(54) Title: REMOTE VIDEO RECOGNITION SYSTEM
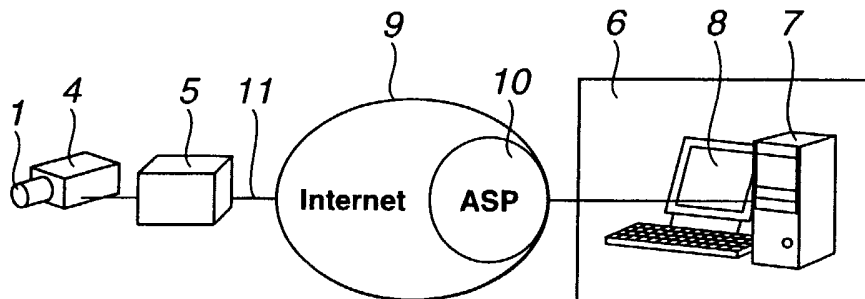
(57) **Abstract:** A remote video recognition system is provided which realizes a new, one-source-multiscreen image reception system. The system comprises an imaging means such as a CCD device (4), a transmission means (5) for transmitting a video shot by the imaging means, and a display means (8) installed in a remote place (6) to receive video information transmitted from the transmission means and display the video information. The imaging means has a fish-eye lens (1) that can capture a curved image with a wide viewing angle. The transmission means can transmit the video shot by the imaging means to a desired location via the Internet (9). The imaging means, the transmission means or the display means (8) is provided with an input device that can select and specify an arbitrary range or area of the image. The selected arbitrary range or area of the image is automatically tracked.

DESCRIPTION

Remote Video Recognition System

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates to a remote video
recognition system applied, for example, to a surveillance
system and capable of outputting and displaying a video
produced by an imaging means, including projection lenses
such as a fish-eye lens and hemispherical reflection mirrors
such as a convex mirror, in any desired form at a site remote
from where the imaging means is installed.

Background of the Invention

Significant advances have been made in the computer-
related technologies in recent years. Particularly,
technologies (software) associated with computer graphics
have progressed remarkably as the processing speed of the
computer itself and the storage capacities are increasing.
The use of graphics processing software allows figures or
images taken into the computer to be not only enlarged or
reduced but also deformed arbitrarily. Deforming or morphing
an image taken into the computer currently involves breaking
down the image into pixels and performing complicated
computations on each of the pixels to produce a desired

deformed image.

However, since the image deformation processing described above requires performing complex calculations for each pixel, its practical application has been limited to drawing. When such image deformation processing is to be applied, however, the conventional processing software, which must perform complex calculations on each pixel, inevitably increases the amount of time required. That is why it has found only a limited use in everyday life. If the image deformation processing can be done quickly, an image shot by a hemispherical reflection mirror such as a convex mirror or a fish-eye lens, which can cover a wider viewing area than ordinary lenses, can be converted into a plane image for display. It is thus considered possible to build a surveillance system that can monitor a wide observation area with a smaller number of imaging operations.

Based on this technology, it is also considered possible to build another technology for easily monitoring sites from a remote place. In a field of broadcast, too, based on the above technology it is further considered possible with a limited number of components to track and display only a particular person or enlarge or reduce an output view of a particular area being monitored.

Under these circumstances the present invention has been accomplished after vigorous study and research and

provides a remote video recognition system which allows the
user at a remote place to select a desired range of a video
produced by an imaging means to enlarge or reduce or track a
particular person, for example.

SUMMARY OF THE INVENTION

To achieve the above objective, the present invention
provides a remote video recognition system which comprises:
an imaging means installed at an arbitrary position; a
transmission means for transmitting a video shot by the
imaging means; and an output means installed at a position
remote from where the imaging means is installed, the output
means being adapted to receive video information transmitted
from the transmission means and display an image according to
the video information; wherein the output means is provided
with an input device and an arbitrary range of the displayed
image can be selected through the input means and enlarged or
reduced for display.

In another aspect of this invention, after the
arbitrary range of the image information obtained is selected
through the input means, a portion of the image that is
within the selected range is automatically tracked down and
displayed.

In still another aspect of the invention, the imaging
means has an imaging device capable of capturing a curved

image with a wide viewing angle. The transmission means, as
claimed in claim 4, can transmit the image information taken
in by the imaging means to the output means through a wired
or wireless network or the Internet.

In a further aspect of this invention, at least one of
the imaging means, the transmission means and the output
means has a transformation means for transforming the image
information into a plane image, the output means has a
monitor to which the plane image transformed by the
transformation means is output, and the transformation means
calculates sampling points on the curved image according to a
projection characteristic of the imaging device and
transforms the curved image into the plane image.

In a further aspect of this invention, the
transformation means may build a spherical polygon model
according to the projection characteristic of the imaging
device, match the sampling points on the curved image to
vertices of a plurality of triangles making up the polygon
model, transform the sampling points into a camera viewing
system by a geometry transformation, and perform various
projection conversions to transform the curved image produced
by the imaging device into the plane image.

In a further aspect of this invention, rather than
being provided in at least one of the imaging means, the
transmission means and the output means, the transformation

means may be provided in a server on the wired or wireless network or the Internet, the image information taken in by the imaging means may be transmitted by the transmission means to the server, stored there and transformed into a plane image, and the output means may connect to the wired or wireless network including the Internet to receive the image and output it to a monitor or the like.

In a further aspect of this invention, the projection characteristic of the imaging device may include parameters associated with a radius of curvature of the imaging device; the projection lens may use a fish-eye lens; and the fish-eye lens may be replaced with a hemispherical reflection mirror such as a convex or concave mirror.

In a further aspect of this invention, the output means may use a computer, a cell phone (including a PHS), or even a television receiver.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic block diagram showing a first embodiment of the present invention.

Fig. 2 is a block diagram showing a detail of a CCD device.

Fig. 3 is a schematic diagram showing a first half of an action performed by a transformation means.

Fig. 4 is a schematic diagram showing a second half of

the action performed by the transformation means.

Fig. 5A illustrates a curved image produced by a fish-eye lens and Fig. 5B illustrates a plane image converted from the curved image by a conversion program.

Fig. 6 is a schematic block diagram showing a variation of the first embodiment of the present invention.

Fig. 7 is a schematic block diagram showing a second embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 shows an example embodiment of the present invention as applied to a surveillance system. The surveillance system of this embodiment includes a CCD device 4 installed at a site being monitored, a transmission means 5 for transmitting a video shot by the CCD device 4, a computer 7 installed in a monitoring center 6 remote from the site where the CCD device 4 is installed, and intended to receive video information transmitted from the transmission means 5 (in this invention the "computer" includes devices with computer functions; this applies in the following descriptions), and a monitor 8 making up the computer and displaying the video information received. The CCD device 4 corresponds to the imaging means defined in claims. In this specification, the word "computer" is intended to include general computers and other devices that incorporate CPU and

MPU or the like and perform computer functions.

The CCD device 4, as shown in Fig. 2, has a fish-eye lens 1 or an imaging device, an optical filter 2, an optical lens 3, and a CCD camera 4. An image produced by the fish-eye lens 1 (curved image) is taken into the CCD device 4 through the optical filter 2 and the optical lens 3. The CCD device 4 is connected to a first controller (CPU) not shown, and thus the curved image taken into the CCD device 4 is sent to the first controller. The curved image refers to an image produced by the fish-eye lens 1. It is noted, however, that where a convex mirror, concave mirror or wide-angle lens is used in place of the fish-eye lens 1 as described later, the curved image refers to an image produced by the convex mirror, concave mirror or wide-angle lens.

The transmission means 5 is allowed by a second controller (CPU) not shown to connect to the Internet 9 via a telephone line 11, so that image information taken in from the CCD device 4 is transmitted to a server (including ASP) 10 on the Internet 9. The server 10 refers to a service in general that provides software functions via the Internet. The computer in the monitoring center 6 can connect to the server 10 through a communication device including a terminal adapter (TA). The computer 7 receives the image information from the server 10 and displays it on the monitor 8 that makes up the computer 7.

In this embodiment, a conversion means (not shown) to transform the image information is incorporated in a computer not shown which is installed in the server 10. For a connection with the Internet 9, a LAN and a wireless communication may be used in addition to the public switched telephone network.

The conversion means is a conversion program to transform the curved image taken into the CCD device 4 into a plane image. The plane image refers to an image that is presented to user's eye.

The conversion program is intended to transform the curved image produced by the fish-eye lens 1 into a plane image by calculating sampling points on the curved image based on projection characteristics of the fish-eye lens 1. That is, the process of converting a curved image formed by the imaging device into a plane image involves building a spherical polygon model based on projection characteristics including those associated with a radius of curvature of the fish-eye lens 1, matching the sampling points on the curved image to the vertices of a plurality of triangles making up the polygon model, converting them into a camera viewing field system by a geometry conversion and then performing a variety of projection conversions.

The projection characteristic of the fish-eye lens 1 has a hemispherical or pyramidal shape, as shown in Fig. 3.

A sampling model marked with sampling points is imaged by the fish-eye lens 1. The sampling model imaged by the fish-eye lens 1 is shot as by the CCD device to determine destination points on the plane image (two-dimensional image) that are projected from the sampling points. Based on the destination points, a polygon model with the same or approximately the same shape as the sampling model is built on the computer. Then, the sampling points on the sampling model imaged by the fish-eye lens 1 are matched to corresponding vertices on the polygon model. In this way the projection characteristic of the fish-eye lens 1 is obtained. This projection characteristic need only be determined once. If the projection characteristic of the fish-eye lens 1 is already known, the vertices on the polygon model that match the corresponding sampling points are calculated without using the sampling model.

Based on the projection characteristic of the fish-eye lens 1 thus obtained, the vertices of a plurality of triangles on the polygon model are geometry-transformed into a camera coordinate system where they are subjected to various projection processing such as parallel projection and perspective projection to determine destination pixels on the plane that are projected from the vertices. Next, triangular sampling areas on the curved image that correspond to the triangular areas on the plane determined as described above

are deformed as required. That is, for each pixel in the

triangular areas on the plane, a pixel on the curved image

that should be referenced is determined. These processing

are not precise calculations but approximations, which can

improve the processing speed.

        In other words, as shown in Fig. 3, the sampling points

on the sampling model imaged by the fish-eye lens 1 are

matched to the corresponding vertices of a plurality of

triangles making up the polygon model and then geometry-

transformed into a camera viewing field system where they are

subjected to the above-described projection processing. That

is, if a virtual camera with a line of sight, a viewing angle,

a clipping plane and a banking angle is assumed to be placed

in a three-dimensional space and one looks through the camera

positioned at an origin of the polygon model, then he or she

can see a plane image that was converted from the curved

image. In practice, this conversion procedure consists in

determining destination points on the two-dimensional image

that are projected from the sampling points through the

virtual camera and, as shown in Fig. 4, filling the

triangular area of each sampling point without a gap by the

affine transformation. This process obviates the need for

performing complex calculations for each of a large number of

pixels as required by the conventional method, and enables a

fast conversion.

The plane image produced by the method of this
embodiment is an approximated image. It can be made close to
an actual image as by increasing the number of polygons in
the polygon model to make it more resemble the sampling model
or improving the density of the polygon model, as required.

This embodiment constructed as described above operates
as follows. The fish-eye lens 1 produces an image (curved
image) as shown in Fig. 5A. This curved image is taken in by
the CCD device 4 which transfers the image to the computer 7
in the server 10 through the Internet 9. The curved image is
then transformed into a plane image by the conversion program
in the computer. The burden on the computer can be
alleviated by performing the curved image-to-plane image
transformation through a predetermined angle (for example, 90
degrees) at a time. As described earlier, this
transformation is processed at higher speed than in the
conventional method. The computer 7 serving as the output
means connects to the server 10 via the Internet 9 to receive
the transformed plane image. The plane image transferred to
the computer 7 is then displayed on the monitor 8 of the
computer 7. Fig. 5B shows a plane image displayed on the
monitor 8.

In this embodiment, the user can select any desired
range of the plane image output to the monitor 8 by using an
input means of the computer 7, such as a mouse, and enlarge

or reduce the selected range for display. This configuration

can be realized by adopting a conventionally known method.

Further, a desired range of the plane image, which was

selected by the input means such as a mouse and displayed on

the monitor 8, can be tracked. This tracking can be

performed, for example, by transmitting the data of the

selected range to the computer 7 on the server 10 and by

having the computer select a portion of the curved image

corresponding to the selected range of image data and

transmit it to the computer 7. For this purpose, the

computer 7 on the server 10 is provided with a storage means

(e.g., a hard disk or semiconductor memory) to store the

image data supplied and with a decision program that

determines and selects that portion of the curved image

transmitted successively from the transmission means 5 which

matches the selected range of the image data. This decision

program may be chosen from those available on the market in

the form of software stored in a RAM (Random Access Memory).

As can be seen from Fig. 5, in this embodiment, a video

of almost the entire area around the CCD device 4 which was

captured by a single fish-eye lens or by the fish-eye lens 1

and the single CCD device 4 can be displayed on the monitor 8.

Hence, there is no need to install a large number of

surveillance cameras as required in the conventional

surveillance system. Further, in this embodiment, since the

video is taken in via the Internet 9, if the monitoring

center 6 is located in a place or country remote from where

the CCD device 4 is installed, the surveillance can be

performed with ease.

The image taken in by the CCD device 4 can be subjected

to additional processing by the computer in the server 10,

for example, to make the face of a suspicious man more

identifiable. This widens the range of applications.

Further, the ability to enlarge or reduce a selected

range of the video and to track a selected range (e.g., a

particular person) as described above can improve the

surveillance function. This invention may also be applied to

the broadcast of baseball and soccer games, whereby a viewer

can choose a particular player (e.g., a forward) and enjoy a

video showing that player always at the center.

Alternatively, a so-called one-source-multiscreen system may

be built whereby, although the same original video is

received, a receiver on the viewer side can pick up a desired

image portion so that each viewer can enjoy his or her own

image or multiple, different images at the same time. This

can realize a personal image system with ease and at low cost

without requiring a huge facility investment.

Although in the above embodiment, a fish-eye lens is

used for the imaging device, a hemispherical reflection

mirror such as a concave or convex mirror can be employed.

Further, in the first embodiment described above, the
transformation means has been described to be installed in
the computer on the server 10. In this invention, the
transformation means (conversion program) may be provided in
the first controller making up the CCD device 4, or the
second controller making up the transmission means 5, or the
computer 7 making up the output means. In other words,
rather than being provided in the computer on the server 10
as described above, the conversion program may be installed
in the first controller forming the CCD device 4 or in the
second controller forming the transmission means 5. It may
of course be installed in the computer 7 forming the output
means. When this configuration is adopted, there is no need
to provide the server 10 as shown in Fig. 6. The
configuration shown in Fig. 6 represents a case where the
conversion program is installed in the computer 7 forming the
output means. In this configuration, the image data (curved
image) transmitted via the transmission means 5 to the
computer 7 is transformed by the computer 7 into a plane
image which is then output to the monitor 8. As mentioned
earlier, in this invention the conversion program may be
installed in any of the devices 4, 5, 7 making up this system.

Fig. 7 shows a second embodiment of the present
invention. In this embodiment the monitoring center 6 of the
first embodiment is not provided and the video captured by

the CCD device 4 is displayed on a cell phone or mobile

terminal 12. Hence, the cell phone or mobile terminal 12

must be able to connect to the Internet. Other

configurations and operations are similar to those of the

first embodiment.

With this embodiment, a variety of applications are

conceivable. For example, the CCD device 4 may be installed

in a kindergarten or home so that a mother working in an

office can watch her child in the kindergarten or home by

using her cell phone 12. In this case, by using a memory in

the computer at home or a server on an internet service

provider side, it is possible not only to realize the real-

time observation but also to view a recorded and stored video

by fast-feeding it. Further, at kindergartens and homes, it

is possible to build an observation system by simply

installing the CCD device 4 and necessary software.

Therefore, this embodiment has an excellent versatility.

In this invention, the cell phone 12 may be replaced

with a portable computer or PDA. It is also possible to use

a PHS or even a TV receiver in the place of the cell phone.

In the above embodiment, we have described an example

case where a desired portion of the image is selected from

the plane image output to the monitor 8. This invention is

not limited to this arrangement, and the desired portion of

the image may be selected from the curved image captured by

the imaging means such as the CCD device 4 or from the image

transmitted by the transmission means. Further, the selected

portion of the image does not need to be transformed into a

plane image and may be recorded and stored as is. The

selected portion of the image may also be tracked and then

recorded and stored without converting it into the plane

image.

INDUSTRIAL APPLICABILITY

Since the present invention is configured and operates

as described above, a portion of the image that is selected

using an input means can be enlarged or reduced, or tracked

down. This not only improves the surveillance function but

also allows the application of the invention to the

television broadcast whereby a viewer can select a particular

person and watch the TV showing that person at the center of

the screen. This invention can also realize a one-source-

multiscreen system, thus offering new ways to enjoy the TV

broadcasting. Further, the use of a curved image shooting

means can realize fast image transformation processing. This

invention therefore can be applied at low cost to a variety

of equipment including a surveillance system.

CLAIMS

1. A remote video recognition system comprising:

an imaging means with a wide viewing angle installed at an arbitrary position;

a transmission means for transmitting a video shot by the imaging means; and

an output means installed at a position remote from where the imaging means is installed, the output means being adapted to receive video information transmitted from the transmission means and display an image according to the video information;

wherein the output means is provided with an input device and an arbitrary range or area of the displayed image can be selected through the input means and enlarged or reduced for display.

2. A remote video recognition system according to claim 1, wherein, after the arbitrary range or area of the image information obtained is selected through the input means, a portion of the image that is within the selected range is manually or automatically tracked down by a means such as a mouse or cursor and displayed.

3. A remote video recognition system according to claim 1 or 2, wherein the imaging means has an imaging device capable of capturing a curved image with a wide viewing angle.

4. A remote video recognition system according to any

one of claims 1 to 3, wherein the transmission means can transmit the image information taken in by the imaging means to the output means through a wired or wireless network.

5. A remote video recognition system according to any one of claims 1 to 4, wherein at least one of the imaging means, the transmission means and the output means has a transformation means for transforming the image information into a plane image, and the transformation means calculates sampling points on the curved image according to a projection characteristic of the imaging device and transforms the curved image into the plane image.

6. A remote video recognition system according to claim 5, wherein the transformation means builds a spherical polygon model according to the projection characteristic of the imaging device, matches the sampling points on the curved image to vertices of a plurality of triangles making up the polygon model, transforms the sampling points into a camera viewing system by a geometry transformation, and performs various projection conversions and rasterization to transform the curved image produced by the imaging device into the plane image.

7. A remote video recognition system according to claim 5 or 6, wherein, rather than being provided in at least one of the imaging means, the transmission means and the output means, the transformation means is provided in a

server on the wired or wireless network, the image

information taken in by the imaging means can be stored in

the server and transformed into a plane image, and the output

means connects to the wired or wireless network including the

Internet to receive the image and output it to a monitor or

the like.

8. A remote video recognition system according to any

one of claims 1 to 7, wherein the projection characteristic

of the imaging device includes parameters associated with a

radius of curvature of the imaging device.

9. A remote video recognition system according to any

one of claims 1 to 8, wherein the imaging device is a

hemispherical reflection mirror or a projection lens.

10. A remote video recognition system according to

claim 9, wherein the projection lens is a fish-eye lens.

11. A remote video recognition system according to

claim 9, wherein the hemispherical mirror is a convex mirror

or a concave mirror.

12. A remote video recognition system according to any

one of claims 1 to 11, wherein the output means is a computer.

13. A remote video recognition system according to any

one of claims 1 to 11, wherein the output means is a cell

phone.

14. A remote video recognition system according to any

one of claims 1 to 11, wherein the output means is a
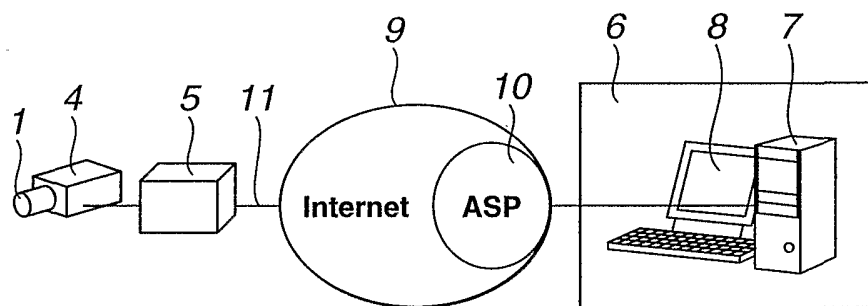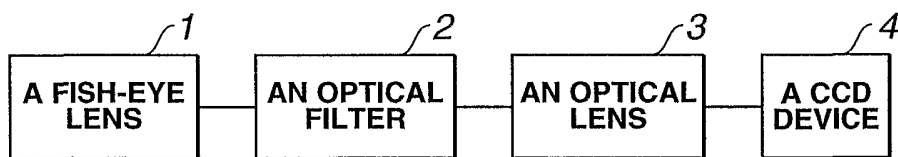
television receiver.

FIG.1

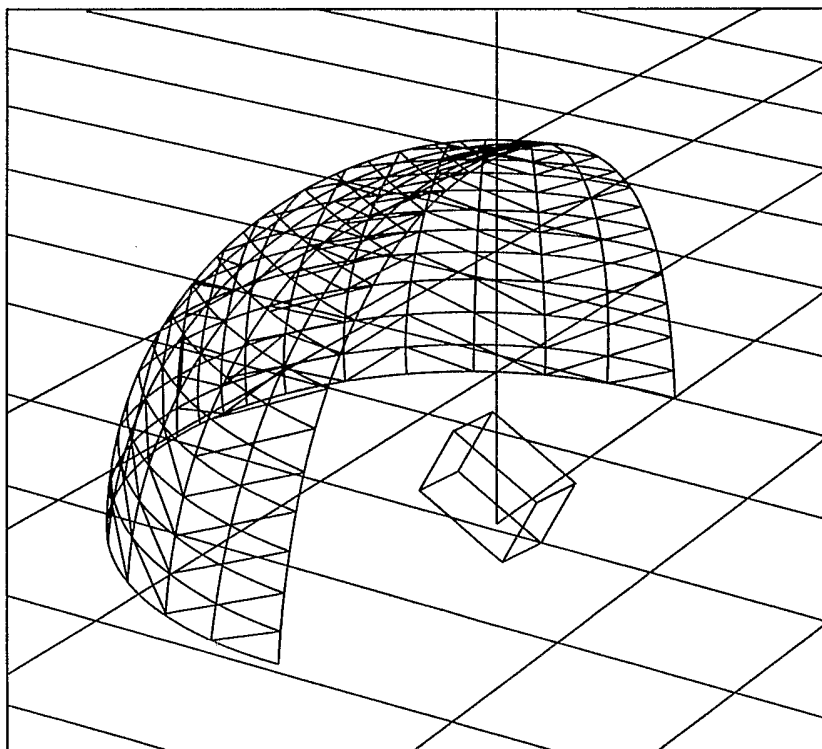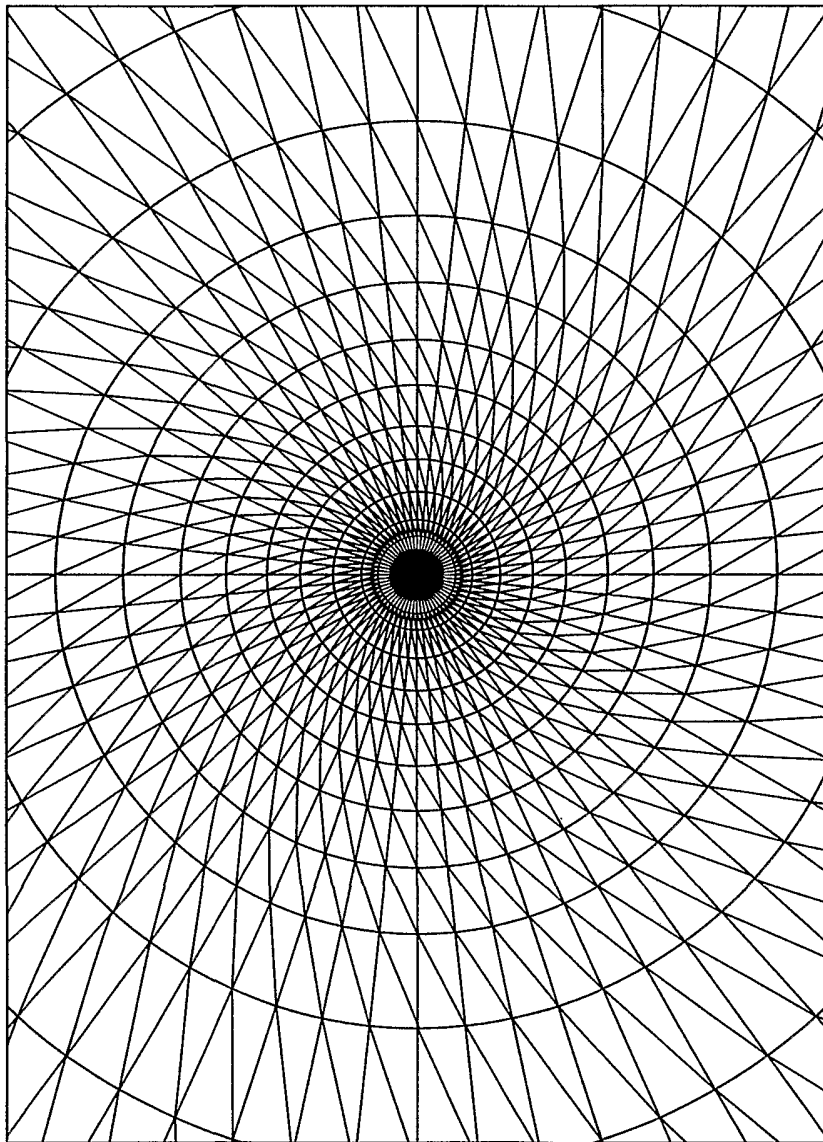# FIG.2

A FISH-EYE LENS	AN OPTICAL FILTER	AN OPTICAL LENS	A CCD DEVICE

FIG.3

FIG.4

FIG.5A
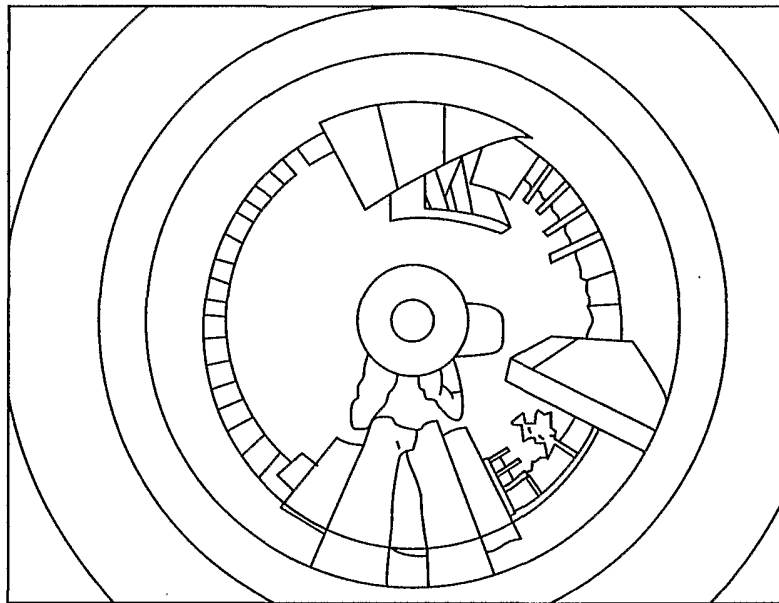
FIG.5B
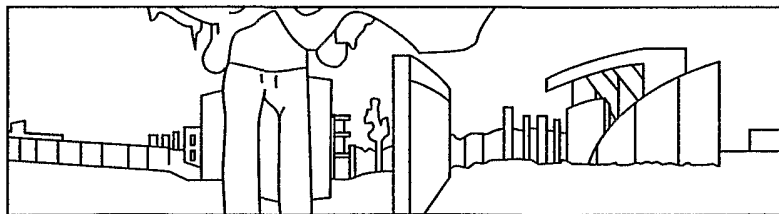
FIG.6
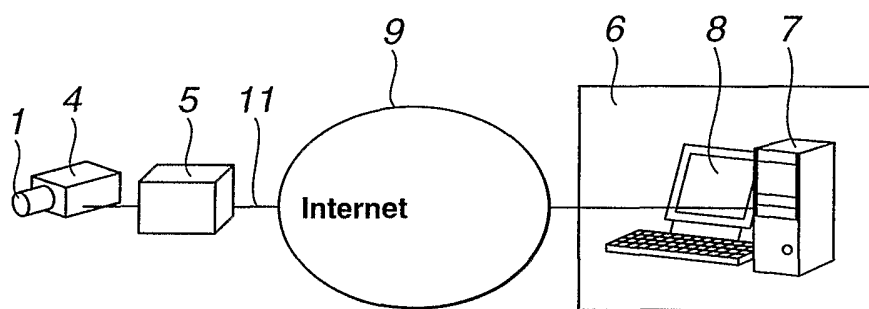
FIG.7
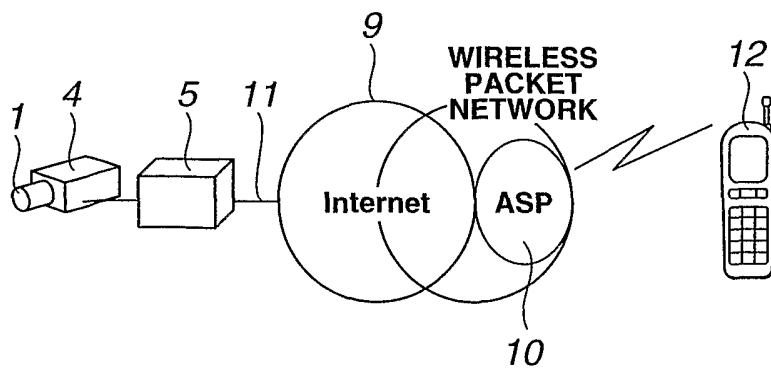
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04N7/18

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)
IPC 7   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 practical, search terms used)

WPI Data, EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 00 08889 A (BE HERE INC ;FURLANI JOHN (US); DRISCOLL EDWARD JR (US)) 17 February 2000 (2000-02-17)	1
A	the whole document	2-14
Y	WO 01 05154 A (HAYASHI KENICHI ;MURATA SHIGEKI (JP); SOGABE YASUSHI (JP); ISHIGUR) 18 January 2001 (2001-01-18)	1
A	abstract	2-14
A	US 5 185 667 A (ZIMMERMANN STEVEN D) 9 February 1993 (1993-02-09) the whole document	1-14
A	US 5 790 182 A (ST HILAIRE PIERRE) 4 August 1998 (1998-08-04) column 4, line 3 - line 45	1-14

−/−−

☒ Further documents are listed in the continuation of box C.   ☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"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

"P" document published prior to the international filing date but later than the priority date claimed

"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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 August 2002	13/08/2002

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, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Greve, M

Form PCT/ISA/210 (second sheet) (July 1992)

International Application No

PCT/JP 02/05849

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 920 211 A (LSI CARD CORP) 2 June 1999 (1999-06-02) column 6, line 56 –column 9, line 9 ---	1-14
A	EP 0 637 168 A (CANON KK) 1 February 1995 (1995-02-01) column 3, line 20 –column 4, line 47 -----	1-14

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
WO 0008889	A	17-02-2000	US	6331869 B1	18-12-2001
			AU	2459999 A	28-02-2000
			EP	1064817 A1	03-01-2001
			WO	0008889 A1	17-02-2000
			US	6337708 B1	08-01-2002
WO 0105154	A	18-01-2001	JP	2001008232 A	12-01-2001
			CN	1315114 T	26-09-2001
			EP	1117256 A1	18-07-2001
			WO	0105154 A1	18-01-2001
US 5185667	A	09-02-1993	AT	219875 T	15-07-2002
			DE	69232663 D1	01-08-2002
			EP	0539565 A1	05-05-1993
			EP	0971540 A1	12-01-2000
			JP	3051173 B2	12-06-2000
			JP	6501585 T	17-02-1994
			US	5359363 A	25-10-1994
			US	5313306 A	17-05-1994
			WO	9221208 A1	26-11-1992
			US	6256061 B1	03-07-2001
			US	6301447 B1	09-10-2001
			US	5384588 A	24-01-1995
			US	2002097332 A1	25-07-2002
			US	5903319 A	11-05-1999
			US	6243131 B1	05-06-2001
			US	5990941 A	23-11-1999
			US	RE36207 E	04-05-1999
			US	5764276 A	09-06-1998
			US	6201574 B1	13-03-2001
			US	5877801 A	02-03-1999
US 5790182	A	04-08-1998	AU	714042 B2	16-12-1999
			AU	4051697 A	25-02-1998
			EP	0916224 A1	19-05-1999
			JP	2000515704 T	21-11-2000
			WO	9806220 A1	12-02-1998
EP 0920211	A	02-06-1999	JP	3232408 B2	26-11-2001
			JP	11164292 A	18-06-1999
			JP	11308608 A	05-11-1999
			EP	0920211 A2	02-06-1999
EP 0637168	A	01-02-1995	JP	7046566 A	14-02-1995
			DE	69418111 D1	02-06-1999
			DE	69418111 T2	23-12-1999
			EP	0637168 A1	01-02-1995