Claims

1. A method for visual inspection, the method comprising:

instructing an image capturing device to capture a first image of an object;

processing the captured first image to detect whether the object has a defect;

calculating a confidence score for the detection on whether the object has the defect;

generating the calculated confidence score as a feedback to a user; and

determining based on the calculated confidence score whether to generate improved imaging parameters with respect to translation and/or rotation movement of the image capturing device;

generating the improved imaging parameters if required after considering the calculated confidence score; and

receiving an input to instruct the image capturing device to capture, according to the improved imaging parameters, a second image of the object that results in calculation of an improved confidence score.

wherein the method further comprises:

upon the detection that the object has the defect, instructing a light projector to project a coded structured pattern on the object;

instructing the image capturing device to capture a two dimensional image of the object comprising the projected coded structured pattern;

constructing a three dimensional (3D) model of the object from the captured two dimensional image by decoding the projected coded structured pattern to obtain surface geometry of the object; and

performing 3D measurements of the defect using the surface geometry obtained.

2. The method as claimed in claim 1, wherein the method further comprises:

collating confidence scores obtained from different images captured by the image capturing device for a common defect on the object; and

using the collated confidence scores to fine tune detection of the common defect on the object or another object.

3. The method as claimed in claim 1, where the method further comprises:

selecting an operation mode from a plurality of operation modes so that the processing of the captured first image to detect whether the object has the defect is performed according to the selected operation mode,

wherein each operation mode is for detecting one type of defect, wherein the plurality of operation modes includes at least two of the following operation modes:

an operation mode to detect a crack on the object using a decision-theory based algorithm; an operation mode to detect erosion on the object using a classification algorithm that trains on a plurality of training images;

an operation mode to detect missing material on the object using an algorithm that matches features points of a reference two dimensional (2D) image with feature points of a captured image of the object; and

an operation mode to detect missing material on the object using an algorithm that matches features points of a three dimensional (3D) model with feature points of a captured image of the object.

4. The method as claimed in claim 1, wherein the calculated confidence score is generated as feedback to the user after comparing the calculated confidence score against a threshold, wherein the threshold is used to reduce a number of false detection.

~~5. The method as claimed in claim 1 , wherein the method further comprises:~~

~~upon the detection that the object has the defect, instructing a light projector to project a coded structured pattern on the object;~~

~~instructing the image capturing device to capture a two dimensional image of the object comprising the projected coded structured pattern;~~

~~constructing a three dimensional (3D) model of the object from the captured two dimensional image by decoding the projected coded structured pattern to obtain surface geometry of the object; and~~

~~performing 3D measurements of the defect using the surface geometry obtained.~~

~~6~~5. The method as claimed in claim ~~5~~1, wherein the coded structured pattern is a monochromatic spatially coded pattern.

~~7~~6. The method as claimed in claim ~~5~~1, wherein the method further comprises:

adapting the coded structured pattern based on viewpoint between a defect and the image capturing device; and/or

tuning colours of the coded structured pattern in regard to a specific defect region; and/or increasing spatial sample resolution for a target defect region considered.

~~8~~7. The method as claimed in claim ~~5~~1, wherein the method further comprises:

directing the image capturing device and the light projector towards a calibration board comprising an area with calibration pattern such that the light projector projects asymmetrical circle patterns outside the area with calibration pattern;

detecting the calibration pattern and the projected asymmetrical circle patterns by capturing using the image capturing device an image of the calibration board comprising the calibration pattern and the projected asymmetrical circle patterns;

tilting the image capturing device and the light projector at a different angle towards the calibration board for at least two more times;

detecting the calibration pattern and the projected asymmetrical circle patterns for additional images captured at the different angles by the image capturing device; and

obtaining a calibration result based on collated data of the detected calibration pattern and detected projected asymmetrical circle patterns.

~~9~~8. The method as claimed in claim ~~8~~7, wherein the calibration pattern is a plurality of asymmetrical circle patterns.

~~10~~9. The method as claimed in claim ~~8~~7, wherein the method further comprises:

taking into consideration the calibration result, performing measurement using stereo triangulation on an image of the object captured by the image capturing device.

~~11~~10. The method as claimed in claim 1, wherein the method further comprises:

projecting four illuminated dots onto a surface containing an elevated or a dented point for measuring respective height or depth of the point relative to the surface, wherein three of the four illuminated dots for forming a reference plane are projected on the surface and the remaining one illuminated dot is projected on the point;

calculating 3D coordinates of the four illuminated dots with respect to a centre of the image capturing device based on triangulation; and

after obtaining the 3D coordinates of the four illuminated dots, calculating height or depth of the point relative to the surface based on distance between the point and the reference plane.

~~12~~11. An apparatus for visual inspection, the apparatus comprises:

a processor configured to execute instructions in a memory to control the apparatus to:

instruct an image capturing device to capture a first image of an object;

process the captured first image to detect whether the object has a defect;

calculate a confidence score for the detection on whether the object has the defect;

generate the calculated confidence score as a feedback to a user;

determine based on the calculated confidence score whether to generate improved imaging parameters with respect to translation and/or rotation movement of the image capturing device;

generate the improved imaging parameters if required after considering the calculated confidence score; and

receive an input to instruct the image capturing device to capture, according to the improved imaging parameters, a second image of the object that results in calculation of an improved confidence score,

wherein the apparatus is controllable to:

upon the detection that the object has the defect, instruct a light projector to project a coded structured pattern on the object;

instruct the image capturing device to capture a two dimensional image of the object comprising the projected coded structured pattern;

construct a three dimensional (3D) model of the object from the captured two dimensional image by decoding the projected coded structured pattern to obtain surface geometry of the object; and

perform 3D measurements of the defect using the surface geometry obtained.

~~13~~12. The apparatus as claimed in claim ~~12~~11, wherein the apparatus is controllable to:

collate confidence scores obtained from different images captured by the image capturing device for a common defect on the object; and

use the collated confidence scores to fine tune detection of the common defect on the object or another object.

~~14~~13. The apparatus as claimed in claim ~~12~~11, where the apparatus is controllable to:

select an operation mode from a plurality of operation modes so that the processing of the captured first image to detect whether the object has the defect is performed according to the selected operation mode,

wherein each operation mode is for detecting one type of defect, wherein the plurality of operation modes includes at least two of the following operation modes:

an operation mode to detect a crack on the object using a decision-theory based algorithm; an operation mode to detect erosion on the object using a classification algorithm that trains on a plurality of training images; an operation mode to detect missing material on the object using an algorithm that matches features points of a reference two dimensional (2D) image with feature points of a captured image of the object; and

an operation mode to detect missing material on the object using an algorithm that matches features points of a three dimensional (3D) model with feature points of a captured image of the object.

~~15~~14. The apparatus as claimed in claim ~~12~~11, wherein the calculated confidence score is generated as feedback to the user after comparing the calculated confidence score against a threshold, wherein the threshold is used to reduce a number of false detection.

~~16. The apparatus as claimed in claim 12, wherein the apparatus is controllable to:~~

~~upon the detection that the object has the defect, instruct a light projector to project a coded structured pattern on the object;~~

~~instruct the image capturing device to capture a two dimensional image of the object comprising the projected coded structured pattern;~~

~~construct a three dimensional (3D) model of the object from the captured two dimensional image by decoding the projected coded structured pattern to obtain surface geometry of the object; and~~

~~perform 3D measurements of the defect using the surface geometry obtained.~~

~~17~~15. The apparatus as claimed in claim ~~16~~11, wherein the coded structured pattern is a monochromatic spatially coded pattern.

~~18~~16. The apparatus as claimed in claim ~~16~~11, wherein the apparatus is controllable to:

adapt the coded structured pattern based on viewpoint between a defect and the image capturing device; and/or

tune colours of the coded structured pattern in regard to a specific defect region; and/or increase spatial sample resolution for a target defect region considered.

~~19~~17. The apparatus as claimed in claim ~~16~~11, wherein

after directing the image capturing device and the light projector towards a calibration board comprising an area with calibration pattern such that the light projector projects asymmetrical circle patterns outside the area with calibration pattern, the apparatus is controllable to:

detect the calibration pattern and the projected asymmetrical circle patterns from an image captured using the image capturing device, wherein the image comprises the calibration board comprising the calibration pattern and the projected asymmetrical circle patterns; and

after tilting the image capturing device and the light projector at a different angle towards the calibration board for at least two more times, the apparatus is controllable to:

detect the calibration pattern and the projected asymmetrical circle patterns for additional images captured at the different angles by the image capturing device; and

obtain a calibration result based on collated data of the detected calibration pattern and detected projected asymmetrical circle patterns.

~~20~~18. The apparatus as claimed in claim ~~19~~17, wherein the calibration pattern is a plurality of asymmetrical circle patterns.

~~21~~ 19. The apparatus as claimed in claim ~~19~~17, wherein the apparatus is controllable to:

take into consideration the calibration result to perform measurement using stereo triangulation on an image of the object that is captured by the image capturing device.

~~22~~20. The apparatus as claimed in claim ~~12~~11, wherein

after projecting four illuminated dots onto a surface containing an elevated or a dented point for measuring respective height or depth of the point relative to the surface, wherein three of the four illuminated dots for forming a reference plane are projected on the surface and the remaining one illuminated dot is projected on the point, the apparatus is controllable to:

calculate 3D coordinates of the four illuminated dots with respect to a centre of the image capturing device based on triangulation from an image captured by the image capturing device, wherein the image comprises the four illuminated dots, the surface and the point; and

after obtaining the 3D coordinates of the four illuminated dots, the apparatus is controllable to: calculate height or depth of the point relative to the surface based on distance between the point and the reference plane.