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# (54) SURVEILLANCE SYSTEM

ÜBERWACHUNGSSYSTEM

SYSTEME DE SURVEILLANCE

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## Description

This invention relates to surveillance devices for use with security systems, and in particular but not exclusively to optical surveillance.

It is well known for closed loop television systems to be installed in such a manner to enable central monitoring of sites for security purposes. In such systems a plurality of channels may be utilised, for example each channel being assigned to display a given area and/or be displayed on a particular monitor, with one or more operators monitoring the displays.

Alternatively, some or all channels may be multiplexed into one display, so that an operator views different areas by switching between channels.

Although in common use, such methods are often relatively inefficient for detection purposes and frequently suffer from poor operator attention, for example due to fatigue or distraction. Specific problems that arise are that due to difficulty in moving bulky cameras rapidly, the field of view tends to be arranged to be relatively static or slow moving. To provide adequate observation areas this necessitates relatively wide fields of view but this in turn results in comparatively poor resolution in the video display system, making the operator's task more difficult. The multiplex nature of an operator's observation either between screens or channels also increase the potential for slight movements in scenes to be missed, for example due to the distraction caused by switching between scenes or because a movement was at high speed and not fully observed. In other instances events may be completely missed simply because the relevant camera view picking up the event was not on the display or was not being observed at the time of the event.

A further problem with bulky observation cameras is that their size makes pan and tilt operations obvious to a would-be trespasser, who can thereby be assisted to evade the field of view. Also if their mass limits maximum pan and tilt rates it may not be possible to scan an area rapidly and efficiently enough in the event of an alarm.

Thus it is desirable to have a surveillance system so configured that the moving masses for pan and tilt are minimal in order to enhance speed of scan and for the moving elements to be enclosed to prevent their observation. The system as a whole should preferably be potentially compatible with advanced, computer supported processing and display technology and be able to compete effectively in terms of operating costs and reliability with human operators.

DE-A-3825757 shows a surveillance system with a pivoting mirror, a sensor and a graphics processor.

Accordingly the invention provides a surveillance system comprising at least one reflector capable of reflecting a field of view of varying azimuthal angle, at least one sensor for receiving reflected images, means for selecting the azimuthal angle of the field of view to be observed and a graphics processing system, characterised in that the means for selecting the azimuthal angle of the field of view to be observed comprises at least one of: means for altering the azimuthal angle of the reflector; means for altering the sensor position or actuation to detlect images from a selected azimuthal angle; and means for altering signal monitoring or switching of the sensor or sensors, and the graphics processing system effects a vector translation of the image signals in accordance with the selected azimuthal angle of the field of view.

Alteration of the reflector position preferably comprises rotation, for example the reflector may be rotated about two orthogonal axes, generally vertical and horizontal, in order to vary respectively the azimuthal and elevational angles of the field of view that is monitored (or line of sight).

In a particularly preferred embodiment the reflector is formed to have a sufficient elevational field of view to not require movement and the reflector is only mounted for azimuthal rotation.

The sensor may be rotated or translated. It is particularly convenient to utilise sensor translation to provide change in monitored elevation. This may be achieved by the reflector providing a larger field of view, at least in elevation, than the sensor area.

Alternatively the sensor may comprise a group of sensors or a sensor having separately operable zones, and different areas may be activated instead of sensor movement.

Sensor signal monitoring may be altered by selectively activated different ones or areas of a compound sensor or by varying the times of response. The reflector may be arranged, by its shape or by constant rotation to provide a scan of a substantial azimuthal field of view. Selective activation of sensor areas or instance of response may be used to determine the azimuthal angle that is monitored.

The graphics processing system preferably presents an image to a viewer that is easy to comprehend in that it is 'normalised' to correspond to an image that resembles direct viewing or displays information relating to detection of change.

The invention is now described by way of example with reference to the accompanying drawings in which:

Figure 1 illustrates an embodiment of the invention having a fixed camera and moving plane mirror;

Figures 2a and 2b show embodiments with a fixed camera and a moving shaped mirror;

Figure 3 shows a further embodiment with a fixed camera and a series of faceted mirrors; and

Figure 4 shows another embodiment with a fixed camera and a single complex mirror.

Referring to Figure 1, a surveillance system comprises a mirror 1 which reflects an image of an external scene 5 on to a sensor 7, which may be a camera sensor, an electro-optical device or part of an integrated electronic processing circuit forming part of an ultimate video display.

The plane mirror 1 rests in a horizontal bearing 2 so that it is free to move under the influence of a servo motor (not shown) to control the angle θ between a line 3 normal to the plane of the mirror, and horizontal plane 4. The external scene 5 reflected at the plane mirror is imaged by a lens 6 on to the imaging sensor 7. The particular area of the scene can be changed in the vertical plane by adjustment of the angle θ under servo control. Horizontal adjustment of the area of the scene is similarly achieved by rotation about vertical line Y-Y. The vertical line Y-Y passes through the axis 2 of vertical rotation of the plane mirror, the centre of the focusing lens and the centre of the imaging sensor.

Thus movement of the mirror in the azimuth and elevation planes provides effectively a pan and tilt function, but only the masses of the mirror mount and associated servo trains need to be moved, not the whole camera, and this permits a fast, economic servo-system design.

In the implementation of Figure 1 when the sightline is rotated in azimuth, one effect is rotation of the image at the sensor. It is known to use an optical device such as a Dove prism to counter image rotation, but such a device would need to be mechanically coupled, with complex gearing, to the rotating mirror and would add to the system inertia. Similarly, the sensor 7 could be coupled to rotate with the mirror but again introducing mechanical problems. For example it would be necessary to utilise high performance slip rings to connect between the sensor and static electrical connection, or the permissible extent of rotation would be limited, and in either case there would be increases to system mass, complexity and cost.

A signal from an encoder 8, in this embodiment indicative of the azimuth angular position of the mirror, is utilised to control a vector translation of the sensor image signals by means of a computer graphics unit 9 which provides output signals to control a display 10 and which processes the sensor image signals so as to counter the image rotation. The detailed method by which such translation can be achieved is not, of itself, a feature of this invention. One method is to store each frame of image data in a digital frame store, and then to read out the data in the required staggered sequence to counteract the image rotation on the sensor and present an erect image to the viewer. The delays imposed by such processing are small and the final image is capable of presentation in a substantially real time basis.

Returning to Figure 1, it can be seen that if the lens is of sufficiently large area, the image of the scene produced in the plane of the sensor can be significantly larger than the sensitive area of the sensor. Selection of the scene for display from this extended field of view can then be achieved by movement of the sensor. The elevation scene segment may be selected by relative movement of the sensor in the plane X-X, and the pan or azimuth scene changed by circumferential movement of the sensor centred on the lens axes. In a particularly preferred modification of the Figure 1 embodiment, tilting action of the mirror to change the sightline in the vertical plane is eliminated by having an enlarged vertical field of view for the mirror with movement of the sensor used for vertical scanning. This enables reduced mass and mechanical complexity in the mirror mounting arrangement, which only provides azimuthal scanning.

Figures 2 (a) and (b) show similar arrangements to that of Figure 1, except that the mirrors are curved in the vertical plane so as to modify the optical characteristics of the elevation (tilt) process. Similarly, a mirror having a more complex profile in the vertical scan direction, or indeed, in the azimuth plane, may be utilised to compensate for geometric distortion or to impart some required optical feature to the system. Curved mirrors may also be utilised with fixed vertical mirror angles, again using sensor movement to vary the field of view.

The benefits of the systems described are reduction of moving masses, simplicity of design and manufacture, and because of this correspondingly higher angular movement rates can be achieved. Use of reflectors other than simple plane mirrors enables selective changes to images that may be helpful, for example, the resolution of the sensor may be distributed over the image as a function of range. When such optical changes are made to the image, the aspect ratio or other features in the final image presented to an observer may be restored to normal viewing presentation, if required, by suitable graphics processing. Angular sensors at the mirror axes, or sensor may be utilised to provide suitable vector and other control signals for the graphics processing.

Compound sensors consisting of a plurality of discrete sensors or sensors with selectively operable areas may be utilised, selective activation of the individual sensors or areas being used to augment or replace sensor movement. Signals indicative of the area activated or sensor are also provided to the graphics processor.

Figure 3 shows schematically a further embodiment in which multiple mirrors or a multi-faceted mirror is employed to produce multiple images from the scene around the system. This system may be regarded as a compound grouping of several mirrors and sensors like those in Figures 1 and 2, with each mirror covering a smaller scanning area, and hence enabling faster changes by switching from one mirror to another with only a small angular adjustment. The mirrors reflect scenes from their different fields of view on to one or more suitably placed image sensors. If it is required to rotate the mirror assembly to redirect the line of sight, either as part of a routine scan or to track a movement, a discrete group of, for example four sensors located below a four faceted mirror, is rotated through a limited angular range to re-align a sensor with a mirror. With this arrangement only relatively small angular rotation capability is required, e.g. 90° maximum for a four sensor arrangement.

Alternatively, in a similar mirror configuration the multi-faceted mirrors may be rotated continuously at a high speed, and the nearest of the sensors angularly relocated to define an effective and required line of sight. Since the mirrors would under this condition be rotating, the corresponding images would describe a circle in the plane of the sensors, and it would be necessary to gate or strobe the selected sensor to produce a 'snapshot' of the image acceptably free from movement and blur. Utilising a strobe may eliminate the need for graphic rotation. Stroboscopic monitoring of the sensor may be provided within the graphics processor.

A particular advantage of this embodiment is high slew rates because the constantly rotating mirrors would not need acceleration after running up and only limited movement is required of the lightweight imaging sensors (less than 90° for a four sensor group) to redirect the sightline enabling rapid alterations in azimuth bearing. The use of multiple mirrors and sensors effectively reduces the extent of the angular steps involved. Such a system would be compatible with a need for a rapid repetitive scanning but less convenient for 'continuous' angular tracking.

Figure 4 illustrates an all around surveillance device with a static mirror replacing a rotating or rotatable mirror of the previous embodiments. The mirror may have a plane sectional profile, or be shaped in the manner of Figure 2a or 2b, or be a combination. An imaging sensor lies beneath the mirror and acquires a 360° panoramic view of the scene around the the device, the vertical profile of the mirror defining the vertical swathe of the scene effectively 'swept out' around the device and presented to the sensor. Optionally such a mirror may be provided with vertical movement. Arrangements with less than a 360° azimuthal range may also be useful when 360° viewing is not required.

Graphics processing by means of unit 9 may be used with this embodiment of the invention to select a suitable angular segment and process it for presentation to an observer. Alternatively, the full 360° image may be 'cut and processed' by appropriate graphics operations, before presentation as a continuous strip to an observer. Selective activation of compound sensors may also be used.

The concept of Figure 4 overcomes the problem in Figure 3 of continuous angular tracking by the use of a more complex but static mirror formed as a surface of revolution of a mirror of a profile such as those shown in Figures 1 or 2. Such a mirror would produce (ideally) a circular image at the sensor, having a radius corresponding to the vertical angle subtended by the mirror, and a 360° range about the system centre line. A sensor smaller than the complete reflected image may be used and rotated to change the field of view.

Images from a mirror of this type may be difficult to comprehend directly as a display by an observer, but could be used by an automatic processing system to detect significant changes or movement in scene detail such as the advent of intruders. This may be achieved by automatic frame comparison techniques. A fast slewing mirror as described with respect to Figures 1 or 2 could then be quickly directed to the coordinates of any such disturbance to facilitate closer examination. In this instance the graphics processing device provides the signals to the fast slewing mirror and displays either the image from that mirror or a readout indicative of information relating to the frame comparison.

It will be appreciated that the smaller nature of a rotatable mirror, rather than a bulky camera renders their changes in angle less obvious. Continuously rotating mirrors, static mirrors and variation of the field of view through sensor movement removes detection of changes to field of view by observation of the mirror. Mirrors may be replaced by other forms of reflectors.

**Claims**

1. A surveillance system comprising at least one reflector capable of reflecting a field of view of varying azimuthal angle, at least one sensor for receiving reflected images, means for selecting the azimuthal angle of the field of view to be observed and a graphics processing system, characterised in that the means for selecting the azimuthal angle of the field of view to be observed comprises at least one of:

   means for altering the azimuthal angle of the reflector;

   means for altering the sensor position or actuation to detlect images from a selected azimuthal angle; and

   means for altering signal monitoring or switching of the sensor or sensors,

   and the graphics processing system effects a vector translation of the image signals in accordance with the selected azimuthal angle of the field of view.

2. A surveillance system according to claim 1 in which either the sensor position is altered to select the angle of elevation of the field of view to be observed or a different sensor or sensor zone is activated to select the angle of elevation of the field of view to be observed.

3. A surveillance system according to any preceding

claim in which the reflector is movable and the sensor is movable, selectively actuable or a plurality of sensors switchable to select the azimuthal and elevational angles of the field of view to be observed.

**4.** A surveillance system according to claim 1 in which the reflector comprises a multi-faceted surface and the reflector and the sensor are rotated to select the azimuthal field of view to be observed.

**5.** A surveillance system according to any preceding claim in which the reflector is continuously rotated and sensor signals are monitored stroboscopically.

**6.** A surveillance system according to claim 5 in which synchronization of stroboscopic monitoring with the sensor, sensors or sensor area is varied to select the azimuthal angle of the field of view to be observed.

**7.** A surveillance system according to claim 1 in which the reflector is shaped to reflect images from a field of view with a substantial azimuthal distribution and the sensor or sensors are selectively moved or monitored to select the azimuthal angle of the field of view to be observed.

**8.** A surveillance system according to claim 7 in which the reflector comprises a surface of revolution of a curve.

**9.** A surveillance system according to any preceding claim in which the graphics processing system receives signals indicative of the azimuthal angle of the field of view to be observed from angular sensors associated with the reflector and/or sensor or sensors.

## Patentansprüche

**1.** Überwachungssystem, das zumindest einen Reflektor, der geeignet ist, ein Sichtfeld mit einem sich ändernden Seitenwinkel zu reflektieren, zumindest einen Sensor zum Empfangen reflektierter Bilder, eine Einrichtung zum Auswählen des Seitenwinkels des zu beobachtenden Sichtfelds und ein Grafikverarbeitungssystem aufweist, dadurch gekennzeichnet, daß die Einrichtung zum Auswählen des Seitenwinkels des zu beobachtenden Sichtfelds aufweist, zumindest eine von:

einer Einrichtung zum Ändern des Seitenwinkels des Reflektors;

einer Einrichtung zum Ändern der Sensorlage oder -betätigung, so daß Bilder von einem ausgewählten Seitenwinkel erfaßt werden; und

einer Einrichtung zum Ändern der Signalüberwachung oder zum Schalten des Sensors oder der Sensoren

und daß das Grafikverarbeitungssystem eine Vektorübertragung der Bildsignale entsprechend dem ausgewählten Seitenwinkel des Sichtfelds bewirkt.

**2.** Überwachungssystem nach Anspruch 1, bei dem entweder die Sensorlage geändert wird, so daß der Höhenwinkel des zu beobachtenden Sichtfelds geändert wird, oder ein anderer Sensor oder eine andere Sensorzone aktiviert wird, so daß der Höhenwinkel des zu beobachtenden Sichtfelds ausgewählt wird.

**3.** Überwachungssystem nach einem vorhergehenden Anspruch, bei dem der Reflektor beweglich ist und der Sensor beweglich ist, und zwar wahlweise betätigbar, oder eine Vielzahl Sensoren schaltbar ist, so daß der Seitenwinkel und der Höhenwinkel des zu beobachtenden Sichtfelds auswählbar ist.

**4.** Überwachungssystem nach Anspruch 1, bei dem der Reflektor eine mehrfach- facettierte Oberfläche aufweist und der Reflektor und der Sensor gedreht werden, so daß das zu beobachtende Seitensichtfeld ausgewählt wird.

**5.** Überwachungssystem nach einem vorhergehenden Anspruch, bei dem der Reflektor kontinuierlich gedreht wird und Sensorsignale stroboskopisch überwacht werden.

**6.** Überwachungssystem nach Anspruch 5, bei dem die Synchronisation des stroboskopischen Überwachens mit dem Sensor, den Sensoren oder dem Sensorbereich variiert wird, so daß der Seitenwinkel des zu beobachtenden Sichtfelds ausgewählt wird.

**7.** Überwachungssystem nach Anpruch 1, bei dem der Reflektor geformt ist Bilder von einem Sichtfeld mit einer im wesentlichen azimuthalen Verteilung zu reflektieren und der Sensor oder die Sensoren wahlweise bewegt oder überwacht werden, so daß der Seitenwinkel des zu beobachtenden Sichtfelds ausgewählt wird.

**8.** Überwachungssystem nach Anspruch 7, bei dem der Reflektor eine Oberfläche mit einer Kurvenkrümmung aufweist.

**9.** Überwachungssystem nach einem vorhergehenden Anspruch, bei dem das Grafikverarbeitungssystem Signale, die den Seitenwinkel des zu beobachtenden Sichtfelds anzeigen, von Winkelsensoren empfängt, die dem Reflektor und/oder dem Sensor oder den Sensoren zugeordnet sind.

**Revendications**

1. Système de surveillance comprenant au moins un réflecteur capable de réfléchir un champ de vision d'angle azimutal variable, au moins un capteur pour recevoir des images réfléchies, un moyen de choix pour choisir l'angle azimutal du champ de vision à observer et un système de traitement graphique, caractérisé en ce que le moyen de choix pour choisir l'angle azimutal du champ de vision à observer comprend au moins l'un :

   d'un moyen pour modifier l'angle azimutal du réflecteur;
   d'un moyen pour modifier la position ou la manoeuvre de capteur pour détecter des images à partir d'un angle azimutal choisi ; et
   d'un moyen pour modifier le pilotage ou la commutation des signaux du capteur ou des capteurs ;
   et en ce que le système de traitement graphique effectue une translation vectorielle des signaux d'image en fonction de l'angle azimutal choisi pour le champ de vision.

2. Système de surveillance selon la revendication 1, dans lequel soit l'on modifie la position de capteur pour choisir l'angle d'élévation du champ de vision à observer soit, l'on active un capteur différent ou une zone de capteur différente pour choisir l'angle d'élévation du champ de vision à observer.

3. Système de surveillance selon l'une quelconque des revendications précédentes, dans lequel le réflecteur est mobile et le capteur est mobile, manoeuvrable de façon sélective, ou comporte une pluralité de capteurs commutables pour sélectionner les angles azimutal et d'élévation du champ de vision à observer.

4. Système de surveillance selon la revendication 1, dans lequel le réflecteur comprend une surface à facettes multiples et dans lequel le réflecteur et le capteur sont mobiles en rotation pour choisir le champ de vision azimutal à observer.

5. Système de surveillance selon l'une quelconque des revendications précédentes, dans lequel le réflecteur est entraîné en rotation continuellement et les signaux de capteur sont pilotés de façon stroboscopique

6. Système de surveillance selon la revendication 5, dans lequel la synchronisation du pilotage stroboscopique à l'aide du capteur, des capteurs, ou d'une zone de capteur, varie pour choisir l'angle azimutal du champ de vision à observer.

7. Système de surveillance selon la revendication 1, dans lequel le réflecteur est conformé pour réfléchir des images provenant d'un champ de vision avec une répartition azimutale substantielle, et dans lequel le capteur ou les capteurs se déplacent ou sont pilotés de manière sélective pour choisir l'angle azimutal du champ de vision à observer.

8. Système de surveillance selon la revendication 7, dans lequel le réflecteur comprend une surface de révolution d'une courbe.

9. Système de surveillance selon quelconque des revendications précédentes, dans lequel le système de traitement graphique reçoit des signaux indicatifs de l'angle azimutal du champ de vision à observer à partir de capteurs angulaires associés au réflecteur et/ou au capteur, ou aux capteurs

FIG.1

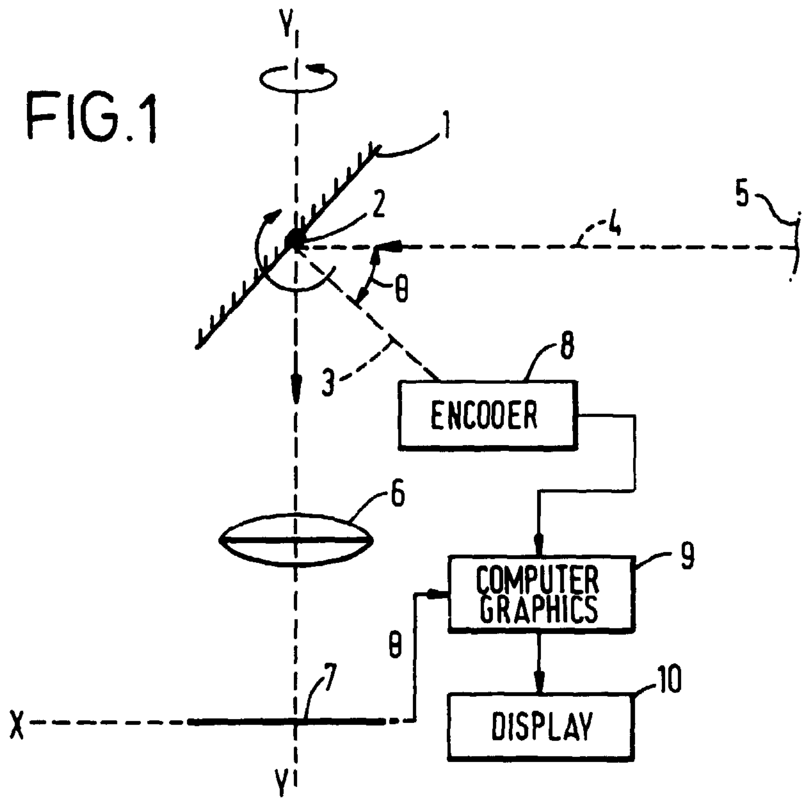
Y
1
2
5
4
θ
8
3
ENCODER
6
COMPUTER
GRAPHICS
9
θ
7
10
X
DISPLAY
Y

FIG.2(a)

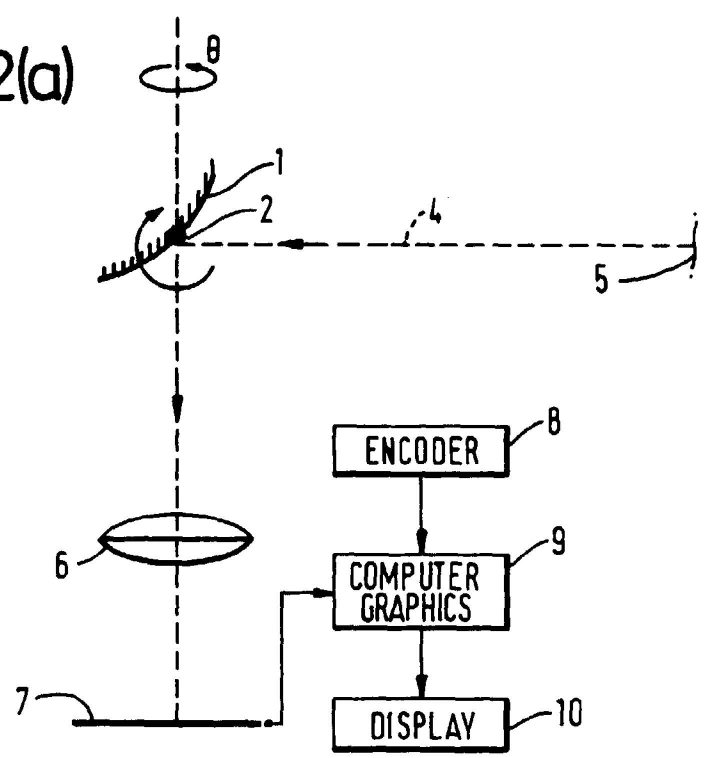
θ
1
2
4
5
8
ENCODER
9
6
COMPUTER
GRAPHICS
7
DISPLAY
10

FIG.2(b)

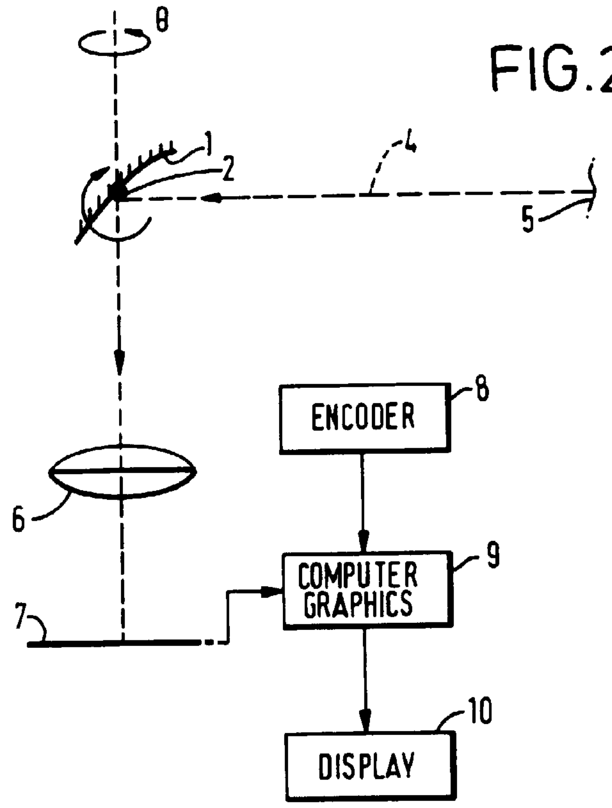
θ
1
2
4
5
ENCODER
8
6
COMPUTER GRAPHICS
9
7
DISPLAY
10

FIG.3

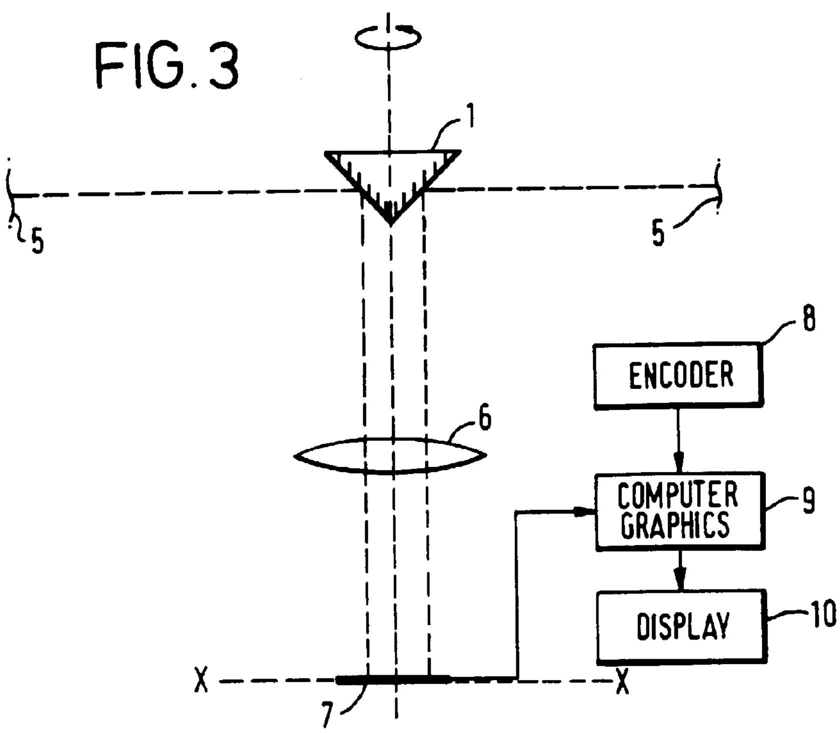
1
5
5
8
ENCODER
6
COMPUTER GRAPHICS
9
DISPLAY
10
X
X
7

FIG. 4