The calibrator further identifies calibration information using the plurality of angles. The calibration information is used to convert the output data into angular data in desired angular units.

In yet another illustrative embodiment, a method for calibrating a set of transducers is provided. A plurality of images of a target formed by a target device is generated as the target device is rotated about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure. A plurality of angles about the pivot axis is identified for the target using the plurality of images. Calibration information is identified using the plurality of angles.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0001] The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

[0002] **Figure 1** is an illustration of a calibration environment in the form of a block diagram in accordance with an illustrative embodiment;

The calibrator further identifies calibration information using the plurality of angles. The calibration information is used to convert the output data into angular data in desired angular units.

In yet another illustrative embodiment, a method for calibrating a set of transducers is provided. A plurality of images of a target formed by a target device is generated as the target device is rotated about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure. A plurality of angles about the pivot axis is identified for the target using the plurality of images. Calibration information is identified using the plurality of angles.

In a first aspect, an apparatus for calibrating transducers, comprising: a target device; an imaging device that generates a plurality of images of a target formed by the target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure; a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data; and a calibrator that identifies a plurality of angles of the target about the pivot axis using the plurality of images and identifies calibration information using the plurality of angles; wherein the calibration information identified by the calibrator is used to convert the output data into angular data in desired angular units and thereby calibrate the set of transducers; and wherein the set of transducers is associated with at least one of the first structure, the second structure, and the interface between the first structure and the second structure.

In a second aspect, a calibration system comprising: the apparatus according to the first aspect; a number of additional target devices; a number of additional imaging devices; and a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data; wherein the calibration information is used to convert the output data into angular data in desired angular units.

In a third aspect, a method for calibrating a set of transducers, the method comprising: generating, by an imaging device, a plurality of images of a target formed by a target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure; identifying a plurality of angles about the pivot axis for the target using the plurality of images; identifying calibration information using the plurality of angles; measuring rotation of the first structure about the pivot axis relative to the second structure with the target device attached to the first structure using the set of transducers to generate output data; and converting the output data generated by the set of transducers into angular data in desired angular units using the calibration information, thereby calibrate the set of transducers.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0001] The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

[0002] **Figure 1** is an illustration of a calibration environment in the form of a block diagram in accordance with an illustrative embodiment;

CLAIMS:

What is claimed is:

1. An apparatus comprising:

a target device;

an imaging device that generates a plurality of images of a target formed by the target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure; and

a calibrator that identifies a plurality of angles of the target about the pivot axis using the plurality of images and identifies calibration information using the plurality of angles.

2. The apparatus of claim 1, further comprising:

a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data;

wherein the calibration information identified by the calibrator is used to convert the output data into angular data in desired angular units; and

wherein the set of transducers is associated with at least one of the first structure, the second structure, and the interface between the first structure and the second structure.

3. The apparatus of claim 2, wherein the output data generated by the set of transducers is used to identify a set of output values for any given point in time in which

an output value in the set of output values is a measure of the rotation of at least a portion of the first structure about the pivot axis and wherein the calibration information comprises a table that identifies a corresponding set of angle values in the desired angular units for each set of output values identified by the set of transducers; and

wherein the calibration information comprises an algorithm for converting any set of output values generated by the set of transducers into the corresponding set of angle values in the desired angular units; and

wherein the desired angular units are selected from one of degrees and radians.

4. The apparatus of claim 1, wherein the second structure is a wing of an aircraft and the first structure is a control surface moveably attached to the wing;

wherein the target device is a light pen that is attached to the first structure and the target is a beam of light generated by the light pen;

wherein the beam of light is captured in the plurality of images as a point object and wherein the calibrator identifies a location of the point object in each image in the plurality of images with respect to a reference coordinate system as a target location; and

wherein the reference coordinate system is a coordinate system centered on the imaging device.

5. The apparatus of claim 1, wherein the imaging device is a camera attached to at least one of the second structure and the interface between the first structure and the second structure and wherein the camera is selected from

one of a group consisting of an electro-optical camera, an infrared camera, and an ultraviolet camera.

6. The apparatus of claim 1, wherein the target device and the imaging device are removed from the first structure after the plurality of images has been generated by the imaging device; and

wherein the target device is one of a number of target devices and wherein the imaging device is one of a number of imaging devices) in which the number of target devices, the number of imaging devices, and the calibrator form a calibration system.

7. A calibration system comprising:

the apparatus of any claims 1 to 6;

a number of additional target devices;

a number of additional imaging devices;

a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data; and

wherein the calibration information is used to convert the output data into angular data in desired angular units.

8. A method for calibrating a set of transducers, the method comprising:

generating, by an imaging device, a plurality of images of a target formed by a target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure;

identifying a plurality of angles about the pivot axis for the target using the plurality of images; and

identifying calibration information using the plurality of angles.

9. The method of claim 8, further comprising:

measuring rotation of the first structure about the pivot axis relative to the second structure with the target device attached to the first structure using the set of transducers to generate output data; and

converting the output data generated by the set of transducers into angular data in desired angular units using the calibration information.

10. The method of claim 9, further comprising:

identifying a set of output values for any given point in time using the output data; and

wherein identifying the calibration information using the plurality of angles comprises:

generating a table that identifies a corresponding set of angle values in the desired angular units for each set of output values identified by the set of transducers.

11. The method of claim 8, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images comprises:

identifying a location of the target in each image in the plurality of images with respect to a reference coordinate system as a target location.

12. The method of claim 11, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images further comprises:

identifying a location of an intersection of the pivot axis with a plane formed by the imaging device and the target device with respect to the reference coordinate system as a pivot location.

13. The method of claim 12, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images further comprises:

identifying an angle about the pivot axis for the target in an image in the plurality of images using the target location identified for the image and the pivot location.

CLAIMS:

What is claimed is:

1. An apparatus for calibrating transducers, comprising:

a target device;

an imaging device that generates a plurality of images of a target formed by the target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure;

a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data; and

a calibrator that identifies a plurality of angles of the target about the pivot axis using the plurality of images and identifies calibration information using the plurality of angles;

wherein the calibration information identified by the calibrator is used to convert the output data into angular data in desired angular units and thereby calibrate the set of transducers; and

wherein the set of transducers is associated with at least one of the first structure, the second structure, and the interface between the first structure and the second structure.

2. The apparatus of claim 1, wherein the output data generated by the set of transducers is used to identify a set of output values for any given point in time in which an output value in the set of output values is a measure of the rotation of at least a portion of the first structure about the pivot axis and wherein the calibration information comprises a table that

identifies a corresponding set of angle values in the desired angular units for each set of output values identified by the set of transducers; and
wherein the calibration information comprises an algorithm for converting any set of output values generated by the set of transducers into the corresponding set of angle values in the desired angular units; and
wherein the desired angular units are selected from one of degrees and radians.

3. The apparatus of claim 1, wherein the second structure is a wing of an aircraft and the first structure is a control surface moveably attached to the wing;
wherein the target device is a light pen that is attached to the first structure and the target is a beam of light generated by the light pen;
wherein the beam of light is captured in the plurality of images as a point object and wherein the calibrator identifies a location of the point object in each image in the plurality of images with respect to a reference coordinate system as a target location; and
wherein the reference coordinate system is a coordinate system centered on the imaging device.

4. The apparatus of claim 1, wherein the imaging device is a camera attached to at least one of the second structure and the interface between the first structure and the second structure and wherein the camera is selected from one of a group consisting of an electro-optical camera, an infrared camera, and an ultraviolet camera.

5. The apparatus of claim 1, wherein the target device and the imaging device are removed from the first structure after the plurality of images has been generated by the imaging device;

and wherein the target device is one of a number of target devices and wherein the imaging device is one of a number of imaging devices) in which the number of target devices, the number of imaging devices, and the calibrator form a calibration system.

6. A calibration system comprising:

the apparatus of any claims 1 to 5;

a number of additional target devices;

a number of additional imaging devices; and

a set of transducers that measure rotation of the first structure about the pivot axis relative to the second structure to generate output data;

wherein the calibration information is used to convert the output data into angular data in desired angular units.

7. A method for calibrating a set of transducers, the method comprising:

generating, by an imaging device, a plurality of images of a target formed by a target device as the target device is rotated relative to the imaging device about a pivot axis formed at an interface between a first structure and a second structure in response to the first structure being rotated about the pivot axis relative to the second structure;

identifying a plurality of angles about the pivot axis for the target using the plurality of images;

identifying calibration information using the plurality of angles;

measuring rotation of the first structure about the pivot axis relative to the second structure with the target device attached to the first structure using the set of transducers to generate output data; and

converting the output data generated by the set of transducers into angular data in desired angular units using

the calibration information, thereby calibrate the set of transducers.

8. The method of claim 7, further comprising:

identifying a set of output values for any given point in time using the output data;

wherein identifying the calibration information using the plurality of angles comprises:

generating a table that identifies a corresponding set of angle values in the desired angular units for each set of output values identified by the set of transducers.

9. The method of claim 7, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images comprises:

identifying a location of the target in each image in the plurality of images with respect to a reference coordinate system as a target location.

10. The method of claim 9, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images further comprises:

identifying a location of an intersection of the pivot axis with a plane formed by the imaging device and the target device with respect to the reference coordinate system as a pivot location.

11. The method of claim 10, wherein identifying the plurality of angles about the pivot axis for the target using the plurality of images further comprises:

identifying an angle about the pivot axis for the target in an image in the plurality of images using the

target location identified for the image and the pivot location.