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DESCRIPTION

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to the field of measuring apparatuses in distribution systems, and particularly to a measuring apparatus allowing for measuring presence and position of an object placed on a carrier as well as a method for such measuring.

Description of the Related Art

[0002] In large sorting and distribution systems a large number of objects are handled automatically, e.g. sorting of packages in postage systems or handling of parts in re-distribution centrals. Typically the objects are loaded onto a carrier which transports the objects to a determined location where they are loaded off the carrier. In these types of systems it is important to know the presence, position and shape of objects on the carriers. The presence is required to determine if any objects can be placed onto the carrier prior to loading the object on the carrier or to detect that the object really is placed on a specific carrier. Position is required to adjust cross-belt carrier position to keep the object safely within the carrier or to calculate the optimum extraction position. Two-dimensional and/or three-dimensional shape is required in e.g. a package distribution system, where there is a need to calculate volume based freight costs and/or optimum loading on e.g. a truck.

[0003] The objects to be handled in such sorting and distribution systems can be of very different sizes and materials, and may be wrapped in clear plastics etc. This makes the detection/measuring of presence, position and shape of objects difficult with simple techniques.

[0004] A commonly used technique for sensing that an object is present on a carrier is the use of a simple light switch, such as a photo sensor, which can detect presence and position information in at least one dimension along the carriers' direction of movement. However, a problem associated with this technique is that it is nearly impossible for the sensor to sense an object which is low in relation to the vertical vibration of the carriers and the technique can only be used for systems that use carriers which are flat-shaped. Also, the sensor is not able to detect the position of the object in a transversal direction across the carrier.

[0005] Another commonly used technique for sensing that an object is present on a carrier is conventional two-dimensional (2D) image processing. This is made with a standard two-dimensional camera taking a snapshot of the carrier, or a line-scan sensor acquiring the 2D image information as the carrier moves through the Field-of-View (FoV). If the carriers are free from disturbing artifacts, such as paint or stickers, two-dimensional image processing can typically extract 2D-position and shape of objects. However, typically the carriers will be stained with e.g. stickers after being used for a while, which makes it hard to extract the needed information using 2D image processing. Additionally, using 2D image processing is very hard when the color of the object is similar to the color of the background, i.e. the carrier.

[0006] Still another used technique for sensing that an object is present on a carrier is a three-dimensional (3D) image processing. When using 3D data most objects are detected securely. However, for certain materials the 3D image acquisition might give no secure 3D information, such if the objects are very reflective, very dark or very low in height.

[0007] Many of the systems existing today, described above, used for these types of measurements of objects are only capable of handling carriers having a flat form but often there is a requirement for the use of carriers with different shapes, for example flat carriers with edges and bowl-shaped carriers. It is also desirable to be able to do the measuring of the objects even if the carrier is vibrating or if it for any reason is tilted with reference to the nominal alignment.

[0008] One prior art approach is disclosed in US 6.102.291, in which an apparatus detects the presence and position of an object on a bearing surface of a moving supply plane. The measuring is made with a modulated light laser scanner that is placed above the supply plane. The apparatus is first of all used for the reading of optical codes (bar codes) positioned on the surface of the object.

[0009] However, in this prior art approach the measuring is done with a modulated time-of-flight laser scanner. The modulated light laser scanner has movable parts which causes wear and it also requires regular maintenance. Also, when a high level of 3D accuracy is needed the use of a modulated light laser scanner becomes very expensive.

[0010] Although the known prior art solves some of the problems described above it does not specifically address the problem of non-flat carriers and the problem of providing measurement for very small objects or objects having similar color as the background color.

[0011] Thus, an object of the present invention is to provide an improved apparatus and method that enables for the use of non-flat carriers and for the measuring of very small objects or objects having similar color as the background color.

[0012] US-4498778 discloses a method and apparatus for determining the spatial coordinates of a workpiece.

[0013] DE-3528047discloses a method where an unknown object is illuminated by a obliquely mounted slot-shaped light source in such a manner that a slot-shaped light beam is imaged on the object and its support. This imaged line of light is then detected by a television camera.

[0014] US-6369401 discloses a three-dimensional measurement system and method for objects, such as oysters, projects one or more laser lines onto a surface on which the object is currently located. The laser lines are picked up as parallel lines by a camera where no object is located on the surface. When an object is located on the surface, the camera obtains an image that includes lines displaced from the parallel. The displacement data allows a processor to determine the height of the object at various positions. Volume can be obtained using a binary image of the object to calculate area from the height data.

[0015] US-5900611 discloses a scanner for reading coded symbologies The invention uses a coherent, visible light source for illuminating the coded symbol durina a scan and a detecting means for collecting the reflected light energy from the coded symbol.

[0016] US-4929843 discloses a method where the height of an object is determined by projecting a beam of light there across to form a light stripe. A camera views the object obliquely, and forms an image of the light stripe. As a result of the oblique view, the light stripe is imaged as a series of bright vertical lines on a horizontally-scanned image. Each horizontal line scan crosses the light stripe at a particular horizontal position, representative of the height of the object. A logic circuit finds the pixel with the greatest intensity and stores its position and value, and the values of its neighboring pixels, At the end of each line scan, the sum of the stored intensities is formed, together with a weighted sum, so that a ratio may be formed which represents the center position.

[0017] US-5461478 discloses a method and an apparatus capable of accurately measuring the three-dimensional position and orientation of an object. A first slit light is projected from a first light projector for scanning an object, and each light image is obtained by a CCD camera. Similarly, a second slit light is projected from a second light projector for scanning the object and each light image is obtained by the CCD camera. The first and second slit lights are perpendicular to each other. The individual images obtained are processed to find a bent point and a disconnection point in each slit-light scan image. From among these points, a group of points which are reckoned to be lying on the same straight line is extracted, and theobtained straight fine of points is used as edge information of the object.

[0018] US-4741621 discloses a surface inspection system with a single light source producing two light stripe sheets projected from different angles onto an inspected surfaceso that a combined light sheet produces a light stripe image with no shadows results. The two light stripe sheets are created by tangentially reflecting a laser beam off of separate cylindrical reflectors. The light stripe is detected by an imaging system, including a camera having a CCD image array, held at a fixed angle with respect to the light sheet which allows the two-dimensional curvature of the stripe to be detected.

SUMMARY OF THE INVENTION

[0019] An object of the present invention is to provide an improved method for measuring the presence and/or position of an object placed on a carrier moving in a predetermined direction of movement in a distribution system.

[0020] This object is achieved through providing a method according to claim 1. A further object of the present invention is to provide an improved apparatus allowing for measuring the presence and/or position of an object placed on a carrier moving in a predetermined direction of movement in a distribution system.

[0021] This object is achieved through providing an apparatus according to claim 16. Still a further object of the present invention is to provide an improved system for distributing and/or sorting objects placed on carriers moving in a predetermined direction of movement in the system.

[0022] Still other objects and features of the present invention will become apparent from the following detailed description considered in conjunction with the accompanying drawings. It is to be understood, however, that the drawings are designed solely for purposes of illustration and not as a definition of the limits of the invention, which is defined by the appended claims. It should be further understood that the drawings are not necessarily drawn to scale and that, unless otherwise indicated, they are merely intended to conceptually illustrate the structures and procedures described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] In the drawings, wherein like reference characters denote similar elements throughout the several views:

Fig. 1 illustrates schematically an apparatus for measuring presence, position and shape of an object placed on a carrier in a distribution system, according to a first embodiment of the invention;

Fig. 2 illustrates the first embodiment of the present invention wherein an occluded area is formed where the sensor does not detect any reflected light;

Fig. 3a illustrates a 2D intensity image of an object and a disturbing artifact;

Fig. 3b illustrates a 3D range image of an object wherein a part of the object is occluded;

Fig. 3c illustrates a 2D image of a dark object placed on a dark carrier;

Fig. 3d illustrates the "lost data" phenomenon;

Fig. 4a illustrates a perspective view of an object placed on a flat carrier;

Fig. 4b illustrates the process of determining the presence, position and shape of an object placed on a flat carrier;

Fig. 5a illustrates a perspective view of an object placed on a carrier that is bowl-shaped;

Fig. 5b illustrates the process of determining the presence, position and shape of an object placed on a bowl-shaped carrier;

Fig. 6a illustrates a perspective view of an object having a very low profile (height) placed on a flat carrier;

Fig. 6b illustrates the process of determining the presence and position of an object having a very low profile (height);

Fig. 7 illustrates schematically an alternative to the first embodiment of the apparatus according to the invention, wherein one sensor and two light sources are used;

Fig. 8a illustrates schematically another alternative to the first embodiment of the apparatus according to the invention, wherein two sensors and two light sources are used;

Fig. 8b illustrates the same embodiment as shown in fig. 8a but seen from above;

Fig. 9 illustrates schematically still another alternative to the first embodiment of the apparatus according to the invention, wherein one light source and two sensors are used;

Fig. 10 illustrates schematically a second embodiment of the apparatus according to the invention, wherein additional detectors are arranged to detect if there is a large object present on the carrier.

Fig. 11 illustrates schematically a third embodiment of the apparatus according to the invention wherein additional detectors are used to synchronize the acquisition with the motion of the carrier to be able to measure the position of the objects on the carriers.

DETAILED DESCRIPTION OF THE PRESENTLY PREFERRED EMBODIMENTS

[0024] In the following a preferred embodiment of an apparatus in a distribution system for measuring the presence, position and shape of an object placed on a carrier will be described.

[0025] Figure 1 shows a first embodiment of an apparatus in a distribution system for measuring the presence and position of an object 12 placed on a carrier 13. The apparatus comprises one light source 14 arranged to illuminate the object 12 and the carrier 13 with incident light. The light source 14 generates a line of light across the object 12. At least one sensor 11 is arranged to detect the reflected light from the object 12 and the carrier 13 and to convert the detected light into electrical signals. An image/signal-processing unit (not shown) is arranged to create an analogue or digital representation of the illuminated cross-section of the object 12 and the carrier 13 according to the electrical signals. In the preferred embodiment of the present invention, a digital representation of the object 12 and carrier 13 is created. The apparatus further comprises a calculating unit (not shown) arranged to determine the presence and position of the object 12 and carrier 13 from the digital representation.

[0026] In the first embodiment of the present invention the carrier 13 moves relative to the measuring apparatus in a predetermined direction of movement, denoted by arrow 1, shown in figure 1. The distribution system consists of a plurality of carriers 13 where each carrier 13 also is capable of moving in a direction that differs from the predetermined direction, preferably substantially orthogonal to the predetermined direction of movement, denoted by arrow 2, shown in figure 1. The carrier 13 may be of any shape, for example flat-shaped, bowl-shaped or flat-shaped with edges. One example of a bowl-shaped carrier is shown in figure 5a, another type of a bowl-shaped carrier is a carrier having a U-shaped profile in a transversal direction (x-direction) but having a flat profile in the direction of movement (y-direction). Further the carrier may be a flip-tray, a cross-belt sorter, a conveyor, or the like.

[0027] The object 12 may be of any shape, size, material or color and may be placed anywhere on the carrier 13. Also, the object may have a size which covers more than one carrier. Or, alternatively, may be so small that there might be several objects placed on the same carrier.

[0028] The light source 14 generates structured light, for example, point light, linear light or light composed of multiple, substantially point or linear segments and may be of any type suitable for the application, for example a laser, a light-emitting diode (LED), ordinary light (light bulb) etc, which are familiar to the person skilled in the art and will not be described further herein. Laser light is preferably used in the preferred embodiment of the present invention.

[0029] The sensor 11 is placed on a predetermined distance from the light source 14. The sensor 11 may be a CCD camera, a CMOS camera or any other camera suitable for imaging characteristics of an object. The image/signal-processing unit may be integrated in the sensor 11, may be a separate unit provided in the same housing as the sensor 11 (in the camera housing), or may be a totally separate unit outside the camera housing. The sensor 11 is in the present system capable of detecting both two-dimensional (2D, intensity) and three-dimensional (3D, range) information, i.e. is capable of measuring both intensity distribution and geometric profile of the object 12. The information on geometric profile (3D shape) of the object 12 is obtained by using triangulation, i.e. the position of the reflected light on the sensor 11 indicates the distance from the sensor 11 to the object 12 when the light source 14 is placed on a predetermined distance from the sensor 11. The 2D information in itself helps in the detection of the object 12, but may also be used as a confidence measurement of the quality of the 3D data. Occasionally the sensor 11 do not detect any reflected light and this may be an indication of that an object is present. This phenomenon is called "missing data" and will be further described below.

[0030] The sensor 11 is arranged to detect 2D and 3D information of the object 12 and carrier 13 in a plurality of cross-sections of the object 12 and the carrier 13 illuminated by the light source 14, i.e. it is arranged to repeatedly measure (scan) the object 12 and the carrier 13 when the carrier 13 moves along in the direction of movement, in order to obtain a plurality of cross-section images (sub-images) which are put together into a measured 3D image of the object 12 and the carrier 13.

[0031] When using 3D image information most objects may be detected securely. However, for certain materials the 3D image acquisition does not give secure 3D information and the result is missing data. This is e.g. the case if the objects are very reflective or dark. Thus the best information of an objects presence, position and/or shape is obtained by using sensors capable of detecting both 2D and 3D information. The 2D can help the detection and it can also be used as a confidence measurement of the quality of the 3D data.

[0032] Figure 3c and figure 3d illustrates the "lost data" phenomenon. In figure 3c the object and the carrier have similar dark color. If the sensor does not detect any reflected light of the object, such as when the light is reflected away from the receiver, this is an indication of that an object is present on the carrier and a position estimate is determined using this missing data.

[0033] Figure 4a shows a perspective view of the object 12 on the carrier 13, where the carrier is moving in the γ-direction.

[0034] Figure 4b illustrates the process of determining the presence, position and/or shape of a cross-section of the object 12. At the top is shown the cross-section A-A of the object 12, thus what is illuminated by the light source 14. R is, when taken along the A-A cross-section, a geometric profile of the carrier 13 and the object 12 produced by the image-processing unit using range information detected by the sensor 11. I (intensity) indicates the measured intensity (2D) reflected from the cross-section A-A of the object 12. As seen in the figure the intensity modulation continues after the object, this is an indication of other artifacts present on the carrier for example dirt, paint or stickers. The last representation is the A-A cross-section 3D shape of the object determined by the calculating unit.

[0035] Figure 5a shows a perspective view of a bowl-shaped carrier 53 in which the object 12 is placed. The carrier moves in the y-direction.

[0036] Figure 5b illustrates the process of determining the presence, position and shape of a cross-section of an object 12 placed in a bowl-shaped carrier 53. At the top is shown the cross-section **B-B** of the object 12, thus what is illuminated by the light source. R is, when taken along the **B-B** cross-section, a geometric profile of the carrier 53 and the object 12 produced by the image-processing unit using range information detected by the sensor 11. I (intensity) indicates the measured intensity (2D) reflected from the cross-section **B-B** of the object 12. T shows the 3D cross-section reference image of the shape of the carrier learned by the apparatus. The last representation is the **B-B** cross-section 3D shape of the object determined by the calculating unit by subtracting T from R.

[0037] Figure 6a shows a perspective view of an object 62 having a very low profile (height) such as a credit card, a business card or the like. The object 62 is placed on a carrier 13 which moves in the γ-direction. A disturbing artifact 66 such as paint, dirt or a sticker on the carrier 13 can also be seen in the figure.

[0038] Fig 6b illustrates the process of determining the presence and position of a cross-section of the object 62 on the carrier 13. At the top is shown the cross-section C-C of the object 62, thus what is illuminated by the light source. R is, when taken along the C-C cross-section, a geometric profile of the carrier 13 and the object 62 produced by the image-processing unit. As can be seen from the figure, it is very difficult to read-out any information from this geometric profile of the object 62 and the carrier 13 when the object 62 has a low profile. I (intensity) indicates the measured intensity (2D) reflected from the cross-section C-C of the object 62. Since there is some sort of artifact 66 on the carrier 13, the intensity modulation does not correctly identify the presence and position of the object 62. S (scatter) indicates the measured scattering of the incident light in the surface layer of the object 62. That is to say, the light penetrating the material of the object 62 and after scattering is registered when it emerges from the material at a different location from that at which it entered. How this occurs depend on the internal characteristics of the material. When the object 62 and the artifact 66 consist of different types of materials, the incident light scatters differently and, thus, the presence and/or position of the object 62 is in this example identified by measuring the scattered light. To measure scattered light is previously known from e.g. EP 765 471, which is hereby incorporated by reference.

[0039] The setup in figures 1 through 6 comprises a single light source and a single sensor. It is however obvious for the person skilled in the art that more than one light source and sensor may be used. Multiple light sources illuminate the object in the same light plane and this reduces occlusion. Multiple sensors may give increased FoV and reduced occlusion.

[0040] Figures 7, 8 and 9 show alternative embodiments of the first embodiment. The alternative embodiments are described in more detail below.

[0041] the carrier for example dirt, paint or stickers. The last representation is the A-A cross-section 3D shape of the object determined by the calculating unit.

[0042] Figure 5a shows a perspective view of a bowl-shaped carrier 53 in which the object 12 is placed. The carrier moves in the γ-direction.

[0043] Figure 5b illustrates the process of determining the presence, position and shape of a cross-section of an object 12 placed in a bowl-shaped carrier 53. At the top is shown the cross-section B-B of the object 12, thus what is illuminated by the light source. R is the B-B cross-section 3D (range) image of the carrier 53 and the object 12 produced by the image-processing unit. I (intensity) indicates the measured intensity (2D) reflected from the cross-section B-B of the object 12. T shows the 3D cross-section reference image of the shape of the carrier learned by the apparatus. The last representation is the B-B cross-section 3D shape of the object determined by the calculating unit by subtracting T from R.

[0044] Figure 6a shows a perspective view of an object 62 having a very low profile (height) such as a credit card, a business card or the like. The object 62 is placed on a carrier 13 which moves in the γ-direction. A disturbing artifact 66 such as paint, dirt or a sticker on the carrier 13 can also be seen in the figure.

[0045] Fig 6b illustrates the process of determining the presence and position of a cross-section of the object 62 on the carrier 13. At the top is shown the cross-section C-C of the object 62, thus what is illuminated by the light source. R is the C-C cross-section 3D (range) image of the carrier 13 and the object 62 produced by the image-processing unit. As can be seen from the figure, it is very difficult to read-out any information from this 3D image of the object 62 and the carrier 13 when the object 62 has a low profile. I (intensity) indicates the measured intensity (2D) reflected from the cross-section C-C of the object 62. Since there is some sort of artifact 66 on the carrier 13, the intensity modulation does not correctly identify the presence and position of the object 62. S (scatter) indicates the measured scattering of the incident light in the surface layer of the object 62. That is to say, the light penetrating the material of the object 62 and after scattering is registered when it emerges from the material at a different location from that at which it entered. How this occurs depend on the internal characteristics of the material. When the object 62 and the artifact 66 consist of different types of materials, the incident light scatters differently and, thus, the presence and/or position of the object 62 is in this example identified by measuring the scattered light. To measure scattered light is previously known from e.g. EP 765 471, which is hereby incorporated by reference.

[0046] The setup in figures 1 through 6 comprises a single light source and a single sensor. It is however obvious for the person skilled in the art that more than one light source and sensor may be used. Multiple light sources illuminate the object in the same light plane and this reduces occlusion. Multiple sensors may give increased FoV and reduced occlusion.

[0047] Figures 7, 8 and 9 show alternative embodiments of the first embodiment. The alternative embodiments are described in more detail below.

[0048] Figure 7 shows an alternative to the first embodiment of the apparatus according to the invention. The apparatus comprises two light sources 74a, 74b arranged to illuminate the object 12 and the carrier 33 with incident light in the same light plane from different locations and angles. One sensor 71 is arranged to detect the reflected light from the object 12 and the carrier 13 in a plurality of cross-sections of the object 12 and the carrier 13 illuminated by the light sources 74a, 74b when the carrier 13 moves in the γ-direction. The sensor 71 is further arranged to convert the detected light into electrical signals. At least one image/signal processing unit (not shown) is arranged to create an analogue or digital representation of the object and the carrier according to the electrical signals and thus obtain a plurality of sub-images, one for each measured cross-section, which are put together into a measured image of the object 12 and the carrier 13. At least one calculating unit (not shown) is arranged to determine the presence, position and shape of the object 12 from the measured image. The two light sources 74a, 74b are arranged on each side of the sensor 71 and on a predetermined distance from the sensor 71 and arranged to reduce occlusion.

[0049] Figure 8a shows another alternative to the first embodiment of the apparatus according to the invention. The apparatus comprises a first and a second light source 84a, 84b are arranged to illuminate the object 12 and the carrier 13 with incident light in the same light plane from different locations and angles. The apparatus further comprises first and a second sensor 81a, 81b arranged to detect the reflected light from the object 12 and the carrier 13 in a plurality of cross-sections of the object 12 and the carrier 13 illuminated by the light sources 84a, 84b when the carrier 13 moves in the y-direction. The sensors 81a, 81b are further arranged to convert the detected light into electrical signals. At least one image/signal processing unit (not shown) is arranged to create an analogue or digital representation of the object 12 and the carrier 13 according to the electrical signals and thus obtain a plurality of sub-images, one for each measured cross-section, which are put together into a measured image of the object 12 and the carrier 13. At least one calculating unit (not shown) is arranged to determine the presence, position and shape of the object 12 from the measured image. The two sensors 81a, 81b are arranged on a predetermined distance from the two light sources 84a, 84b respectively, above the carrier 13 and on each side of the object 12 in the x-direction. The first and the second sensors 81a, 81b are arranged to extract information of partial views of the object/carrier cross-section, to minimize occlusion and/or to extend the FoV of each sensor to a larger combined FoV. It is seen from figure 8a that the combined FoV is larger than the FoV in fig. 7 comprising one single sensor. The first and the second sensors 81a, 81b are connected to each other and the calculating unit (not shown) is arranged in one of the two sensors 81a, 81b. Alternatively, the calculating unit is arranged in a separate unit connected to the first 81a and the second 81b sensor.

[0050] Figure 8b shows the same embodiment as in figure 8a but seen from above.

[0051] Figure 9 shows still another alternative to the first embodiment of the apparatus according to the invention. The apparatus comprises one light source 94 arranged to illuminate the object 12 and the carrier 13 with incident light, and a first and a second sensor 91a, 91b arranged to detect the reflected light from the object 12 and the carrier 13 in a plurality of cross-sections of the object 12 and the carrier 13 illuminated by the light source 94 when the carrier 13 moves in the y-direction. The sensors 91a, 91b are further arranged to convert the detected light into electrical signals. At least one image/signal processing unit (not shown) is arranged to create an analogue or digital representation of the object 12 and the carrier 13 according to the electrical signals and thus obtain a plurality of sub-images, one for each measured cross-section, which are put together into a measured image of the object 12 and the carrier 13. At least one calculating unit (not shown) is arranged to determine the presence, position and shape of the object 12 from the measured image. The light source 94 is arranged above the object 12 in between the two sensors 91a, 91b. The first and the second sensors 91a, 91b are arranged on each side of the light source 94 in the movable direction of the carrier 13 and on a predetermined distance from the light source 94 and are arranged to extract information of partial views of the object/carrier cross-section, to minimize occlusion and missing data.

[0052] Figure 10 through 11 shows optional units that may be added to all the above described embodiments.

[0053] Figure 10 shows a second embodiment of the apparatus according to the invention. The apparatus comprises a light source 104 arranged to illuminate the object 102 and the carrier 103 with incident light. A sensor 101 is arranged to detect the reflected light from the object 102 and the carrier 103 in a plurality of cross-sections of the object 102 and the carrier 103 illuminated by the light source 104 when the carrier 103 moves in the γ-direction and, to convert the detected light into electrical signals. At least one image/signal processing unit (not shown) is arranged to create an analogue or digital representation of the object 102 and the carrier 103 according to the electrical signals and thus obtain a plurality of sub-images, one for each measured cross-section, which are put together into a measured image of the object 102 and the carrier 103. At least one calculating unit (not shown) is arranged to determine the presence, position and shape of the object 102 from the measured image. At least one additional detector 105a-c is arranged to detect if there is an object 102 present on the carrier 103 at a position outside the FoV of the sensor 101. In the embodiment shown in fig. 10, three detectors 105a-c are used. The detectors 105a-c may be point detectors, photo switches, photo sensors or any other detector suitable for the detection of the presence and/or position of objects. If large objects 102 are transported on the carrier 103 it sometimes is difficult for the sensor 101 to view the entire object 102, i.e. the object 102 is larger than the FoV of the sensor 101. This problem may be solved by using more than one sensor but sometimes it is more cost efficient to use one or more detectors 105a-c. The detectors 105a-c may be arranged anywhere above the carrier 103 so that a measurement optimized for the current application is performed.

[0054] Figure 11 shows a third embodiment of the apparatus according to the invention. The apparatus comprises at least one light source arranged to illuminate the object on the carrier. At least one sensor is arranged to detect the reflected light from the object and the carrier in a plurality of cross-sections of the object 102 and the carrier 103 illuminated by the light source 104 when the carrier 103 moves in the γ-direction and, to convert the detected light into electrical signals. At least one image/signal processing unit is arranged to create an analogue or digital representation of the object and the carrier according to the electrical signals and thus obtain a plurality of sub-images, one for each measured cross-section, which are put together into a measured image of the object and the carrier. At least one calculating unit is arranged to determine the presence and position of the object from the measured image. At least two detectors 115a, 115b are arranged to give a signal when the carrier passes through the beams of light of the detectors 115a, 115b. The detectors may be point detectors, photo switches, photo sensors or any other detector suitable for the measurement. The object of using the detectors is to synchronize the acquisition with the motion of the carrier and thereby avoid to measure parts on the carrier where no relevant information is expected. The at least two detectors are arranged on one side of the carrier and substantially orthogonal to the direction of movement. The carrier moves along the predetermined direction and passes the first and the second detector, the apparatus then gets a trigger signal. In the shown embodiment, two detectors are shown. The person skilled in the art realizes, however, that the use of more than two detectors may have certain advantages, e.g. to prevent a false trigger signal in the case when the space between the carriers are narrower than the parts (Δl in the figure) of the carriers where no relevant information is expected.

[0055] By knowing the distances L and Δl, shown in the figure, and the time Δt that elapse between each sample of the sensor the apparatus can calculate the distance Δx between each sample and thus is able to extract the required information, i.e. is able to measure the position of the objects on the carriers (when the speed of the carriers are constant).

[0056] Alternatively, instead of calculating the distance Δx using the distances L and Al, a motion detector is used to synchronize the acquisition with the motion of the carrier to be able to measure the position of the objects on the carriers. The motion detector feeds pulses when the carrier moves along in the direction of movement, which are received by the sensor and/or the calculating unit.

[0057] Thus, while there have been shown and described and pointed out fundamental novel features of the invention as applied to a preferred embodiment thereof, it will be understood that various omissions and substitutions and changes in the form and details of the devices illustrated, and in their operation, may be made by those skilled in the art without departing from the scope of the invention as defined by the appended claims. For example, it is expressly intended that all combinations of those elements and/or method steps which perform substantially the same function in substantially the same way to achieve the same results are within the scope of the invention. Moreover, it should be recognized that structures and/or elements and/or method steps shown and/or described in connection with any disclosed form or embodiment of the invention may be incorporated in any other disclosed or described or suggested form or embodiment as a general matter of design choice. It is the intention, therefore, to be limited only as indicated by the scope of the claims appended hereto.

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US6102291A [0008]
- US4498778A [0012]

- DE3528047 [0013]
- US6369401B [0014]
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- US4929843A [0016]
- US5461478A [0017]
- US4741621A [0018]
- EP765471A [0038] [0045]

Patentkrav

1. Fremgangsmåde til at måle tilstedeværelsen og/eller positionen af en genstand (12) placeret på en bærer (13), som bevæger sig i en forudbestemt bevægelsesretning (1) i et fordelingssystem, omfattende trinnene:

- belysning af nævnte genstand (12) og nævnte bærer (13) med indfaldslys med mindst en lyskilde (14);
- gentagende måling af tværsnit af nævnte genstand (12) og nævnte bærer (13) ved at detektere reflekteret lys fra nævnte genstand (12) og nævnte bærer (13) når nævnte bærer (13) bevæges i nævnte bevægelsesretning (1) under anvendelse af mindst en sensor (11), der er placeret med en forudbestemt afstand fra nævnte mindst ene lyskilde (14);
- konvertering af det detekterede lys til elektriske signaler;
- opnåelse af et tredimensionelt underbillede (R) for hvert målte tværsnit af nævnte genstand (12) og nævnte bærer (13) fra hver måling af nævnte genstand (12) og nævnte bærer (13) under anvendelse af nævnte elektriske signaler;
- opnåelse af et tredimensionelt billede af nævnte genstand (12) og nævnte bærer (13) fra en eller flere af nævnte opnåede underbilleder ved sammensætning af nævnte opnåede underbilleder; og
- bestemmelse af tilstedeværelsen og/eller positionen af nævnte genstand (12) på nævnte bærer (13) fra nævnte tredimensionelle billede, hvor bestemmelsen omfatter at sammenligne nævnte tredimensionelle billede med et referencebillede af formen af nævnte bærer (13).

2. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til bestemmelse af intensitetsfordelingen af det reflekterede lys fra nævnte genstand (12).

3. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til bestemmelse af den tredimensionelle form af nævnte genstand (12) fra nævnte tredimensionelle billede, hvilken bestemmelse omfatter at sammenligne nævnte tredimensionelle billede med referencebilledet af formen af nævnte bærer (13).

4. Fremgangsmåde ifølge krav 1, hvor nævnte referencebillede manuelt lagres i en beregningsenhed.

5. Fremgangsmåde ifølge krav 1, hvor nævnte referencebillede automatisk lagres i en beregningsenhed, hvilken enhed automatisk læres formen af nævnte bærer (13).

6. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til måling af lys spredt i nævnte genstand.

7. Fremgangsmåde ifølge krav 1, hvor bæreren (13) yderligere er bevægelig i en anden retning forskellig fra den forudbestemte bevægelsesretning (1), hvorved positionen af nævnte genstand (12) på bæreren (13) justeres, når den bestemte position af nævnte genstand (12) er uden for et forudbestemt positionsområde på nævnte bærer.

8. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til reducering af okklusion ved at anvende mindst to lyskilder (74a, 74b; 84a, 84b), der belyser nævnte genstand (12) og nævnte bærer (13) i det samme lysplan.

9. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til reducering af okklusion ved at anvende mindst to sensorer (81a, 81b; 91a, 91b), der ser nævnte genstand (12) og nævnte bærer (13) fra forskellige positioner.

10. Fremgangsmåde ifølge krav 1, hvor positionen af nævnte genstand (12) beregnes ved at anvende manglende data opnået, hvis intet reflekteret lys er detekteret af nævnte mindst ene sensor (11).

11. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til optimering af målingen af tilstedeværelsen og positionen af nævnte genstand (102) ved at anvende mindst en detektor (105a-c), som måler uden for et synsfelt af nævnte mindst ene sensor (101).

12. Fremgangsmåde ifølge krav 1, yderligere omfattende trinnet til synkronisering af målingen af nævnte genstand (12) med bærebevægelsen ved at anvende mindst en detektor (115a-c).

13. Fremgangsmåde ifølge krav 12, hvor synkroniseringen opnås ved at anvende en bevægelsesdetektor, som føder impulser, når nævnte bærer (13) bevæger sig i bevægelsesretningen.

14. Fremgangsmåde ifølge krav 12, hvor synkroniseringen opnås ved at anvende mindst to detektorer (115a-c), der tilvejebringer et udløsersignal, når bæreren (13) er i en målingsposition.

15. Fremgangsmåde ifølge krav 1, hvor formmålingen udføres ved at anvende triangulering.

16. Apparat til måling af tilstedeværelsen og/eller positionen af en genstand (12) placeret på en bærer (13), som bevæger sig i en forudbestemt bevægelsesretning (1) i et fordelingssystem, hvilket apparat omfatter:

- mindst en lyskilde (14) indrettet til at belyse nævnte genstand (12) og nævnte bærer (13) med indfaldslys;
- mindst en sensor (11) placeret på en forudbestemt afstand fra nævnte mindst ene lyskilde (14) og indrettet til gentagende at måle tværsnit af nævnte genstand (12) og nævnte bærer (13) ved at detektere reflekteret lys fra nævnte genstand (12) og nævnte bærer (13), når nævnte bærer (!3) bevæges i nævnte bevægelsesretning (1) og til at konvertere det detekterede lys til elektriske signaler;
- en billedbehandlingsenhed indrettet til at anvende de elektriske signaler og at opnå et tredimensionelt underbillede (R) af hvert af de målte tværsnit af nævnte genstand (12) og nævnte bærer (13) og til at opnå et tredimensionelt billede af nævnte genstand (12) og nævnte bærer (13) fra en eller flere af nævnte opnåede underbilleder ved sammensætning af nævnte opnåede underbilleder; og

- en beregningsenhed indrettet til at bestemme tilstedeværelsen og/eller positionen af nævnte genstand (12) på nævnte bærer (13) fra nævnte tredimensionelle billede, hvor beregningsenheden er yderligere indrettet til at sammenligne nævnte tredimensionelle billede med et referencebillede af formen af nævnte bærer (13).

17. Apparat ifølge krav 16, hvor beregningsenheden yderligere er indrettet til at bestemme intensitetsfordelingen af det reflekterede lys fra nævnte genstand (12).

18. Apparat ifølge krav 16, hvor beregningsenheden yderligere er indrettet til at bestemme den tredimensionelle form af nævnte genstand (12) fra nævnte tredimensionelle billede.

19. Apparat ifølge krav 16, hvor nævnte referencebillede manuelt lagres i nævnte beregningsenhed.

20. Apparat ifølge krav 16, hvor nævnte beregningsenhed er indrettet til automatisk at lære formen af nævnte bærer (13).

21. Apparat ifølge krav 16, hvor nævnte sensor yderligere er indrettet til at måle lys spredt i nævnte genstand (12).

22. Apparat ifølge krav 16, hvor lyskilden (14) er et laserlys.

23. Apparat ifølge krav 16, hvor lyskilden (14) er indrettet til at generere et af de følgende lys: lineært lys, punktlys eller lys bestående af flere i alt væsentligt punkt- eller lineære segmenter.

24. Apparat ifølge krav 16, omfattende to lyskilder (74a, 74b) og en sensor (71) hvor de to lyskilder (74a, 74b) er indrettet på hver side af nævnte sensor (71) og på en forudbestemt afstand fra nævnte sensor (71), hvor de to lyskilder (74a, 74b) er indrettet til at belyse nævnte genstand (12) og nævnte bærer (13) i det samme lysplan og til at reducere okklusion.

25. Apparat ifølge krav 16 omfattende en første og en anden sensor (81a, 81b) og en første og en anden lyskilde (84a, 84b), hvor nævnte første og nævnte anden sensor (81a, 81b) er forbundet til hinanden og hvor nævnte beregningsenhed er indrettet i en af de to sensorer (81a, 81b).

26. Apparat ifølge krav 16, omfattende en første og en anden sensor og en første og en anden lyskilde (84a, 84b), hvor nævnte første og nævnte anden sensor (81a, 81b) er forbundet til hinanden og hvor nævnte beregningsenhed er indrettet som en separat enhed forbundet til nævnte to sensorer (81a, 81b).

27. Apparat ifølge krav 16, hvor apparatet omfatter en første og en anden sensor (91a, 91b) og en lyskilde (94), hvor lyskilden (94) er anbragt over genstanden mellem de to sensorer (91a, 91b) og hvor nævnte første og nævnte anden sensor (91a, 91b) er anbragt på hver side af lyskilden (94) i nævnte bevægelsesretning af nævnte bærer (13) på en forudbestemt afstand fra nævnte lyskilde (94) og indrettet til at reducere okklusion.

28. Apparat ifølge krav 27, hvor nævnte første og nævnte anden sensor (91a, 91b) er forbundet til hinanden og hvor nævnte beregningsenhed er anbragt i en af de to sensorer (91a, 91b).

29. Apparat ifølge krav 27, hvor nævnte første og nævnte anden sensor (91a, 91b) er forbundet til hinanden og hvor nævnte beregningsenhed er indrettet som en separat enhed forbundet til nævnte to sensorer (91a, 91b).

30. Apparat ifølge krav 16, hvor nævnte lyskilde (14) og nævnte sensor (11) er anbragt i et hus.

31. Apparat ifølge krav 30, hvor nævnte beregningsenhed også er anbragt i nævnte hus.

32. Apparat ifølge krav 16, yderligere omfattende mindst en detektor (105a-c) indrettet til at måle uden for et synsfelt af nævnte mindst ene sensor (101) og indrettet til optimere målingen af tilstedeværelsen og positionen af nævnte genstand (102).

33. Apparat ifølge krav 32, hvor nævnte mindst en detektor (105a-c) er en af de følgende: en punktdetektor, en fotoskifter eller en fotosensor.

34. Apparat ifølge krav 16, yderligere omfattende mindst en detektor (115a, 115b) indrettet til at synkronisere målingen af nævnte genstand (12) med bærebevægelsen.

35. Apparat ifølge krav 34, hvor en bevægelsesdetektor er anvendt til at synkronisere målingen af positionen af nævnte genstand (12) med bærebevægelsen og indrettet til at føde impulser mod nævnte genstand (12) når nævnte bærer (13) bevæger sig i bevægelsesretningen.

36. Apparat ifølge krav 34, omfattende mindst to detektorer (115a, 115b) indrettet til at opnå nævnte synkronisering ved at tilvejebringe et udløsersignal når nævnte bærer (13) er i en målingsposition.

37. Apparat ifølge krav 36, hvor nævnte mindst to detektorer (115a, 115b) er en af de følgende: punktdetektorer, fotoskiftere eller fotosensorer.

38. System til fordeling og/eller sortering af genstande, hvilket system omfatter mindst en bærer (13), som bevæger sig i en forudbestemt bevægelsesretning (1) og apparatet ifølge krav 16.

39. System ifølge krav 38, hvor bæreren yderligere er indrettet til at bevæge i en anden retning forskellig fra den forudbestemte bevægelsesretning (1) og til at justere positionen af nævnte genstand (12) på bæreren (13) når den bestemte position af nævnte genstand (12) er uden for et forudbestemt positionsområde på nævnte bærer (13).

40. System ifølge krav 38, hvor bæreren (13) er en af de følgende: en flipbakke, en båndsorterer, en krydsbæltebakke eller et transportbånd.

41. System ifølge krav 38, hvor nævnte bærer (13) har en af de følgende former: skålform, fladform eller fladform med kanter.

DRAWINGS

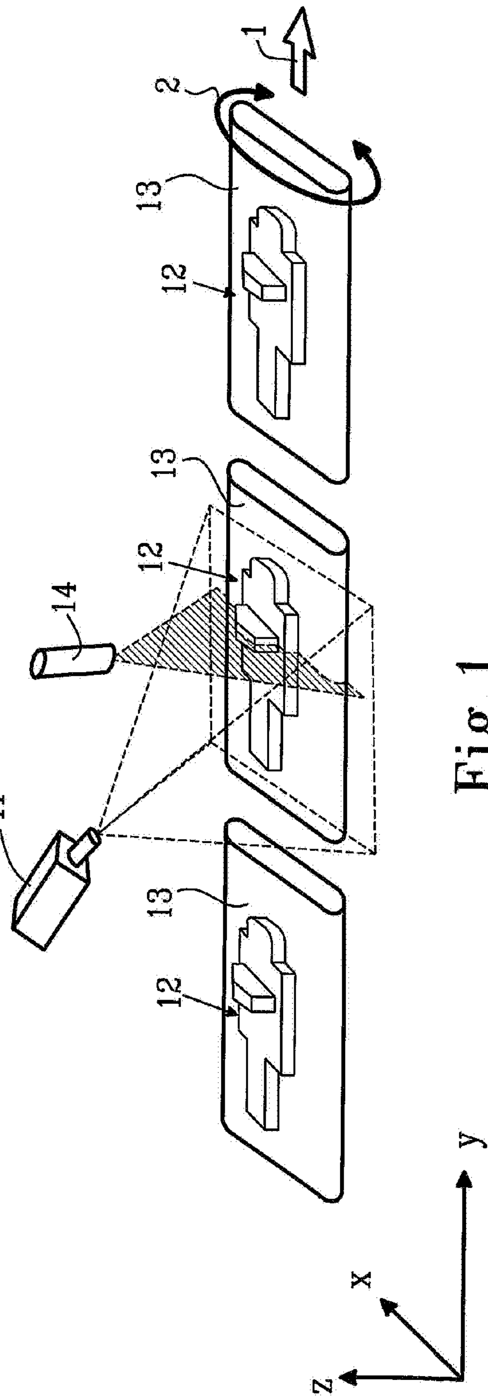

Fig.1

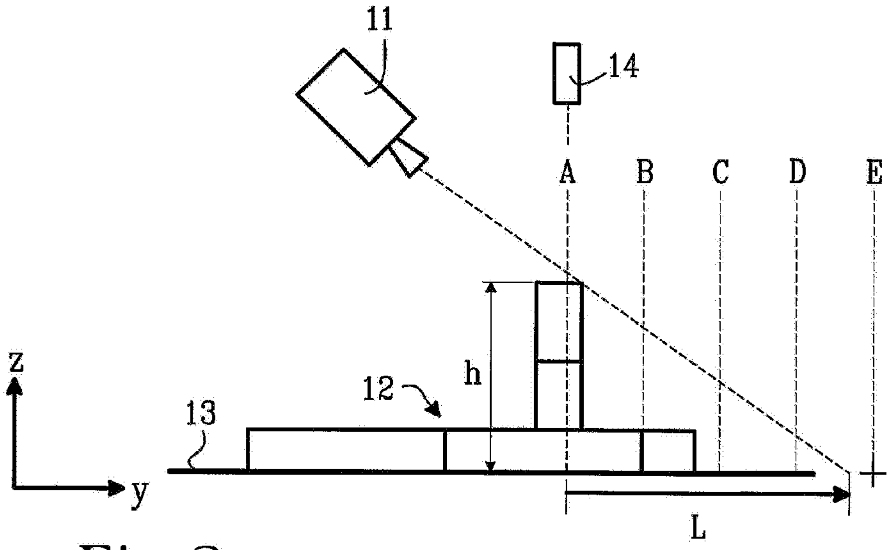

Fig.2

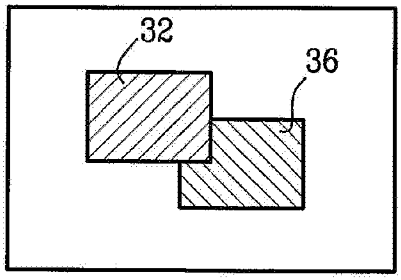

Fig.3a

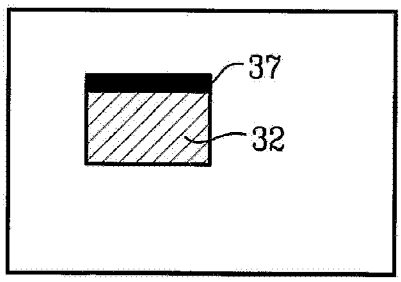

Fig.3b

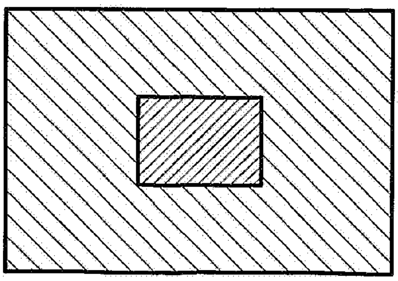

Fig.3c

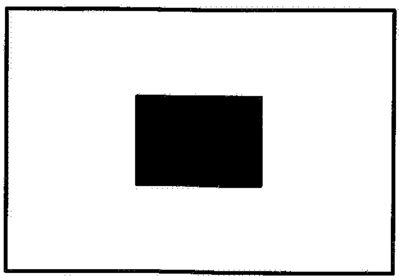

Fig.3d

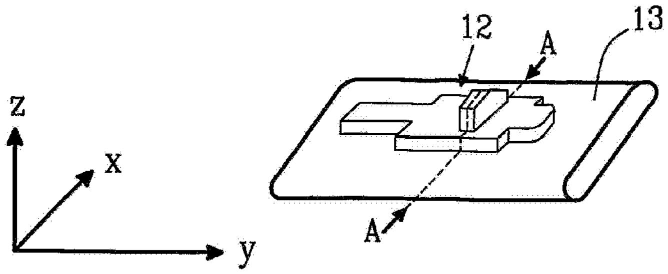

Fig.4a

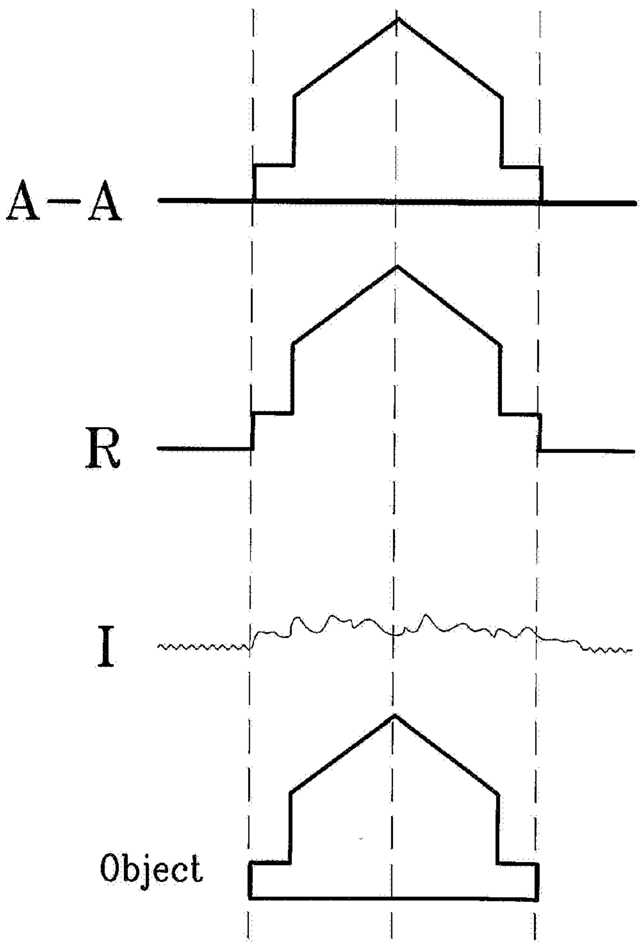

Fig.4b

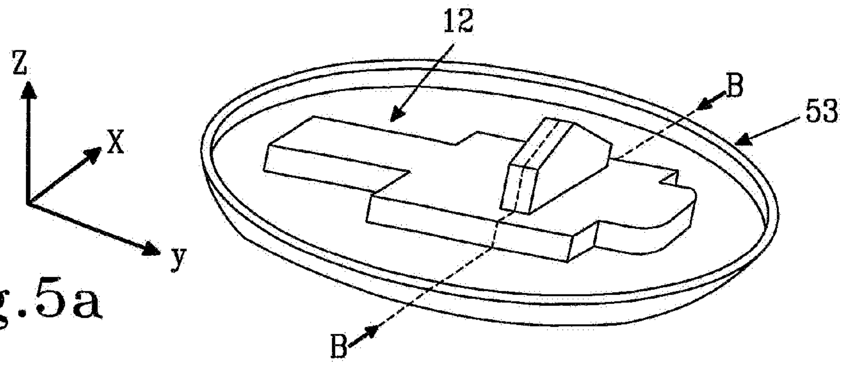

Fig.5a

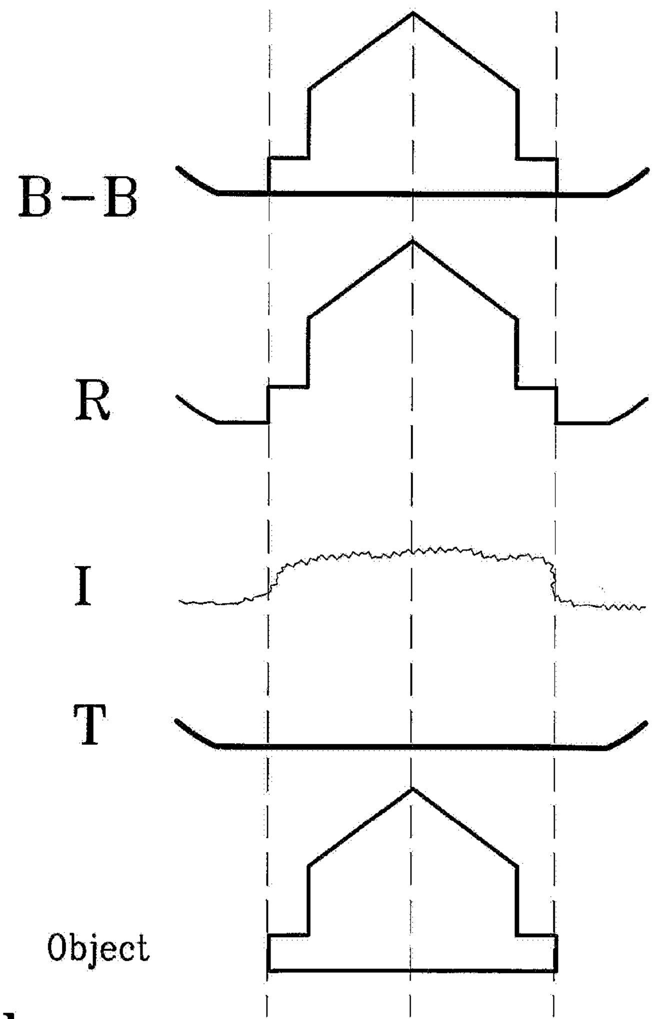

Fig.5b

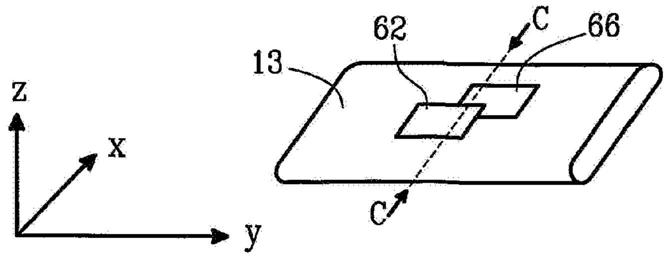

Fig.6a

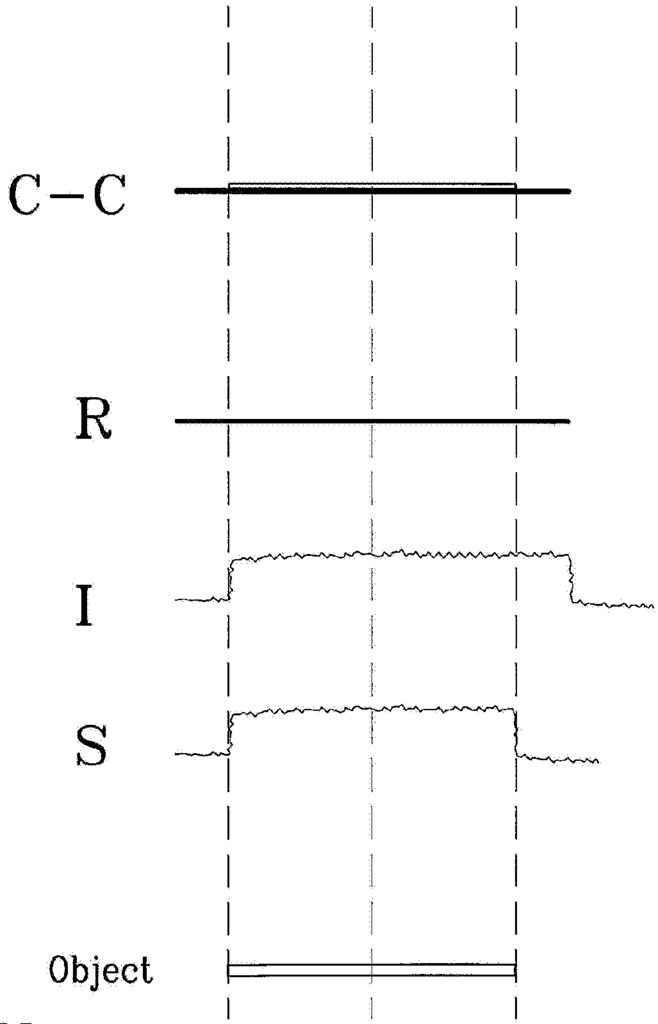

Fig.6b

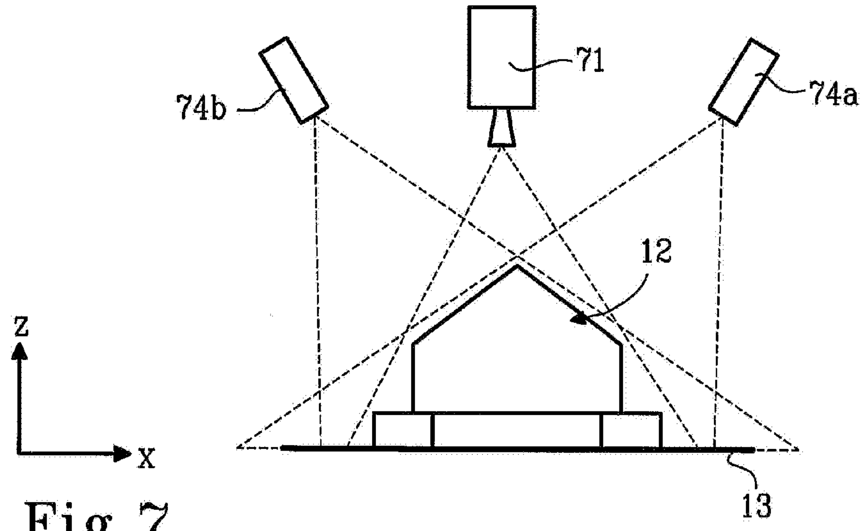

Fig.7

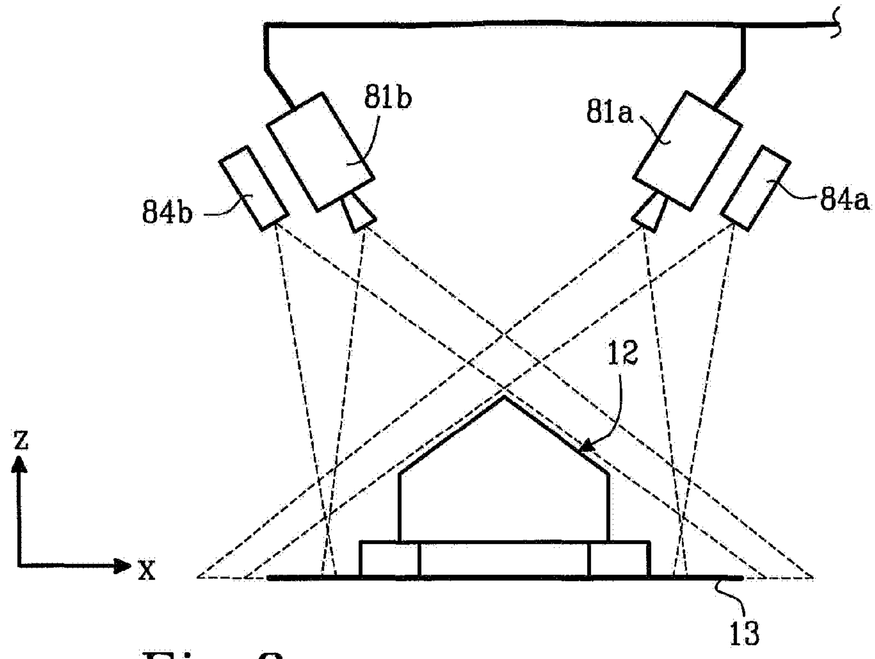

Fig.8a

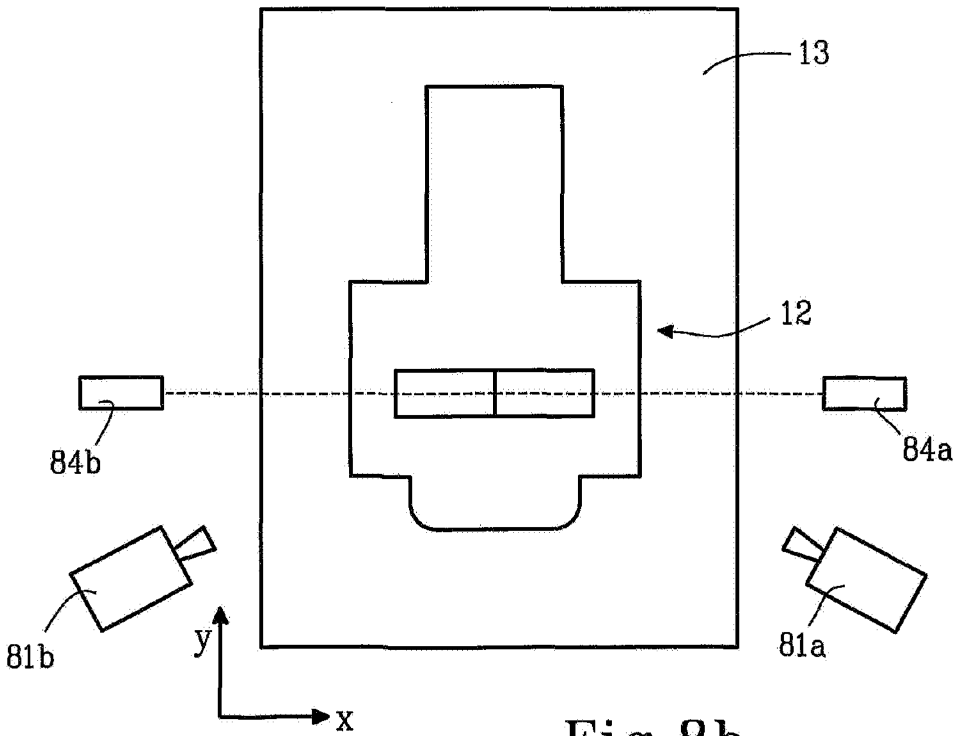

Fig.8b

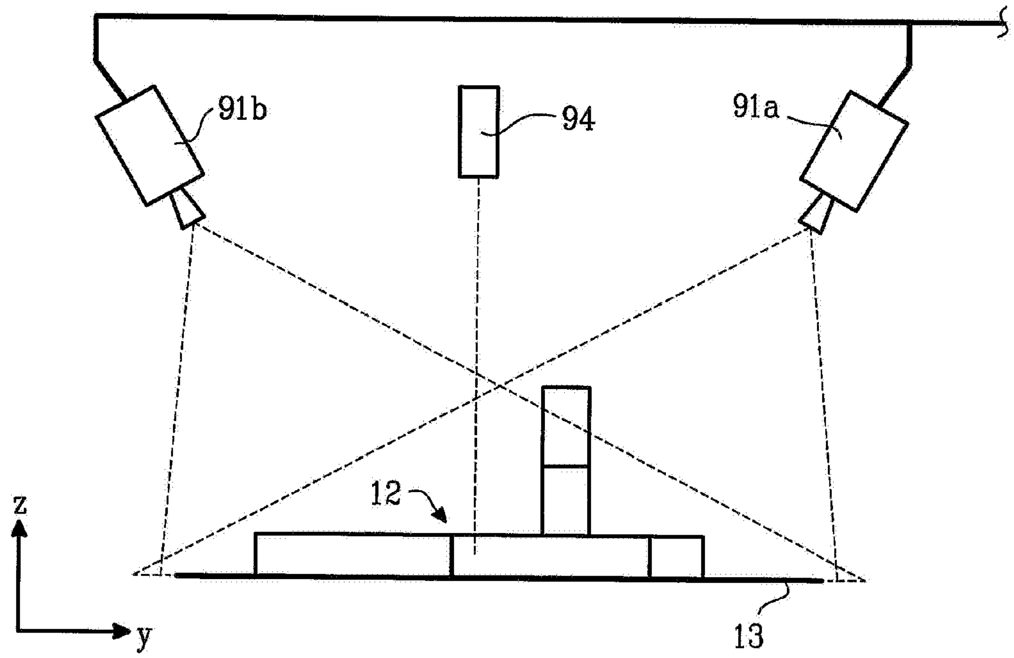

Fig.9

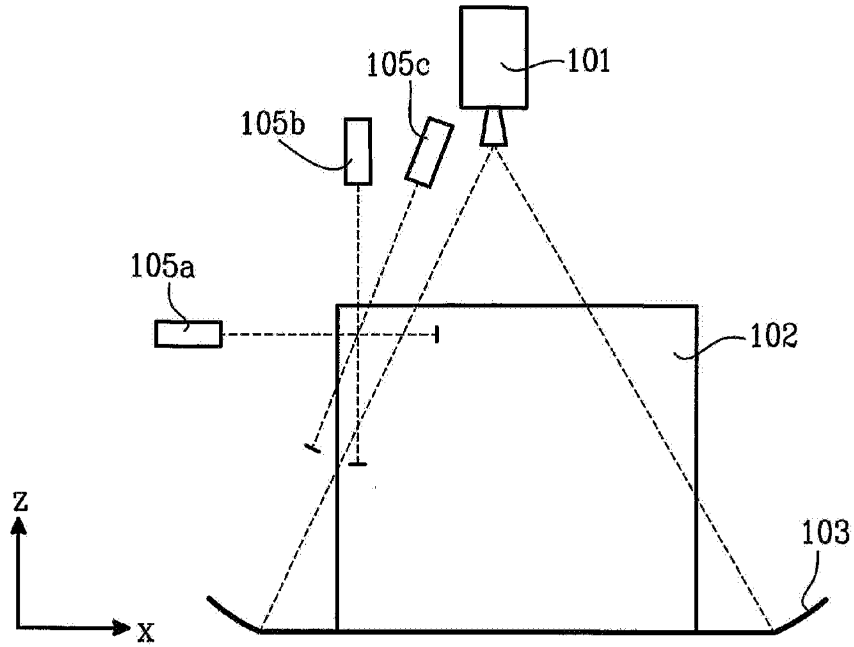

Fig.10

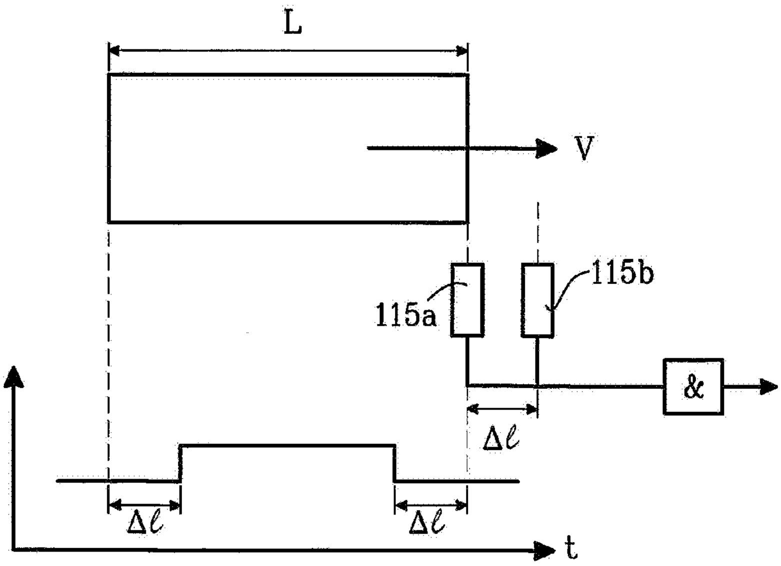

Fig.11