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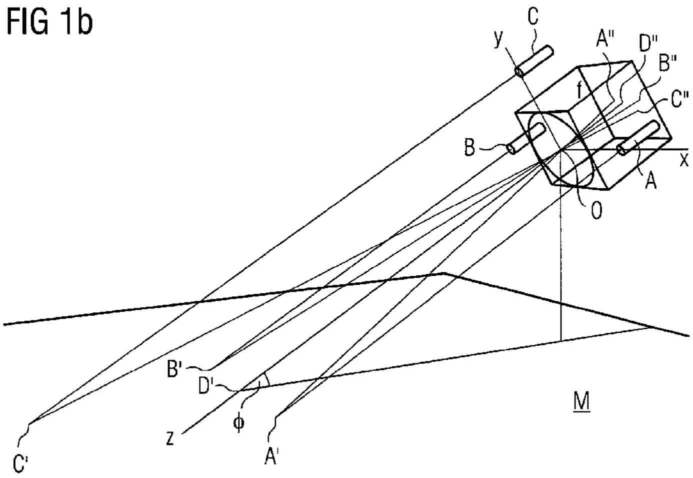
(54) Title: A METHOD, MEANS, AND SYSTEM FOR ACQUIRING LOCATION PARAMETERS

FIG 1b



(57) Abstract: The present invention relates to a method for acquiring location parameters, which method comprises: emitting by emitting means at least two light beams, with said light beams irradiating on a plane A to form light spots; acquiring by imaging means images of said light spots on an image plane B; detecting by processing means the location of said images in said image plane B; and calculating by calculating means the location parameters of an object to be measured according to said location. The present invention further provides a method for judging the rotation of an imaging device about a optical axis, emitting means, an imaging device and a system for acquiring location parameters. By way of various technical solutions provided by the present invention, automatic measurement (i.e. automatically measuring the location parameters of an imaging device or an object to be measured, including a height, an angle, and a rotated angle thereof) can be achieved. Accordingly, the technical solution provided by the embodiments of the present invention can reduce installation errors and at the same time can also save installation costs, which is advantageous for expanding intelligent traffic applications.

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Description

A method, means, and system for acquiring location parameters

Technical field

The present invention relates to the field of automatic measurement, and in particular to a technology for acquiring location parameters.

Background art

In the intelligent traffic system, imaging devices are widely used in various scenarios. For example, automatic number identification, speed monitoring and traffic capacity monitoring all require the use of imaging devices. However, the installation costs of infrastructures become a serious issue in traffic solutions based on images, and this issue is especially prominent in scenarios that are very sensitive to the installation parameters of the imaging devices.

Taking the automatic number identification in ITS for example, for automatically identifying car number plates, it is necessary to know the size of a car number plate in the image, but the size of the car number plate in the image is intimately related to the installation parameters of the imaging devices, i.e. very sensitive to the installation parameters. Accordingly, precise measurements are required during the installation of imaging devices, and the costs are rather high.

In ITS, there are many applications which require to perform particular application calculations according to the installation parameters, therefore acquiring the installation parameters is very important for ITS. Currently, it is necessary to manually acquire the installation parameters before the system starts to operate and manually configure the installation parameters into the system, which results in rather high costs and relatively low precision. Moreover, when the configuration scenario changes, the installation parameters will also change, which causes the necessity to reacquire the installation parameters, thus making it difficult to control the costs.

Contents of the invention

Having the above defects in the prior art in mind, the object of the present invention is to provide a method, means and system for acquiring location parameters so as to automatically acquire installation parameters.

A further object of the present invention is to provide a method for judging the rotation of an imaging device about a optical axis, emitting means, an imaging device and a system for acquiring location parameters.

The embodiments of the present invention provide the following technical solutions so as to solve the above technical problems.

A method for acquiring location parameters is provided by the embodiments of the present invention, said method comprising:

emitting by emitting means at least two light beams, with said light beams irradiating on a plane A to form light spots;

acquiring by imaging means images of said light spots on an image plane B;

detecting by processing means the location of said images in said image plane B; and

calculating by calculating means the location parameters of an object to be measured according to said location.

The embodiments of the present invention further provide a method for judging the rotation of an imaging device about a optical axis, which method comprises:

emitting by emitting means at least two light beams, with said light beams irradiating on a plane A to form light spots, wherein said light beams meet the following conditions: 1) there are at least two light beams in said light beams, with the emitting points thereof being located at locations other than the origin of a first coordinate system and the y components of the coordinates of the emitting points of said at least two light beams being the same; or 2) there are at least three light beams in said light beams, with the emitting points thereof being located at locations other than the origin of said first coordinate system and the emitting points of said at least three light beams being not on the same straight line.

acquiring by an imaging device images of the light spots of said at least two light beams on an image plane B;

detecting by processing means the location of said images in said image plane B; and

if said light beams meet the condition 1), then judging by the calculating means whether or not the distances from the emitting points of said at least two light beams to their light spots are equal according to the location of said images in said image plane B; if they are equal, then it is determined that there is no rotation of said imaging device about its optical axis; and if they are not equal, then it is determined that said imaging device is rotated along its optical axis;

if said light beams meet the condition 2), then the calculating means determining said plane A by a plane formula according to the location of said images in said image plane and the location of the emitting points of said light beams, and calculating the rotation angle of said imaging device about its optical axis according to the formula for included angle between a line and a plane so as to judge whether or not said imaging device is rotated about its optical axis;

wherein, the origin of said first coordination system is located at the light center of said imaging device, the z axis of said first coordinate system is located on the optical axis of said imaging device, the x axis of said first coordinate system is perpendicular to said z axis and located in the horizontal plane of said imaging device, and the y axis of said first coordinate system is perpendicular to the horizontal plane of said imaging device.

The embodiments of the present invention further provide emitting means for installation on an imaging device, with said emitting means comprising at least two light beam emitting members, and if a first coordinate system is taken as reference, then said at least two light beam emitting members meet the following conditions:

there are at least two light beam emitting members, with the emitting points thereof being located at locations other than the origin of said first coordinate system and the y components of the coordinates of said emitting points being different; or

there are at least three light beam emitting members, with the emitting points thereof being located at locations other than the origin of said first coordinate system and said emitting points being not on the same straight line;

wherein, the z axis of said first coordinate system is located on the optical axis of said imaging device, the origin is located at the light center of said imaging device, the x axis is located in the horizontal plane of said imaging device and perpendicular to said z axis, and the y axis is perpendicular to the horizontal plane of said imaging device.

The embodiments of the present invention further provide an imaging device, which imaging device comprises:

a lens and an image plane for acquiring images of light spots formed by light beams on a plane A;

detecting means for detecting the location of the images of said light spots in said image plane; and

calculating means for calculating the location parameters of an object to be measured according to the location detected by said detecting means.

The embodiments of the present invention further provide a system for acquiring location parameters, which system comprises:

emitting means for emitting at least two light beams, with said light beams forming light spots on a plane A;

imaging means for acquiring images of said light spots on an image plane;

detecting means for detecting the location of the images acquired by said imaging means in the image plane; and calculating means for calculating the location parameters of an object to be measured according to the location detected by said detecting means.

By way of the technical solutions provided by the embodiments of the present invention, the location parameters of objects to be measured, especially those of the imaging devices, can be obtained by automatic measurements, thus avoiding the costs and errors involved in manual measurement, and improving the automation of the system.

Brief description of the accompanying drawings

The other features, characteristics and advantages of the embodiments of the present invention will become more apparent by way of the detailed description hereinbelow in conjunction with the accompanying drawings, wherein:

Fig. 1a is a schematic flow chart of the procedure of a method for acquiring location parameters provided by the embodiments of the present invention;

Fig. 1b is a schematic view of the installation of emitting means provided by the embodiments of the present invention;

Fig. 1c is a schematic view of the installation of another emitting means provided by the embodiments of the present invention;

Fig. 2 is a schematic flow chart of the procedure of a method for judging the rotation of an imaging device about a optical axis, provided by the embodiments of the present invention;

Fig. 3 is a schematic structural view of emitting means provided by the embodiments of the present invention;

Fig. 4 is a schematic structural view of an imaging device provided by the embodiments of the present invention;

Fig. 5 is a schematic structural view of a data processing device provided by the embodiments of the present invention; and

Fig. 6 is a schematic structural view of a system for acquiring location parameters, provided by the embodiments of the present invention.

Exemplary embodiments

A method and means for acquiring location parameters provided by the embodiments of the present invention, for example, can be applied in various ITS applications so as to automatically acquire the installation parameters of an imaging device, and can further configure the installation parameters automatically. In this embodiment and the following embodiments, the installation parameters of the imaging device in the ITS belong to one type of location parameter.

Fig. 1a is a schematic flow chart of the procedure of a method for acquiring location parameters, provided by the embodiments of the present invention. For the convenience of description, in this embodiment, an imaging device is used as the object to be measured, i.e. it is required to measure the installation parameters of the imaging device. However, the method provided by this embodiment can further be applied in other measurement scenarios, for example, installing emitting means and imaging means together onto an object to be measured and measuring the location parameters of the object to be measured. The method provided by this embodiment comprises:

Step 101: the emitting means emits light beams.

In this embodiment, the emitting means, for example, is installed on the imaging device. In particular implementation, this emitting means can be fixed on a bracket, and this bracket can be flexibly installed on the imaging device, i.e. this bracket can be installed, removed or adjusted conveniently. In particular implementation, this emitting means can further be fixed on the imaging device directly.

Preferably, the emitting means is fixed on the bracket, and thus it can be installed and removed flexibly, so that it can be used during the adjustment or installation of the imaging device, and after the adjustment or installation of the imaging device is completed this emitting means can be removed to be used for the adjustment and installation of other imaging devices which in turn saves costs.

In this embodiment, the emitting means, for example, can be a laser emitter. Furthermore, this emitting means can emit light beams of specific color, i.e. light beams of specific wavelength, to meet various requirements. For example, this emitting means can emit red light beams, so that the light spots formed by the light beams irradiating on a surface have sufficiently remarkable difference from the surface, which is more advantageous for identifying the light spots. Alternatively, this emitting means can emit yellow light beams, so that the light beams have stronger penetration power so as to form light spots on a surface irradiated by the light beams even in areas with a poor environment.

Since laser is coherent light and is nearly of single wavelength, and it can still maintain its strength and waveform even after propagation of long distance, therefore, a laser emitter can be used to obtain clearer images and improve measurement accuracy, and it can also be used in situations where the distance between the imaging device and the irradiation plane is relatively long.

Under normal circumstances, the irradiation plane of the light beams is the road surface of a street and can also be the surface of other objects, such as the surface of a building.

In this embodiment, when one emitting means can only emit one light beam, there are at least two emitting means; and when one emitting means can emit at least two light beams, there can be one or more emitting means and at least two light beams are emitted altogether. For the convenience of description, in this embodiment and the following embodiments, the situation where one emitting means only emits one light beam is taken for example to illustrate.

Step 102: the imaging means acquires an image of a light spot in an image plane.

In this embodiment, the imaging means is an imaging device or it is considered to be integrated in an imaging device. The imaging means acquires the image of the light spot on the image plane by imaging.

Step 103: the processing means detects the location of the images of the light spots in the image plane.

Either during the imaging or after the imaging, the imaging device can detect the location of the light spot in the image. In particular implementation, if the processing capability of the imaging device itself is strong, then the imaging device can detect the location of the light spot by itself, i.e. integrating the processing means in the imaging device; and if the processing capability of the imaging device is poor, then the image of the imaging device can be processed by an external device to detect the location of the light spot, i.e. the processing means is provided outside the imaging device.

Step 104: the calculating means calculates the location parameters of an object to be measured according to the detected location of the image.

In this embodiment, as the object to be measured is the imaging device itself, the location parameters are the installation parameters of this imaging device.

In particular implementation, if the processing capability of the imaging device is poor, then the installation parameters can be obtained by completing particular calculations through an external device, i.e. the calculating means is provided outside the imaging device; and if the processing capability of the imaging device is strong, then the particular calculations can be done by the imaging device itself to obtain the installation parameters, i.e. the calculating means is integrated in this imaging device.

Since the number and installation locations of the emitting means are different, there is a difference between the particular methods for calculating installation parameters, and there is also restriction on the location of corresponding imaging devices.

For the convenience of description, in this embodiment and the following embodiments, it is assumed that the emitting means can represent the emitting point of a light beam and that the emitting point is located in the lens plane of the imaging device, i.e. the plane passing through the light center and perpendicular to the optical axis. In this embodiment, it is not required for the emitting point of the emitting means to be accurately located in the lens plane, and its projection location in the lens plane can be used as the location of the emitting point in the following description.

In this embodiment, the installation parameters, for example, include height and angle. The height, for example, is the distance from the light center of the lens to the irradiation plane, and the angle, for example, is the included angle between the object to be measured and the irradiation plane, i.e. the included angle between the optical axis of the imaging device and the irradiation plane in this embodiment. In this embodiment, in a certain scenario, the angle can further include the rotation angle of the imaging device along the optical axis.

During the calculation of the installation parameters, the above height and angle can be calculated from the coordinates of the light spots or the distance between the light spots and by using the nature of similar triangles or other calculation formulas of triangles as well as the formula for distance from a point to a plane and/or the formula for included angle between a line and a plane.

In this embodiment, when the light beams are parallel to the optical axis of the imaging device, the calculation is relatively simple. Accordingly, in the following embodiments, the light beams being parallel to the imaging device is taken for example, and those skilled in the art can obtain a calculation method for the case that the light beams are not parallel to the optical axis of the imaging device according to the following examples.

Taking Fig. 1b for example, the manner of calculation of installation parameters will be described in detail in the following. In the example shown in Fig. 1, three emitting means are installed around the imaging device by a bracket. With the light center of the imaging device as the origin, which is represented by O in Fig. 1b, z axis is along the optical axis direction, x axis is perpendicular to z axis and located on the horizontal plane of the imaging device, and y axis is perpendicular to the horizontal plane of the imaging device. The setting of the above coordinate system is only an example, and those skilled in the art can learn other coordinate system settings and the corresponding calculation methods.

The coordinates of the emitting point of the first emitting means A are (D, 0, 0), the coordinates of the emitting point of the second emitting means B are (-D, 0, 0), and coordinates of the emitting point of the third emitting means C are (0, D, 0) The light spots formed by the three emitting means on the irradiation plane are, respectively: the light spot produced by the first emitting means A is A' with the coordinates of A′ being (x1, y1, z1), the light spot produced by the second emitting means B is B' with the coordinates of B' being (x2, y2, z2), and the light spot produced by the third emitting means C is C' with the coordinates of C' being (x3, y3, z3).

On the image plane of the imaging device, the image of point A' is A'', with the coordinates of A'' being (x1', y1', z'), the image of point B' is B'', with coordinates of B'' being (x2', y2', z'), and the image of point C' is C'', with the coordinates of C'' being (x3', y3', z').

For the convenience of description, the intersection point of the optical axis and the irradiation plane is represented by D', and the intersection point of the optical axis and the image plane is represented by D''. The light beams emitted by the three emitting means are all parallel to z axis. Now it is known that x1=D and y1=0. Since the triangle formed by A'D'O and the triangle formed by A''D''O are similar triangles, the corresponding sides are proportional, i.e. D'O/D''O=A'D'/A''D'', thus obtaining z1=fD/x1'. In this case, f is the focal length of the imaging device.

According to the same principles, x2=-D, y2=0, z=-fD/x2'; and x3=0, y3=D, z3=fD/y3' can also be obtained.

According to the expression of a plane, the irradiation plane can be represented as ax+by+cz+d=0; since the above 3 points are all located in this irradiation plane, the coordinates of the above 3 points can be substituted to obtain the following results: a=-f/2(1/x1'+1/x2'), b=(f/2)*(1/x1'-1/x2')-f/y3', c=1, and d=-(fD/2)*(1/x1'-1/x2'). Therefore, the irradiation plane can be determined. Since a, b, c, and d can simultaneously change proportionally, the above values of a, b, c, and d are not a unique set, for example, they also can be: a=(1/D)*(x1'+x2')/(x2'-x1'), b=[1/(D*y3')]*[2*x1'*x2'/(x2'-x1')-y3'], c=(2/fD)*x1'*x2'/(x1'-x2'), and d=1.

The location of the light spot on the image plane has been detected in step 103, so x1', x2', and y3' are all known quantities.

The distance from the light center to the irradiation plane can be obtained by calculation according to the formula for distance from a point to a plane, $H=|d|/\sqrt{a^2+b^2+c^2}$.

The included angle between the optical axis and the irradiation plane can be obtained by calculation according to the formula for included angle between a straight line and a plane, $\varphi=\arcsin\frac{1}{\sqrt{a^2+b^2+c^2}}$.

Likewise, the included angle between the x axis and the irradiation plane can also be obtained by calculation according to the formula for included angle between a straight line and a plane, $\gamma=\arcsin\frac{|a|}{\sqrt{a^2+b^2+c^2}}$. Expressed with the angle at which x axis deviates from the horizontal plane of the imaging device, it becomes $\kappa=\arctan\left|\frac{a}{b}\right|$.

The above given calculation method is only an example, and the above height and angle can also be obtained by calculation according to the location of the light spots on the image plane by other calculation methods.

In this embodiment, when it cannot be ensured that the x axis of the above coordinate system is parallel to the irradiation plane (i.e. the imaging device has not rotated along the optical axis) or the angle between the x axis of the above coordinate system and the irradiation plane cannot be ignored, it is required to provide at least 3 emitting means, and of these emitting means, at least 3 emitting means cannot be located on the same straight line simultaneously, i.e. these 3 emitting means can form any geometrical shape other than a straight line. Also, these emitting means cannot be provided at the origin.

In this embodiment, when it can be ensured that the x axis of the above coordinate system is parallel to the irradiation plane or the angle between the x axis of the above coordinate system and the irradiation plane can be ignored, it is required to provide at least 2 emitting means for the calculation of the above height and angle and there are at least 2 emitting means in these emitting means the y components of which are different. The above at least 2 emitting means cannot be provided at the origin either.

The method provided by the embodiments of the present invention will be described in the following by the example where 2 emitting means are provided. As shown in Fig. 1c, emitting means P and Q are installed above and lateral to the imaging device respectively. Still taking the coordinate system settings in Fig. 1b for example, the coordinates of emitting means P are (D, 0, 0), the coordinates of emitting means Q are (0, D, 0), and the corresponding light spots formed on irradiation plane M are P' (x4, y4, z4) and Q' (x5, y5, z5) respectively. The images of light spots P' and Q' on the imaging plane are P'' (x4', y4', z4') and Q'' (x5', y5', z5') respectively.

In this case, referring to the calculation method in the example shown in Fig. 1b, x4=D, y4=0, and z4=f*D/x4'; x5=0, y5=D, and z5=fD/y5'. Since the x axis is parallel to irradiation plane M, S (0, 0, f*D/x4') is also necessarily located on irradiation plane M.

The irradiation plane is still represented as ax+by+cz+d=0, then the following can be obtained: a=0, b=f*(1/x4'-1/y5'), c=1 and d=-f*D/x4'.

Correspondingly, the height is still calculated by the formula for distance from a point to a plane, and the included angle between the optical axis and the irradiation plane M is still calculated by the formula for included angle between a line and a plane.

Furthermore, in this embodiment, it can further include step 105 which performs subsequent processing according to the obtained installation parameters.

After the ITS learns the installation parameters, it can perform further subsequent processing, and there is variation in the subsequent process steps depending on different particular applications.

For example, in the car number plate identification application, the ITS knows the size of the actual car number plate and can obtain the size of the car number plate in the image by calculation according to the installation parameters, so that the car number plate in the image can be specifically identified according to the size of the car number plate in the image.

For example, in occasions of specific application where the posture of the imaging device needs to be changed, judgment on how to adjust the imaging device can be made according to the existing installation parameters.

For example, the method provided by this embodiment can be further used for judging whether or not there is a rotation of the imaging device along the optical axis, i.e. whether or not the x axis is parallel to the irradiation plane according to the settings of the above coordinate system.

The method provided by this embodiment is not limited to acquiring the installation parameters of the imaging device but can also be used for other measurement scenarios, and it requires this measurement scenario to include a member capable of imaging and light source. In specific scenarios, if the imaging can be performed on a member by other approaches, then it can also exclude the light source.

When the method provided by this embodiment is applied in other measurement scenarios, the whole emitting means, imaging device, etc. can be viewed as a single measurement system to measure the location parameters of an object to be measured. In such a scenario, the distance from the object to be measured and the irradiation plane, the angle it makes with respect to the irradiation plane, and the rotation angle along the optical axis can be calculated according to the position relationship between the imaging device and the object to be measured. The position relationship between the object to be measured and the imaging device generally will not change any more after the initial locations are determined.

In an exemplary implementation, the irradiation plane in the above example may be a plane that is not totally flat, for example, a road surface may have irregular portions. During calculation, it is still calculated as a plane, and after verification, the corresponding errors are within the allowed range of engineering.

By way of the above method, the installation parameters of the imaging device can be obtained automatically, which avoids the costs of manual acquisition, and at the same it is more accurate than the results obtained by manual measurement. Moreover, corresponding to the subsequent operation and processing, the installation parameters automatically acquired can be directly transmitted to the processing means, which avoids the costs of manual configuration and the risk of errors and improves the automation of intelligent traffic.

As shown in Fig. 2, the embodiments of the present invention further provide a method for judging the rotation of an imaging device about a optical axis, which method comprises:

Step 201: the emitting means emits light beams.

In this embodiment, if one emitting means only emits one light beam, then the provision of at least 2 emitting means is needed. The light beams emitted by the emitting means shine on an irradiation plane A and form light spots.

In this case, there are at least 2 emitting means, with the emitting points thereof being all located at locations other than the origin and the y components of their coordinates being the same. Alternatively, there are at least 3 emitting means, with the emitting points thereof being all located at locations other than the origin and not on the same straight line, i.e. the emitting points of these at least 3 emitting means can form any geometrical shape other than a straight line, for example, form a triangle or quadrilateral, etc.

Preferably, the light beams emitted by the emitting means are all parallel to the optical axis of the imaging device.

Step 202: the imaging device acquires images of the light spots in an image plane.

This step can refer to the exemplary embodiment shown in Fig. 1a, which will not be described here redundantly.

Step 203: the processing means detects the location of the above images in the image plane.

This step can refer to the embodiment shown in Fig. 1a, which will not be described here redundantly.

Step 204: the calculating means can judge the distances from the emitting means of the above parallel light beams to the light spots according to the location detected in step 203, and if they are equal, then proceed to step 205, and if they are not equal, then proceed to step 206.

In this step, the location of the emitting means can be considered as the location of the emitting point of the light beam. If the coordinate system is set as in Fig. 1b, then the distance from the emitting means to the light spot is the distance on the z axis.

In this embodiment, when there are at least 3 emitting means and all the emitting points neither are located at the origin nor form a straight line, step 204 can obtain the rotation angle of the imaging device along the optical axis by calculation according to the calculation method in the embodiment shown in Fig. 1b, thus judging whether or not there is a rotation of the imaging device along the optical axis.

Step 205: it is determined that there is no rotation of the imaging device about the optical axis.

Step 206: it is determined that there is a rotation of the imaging device about the optical axis.

The method provided by this embodiment can be combined with the embodiments shown in Figs. 1a, 1b, and 1c, thus obtaining more examples.

With the method provided by this embodiment, whether or not there is rotation of the imaging device along the optical axis can be judged by the measurement of the irradiation light spot with the imaging device, so that the posture of the imaging device can be adjusted. Furthermore, the rotation angle of the imaging device along the optical axis can also be calculated, so that the posture of the imaging device can be learnt precisely, and highly efficient and targeted adjustment can be achieved.

The above examples can be cross-referenced, and the steps of the method disclosed in each embodiment can be implemented by software, hardware, or the combination of software and hardware.

As shown in Fig. 3, the embodiments of the present invention further provide emitting means, which emitting means is specially for installation on an imaging device and capable of being used for the acquisition of location parameters. This means comprises: at least two light beam emitting members 301. In this case, each light beam emitting member 301 emits at least one light beam.

Furthermore, this means can further comprise a bracket 302, and the above at least two light beam emitting members 301 are fixed on this bracket 302, and this bracket 302 can be installed on the imaging device. Each light beam emitting member 301 can be directly fixed on the imaging device or installed on the imaging device through the bracket 302.

Taking this means comprising the bracket 302 for example to illustrate in the following, the situation where the light beam emitting member 301 is directly fixed on the imaging device can be implemented by referring to this. Still, the coordinate system of the example shown in Fig. 1b is taken as a reference to describe this embodiment.

If this means is applied in the scenario where it cannot be ensured that the x axis is parallel to the irradiation plane or the included angle between the x axis and the irradiation plane cannot be ignored, then this means includes 3 or more light beam emitting members, and the emitting points of these 3 or more light beam emitting members neither can be located at the origin nor can be located on the same straight line.

If this means is applied in the scenario where it can be ensured that the x axis is parallel to the irradiation plane or the included angle between the x axis and the irradiation plane can be ignored, then this means can include 2 or more light beam emitting members, and the emitting points of these 2 or more light beam emitting members cannot be located at the origin and the y components of their coordinates are different.

If this means is used for judging whether or not the imaging device is rotated about its optical axis, then this means may only include 2 or more emitting means, and all the emitting points of these emitting means are not located at the origin and the y components of their coordinates are the same.

In this embodiment, the light beam emitting members can emit light beams of specific color, i.e. light beams of specific wavelength, so as to enable the color of the light spot and that of the irradiation plane can be distinguished by the imaging device.

In particular, the light beam emitting member, for example, is a laser emitter.

In this embodiment, preferably, the position relationship of the light beam emitting member and the imaging device can enable the light beams emitted by the light beam emitting member to be parallel to the optical axis of the imaging device.

With the emitting means provided by the present embodiment, the location parameters of an imaging device or other objects to be measured can be obtained in conjunction with the imaging device, thus it can perform the subsequent operation or adjustment, and configuration, which avoids the inaccuracy and high costs of the acquisition with manual measurement.

As shown in Fig. 4, the embodiments of the present invention provide an imaging device for acquiring location parameters. This imaging device comprises:

a lens 401 and an image plane 402; and

detecting means 403 for detecting the location of images of light spots on the image plane 402.

Furthermore, this imaging device can further comprise calculating means 404 for calculating the location parameters of this imaging device or an object to be measured according to the location information detected by the detecting means 403. Particular calculation methods can refer to the calculation methods in the examples shown in Figs. 1b, 1c, and Fig. 2. For example, the calculating means 404 can include: a plane determining module 4041 for determining an irradiation plane according to the location of the emitting points of light beams and the image of the light spots in the image plane by way of a plane formula; and one of the following modules or any combination thereof:

a distance module 4042 for calculating the distance from this imaging device to the irradiation plane according to the formula for distance from a point to a plane;

a first angle module 4043 for calculating the included angle between the optical axis of the imaging device and the irradiation plane according to the formula for included angle between a line and a plane; and

a second angle module 4044 for calculating the rotation angle of this imaging device along its optical axis according to the formula for included angle between a line and a plane.

In this embodiment, when the imaging device does not include the calculating means 404, the location information detected by the detecting means 403 can be sent to an external calculating device, thus finally measuring the location parameters of the imaging device or the object to be measured.

In this embodiment, the imaging device can further include emitting means provided by the embodiment as shown in Fig. 3.

The location parameters of the imaging device or the object to be measured can be obtained by calculation through the imaging device provided in this embodiment in conjunction with the emitting means provided by the embodiment shown in Fig. 3 via measuring the image of the light spot formed by the emitting means in the image device, thus avoiding the costs and errors of manual measurement.

As shown in Fig. 5, the embodiments of the present invention provide a data processing means for acquiring location parameters, which data processing means comprises: a receiving module 501 for receiving the information from an imaging device; and a calculating module 502 for calculating the location parameters of the imaging device or an object to be measured according to the received information. In this case, the information from the imaging device includes the location of the light spot on the image plane. The specific calculation method of the calculating module 502 can refer to the methods provided by the examples shown in Figs. 1b and 1c.

Furthermore, the data processing means can further comprise a detecting module 503 for detecting the locations of the light spots in this image according to the image received by the receiving module 501; and hereby the calculating module 502 is used for calculating the location parameters of the imaging device or the object to be measured according to the location information detected by the detecting module 503.

The location information of the imaging device or the object to be measured can be obtained by calculation through the data processing means provided by this embodiment in conjunction with the emitting means and imaging device provided by the embodiments shown in Figs. 3 and 4 via measuring the imaging location of the light spot formed by the light beam emitted by the emitting means in the image plane of the imaging device, thus achieving the automatic acquisition of location information, which avoids the errors and costs of manual measurement.

The embodiments provided by Figs. 3, 4 and 5 can be combined with and referred to each other and the particular implementation can refer to the exemplary embodiments shown in Figs. 1a, 1b, 1c and Fig. 2.

As shown in Fig. 6, a system for acquiring location parameters is provided by the embodiments of the present invention, this system comprising:

emitting means 601 for emitting at least 2 light beams. The light beams emitted by the emitting means 601 irradiate on an irradiation plane and form light spots.

imaging means 602 for acquiring the images of the light spots on an image plane.

detecting means 603 for detecting the location of the images in the image plane acquired by the imaging means 602.

calculating means 604 for calculating the location parameters of an object to be measured according to the detected location.

In this embodiment, the emitting means 601, for example, is a laser emitter and is capable of emitting light beams of specific color so as to enable the color of the light spots and that of the irradiation plane to be distinguished during the detection by the detecting means 603.

Referring to the embodiments shown in Figs. 1a, 1b, and 1c, in this embodiment, if it can be ensured that the x axis is parallel to the irradiation plane or that the included angle between the x axis and the irradiation plane can be ignored, the emitting means can emit 2 or more light beams, and of these light beams, there are at least two light beams the emitting points of which are not located at the origin and the y components of whose coordinates are different. If it cannot be ensured that the x axis is parallel to the irradiation plane or that the included angle between the x axis and the irradiation plane cannot be ignored, the emitting means, for example, needs to emit at least 3 light beams, and there are at least 3 light beams in these light beams the emitting points of which cannot be located at the origin and cannot be on the same straight line.

In this embodiment, for convenience of detection and calculation, the light beams emitted by the emitting means 604 are preferably parallel to the optical axis of the imaging means 602.

In this embodiment, the particular calculation method of the calculating means 604 can refer to the calculation method in the embodiments shown in Figs. 1a, 1b, and 1c. The calculating means 604 includes: a plane determining module 6041 for determining an irradiation plane according to the location of the emitting points of light beams and the image of the light spots in the image plane by way of a plane formula; and one of the following modules or any combination thereof:

a distance module 6042 for calculating the distance from an object to be measured to the irradiation plane according to the formula for distance from a point to a plane;

a first angle module 6043 for calculating the included angle between the optical axis of the imaging means 602 and the irradiation plane according to the formula for included angle between a line and a plane, and acquiring the included angle between the object to be measured and the irradiation plane according to the angle between the imaging means 602 and the object to be measured; and

a second angle module 6044 for calculating the rotation angle of the imaging means 602 along its optical axis according to the formula for included angle between a line and a plane, and acquiring the rotation angle of the object to be measured along the optical axis of the imaging means 602 according to the angle between the imaging means 602 and the object to be measured.

The system for acquiring location parameters provided by this embodiment, for example, can also perform the method for judging the rotation angle provided by the embodiment shown in Fig. 2.

By way of the system for acquiring location parameters provided in this embodiment, the location parameters of the imaging means in the system can be measured or the location parameters of an object to be measured can be measured. Thus, the function of automatically obtaining location parameters can be achieved, which avoids the costs and errors of manual measurement. When this system is applied in the ITS, it can greatly improve the automation of the ITS and reduce the costs of ITS.

It should be appreciated by those skilled in the art that, various variations and modifications can be made to each of the embodiments of the present invention without departing from the essence of the invention, and all these variations and modifications should be within the protection scope of the present invention. Therefore, the protection scope of the present invention is to be defined by the attached claims.

Claims

1. A method for acquiring location parameters, said method comprising:

emitting by emitting means (601) at least two light beams, with said light beams irradiating on a plane A to form light spots;

acquiring by imaging means (602) images of said light spots on an image plane B;

detecting by processing means the location of said images in said image plane B; and

calculating by calculating means (404, 604) the location parameters of an object to be measured according to said location.

2. The method as claimed in claim 1, characterized in that a combination of any of said emitting means (601), said imaging means (602), said processing means, said calculating means (404, 604) and said object to be measured is integrated in the same device.

3. The method as claimed in claim 1, characterized in that said emitting means (601) is a laser emitter, which is capable of emitting a light beam of a specific color so as to enable the color of said light spot and that of said plane A to be distinguished during detection.

4. The method as claimed in claim 1, characterized in that said emitting means (601) is installed on said imaging means (602) by a bracket and can be separated from said imaging means (602).

5. The method as claimed in claim 1, characterized in that said light beams are parallel to the optical axis of said imaging means (602).

6. The method of claims 1 to 5, characterized in that said object to be measured is said imaging means and said location parameters comprise one of the following or any combination thereof:

the distance from said imaging means (602) to said plane A;

the included angle between the optical axis of said imaging means and said plane A; and

the rotated angle of said imaging means (602) along its optical axis.

7. The method as claimed in claim 6, characterized in that the origin of a first coordinate system is located at the light center of said imaging means (602), the z axis of said first coordinate system is located on the optical axis of said imaging means (602), the x axis of said first coordinate system is perpendicular to said z axis and located in the horizontal plane of said imaging means (602), and the y axis of said first coordinate system is perpendicular to the horizontal plane of said imaging means (602), and if said first coordinate system is taken as reference, then said light beams need to meet one of the following conditions:

there are at least two light beams in said light beams, with the emitting points thereof being located at locations other than said origin, the y components of the coordinates of the emitting points of said at least two light beams being different, and said x axis being parallel to said plane A; and

there are at least three light beams in said light beams, with the emitting points thereof being located at locations other than said origin and the emitting points of said at least three light beams being not on the same straight line.

8. The method as claimed in claim 7, characterized in that said calculating by calculating means (404, 604) according to said location the location parameters of an object to be measured comprises:

determining said plane A by said calculating means (404, 604) according to the location of the emitting points of said light beams and the location of the images of said light spots in said image plane B by way of a plane formula; and

calculating by said calculating means (404, 604) the distance from said imaging means (602) to said plane A according to the formula for distance from a point to a plane, and/or, calculating by said calculating means (404, 604) the included angle between the optical axis of said imaging means (602) and said plane A according to the formula for included angle between a line and a plane, and/or, calculating by said calculating means the rotation angle of said imaging means along its optical axis according to the formula for included angle between a line and a plane.

9. A method for judging the rotation of an imaging device about a optical axis, said method comprising:

emitting by emitting means (601) at least two light beams, with said light beams irradiating on a plane A to form light spots, wherein said light beams meet the following conditions: 1) there are at least two light beams in said light beams, with the emitting points thereof being located at locations other than the origin of a first coordinate system, and the y components of the coordinates of the emitting points of said at least two light beams being the same; or 2) there are at least three light beams in said light beams, with the emitting points thereof being located at locations other than the origin of said first coordinate system and the emitting points of said at least three light beams being not on the same straight line;

acquiring by an imaging device images of the light spots of said at least two light beams on an image plane B;

detecting by processing means the location of said images in said image plane B; and

if said light beams meet the condition 1), then judging by the calculating means (404, 604) whether or not the distances from the emitting points of said at least two light beams to their light spots are equal according to the location of said images in said image plane B; if they are equal, then it is determined that there is no rotation of said imaging device about its optical axis; and if they are not equal, then it is determined that said imaging device is rotated along its optical axis; and

if said light beams meet the condition 2), then determining by the calculating means (404, 604) said plane A by way of a plane formula according to the location of said images in said image plane and the location of the emitting points of said light beams, and calculating the rotation angle of said imaging device about its optical axis according to the formula for included angle between a line and a plane, so as to judge whether or not said imaging device is rotated about its optical axis;

wherein, the origin of said first coordination system is located at the light center of said imaging device, the z axis of said first coordinate system is located on the optical axis of said imaging device, the x axis of said first coordinate system is perpendicular to said z axis and located in the horizontal plane of said imaging device, and the y axis of said first coordinate system is perpendicular to the horizontal plane of said imaging device.

10. The method as claimed in claim 9, characterized in that said light beams are all parallel to said optical axis.

11. The method as claimed in claim 9 or 10, characterized in that said processing means and/or said calculating means (404, 604) are integrated in said imaging device.

12. Emitting means (601) for installation on an imaging device, said emitting means (601) comprising at least two light beam emitting members (301), and if a first coordinate system is taken as reference, then said at least two light beam emitting members meet the following conditions:

there are at least two light beam emitting members, with the emitting points thereof being located at locations other than the origin of said first coordinate system and the y components of the coordinates of said emitting points being different; or

there are at least three light beam emitting members, with the emitting points thereof being located at locations other than the origin of said first coordinate system and said emitting points being not on the same straight line;

wherein, the z axis of said first coordinate system is located on the optical axis of said imaging device, the origin is located at the light center of said imaging device, the x axis is located in the horizontal plane of said imaging device and perpendicular to said z axis, and the y axis is perpendicular to the horizontal plane of said imaging device.

13. The emitting means (601) as claimed in claim 12, characterized in that the location relationship of said light beam emitting members relative to said imaging device enables the light beams emitted by said light beam emitting members to be parallel to the optical axis of said imaging device.

14. The emitting means (601) as claimed in claim 12 or 13, characterized in that said emitting means (601) further comprises a bracket and said bracket is used for installing said light beam emitting members onto said imaging device.

15. An imaging device, said imaging device comprising:

a lens (401) and an image plane (402) for acquiring images of light spots formed by light beams on a plane A;

detecting means (403, 603) for detecting the location of the images of said light spots in said image plane (402); and

calculating means (404, 604) for calculating the location parameters of an object to be measured according to the location detected by said detecting means (403, 603).

16. The imaging device as claimed in claim 15, characterized in that said calculating means includes: a plane determining module for determining said plane A according to the location of the emitting points of said light beams and the location of the images of said light

spots in said image plane (402) by way of a plane formula; and one of the following modules or any combination thereof:

a distance module for calculating the distance from this imaging device to said plane A according to the formula for distance from a point to a plane;

a first angle module for calculating the included angle between the optical axis of this imaging device and said plane A according to the formula for included angle between a line and a plane; and

a second angle module for calculating the rotation angle of this imaging device along its optical axis according to the formula for included angle between a line and a plane.

17. The imaging device as claimed in claim 15, characterized in that said imaging device further comprises emitting means as claimed in claim 12 or 13.

18. A system for acquiring location parameters, said system comprising:

emitting means (601) for emitting at least 2 light beams, with said light beams forming light spots on a plane A;

imaging means (602) for acquiring images of said light spots on an image plane;

detecting means for detecting the location of the images acquired by said imaging means in the image plane; and

calculating means (404, 604) for calculating the location parameters of an object to be measured according to the location detected by said detecting means.

19. The system as claimed in claim 18, characterized in that if a first coordinate system is taken as reference, then at least two light beams emitted by said emitting means (601) meet the following conditions:

there are at least two light beams, with the emitting points thereof being located at locations other than the origin of said first coordinate system and the y components of the coordinates of said emitting points being different; or there are at least three light beams, with the emitting points thereof being located at locations other than the origin of said first coordinate system and said emitting points being not on the same straight line;

wherein, the z axis of said first coordinate system is located on the optical axis of said imaging means, the origin is located at the light center of said imaging means, the x axis is located in the horizontal plane of said imaging device and perpendicular to said z axis, and the y axis is perpendicular to the horizontal plane of said imaging means.

20. The system as claimed in claim 18 or 19, characterized in that said calculating means (404, 604) includes: a plane determining module for determining said plane A according to the location of the emitting points of said light beams and the location of the images of said light spots in said image plane by way of a plane formula; and one of the following modules or any combination thereof:

a distance module for calculating the distance from said object to be measured to said plane A according to the formula for distance from a point to a plane;

a first angle module for calculating the included angle between the optical axis of said imaging means (602) and said plane A according to the formula for included angle between a line and a plane, and for calculating the included angle between said object to be measured and said plane A according to the angle between said imaging means and said object to be measured; and

a second angle module for calculating the rotation angle of said imaging means along its optical axis according to the formula for included angle between a line and a plane, and for calculating the rotation angle of said object to be measured along said optical axis according to the angle between said imaging means (602) and said object to be measured.

FIG 1a

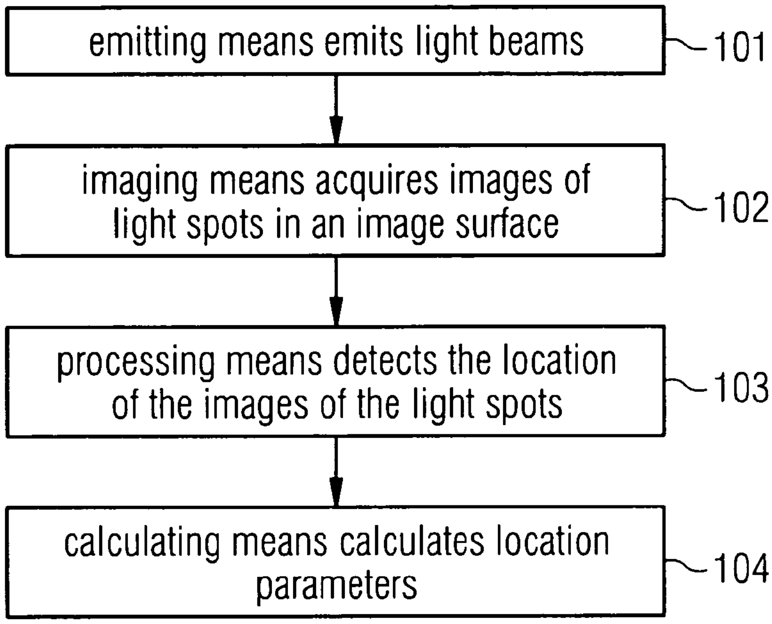

emitting means emits light beams
101
imaging means acquires images of light spots in an image surface
102
processing means detects the location of the images of the light spots
103
calculating means calculates location parameters
104

FIG 1b

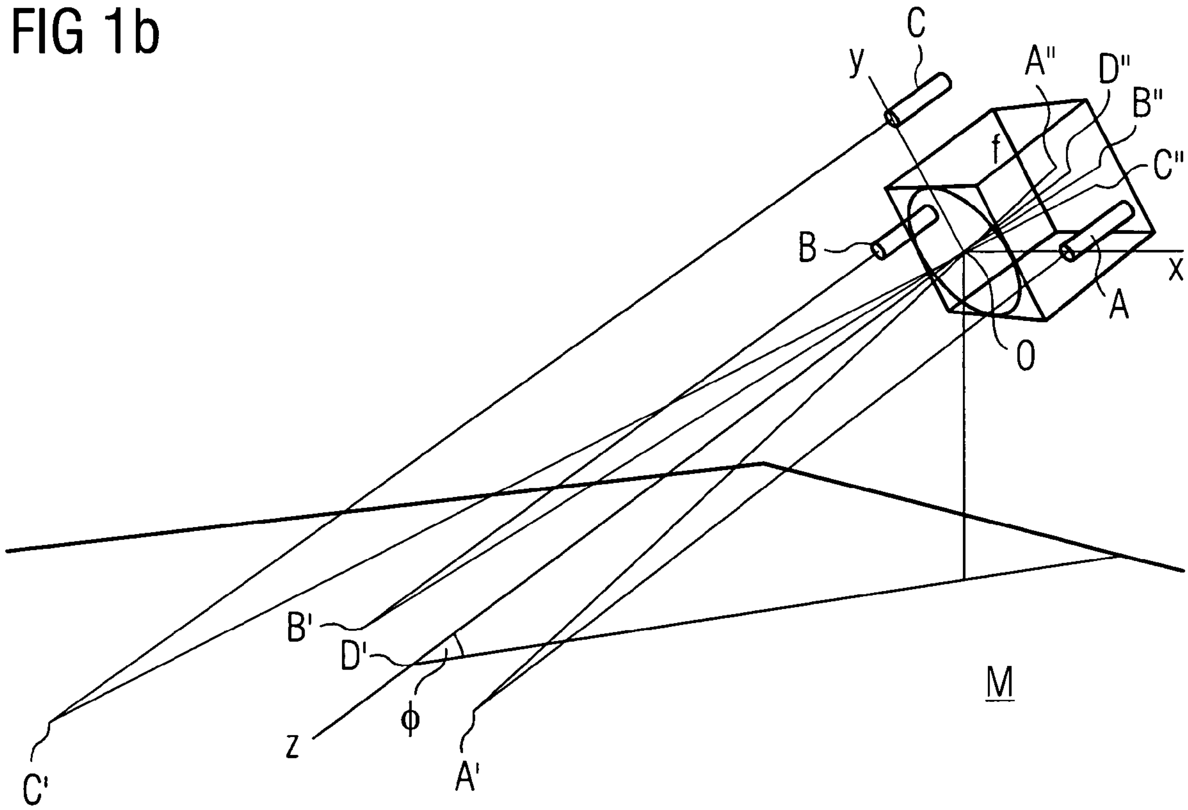

C
y
A"
D"
B"
f
C"
B
x
A
O
B'
D'
φ
M
z
A'
C'

FIG 1c

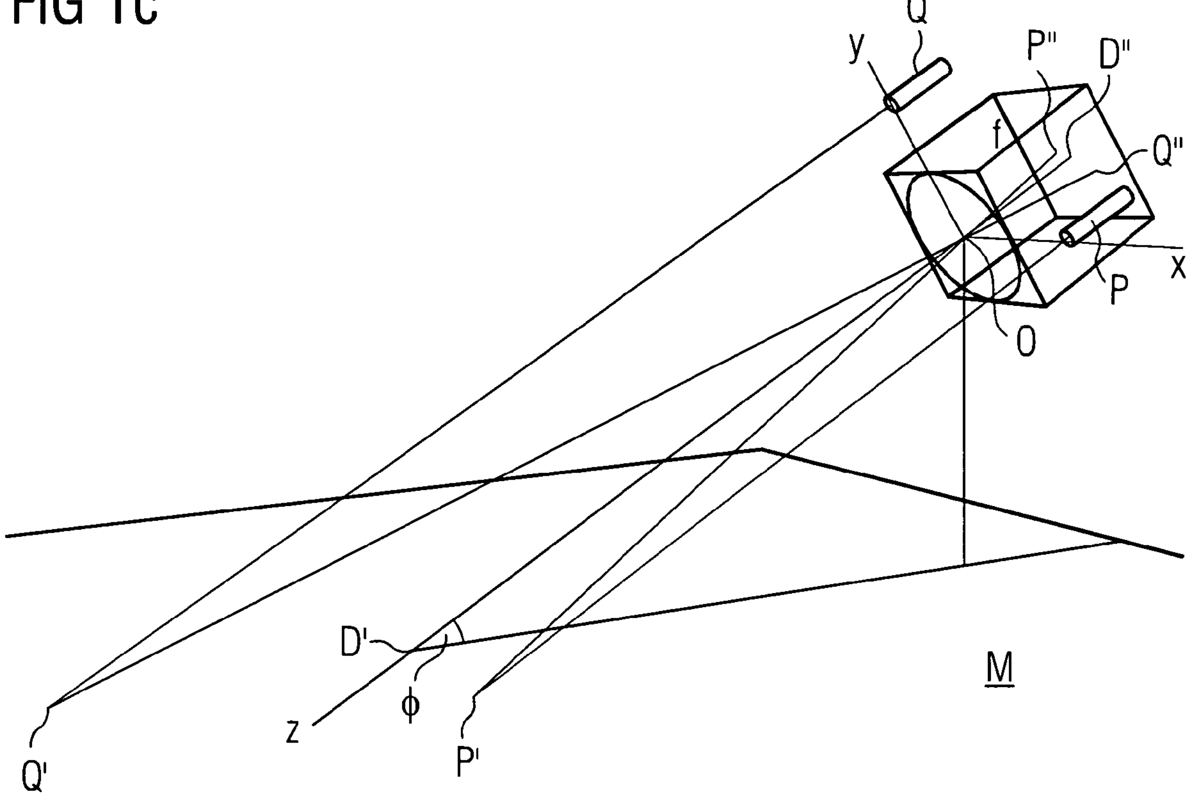


FIG 2

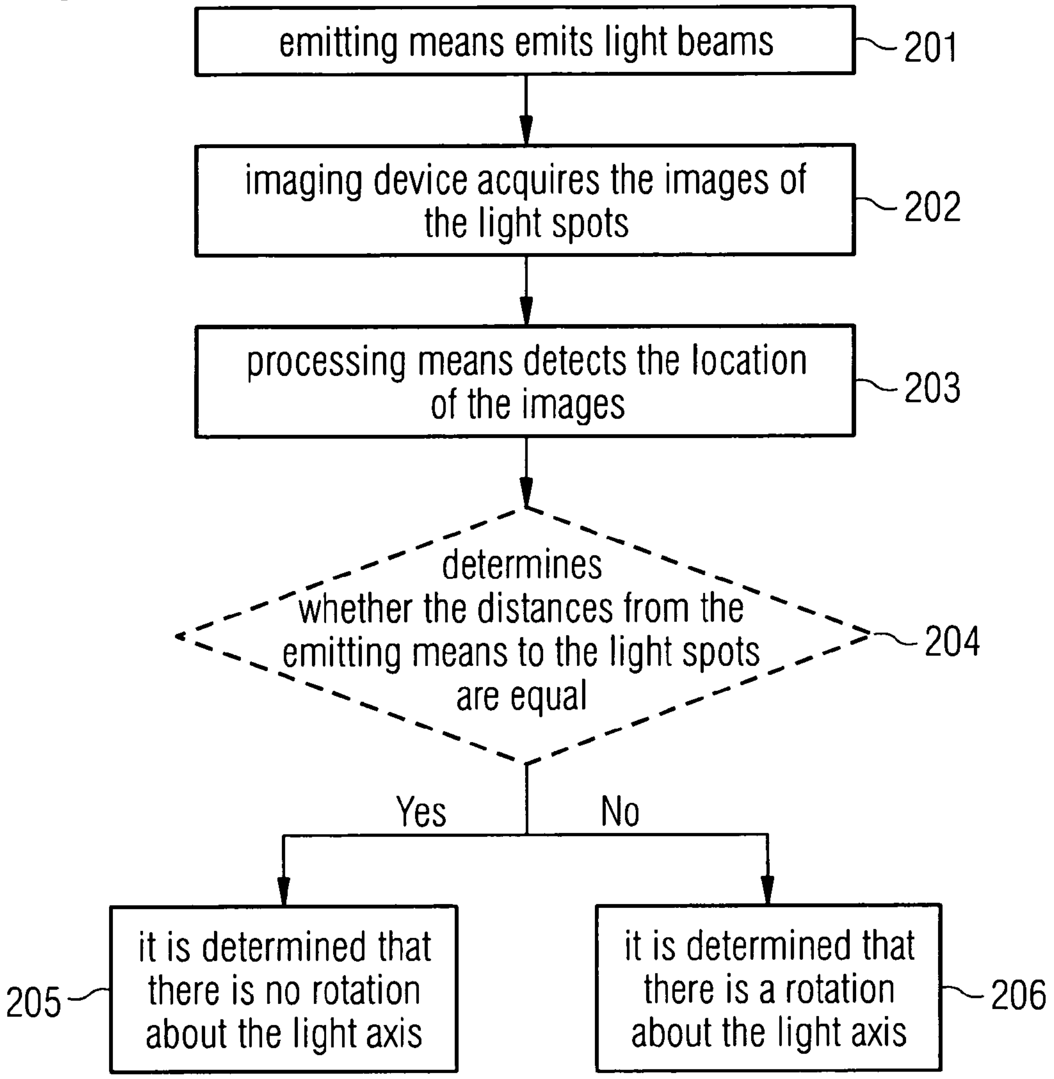

emitting means emits light beams
201
imaging device acquires the images of the light spots
202
processing means detects the location of the images
203
determines whether the distances from the emitting means to the light spots are equal
204
Yes
No
it is determined that there is no rotation about the light axis
205
it is determined that there is a rotation about the light axis
206

FIG 3

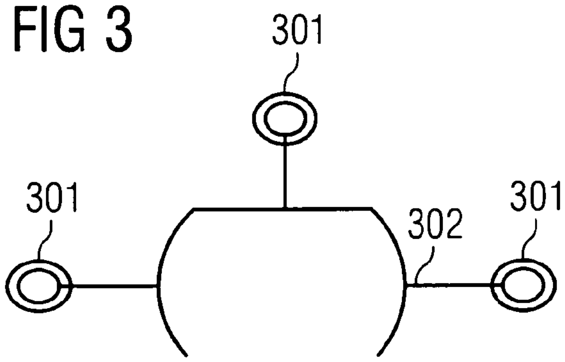

301
301
302
301

FIG 4

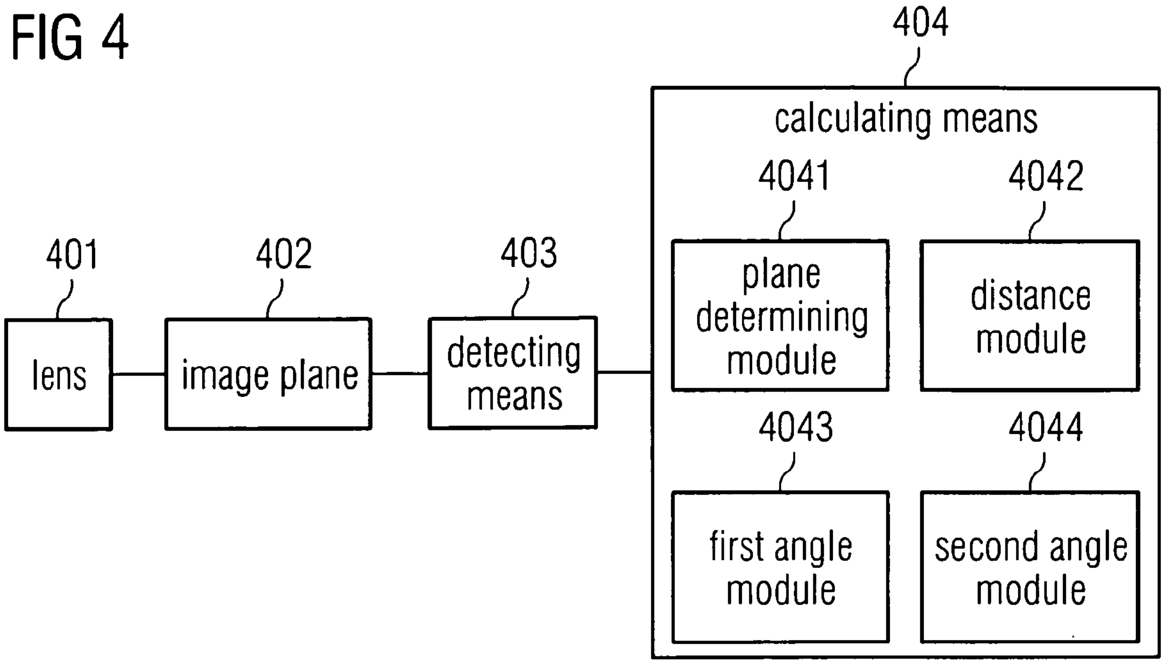


FIG 5

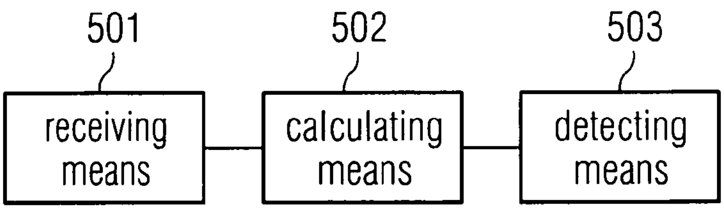
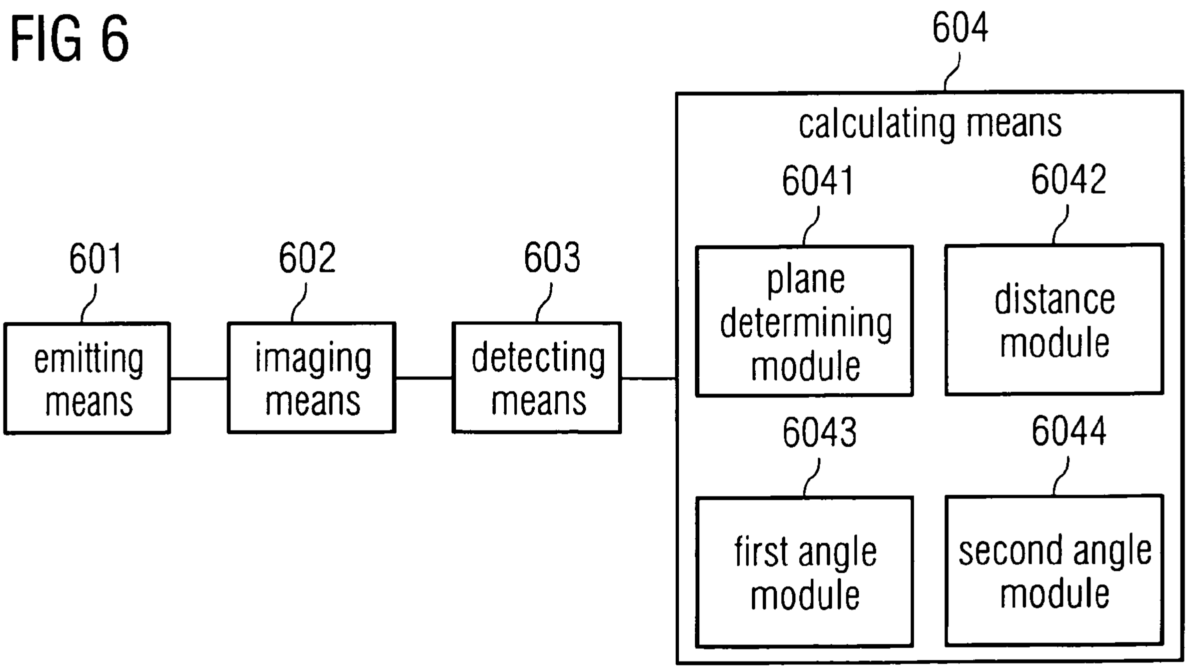


FIG 6



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/065742

A. CLASSIFICATION OF SUBJECT MATTER
INV. G01C3/08 G01C11/30 G01S17/46 G08G1/017
ADD.

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)
G01C G01S G08G G01B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/128102 A1 (PETTY JOHN [GB] ET AL PETTY JOHN MICHAEL [GB] ET AL) 1 July 2004 (2004-07-01) figures 1-3 paragraphs [0014], [0017], [0019] paragraphs [0102] - [0110], [0115], [0121] -----	1-20
X	EP 1 739 391 A2 (FUJITSU LTD [JP]) 3 January 2007 (2007-01-03) paragraphs [0028] - [0038], [0044] - [0056] paragraphs [0081] - [0097] figures 1,2 -----	1-20
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	-/--	

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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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
12 December 2011	22/12/2011

Name and mailing address of the ISA/	Authorized officer
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International application No
PCT/EP2011/065742

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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1

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Information on patent family members

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