(12) UK Patent Application (19) GB (11) 2 308 199 (13) A

(43) Date of A Publication 18.06.1997

(21) Application No 9525309.2

(22) Date of Filing 11.12.1995

(71) Applicant(s)
Thomson Multimedia S A

(Incorporated in France)

9 Place Des Vosges, La Defense 5,
F-92400 Courbevoie, France

(72) Inventor(s)
Yoshiharu Chikazawa

(74) Agent and/or Address for Service
Williams,Powell & Associates
34 Tavistock Street, LONDON, WC2E 7PB,
United Kingdom

(51) INT CL^6
G03B 41/04 // G03B 35/00 , H04N 13/02

(52) UK CL (Edition O)
G2A AAA ACL ADE AG1V AG15 AG39 AG5C AG5D
H4F FCCC FDD FD15 FD27A2 FD27B FD27T2 FD83B

(56) Documents Cited
GB 1569579 A GB 1530755 A EP 0410419 A2
EP 0170747 A1 WO 88/10449 A1 WO 84/00825 A1
US 4437745 A

(58) Field of Search
UK CL (Edition O) **G2A AAA ACL ADE ADK ADX , H4F FCCC FDD**
INT CL^6 **G03B , H04N**
Online;WPI

(54) Camera with variable deflection

(57) It is the object of this invention to realise a camera for recording a target object with different convergence angles.

The proposed camera uses a controllable light deflecting device 8 located between an objective lens optic 7 and an intermediate optic 9, wherein only the objective lens system is rotatable. Such camera needs less motor power than conventional stereoscopic cameras. The use of such a camera in a stereoscopic camera system makes the controlling of the convergence angle, which depends from the viewing point and the distance of a target object, easier and more reliable.

The proposed camera can be used e.g. as part of a stereo camera system.

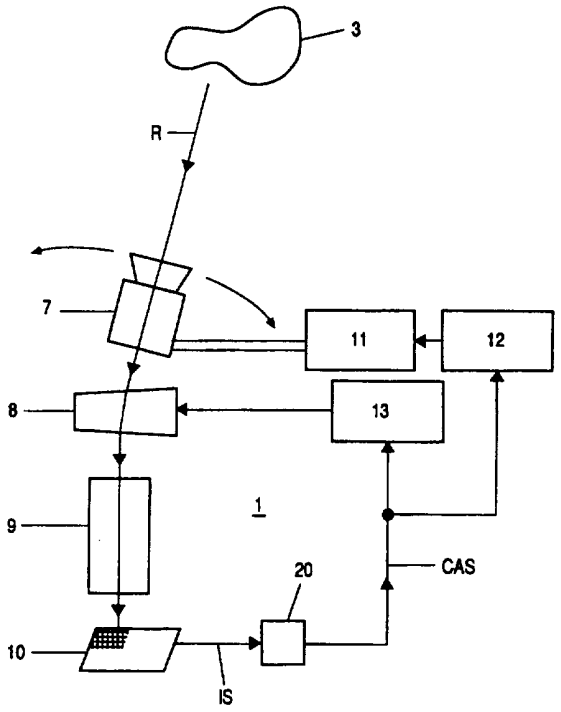

Fig.1

GB 2 308 199 A

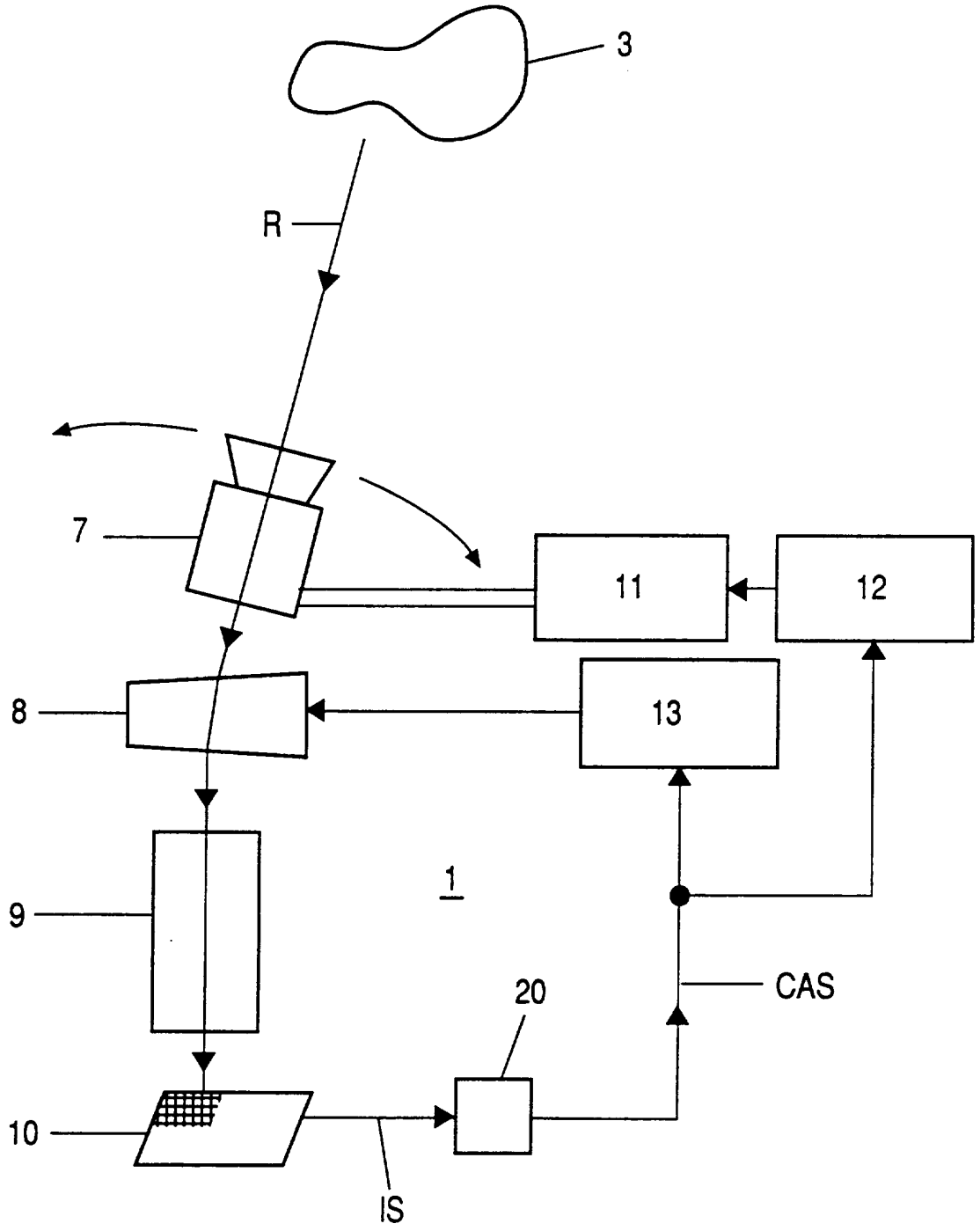

Fig.1

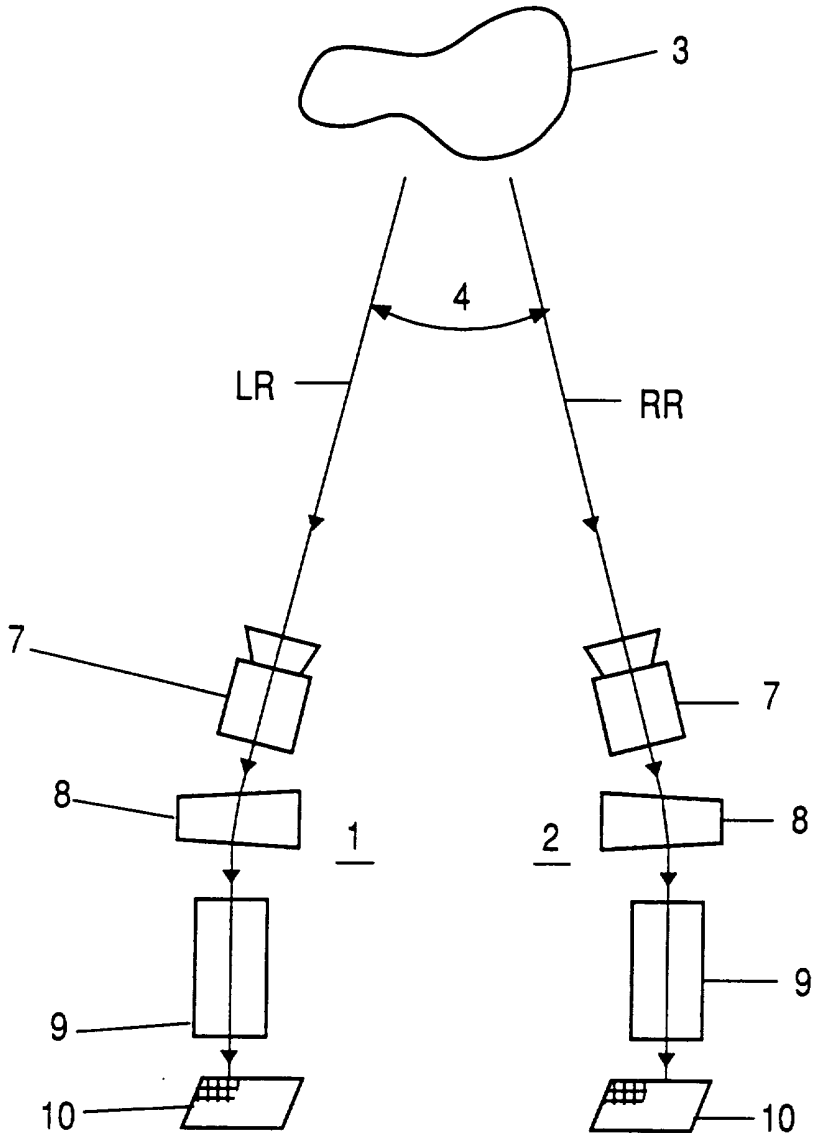

Fig.2

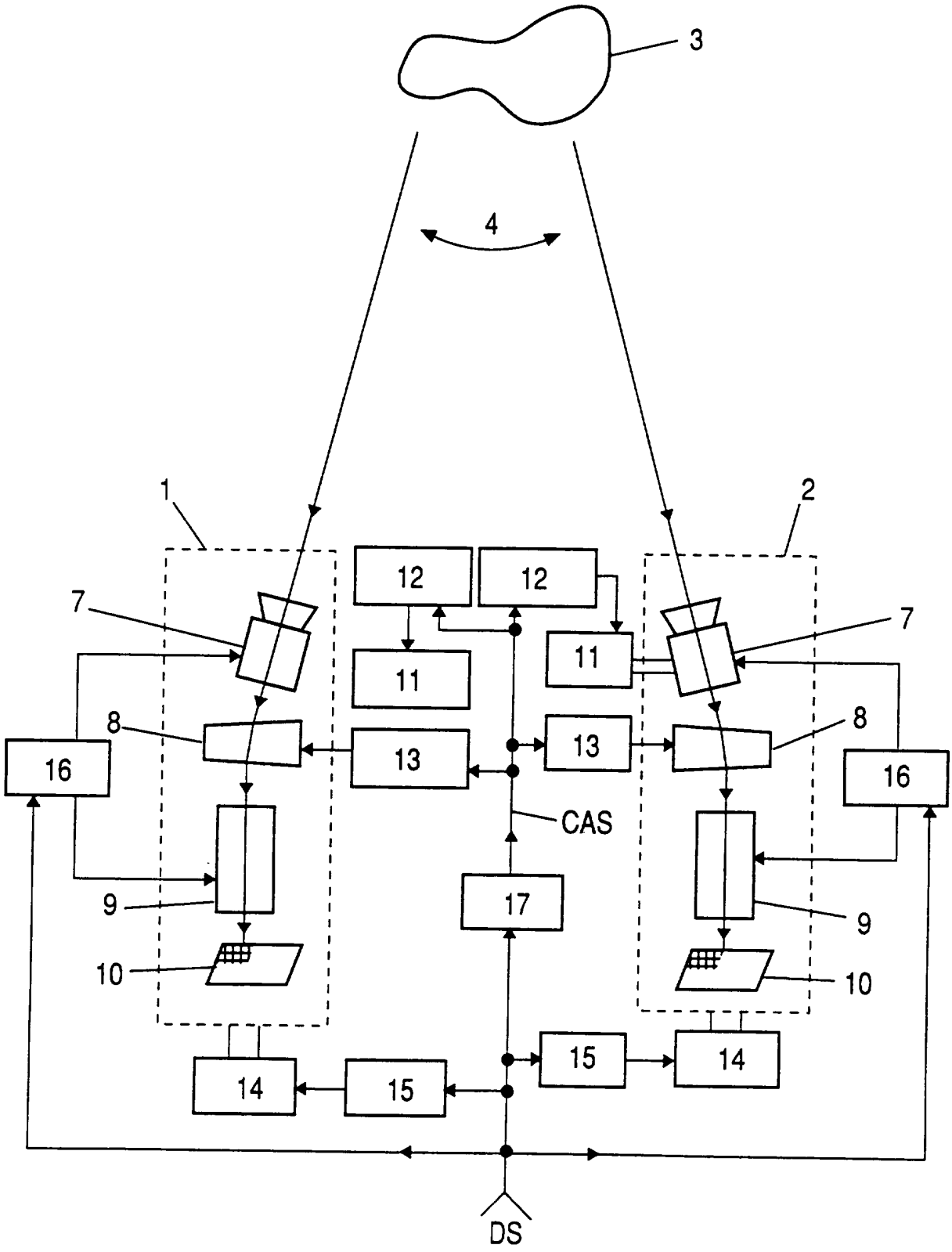

Fig.3

Prior Art

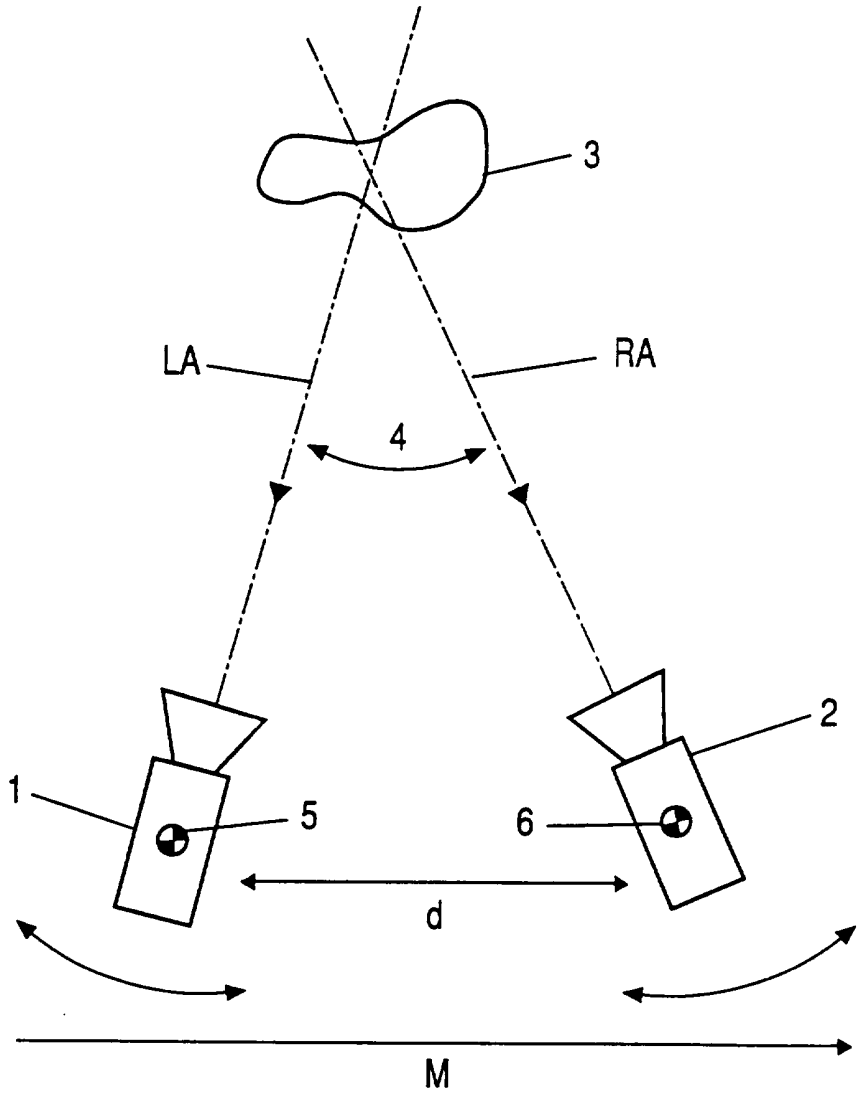

Fig.4

2308199

Camera with variable Deflection

The present invention relates to a camera with variable deflection and to a stereoscopic camera system using such cameras.

Known cameras used in stereoscopic applications do not differ in principle from normal cameras and comprise an objective lens system, which receives the light emitted from a target object, and an intermediate optic system, which forms the light beam into an appropriate shape for the following image device, which creates pixel signals and is formed by an electronic image device.

Known stereoscopic camera systems use two or more different angle images. In order to obtain two or more different angle images at the same time, two or more cameras, depending on the number of images required, have to be used. At the time of taking the stereoscopic image, each camera forms special convergence angles with each of the other cameras. In the further discussion, the number of cameras is chosen as two. Then, the only convergence angle is the angle formed by the two cameras focused on the target object. Further, the convergence angle is related to the viewing position of the observer. If, for example, the target moves, the two cameras must be focused onto the moving target under the condition that the convergence angle has to be kept in an appropriate range. This in turn implies that the cameras have to be moved and rotated independent of each other by motors under the conditions that the convergence angle, as well as the distance between the cameras, and the distance between the cameras and the target object have to be kept to appropriate values, otherwise no stereoscopic effect will be created during the display. Therefore, a large mechanical system comprising motors and respective control systems is needed which makes the camera system large and heavy. Further it is not easy to change the convergence angle rapidly as the distance between the cameras and the target changes.

FR 2 699 296 shows a camera system for the generation of stereoscopic images using two single cameras, wherein the distance of the camera and their convergence angle can be changed automatically as function of the distance of the target object. In the known system the

cameras are moved and rotated as a whole by motor means on a supplying arm to change the convergence angle.

Further the article "A Study of an Autostereocopic Camera System Using Liquid Prisms"; Okimura (of NTT Human Interface Laboratories) et al, D-369, Proceedings of the 1994 IEICE Spring Conference (Institute of Electronics, Information and Communication Engineers), page 7-102, shows a stereoscopic camera system, wherein a vari-angle prism is placed in the light path between the target object and each of the two cameras.

A vari-angle prism is an electro-optically induced deflection device. Such kind of devices are described e.g. in the articles "A Planar Electrooptic-Prism Switch", from I. P. Kaminow et al.; IEEE Journal of Quantum Electronics, August 1975 and ""Electro-optically induced deflection in liquid-crystal waveguides", J. P. Sheridan et al; Journal of Applied Physics, Vol. 45, No 12, December 1974.

The known camera systems show the above mentioned disadvantages, i.e. it is not easy to change the convergence angle rapidly as the distance between the cameras and the target changes.

It is therefore an object of the present invention to provide a camera with variable deflection and a stereoscopic camera system using such cameras wherein the handling of the cameras is easier and the complexity of the system is reduced.

This object is solved by the subject matter of the independend claims. Preferred embodiments are subject of the dependent claims.

The present invention relates to a camera with an objective lens system, an intermediate lens system, which forms the incident light beam, and an image device, characterized in that a controllable light deflecting device is located between the objective lens system and the intermediate lens system.

Such a controllable light deflecting device of the camera can be any device, which allows the controllable deflection of an incident light beam, like for example an electro-optical device, such as a vari-angle prism or a vari-angle plate.

It is one advantage of such a camera that movable target objects can be recorded without moving or rotating the whole camera by a user.

In a further embodiment the image device is formed by an electronically image device for creating pixel signals. The objective lens system is rotatable by a rotation mechanism. The combination of a rotable objective lens and a controllable light deflecting device has the advantage, that a very wide range of convergence angles can be covered, but it is not necessary to rotate the whole camera. Instead it is sufficient just to rotate the objective lens. Therefore, smaller motors can be used.

Both the rotation mechanism and the controllable light deflecting device can be controlled with the help of a common convergence angle signal.

Further the invention relates to a camera system using at least two of the above described cameras which can be focused at a target object and include controllable light deflecting devices, wherein the convergence angle between each two of the cameras and the object can be controlled.

To set the camera system at the necessary positions, at least one of said cameras can be provided with a moving mechanism for manually or automatic control. For good stereoscopic impressions the distance between said two cameras is controlled such that the ratio

$R = D/d$ is about 50,

with D: distance between camera system and target object;
d: distance between said two cameras of the camera system.

Further each camera can be provided with a focus controller for controlling the optics of the camera.

Further the rotation mechanism controllers and the controllers of the light deflection devices are controlled by a common convergence angle signal, which can be supplied by, for example, a conventional sensor which measures the distance between the camera and said target object.

Preferably all controllers of the camera system according to the invention are controlled by a distance signal. This distance signal is converted by a signal converter into a convergence angle signal used for the vari-angle prism controllers and the rotation mechanism controllers.

Further advantages and details of the invention are described with the aid of preferred embodiments with reference to the accompanying drawings, wherein:

Fig. 1 shows a basic embodiment of a camera according to the invention;
Fig. 2 shows a first embodiment of a stereoscopic camera system using cameras according to the embodiment of Fig. 1;
Fig. 3 shows a second embodiment of a stereoscopic camera system;
Fig. 4 shows a diagram of a prior stereoscopic camera system.

Fig. 4 shows a stereoscopic camera system according to the prior art, wherein two cameras 1, 2 are focused onto a target object 3, so that a convergence angle 4 is enclosed between an optical axis LA of the left camera and an optical axis RA of the right camera 2.

Both cameras 1, 2 can be independently rotated around a respective centre of rotation 5, 6. Further the cameras can be moved, e.g. such that the distance d between them is varied and/or as the whole camera sytem is moved in any direction, indicated by arrow M for one coordinate. As it is clear from Fig. 4, the cameras are moved and rotated as a whole in respect to their optical axes.

Fig. 1 shows a preferred embodiment according to the present invention, which is a camera, wherein an objective lens system 7 captures the incident light rays R from a target object 3. This objective lens system 7 is rotatable by a rotation mechanism 11, which is controlled by a controller 12. The light from the objective lens system 7 passes through a vari-angle prism 8, wherein the deflection angle can be controlled. Such vari-angle prisms are known in the art. The light passes through an intermediate bus system 9 which can be viewed as a beam forming optics, and is incident onto an image device 10, which is usually an electronic image device. The deflection angle of the vari-angle prism 8 is controlled as a function of a convergence angle signal CAS by a controller 13.

It is preferred that the signal CAS is determined by detecting means 20, which get input signals IS from said image device 10. Signals IS are a mass for the position of object 3 in relation to the direction of the whole camera 1. As said signal IS depends also on control parameters for rotation mechanism 11 and prism 8, a closed loop control of signal CAS can be realsied.

Of course, also other kind of detecting means are possible which detect the relative position of object 3. Such means may work with electromagnetical, optical and/or acoustical ray detection and may include as well receiving means as transmitting means for said rays.

With the use of said deflection angle controllable device 8 it is not necessary to rotate the whole camera, instead it is only necessary to rotate the objective lens system 7 so that the necessary motors (not shown) can be of a smaller size.

The embodiment is not restricted to the use of a vari-angle prism 8, but every electronical and/or optical controllable device capable of controlling the deflection of a light beam can be used.

Fig. 2 shows the basic illustration of a stereoscopic camera system using two cameras according to Fig. 1.

The left camera 1 having objective lens system 7 captures the incident light rays LR from a target object 3.

The right camera 2 is symmetrical to the left camera 1 and receives rays RR and includes also an objectice lens 7, a vari-angle prism 8, a intermediate bus system 9, and an image device 10.

The means of both cameras 1,2 perform the same function. That is why they are indicated with the same reference numbers.

Fig. 3 shows more detailed schematics of a embodiment of a stereo camera system. Means having same functions as in the preceding figures are marked with the same reference numbers.

The two cameras 1, 2 are formed by cameras according to Fig. 1, each comprising an objective lens system 7, a vari-angle prism 8, an intermediate lens system 9 and an image device 10. The rotation of the objective lens system 7 of each camera 1, 2 is controlled by a respective rotation mechanism 11, together with controllers 12. The deflection angles of the vari-angle prisms 8 are controlled by controllers 13.

Both cameras 1, 2 can be moved independent from each other by a respective moving mechanism 14 controlled by a controller 15, respectively.

The focus of each camera 1, 2 is controlled by a focus controller 16 provided for each camera 1, 2. Both focus controllers 16 are controlled by a distance signal DS of the distance between the cameras and the target object 3 which is measured appropriately. This distance signal DS is also used to control the moving mechanisms 14 by the controllers 15. With a signal converter 17 this distance signal DS is converted into a convergence angle signal CAS, which is necessary for the rotation and the deflection angle controllers 12, 13.

It is possible that the signal DS is determined e.g. by not shown detecting means, which get input signals from said image devices 10, by a manual-input signal from a camera operator, or thelike. These input signals are a mass for the position of object 3 in relation to the direction of the whole camera 1. As said input signal depends also on control parameters for rotation mechanism 11 and prism 8, a closed loop control of said input signals and of signal CAS can be realsied.

Of course, also other kind of detecting means are possible which detect the distance between camera system 1, 2 and object 3. Such means are well known for focus-control and may work with electromagnetical, optical and/or acoustical ray detection and may include as well receiving means as transmitting means for said rays.

By the present invention it is possible for a wide range of possible values of the convergence angle and the target object distance, to keep the intermediate optics 9, i.e. the whole camera, fixed. By controlling the deflection angle of the vari-angle prism 8 it is only necessary that the objective lens optics 7 of the cameras 1, 2 is rotated. The stereoscopic camera system is not limited to the use of two cameras. According to the application it is possible to use more than two cameras.

Claims

1. Camera (1; 2) with an objective lens system (7), an intermediate lens system (9), and an image device (10),

characterized in that

a controllable light deflecting device (8) is located between the objective lens system (7) and the intermediate lens system (9).

2. Camera according to claim 1, wherein the controllable light deflecting device (8) is an electro-optical device, such as a vari-angle prism or a vari-angle plate.

3. Camera according to one of the preceding claims, wherein a rotation mechanism (11) is provided for rotating the objective lens system (7).

4. Camera according to claim 3, wherein signal generating means (20) are provided which generate a convergence angle signal (CAS) which is used for controlling said rotating mechanism (11) and said deflection device (8).

5. Camera according to claim 4, wherein said convergence angle signal (CAS) is derived from a signal (IS) which depends on the relative position between said camera (1; 2) and a target object (3).

6. Stereoscopic camera system using at least two cameras (1, 2) which can be focused at a target object (3) and which have controllable light deflecting devices (8), wherein the convergence angle (4) between each two of the cameras (1, 2) and the object (3) can be controlled,

characterized in that

the stereoscopic camera system uses cameras (1, 2) according to one of the preceding claims.

6. Stereoscopic camera system according to claim 5, wherein at least one of said cameras (1, 2) is provided with a moving mechanism (14).

7. Stereoscopic camera system according to one of the claims 5 or 6, wherein said rotating mechanism (11) and said deflection device (8) are controlled with the help of a common convergence angle signal (CAS).

8. Stereoscopic camera system according to one of the claims 5 to 7, wherein each camera (1, 2) is provided with a focus controller (16) for controlling the optics of the camera (1, 2).

9. Stereoscopic camera system according to one of the claims 6 to 8, wherein all controllers (12, 13, 16) of the system are controlled in dependence on a distance signal (DS).

10. Stereoscopic camera system according to claim 9, wherein the distance signal (DS) is converted by a signal converter (17) into a convergence angle signal (CAS) used for the vari-angle prism controllers (13) and the rotation mechanism controllers (12).

Patents Act 1977 10 **Examiner's report to the Comptroller under Section 17 (The Search report)**	Application number GB 9525309.2
Relevant Technical Fields (i) UK Cl (Ed.O) HEADING G2A (MARKS AAA, ACL, ADX, ADE, ADK) HEADING H4F (MARKS FCCC, FDD) (ii) Int Cl (Ed.6) G03B AND H04N	Search Examiner R SHORT Date of completion of Search 24 JANUARY 1996
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1-10

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1569579 A	(VIVITAR) see movable mirror 27	1
X	GB 1530755 A	(LEXIE) see movable mirror 12	1
A	EP 0410419 A2	(CANON)	
X	EP 0170747 A1	(CONDON) see page 10, lines 9, 10	1
X	WO 88/10449 A1	(DEGUERVILLE) note movable rhombs 24, 25	1
X	WO 84/00825 A1	(KISUZEMI) see page 10, lines 4-7	1, 2
X	US 4437745 A	(HAJNAL) see mirrors 10, 11	1

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).