MACHINING PARAMETER TESTING METHOD AND APPARATUS, ELECTRONIC DEVICE, AND STORAGE MEDIUM

[0001] This application claims the priority to Chinese Patent Application No. 202311748588.4, titled "MACHINING PARAMETER TESTING METHOD AND APPARATUS, ELECTRONIC DEVICE, AND STORAGE MEDIUM", filed on December 18, 2023 with the China National Intellectual Property Administration, which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates to the technical field of image processing, and in particular to a method and an apparatus for detecting a processing parameter, an electronic device and a storage medium.

BACKGROUND

[0003] In the semiconductor industry, the manufacturing of semiconductor components involves various procedures. A wafer being a to-be-processed workpiece is taken as an example, and the manufacturing process of the wafer includes multiple procedures such as wafer dicing and wafer cleaving after the dicing. In the wafer cleaving procedure, a cleaving blade of a cleaving system (also referred to as a cleaving machine) is utilized to cleave the diced wafer along a dicing street, so as to separate individual dies from the wafer. When the cleaving blade acts on a surface of the wafer, the back of the cleaving blade is struck with a hammer. Under a combined action of the cleaving blade, the hammer and a cleaving stage, the wafer is cleaved along the cleaving line, enabling the dies to be separated from the wafer.

[0004] During the processing of the workpiece, improper processing parameter settings may cause a processing device to fail to align with a predetermined processing line for processing, leading to a scrapped workpiece. The wafer is taken as an example, since the cleaving blade directly acts on the surface of the wafer during the wafer cleaving procedure, if the cleaving blade is not positioned precisely on the dicing street, it may lead to die damage and wafer scrappage.

SUMMARY

[0005] In view of the above problem, a method and an apparatus for detecting a processing parameter, an electronic device and a storage medium are provided according to the present disclosure.

[0006] In a first aspect, a method for detecting a processing parameter applied to a processing device is provided according to the present disclosure. The method includes:

acquiring a first detection image, where the first detection image includes a to-be-processed workpiece;

determining a first image position of a first target feature point in the first detection image, where the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

determining at least one predicted processing mark based on first position information and a preset processing parameter, where the first position information is the first image position or a first physical position of the first target feature point, the first physical position is determined based on the first image position, the at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, where the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark includes at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

[0007] In an embodiment, the processing device includes a first image acquisition apparatus and a second image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

in a case that the at least one predicted processing mark includes the at least one predicted processing line, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes:

identifying a contour of the to-be-processed workpiece in a second detection image acquired by the first image acquisition apparatus; and

determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, where

the at least one predicted processing line includes the at least one predicted line segment, one of the at least one predicted line segment passes through the first target feature point, a distance between any two adjacent predicted line segments of the at least one predicted line segment is identical to the preset spacing in a direction perpendicular to the target direction, and two endpoints of each of the at least one predicted line segment are located within the contour of the to-be-processed workpiece.

[0008] In an embodiment, the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece includes:

constructing, based on the first position information, a target straight line along the target direction through an initial feature point until the target straight line intersects with the contour of the to-be-processed workpiece, where the first target feature point or a second target feature point is determined as the initial feature point, where the second target feature point is located closest to a product center of the to-be-processed workpiece and determined based on the first target feature point; and

translating the initial feature point along a direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more feature points, and constructing a target straight line along the target direction through each of the obtained one or more feature points until the target straight line intersects with the contour of the to-be-processed workpiece; or

translating the target straight line passing through the initial feature point along the direction perpendicular to the target direction by an integer multiple of the preset spacing to

obtain one or more target straight lines, where a segment of the obtained one or more target straight lines that is within the contour of the to-be-processed workpiece is determined as a predicted line segment passing through a corresponding feature point.

[0009] In an embodiment, after the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, the method further includes:

displaying a third detection image, where the third detection image includes the at least one predicted line segment and the third detection image is at least a portion of an image acquired by the first image acquisition apparatus, and where

the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark includes:

determining that the preset processing parameter is qualified in response to a qualification indication information inputted by a user; and/or determining that the preset processing parameter is unqualified in response to a disqualification indication information inputted by the user, where

the position detection information includes the qualification indication information and/or the disqualification indication information, the qualification indication information is to indicate that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, and the disqualification indication information is to indicate that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark.

[0010] In an embodiment, in a case that the at least one predicted processing mark includes the at least one first predicted feature point, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes:

determining a physical position as a third physical position of the first predicted feature point based on the first position information and the preset processing parameter, where a distance between the physical position and the first physical position, or a distance between the physical position and a second physical position determined based on the first position information, meets a predetermined distance condition, where

the second physical position is a physical position of a second target feature point, where

the second target feature point is closest to the product center of the to-be-processed workpiece,

and the predetermined distance condition includes: a distance in a second direction being equal to a first quantity of first spacings and a distance in a first direction being equal to a second quantity of second spacings,

the first direction and the second direction are perpendicular to each other, and the preset spacing includes the first spacing and/or the second spacing.

[0011] In an embodiment, the processing device includes a second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark includes:

moving a center of a field of view of the second image acquisition apparatus to the third physical position;

acquiring, after the movement, a fourth detection image by the second image acquisition apparatus;

identifying a third target feature point in the fourth detection image;

determining an image position difference between an image position of the third target feature point in the fourth detection image and an image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image, or determining a physical position difference between a physical position of the third target feature point and a physical position of the center of the field of view of the second image acquisition apparatus;

determining whether the image position difference is less than or equal to a first preset error threshold or whether the physical position difference is less than or equal to a second preset error threshold, to obtain a position determination result, where the position detection information includes the position determination result; and

determining that the preset processing parameter is qualified in a case that the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, or determining that the preset processing parameter is unqualified in a case that the position determination result indicates that the position of the at least one predicted processing mark does not align with the position

of the predetermined processing mark, where

the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark in a case that the image position difference is less than or equal to the first preset error threshold or the physical position difference is less than or equal to the second preset error threshold, and

the position determination result indicates that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark in a case that the image position difference is greater than the first preset error threshold or the physical position difference is greater than the second preset error threshold.

[0012] In an embodiment, where before the moving a center of a field of view of the second image acquisition apparatus to the third physical position, the method further includes:

moving the center of the field of view of the second image acquisition apparatus to the first physical position or the second physical position based on the first position information, and where

the moving a center of a field of view of the second image acquisition apparatus to the third physical position includes:

moving the center of the field of view of the second image acquisition apparatus by a distance specified by the predetermined distance condition to reach the third physical position.

[0013] In an embodiment, where before the determining a first image position of a first target feature point in the first detection image, the method further includes:

performing feature point matching on the first detection image by using a first template image that includes a template feature point; and

determining a feature point matching the template feature point as the first target feature point, where the feature point is identified in the first detection image, and where

the identifying a third target feature point in the fourth detection image includes:

performing feature point matching on the fourth detection image by using the first template image; and

determining a feature point matching the template feature point as the third target feature point, where the feature point is identified in the fourth detection image.

[0014] In an embodiment, the processing device includes a second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

before the determining a first image position of a first target feature point in the first detection image, the method further includes:

a first operation;

or

the first operation and a second operation performed after the first operation;

or

the first operation, the second operation and a third operation performed after the second operation, where

the first operation includes: identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus,

the second operation includes: calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located;

moving, after the calibration, a center of a field of view of the second image acquisition apparatus to a physical position, where the center of the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image; acquiring, after the movement, a sixth detection image by the second image acquisition apparatus; and identifying a fifth target feature point in the sixth detection image, and

the third operation includes: determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is closest to a product center of the to-be-processed workpiece; moving the center of the field of view of the second image acquisition apparatus to the fourth physical position; acquiring, after the movement, a seventh detection image by the second image acquisition apparatus; and identifying a sixth target feature point in the seventh detection image, where

in a case that the method includes the first operation and does not include the second operation, the fifth detection image is determined as the first detection image and the fourth

target feature point is determined as the first target feature point,

in a case that the method includes the first operation and the second operation and does not include the third operation, the sixth detection image is determined as the first detection image and the fifth target feature point is determined as the first target feature point, and

in a case that the method includes the first operation, the second operation and the third operation, the seventh detection image is determined as the first detection image and the sixth target feature point is determined as the first target feature point.

[0015] In an embodiment, the processing device further includes a first image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, and before the identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus, the method further includes:

identifying a contour of the to-be-processed workpiece in an eighth detection image acquired by the first image acquisition apparatus, where a center of a field of view of the first image acquisition apparatus coincides with a center of a carrying apparatus when the first image acquisition apparatus acquires the eighth detection image, and the carrying apparatus carries the to-be-processed workpiece;

determining a second image position of the product center of the to-be-processed workpiece in the eighth detection image based on the contour of the to-be-processed workpiece;

determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference;

moving the carrying apparatus to a position within the field of view of the second image acquisition apparatus to enable the center of the carrying apparatus to coincide with the center of the field of view of the second image acquisition apparatus;

adjusting the position of the carrying apparatus based on the physical position difference to enable a physical position of the product center of the to-be-processed workpiece on the carrying apparatus to coincide with the physical position of the center of the field of view of the second image acquisition apparatus; and

acquiring, after the adjustment, the fifth detection image by the second image acquisition apparatus.

[0016] In an embodiment, before the determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference, the method further includes:

acquiring a plurality of ninth detection images, where the plurality of ninth detection images of the to-be-processed workpiece are acquired by the second image acquisition apparatus when the to-be-processed workpiece is located at a plurality of fifth physical positions, the quantity of the plurality of ninth detection images is greater than or equal to 3, and the plurality of fifth physical positions are different from each other;

for each ninth detection image of the plurality of ninth detection images, determining an image position of an identification feature in the ninth detection image based on a second template image, where the second template image includes the identification feature on the to-be-processed workpiece; and

determining the conversion relationship based on the image positions of the identification feature in the plurality of ninth detection images and the plurality of fifth physical positions.

[0017] In an embodiment, the determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is closest to a product center of the to-be-processed workpiece, includes:

determining at least one second predicted feature point closest to the product center of the to-be-process workpiece based on the image position of the fifth target feature point in the sixth detection image and the preset spacing, where the at least one second predicted feature point is circumferentially distributed relative to the product center;

calculating a distance between each of the at least one second predicted feature point and the product center; and

determining a second predicted feature point, with a smallest distance to the product center, among the at least one second predicted feature point, as the second target feature point, and

determining a physical position of the second target feature point as the fourth physical position.

[0018] In an embodiment, the calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located includes:

determining the fourth target feature point as a reference position point and sequentially determining a plurality of groups of position points based on the reference position point, where each group of the plurality of groups of position points includes a first position point and a second position point, the first position point and the second position point are located on different sides of the reference position point, a spacing between the first position point and the second position point in the plurality of groups of position points gradually increases along the first direction across the groups, and among the reference position point and the plurality of groups of position points, different position points correspond to different feature points lying on the target predetermined processing line; and

calculating, each time after a group of the plurality of groups of position points is determined, an angle of a connecting line relative to the first direction, where the connecting line is between the first position point and the second position point in the group of position points, and performing a calibration operation, which includes:

determining an adjustment angle based on the angle of the connecting line in a case that the angle of the connecting line is greater than a preset angle threshold, and adjusting a position of the to-be-processed workpiece according to the adjustment angle to calibrate a position of the target predetermined processing line on the to-be-processed workpiece; and

stopping the calibration operation in a case that the angle of the connecting line is less than or equal to the preset angle threshold, where

for the plurality of groups of position points, after a current group of the plurality of groups of position points is determined and the calibration operation is performed, a next group of position points is determined, and along the first direction, a spacing between the first position point and the second position point in the next group of position points is greater than a spacing between the first position point and the second position point in the current group of position points.

[0019] In a second aspect, an apparatus for detecting a processing parameter applied to a processing device, is provided according to the present disclosure. The apparatus includes:

an acquisition module, configured to acquire a first detection image, where the first detection image includes a to-be-processed workpiece;

a first determination module, configured to determine a first image position of a first target feature point in the first detection image, where the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

a second determination module, configured to determine at least one predicted processing mark based on first position information and a preset processing parameter, where the first position information is the first image position or a first physical position of the first target feature point determined based on the first image position, the at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

a third determination module, configured to determine whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, where the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark includes at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

[0020] In a third aspect, an electronic device is provided according to the present disclosure. The electronic device includes a processor and a memory. The memory stores a computer program instruction, and the computer program instruction, when being executed by the processor, performs the method for detecting the processing parameter according to any embodiment of the first aspect.

[0021] In a fourth aspect, a storage medium is provided according to the present disclosure. The storage medium stores a computer program or an instruction. The computer program or the instruction, when being executed, performs the method for detecting the processing parameter according to any embodiment of the first aspect.

[0022] With the method and the apparatus for detecting the processing parameter, the electronic device and the storage medium according to the present disclosure, a second image

acquisition apparatus is moved based on a determined first physical position of a first target feature point so that a center of the field of view of the second image acquisition apparatus coincides with the first physical position after the movement. At least one predicted processing mark is determined based on the first physical position and a preset processing parameter. It is determined whether the preset processing parameter is a target processing parameter based on feedback information. According to the technical solution described herein, at least one predicted processing mark is determined based on the first physical position and the preset processing parameter. Through determining whether a position of the at least one predicted processing mark aligns with a position of the predetermined processing mark, it is determined whether a position where the cleaving blade acts is accurate, so as to prevent cleaving damage to a to-be-processed workpiece. In addition, non-contact cleaving and missed cleaving during processing can be prevented, improving the processing efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Above and other objects, features, and advantages of the present disclosure will become more apparent with reference to the detailed description of the embodiments of the present disclosure made in conjunction with the drawings. The drawings are intended to provide further understanding of the embodiments of the present disclosure, and constitute a part of the specification. The drawings are intended to describe the present disclosure in conjunction with the embodiments of the present disclosure, and do not limit the present disclosure. In the drawings, same reference numerals generally represent same parts or steps.

[0024] FIG. 1 is a flowchart of a method for detecting a processing parameter according to an embodiment of the present disclosure;

[0025] FIG. 2 is a schematic diagram of an image coordinate system established for a first detection image according to an embodiment of present disclosure;

[0026] FIG. 3 is a schematic diagram of a predicted processing line according to an embodiment of the present disclosure;

[0027] FIG. 4 is a schematic diagram of a processing device according to an embodiment of the present disclosure;

[0028] FIG. 5 is a schematic diagram of a second detection image according to an

embodiment of the present disclosure;

[0029] FIG. 6 is a schematic diagram of a first template image according to an embodiment of the present disclosure;

[0030] FIG. 7 is a schematic diagram of a position of at least one second predicted feature point in a sixth detection image according to an embodiment of present disclosure;

[0031] FIG. 8 is a schematic block diagram of an apparatus for detecting a processing parameter according to an embodiment of the present disclosure; and

[0032] FIG. 9 is a schematic block diagram of an electronic device according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0033] Exemplary embodiments of the present disclosure are described in detail with reference to the drawings to make objects, technical solutions, and advantages of the present disclosure more apparent. Apparently, the described embodiments are only a part of the embodiments instead of all embodiments of the present disclosure. It should be understood that, the present disclosure is not limited by the exemplary embodiments described herein. Based on the embodiments of the present disclosure described herein, all other embodiments obtained by those skilled in the art without creative efforts are deemed to fall into the scope of protection of the present disclosure.

[0034] To address the above problem, a method for detecting a processing parameter is provided according to the present disclosure. The method for detecting the processing parameter may be applied to a processing device, such as a cleaving system, capable of processing a workpiece along a predetermined processing line on the workpiece. FIG. 1 is a flowchart of a method 100 for detecting a processing parameter according to an embodiment of present disclosure. As shown in FIG. 1, the method 100 may include steps S110, S120, S130, and S140.

[0035] In step S110, a first detection image is acquired. The first detection image includes a to-be-processed workpiece.

[0036] In an embodiment, the first detection image may be any type of image including the

to-be-processed workpiece. The to-be-processed workpiece may be, for example, any product to be processed, such as ceramics and a wafer. The first detection image may be a static image or any video frame in a dynamic video. The first detection image may be an original image acquired by an image acquisition apparatus (for example, an image sensor in a camera), or may be an image obtained by preprocessing (such as digitizing, normalizing and smoothing) the original image. To facilitate description and understanding, the following description is provided by taking an example that a wafer serves as the to-be-processed workpiece.

[0037] In step S120, a first image position of a first target feature point in the first detection image is determined. The to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines.

[0038] In an embodiment, the target feature point (including the first target feature point, a second target feature point, a third target feature point and the like) described herein is any recognizable feature point on the to-be-processed workpiece. In an embodiment, the target feature point may be a feature point inherently present on the to-be-processed workpiece, such as a shape feature point or a structure feature point. In an embodiment, the target feature point may further be a feature point marked on the to-be-processed workpiece manually or by a processing device, such as an easily recognizable symbol and an easily recognizable pattern. The target feature point may be in any shape, such as a circle, a cross and a star. The to-be-processed workpiece may be provided with at least two predetermined processing lines. The predetermined processing lines are feature lines on the to-be-processed workpiece. The target feature point is located on the predetermined processing line. In an example, the predetermined processing line may be a dicing street on a wafer. Preferably, the target feature point is a center point of the intersection region between two mutually perpendicular dicing streets (referred to as "dicing street center"). In an embodiment of the present disclosure, the first target feature point may be a feature point among feature points which is closest to a product center of the to-be-processed workpiece or at other positions on the to-be-processed workpiece. In an embodiment of the present disclosure, a template image (for example, a first template image or a second template image described below) and the first detection image are matched to determine a first image position of the first target feature point in the first detection image. The template image may include a template feature point. The first target feature point in the first detection image which matches the template feature point is determined by using an image

matching algorithm, and thus the first image position of the first target feature point is determined. In an embodiment, the template image includes a dicing street center (represented by a black dot), and the dicing street center is determined as the template feature point.

[0039] To facilitate understanding, a determination process of a physical position and an image position mentioned in the present disclosure is described below.

[0040] An image position of any feature point described herein (for example, the first target feature point) may be represented by a pixel coordinate in an image coordinate system where the feature point is located. FIG. 2 is a schematic diagram of an image coordinate system established for a first detection image according to an embodiment of present disclosure. For example, the image coordinate system shown in FIG. 2 is established as follows: a vertex at the upper left corner of the first detection image is determined as an origin O, an axis passing through the origin O and parallel to an upper edge of the first detection image is determined as an X-axis, and an axis passing through the origin O and perpendicular to the X-axis and parallel to a left edge of the first detection image is determined as an y-axis. The point P is the first target feature point. For example, the first detection image includes 1000×1000 pixels. The first target feature point P is located at a pixel in row 150 and column 300, and a first image position of the first target feature point P is represented by (150,300).

[0041] Physical positions described herein may be represented by coordinates in a same world coordinate system. The world coordinate system may be further referred to as a mechanism coordinate system. An example of establishing the world coordinate system is described as follows. A to-be-processed workpiece may be placed on a movable carrying apparatus, such as a movable stage. The movable stage is capable of translating within a plane (which may be referred to as a "movement plane") or rotating around a fixed axis within the movement plane. The to-be-processed workpiece and the movable stage move synchronously. Therefore, a physical position of the movable stage and a physical position of the to-be-processed workpiece described herein are regarded as the same, and both of which may be represented interchangeably. Within a movement range of the movable stage, two mutually perpendicular grating scales are configured. For example, in a case that the movable stage stays at a predetermined initial physical position, the readings on the grating scales in this case may be set to 0, and the physical position is determined as the origin O of the world coordinate system. A first grating scale is arranged along a first direction and passing through the origin O,

and the axis on which the first grating scale is located serves as the X-axis of the world coordinate system. A second grating scale is arranged perpendicular to the X-axis and passing through the origin O. The axis on which the second grating scale is located serves as the Y-axis of the world coordinate system. Based on the world coordinate system established above, each time the movable stage moves, that is, each time the to-be-processed workpiece moves, the X-axis coordinate is read from the first grating scale and the Y-axis coordinate is read from the second grating scale, and a coordinate (X, Y) represents a physical position of the to-be-processed workpiece. It can be understood that (X, Y) is coordinate data representing the displacement of the to-be-processed workpiece.

[0042] In step S130, at least one predicted processing mark is determined based on first position information and a preset processing parameter. The first position information is a first image position or a first physical position of the first target feature point, and the first physical position is determined based on the first image position. The at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines.

[0043] In an embodiment, first position information may be a first image position or a first physical position of the first target feature point. A predetermined conversion relationship is set between an image position and a physical position and is stored in advance in a storage apparatus. The storage apparatus may be included in an apparatus for performing the method 100 for detecting the processing parameter, or may be an independent storage apparatus. The apparatus for performing the method 100 for detecting the processing parameter may be communicatively connected to the independent storage apparatus. The apparatus for performing the method 100 for detecting the processing parameter is referred to as an apparatus for detecting a processing parameter herein, and may be a processing device, a control apparatus included in the processing device or the like. Based on the predetermined conversion relationship, an image position is determined by using a known physical position, and a physical position is determined by using a known image position. At least one predicted processing mark may be determined based on the first position information and the preset processing parameter. The preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines. In an embodiment, in a case that a to-be-processed workpiece is a wafer, the preset spacing represents

a predetermined distance between any two adjacent dicing streets and may further be referred to as a predetermined die pitch. The at least one predicted processing mark may include at least one predicted processing line and at least one first predicted feature point. Alternatively, the at least one predicted processing mark may include at least one predicted processing line or at least one first predicted feature point. Given a known preset spacing between two adjacent predetermined processing lines, based on the first image position or the first physical position of the first target feature point, an image position or a physical position of another predetermined processing line or feature point may be inferred by using the first target feature point. For the purpose of distinction, a processing line which is inferred (not an actual predetermined processing line on a to-be-processed workpiece) is referred to as a predicted processing line, and a feature point which is inferred (not an actual feature point on the to-be-processed workpiece) is referred to as a predicted feature point.

[0044] In an embodiment, the predicted processing line is displayed on a display apparatus as a preview line of a cleaving position, so that a user determines whether the position of the predicted processing line aligns with a position of a predetermined processing mark and further determines whether the preset processing parameter is qualified. FIG. 3 is a schematic diagram of predicted processing lines according to an embodiment of present disclosure. As shown in FIG. 3, each white solid line represents one predicted processing line. The dicing street lies within a region between two adjacent black dots. In an embodiment, the predicted processing line is not displayed, and the apparatus for detecting the processing parameter automatically evaluates alignment between an obtained predicted processing line and a predetermined processing line and determines whether a preset processing parameter is qualified based on the evaluation result. Similarly, a predicted feature point is displayed, and the user determines whether the preset processing parameter is qualified. Alternatively, the apparatus for detecting the processing parameter automatically evaluates alignment between the predicted feature point and a feature point on a predetermined processing line and determines whether the preset processing parameter is qualified based on the evaluation result.

[0045] In step S140, it is determined whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark. The position detection information is to indicate whether the position of the at least one predicted processing mark aligns with a position of a predetermined processing mark. The predetermined processing mark includes at least one predetermined processing line and/or at

least one feature point on a predetermined processing line.

[0046] In an embodiment, it is determined whether the preset processing parameter is qualified based on position detection information related to at least one predicted processing mark. In a case that the at least one predicted processing mark includes at least one predicted processing line, the position detection information indicates whether a position of the at least one predicted processing line aligns with a position of at least some of at least one predetermined processing line. In a case that the at least one predicted processing mark includes at least one first predicted feature point, the position detection information indicates whether a position of the at least one predicted feature point aligns with a position of at least some target feature points on the at least one predetermined processing line. A case that the at least one predicted processing mark including at least one predicted processing line is taken as an example. In a case that the position of the at least one predicted processing line aligns with the position of at least some of the at least one predetermined processing line, it is determined that the preset processing parameter is qualified; and otherwise, it is determined that the preset processing parameter is unqualified.

[0047] The position detection information may be inputted by a user. That is, the position detection information may be user feedback information of whether the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, inputted by the user. The position detection information may further be automatically determined by the apparatus for detecting the processing parameter based on the at least one predicted processing mark.

[0048] In the method for detecting the processing parameter provided in the embodiments of the present disclosure, the at least one predicted processing mark is determined based on first position information of a first target feature point and a preset processing parameter. It is determined whether the preset processing parameter is qualified based on the position detection information indicating the position alignment between the predicted processing mark and the predetermined processing mark. With this technical solution, it is determined whether the preset processing parameter is qualified (accurate) according to the determination result of whether a position of the predicted processing mark inferred based on the preset processing parameter aligns with a position of the predetermined processing mark. Processing errors caused by incorrect settings of the processing parameter can be effectively avoided, thereby preventing

workpiece damage. For example, during wafer processing, this technical solution effectively prevents the wafer from being damaged by a cleaving blade and thereby preventing wafer scrappage, eliminating non-contact cleaving and missed cleaving during processing, thereby improving processing efficiency.

[0049] In an embodiment, the processing device includes a first image acquisition apparatus and a second image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus. The first detection image is acquired by the second image acquisition apparatus. In a case that the at least one predicted processing mark includes the at least one predicted processing line, determining at least one predicted processing mark based on first position information and a preset processing parameter includes: identifying a contour of the to-be-processed workpiece in a second detection image acquired by the first image acquisition apparatus; and determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece. The at least one predicted processing line includes at least one predicted line segment, one of the at least one predicted line segment passes through the first target feature point. A distance between any two predicted line segments of the at least one predicted line segment is identical to the preset spacing in a direction perpendicular to the target direction, and the preset spacing is a distance between adjacent predetermined processing lines. Two endpoints of each of the at least one predicted line segment are located within the contour of the to-be-processed workpiece.

[0050] The target direction may include a first direction and/or a second direction. A predicted line segment may be constructed along the first direction and/or a predicted line segment may be constructed along the second direction as a predicted processing line. The first direction is perpendicular to the second direction. In an embodiment, a processing device includes a first image acquisition apparatus and a second image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, and the first detection image is acquired by the second image acquisition apparatus. In a case that the at least one predicted processing mark includes the at least one predicted processing line, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes: identifying a contour of a to-be-processed workpiece in a second detection image acquired by

the first image acquisition apparatus; and determining at least one first predicted line segment along the first direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, and/or determining at least one second predicted line segment along the second direction, to obtain at least one predicted processing line. The at least one predicted processing line includes the at least one first predicted line segment and/or the at least one second predicted processing line segment. The first direction is perpendicular to the second direction. One of the at least one first predicted line segment passes through the first target feature point and one of the at least one second predicted line segment passes through the first target feature point. A distance between any two first predicted line segments is identical to a first spacing, in the second direction, between adjacent predetermined processing lines. A distance between any two second predicted line segments is identical to a second spacing, in the first direction, between adjacent predetermined processing lines. The preset spacing includes the first spacing and the second spacing. Two endpoints of each of the first predicted line segments are located within the contour of the to-be-processed workpiece. Two endpoints of each of the second predicted line segments are located within the contour of the to-be-processed workpiece.

[0051] In an embodiment, the processing device includes a first image acquisition apparatus and a second image acquisition apparatus. An image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus. FIG. 4 is a schematic diagram of a processing device according to an embodiment of the present disclosure. As shown in FIG. 4, the processing device 400 includes a first image acquisition apparatus 410, a second image acquisition apparatus 420, and a carrying apparatus 430. The first image acquisition apparatus 410 is configured to acquire an image of a to-be-processed workpiece and determine a position of a product center of the to-be-processed workpiece and a contour of the to-be-processed workpiece based on the acquired image. The second image acquisition apparatus 420 is configured to determine a processing position of the to-be-processed workpiece. A case that a cleaving system serves as a processing device and a wafer serves as a to-be-processed workpiece is taken as an example for illustrating. The second image acquisition apparatus 420 is configured to determine a position where the wafer undergoes front-side cleaving. The second image acquisition apparatus 420 is arranged at the positive half-axis of the Z axis (not shown in FIG. 4). The Z-axis is perpendicular to the X-axis and the Y-axis in a world coordinate system where the to-be-processed workpiece is located.

The carrying apparatus 430 may be the above-described movable stage. The carrying apparatus 430 is movable along the X-axis, and is to enable the to-be-processed workpiece carried thereon to move within the field of view of the first image acquisition apparatus or within the field of view of the second image acquisition apparatus. The structure of the processing device shown in FIG. 4 is merely exemplary and does not impose any limitation on the present disclosure. For example, the processing device may further include a third image acquisition apparatus. The third image acquisition apparatus may be arranged on a side opposite to the second image acquisition apparatus 420, that is, at the negative half-axis of the Z axis. For processing a wafer, the third image acquisition apparatus is configured to determine a position where the wafer undergoes back-side cleaving. The second image acquisition apparatus 420 and the third image acquisition apparatus may further be configured to perform horizontal calibration for the to-be-processed workpiece and provide a cleaving preview of the to-be-processed workpiece or the like.

[0052] In an embodiment, the above-described first detection image is acquired by the second image acquisition apparatus. Furthermore, a contour of a to-be-processed workpiece is identified in a second detection image acquired by a first image acquisition apparatus. FIG. 5 is a schematic diagram of a second detection image according to an embodiment of the present disclosure. As shown in FIG. 5, the black circular region represents a wafer. A contour of the black circular region is a contour of the wafer. For the second detection image, a grayscale threshold is set, and pixel values of the second detection image are compared with the grayscale threshold, so as to determine a position of the contour of the wafer. The grayscale threshold may be any numerical value, for example, 50, 100 or 150. Referring to FIG. 5, a dark region may represent a region where a pixel with a grayscale value less than 50 is located. In this way, a region where the wafer is located and the contour of the wafer are obtained.

[0053] One or more first predicted line segments may be determined along a first direction. The first direction may be any direction, such as the horizontal direction. The first direction may be defined as required. To facilitate descriptions, the first direction is defined herein as the horizontal direction, that is, the direction of the X-axis. The direction of the Y-axis, which is perpendicular to the direction of the X-axis, is defined herein as the vertical direction. In a case that at least one first predicted line segment is determined along the first direction, a distance between any two first predicted line segments is identical to a spacing, in a second direction, between adjacent predetermined processing lines. The first direction and the second direction

are perpendicular to each other. In a case that the first direction is the horizontal direction, the second direction is the vertical direction (that is, the direction of the Y-axis). In an embodiment, a first first predicted line segment passing through the first target feature point is constructed along the first direction. A second first predicted line segment is constructed along the horizontal direction and spaced apart from the first first predicted line segment by the first spacing. A third first predicted line segment is constructed along the horizontal direction and spaced apart from the second first predicted line segment by the first spacing. The rest is constructed in the same manner. The first spacing is a distance, in the second direction, between two adjacent predetermined processing lines extending along the first direction. Two endpoints of each of the first predicted line segments are located within the contour of to-be-processed workpiece. In an embodiment, two endpoints of each of the first predicted line segments may lie on the contour of the to-be-processed workpiece.

[0054] Further, at least one second predicted line segment may be determined along the second direction. A distance between two second predicted line segments is identical to a spacing, in the first direction, between adjacent predetermined processing lines. In an embodiment, a first second predicted line segment passing through the first target feature point is constructed along the second direction. A second second predicted line segment is constructed along the vertical direction and spaced apart from the first second predicted line segment by a second spacing. A third second predicted line segment is constructed along the vertical direction and spaced apart from the second second predicted line segment by the second spacing. The rest is constructed in the same manner. The second spacing is a distance between any two second predicted line segments, and the second spacing is identical to a spacing, in the first direction, between two adjacent predetermined processing lines. Two endpoints of each of the second predicted line segments are located within the contour of to-be-processed workpiece. In an embodiment, the two endpoints of each of the second predicted line segments may lie on the contour of the to-be-processed workpiece.

[0055] The number of the at least one first predicted line segment and the number of the at least one second predicted line segment may be or may not be identical. As described above, one of the at least one first predicted line segment and one of the at least one second predicted line segment pass through the first target feature point. Based on the contour of wafer and the at least one first predicted line segment and/or the at least one second predicted line segment, a physical position of the at least one predicted line is determined.

[0056] According to the above technical solution, at least one predicted processing line is determined based on the at least one first predicted line segment determined along the first direction and/or the at least one second predicted line segment determined along the second direction, in conjunction with the contour of the to-be-processed workpiece. With the technical solution, a position of the at least one predicted processing line can be automatically, simply and rapidly determined.

[0057] In an embodiment, determining at least one predicted line segment along a target direction based on first position information, a preset processing parameter and a contour of the to-be-processed workpiece includes:

constructing, based on the first position information, a target straight line along the target direction through an initial feature point until the constructed target straight line intersects with the contour of the to-be-processed workpiece, where the first target feature point or a second target feature point is determined as the initial feature point, and the second target feature point is located closest to a product center of the to-be-processed workpiece and determined based on the first target feature point; and

translating the initial feature point along a direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more feature points, and constructing a target straight line along the target direction through each of the obtained one or more feature points until the target straight line intersects with the contour of the to-be-processed workpiece; or

translating the target straight line passing through the initial feature point along the direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more target straight lines, where a segment of the obtained one or more target straight lines that is within the contour of the to-be-processed workpiece is determined as a predicted line segment passing through the feature point.

[0058] In an embodiment, determining at least one first predicted line segment along a first direction based on first position information, a preset processing parameter and a contour of a to-be-processed workpiece includes:

constructing, based on the first position information, a first straight line along a first direction through an initial feature point until the constructed first straight line intersects with

the contour of to-be-processed workpiece, where the first target feature point or a second target feature point is determined as the initial feature point, and the second target feature point is located closest to a product center of the to-be-processed workpiece and determined based on the first target feature point; and

translating the initial feature point along a second direction by an integer multiple of a first spacing to obtain one or more feature points, and constructing the first straight line along the first direction through each of the one or more feature points until the constructed first straight line intersects with the contour of the to-be-processed workpiece; or

translating the first straight line passing through the initial feature point along the second direction by an integer multiple of the first spacing to obtain one or more first straight lines, where a segment of the one or more first straight lines that is within the contour of the to-be-processed workpiece is determined as a first predicted line segment passing through a corresponding feature point.

[0059] Determining at least one second predicted line segment along a second direction based on the first position information, the preset processing parameter and the contour of a to-be-processed workpiece includes: constructing, based on the first position information, a second straight line along the second direction through the initial feature point until the constructed second straight line intersects with the contour of to-be-processed workpiece; and

translating the initial feature point along the first direction by an integer multiple of a second spacing to obtain one or more feature points, and constructing the second straight line along the second direction through each of the one or more feature points until the constructed second straight line intersects with the contour of the to-be-processed workpiece; or

translating the second straight line passing through the initial feature point along the first direction by an integer multiple of the second spacing to obtain one or more second straight lines, where a segment of the one or more second straight lines that is within the contour of the to-be-processed workpiece is determined as a second predicted line segment passing through a corresponding feature point.

[0060] In an embodiment, at least one first predicted line segment is determined in the following manner. Based on first position information, a first straight line passing through an initial feature point is constructed and extends bidirectionally along the first direction, for

example, the horizontal direction. When the first straight line intersects with a contour of a to-be-processed workpiece, the extension is ended, and the obtained line segment is determined as the first predicted line segment. In an embodiment, the first target feature point in the foregoing embodiment may be directly determined as an initial feature point, and a straight line passing through the initial feature point is constructed. In another embodiment, a second target feature point P0 closest to a product center of the to-be-processed workpiece is determined based on the first target feature point, the second target feature point P0 is determined as an initial feature point, and a straight line passing through the initial feature point is constructed.

[0061] In an embodiment, an initial feature point is translated along a second direction, for example, the vertical direction, by an integer multiple of a first spacing to obtain one or more feature points. For example, in a case that a first spacing L_1 is 1.5 millimeters (mm), and a physical position of the initial feature point is a first physical position represented by (1.5, 1.5). A first feature point is obtained by translating the initial feature point upward by 7.5mm (that is, 5 times of L_1) along the vertical direction, and a physical position of the first feature point is represented by (1.5, 9). Similarly, a second feature point is obtained by translating the initial feature point downward by 7.5mm (that is, 5 times of L_1) along the vertical direction, and a physical position of the second feature point is represented by (1.5, -6). In a similar manner, one or more feature points are obtained. In an embodiment, for each of the obtained feature points, a first straight line passing through the feature point is constructed along a first direction until the constructed first straight line intersects with the contour of the to-be-processed workpiece. For example, given a predetermined die pitch in a first direction on a wafer, an initial feature point is translated upward and downward respectively by one predetermined die pitch along the first direction to obtain two feature points. Two straight lines H1 and H2 are constructed, and the two straight lines are parallel to a second direction and respectively pass through the obtained two feature points. Intersection points of the straight line H1 and the contour of the to-be-processed workpiece are denoted as points U1 and U2. Intersection points of the straight line H2 and the contour of the to-be-processed workpiece are denoted as D1 and D2. A first predicted line segment along the first direction and corresponding to one of the two feature points is determined based on positions of U1 and U2, and a first predicted line segment along the first direction and corresponding to the other of the two feature points is determined based on positions of D1 and D2. In a similar manner, respective first predicted line segments H1, H2, H3, ..., and Hn along the first direction and corresponding to feature points are

determined.

[0062] In another embodiment, a first straight line passing through an initial feature point is directly translated along a second direction by an integer multiple of a first spacing, for example, 7.5mm upward in the vertical direction, to obtain another first straight line and a first predicted line segment. The first predicted line segment described in the above embodiment represents a segment of the first straight line that is within the contour of the to-be-processed workpiece.

[0063] One or more second straight lines may be determined along the second direction in a similar manner as described above in which one or more feature points or one or more first straight lines are obtained, which is not repeated herein for brevity. The second predicted line segment described in the above embodiment represents a segment of the second straight line that is within the contour of the to-be-processed workpiece.

[0064] According to the above technical solution, based on the first position information, a first straight line is constructed along the first direction through an initial feature point until the constructed first straight line intersects with the contour of the to-be-processed workpiece. The initial feature point is translated along the second direction by an integer multiple of the first spacing to obtain one or more feature points. For each of the obtained feature points, a first straight line is determined based on the feature point. Alternatively, one or more first straight lines are obtained by translating the first straight line passing through the initial feature point along the second direction by an integer multiple of the first spacing. In addition, one or more second straight lines are further determined along the second direction in a similar manner. With the technical solution, at least one first predicted line segment and/or at least one second predicted line segment are simply and rapidly determined with a high efficiency.

[0065] In an embodiment, after determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, the method further includes: displaying a third detection image, where the third detection image includes the at least one predicted line segment and the third detection image is at least a portion of an image acquired by the first image acquisition apparatus, and the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark includes: determining that the preset processing parameter is qualified in response to a

qualification indication information inputted by a user; and/or determining that the preset processing parameter is unqualified in response to a disqualification indication information inputted by the user. The position detection information includes the qualification indication information and/or the disqualification indication information. The qualification indication information is to indicate that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark. The disqualification indication information is to indicate that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark.

[0066] In a case that at least one first predicted line segment is determined along a first direction and/or at least one second predicted line segment is determined along a second direction, a third detection image includes the at least one first predicted line segment and/or the at least one second predicted line segment.

[0067] In an embodiment, a processing device further includes an input apparatus and/or an output apparatus. The input apparatus and/or the output apparatus may be communicatively connected to or included in an apparatus for detecting a processing parameter. The input apparatus may include, but is not limited to, one or more of a mouse, a keyboard, a microphone, a touch screen and the like. The output apparatus may include, but is not limited to, one or more of a display apparatus, a speaker and the like. In a case that at least one first predicted line segment and at least one second predicted line segment are determined, a third detection image including the at least one first predicted line segment and the at least one second predicted line segment is displayed on an interface of the display apparatus. In a case that only the at least one first predicted line segment or only the at least one second predicted line segment is determined, a third detection image including the at least one first predicted line segment or the at least one second predicted line segment is displayed on the interface of the display apparatus. The third detection image is acquired by the first image acquisition apparatus. The third detection image may be identical to the second detection image, or may be a different image. A complete to-be-processed workpiece or a portion of the to-be-processed workpiece may be included in the third detection image. In an embodiment of the present disclosure, the third detection image is identical to the second detection image shown in FIG. 2.

[0068] The position detection information in the foregoing embodiments may include qualification indication information and/or disqualification indication information. The

qualification indication information is to indicate that the position of the at least one predicted processing line aligns with the position of at least some of the at least one predetermined processing line. The disqualification indication information is to indicate that the position of the at least one predicted processing line does not align with the position of the at least some of the at least one predetermined processing line.

[0069] In an embodiment, the user may further input qualification indication information by using an input apparatus. It is determined according to the qualification indication information that the preset processing parameter is qualified. For example, the user inputs characters such as "Processing parameter is qualified" by using a keyboard or a mouse to indicate that the preset processing parameter is qualified. In another example, the user further clicks a "Confirm" control by using the keyboard or the mouse to indicate that the preset processing parameter is qualified. If the user does not enter any qualification indication information, for example, the input apparatus does not receive qualification indication information inputted by the user within a preset time period, it is determined that the current preset processing parameter is unqualified.

[0070] In another embodiment, it may be further determined that the preset processing parameter is unqualified based on disqualification indication information inputted by the user. For example, the user may input characters such as "Processing parameter is unqualified" by using a keyboard or a mouse to indicate that the preset processing parameter is unqualified. In another example, the user may further click an "Incorrect" control by using the keyboard or the mouse to indicate that the preset processing parameter is unqualified. If the input apparatus does not receive disqualification indication information inputted by the user within a preset time period, it is determined that the preset processing parameter is qualified.

[0071] In another embodiment, the user may input both qualification indication information and disqualification indication information by using an input apparatus. On receiving the qualification indication information inputted by the user, the apparatus for detecting the processing parameter determines that the preset processing parameter is qualified. On receiving the disqualification indication information inputted by the user, the apparatus for detecting the processing parameter determines that the preset processing parameter is unqualified.

[0072] According to the above technical solution, it is determined that a preset processing parameter is qualified based on qualification indication information inputted by a user; and/or it is determined that the preset processing parameter is unqualified based on disqualification

indication information inputted by the user. The method is highly interactive. With the method, whether the preset processing parameter is qualified can be accurately determined based on qualification indication information or disqualification indication information inputted by the user, improving efficiency.

[0073] In an embodiment, in a case that the at least one predicted processing mark includes the at least one first predicted feature point, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes: determining a physical position as a third physical position of the first predicted feature point based on the first position information and the preset processing parameter, where a distance between the physical position and the first physical position, or a distance between the physical position and a second physical position determined based on the first position information, meets a predetermined distance condition, where the second physical position is a physical position of a second target feature point closest to a product center of the to-be-processed workpiece, the predetermined distance condition includes: a distance in a second direction being equal to a first quantity of first spacings and a distance in a first direction being equal to a second quantity of second spacings, the first direction and the second direction are perpendicular to each other; and the preset spacing includes the first spacing and/or the second spacing.

[0074] In an embodiment, in a case that at least one predicted processing mark includes at least one first predicted feature point, based on first position information and a preset processing parameter, a physical position spaced apart from the first physical position by a distance meeting the predetermined distance condition may be determined as a third physical position of a first predicted feature point. The predetermined distance condition includes: a distance in a second direction being equal to a first quantity of first spacings and a distance in a first direction being equal to a second quantity of second spacings. The first spacing may be or may not be equal to the second spacing. The first quantity and the second quantity may be any numerical values, such as 0, 1, 2 or 3. In addition, the first quantity may be or may not be equal to the second quantity. The first quantity and the second quantity are not simultaneously zero. Assuming that both the first spacing and the second spacing are equal to 1.5 and the first physical position is represented by (1.5, 1.5), the third physical position of the first predicted feature point may be any physical position meeting the predetermined distance condition, such as (3, 1.5), (1.5, 3) or (3, 3). In an embodiment of the present disclosure, coordinates of the third

physical position may be represented by (3, 3). It can be understood that the third physical position is inferred based on the first position information and the preset processing parameter. A feature point at the third physical position may be assumed, that is, the first predicted feature point. The first predicted feature point is a theoretical feature point or a virtual feature point, and is not an actually detected feature point.

[0075] In another embodiment, based on first position information and a preset processing parameter, a physical position spaced apart from a second physical position by a distance meeting a predetermined distance condition may be determined as a third physical position of a first predicted feature point. The second physical position may be a physical position of the second target feature point P0 closest to the product center of the to-be-processed workpiece.

[0076] According to the above technical solution, the third physical position of the first predicted feature point is determined based on the first position information and the preset processing parameter. The third physical position is spaced apart from the first physical position or the second physical position by a distance meeting the predetermined distance condition. The technical solution is implemented without complex parameter settings. The third physical position of the first predicted feature point can be determined based on the first position information and the preset processing parameter, improving the efficiency of determining whether the preset processing parameter is qualified.

[0077] In an embodiment, the processing device may include a second image acquisition apparatus, a first detection image is acquired by the second image acquisition apparatus, and determining whether a preset processing parameter is qualified based on position detection information related to at least one predicted processing mark includes:

moving a center of a field of view of the second image acquisition apparatus to the third physical position;

acquiring, after the movement, a fourth detection image by the second image acquisition apparatus;

identifying a third target feature point in the fourth detection image;

determining an image position difference between an image position of the third target feature point in the fourth detection image and an image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image, or determining a

physical position difference between a physical position of the third target feature point and a physical position of the center of the field of view of the second image acquisition apparatus;

determining whether the image position difference is less than or equal to a first preset error threshold or whether the physical position difference is less than or equal to a second preset error threshold, to obtain a position determination result, where the position detection information includes the position determination result; and

determining that the preset processing parameter is qualified in a case that the position determination result indicates that the position of the predicted processing mark aligns with the position of the predetermined processing mark, or determining that the preset processing parameter is unqualified in a case that the position determination result indicates that the position of the predicted processing mark does not align with the position of the predetermined processing mark, where

the position determination result indicates that the position of the predicted processing mark aligns with the position of the predetermined processing mark in a case that the image position difference is less than or equal to the first preset error threshold or the physical position difference is less than or equal to the second preset error threshold, and

the position determination result indicates that the position of the predicted processing mark does not align with the position of the predetermined processing mark in a case that the image position difference is greater than the first preset error threshold or the physical position difference is greater than the second preset error threshold.

[0078] In an embodiment, the processing device may include a second image acquisition apparatus. A first detection image is acquired by the second image acquisition apparatus. In a case that the center of the field of view of the second image acquisition apparatus is moved to a third physical position, for example (3, 3), a fourth detection image is acquired by the second image acquisition apparatus at the current position. In an image coordinate system, an image coordinate of the center of the field of view of the second image acquisition apparatus coincides with an image coordinate of the first predicted feature point. That is, the image position of the center of the field of view is identical to the image position of the first predicted feature point, and the physical position of the center of the field of view is identical to the physical position of the first predicted feature point. A third target feature point may be identified in the fourth detection image based on a template image. Based on the third target feature point, an image

position difference between the image position of the third target feature point and the image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image is determined. For example, assuming that the image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image is represented by (400, 550) and the image position of the third target feature point in the fourth detection image is represented by (405, 551), an image position difference (Δx_1, Δy_1) is determined as (5, 1). In another embodiment, a physical position difference between the physical position of the third target feature point and the physical position of the center of the field of view of the second image acquisition apparatus is further determined. For example, assuming that the physical position of the center of the field of view of the second image acquisition apparatus is represented by (3, 3) and the physical position of the third target feature point is represented by (2.97, 2.93), a physical position difference (ΔX_1, ΔY_1) is determined as (-0.03, -0.07). The negative sign "-" indicates that the displacements are respectively along the negative directions of the X-axis and the Y-axis. Theoretically, when a preset processing parameter is configured correctly, the position of the third target feature point coincides or virtually coincides with the position of the first predicted feature point. In a case of a large difference between the two positions, it is determined that the preset processing parameter is unqualified. After the center of the field of view of the second image acquisition apparatus is moved to the third physical position, the position of the center of the field of view of the second image acquisition apparatus is identical to the position of the first predicted feature point, and the position of the center of the field of view is directly compared with the position of the third target feature point. A position determination result is obtained through determining whether an image position difference is less than or equal to a first preset error threshold or determining whether a physical position difference is less than or equal to a second preset error threshold. The first preset error threshold may be any numerical value, and the value represents a distance error in an image coordinate system. For example, the first preset error threshold may be equal to a distance of 2 pixels, a distance of 3 pixels or the like. In an embodiment of the present disclosure, the first preset error threshold is equal to a distance of 3 pixels. The second preset error threshold may be any numerical value, and the value represents a distance error in a physical coordinate system. For example, the second preset error threshold may be equal to 0.01mm, 0.02mm or the like. In an embodiment of the present disclosure, the second preset error threshold is equal to 0.02mm. The position detection information includes the position

determination result. In a case that the position determination result indicates that a position of a predicted processing mark aligns with a position of a predetermined processing mark, that is, an image position difference is less than or equal to the first preset error threshold or a physical position difference is less than or equal to the second preset error threshold, it is determined that the preset processing parameter is qualified; otherwise, it is determined that the preset processing parameter is unqualified.

[0079] According to the above technical solution, after the center of the field of view of the second image acquisition apparatus is moved to the third physical position, the fourth detection image is acquired by the second image acquisition apparatus. The third target feature point is identified in the fourth detection image. The image position difference between the image position of the third target feature point in the fourth detection image and the image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image is determined. Alternatively, the physical position difference between the physical position of the third target feature point and the physical position of the center of the field of view is determined. By determining whether the image position difference is less than or equal to the first preset error threshold or whether the physical position difference is less than or equal to the second preset error threshold, it is determined whether the preset processing parameter is qualified. This technical solution is implemented without any complex determination logic. With this technical solution, based on the fourth detection image acquired by the second image acquisition apparatus after the movement of the second image acquisition apparatus, a position difference between the third target feature point and the center of the field of view of the second image acquisition apparatus is determined, such that it is determined whether the preset processing parameter is qualified, improving the efficiency and reliability.

[0080] In an embodiment, before the moving a center of a field of view of the second image acquisition apparatus to the third physical position, the method further includes: moving the center of the field of view of the second image acquisition apparatus to the first physical position or the second physical position based on the first position information, and the moving a center of a field of view of the second image acquisition apparatus to the third physical position includes: moving the center of the field of view of the second image acquisition apparatus by a distance specified by the predetermined distance condition to reach the third physical position.

[0081] In an embodiment, before the center of the field of view of the second image

acquisition apparatus is moved to the third physical position, the center of the field of view of the second image acquisition apparatus is moved to the first physical position or the second physical position based on the first position information. Then, the second image acquisition apparatus is moved according to a predetermined distance condition, for example, the second image acquisition apparatus is moved by a distance of 5 predetermined die pitches along the horizontal direction, and a physical position of the center of the field of view of the second image acquisition apparatus is the third physical position in this case.

[0082] According to the above technical solution, after the center of the field of view of the second image acquisition apparatus is moved to the first physical position or the second physical position, the physical position of the center of the field of view of the second image acquisition apparatus aligns with a physical position of a specific processing mark. Then, the center of the field of view of the second image acquisition apparatus is moved by a distance specified by the predetermined distance condition so that the third physical position is determined. Based on this technical solution, it is determined whether the predetermined distance condition meets requirements, thereby determining whether the preset processing parameter is qualified.

[0083] In an embodiment, before determining the first image position of the first target feature point in the first detection image, the method further includes: performing feature point matching on the first detection image by using a first template image that includes a template feature point; and determining a feature point matching the template feature point as the first target feature point, where the feature point is identified in the first detection image, and the identifying a third target feature point in the fourth detection image includes: performing feature point matching on the fourth detection image by using the first template image; and determining a feature point matching the template feature point as the third target feature point, where the feature point is identified in the fourth detection image.

[0084] In an embodiment, the to-be-processed workpiece is a wafer. A first template image may include an intersection region of two mutually perpendicular dicing streets on the wafer and a region within a preset range around the intersection region. A matched feature point may be a center point of the intersection region. FIG. 6 is a schematic diagram of a first template image according to an embodiment of the present disclosure. As shown in FIG. 6, the first template image includes a center point (represented by a black dot) of a dicing street. The center point of the dicing street is determined as a reference point. Furthermore, FIG. 6 shows a cross-

shaped white region. The cross is formed by two mutually perpendicular dicing streets. The intersection region is illustrated by a rectangular box in dotted lines in the middle of the cross. In addition, the first template image may further include a region (which may be referred to as a predetermined region) located within the preset range around the intersection region. As shown in FIG. 6, the predetermined region includes four gray sub-regions and a portion of the two dicing streets which is located outside the intersection region. The preset range is configured such that the image feature within both the intersection region and predetermined region provide sufficient information for identifying the positions of the intersection region and predetermined region in an image through an image processing algorithm, where the image is acquired by the image acquisition apparatus. As shown in FIG. 6, the image feature in the intersection region is unapparent and difficult to distinguish. A distinguishable image feature may be determined in conjunction with the predetermined region around the intersection region, facilitating determining a position of the intersection region and a position of the predetermined region. The main purpose is to determine the position of the intersection region and further determine a position of the matched feature point. Similarly, a third target feature point matching a template feature point may be identified in a fourth detection image by using the first template image.

[0085] According to the above technical solution, based on a matching result of performing the feature point matching on the first detection image and/or the fourth detection image by using the first template image, a target feature point in the first detection image and/or the fourth detection image is determined. The method is implemented without any complex operation or calculation, and the first target feature point in the first detection image and/or the third target feature point in the fourth detection image can be accurately and efficiently obtained.

[0086] In an embodiment, the processing device includes a second image acquisition apparatus. The first detection image is acquired by the second image acquisition apparatus. Before the determining a first image position of a first target feature point in the first detection image, the method further includes: a first operation; or the first operation and a second operation performed after the first operation; or the first operation, the second operation and a third operation performed after the second operation, where

the first operation includes: identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus;

the second operation includes: calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located; moving, after the calibration, a center of a field of view of the second image acquisition apparatus to a physical position, where the center of the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image; acquiring, after the movement of the second image acquisition apparatus, a sixth detection image by the second image acquisition apparatus; and identifying a fifth target feature point in the sixth detection image; and

the third operation includes: determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is a feature point which is closest to the product center of the to-be-processed workpiece; moving the center of the field of view of the second image acquisition apparatus to the fourth physical position; acquiring, after the movement of the second image acquisition apparatus, a seventh detection image by the second image acquisition apparatus; and identifying a sixth target feature point in the seventh detection image, where

in a case that the method includes the first operation and does not include the second operation, the fifth detection image is determined as the first detection image and the fourth target feature point is determined as the first target feature point,

in a case that the method includes the first operation and the second operation and does not include the third operation, the sixth detection image is determined as the first detection image and the fifth target feature point is determined as the first target feature point, and

in a case that the method includes the first operation, the second operation and the third operation, the seventh detection image is determined as the first detection image and the sixth target feature point is determined as the first target feature point.

[0087] In an embodiment, the processing device further includes the second image acquisition apparatus. The first detection image is acquired by the second image acquisition apparatus. The above-described method for detecting the processing parameter further includes: a first operation; or the first operation and a second operation performed after the first operation; or the first operation, the second operation, and a third operation performed after the second operation.

[0088] In an embodiment of the present disclosure, the first operation is performed. A fifth detection image obtained by performing the first operation is determined as the above-described first detection image, and a fourth target feature point obtained by performing the first operation is determined as the first target feature point. In an embodiment, the first operation includes: identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus. The fifth detection image may be identical to the second detection image or may be a portion of the second detection image, or the fifth detection image may be a different image acquired by the second image acquisition apparatus. The fourth target feature point is determined in the fifth detection image by performing feature point matching on the fifth detection image based on a template image (for example, the first template image in the above embodiment).

[0089] In another embodiment of the present disclosure, the second operation is performed after the first operation. A sixth detection image obtained by performing the second operation is determined as the above-described first detection image, and a fifth target feature point obtained by performing the second operation is determined as the first target feature point. In an embodiment, the second operation includes: calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located; moving, after the calibration, a center of a field of view of the second image acquisition apparatus to a physical position, where the center of the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image; acquiring, after the movement of the second image acquisition apparatus, a sixth detection image by the second image acquisition apparatus; and identifying a fifth target feature point in the sixth detection image. The first direction may be the horizontal direction. In an embodiment, the target predetermined processing line where the fourth target feature point is located is calibrated based on an angle between the target predetermined processing line and the first direction. For example, in a case that the angle between the target predetermined processing line and the first direction in the clockwise direction is equal to +2°, the target predetermined processing line is rotated by 2° in the counterclockwise direction for calibration. After the calibration is completed, the center of the field of view of the second image acquisition apparatus is moved to a physical position, where the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image. After the movement, the sixth detection image is

acquired by the second image acquisition apparatus. The fifth target feature point is identified in the sixth detection image based on the acquired sixth detection image and a template image (for example, the first template image in the above embodiment).

[0090] In another embodiment of the present disclosure, the third operation is performed after the first operation and the second operation. A seventh detection image obtained by performing the third operation is determined as the above-described first detection image, and a sixth target feature point obtained by performing the third operation is determined as the first target feature point. In an embodiment, the third operation includes: determining a fourth physical position of a second target feature point P0 closest to a product center of the to-be-processed workpiece based on an image position of the fifth target feature point in the sixth detection image; moving the center of the field of view of the second image acquisition apparatus to the fourth physical position; acquiring, after the movement of the second image acquisition apparatus, a seventh detection image by the second image acquisition apparatus; and identifying a sixth target feature point in the seventh detection image. In an embodiment, a physical position of the product center of the to-be-processed workpiece is determined as an origin (0, 0) of a world coordinate system. The physical position of the fifth target feature point is determined based on the image position of the fifth target feature point in the sixth detection image and a conversion relationship between the physical coordinate system and the image coordinate system. A coordinate of the fourth physical position of the second target feature point P0 is determined based on a distance difference between the physical position of the fifth target feature point and the physical position of the product center, and the preset spacing. For example, assuming that the physical position of the fifth target feature point is (5.5, 5.5), and a first spacing and a second spacing included in the preset spacing are equal to 1.5 mm, it is determined that a distance between the fifth target feature point and the product center in the first direction and a distance between the fifth target feature point and the product center in the second direction are respectively equal to 3 times the preset spacing. The fourth physical position of the second predicted feature point closest to the product center of the to-be-processed workpiece is determined as A1 (1, 1) by moving the fifth target feature point downward by 4.5mm and then left by 4.5mm.

[0091] According to the above technical solution, by performing the first operation, the fourth target feature point is rapidly identified in the fifth detection image. By performing the second operation, the target predetermined processing line where the fourth target feature point is

located is calibrated based on the first direction. After the calibration, the center of the field of view of the second image acquisition apparatus is moved to the physical position where the center of the field of view of the second image acquisition apparatus is located when the second image acquisition apparatus acquires the fifth detection image. After the movement, the sixth detection image is acquired by the second image acquisition apparatus. The fifth target feature point is identified in the sixth detection image. Through the operation, the target predetermined processing line is calibrated to achieve high-precision positioning of the target predetermined processing line, thereby ensuring the accuracy of the obtained fifth target feature point. By performing the third operation, the fourth physical position of the second target feature point closest to the product center of the to-be-processed workpiece is determined. The center of the field of view of the second image acquisition apparatus is moved to the fourth physical position, and the seventh detection image is acquired by the second image acquisition apparatus after the movement. The sixth target feature point is identified in the seventh detection image. In this manner, it is ensured that the determined sixth target feature point is located in a central region of an image as possible, providing an operation possibility for subsequent determination of whether the preset processing parameter is qualified based on one or more predetermined processing marks.

[0092] In an embodiment, the processing device may further include a first image acquisition apparatus. An image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus. Before the identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus, the method further includes:

identifying a contour of the to-be-processed workpiece in an eighth detection image acquired by the first image acquisition apparatus, where a center of a field of view of the first image acquisition apparatus coincides with a center of a carrying apparatus when the first image acquisition apparatus acquires the eighth detection image, and the carrying apparatus carries the to-be-processed workpiece;

determining a second image position of the product center of the to-be-processed workpiece in the eighth detection image based on the contour of the to-be-processed workpiece;

determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position

and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference;

moving the carrying apparatus to a position within the field of view of the second image acquisition apparatus to enable the center of the carrying apparatus to coincide with the center of the field of view of the second image acquisition apparatus;

adjusting the position of the carrying apparatus based on the physical position difference to enable a physical position of the product center of the to-be-processed workpiece on the carrying apparatus to coincide with the physical position of the center of the field of view of the second image acquisition apparatus; and

acquiring, after the adjustment, the fifth detection image by the second image acquisition apparatus.

[0093] In an embodiment of the present disclosure, the processing device may further include a first image acquisition apparatus. The image acquisition range of the first image acquisition apparatus is greater than the image acquisition range of the second image acquisition apparatus. A contour of a to-be-processed workpiece is identified in an eighth detection image acquired by the first image acquisition apparatus. The eighth detection image may be identical to the second detection image in the foregoing embodiments or may be a portion of the second detection image. In addition, the eighth detection image may be an image acquired by the second image acquisition apparatus. The manner for identifying the contour of the to-be-processed workpiece in the eighth detection image acquired by the first image acquisition apparatus may refer to the description of identifying the contour of to-be-processed workpiece in the second detection image in the foregoing embodiments, and is not repeated herein for brevity. When the first image acquisition apparatus acquires the eighth detection image, the center of the field of view of the first image acquisition apparatus coincides with the center of the carrying apparatus for carrying the to-be-processed workpiece. In an embodiment of the present disclosure, a wafer serving as a to-be-processed workpiece is generally arranged at an iron ring. A product center of the wafer may not coincide with a center of the iron ring due to misaligned wafer arrangement or an incomplete wafer. Restricted by hardware of a processing device, the center of the iron ring may be defaulted to coincide with the center of the carrying apparatus when the iron ring is placed on the carrying apparatus. Therefore, the product center of the wafer and the center of the carrying apparatus do not necessarily coincide with each other.

An image position of the center of the field of view of the first image acquisition apparatus may be represented by (x_M, y_M). Based on the contour of the to-be-processed workpiece, by calculating an average value of a sum of pixel values of each row of pixels within the contour of the to-be-processed workpiece as a first average value and an average value of a sum of pixel values of each column of pixels within the contour of the to-be-processed workpiece as a second average value, a second image position of the product center is determined in the eighth detection image. The second image position is represented by (x_{C1}, y_{C1}). Thus, an image position difference between the second image position (x_{C1}, y_{C1}) and a third image position (x_M, y_M) of the center of the field of view of the first image acquisition apparatus is calculated based on the (x_{C1}, y_{C1}) and (x_M, y_M). A difference between x-axis coordinates of the image positions is expressed as $\Delta x_2=x_{C1}-x_M$, and a difference between y-axis coordinates of the image positions is expressed as $\Delta y_2=y_{C1}-y_M$. An image position of any object described herein has a one-to-one conversion relationship with a physical position of the object in a world coordinate system. For example, based on an image position (x', y'), a physical position (X', Y') corresponding to the image position (x', y') in the world coordinate system is obtained via the conversion relationship. Physical position differences δX_2 and δY_2 respectively corresponding to the image position differences Δx_2 and Δy_2 are obtained based on the image position differences Δx_2 and Δy_2 via the above conversion relationship. The carrying apparatus is moved to a position within the field of view of the second image acquisition apparatus, so that the center of the carrying apparatus coincides with the center of the field of view of the second image acquisition apparatus after the movement. The position of the carrying apparatus is adjusted based on the calculated physical position differences δX_2 and δY_2. The moving operation on the carrying apparatus may be manually performed by the user or automatically performed by a processing control system. For example, the carrying apparatus may be moved by a robotic arm or may be directly moved. The processing control system may be a processing device for processing a workpiece or another control system communicatively connected to the processing device, such as a host computer system. A physical position of the product center of the to-be-processed workpiece on the adjusted carrying apparatus coincides with the physical position of the center of the field of view of the second image acquisition apparatus. After the adjustment, a fifth detection image is acquired by the second image acquisition apparatus.

[0094] According to the above technical solution, based on the image position difference between the second image position and the third image position of the center of the field of

view of the first image acquisition apparatus and the conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference is determined. The carrying apparatus is moved according to the physical position difference after the carrying apparatus is moved to a position within the field of view of the second image acquisition apparatus, so that the physical position of the product center of the to-be-processed workpiece coincides with the physical position of the center of the field of view of the second image acquisition apparatus. After the movement, the fifth detection image is acquired by the second image acquisition apparatus. With the technical solution, based on the conversion relationship and through the movement of the carrying apparatus, the physical position where the product center of the to-be-processed workpiece coincides with the center of field of view of the second image acquisition apparatus is determined rapidly. The technical solution is implemented with a simple algorithm and the physical position of the coincidence is determined accurately.

[0095] In an embodiment, before the determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference, the method further includes:

acquiring multiple ninth detection images, where the multiple ninth detection images of the to-be-processed workpiece are acquired by the second image acquisition apparatus when the to-be-processed workpiece is located at multiple fifth physical positions, where the quantity of the multiple ninth detection images is greater than or equal to 3, and the multiple fifth physical positions are different from each other;

for each ninth detection image of the multiple ninth detection images, determining an image position of an identification feature in the ninth detection image based on a second template image, where the second template image includes the identification feature on the to-be-processed workpiece; and

determining the conversion relationship based on the image positions of the identification feature in the multiple ninth detection images and the multiple fifth physical positions.

[0096] In an embodiment, the quantity of the multiple ninth detection images is greater than or equal to 3. By way of example and not limitation, the quantity of the ninth detection images

is greater than or equal to 3 and less than or equal to 9. For example, nine ninth detection images are acquired. The nine ninth detection images of the to-be-processed workpiece may be acquired by an image acquisition apparatus when the to-be-processed workpiece is located at nine different fifth physical positions. The nine fifth physical positions may be denoted as K_1, K_2, ..., and K_9 respectively and may be any positions.

[0097] An image position of an identification feature may be determined in each of the nine ninth detection images based on an acquired second template image. The identification feature may be any recognizable feature on the to-be-processed workpiece, which may be a feature point on the predetermined processing line described herein, or a feature in another form. In an embodiment, the identification feature is a feature inherently present on a to-be-processed workpiece, such as a shape feature or a structure feature. In an embodiment, the identification feature may further be a feature marked on the to-be-processed workpiece manually or by a processing device, such as an easily recognizable symbol and an easily recognizable pattern. The identification feature may be in any shape, such as a circle, a cross and a star. An image position of the identification feature in the ninth detection image may be determined based on the second template image by: identifying a second identification feature in the ninth detection image which matches an identification feature in the second template image, and determining an image position of the second identification feature in the ninth detection image as an image position of the identification feature in the ninth detection image.

[0098] Image positions of the identification feature in the nine ninth detection images are respectively denoted as F_1, F_2, ..., and F_9 and the nine physical positions corresponding to the image positions are denoted as K_1, K_2, ..., and K_9. A mapping relationship between coordinates of the image positions and coordinates of the physical positions is determined as $(X_K, Y_K)=f(w)(x_F, y_F)$. (X_K, Y_K) represents the fifth physical position, and (x_F, y_F) represents the image position. The f(w) matrix is calculated based on the determined nine coordinate points, and a conversion relationship between the image position and the corresponding fifth physical position is further determined. Based on the conversion relationship, a conversion relationship between any image position and a physical position corresponding to the image position is determined.

[0099] According to the above technical solution, the conversion relationship is determined based on image positions of the identification feature in multiple ninth detection images and

multiple fifth physical positions of the identification feature. With the technical solution, the conversion relationship can be determined based on the multiple image positions and multiple fifth physical positions. The technical solution features a simple algorithm and straightforward implementation.

[0100] In an embodiment, the determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is a feature point which is closest to the product center of the to-be-processed workpiece includes:

determining at least one second predicted feature point closest to the product center of the to-be-process workpiece based on the image position of the fifth target feature point in the sixth detection image and the preset spacing, where the at least one second predetermined feature point is circumferentially distributed relative to the product center;

calculating a distance between each of the at least one second predicted feature point and the product center; and

determining a second predicted feature point, with a smallest distance to the product center among the at least one second predicted feature point, as the second target feature point, and determining a physical position of the second target feature point as the fourth physical position.

[0101] In an embodiment, the physical position of the fifth target feature point may be determined based on the image position of the fifth target feature point in the sixth detection image and a conversion relationship. At least one second predicted feature point closest to the product center is determined based on the physical position of the fifth target feature point and the preset spacing. The at least one second predetermined feature point is circumferentially distributed relative to the product center. FIG. 7 is a schematic diagram of a position of at least one second predicted feature point in a sixth detection image according to an embodiment of present disclosure. As shown in FIG. 7, the "+" symbol marked by an arrow represents a position of a predicted feature point in a sixth detection image. A1, A2, A3, and A4 represent second predicted feature points. For example, assuming that the physical position of the fifth target feature point is (5.5, 5.5), and a first spacing and a second spacing included in the preset spacing are equal to 1.5 mm, it is determined that a distance between the fifth target feature point and the product center in the first direction and a distance between the fifth target feature point and the product center in the second direction are respectively equal to 3 times the preset

spacing. The fourth physical position of one of the at least one second predicted feature point closest to the product center of the to-be-processed workpiece is determined as A1 (1, 1) by moving the fifth target feature point downward by 4.5mm and then left by 4.5mm. Coordinates of other second predicted feature points circumferentially distributed relative to the product center are calculated as A2 (-0.5, 1), A3 (-0.5, -0.5) and A4 (1, -0.5). A distance between each of the second predicted feature points and the product center of the to-be-processed workpiece is calculated based on the physical coordinate of the second predicted feature point. Among the four second predicted feature points, the distance between the second predicted feature point A3 and the product center is the smallest. Therefore, A3 is determined as the second target feature point P0, and the physical position of A3 is determined as the fourth physical position.

[0102] According to the above technical solution, the second target feature point and the fourth physical position of the second target feature point is determined based on a distance between each of at least one second predicted feature point and the product center. With the technical solution, distances between multiple second predicted feature points circumferentially distributed around the product center and the product center are calculated, enabling determination of the second target feature point which is closest to the product center.

[0103] In an embodiment, the calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located includes:

determining the fourth target feature point as a reference position point and sequentially determining multiple groups of position points based on the reference position point, where each group of the multiple groups of position points includes a first position point and a second position point, the first position point and the second position point are located on different sides of the reference position point, a spacing between the first position point and the second position point in the multiple groups of position points gradually increases along the first direction across the groups, and among the reference position point and the multiple groups of position points, different position points correspond to different feature points lying on the target predetermined processing line; and

calculating, each time after a group of the multiple groups of position points is determined, an angle of a connecting line relative to the first direction, where the connecting line is between the first position point and the second position point in the group of position points, and performing a calibration operation, which includes:

determining an adjustment angle based on the angle of the connecting line in a case that the angle of the connecting line is greater than a preset angle threshold, and adjusting a position of the to-be-processed workpiece according to the adjustment angle to calibrate a position of the target predetermined processing line on the to-be-processed workpiece; and

stopping the calibration operation in a case that the angle of the connecting line is less than or equal to the preset angle threshold, where

for the multiple groups of position points, after a current group of the multiple groups of position points is determined and the calibration operation is performed, a next group of position points is determined, and along the first direction, a spacing between the first position point and the second position point in the next group of position points is greater than a spacing between the first position point and the second position point in the current group of position points.

[0104] In an embodiment, the fourth target feature point is determined as a reference position point. Multiple groups of position points are sequentially determined based on the reference position point. Different position points among the reference position point and the multiple groups of position points correspond to different feature points lying on the target predetermined processing line. A position point corresponding to any feature point may be an image position point of the feature point in the image coordinate system, or may be a physical position point of the feature point in the world coordinate system.

[0105] In an embodiment, multiple groups of position points may be determined by taking the fourth target feature point as a reference position point. For example, a first group of position points B1B2 may include a first position point B1 and a second position point B2. The first position point B1 and the second position point B2 may be located on different sides of the reference position point. In a similar manner, multiple groups of position points C_1C_2, D_1D_2 and the like may be sequentially determined, and each group of the multiple groups of position points may include a first position point and a second position point. A spacing between the first position point and the second position point in the multiple groups of position points gradually increases along the first direction (horizontal direction) across the groups. That is, a spacing between the two position points D_1 and D_2 is greater than a spacing between the two position points C_1 and C_2. Different position points among the reference position point and the multiple groups of position points correspond to different feature points lying on the target

predetermined processing line.

[0106] The following operations may be performed each time after a group of position points is determined, to calibrate a position of the target predetermined processing line. The user may pre-configure a preset angle threshold for determining whether the target predetermined processing line is to be calibrated. The preset angle threshold may be any angle greater than 0 degree. By way of example and not limitation, the preset angle threshold may be in the range of [0.001, 0.2] degrees, such as 0.1 degrees, 0.03 degrees, 0.006 degrees or 0.002 degrees. Calibrating a position of the target predetermined processing line may include the following calibration operation. Assuming that an angle of a connecting line, relative to the first direction, between the first position point B_1 and the second position point B_2 is 0.7 degrees, which is greater than the preset angle threshold of 0.002 degrees, the wafer is rotated by the angle opposite to a tilt direction of the connecting line between the first position point B1 and the second position point B2, so that the connecting line aligns with the horizontal direction. The second group of position points C_1C_2 includes a first position point C_1 and a second position point C_2. It is determined whether an angle of a connecting line between the first position point C_1 and the second position point C_2 is greater than the preset angle threshold of 0.002 degrees in a manner similar to the above. If the angle is greater than the preset angle threshold, the calibration operation is performed. The above calibration operations may be performed sequentially until the angle of each of connecting lines between the first position point and the second position point in the groups of position points is less than or equal to the preset angle threshold of 0.002 degrees. It should be noted that a spacing between the first position point and the second position point (for example, C1 and C2) in a next group of position points is greater than a spacing between the first position point and the second position point (for example, B1 and B2) in the current group of position points.

[0107] According to the above technical solution, multiple groups of position points are determined, and a position of a to-be-processed workpiece is adjusted by an angle of a connecting line, relative to a predetermined reference direction, between two position points in a group of position points. Thus, a position of a target predetermined processing line is calibrated. With the multiple groups of position points, high-precision positioning of the target predetermined processing line on the to-be-processed workpiece can be achieved across a wide range.

[0108] According to another aspect of the present disclosure, an apparatus for detecting a processing parameter is provided. The apparatus for detecting the processing parameter may be applied to a processing device. FIG. 8 is a schematic block diagram of an apparatus 800 for detecting a processing parameter according to an embodiment of the present disclosure. As shown in FIG. 8, the apparatus 800 for detecting the processing parameter includes an acquisition module 810, a first determination module 820, a second determination module 830 and a third determination module 840.

[0109] The acquisition module 810 is configured to acquire a first detection image, where the first detection image includes a to-be-processed workpiece.

[0110] The first determination module 820 is configured to determine a first image position of a first target feature point in the first detection image. The to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines.

[0111] The second determination module 830 is configured to determine at least one predicted processing mark based on first position information and a preset processing parameter. The first position information is the first image position or a first physical position of the first target feature point determined based on the first image position. The at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines.

[0112] The third determination module 840 is configured to determine whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark. The position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark. The predetermined processing mark includes at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

[0113] Those skilled in the art can understand the specific implementation and technical effect of the above-described apparatus for detecting the processing parameter by reading the above description of the method 100 for detecting the processing parameter. The apparatus is not repeated herein for brevity.

[0114] According to another aspect of the present disclosure, an electronic device is provided. FIG. 9 is a schematic block diagram of an electronic device according to an embodiment of the present disclosure. As shown in FIG. 9, an electronic device 900 includes a processor 910 and a memory 920. The memory 920 stores a computer program instruction. The computer program instruction, when being executed by the processor 910, performs the above-described method for detecting the processing parameter.

[0115] According to another aspect of the present disclosure, a storage medium is provided. The storage medium stores a computer program or an instruction. The storage medium may include, for example, a storage component of a tablet computer, a hard disk of a personal computer, an erasable programmable read-only memory (EPROM), a portable read-only memory (CD-ROM), a USB memory, or any combination of the above storage media. The storage medium may adopt any combination of one or more computer-readable storage media. The computer program or the instruction, when being executed by a processor, performs the above-described method for detecting the processing parameter.

[0116] Those skilled in the art can understand the specific implementation of the above-described electronic device and the storage medium by reading the above description of the method for detecting the processing parameter. The electronic device and the storage medium are not repeated herein for brevity.

[0117] Embodiments:

[0118] Embodiment 1

A method for detecting a processing parameter, applied to a processing device, is provided. The method includes:

acquiring a first detection image, where the first detection image includes a to-be-processed workpiece;

determining a first image position of a first target feature point in the first detection image, where the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

determining at least one predicted processing mark based on first position information and a preset processing parameter, where the first position information is the first image position or

a first physical position of the first target feature point, the first physical position is determined based on the first image position, the at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, where the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark includes at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

[0119] Embodiment 2

The method according to embodiment 1 is provided, where the processing device includes a first image acquisition apparatus and a second image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

in a case that the at least one predicted processing mark includes the at least one predicted processing line, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes:

identifying a contour of the to-be-processed workpiece in a second detection image acquired by the first image acquisition apparatus; and

determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, where

the at least one predicted processing line includes the at least one predicted line segment, one of the at least one predicted line segment passes through the first target feature point, a distance between any two predicted line segments of the at least one predicted line segment is identical to the preset spacing in a direction perpendicular to the target direction, and two endpoints of each of the at least one predicted line segment are located within the contour of

the to-be-processed workpiece.

[0120] Embodiment 3

The method according to embodiment 1 or 2 is provided, where the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece includes:

constructing, based on the first position information, a target straight line along the target direction through an initial feature point until the target straight line intersects with the contour of the to-be-processed workpiece, where the first target feature point or a second target feature point is determined as the initial feature point, where the second target feature point is located closest to a product center of the to-be-processed workpiece and determined based on the first target feature point; and

translating the initial feature point along a direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more feature points, and constructing a target straight line along the target direction through each of the obtained one or more feature points until the target straight line intersects with the contour of the to-be-processed workpiece; or

translating the target straight line passing through the initial feature point along the direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more target straight lines, where a segment of the obtained one or more target straight lines that is within the contour of the to-be-processed workpiece is determined as a predicted line segment passing through a corresponding feature point.

[0121] Embodiment 4

The method according to any one of embodiments 1 to 3 is provided, where after the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, the method further includes:

displaying a third detection image, where the third detection image includes the at least one predicted line segment and the third detection image is at least a portion of an image acquired by the first image acquisition apparatus, and where

the determining whether the preset processing parameter is qualified based on position

detection information related to the at least one predicted processing mark includes:

determining that the preset processing parameter is qualified in response to a qualification indication information inputted by a user; and/or determining that the preset processing parameter is unqualified in response to a disqualification indication information inputted by the user, where

the position detection information includes the qualification indication information and/or the disqualification indication information, the qualification indication information is to indicate that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, and the disqualification indication information is to indicate that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark.

[0122] Embodiment 5

The method according to any one of embodiments 1 to 4 is provided, where

in a case that the at least one predicted processing mark includes the at least one first predicted feature point, the determining at least one predicted processing mark based on first position information and a preset processing parameter includes:

determining a physical position as a third physical position of the first predicted feature point based on the first position information and the preset processing parameter, where a distance between the physical position and the first physical position, or a distance between the physical position and a second physical position determined based on the first position information, meets a predetermined distance condition, where

the second physical position is a physical position of a second target feature point, where the second target feature point is closest to the product center of the to-be-processed workpiece, and the predetermined distance condition includes: a distance in a second direction being equal to a first quantity of first spacings and a distance in a first direction being equal to a second quantity of second spacings, the first direction and the second direction are perpendicular to each other, and the preset spacing includes the first spacing and/or the second spacing.

[0123] Embodiment 6

The method according to any one of embodiments 1 to 5 is provided, where the processing device includes a second image acquisition apparatus, the first detection image is acquired by

the second image acquisition apparatus, and

the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark includes:

moving a center of a field of view of the second image acquisition apparatus to the third physical position;

acquiring, after the movement, a fourth detection image by the second image acquisition apparatus;

identifying a third target feature point in the fourth detection image;

determining an image position difference between an image position of the third target feature point in the fourth detection image and an image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image, or determining a physical position difference between a physical position of the third target feature point and a physical position of the center of the field of view of the second image acquisition apparatus;

determining whether the image position difference is less than or equal to a first preset error threshold or whether the physical position difference is less than or equal to a second preset error threshold, to obtain a position determination result, where the position detection information includes the position determination result; and

determining that the preset processing parameter is qualified in a case that the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, or determining that the preset processing parameter is unqualified in a case that the position determination result indicates that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark, where

the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark in a case that the image position difference is less than or equal to the first preset error threshold or the physical position difference is less than or equal to the second preset error threshold; and

the position determination result indicates that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark in a case that the image position difference is greater than the first preset error threshold or the

physical position difference is greater than the second preset error threshold.

[0124] Embodiment 7

The method according to any one of embodiments 1 to 6 is provided, where before the moving a center of a field of view of the second image acquisition apparatus to the third physical position, the method further includes:

moving the center of the field of view of the second image acquisition apparatus to the first physical position or the second physical position based on the first position information, and where

the moving a center of a field of view of the second image acquisition apparatus to the third physical position includes:

moving the center of the field of view of the second image acquisition apparatus by a distance specified by the predetermined distance condition to reach the third physical position.

[0125] Embodiment 8

The method according to any one of embodiments of 1 to 7 is provided, where before the determining a first image position of a first target feature point in the first detection image, the method further includes:

performing feature point matching on the first detection image by using a first template image that includes a template feature point; and

determining a feature point matching the template feature point as the first target feature point, where the feature point is identified in the first detection image, and where

the identifying a third target feature point in the fourth detection image includes:

performing feature point matching on the fourth detection image by using the first template image; and

determining a feature point matching the template feature point as the third target feature point, where the feature point is identified in the fourth detection image.

[0126] Embodiment 9

The method according to any one of embodiments 1 to 8 is provided, where the processing device includes a second image acquisition apparatus, the first detection image is acquired by

the second image acquisition apparatus, and

before the determining a first image position of a first target feature point in the first detection image, the method further includes:

a first operation;

or

the first operation and a second operation performed after the first operation;

or

the first operation, the second operation and a third operation performed after the second operation, where

the first operation includes: identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus,

the second operation includes: calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located; moving, after the calibration, a center of a field of view of the second image acquisition apparatus to a physical position, where the center of the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image; acquiring, after the movement, a sixth detection image by the second image acquisition apparatus; and identifying a fifth target feature point in the sixth detection image, and

the third operation includes: determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is closest to a product center of the to-be-processed workpiece; moving the center of the field of view of the second image acquisition apparatus to the fourth physical position; acquiring, after the movement, a seventh detection image by the second image acquisition apparatus; and identifying a sixth target feature point in the seventh detection image, where

in a case that the method includes the first operation and does not include the second operation, the fifth detection image is determined as the first detection image and the fourth target feature point is determined as the first target feature point,

in a case that the method includes the first operation and the second operation and does

not include the third operation, the sixth detection image is determined as the first detection image and the fifth target feature point is determined as the first target feature point, and

in a case that the method includes the first operation, the second operation and the third operation, the seventh detection image is determined as the first detection image and the sixth target feature point is determined as the first target feature point.

[0127] Embodiment 10

The method according to any one of embodiments 1 to 9 is provided, where the processing device further includes a first image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, and before the identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus, the method further includes:

identifying a contour of the to-be-processed workpiece in an eighth detection image acquired by the first image acquisition apparatus, where a center of a field of view of the first image acquisition apparatus coincides with a center of a carrying apparatus when the first image acquisition apparatus acquires the eighth detection image, and the carrying apparatus carries the to-be-processed workpiece;

determining a second image position of the product center of the to-be-processed workpiece in the eighth detection image based on the contour of the to-be-processed workpiece;

determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference;

moving the carrying apparatus to a position within the field of view of the second image acquisition apparatus to enable the center of the carrying apparatus to coincide with the center of the field of view of the second image acquisition apparatus;

adjusting the position of the carrying apparatus based on the physical position difference to enable a physical position of the product center of the to-be-processed workpiece on the carrying apparatus to coincide with the physical position of the center of the field of view of the second image acquisition apparatus; and

acquiring, after the adjustment, the fifth detection image by the second image acquisition

apparatus.

[0128] Embodiment 11

The method according to any one of embodiments of 1 to 10 is provided, where before the determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference, the method further includes:

acquiring a plurality of ninth detection images, where the plurality of ninth detection images of the to-be-processed workpiece are acquired by the second image acquisition apparatus when the to-be-processed workpiece is located at a plurality of fifth physical positions, the quantity of the plurality of ninth detection images is greater than or equal to 3, and the plurality of fifth physical positions are different from each other;

for each ninth detection image of the plurality of ninth detection images, determining an image position of an identification feature in the ninth detection image based on a second template image, where the second template image includes the identification feature on the to-be-processed workpiece; and

determining the conversion relationship based on the image positions of the identification feature in the plurality of ninth detection images and the plurality of fifth physical positions.

[0129] Embodiment 12

The method according to any one of embodiment 1 to 11 is provided, where the determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, where the second target feature point is closest to a product center of the to-be-processed workpiece, includes:

determining at least one second predicted feature point closest to the product center of the to-be-process workpiece based on the image position of the fifth target feature point in the sixth detection image and the preset spacing, where the at least one second predetermined feature point is circumferentially distributed relative to the product center;

calculating a distance between each of the at least one second predicted feature point and the product center; and

determining a second predicted feature point, with a smallest distance to the product center, among the at least one second predicted feature point, as the second target feature point, and determining a physical position of the second target feature point as the fourth physical position.

[0130] Embodiment 13

The method according to any one of embodiments of 1 to 12 is provided, where the calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located includes:

determining the fourth target feature point as a reference position point and sequentially determining a plurality of groups of position points based on the reference position point, where each group of the plurality of groups of position points includes a first position point and a second position point, the first position point and the second position point are located on different sides of the reference position point, a spacing between the first position point and the second position point in the plurality of groups of position points gradually increases along the first direction across the groups, and among the reference position point and the plurality of groups of position points, different position points correspond to different feature points lying on the target predetermined processing line; and

calculating, each time after a group of the plurality of groups of position points is determined, an angle of a connecting line relative to the first direction, where the connecting line is between the first position point and the second position point in the group of position points, and performing a calibration operation, which includes:

determining an adjustment angle based on the angle of the connecting line in a case that the angle of the connecting line is greater than a preset angle threshold, and adjusting a position of the to-be-processed workpiece according to the adjustment angle to calibrate a position of the target predetermined processing line on the to-be-processed workpiece; and

stopping the calibration operation in a case that the angle of the connecting line is less than or equal to the preset angle threshold, where

for the plurality of groups of position points, after a current group of the plurality of groups of position points is determined and the calibration operation is performed, a next group of position points is determined, and along the first direction, a spacing between the first position point and the second position point in the next group of position points is greater than a spacing

between the first position point and the second position point in the current group of position points.

[0131] Embodiment 14

An apparatus for detecting a processing parameter, applied to a processing device, is provided. The apparatus includes:

an acquisition module, configured to acquire a first detection image, where the first detection image includes a to-be-processed workpiece;

a first determination module, configured to determine a first image position of a first target feature point in the first detection image, where the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

a second determination module, configured to determine at least one predicted processing mark based on first position information and a preset processing parameter, where the first position information is the first image position or a first physical position of the first target feature point determined based on the first image position, the at least one predicted processing mark includes at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter includes a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

a third determination module configured to determine whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, where the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark includes at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

[0132] Embodiment 15

An electronic device is provided, including a processor and a memory, where the memory stores a computer program instruction, and the computer program instruction, when being executed by the processor, performs the method for detecting the processing parameter according to any one of embodiments 1 to 13.

[0133] Embodiment 16

A storage medium is provided. The storage medium stores computer program or an instruction, where the computer program or the instruction, when being executed, performs the method for detecting the processing parameter according to any one of embodiments 1 to 13.

[0134] Although the embodiments have been described herein with reference to the drawings, it should be understood that the above embodiments are merely exemplary and are not intended to limit the scope of the present disclosure. Various changes and modifications may be made by those skilled in the art without departing from the scope and spirit of the present disclosure. All such changes and modifications are deemed to fall into the scope of the claims of the present disclosure.

[0135] Those skilled in the art may realize that the units and algorithm steps of each example described in conjunction with the embodiments herein may be implemented by electronic hardware, or a combination of computer software and electronic hardware. Whether a function is to be implemented by hardware or software depends on a particular application of the technical solutions and a design constraint. Those skilled in the art may use different methods to implement the described functions for each specific application, but such implementation should not be regarded as exceeding the scope of the present disclosure.

[0136] In the embodiments of the present disclosure, it should be understood that the disclosed device and method may also be implemented in other ways. For example, the device embodiments described hereinabove are only schematic. For example, the division of the units is only based on logical functions, and there may be other division ways in actual implementation, such as multiple units or components can be combined or integrated into another device, or some features may be neglected or not executed.

[0137] In the specification provided herein, a lot of specific details are described. However, it may be appreciated that the embodiments of the present disclosure may be practiced without these specific details. In some instances, well-known methods, structures and techniques are not shown in detail in order to avoid obscuring understanding of the description.

[0138] Similarly, it should be understood that in order to simplify the present disclosure and help to understand one or more of the various aspects of the disclosure, in the description of the exemplary embodiments of the present disclosure, the various features of the present disclosure are sometimes grouped together into a single embodiment, figure, or description thereof. However, the method according to the present disclosure should not be interpreted as reflecting

the following intention: the claimed disclosure requires more features than those explicitly stated in each claim. More specifically, as reflected in the corresponding claims, the inventive point is that the corresponding technical problem can be solved with features fewer than all the features of a single embodiment being disclosed. Therefore, the claims following the detailed description are hereby expressly incorporated into the detailed description, and each claim itself serves as an independent embodiment of the present disclosure.

[0139] It can be understood by those skilled in the art that, except for mutually exclusive features, all features disclosed in this specification (including the claims, abstract and drawings) and all processes or units of any method or device disclosed in this specification can be combined in any way. Unless otherwise expressly stated, each feature disclosed in this specification (including the claims, abstract and drawings) may be replaced by an alternative feature that provides the same, equivalent or similar purpose.

[0140] In addition, it may be understood by those skilled in the art that, although some embodiments described herein include certain features included in other embodiments instead of other features, the combination of features of different embodiments is meant to be within the scope of the present disclosure and form different embodiments. For example, in the claims, any one of the claimed embodiments can be used in any combination.

[0141] The various component embodiments of the present disclosure may be implemented in hardware, or in software modules running on one or more processors, or in a combination thereof. It should be understood by those skilled in the art that a microprocessor or a digital signal processor (DSP) may be used in practice to implement some or all functions of some modules of the apparatus for detecting the processing parameter according to the embodiments of the present disclosure. The present disclosure may alternatively be implemented as a program (such as a computer program and computer program product) for performing part or all of the methods described herein. Such a program implementing the present disclosure may be stored on a computer-readable medium, or may be in the form of one or more signals. Such a signal may be downloaded from an Internet website, or provided on a carrier signal, or provided in any other form.

[0142] It should be noted that the above embodiments illustrate rather than limit the present disclosure, and alternative embodiments may be designed by those skilled in the art without departing from the scope of the claims. In the claims, any reference symbol between parentheses

shall not be construed as a limitation of the claims. The word "comprising/including" does not exclude the presence of elements or steps not listed in the claims. The word "a" or "an" preceding an element does not exclude the presence of multiple such elements. The present disclosure may be implemented by means of hardware including several different elements and by means of a suitably programmed computer. In a unit claim enumerating several devices, several of these devices may be embodied by a same hardware item. The use of the words "first", "second", and "third", etc. does not indicate any order. These words may be interpreted as names.

[0143] Described above are only specific embodiments or description of the specific embodiments of the present disclosure, but the protection scope of the present disclosure is not limited thereto. Any modifications or substitutions that can be easily envisaged by those skilled in the art within the technical scope disclosed in the present disclosure shall be covered within the scope of the present disclosure. Therefore, the protection scope of the present disclosure shall be in accordance with the protection scope of the claims.

CLAIMS

1. A method for detecting a processing parameter, applied to a processing device, comprising:

acquiring a first detection image, wherein the first detection image comprises a to-be-processed workpiece;

determining a first image position of a first target feature point in the first detection image, wherein the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

determining at least one predicted processing mark based on first position information and a preset processing parameter, wherein the first position information is the first image position or a first physical position of the first target feature point, the first physical position is determined based on the first image position, the at least one predicted processing mark comprises at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter comprises a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, wherein the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark comprises at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

2. The method according to claim 1, wherein the processing device comprises a first image acquisition apparatus and a second image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

in a case that the at least one predicted processing mark comprises the at least one predicted processing line, the determining at least one predicted processing mark based on first position

information and a preset processing parameter comprises:

identifying a contour of the to-be-processed workpiece in a second detection image acquired by the first image acquisition apparatus; and

determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, wherein

the at least one predicted processing line comprises the at least one predicted line segment, one of the at least one predicted line segment passes through the first target feature point, a distance between any two adjacent predicted line segments of the at least one predicted line segment is identical to the preset spacing in a direction perpendicular to the target direction, and two endpoints of each of the at least one predicted line segment are located within the contour of the to-be-processed workpiece.

3. The method according to claim 2, wherein the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece comprises:

constructing, based on the first position information, a target straight line along the target direction through an initial feature point until the target straight line intersects with the contour of the to-be-processed workpiece, wherein the first target feature point or a second target feature point is determined as the initial feature point, wherein the second target feature point is located closest to a product center of the to-be-processed workpiece and determined based on the first target feature point; and

translating the initial feature point along a direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more feature points, and constructing a target straight line along the target direction through each of the obtained one or more feature points until the target straight line intersects with the contour of the to-be-processed workpiece; or

translating the target straight line passing through the initial feature point along the direction perpendicular to the target direction by an integer multiple of the preset spacing to obtain one or more target straight lines, wherein a segment of the obtained one or more target straight lines that is within the contour of the to-be-processed workpiece is determined as a

predicted line segment passing through a corresponding feature point.

4. The method according to claim 2, wherein after the determining at least one predicted line segment along a target direction based on the first position information, the preset processing parameter and the contour of the to-be-processed workpiece, the method further comprises:

displaying a third detection image, wherein the third detection image includes the at least one predicted line segment and the third detection image is at least a portion of an image acquired by the first image acquisition apparatus, and wherein

the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark comprises:

determining that the preset processing parameter is qualified in response to a qualification indication information inputted by a user; and/or determining that the preset processing parameter is unqualified in response to a disqualification indication information inputted by the user, wherein

the position detection information comprises the qualification indication information and/or the disqualification indication information, the qualification indication information is to indicate that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, and the disqualification indication information is to indicate that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark.

5. The method according to claim 1, wherein

in a case that the at least one predicted processing mark comprises the at least one first predicted feature point, the determining at least one predicted processing mark based on first position information and a preset processing parameter comprises:

determining a physical position as a third physical position of the first predicted feature point based on the first position information and the preset processing parameter, wherein a distance between the physical position and the first physical position, or a distance between the physical position and a second physical position determined based on the first position information, meets a predetermined distance condition, wherein

the second physical position is a physical position of a second target feature point,

wherein the second target feature point is closest to the product center of the to-be-processed workpiece, and the predetermined distance condition comprises: a distance in a second direction being equal to a first quantity of first spacings and a distance in a first direction being equal to a second quantity of second spacings, the first direction and the second direction are perpendicular to each other, and the preset spacing comprises the first spacing and/or the second spacing.

6. The method according to claim 5, wherein the processing device comprises a second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

the determining whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark comprises:

moving a center of a field of view of the second image acquisition apparatus to the third physical position;

acquiring, after the movement, a fourth detection image by the second image acquisition apparatus;

identifying a third target feature point in the fourth detection image;

determining an image position difference between an image position of the third target feature point in the fourth detection image and an image position of the center of the field of view of the second image acquisition apparatus in the fourth detection image, or determining a physical position difference between a physical position of the third target feature point and a physical position of the center of the field of view of the second image acquisition apparatus;

determining whether the image position difference is less than or equal to a first preset error threshold or whether the physical position difference is less than or equal to a second preset error threshold, to obtain a position determination result, wherein the position detection information comprises the position determination result; and

determining that the preset processing parameter is qualified in a case that the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark, or determining that the preset processing parameter is unqualified in a case that the position determination result indicates that the position of the at least one predicted processing mark does not align with the position

of the predetermined processing mark, wherein

the position determination result indicates that the position of the at least one predicted processing mark aligns with the position of the predetermined processing mark in a case that the image position difference is less than or equal to the first preset error threshold or the physical position difference is less than or equal to the second preset error threshold; and

the position determination result indicates that the position of the at least one predicted processing mark does not align with the position of the predetermined processing mark in a case that the image position difference is greater than the first preset error threshold or the physical position difference is greater than the second preset error threshold.

7. The method according to claim 6, wherein before the moving a center of a field of view of the second image acquisition apparatus to the third physical position, the method further comprises:

moving the center of the field of view of the second image acquisition apparatus to the first physical position or the second physical position based on the first position information, and wherein

the moving a center of a field of view of the second image acquisition apparatus to the third physical position comprises:

moving the center of the field of view of the second image acquisition apparatus by a distance specified by the predetermined distance condition to reach the third physical position.

8. The method according to claim 6, wherein before the determining a first image position of a first target feature point in the first detection image, the method further comprises:

performing feature point matching on the first detection image by using a first template image that comprises a template feature point; and

determining a feature point matching the template feature point as the first target feature point, wherein the feature point is identified in the first detection image, and wherein

the identifying a third target feature point in the fourth detection image comprises:

performing feature point matching on the fourth detection image by using the first template image; and

determining a feature point matching the template feature point as the third target feature

point, wherein the feature point is identified in the fourth detection image.

9. The method according to claims 1 to 8, wherein the processing device comprises a second image acquisition apparatus, the first detection image is acquired by the second image acquisition apparatus, and

before the determining a first image position of a first target feature point in the first detection image, the method further comprises:

a first operation;

or

the first operation and a second operation performed after the first operation;

or

the first operation, the second operation and a third operation performed after the second operation, wherein

the first operation comprises: identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus,

the second operation comprises: calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located; moving, after the calibration, a center of a field of view of the second image acquisition apparatus to a physical position, wherein the center of the field of view of the second image acquisition apparatus is located at the physical position when the second image acquisition apparatus acquires the fifth detection image; acquiring, after the movement, a sixth detection image by the second image acquisition apparatus; and identifying a fifth target feature point in the sixth detection image, and

the third operation comprises: determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, wherein the second target feature point is closest to a product center of the to-be-processed workpiece; moving the center of the field of view of the second image acquisition apparatus to the fourth physical position; acquiring, after the movement, a seventh detection image by the second image acquisition apparatus; and identifying a sixth target feature point in the seventh detection image, wherein

in a case that the method comprises the first operation and does not comprise the second operation, the fifth detection image is determined as the first detection image and the fourth target feature point is determined as the first target feature point,

in a case that the method comprises the first operation and the second operation and does not comprise the third operation, the sixth detection image is determined as the first detection image and the fifth target feature point is determined as the first target feature point, and

in a case that the method comprises the first operation, the second operation and the third operation, the seventh detection image is determined as the first detection image and the sixth target feature point is determined as the first target feature point.

10. The method according to claim 9, wherein the processing device further comprises a first image acquisition apparatus, an image acquisition range of the first image acquisition apparatus is greater than an image acquisition range of the second image acquisition apparatus, and before the identifying a fourth target feature point in a fifth detection image acquired by the second image acquisition apparatus, the method further comprises:

identifying a contour of the to-be-processed workpiece in an eighth detection image acquired by the first image acquisition apparatus, wherein a center of a field of view of the first image acquisition apparatus coincides with a center of a carrying apparatus when the first image acquisition apparatus acquires the eighth detection image, and the carrying apparatus carries the to-be-processed workpiece;

determining a second image position of the product center of the to-be-processed workpiece in the eighth detection image based on the contour of the to-be-processed workpiece;

determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference;

moving the carrying apparatus to a position within the field of view of the second image acquisition apparatus to enable the center of the carrying apparatus to coincide with the center of the field of view of the second image acquisition apparatus;

adjusting the position of the carrying apparatus based on the physical position difference to enable a physical position of the product center of the to-be-processed workpiece on the

carrying apparatus to coincide with the physical position of the center of the field of view of the second image acquisition apparatus; and

acquiring, after the adjustment, the fifth detection image by the second image acquisition apparatus.

11. The method according to claim 10, wherein before the determining, based on an image position difference between a third image position of the center of the field of view of the first image acquisition apparatus and the second image position and a conversion relationship between an image position and a physical position, a physical position difference corresponding to the image position difference, the method further comprises:

acquiring a plurality of ninth detection images, wherein the plurality of ninth detection images of the to-be-processed workpiece are acquired by the second image acquisition apparatus when the to-be-processed workpiece is located at a plurality of fifth physical positions, the quantity of the plurality of ninth detection images is greater than or equal to 3, and the plurality of fifth physical positions are different from each other;

for each ninth detection image of the plurality of ninth detection images, determining an image position of an identification feature in the ninth detection image based on a second template image, wherein the second template image comprises the identification feature on the to-be-processed workpiece; and

determining the conversion relationship based on the image positions of the identification feature in the plurality of ninth detection images and the plurality of fifth physical positions.

12. The method according to claim 9, wherein the determining a fourth physical position of a second target feature point based on an image position of the fifth target feature point in the sixth detection image, wherein the second target feature point is closest to a product center of the to-be-processed workpiece, comprises:

determining at least one second predicted feature point closest to the product center of the to-be-process workpiece based on the image position of the fifth target feature point in the sixth detection image and the preset spacing, wherein the at least one second predicted feature point is circumferentially distributed relative to the product center;

calculating a distance between each of the at least one second predicted feature point and the product center; and

determining a second predicted feature point, with a smallest distance to the product center, among the at least one second predicted feature point, as the second target feature point, and determining a physical position of the second target feature point as the fourth physical position.

13. The method according to claim 9, wherein the calibrating, based on a first direction, a target predetermined processing line where the fourth target feature point is located comprises:

determining the fourth target feature point as a reference position point and sequentially determining a plurality of groups of position points based on the reference position point, wherein each group of the plurality of groups of position points comprises a first position point and a second position point, the first position point and the second position point are located on different sides of the reference position point, a spacing between the first position point and the second position point in the plurality of groups of position points gradually increases along the first direction across the groups, and among the reference position point and the plurality of groups of position points, different position points correspond to different feature points lying on the target predetermined processing line; and

calculating, each time after a group of the plurality of groups of position points is determined, an angle of a connecting line relative to the first direction, where the connecting line is between the first position point and the second position point in the group of position points, and performing a calibration operation, which comprises:

determining an adjustment angle based on the angle of the connecting line in a case that the angle of the connecting line is greater than a preset angle threshold, and adjusting a position of the to-be-processed workpiece according to the adjustment angle to calibrate a position of the target predetermined processing line on the to-be-processed workpiece; and

stopping the calibration operation in a case that the angle of the connecting line is less than or equal to the preset angle threshold, wherein

for the plurality of groups of position points, after a current group of the plurality of groups of position points is determined and the calibration operation is performed, a next group of position points is determined, and along the first direction, a spacing between the first position point and the second position point in the next group of position points is greater than a spacing between the first position point and the second position point in the current group of position points.

14. An apparatus for detecting a processing parameter, applied to a processing device, comprising:

an acquisition module, configured to acquire a first detection image, wherein the first detection image comprises a to-be-processed workpiece;

a first determination module, configured to determine a first image position of a first target feature point in the first detection image, wherein the to-be-processed workpiece is provided with at least two predetermined processing lines and the first target feature point lies on any one of the at least two predetermined processing lines;

a second determination module, configured to determine at least one predicted processing mark based on first position information and a preset processing parameter, wherein the first position information is the first image position or a first physical position of the first target feature point determined based on the first image position, the at least one predicted processing mark comprises at least one predicted processing line and/or at least one first predicted feature point, and the preset processing parameter comprises a preset spacing between any two adjacent predetermined processing lines of the at least two predetermined processing lines; and

a third determination module, configured to determine whether the preset processing parameter is qualified based on position detection information related to the at least one predicted processing mark, wherein the position detection information indicates whether a position of the at least one predicted processing mark aligns with a position of a predetermined processing mark, and the predetermined processing mark comprises at least one predetermined processing line and/or at least one feature point on a predetermined processing line.

15. An electronic device, comprising:

a processor, and

a memory, wherein

the memory stores a computer program instruction, and the computer program instruction, when being executed by the processor, performs the method for detecting the processing parameter according to any one of claims 1 to 13.

16. A storage medium, storing a computer program or an instruction, wherein

the computer program or the instruction, when being executed, performs the method for

detecting the processing parameter according to any one of claims 1 to 13.