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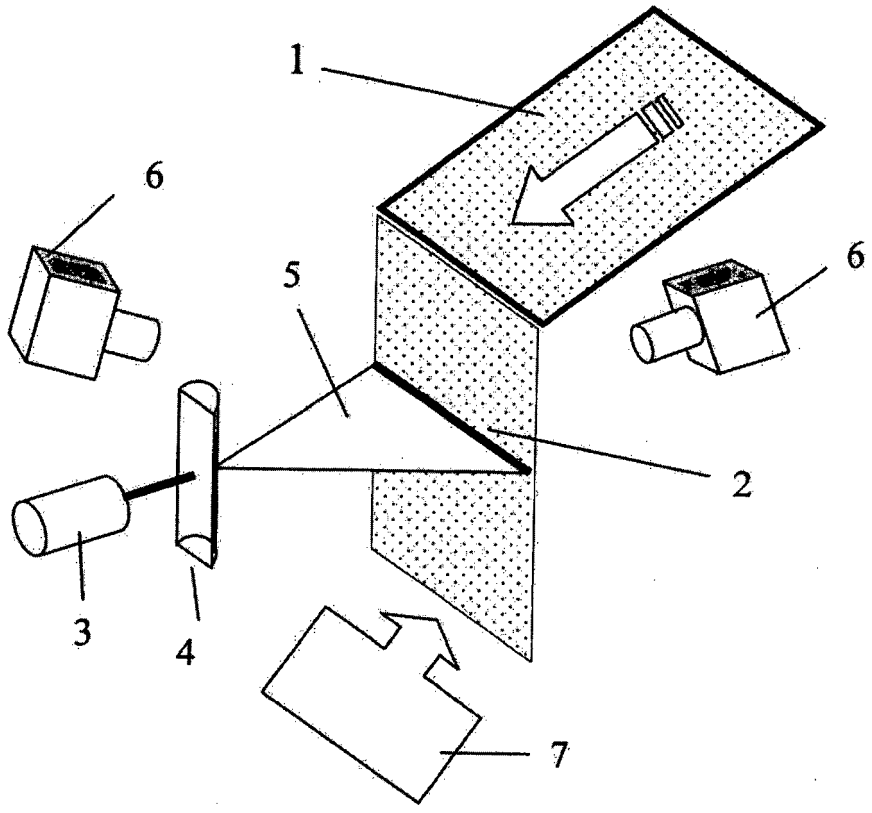
(54) **Laser sorter**

(57) Laser sorter consists of a material carrier (1), collimated laser illumination source (3), image read-and-process device, device for removing defected material (6). It additionally comprises cylindrical lens (4) arranged so that a formed flat ray (5) illuminates the area of the image reading the sorted material (2).

Figure 1



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Description

Field of the Invention

[0001] Laser sorter is a device for sorting objects by color, size, shape and other characteristics available for analysis by means of machine vision. It may be primarily used for sorting agricultural products.

Background of the Invention

[0002] The state of art includes material carrier, collimated laser illumination source, image read-and-process device and a device for removing defective material. According to the invention, it additionally comprises a cylindrical lens arranged on collimated ray path. The lens is designed so that a formed flat light beam illuminates the area of the image reading the sorted material.

[0003] The state of art also includes two or more readers to process laser light reflected and transmitted through the material and to in different spectral ranges. Use of laser radiation for illuminating the moving product allows to increase substantially the illumination of the image-forming region as well as to reduce the exposure time in order to increase the resolution of the formed image by augmenting the scanning frequency of the linear video sensor. In the known device scanning frequency of the linear video sensor and laser beam sweep frequency are synchronous and, therefore, are limited by the capacity of mechanical scanner. High illumination also provides relatively small exposure periods when registering radiation or emission of fluorescence that have passed through the material. Thus, different reading devices detect simultaneously reflected and transmitted signals at a high sorting performance. This reading apparatus can perform its functions in different spectral ranges which extends the functional possibilities of the claimed laser sorter in comparison with the known device.

[0004] The state of art also includes two or more collimated laser light sources, each of which is added by a cylindrical lens, and the orientation of the sources enables to form one or more flat light beams. In that case laser light control expands. Control over laser power and spatial arrangement of illumination area allows to adjust the total spatial distribution of the illumination of the working area. Use of lasers of different spectral ranges and formation of separate illumination areas in these ranges allow to analyze objects according to various predefined sorting criteria within one sorting cycle.

[0005] The state of art further includes laser light sources intensity modulators. In this case, images may be formed in different spectral ranges and recorded by a broadband linear video sensor in one sorting cycle. The low inertia of control over laser light allows to turn off of the material as it moves in one range and to turn on the backlight in another range, synchronizing the process with the movement of the material from one area to another.

[0006] U.S. Pat. No 6,509,537 B1 dated 21.01.2003, U.S. Pat. No 6,864,970 B1 dated 8.05.2005 disclose apparatus comprising a material carrier, image read-and-process device and a device for removing defective material. The material carrier provides continuous transport of the material into the image reading area and the zone of the defective material removing device. After reading the image is analyzed by an image processing device according to one or more of the following characteristics: color, texture and shape of the object . Those objects whose values significantly deviate from the preset ones are removed from the feed stream with device for defective material removal, which is usually an array of air ejectors. Illumination of the sorter image reading area constructed with the use of a beam-scanning mechanical system. A beam of laser light from the source is directed through a semitransparent mirror on a high-speed lens with mirror facets. Due to the rotation of the prism, laser beam sweeps over the entire image scanning area. The light, reflected by the material moving through the scanning area, is reflected by a rotating mirror and is directed to radiation detectors. The signal from the photo detectors goes to the image processing system, which determines the suitability of the product and gives signals to a device for the defective material removing. The common disadvantages of these schemes are as follows. First, to get high performance the laser beam is to scathes image reading region 2000-5000 times per second, which requires very high speed rotation of the mirror prism. Secondly, the photo-detectors cannot provide high-resolution required for scanning small (1-5 mm) materials. Thirdly, complexity of the optical system leads to the fact that the slightest irregularities in the arrangement of optical elements can cause failure of the entire system.

[0007] U.S. Pat. No 2010/0046826 A1 dated 25.02.2010 describes devices wherein the rotating mirror is intended only for a laser beam sweep and performs the function of redirecting the reflected light to the photo detectors. This can greatly simplify the optical system of the device. The function of photographic recording of the images is performed by the camcorder with linear video sensor which greatly improves the resolution of the device.

[0008] This means that it is necessary to provide a high speed rotation of the mirror prism and a high precision of the moving mechanical parts to ensure the stability of the optical circuit configuration that, together with the high cost of the scanner device, reduces the reliability and limits the scope of its application.

Summary of the Invention

[0009] The invention is represented and characterized in the main claims while the dependent claims describe other characteristics of the invention.

[0010] The aim of the present invention is to create a device for sorting of agricultural products by color, size,

shape and other characteristics available for analysis by means of machine vision.

[0011] Another aim of the invention is to increase the self-descriptiveness of the recorded image, to simplify the structure of the sorter, to increase its reliability and reduce manufacturing costs.

[0012] In compliance with the invention, laser sorter consists of a material carrier, collimated laser illumination source, image read-and-process device and a device for removing defective material.

[0013] Laser sorter additionally comprises a cylindrical lens arranged on collimated ray path. The lens is designed so that a formed flat light beam illuminates the area of the image reading the sorted material.

[0014] Laser sorter includes two or more readers to process laser light reflected and transmitted through the material and to read in different spectral ranges.

[0015] Laser sorter also includes two or more collimated laser light sources, each of which is added by a cylindrical lens, and the orientation of the sources enables to form one or more flat light beams.

[0016] The state of art further includes laser light sources intensity modulators.

[0017] As opposed to the known scanning sorter wherein the image alters with time because of 2 dynamic processes - movement of the material and movement of the laser ray formed by the movable mirror, the proposed invention laser illumination is fixed. Furthermore, for equal exposures of image registration and hence equal optical power of laser illuminators, momentary density of the power increases multiply in scanning sorters and affects the material causing its damage. In comparison with the known apparatus, the radiation of laser backlight of the claimed invention is distributed across the aperture of the moving stream. Absence of the moving optical elements, reliability, eases of manufacture and low cost are important advantages of the claimed invention.

Brief Description of the Drawing

[0018] These and other characteristics of the invention will become clearer from the following description of the specific claim, represented as non-limiting examples, with reference to the accompanying drawings where:

Fig.1 describes the scheme of the laser sorter.

Detailed Description of the Preferable Specific Claim

[0019] Material carrier 1 directs the product to the laser illumination area 2. The collimated laser light source 3, augmented by a cylindrical lens 4 located on the path of the collimated beam, forms a flat light beam 5, illuminating the area of the image reading. Image read-and-process device 6 analyses the image and, according to the preset criteria, generates control signals given to the device for defect material removal 7.

[0020] Laser sorter functionates as follows. The material sorter 1 feeds the product from the storage to the laser illumination area 2 in any way: by using a conveyor belt, with a vibratory feeder with sack chute or otherwise. Falling or moving the product flow is limited widthway by the aperture of the registered image and the line of sight limited by the depth of field of the lens of the image reader. The collimated laser light source 3 has a beam width greater than the width of the image recording device 6 comprising a linear video sensor. The cylindrical lens 4 converts the flat phase front of the laser beam in a cylindrical phase front. Its focal length is calculated on the basis of the required aperture of beam illumination area 5 and the distance from the moving product 2 to lens 4. Uneven illumination area corresponding to the Gaussian distribution, can be compensated at the stage of forming video signal by a CCD-receiver. Optional compensation occurs when using several lasers since the spatial distribution of light can be synthesized by the choice of the arrangement of lasers and optical power adjustment of each of them. The image read-and-process device 6 for a time not exceeding the time of passage from the image recording zone to the device for defective materials removal decides to remove substandard product. Device 6 delivers the address of the of the spatial position of the object to be deleted to device 7 and activates it within the estimated time.

[0021] Experimental studies of the claimed invention have been performed using Colour sorter F5.1 equipped with a system of laser illumination, made according to the claimed invention. A cylindrical lens with a focal length F = 1.3 mm has been made of optical glass TF-5. Single Mode Hitachi HL6545MG laser with a wavelength of 635 nm and a maximum optical beam power of 120 mW has been used. Studies have shown high efficiency of grid products separation using laser illumination at image registration in the reflected and transmitted light.

Claims

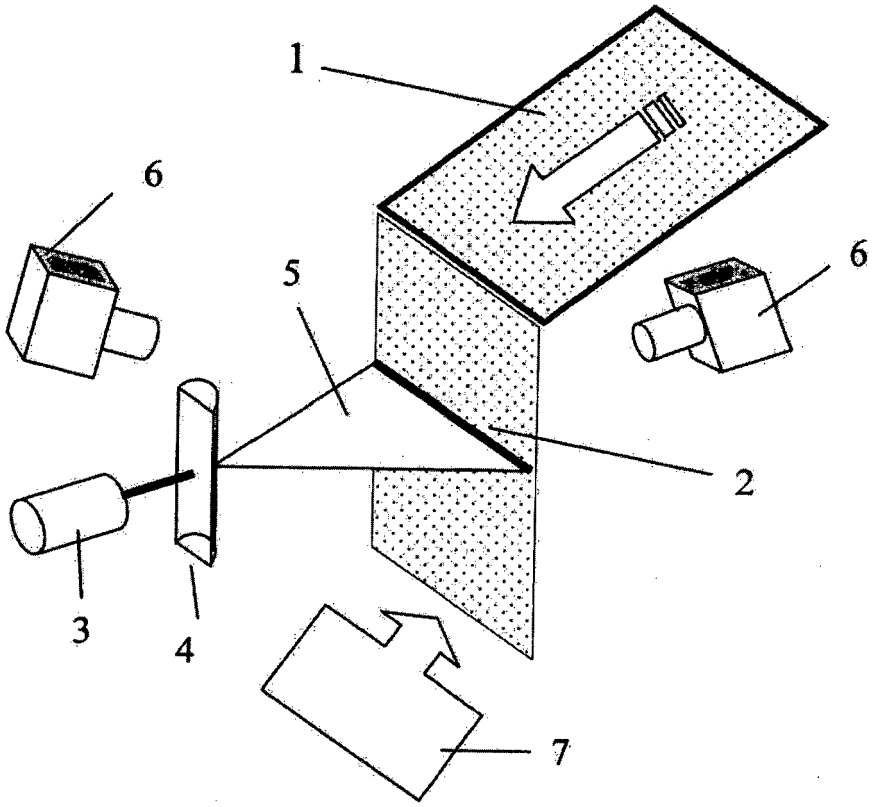
1. Laser sorter consists of a material carrier (1), collimated laser illumination source (3), image read-and-process device, device for removing defected material (6). It additionally comprises cylindrical lens (4) arranged so that a formed flat ray (5) illuminates the area of the image reading the sorted material (2).

2. Device as in Claim 1 **characterized in that** said that laser sorter includes two or more reading devices (6) to process laser light reflected and transmitted through the material and to read in different spectral ranges.

3. Device as in Claim 1 **characterized in that** said that laser sorter comprises two or more collimated laser light sources (3), each of which is added by a cylindrical lens(4), and the orientation of the sources(3) enables to form one or more flat light beams (5).

4. Device as in Claim 1 **characterized in that** said that laser sorter additionally comprises laser light sources intensity modulators.

Figure 1



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EUROPEAN SEARCH REPORT

Application Number
EP 13 00 5264

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 5 865 990 A (NOVAK THOMAS JOSEPH [US] ET AL) 2 February 1999 (1999-02-02) * column 6, line 21 - line 36 * -----	1-4	INV. B07C5/342
A	WO 2013/095088 A1 (UNIV DELFT TECH [NL]; RESTEEL B V [NL]) 27 June 2013 (2013-06-27) * figure 1 * -----	1-4	
A	WO 00/70331 A1 (KRIEG GUNTHER [DE]; FEY DIRK [DE]; BOHLEBER JUERGEN [DE]; DAUSCH MANFR) 23 November 2000 (2000-11-23) * figures * -----	1-4	
			TECHNICAL FIELDS SEARCHED (IPC) B07C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	21 March 2014	Wich, Roland

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 13 00 5264

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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21-03-2014

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EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6509537 B1 **[0006]**
- US 6864970 B1 **[0006]**
- US 20100046826 A1 **[0007]**