move in accordance with a size of the bird candidate image in the captured image,

a driving step for causing an image capturing area covered by the image capturing unit to swivel at a constant speed, and

a difference extraction step for detecting a movement of an object in captured images by calculating the amount of shift in an image caused by swiveling of the image capturing unit, correcting images by the calculated amount of shift, and extracting a difference between corrected images,

wherein the bird detection determination step determines whether a bird has been detected, based on a degree of change in a shape of the bird candidate image per predetermined time.