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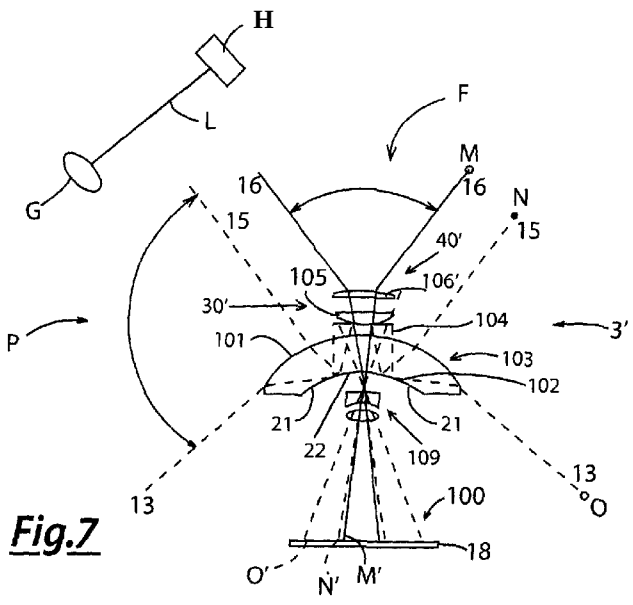

Fig.7

(57) Abstract: The invention relates to an environment monitoring device (1), comprising an image recording device, an optical lens (3, 3') for the acquisition of images, adapted to acquire a panoramic field of view of at least 180° in azimuth, and greater than 100° in elevation, a georeferencing sensor (4) and/or other data collecting sensors (5, 6, 7), a matrix detector (8) placed on the focal plane of the optical lens (3, 3') and connected to the data recording device, comprising in turn a PC (9), so that the images belonging to said panoramic field of view and acquired by said optical lens (3, 3') and detected by said matrix detector (8), and the data collected by the georeferencing sensor (4) and/or from other data colletcing sensors (5, 6, 7) are sent to the image recording device.

ENVIRONMENT MONITORING DEVICE

The present invention relates to the field of environment monitoring devices and, in particular, relates to an environment monitoring device with multi-sensor platform.

In detail, compared to traditional multi-sensor systems already commercially available, the device of the invention is provided with a panoramic bifocal optical lens newly developed capable of providing, using a single image sensor, a panoramic field of view of at least 180° axis azimuth and at least 100° in the elevation.

The device is also able to observe, using the same sensor and with an independent focal length (bifocal lens) a same zone of the panoramic field (enlarged), for example the zone at street number height of dwellings, or another area surrounding the panoramic field of the observer, such as the road surface.

The device is completed by a system of geo-referencing (GPS and odometer).

Recently, the traditional models of representation of the territory are moving towards integrated systems of geo-referenced information with data collected from multiple sources, including public information accessible through websites, cine-photographic material taken from both aircraft (satellites, helicopters, airplanes, drones, etc ...) as well as land vehicles (camera mounted on ground vehicles public or private).

The global spread of these environment monitoring systems is due, in turn, to the spread of public resources available on the web (one among all Google Earth), to the spread of satellite tracking devices

(eg. GPS) and those of image acquisition from terrestrial mobile platforms.

Using the integrated information acquired from these devices, multiple applications are developed to support the local government processes and the environment.

The further integration of a mobile phone system allows the development of monitoring activities even in real time, which can be of great support both in the context of public administration and in the professional field.

Among the ongoing applications, there is, among the others, the urban mobility monitoring, the hydrogeological risk monitoring and monitoring of the changes brought about by the use of the soil.

Among the terrestrial monitoring systems there are the Mobile Mapping System (MMS, mobile laboratories mapping shown in Figures 1-2) developed to produce topographic database .

Equipment constituting a terrestrial mobile MMS are installed on vehicles (car, truck) and perform different functions:

- identifying the position of a moving vehicle, allowing to place the data detection system in the space and time in a global geographic referencial system; this function is typically performed by a series of sensors such as GPS , odometer and possibly an Inertial System ;

- identifying the morphological characteristics of the area covered by the vehicles on which the MMS is placed (position, size and morphology of works of art, buildings, fences, equipment, access, etc ...), this function is performed by a series of cameras using the acquisition of images recorded during the movement of the vehicles on which the MMS is placed.

The use of a MMS system integrates other elements, available from aerial photos (satellite, by plane or drone), since it allows to recognize items that would not otherwise visible by means not anchored to the road.

In addition, a MMS system has costs significantly lower than aerial systems and it enables easy integration by the user of other sensors eventually deemed useful for the collection of data to be analyzed (eg., among others, rangefinder laser, radar, thermal infrared rooms, environmental sensors, sound level meters, etc ...).

In more modern solutions of "Mobile Mapping System" (MMS), or environment monitoring visual systems, already present on the market, a vehicle is provided with a multi-sensor system which includes several (more than one) optical cameras for visual monitoring of the space surrounding, a reference system DGPS, an odometer and a vision system of the road surface to determine its degradation.

To be able to view and record a field of view large enough to be able to provide information as complete as possible on the surrounding space (homes, land, etc...), the vehicle is provided with multiple wide angle view cameras (eg. three cameras with the field of view of 60°, so as to monitor a space angle of 180° in azimuth, see Figures 1-2). In addition to these it is possible to provide the device with another camera to see the road and be able to determine its degradation (Figures 1-2).

The main object of the present invention, therefore, is to overcome the above mentioned drawbacks, and to provide an environment monitoring device that is

compact and more economical than known devices.

Another object of the invention is to provide an environment monitoring device which permits the acquisition, with a limited number of components, of all necessary information, in a safe and reliable manner .

Further objects and advantages of the present invention will become clear from the description which follows, which refers to a practical example of embodiment, exemplary and preferred, but not limiting, of the environment monitoring device, object of the invention, and from the enclosed drawings, in such as:

- figure 1 shows a top view of one of the elements included in a device according to the prior art;
- figure 2 shows a side view of a device according to the prior art;
- figure 3 shows a top view of the device of the invention;
- figure 4 shows a side view of the device of figure 3;
- figure 5 shows an operating diagram of the device of figure 3;
- figure 6 shows a section through a first optical system applicable to the device of the invention;
- figure 6A shows in a diagram the two-dimensional field of view detectable by the optical system of Figure 6;
- figure 7 shows in section a second optical system applicable to the device of the invention;
- figure 8 shows in a diagram the two-dimensional field of view detectable by the optical system of Figure 7.

Below, purely by way of example, it is described a particular embodiment of the environment monitoring device of the invention. This does not mean that the

device of the invention may comprise different optical systems, always able to acquire panoramic images.

With reference to figures 3-5, there is shown a MMS type environment monitoring device 1 provided with a casing 2 and with a single optical lens 3, monitoring the scene (with a field of view of at least of 180° in azimuth, and greater than 100° in elevation) and monitoring the degradation of the road. In this way, using a single optical lens 3 and a single sensor 6, it greatly reduces the cost of the system so far known (including at least four optical lens and four sensors), it is easier to install and it considerably reduces the weight and bulk of the monitoring system.

The optical lens 3 can also be configured so that the field of view, which in the known device was to monitor the road surface (Road monitoring field of view), can now be routed in any other direction that is deemed useful to monitoring: for example, the area of the street numbers of dwellings. In this way, this part of the field having a different (higher) focal length it is possible to obtain an enlargement of the field, increasing the resolution and viewing more easily the house numbers or other details of interest.

The heart of the device of the invention is represented by an optical panoramic vision bifocal lens, whose PCT patent application has already been filed by PAN VISION. This lens is able to capture a panoramic scene (360° in azimuth) and of at least 100° around the virtual horizon line and, simultaneously, another area of the surrounding field (i.e. front field) using a focal length that can be also different. In the case in which the focal length of the front field is equal to the one of the panoramic field, reference is made to

the Italian patent applications PAN VISION VI2012A000002 and VI2012A000003 (hyper-hemispherical lens), which is to be considered totally incorporated in the present description; in an alternative configuration, the focal length of the panoramic field may be different from the one of the panoramic field, in which case reference is made to the Italian patent application PAN VISION VI2012A000004 (panoramic bifocal lens), to be considered totally incorporated in the present description.

The latter zone to be detected may be, for example and at the option of the operator, an area of the road surface for the measurement of deterioration, an area of particular interest such as the street numbers of dwellings, or other areas still considered of interest for the operator. Using for this last field of view, a greater focal lenght, the resolution and so the details of the scene will improve. The lens can be mounted with orientation to taste and then, by acting appropriately on the mounting system, it is possible to choose viewing the surrounding area which is able to provide as much information as possible.

Just by way of example in order to better illustrating the invention, it follows the description of a particular configuration that the device of the invention can have.

In a particular and exemplary structure, the environment monitoring device 1 is composed of a supporting sensor casing 2 in which a panoramic bifocal lens 3, as well as various conventional sensors (for example, but not exclusively, a GPS sensor 4, an odometer 5, a possible further casing 6 for vision and other data collection sensors 7) are placed.

The panoramic bifocal lens 3, used in this example has been developed by the company PAN-VISION srl and the correspondent patent application was filed on 03.01.2012 (patent application no. VI2012A000004).

For a detailed description of the functioning of the PAN-VISION lens please refer to figures 6 and 6A, which show:

- a ray 14, shown by a continuous line, coming from an object located in correspondence of the horizon, in which E1=0°,
- a ray 13, shown by a dashed line, coming from an object placed at the upper edge of the field E1+,
- a ray 15, shown by a dash-dot line, coming from an object placed below the horizon E1-, at an angle between the horizon and the Nadir N,
- a ray 16, shown by a dotted line, and a ray 17, shown by a dashed- two points from two respective objects placed in a field of view between E+ and El- (between +45° and -60° in this particular example) .

The panoramic bifocal lens 3 comprises an optical element or catadioptric lens 103, a first optical unit 30, an image sensor 18 for the acquisition of the image, a phothographic lens 109 and a second optical unit 40.

The first optical unit 30 includes a first group of lenses 104 and a semi-reflective surface 105, assembled in a support 108, preferably made of metal, for fixing the optical unit 30 itself to the catadioptric lens in such a way that the first group of lenses 104 is positioned at a fixed distance from the catadioptric lens 103.

In particular, the support 108 is fixed to the catadioptric lens 103 for metal bonding to glass.

In a variant embodiment of the optical unit 30, the first optical unit 30 is fixed directly to the catadioptric lens 103 by bonding the optical element 104 .

In a further variant embodiment of the optical unit 30, alternative or additional to the previous one, the surface 105 is constituted by a semi-reflective coating deposited directly on the outer surface of the first group of lenese 104.

In any case, the semi-reflective surface 105 allow to reflect a part of the incident light and to transmit the remaining part .

In particular, for example, the semi-reflective surface 105 passes 50% of the light and reflects 50%.

The catadioptric lens 103 collect the rays from each azimuth angle (from 0° to 360°) and re-direct them toward the first optical unit 30.

The catadioptric lens 103 is substantially a lens with a first outer convex spherical surface 101 and a second concave interior spherical surface 102, and the photographic lens 109 is opposed to the outer convex spherical surface 101 with respect to the catadioptric lens 103 itself.

The second concave interior spherical surface 102 has a first area 21, which is made reflective by deposition of a coating suitable for the purpose, called "coating", and a second area 22, circular and central, through which the rays 13, 14, 15 16 and 17 pass, after being reflected (in the case of the rays 13, 14 and 15) or transmitted (rays 16 and 17) from the semi-reflective surface 105.

In correspondence with the concave interior spherical surface 102 of the catadioptric lens 103, to collect

the output rays from the second area 22, there is a known photographic lens 109, specially designed for the specific application desired, according to known techniques and parameters such as the field of view required, the spatial resolution or similar.

The photographic lens 109 has a stop 12, which is rigidly fixed by means of a common metal support 110.

Of course, the photographic lens 109 may have an opening or diaphram stop 12 located anywhere within its support 110.

The metal support 110 is in turn fixed to the catadioptric lens 103 through a flange 111.

The group of lenses 104 has the purpose of reducing the angle of incidence with which the rays arrive on the photographic lens 109.

The rays 13, 14 and 15, including between E1+ and El- strike the outer convex spherical surface 1 of the catadioptric lens 103 and are directed towards the concave interior spherical surface 102 of the catadioptric lens 103.

The light is reflected from the concave interior spherical surface 102 and directed back toward the central part of the outer convex spherical surface 101.

The rays 13, 14 and 15 then enter in the first group of lenses 104 and are reflected from the semi-replective surface 105 and re-directed towards the objective 109.

Note that during this journey the rays 13, 14 and 15 have returned from the group of lenses 104 and the catadioptric lens 103 .

The optical system 3 produces on the focal plane 18 the image of the panoramic scene in the shape of a circular crown C , shown in figure 6A.

In this particular example, shown in figure 6 , E1+ is

45° El- applies 60°: the global field of view in elevation is then 105°.

Before reaching the photographic lens 109, the rays pass through the opening or diaphram stop 12 of the photographic lens 109, which controls the amount of light which must enter into the photographic lens 109 itself .

The photographic lens 109, in turn, corrects optical aberrations and produces a corrected image on the image sensor or focal plane 18.

In figure 6A it is shown the projected image on the focal plane 18 of the example of figure 6 .

In particular, the image of the object transmitted by the ray 13 is focused at the point 13 ', on the outer edge of the circular crown C .

Similarly, the images of objects placed on the horizon O and then transmitted to the optical system along the ray 14, or images of objects transmitted by ray 15 are formed respectively in the points 14' and 15' on the focal plane. The first group of lenses 104 and the semi-reflective surface 105 are fixed to the catadioptric lens 103 through their metal support 108.

The optical device 40 includes an optical element 106, mounted on a support 107 preferably made of metal that is fastened to the support 108 by connection means, for example threaded means .

The optical element 106 has deflecting means 19, rotatably fixed to a support 20 provided with three-dimensional rotating means (not shown) , for example a ball joint, in turn fixed to the support 107.

Such deflecting means 19 can rotate in the directions of the two arrows rot .a (around the axis of elevation) and rot.b (around the axis of azimuth), and capture a

field of view between E1+ and El- (between +45° and -60° in this particular example) . In the market many rotation systems that can be used to that purpose are known, and a detailed description of one of them is not the object of this invention.

In particular, the focal length of the optical element 106 is dimensioned so as to form the image of the visual field EL', after that the rays 16 and 17 are passed through the semi-reflective surface 105, the first optical unit 30 and the phptographic lens 109.

The image produced by the second optical device 40 on the focal plane 18 is constituted by the circle B, placed exactly in correspondence of the hole of the circular crown C produced by the optical system 20.

The combined focal length of the optical system 3 is dimensioned so as to form a magnified image of the field El' between the rays 16 and 17.

By rotating the deflecting means 19 on the plane defined by the arrow rot.a, it is possible to capture all the fields of view included within the original panoramic field between E+ and El- (105° in this case) and then it is possible to see an enlargement of these fields of view directly on the image sensor placed on the focal plane 18.

A rotation of the deflecting means 19 and possibly of their support 20 about the axis of symmetry of the optical system, i.e. on the plane defined by the arrow rot.b, allows it to move in azimuth and then to capture enlarged images of the entire original panoramic field.

The fact that in the original panomaric image the central region of the circular crown C is not affected by the image sensor advantageously allows to find an area in which the projecting magnification without

interfering with the panoramic vision.

In other words, the operator can advantageously continue to see both the entire original panomaric field of view and a region magnified, using a single image sensor.

Using different optical elements 106, interchangeable among them, there may be different values of magnification, depending on the application. In particular, it can be used, for example, as an alternative to each other, an optical zoom 3x, 6x, etc.

In a preferred embodiment of the device 40 according to the invention, the deflecting means 19 comprise a mirrored surface.

In one embodiment of the device 40, an alternative to the previous, the deflecting means 19 comprise any other optical system - for example a prism - able to capture rays and return them in a definite direction.

In particular, with reference to the example shown in figure 6, an optical system capable of capturing the rays 16 and 17 within the original panoramic field between E1+ and El- and return them toward the enlarging optical element 106.

More generally, according to the invention, one of the reflective surfaces 21 or 105 - or both - may be replaced by any other optical system capable of capturing rays and return them in a definite direction, for example an optical prism (not shown) .

In essence, the PAN-VISION panoramic bifocal lens manages, in a single solution, to frame a field of view of at least 180° degrees in azimuth and in elevation of 105° degrees around the environment monitoring device 1 and, simultaneously, another field of view to operator's choice with different focal optics

(conveniently increased so as to have a magnification, ie a greater spatial resolution, the video scene) . In this particular example the panoramic bifocal lens 3 is oriented so as to frame 60° above the horizon geographic and 45° below it.

In a different configuration, the lens will frame all 360° degrees in azimuth that it can potentially frame or, in further different configuration, frame a different angle to the horizon geographic area (e.g. 45° above and 60° below it) . In a particoalre configuration the field of view zoomed can frame the road surface, or the zone of street numbers of dwellings, or even any area for which the operator has an interest to have optical magnification.

The image is captured by a matrix detector 8 (bi-dimensional, e.g. a CMOS or CCD sensor) placed on the focal plane of the panoramic bifocal lens 3 and connected to a PC 9 having its own memory 10 (figure 5) . The recorded images are then processed to correct the typical distortion supplied by a panoramic lens (anamorphism) and then provide with the image data-base for analysis ready by the operator.

In a different configuration, the PC 9 can be supplemented by a wi-fi transmission system (e.g. telephonic) 11 through which the images and other data are sent in real time to the operator's station.

In an alternative embodiment of the environment monitoring device 1, as mentioned above the panoramic bifocal lens 3 may be of hyper-hemispherical type, as shown in figures 7 and 8, in which the same or similar references refer to similar or equal elements, with the same characteristics already described, which is referred to for brevity.

In particular, the optical system 3' comprises a semi-reflective mirror 105, the image is formed in a continuous manner representing the reality, as evident in particular in figure 8. The points M, N and 0 of the space projecting now in the points M', N' and 0', forming a continuous image on the focal plane 100: the objects G, H and L are formed correctly in the focal plane 100, projecting the images G', H', and L' in their real disposition.

The optical system 3', according to the invention, comprises an optical element or catadioptric lens 103, a first optical unit 30', a sensor 18 for the acquisition of the image, an photographic lens 109' and a second optical unit 40'.

Even in this second embodiment it is possible to predict the variants already described relative to the first embodiment, and the components of the first optical unit 30' are a first group of lenses 104, a reflective surface 105 and a support preferably made of metal with the same characteristics.

In particular, in the variant embodiment of the optical unit 30', in which the reflective surface 105 is constituted by a reflective coating deposited directly on the outer surface of the group of lenses 104, it advantageously eliminates an optical element.

The concave interior spherical surface 102 has a first area 21, which is made reflective by deposition of a coating suitable for the purpose, called "coating", and a second area 22, circular and central, through which the rays 13, 16 and 15 pass, after being reflected by the reflective surface 105.

Figure 8 shows the projected image on the focal plane 18 of the example of Figure 7.

The optical element 106' captures the field of view ranging from -60° in this specific example up to -90° (in correspondence with the Nadir) .

In particular, the focal length of the optical element 106 is dimensioned so as to form the image of the visual field F, after which the rays 16 are passed through the semi-reflective surface 105, the first optical unit 30' and the photographic lens 109'.

The image produced by the second optical device 40' on the focal plane 18 is constituted by the circle B, placed exactly in correspondence of the hole of the circular crown C produced by the optical system 30'.

The field of view F', comprising the ray 16, produces a circular image B, exactly where they form the image of the object transmitted by the ray 15 of Figure 7.

In particular, the image of the object transmitted by the ray 13 is focused at the point 0', on the outer edge of the circular crown C.

Similarly, the images of objects transmitted by the ray 15 are formed respectively at the point N' on the focal plane. The first group of lenses 104 and the semi-reflective surface 105 are fixed to the catadioptric lens 103 through a metal support.

In other words, the two images produced from the first optical unit 30' and the second optical unit 40', i.e. respectively the circular crown C and the circular image B, are perfectly juxtaposed and the resulting image will be that of a global field with azimuth of 360° and 270° elevation.

In this second embodiment of the invention, just described, the surface 105 may be fully reflective.

In this way it is obtained a classic panoramic field, producing focal plane 18, a circular crown C as shown

in figure 7, with 360° azimuth and elevation between +45° and -60° in the example described above, in the absence of the second optical group 40'.

In a preferred variant of embodiment of the invention, the reflective surface 105 is made semi-reflective, i.e. it reflects a part of the incident light and transmits the remaining part.

In particular, for example, the reflective surface 105 allows to pass the 50% of the light and to reflect 50% of the light.

Advantageously, this embodiment allows the assembly of the second optical unit 40', so as to capture a field of view from -60° in this specific example up to -90° (in correspondence with the Nadir) .

Advantageously, the image produced by the second optical unit 40' on the focal plane 18 is constituted by the circle B, placed exactly in correspondence of the hole of the circular crown C produced by the first optical unit 30'.

In this way the two images produced from the first optical unit 30' and the second optical unit 40', i.e. respectively the circular crown C and the circle B, are juxtaposed perfectly and the resulting image will be that of a global field with azimuth of 360° elevation and 270° .

The present invention has been described for illustrative but not limitative purposes, according to a preferred embodiment, but it is to be understood that variations and/or modifications may be made by the man skilled in the art without departing from the relevant scope of protection, as defined by the appended claims.

ENVIRONMENT MONITORING DEVICE

CLAIMS

1) Environment monitoring device (1), comprising an image recording device, optical lens (3, 3') to provide image acquisition, obtaining a panoramic field of view of at least 180° in azimuth, and greater of 100° in elevation, a georeferencing sensor (4) and/or other data collecting sensors (5, 6, 7), a matrix detector (8) placed on the focal plane of said optical lens (3, 3') and connected to the data recording device, comprising in turn a PC (9), so that the images belonging to the given field of view and acquired by-said optical lens (3, 3') and detected by said matrix detector (8), and the data collected by said georeferencing sensor (4) and/or from other data collecting sensors (5, 6, 7) are sent to the image recording device .

2) Environment monitoring device (1) according to claim 1, characterized in that said PC (9) is provided with a data and images recording device (10).

3) Environment monitoring device (1) according to claim 1, characterized in that said PC (9) is provided with wi-fi data and images transmission system (11) .

4) Environment monitoring device (1) according to one of claims 1-3, characterized in that said other sensors comprise an image storing device (6) .

5) Environment monitoring device (1) according to one of claims 1-4, characterized in that said other sensors comprise an odometer (5) .

6) Environment monitoring device (1) according to one of claims 1-5, characterized in that the optical lens (3, 3') are provided with a catadioptric lens (103), a photographic lens (109, 109'), an image sensor (18) for

digital processing of said image, a first optical unit (30, 30') for the acquisition of a panoramic image and provided with a first focal length and a second optical unit (40, 40') provided with a second focal length;

said catadiopritc lens (103) comprising a spherical lens having a first outer convex (101) and a second concave interior spherical surface (102), said first and second spherical surfaces (101, 102) having a respective centre, said centres defining a first optical axis;

said photographic lens (109, 109') having a second optical axis coinciding with said first optical axis, and comprising a stop (12) opposed to said image sensor (18);

said photographic lens (109, 109') being fixed to said catadiopritc lens (103) in correspondence of said second concave interior spherical surface (102), oriented with said stop (12) facing to said catadiopritc lens (103)

and in comprising an optical device (40, 40') including an optical element (106, 106') fixable to said catadiopritc lens (103) in correspondece of said outer convex spherical surface (101), said optical element (106, 106') transmitting said images to said image sensor (18).

7) Environment monitoring device (1) according to claim 6, characterized in that said optical element (106) is enlarging, and in that said optical device (40) comprises deflecting means (19) capturing images and sanding back said images to said optical element (106), said optical element (106) transmitting said images to said image sensor (18).

8) Environment monitoring device (1) according to claim

6, characterized in that said second focal length is equal to said first focal lenght.

9) Environment monitoring device (1) according to one of claims 6-8, characterized in that said first optical unit (30, 30') comprises a first lens group (104, 104'), suitable for reducing the angle of incidence on said photographic lens (109, 109'), which is interposed between said first outer convex spherical surface (101) of said catadiopritc lens (103) and said semi-reflective surface (105).

PRIOR ART

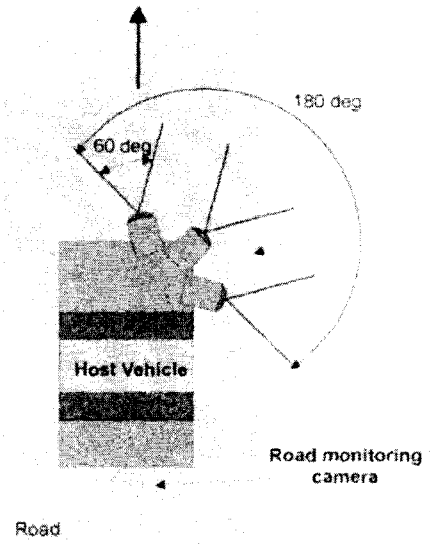

Fig. 1

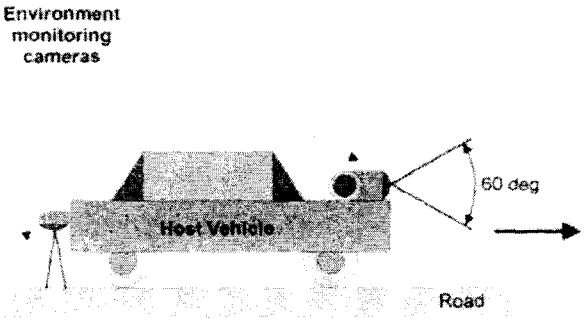

Fig. 2

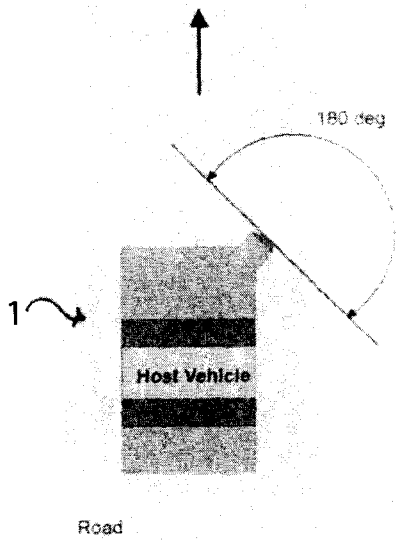

Fig. 3

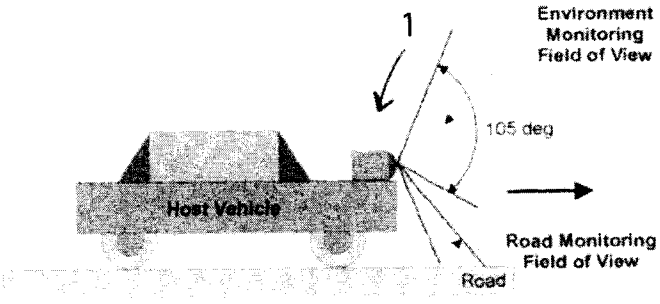

Fig. 4

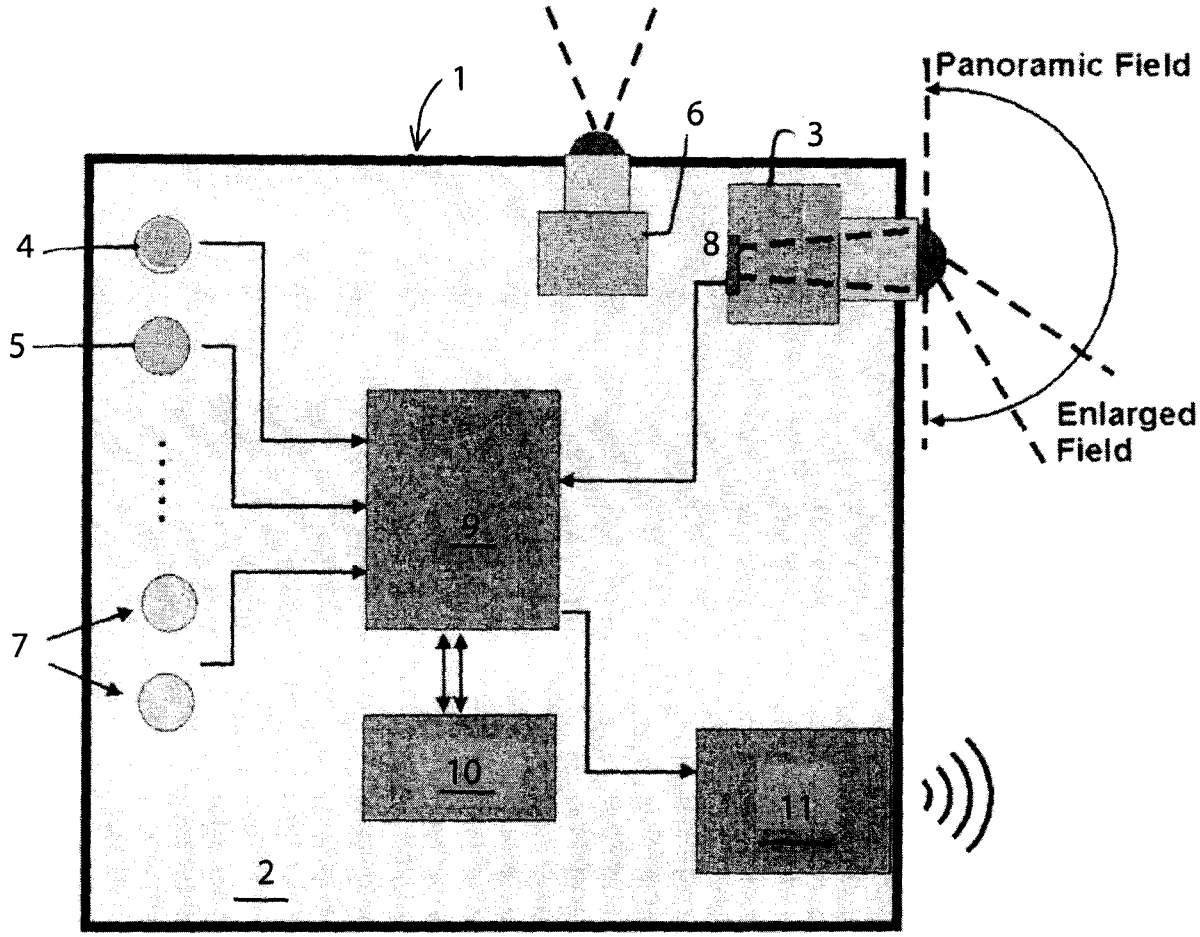

Fig. 5

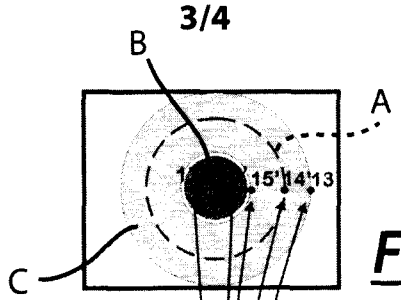
B
A
C
15'
14'
13

Fig.6A

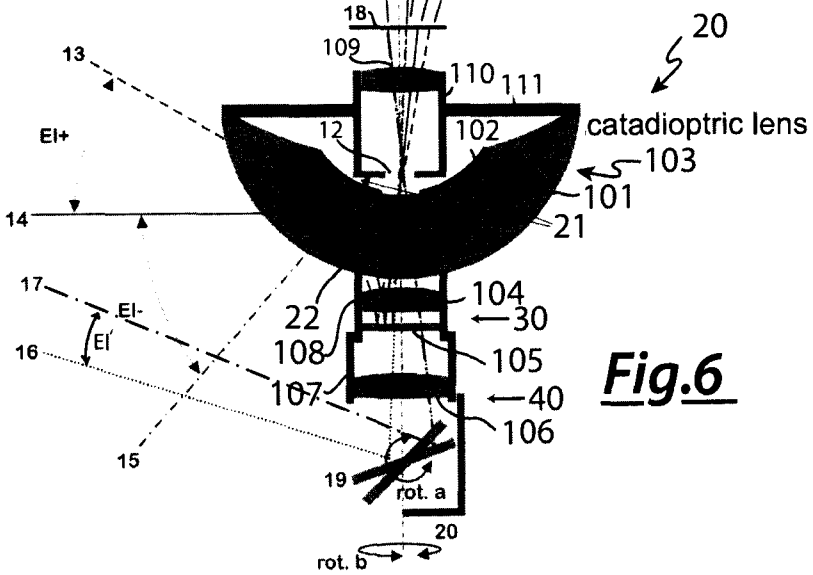
18
109
110
111
20
catadioptric lens
13
12
102
103
El+
101
14
21
17
El-
El'
22
104
30
108
105
16
107
40
106
15
19
rot. a
20
rot. b

Fig.6

Z

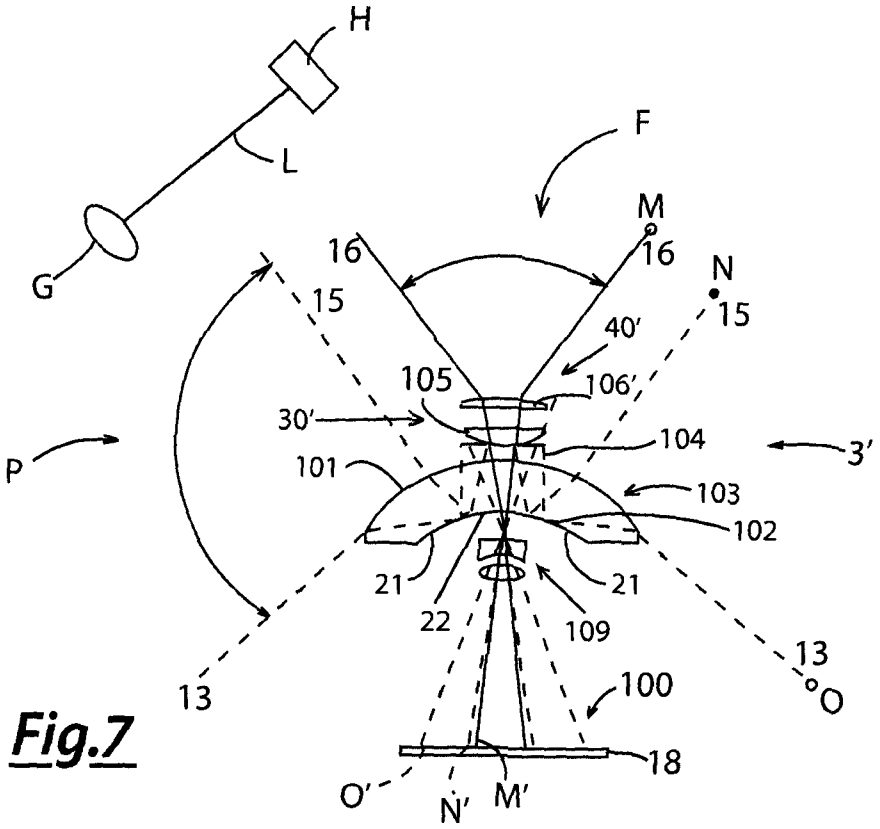
H
L
G
F
M
16
16
N
15
15
40'
105
106'
30'
104
3'
P
101
103
102
21
21
22
109
13
13
100
18
O'
N'
M'

Fig.7

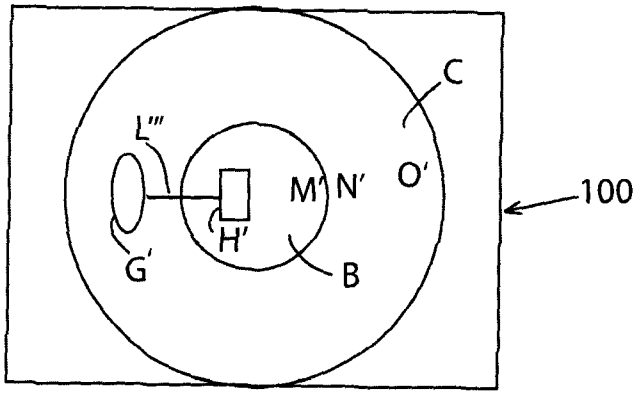
C
L'''
M'
N'
O'
100
H'
G'
B

Fig.8

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2013/000002

A. CLASSIFICATION OF SUBJECT MATTER
INV. G02B13/06 G02B27/18 G03B37/00 H04N5/232
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)
G02B G03B H04N

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 practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2005/029458 Al (GENG Z JASON [US] ET AL) 10 February 2005 (2005-02-10) paragraph [0047] - paragraph [0111] figures 6-8, 19	1-5 6-9
Y	EP 1 099 969 A2 (BE HERE CORP [US]) 16 May 2001 (2001-05-16) paragraph [0007] - paragraph [0057] figures 3-9	6-9
A	US 2009/073254 Al (LI HUI [US] ET AL) 19 March 2009 (2009-03-19) paragraph [0014] - paragraph [0062] figures 4-9	1-9

-/- .

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

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 May 2013	31/05/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Szachowi cz, Marta

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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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International application No
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