

DEFECT DETECTION SYSTEM, METHOD AND APPARATUS, DEVICE, AND STORAGE MEDIUM

[0001] The present application claims priority to Chinese patent application No. 202311836488.7, filed with the Chinese Patent Office on December 27, 2023, the entire contents of which are incorporated herein by reference.

TECHNICAL FIELD

[0002] Embodiments of the present application relate to the technical field of optical detection, and in particular to a defect detection system, method and apparatus, a device, and a storage medium.

BACKGROUND

[0003] With the advancement and popularization of industrial automation and intelligence, replacing existing manual visual inspection with Auto Optical Inspection (AOI) equipment has become a technological development trend.

[0004] AOI equipment typically includes an optical system, a material transfer system, and a data processing system. The optical system primarily includes an illumination system, an imaging lens, and a detector. The illumination system is configured to provide the illumination light required for inspection; the imaging lens is configured to collect optical signals to be detected from a target, and the detector is configured to convert the optical signals into digital signals. However, due to the diverse structural designs, different parts of the target often exhibit different reflectivities. Therefore, during image capture, it is highly probable that some regions remain very dark while other regions are already overexposed, thereby seriously affecting the inspection performance.

[0005] When dealing with this problem, existing AOI inspection equipment typically employs two methods. In one method, inspection performance is sacrificed to ensure inspection efficiency, i.e., selecting an appropriate illumination intensity and accepting that some regions of the test result are saturated while other regions are relatively dark. In the other method, inspection efficiency is sacrificed to ensure inspection performance. This involves adjusting the illumination intensity and performing multiple captures of the target to be inspected under different illumination intensities. Subsequently, the results acquired with appropriate illumination intensities are selected for different regions to obtain accurate inspection results. However, the multiple

captures affect the inspection efficiency. These two methods cannot simultaneously guarantee both the accuracy of inspection results and inspection efficiency.

SUMMARY

[0006] The embodiments of the present application provide a defect detection system, method and apparatus, a device, and a storage medium, which improve inspection efficiency and ensure the accuracy of inspection results.

[0007] In a first aspect, an embodiment of the present application provides a defect detection system, including:

[0008] a stage, an illumination subsystem, an imaging subsystem, a sensor, and a processor, wherein the illumination subsystem is connected to the processor, and the sensor is connected to the processor;

[0009] the imaging subsystem is arranged above the stage and configured to image an inspected object placed on the stage; the illumination subsystem is arranged on an incident optical path of the imaging subsystem; the sensor is arranged on an imaging optical path of the imaging subsystem; and a target area in the inspected object is located within an irradiation area of the illumination subsystem; and

[0010] the processor is configured to control the illumination subsystem to illuminate the target area with a first illumination intensity; the sensor is configured to acquire a first target area image corresponding to the first illumination intensity; the processor is further configured to determine a second illumination intensity based on the first target area image and the first illumination intensity, and adjust an illumination intensity of the illumination subsystem based on the second illumination intensity, so as to control the illumination subsystem to illuminate the target area with the second illumination intensity; the sensor is further configured to acquire a second target area image corresponding to the second illumination intensity; and the processor is further configured to perform defect detection based on the second target area image.

[0011] In a second aspect, an embodiment of the present application provides a defect detection method, including:

[0012] illuminating a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity;

[0013] determining a second illumination intensity based on the first target area image and the first illumination intensity;

[0014] illuminating the target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and

[0015] performing defect detection based on the second target area image.

[0016] In a third aspect, an embodiment of the present application further provides a defect detection apparatus, wherein the apparatus includes:

[0017] a first target area image acquisition module configured to illuminate a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity;

[0018] an illumination intensity determination module configured to determine a second illumination intensity based on the first target area image and the first illumination intensity;

[0019] a second target area image acquisition module configured to illuminate a target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and

[0020] a defect detection module configured to perform defect detection based on the second target area image.

[0021] In a fourth aspect, an embodiment of the present application further provides an electronic device, wherein the electronic device includes:

[0022] at least one processor; and

[0023] a memory communicatively connected to the at least one processor; wherein

[0024] the memory stores a computer program executable by the at least one processor, wherein the computer program, when executed by the at least one processor, causes the at least one processor to perform the defect detection method according to the embodiment of the present application.

[0025] In a fifth aspect, an embodiment of the present application further provides a computer-readable storage medium, wherein the computer-readable storage medium stores computer instructions, and the computer instructions, when executed by a processor, cause the processor to perform the defect detection method described in the embodiment of the present application.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] Fig. 1 is a schematic diagram of a structure of a defect detection system provided by Embodiment 1 of the present application;

[0027] Fig. 2 is an example diagram of a defect detection system provided by the embodiment of the present application;

[0028] Fig. 3 is a schematic diagram of a movement direction of an inspected object relative to an imaging subsystem provided by the embodiment of the present application;

[0029] Fig. 4 is a flowchart of a defect detection method provided by Embodiment 2 of the present application;

[0030] Fig. 5 is a schematic diagram of a structure of a defect detection apparatus provided by Embodiment 3 of the present application;

[0031] Fig. 6 is a schematic diagram of a structure of an electronic device provided by Embodiment 4 of the present application.

DETAILED DESCRIPTION OF THE EMBODIMENTS

[0032] The present application will be described below with reference to the accompanying drawings and embodiments.

[0033] Embodiment 1

[0034] Fig. 1 is a schematic diagram of a structure of a defect detection system provided by Embodiment 1 of the present application. This embodiment is applicable to defect detection on optical elements.

[0035] As shown in Fig. 1, the defect detection system includes: a stage, an illumination subsystem, an imaging subsystem, a sensor, and a processor, wherein the illumination subsystem is connected to the processor, and the sensor is connected to the processor.

[0036] The imaging subsystem is arranged above the stage and configured to image an inspected object placed on the stage; the illumination subsystem is arranged on an incident optical path of the imaging subsystem; the sensor is arranged on an imaging optical path of the imaging subsystem; and a target area in the inspected object is located within an irradiation area of the illumination subsystem.

[0037] In this embodiment, the imaging subsystem is a finite conjugate imaging subsystem or an infinite conjugate imaging subsystem. The number of illumination subsystems is one or two; correspondingly, the number of sensors is one or two.

[0038] The illumination subsystem may be a light emitting diode (LED) lamp, a xenon lamp, or a laser lamp, depending on the specific application. The imaging subsystem includes an objective lens and a tube lens, with the tube lens being arranged above the objective lens. The infinite conjugate imaging subsystem may be a system in which a beam splitter is interposed between the objective lens and the tube lens to introduce

illumination light, whereas the finite conjugate imaging subsystem may be a system in which a beam splitter is positioned below the objective lens to introduce illumination light. The sensor may be a device capable of capturing images, such as a camera.

[0039] In this embodiment, the working process of the defect detection system is as follows: the processor controls the illumination subsystem to illuminate the target area with a first illumination intensity; the sensor acquires a first target area image corresponding to the first illumination intensity; the processor determines a second illumination intensity based on the first target area image and the first illumination intensity, and adjust the illumination intensity of the illumination subsystem based on the second illumination intensity, so as to control the illumination subsystem to illuminate the target area with the second illumination intensity; the sensor acquires a second target area image corresponding to the second illumination intensity; and the processor performs defect detection based on the second target area image.

[0040] In another embodiment, the number of illumination subsystems is two, namely a first illumination subsystem and a second illumination subsystem, and the number of sensors is two, namely a first sensor corresponding to the first illumination subsystem and a second sensor corresponding to the second illumination subsystem.

[0041] The working process of the defect detection system is as follows:

[0042] The target area is placed within the irradiation area of the first illumination subsystem; the processor controls the first illumination subsystem to illuminate the target area with a first illumination intensity. The first sensor acquires a first target area image corresponding to the first illumination intensity. The processor is configured to determine a second illumination intensity based on the first target area image and the first illumination intensity, and adjust the position of the inspected object on the stage and/or the position of the inspected object in the imaging subsystem, such that the target area moves into the irradiation area of the second illumination subsystem. The processor adjusts the illumination intensity of the second illumination subsystem according to the second illumination intensity, so as to control the second illumination subsystem to illuminate the target area with the second illumination intensity. The second sensor acquires a second target area image corresponding to the second illumination intensity. The processor performs defect detection based on the second target area image.

[0043] In this embodiment, since the area of the inspected object (e.g., a silicon wafer) is generally much larger than the irradiation area of the illumination subsystem, during

inspection of the entire inspected object, the inspected object needs to be divided into a plurality of target areas, with each target area being inspected individually. In the case where two illumination subsystems are provided, during the inspection process, it is necessary to adjust the position of the inspected object on the stage and/or its position in the imaging subsystem, such that the target area moves into the irradiation area of the second illumination subsystem. Either the imaging subsystem may be fixed while the inspected object is moved, or the inspected object may be fixed while the imaging subsystem is moved, ultimately resulting in relative motion between the inspected object and the imaging subsystem. In the case where only one illumination subsystem is provided, during the inspection process of the target area, both the position of the inspected object on the stage and its position in the imaging subsystem remain unchanged.

[0044] Fig. 2 is an example diagram of a defect detection system provided by the embodiment of the present application. As shown in Fig. 2, the defect detection system includes a stage, an illumination subsystem 1, an illumination subsystem 2, an objective lens, a tube lens, a beam splitter, a reflector, a sensor 1, a sensor 2, and a processor. Both the illumination subsystems and the sensors are connected to the processor.

[0045] Exemplarily, light generated by the illumination subsystem 1 and the illumination subsystem 2 passes through the beam splitter and then through the objective lens to irradiate the stage, thereby forming two irradiation areas. When the inspected object moves into the irradiation areas, the light reflected from the inspected object passes through the objective lens and the beam splitter to the tube lens, and is then imaged by the sensor 1 and the sensor 2. Upon receiving optical signals, the sensors convert the optical signals into electrical signals, and convert the electrical signals into grayscale values, thereby outputting an image.

[0046] Fig. 3 is a schematic diagram of a movement direction of an inspected object relative to an imaging subsystem provided by the embodiment of the present application. As shown in Fig. 3, when the inspected object moves in a forward direction relative to the imaging subsystem, the illumination subsystem 2 serves as the first illumination subsystem, and the illumination subsystem 1 serves as the second illumination subsystem. When the inspected object moves in a reverse direction relative to the imaging subsystem, the illumination subsystem 1 serves as the first illumination subsystem, and the illumination subsystem 2 serves as the second illumination subsystem.

[0047] Optionally, the irradiation areas of the illumination subsystem 1 and the illumination subsystem 2 have the same size and are symmetrically distributed with respect to the axis orthogonal to the movement axis; the irradiation areas are square, and one side of each square irradiation area is parallel to the movement axis.

[0048] Exemplarily, assume that the inspected object is divided into three target areas, denoted as region 1, region 2, and region 3, respectively. During the inspection process of the target areas, region 1, region 2, and region 3 may be inspected in a forward direction, or a combination of forward and reverse inspections may be performed in an interleaved manner.

[0049] Optionally, when the region 1, region 2, and region 3 are all inspected in a forward direction, the illumination subsystem 2 serves as the first illumination subsystem, and the illumination subsystem 1 serves as the second illumination subsystem. The region 1 is placed within the irradiation area of the illumination subsystem 2. The processor controls the illumination subsystem 2 to illuminate the region 1 with a first illumination intensity. The sensor 2 acquires an image of the region 1 corresponding to the first illumination intensity. The processor is configured to determine a second illumination intensity based on the image of the region 1 and the first illumination intensity, and move the region 1 into the irradiation area of the illumination subsystem 1. The processor adjusts the illumination intensity of the illumination subsystem 1 based on the second illumination intensity, so as to control the illumination subsystem 1 to illuminate the region 1 with the second illumination intensity. The sensor 1 acquires an image of the region 1 corresponding to the second illumination intensity. The processor performs defect detection based on the image of the region 1 acquired by the sensor 1. Similarly, defect detections are performed on region 2 and region 3 in the same manner as the above process.

[0050] Optionally, when a combination of forward and reverse inspections is performed in an interleaved manner on region 1, region 2, and region 3, first, the region 1 is placed within the irradiation area of the illumination subsystem 2. The processor controls the illumination subsystem 2 to illuminate the region 1 with a first illumination intensity. The sensor 2 acquires an image of the region 1 corresponding to the first illumination intensity. The processor is configured to determine a second illumination intensity based on the image of region 1 and the first illumination intensity, and move the region 1 into the irradiation area of the illumination subsystem 1. The processor adjusts the illumination intensity of the illumination subsystem 1 according to the

second illumination intensity, so as to control the illumination subsystem 1 to illuminate the region 1 with the second illumination intensity. The sensor 1 acquires an image of the region 1 corresponding to the second illumination intensity. The processor performs defect detection based on the image of the region 1 acquired by the sensor 1. Next, the region 2 is placed within the irradiation area of the illumination subsystem 1. The processor controls the illumination subsystem 1 to illuminate the region 2 with a first illumination intensity. The sensor 1 acquires an image of the region 2 corresponding to the first illumination intensity. The processor is configured to determine a second illumination intensity based on the image of the region 2 and the first illumination intensity, and move the region 2 into the irradiation area of the illumination subsystem 2. The processor adjusts the illumination intensity of the illumination subsystem 2 based on the second illumination intensity, so as to control the illumination subsystem 2 to illuminate the region 2 with the second illumination intensity. The sensor 2 acquires an image of the region 2 corresponding to the second illumination intensity. The processor performs defect detection based on the image of the region 2 acquired by the sensor 2. Finally, the region 3 is placed within the irradiation area of the illumination subsystem 2. The processor controls the illumination subsystem 2 to illuminate the region 3 with the first illumination intensity. The sensor 2 acquires an image of the region 3 corresponding to the first illumination intensity. The processor is configured to determine a second illumination intensity based on the image of the region 3 and the first illumination intensity, and move the region 3 into the irradiation area of the illumination subsystem 1. The processor adjusts the illumination intensity of the illumination subsystem 1 according to the second illumination intensity, so as to control the illumination subsystem 1 to illuminate the region 3 with the second illumination intensity. The sensor 1 acquires an image of the region 3 corresponding to the second illumination intensity. The processor performs defect detection based on the image of the region 3 acquired by the sensor 1.

[0051] According to the technical solution of this embodiment, a processor is employed to control the illumination subsystem to illuminate the target area with a first illumination intensity, and the sensor acquires a first target area image corresponding to the first illumination intensity. The processor determines a second illumination intensity based on the first target area image and the first illumination intensity, and adjusts the illumination intensity of the illumination subsystem, so as to control the illumination subsystem to illuminate the target area with the second illumination

intensity. The sensor acquires a second target area image corresponding to the second illumination intensity, and the processor performs defect detection based on the second target area image. This ensures the accuracy of inspection results and improves the inspection efficiency.

[0052] Embodiment 2

[0053] Fig. 4 is a flowchart of a defect detection method provided by Embodiment 2 of the present application. This embodiment is applicable to defect detection on optical elements. The method may be performed by a defect detection apparatus, and the apparatus may be implemented in the form of software and/or hardware. Optionally, the apparatus is implemented by an electronic device, and the electronic device may be a mobile terminal, a personal computer (PC), or a server. The method specifically includes the following steps:

[0054] S110: illuminating a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity.

[0055] In this embodiment, the illumination subsystem illuminates the target area of the inspected object with the first illumination intensity, and the sensor obtains a first target area image corresponding to the first illumination intensity.

[0056] S120: determining a second illumination intensity based on the first target area image and the first illumination intensity.

[0057] In this embodiment, the method of determining the second illumination intensity based on the first target area image and the first illumination intensity may be as follows: extracting a brightness value of each pixel in the first target area image; and determining the second illumination intensity based on the brightness value and the first illumination intensity.

[0058] Exemplarily, assuming that the first illumination intensity is I_1 , the actual brightness value is a , and the desired brightness value is b , the second illumination intensity I_2 is obtained according to the formula $I_2 = b/a * K * I_1$. The coefficient K is pre-calibrated.

[0059] S130: illuminating the target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity.

[0060] In this embodiment, the illumination subsystem illuminates the target area of the inspected object with the second illumination intensity, and the sensor obtains a second target area image corresponding to the second illumination intensity.

[0061] S140: performing defect detection based on the second target area image.

[0062] Exemplarily, defect detection is performed on the second target area image to detect whether the inspected object has defects such as dimensional deviations or surface imperfections that may cause the product to fail to meet standard specifications. Surface imperfections include pits, scratches, edge chipping, bubbles, stains, impurities, and the like.

[0063] In the technical solution of this embodiment, the target area of the inspected object is illuminated with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity; a second illumination intensity is determined based on the first target area image and the first illumination intensity; the target area of the inspected object is illuminated with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and defect detection is performed based on the second target area image. In the defect detection method provided by the embodiment of the present application, the second illumination intensity is obtained based on the first target area image and the first illumination intensity, the target area of the inspected object is illuminated with the second illumination intensity to obtain a second target area image, and then defect detection is performed on the second target area image, thereby ensuring the accuracy of inspection results and improving the inspection efficiency.

[0064] Embodiment 3

[0065] Fig. 5 is a schematic diagram of a structure of a defect detection apparatus provided by Embodiment 3 of the present application. As shown in Fig. 5, the apparatus includes:

[0066] a first target area image acquisition module 210 configured to illuminate a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity;

[0067] an illumination intensity determination module 220 configured to determine a second illumination intensity based on the first target area image and the first illumination intensity;

[0068] a second target area image acquisition module 230 configured to illuminate the target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and

[0069] a defect detection module 240 configured to perform defect detection based on the second target area image.

[0070] Optionally, the illumination intensity determination module 220 is further configured to:

[0071] extract a brightness value of each pixel in the first target area image; and determine the second illumination intensity based on the brightness value and the first illumination intensity.

[0072] The above apparatus can perform the methods provided in all the foregoing embodiments of the present application, and possesses corresponding functional modules and effects for performing the above methods. For technical details not exhaustively described in this embodiment, reference may be made to the methods provided in all the foregoing embodiments of the present application.

[0073] Embodiment 4

[0074] Fig. 6 is a schematic structural diagram of an electronic device 10 that can be used to implement embodiments of the present application. The electronic device is intended to represent various forms of digital computers, such as laptops, desktops, workstations, personal digital assistants, servers, blade servers, mainframe computers, and other suitable computers. The electronic device may also represent various forms of mobile devices, such as personal digital assistants, cellular phones, smart phones, wearable devices (e.g., helmets, glasses, watches, etc.), and other similar computing devices. The components shown herein, their connections and relationships, and their functions are merely examples and are not intended to limit the implementation of the present application described and/or claimed herein.

[0075] As shown in Fig. 6, the electronic device 10 includes at least one processor 11, and a memory communicatively connected to the at least one processor 11, such as a read-only memory (ROM) 12 and a random access memory (RAM) 13. The memory stores a computer program executable by the at least one processor. The processor 11 may perform various appropriate actions and processes according to the computer program stored in the ROM 12 or the computer program loaded from the storage unit 18 into the RAM 13. The RAM 13 may also store various programs and data required for the operation of the electronic device 10. The processor 11, the ROM 12, and the

RAM 13 are connected to each other via a bus 14. An input/output (I/O) interface 15 is also connected to the bus 14.

[0076] A plurality of components of the electronic device 10 are connected to the I/O interface 15, including: an input unit 16, such as a keyboard and a mouse; an output unit 17, such as various types of displays and speakers; a storage unit 18, such as a magnetic disk and an optical disk; and a communication unit 19, such as a network card, a modem, and a wireless communication transceiver. The communication unit 19 allows the electronic device 10 to exchange information/data with other devices through a computer network such as the Internet and/or various telecommunications networks.

[0077] The processor 11 may be various general-purpose and/or special-purpose processing components having processing and computing capabilities. Some examples of the processor 11 include, but are not limited to, a central processing unit (CPU), a graphics processing unit (GPU), various specialized artificial intelligence (AI) computing chips, various processors running machine learning model algorithms, a digital signal processor (DSP), and any suitable processor, controller, microcontroller, etc. The processor 11 executes the methods and processes described above, such as the defect detection method.

[0078] In some embodiments, the defect detection method may be implemented as a computer program tangibly contained on a computer-readable storage medium, such as the storage unit 18. In some embodiments, part or all of the computer program may be loaded and/or installed onto the electronic device 10 via the ROM 12 and/or the communication unit 19. When the computer program is loaded into the RAM 13 and executed by the processor 11, it may perform one or more steps of the defect detection method described above. Alternatively, in other embodiments, the processor 11 may be configured to perform the defect detection method by any other suitable means (e.g., by means of firmware).

[0079] Various implementations of the systems and techniques described above herein may be implemented in digital electronic circuitry, integrated circuit systems, field programmable gate arrays (FPGAs), application specific integrated circuits (ASICs), application specific standard products (ASSPs), system on chip (SOC) systems, complex programmable logic devices (CPLDs), computer hardware, firmware, software, and/or combinations thereof. These implementations may be implemented in one or more computer programs that are executable and/or interpretable on a programmable system including at least one programmable processor. The

programmable processor may be a special-purpose or general-purpose programmable processor, and is configured to receive data and instructions from a storage system, at least one input device, and at least one output device, and transmit data and instructions to the storage system, the at least one input device, and the at least one output device.

[0080] Computer programs for implementing the methods of the present application may be written in any combination of one or more programming languages. Such computer programs may be provided to a processor of a general-purpose computer, a special-purpose computer, or other programmable data processing apparatus, such that the functions/operations specified in the flowcharts and/or block diagrams are implemented when the computer program is executed by the processor. The computer program may be executed entirely on the machine, partly on the machine, partly on the machine and partly on a remote machine as a stand-alone software package, or entirely on a remote machine or a server.

[0081] In the context of the present application, a computer-readable storage medium may be a tangible medium that can contain or store a computer program for use by or in connection with an instruction execution system, apparatus, or device. The computer-readable storage medium may include, but is not limited to, electronic, magnetic, optical, electromagnetic, infrared, or semiconductor systems, apparatus, or devices, or any suitable combination of the foregoing. Alternatively, the computer-readable storage medium may be a machine-readable signal medium. More specific examples of machine-readable storage media may include an electrical connection based on one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM) or a flash memory, an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing.

[0082] To provide interaction with a user, the systems and techniques described herein can be implemented on an electronic device. The electronic device is provided with a display device (e.g., a cathode ray tube (CRT) or a liquid crystal display (LCD) monitor) for displaying information to the user; and a keyboard and a pointing device (e.g., a mouse or a trackball) through which the user can provide input to the electronic device. Other types of devices can also be used to provide interaction with a user; for example, the feedback provided to the user can be any form of sensory feedback (e.g., visual

feedback, auditory feedback or tactile feedback); and input from the user can be received in any form (including acoustic input, speech input or tactile input).

[0083] The systems and techniques described herein can be implemented in a computing system that includes a back-end component (e.g., as a data server), or a computing system that includes a middleware component (e.g., an application server) or a computing system that includes a front-end component (e.g., a user computer having a graphical user interface or a web browser, wherein the user can employ the graphical user interface or the web browser to interact with an implementation of the systems and techniques described herein) or a computing system that includes any combination of such back-end components, middleware components or front-end components. The components of the system can be interconnected by any form or medium of digital data communication (e.g., a communication network). Examples of communication networks include: a local area network (LAN), a wide area network (WAN), a blockchain network and the Internet.

[0084] The computing system may include a client and a server. The client and server are generally remote from each other and typically interact through a communication network. The relationship of client and the server arises by virtue of computer programs running on corresponding computers and having a client-server relationship with each other. The server may be a cloud server, also known as a cloud computing server or a cloud host, which is a host product in the cloud computing service system, so as to address the defects of difficult management and weak business scalability existing in traditional physical hosts and virtual private servers (VPS).

[0085] With the various forms of flows shown above, steps may be reordered, added, or deleted. For example, the multiple steps described in the present application may be performed in parallel sequentially, or in a different order. No limitation is imposed herein as long as the desired result of the technical solution of the present application can be achieved.

CLAIMS

1. A defect detection system, comprising: a stage, an illumination subsystem, an imaging subsystem, a sensor, and a processor, wherein the illumination subsystem is connected to the processor, and the sensor is connected to the processor;

the imaging subsystem is arranged above the stage and configured to image an inspected object placed on the stage; the illumination subsystem is arranged on an incident optical path of the imaging subsystem; the sensor is arranged on an imaging optical path of the imaging subsystem; and a target area in the inspected object is located within an irradiation area of the illumination subsystem; and

the processor is configured to control the illumination subsystem to illuminate the target area with a first illumination intensity; the sensor is configured to acquire a first target area image corresponding to the first illumination intensity; the processor is further configured to determine a second illumination intensity based on the first target area image and the first illumination intensity, and adjust an illumination intensity of the illumination subsystem based on the second illumination intensity, so as to control the illumination subsystem to illuminate the target area with the second illumination intensity; the sensor is further configured to acquire a second target area image corresponding to the second illumination intensity; and the processor is further configured to perform defect detection based on the second target area image.

2. The system according to claim 1, wherein the number of the illumination subsystems is one or two; and the number of the sensors is one or two.

3. The system according to claim 2, wherein when the number of the illumination subsystems is one and the number of the sensors is one, during inspection of the target area, both a position of the inspected object on the stage and a position of the imaging subsystem remain unchanged.

4. The system according to claim 2, wherein the number of the illumination subsystems is two, namely a first illumination subsystem and a second illumination subsystem, and the number of the sensors is two, namely a first sensor corresponding to the first illumination subsystem and a second sensor corresponding to the second illumination subsystem;

the processor is configured to place the target area within an irradiation area of the first illumination subsystem, and control the first illumination subsystem to illuminate the target area with the first illumination intensity;

the first sensor is configured to acquire the first target area image corresponding to the first illumination intensity;

the processor is further configured to determine the second illumination intensity based on the first target area image and the first illumination intensity, and adjust at least one of the position of the inspected object on the stage and the position of the inspected object in the imaging subsystem, such that the target area moves into an irradiation area of the second illumination subsystem; and the processor adjusts an illumination intensity of the second illumination subsystem based on the second illumination intensity, so as to control the second illumination subsystem to illuminate the target area with the second illumination intensity;

the second sensor is configured to acquire the second target area image corresponding to the second illumination intensity; and

the processor is further configured to perform defect detection based on the second target area image.

5. The system according to claim 1, wherein the imaging subsystem is a finite conjugate imaging subsystem or an infinite conjugate imaging subsystem.

6. A defect detection method, wherein the method is performed by the defect detection system according to any one of claims 1 to 5, comprising:

illuminating a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity;

determining a second illumination intensity based on the first target area image and the first illumination intensity;

illuminating the target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and

performing defect detection based on the second target area image.

7. The method according to claim 6, wherein the determining a second illumination intensity based on the first target area image and the first illumination intensity comprises:

extracting a brightness value of each pixel in the first target area image; and

determining the second illumination intensity based on the brightness value and the first illumination intensity.

8. A defect detection apparatus, comprising:

a first target area image acquisition module configured to illuminate a target area of an inspected object with a first illumination intensity to obtain a first target area image corresponding to the first illumination intensity;

an illumination intensity determination module configured to determine a second illumination intensity based on the first target area image and the first illumination intensity;

a second target area image acquisition module configured to illuminate a target area of the inspected object with the second illumination intensity to obtain a second target area image corresponding to the second illumination intensity; and

a defect detection module configured to perform defect detection based on the second target area image.

9. An electronic device, comprising:

at least one processor; and

a memory communicatively connected to the at least one processor; wherein

the memory stores a computer program executable by the at least one processor, wherein the computer program, when executed by the at least one processor, causes the at least one processor to perform the defect detection method according to any one of claims 6 and 7.

10. A computer-readable storage medium, wherein the computer-readable storage medium stores computer instructions, and the computer instructions, when executed by a processor, cause the processor to perform the defect detection method according to any one of claims 6 and 7.