Description

Image-recording system and method for image recording

The invention relates to an image-recording system having a corresponding method for mastering quick positioning processes or assembly cycles by using image-recording units and image-evaluating units.

Generally known image-processing systems, contain, for example, image sensors which are based on television pictures and either on a system which scans by point and row, or a photoelectric semiconductor arrangement for image recording which is arranged like in an array. In all cases, an image of an object is generated or recorded, a specific image-recording time being required. A further period is to be considered for subsequent image evaluation. Specific systems rapidly encounter their limits depending on the requirement in relation to the accuracy on the image evaluation or the speed of object testing.

Cycle times are becoming ever shorter in highly automated assembly processes and handling sequences. They are meanwhile being shortened from 1 second to 0.1 second. Typical examples of this are quick positioning processes and assembly sequences in microelectronics and in the manufacture of printed circuit boards. Because of the generally high accuracy requirements, such processes must be performed adaptively. That is to say, the relative and also the absolute position of the workpieces, parts or components are to be detected in a short time in a contactless fashion. For this purpose, use is made today in general of image-processing systems which are based on television pictures and have on average a reaction time of approximately 100 msec, depending on the complexity of the application. This reaction time is composed of the time for the pure image recording of approximately 50 msec. A further 50 msec are required for evaluating 250,000 pixels, for example.

Because of this situation, the reaction time constituting the detection time of present-day image processing systems cannot be further substantially shortened for quick assembly and handling processes. This is also valid for the case in which the computer power is substantially enhanced.

It is the object of the invention to provide an image-recording system and a method for image recording by means of which it is possible to achieve a reduction in the detection time of technical objects, with the result that cycle times can be shortened.

This object is achieved by means of the features of Claim 1 and, respectively, Claim 7.

The invention is based on the finding that the shortening of reaction times of an image-processing system is initially instituted by the use of image sensors which can be read out optionally. Since, owing to the circuit principle of present-day image sensors (for example using CMOS technology), the access times are still substantially longer in the column direction than in the row direction, use is made according to the invention of two identical image sensors which can be read out optionally and are rotated with respect to one another by 90° with reference to the image-recording direction. These two image sensors have the same optical image applied to them via a beam-splitting mirror and are each connected at their outputs to an image-processing unit. This image-processing unit evaluates two-dimensional images, for example grey-scale images. For this purpose, brightness values are recorded at each pixel. The invention virtually completely avoids the relatively slow access times perpendicular to the row direction of the image sensor. The evaluation is substantially accelerated by the parallelism in the two plane directions. The reason for this is that the row directions of the two image sensors employed are rotated with respect to one another by 90° in a plane, with the result that during the relatively quick, optional readout, which is, however, undertaken in the row direction, the image

of the object

can be quickly detected in both plane directions or can be read out of the image sensors. Firstly, this measure shortens the image-recording time. This excludes bottlenecks, which are linked to a frequency of, for example, 100 kHz in the case of readout by column. A pixel readout frequency of, for example, 5 to 10 MHz is rendered possible by the measures according to the invention. The overall effect is to reduce the image recording and also the image-processing time.

Particular advantages are achieved in relation to power consumption during operation or in the off position by virtue of the use of image sensors employing MOS technology or CMOS technology.

A further advantageous embodiment of the invention provides an elongated rectangular configuration of the pixels, which preferably should be aligned parallel to the straight edges of the object. The aspect ratio of the rectangular shape of the pixels can be 1:3 or else 1:4, for example. This reduces the number of pixels. Furthermore, an edge filter is also provided. If elongated rectangular pixels are used, these are uniformly aligned distributed over the sensor and develop their effect by the use of image sensors, which are rotated with respect to one another by 90° in each plane direction.

An advantageous development of the invention provides an offset of the pixels on the sensor which is undertaken between the rows by half a pixel size or half the width thereof. By this means, as well, the straight and orthogonal edges of a technical object, which extends over a plurality of rows as a rule, can be advantageously detected quickly and with high resolution. This is performed on the basis of the fact that interpolation and thus doubling of the resolution can be achieved.

[lacuna] the use of image sensors which can be read out optionally and are set at 90° against one another, and a parallel evaluation in the x- and y-directions, together with pixels which are constructed in an elongated rectangular fashion and extend approximately parallel to the edges of an object which are to be detected and together, furthermore, with offsetting the pixel array in the row direction by half a division inside the image sensor, an overall shortening of reaction time of an image sensor to 1/10 of the currently known reaction times for image sensors known to date, for example a shortening from 100 ms to 10 ms, can be achieved.

An exemplary embodiment is described below with the aid of two diagrammatic figures, in which

Figure 1 shows a high-speed data-recording system with two separate image sensors which can be read out optionally and are rotated with respect to one another by 90°, and

Figure 2 shows the arrangement of pixels of an image sensor which can be read out optionally, which are offset against one another by half a division and have an elongated rectangular shape, the relationship to the visible surfaces of the pins of SMD components being indicated.

The converters uses the most recent development of image converters, for example using CMOS technology. Generally, only a few per cent of all the pixels of an image are required to detect the position of technical objects such as, for example, reference marks, components... Owing to the lower number of pixels, an image sensor which can be read out optionally (by random access) permits a substantial reduction both in the information-recording time (image-recording time) and in the processing time (image-processing time). However, this presupposes an access time which is in the region of the television pixel frequency, for example at 5-10 MHz. By virtue of the

circuit principle in present-day CMOS image sensors, the access times are achieved only in the row direction but not perpendicular thereto in the column direction. These access times are very much shorter in the column direction, for example 100 kHz. As a result, for detection of the position in both plane directions (in the x- and y-directions) the advantage of a single image sensor which can be read out optionally would largely be nullified again by the relatively slow possibility of reading out in the column direction. It is precisely this bottleneck which is removed by the two image sensors according to Figure 1 which are designed according to the invention and rotated with respect to one another by 90°.

A reduction in the pixels to be processed, and a filter-function for orthogonal edges in simultaneous conjunction with an improvement in the signal-to-noise ratio are yielded by the elongated rectangular structure of pixels, for example with an aspect ratio of approximately 1:3. Without worsening the accuracy of detection, this arrangement alone yields a shortening of the image-recording time to a third. The effects on the reduction in the image-detecting time are similar. Fundamentally, an improvement in the image recording and image-processing time can be used to improve the reliability of detection, or to speed up the process. A further reduction in the number of pixels required, such as is rendered possible by the row-wise offsetting of the pixels in the sensor by half a pixel size can, for example, double the resolution.

A system for detecting and monitoring the position of an object, in this case of a surface-mounted electronic component (SMD) with a size of, for example, 50 x 50 mm, is represented in Figure 1. The object 6 is illuminated as uniformly as possible in the ususal way, and projected via a lens 5 onto the two image sensors arranged rotated by 90°. These image sensors 1, 2 comprise a multiplicity of rows 12, 13 which are subdivided, in turn, into pixels 8

(photoelements, photosensitive elements). The two image sensors 1, 2 thus record the same object 6 at the same time, but are rotated with respect to one another by 90° with reference to the image-recording direction, with the result that the row directions for the same image are also set against one another by 90°. The effect of this is that as regards the image-processing unit 3, which accesses the two images or results of one image sensor 1, 2, it is possible not only to have an optional readout, since the two image sensors can be read out optionally, but that, in addition, corresponding points of an image 15, 16 can be read out row-wise at high speed either in one image or in the other image. With the presently available technology (CMOS image sensors), an image sensor 1, 2 which, given the stipulation of appropriate addresses, can in the extreme case individually read out each point optionally, is nevertheless still capable owing to internal circuit principles of being read out much more quickly in the row direction than in the column direction. Because of the mutual rotation of the image sensors 1, 2, there is no need to read out in the column direction.

In the case of technical objects which extend as a rule over a plurality of rows, and which have straight and orthogonal edges, specific image features can be preset for the image processing 3. A check is made in a two-dimensional image as to what is the alignment in the x- and y-directions and what rotation is exhibited by a component on a printed circuit board.

An arrangement of pixels 8 is represented in Figure 2, the individual pixels having, for example, a width 9 of 25 µm and a length 10 of approximately 75 µm. Furthermore, the approximate position of pins 14 or of their image on the image sensor 1, 2 is represented for the purpose of detecting the relationship between an SMD component and an image sensor. The two pins 14 or their parts visible from above have a pin contact spacing 11 of 0.3 mm. The offset between the pixels 8 from row to row is visible in Figure 2.

Also illustrated are elongated rectangular pixels. The component 17 is indicated at the lower edge of Figure 2.

An image sensor employed has, for example, a number of pixels of 2000 x 600. The reduction in the detection time which can be achieved using the invention in the case of technical objects with orthogonal edges and a slight angular rotation is drastically reduced. For so-called SMD automatic component insertion machines, this means, for example, a shortening in the position detection time of 100 ms to 10 ms in conjunction with an increase in accuracy. The insertion performance is thereby doubled per automatic machine with no change in cost.

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Patent claims

1. Image-recording system with a downstream image-processing unit (3), comprising two image sensors (1, 2), which can be read out optionally, for recording a two-dimensional image (15, 16), comprising pixels, of an object (6), the system having two image sensors (1, 2) which are rotated with respect to one another by 90° with reference to the image-recording direction, and the measuring beam being able to be fed to the two image sensors via a beam-splitting mirror (4).

2. Image-recording system according to Claim 1, in which the image sensors (1, 2) which can be read out optionally are constructed using MOS technology.

3. Image-recording system according to Claim 2, in which the image sensors (1, 2) which can be read out optionally are constructed using CMOS technology.

4. Image-recording system according to one of the preceding claims, in which pixels (8) of the image sensors (1, 2) have an elongated rectangular shape.

5. Image-recording system according to Claim 4, in which the pixels (8) have a rectangular shape with an aspect ratio of approximately 1/3.

6. Image-recording system according to one of the preceding claims, in which between the rows there is a mutual offset of the pixels (8) by a fraction of a pixel division in the pixel array of an image sensor.

7. Image-recording system according to Claim 6, in which the offset of the pixels (8) is half a pixel division.

8. Method for image recording having an image-recording system corresponding to one of Claims 1 to 7, in which

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- use is made of two image sensors which can be read out optionally and whose row directions are offset relative to one another by 90°, with the result that for each direction the access times are available in the row direction, and

- there is a reduction in the pixels to be processed owing to an elongated rectangular shape of the pixels (8) in simultaneous conjunction with alignment of the longitudinal extent of the pixels (8) parallel to straight edges of an object (6).

9. Method according to Claim 8, in which there is an additional reduction in the pixels to be processed owing to selection of subregions of the image which are required for the processing.



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