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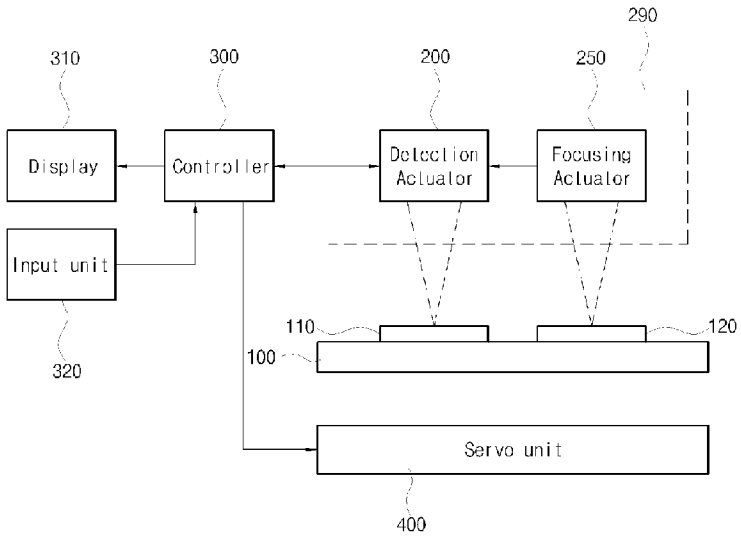
(54) **Title:** COMBO OPTICAL BIO-CHIP DETECTOR SYSTEM USING A VOICE COIL MOTOR ACTUATOR



(57) **Abstract:** A combo-optical bio-chip detection system using a voice-coil motor actuator is disclosed. A detection actuator and a focusing actuator are configured in the form of a single device, such that the single device performs an auto-focusing in real time, and scans a bio-chip. The combo-optical bio-chip detection system using a voice-coil motor actuator includes a substrate including a bio-chip area and a CD/DVD area, an actuator, and a controller. The actuator includes: a focusing actuator for outputting a focusing beam to the CD/DVD area of the substrate to generate a focusing error signal, and outputting the focusing error signal, and a detection actuator for performing a focusing function upon receiving the focusing error signal from the focusing actuator such that it establishes synchronization with the focusing actuator in real time. The controller converts a bio-chip image signal received from the detection actuator into a bio- analysis signal, and outputs the bio-analysis signal.

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Description

COMBO OPTICAL BIO-CHIP DETECTOR SYSTEM USING A VOICE COIL MOTOR ACTUATOR

Technical Field

[1] The present invention relates to a combo-optical bio-chip detection system using a voice-coil motor actuator, and more particularly to a combo-optical bio-chip detection system using a voice-coil motor actuator, which implements a detection actuator and a focusing actuator in the form of a single device, performs an auto-focusing process in real time, and at the same time scans a bio-chip.

Background Art

[2] As well known in the art, a bio-chip is indicative of a biochemical semiconductor in which a biomaterial (e.g., protein, DNA, antibody, enzyme, microbe, animal- and plant- cell and organ, nervous cell, etc.) is integrated on a substrate made of a glass or silicon at high density. Generally, the bio-chip is called a protein chip, a DNA chip, a genetic chip, a cell chip, and a bio-sensor, etc.

[3] The bio-chip can be applied to a variety of technical fields, for example, a genetic-function analysis, a clinical diagnosis, an antibiotic-tolerance inspection, medicinal sensitivity inspection, real-child confirmation, and animal and plant quarantines, etc.

[4] For example, an analysis method using the above-mentioned bio-chip controls the bio-chip to react to a blood or urine of a specific user to be inspected In this case, the bio-chip is configured by integrating not only a protein capable of being reacting to a specific disease or symptoms, but also a fluorescent material. The above-mentioned analysis method analyzes manifestation of the fluorescent material by the reaction between the bio-chip's protein and the protein contained in the blood or urine, such that it can determine the presence or absence of the disease or symptom. The bio-chip for diagnosing a specific disease or symptom is called a diagnosis kit. Due to the promptness and accuracy of the diagnosis kit, the bio-chips are being widely introduced to the market throughout the world.

[5] Generally, the bio-chip is being analyzed by either an examination with the naked eyes of an analyzing user or a microscope examination. However, the naked-eye examination requires good dexterity and many experiences of the user because it wholly depends upon the user's personal decision and experiences, such that the reliability of the resultant data may be deteriorated by errors of the user. Also, the accuracy of the analysis method greatly depends upon the user's fatigue and analysis environments, etc. The microscope examination can increase the reliability of data as compared to the naked-eye examination, however, it may unavoidably require a long period of time and

much manpower.

Disclosure of Invention

Technical Problem

[6] Therefore, the present invention has been made in view of the above problems, and it is an object of the present invention to provide a combo-optical bio-chip detection system using a voice-coil motor actuator, which implements a detection actuator and a focusing actuator in the form of a single device, and scans a bio-chip simultaneously while performing a real-time auto-focusing function.

[7] It is another object of the present invention to provide a combo-optical bio-chip detection system using a voice-coil motor actuator, which is superior to a conventional bio-chip scanner in light of system complexity and size, can easily access data, and is very superior to the conventional bio-chip scanner in light of price.

Technical Solution

[8] In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a combo-optical bio-chip detection system using a voice-coil motor actuator comprising: a substrate including a bio-chip area and a CD/DVD area; an actuator including: a focusing actuator for outputting a focusing beam to the CD/DVD area of the substrate to generate a focusing error signal, and outputting the focusing error signal, and a detection actuator for performing a focusing function upon receiving the focusing error signal from the focusing actuator such that it establishes synchronization with the focusing actuator in real time; and a controller for converting a bio-chip image signal received from the detection actuator into a bio-analysis signal, and outputting the bio-analysis signal.

Brief Description of the Drawings

[9] The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

[10] FIG. 1 is a block diagram illustrating a combo-optical bio-chip detection system using a voice-coil motor actuator according to the present invention;

[11] FIG. 2 is a structural diagram illustrating a detection actuator and a focusing actuator according to the present invention;

[12] FIG. 3 is a conceptual diagram illustrating a correlation between the detection actuator and the focusing actuator according to the present invention;

[13] FIG. 4 is a structural diagram illustrating the detection actuator of FIG. 2 according to the present invention;

[14] FIG. 5 is a conceptual diagram illustrating a circular shield lens of FIG. 4 according to the present invention; and

[15] FIG. 6 is a conceptual diagram illustrating beam areas according to the present invention.

Mode for the Invention

[16] Now, preferred embodiments of the present invention will be described in detail with reference to the annexed drawings. In the drawings, the same or similar elements are denoted by the same reference numerals even though they are depicted in different drawings. In the following description, a detailed description of known functions and configurations incorporated herein will be omitted when it may make the subject matter of the present invention rather unclear.

[17] A combo-optical bio-chip detection system using a voice-coil motor actuator according to the present invention will hereinafter be described with reference to the annexed drawings.

[18] FIG. 1 is a block diagram illustrating a combo-optical bio-chip detection system using a voice-coil motor actuator according to the present invention. FIG. 2 is a structural diagram illustrating a detection actuator and a focusing actuator according to the present invention. FIG. 3 is a conceptual diagram illustrating a correlation between the detection actuator and the focusing actuator according to the present invention. FIG. 4 is a structural diagram illustrating the detection actuator of FIG. 2 according to the present invention. FIG. 5 is a conceptual diagram illustrating a circular shield lens of FIG. 4 according to the present invention. FIG. 6 is a conceptual diagram illustrating beam areas according to the present invention.

[19] Referring to FIG. 1, the combo-optical bio-chip detection system using the voice-coil motor actuator includes: a substrate 100 including a bio-chip area 110 and a CD/DVD area 120; an actuator 290 for illuminating a beam to the bio-chip area 110 to generate a bio-chip image signal; a controller 300 for converting the bio-chip image signal received from the actuator 290 into a bio-analysis signal, and outputting the bio-analysis signal to a display 310; and a servo unit 400.

[20] The actuator 290 includes a focusing actuator 250 and a detection actuator 200. The focusing actuator 250 outputs a focusing beam to the CD/DVD area 120 of the substrate 100 to generate a focusing error signal, and outputs the focusing error signal. The detection actuator 200 performs a focusing function upon receiving the focusing error signal from the focusing actuator 250 such that it establishes synchronization with the focusing actuator 250 in real time.

[21] The detection actuator 200 performs the focusing process after performing a tilt correction. In other words, in the case of a disc tilt, the detection actuator 200 corrects the tilt by a predetermined value " d " as shown in FIG. 3 (where $d = l \times \sin\theta$).

[22] The value of is indicative of a predetermined value for correcting a tilt generated

from the bio-chip and the CD/DVD area in real time during an auto-focusing process. In this case, θ is indicative of a tilt angle. The tilt is indicative of an error generated during the processing or assembling of a machine, and is synchronized with an auto-focusing value generated during the auto-focusing of the CD/DVD area, such that it is corrected.

[23] The detection actuator 200 includes: a first light source 210 for illuminating a beam of a first wavelength on the bio-chip area 110; a second light source 212 for illuminating a beam of a second wavelength on the bio-chip area 100; a circular shield lens 220 for selecting a light signal having several light-emitting fluorescent wavelengths from among a plurality of optical signals illuminated on the bio-chip area 110, and performing the focusing function; a detection head 228 for detecting the bio-analysis signal from a first area or a second area of the circular shield lens 220; and a voice-coil motor actuator 222 for enabling the first light source 210 to be focused on the first area of the circular shield lens 220 upon receiving the focusing error signal from the focusing actuator 250, or enabling the second light source 212 to be focused on the second area of the circular shield lens 220 upon receiving the focusing error signal from the focusing actuator 250.

[24] The circular shield lens 220 has different Numerical Apertures (NAs) according to lens areas. In other words, the circular shield lens 220 focuses laser beams having different wavelengths owned by Cy3 and Cy5 on different areas, respectively, such that the Cy3 and the Cy5 can acquire their focal points at similar locations.

[25] The controller 300 changes a spherical aberration of the circular shield lens 220 according to wavelengths of the first and second light sources 210 and 220, and changes a moving distance of the voice-coil motor actuator 222, such that the detection head 228 can detect the bio-analysis signal.

[26] Operations of he combo-optical bio-chip detection system using the voice-coil motor actuator according to the present invention will hereinafter be described in detail.

[27] When a fluorescent signal generated from the actuator 200 has the highest intensity after the focusing actuator 250 is focused, the system performs an initial adjustment process, such that the system setting is completed.

[28] In other words, if a user desires to analyze the bio-chip area 110 after depositing a Cy3 sample liquid on the bio-chip area, the focusing actuator 250 outputs a laser beam for a CD or DVD to the CD/DVD area 120, receives the laser beam reflected from the CD or DVD using a photo-diode (PD), and performs the focusing process.

[29] The focusing actuator 250 outputs the focusing error signal to the detection actuator 200 after performing the focusing process. The detection actuator 200 performs the focusing function according to the focusing error signal. In other words, the detection

actuator 200 is synchronized with the focusing actuator 250 in real time.

[30] Thereafter, the controller 300 controls the servo-unit 400 including the bio-chip area 110 upon receiving a bio-chip analysis request from the user, rotates the substrate 100 by controlling the detection actuator 200, and at the same time controls the second light source 212 to generate a second beam.

[31] The second beam generated from the second light source 212 is indicative of a laser beam having a wavelength of 554nm, is reflected from a splitter 214, and is then illuminated on the bio-chip 100 via a prism 216, a collimator lens 218, and the circular shield lens 220.

[32] The Cy3 sample of the bio-chip area 110 generates a fluorescent signal by the second beam. The second beam is focused on a first area as shown in FIGS. 3 and 4. The fluorescent signal generated from the Cy3 sample is applied to the prism 216 via the circular shield lens 220 and the collimator lens 218, is reflected from the prism 216, and is then applied to the detection head 228 via a focusing lens 224 and a radiation filter 226.

[33] In this case, the detection head is indicative of a light-emitting fluorescent wavelength head, and is composed of a PMT or APD.

[34] The bio-analysis signal detected by the detection head 228 is applied to the controller 300, and is then displayed on a display (not shown), such that the user can recognize a diagnostic result.

[35] In the meantime, if the user desires to analyze the bio-chip area 110 after depositing the Cy5 sample liquid on the bio-chip area 110, the controller 300 controls the servo=unit 400 equipped with the substrate 100 after recognizing the user's request, controls the detection actuator 200 to rotate the substrate 100 including the bio-chip area 110, and at the same time controls the first light source 210 to generate a first beam.

[36] The first beam generated from the first light source 210 is indicative of a laser beam having a wavelength of 635nm, is reflected from the splitter 214, and is then illuminated on the bio-chip 100 via the prism 216, the collimator lens 218, and the circular shield lens 220.

[37] The Cy5 sample of the bio-chip area 100 generates a fluorescent signal by the first beam. The second beam is focused on the first area as shown in FIGS. 3 and 4.

[38] The fluorescent signal generated from the Cy5 sample is applied to the prism 216 via the circular shield lens 220 and the collimator lens 218, is reflected from the prism 216, and is then applied to the detection head 228 via the focusing lens 224 and the radiation filter 226.

[39] The bio-analysis signal detected by the detection head 228 is applied to the controller 300, and is then displayed on a display (not shown), such that the user can

recognize a diagnostic result.

[40] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

Industrial Applicability

[41] As apparent from the above description, the combo-optical bio-chip detection system using the voice-coil motor actuator according to the present invention combines a voice-coil motor actuator combo optical pickup technology and a bio-chip detection technology into a single head device, such that it can implement the DNA chip detection technology using the single optical system.

[42] The combo-optical bio-chip detection system according to the present invention can be very precisely driven by a high-speed voice-coil motor optical pickup actuator, such that it can precisely analyze bio-chip data.

[43] The combo-optical bio-chip detection system according to the present invention implements a bio-chip precise-recording/reproducing mechanism, is configured in the form of a small-sized product with low production costs.

[44] Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

Claims

[1] A combo-optical bio-chip detection system using a voice-coil motor actuator comprising:
a substrate including a bio-chip area and a CD/DVD area;
an actuator including:
a focusing actuator for outputting a focusing beam to the CD/DVD area of the substrate to generate a focusing error signal, and outputting the focusing error signal, and
a detection actuator for performing a focusing function upon receiving the focusing error signal from the focusing actuator such that it establishes synchronization with the focusing actuator in real time; and
a controller for converting a bio-chip image signal received from the detection actuator into a bio-analysis signal, and outputting the bio-analysis signal.

[2] The combo-optical bio-chip detection system according to claim 1, wherein the detection actuator establishes synchronization with an auto-focusing of the CD/DVD area, such that it corrects a tilt of a bio-chip.

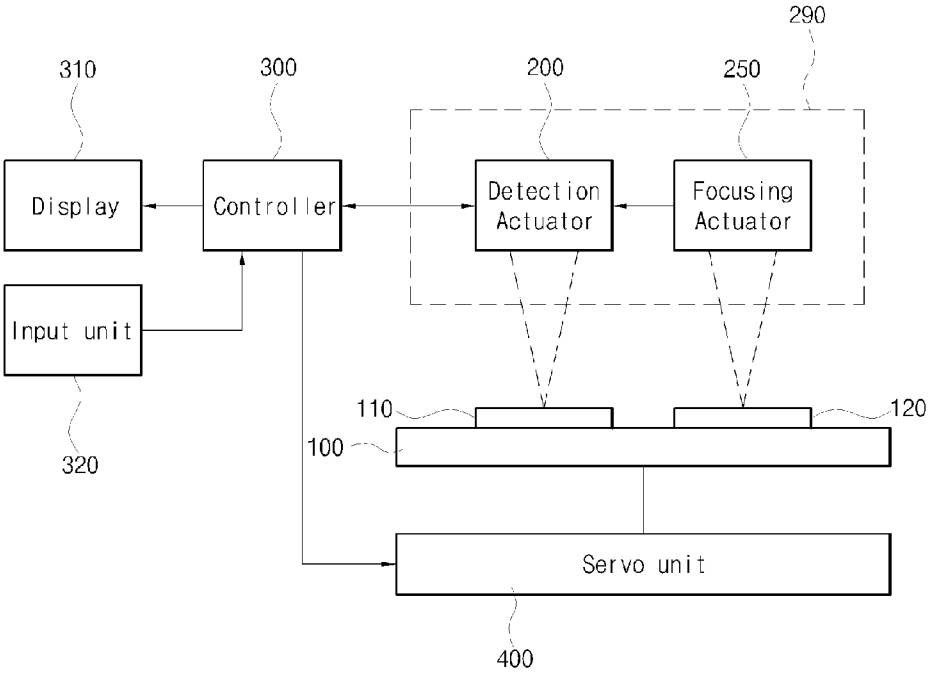
[3] The combo-optical bio-chip detection system according to claim 1, wherein the detection actuator includes a bio-analysis signal detector including:
a first light source for illuminating a beam of a first wavelength on the bio-chip area;
a second light source for illuminating a beam of a second wavelength on the bio-chip area;
a circular shield lens for selecting a light signal having several light-emitting fluorescent wavelengths from among a plurality of optical signals illuminated on the bio-chip area, and performing the focusing function;
a detection head for detecting the bio-analysis signal from a first area or a second area of the circular shield lens; and
a voice-coil motor actuator for enabling the first light source to be focused on the first area of the circular shield lens upon receiving the focusing error signal from the focusing actuator, or enabling the second light source to be focused on the second area of the circular shield lens upon receiving the focusing error signal from the focusing actuator.

[4] The combo-optical bio-chip detection system according to claim 1, wherein the controller changes a spherical aberration of the circular shield lens according to wavelengths of the first and second light sources, and changes a moving distance of the voice-coil motor actuator, such that the detection head can detect the bio-analysis signal.

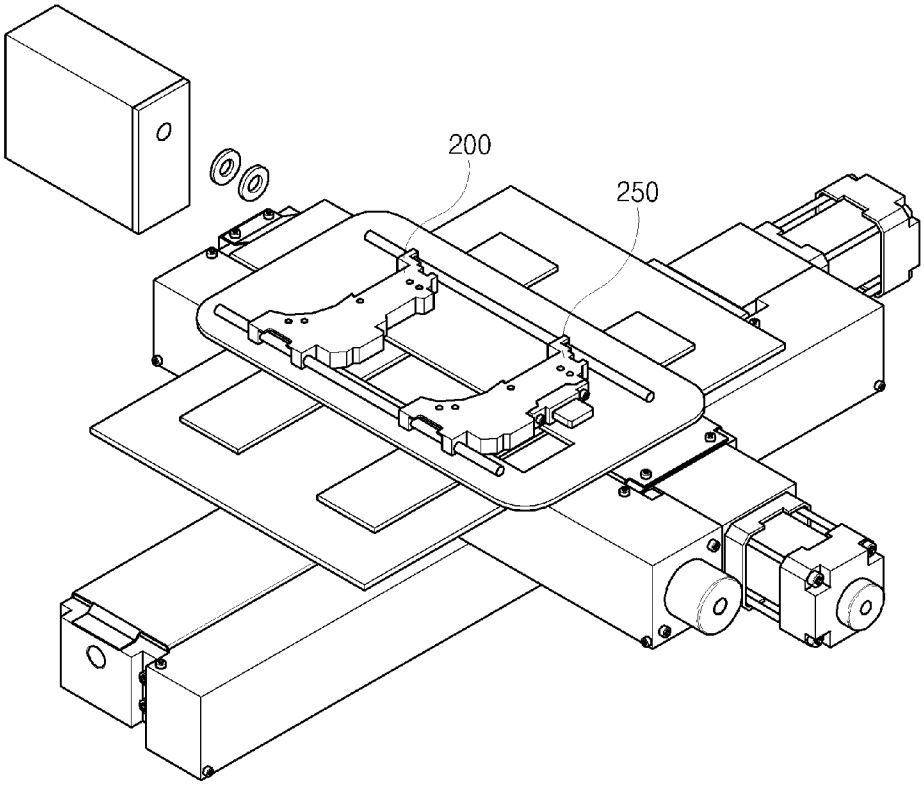
[5] The combo-optical bio-chip detection system according to claim 3, wherein the first light source is indicative of a laser beam having a wavelength of 635nm, and the second light source is indicative of a laser beam having a wavelength of 554nm.

[6] The combo-optical bio-chip detection system according to claim 3, wherein the circular shield lens has different Numeral Apertures (NAs) according to lens areas.

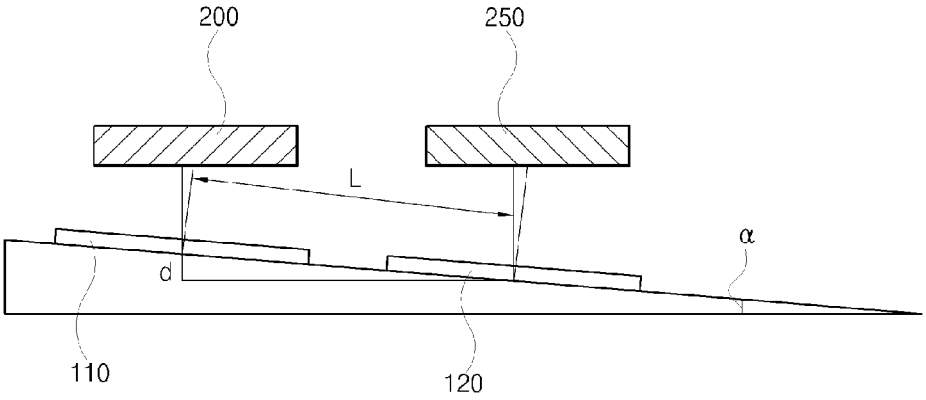
[Fig. 1]


290
310
300
200
250
Display
Controller
Detection Actuator
Focusing Actuator
Input unit
110
120
100
320
Servo unit
400

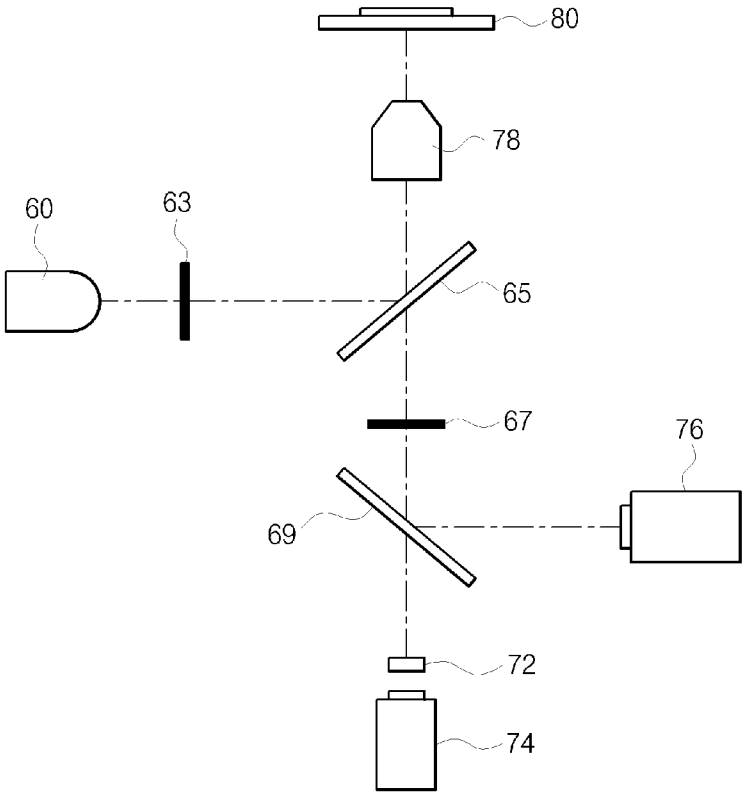
[Fig. 2]


200
250

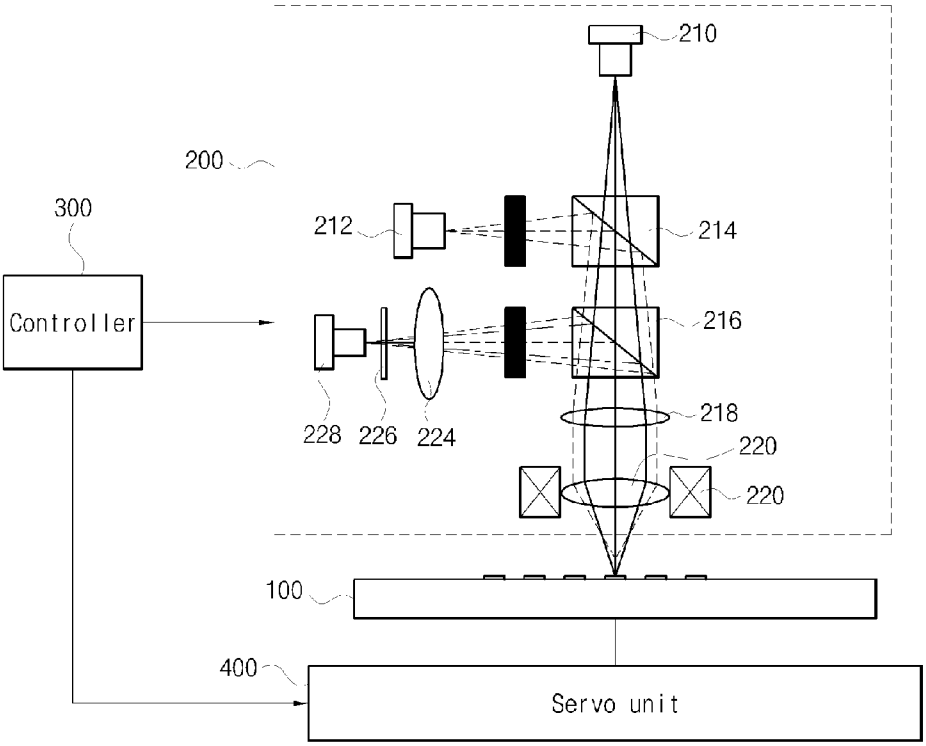
[Fig. 3]



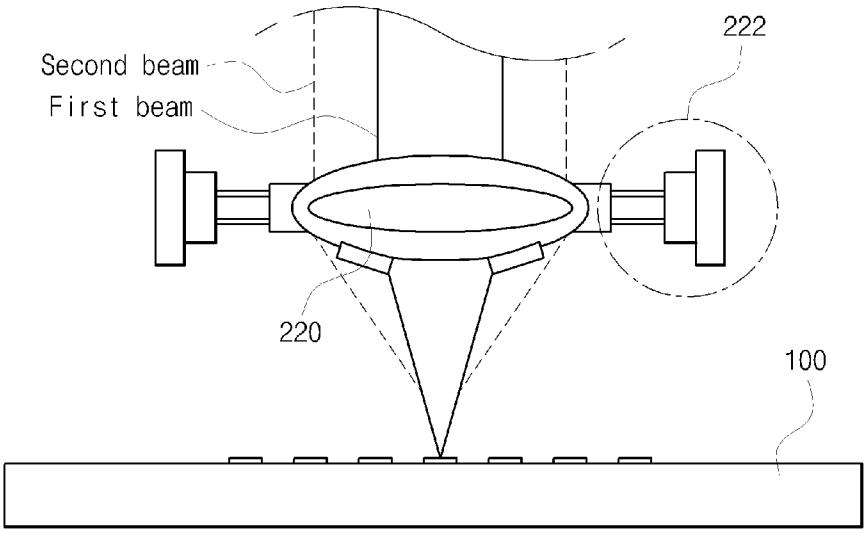
[Fig. 4]



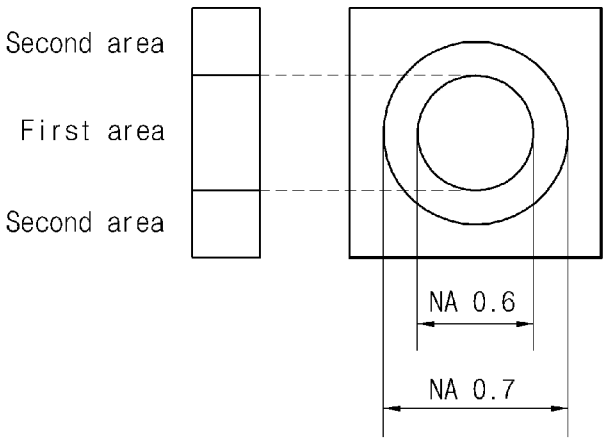
[Fig. 5]



[Fig. 6]



[Fig. 7]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/001143

A. CLASSIFICATION OF SUBJECT MATTER

C12Q 1/00(2006.01)i, C12Q 1/68(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C12Q 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Utility models and applications for Utility models since 1975.
Japanese Utility models and applications for Utility models since 1975.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
STN(CAPLUS)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6902112 (AGILENT TECHNOLOGIES, INC.) 07 JUNE 2005, seethe entire document.	1 - 6
A	JP 2004144839 A2 (OLYMPUS CORP) 20 MAY 2004, see the entire document.	1 - 6

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 JUNE 2007 (15.06.2007)	**15 JUNE 2007 (15.06.2007)**

Name and mailing address of the ISA/KR	Authorized officer
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Facsimile No. 82-42-472-7140	Telephone No. 82-42-481-5893

Form PCT/ISA/210 (second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2007/001143

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6902112	07-06-2005	US 6592036	15-07-2003
		US 6371370	16-04-2002
JP 2004144839 A2	20-05-2004	None	