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Photographing Apparatus and
Lens Position Control Device

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BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to a photographing apparatus and, more particularly, to a photographing apparatus having an optical zoom function using a zoom lens, and a so-called electronic zoom function achieved
10 by electrical processing of an image pickup means.

Related Background Art

Due to recent rapid spread of video cameras, the video cameras are required to have high performance, while the cameras are required to have zoom lenses
15 having high zoom ratios, which can cope with various photographing situations. In recent years, zoom lenses having zoom ratios as high as x6 to x10 are provided, and zoom lenses having still higher zoom ratios are developed.

20 When a high zoom ratio is to be achieved by a zoom lens, the total length of the lens is normally increased, it becomes difficult to correct aberrations over the entire zoom area, and the cost of the lens tends to increase. For this reason, it is considerably
25 difficult to provide a compact, low-cost zoom lens having a high zoom ratio.

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1 In consideration of the above situation, there is
proposed a technique associated with a so-called
electronic zoom function for electrically enlarging an
image on a monitor by processing electrical signals
5 from an image pickup element such as a CCD, which
function is added to a video camera so as to obtain a
zooming effect in a wider range although the zoom ratio
of an optical zoom function remains the same as a
conventional one.

10 Japanese Patent Publication No. 52-15226 and
Japanese Laid-Open Patent Application No. 1-280709
disclose techniques associated with focusing lens
position control of a so-called rear-focus type zoom
lens having the following advantages. That is, a zoom
15 lens can be rendered compact by operating as a focusing
lens group at least a lens group after a variable
magnification lens group, and a photographing operation
up to a closest object can be performed. The present
invention provides a photographing apparatus, which
20 does not adopt a simple system for operating an
electronic zoom function so as to cover a wider zoom
area after a zooming operation for an optical zoom area
is completed, but can utilize the features of the
rear-focus type zoom lens when the so-called electronic
25 zoom function is added to the rear-focus type zoom
lens.

1 More specifically, in the rear-focus type zoom
lens, a focusing lens must be moved upon zooming even
when an object remains at a position of a given
distance. In particular, the rear-focus type zoom lens
5 has an optical nature in that a focusing lens group has
different focus extension amounts at the wide-angle
side and the telephoto side. Therefore, in order to
perform moving control of the focusing lens, as
disclosed in, e.g., Japanese Laid-Open Patent
10 Application No. 1-280709, information associated with
the movement of the focusing lens is preferably stored
in advance in a ROM (Read Only Memory) to move the
focusing lens group according to the stored
information, so that the focusing lens can trace a
15 desirable cam path according to the lens positions of
the zoom lens and the focusing lens.

In this case, the following problem is posed.
That is, when the object distance abruptly changes
during an optical zooming operation, the focusing lens
20 traces a cam path for an object distance before the
change, and always maintains an out-of-focus state. An
AF (Auto-Focus) function may be adopted to attain an
in-focus state. However, when the AF function cannot
follow the zooming function, an in-focus state cannot
25 be attained, either. In particular, a blurred state
may be worsened in a zooming operation from the

1 wide-angle side to the telephoto side even if the AF
function is used.

SUMMARY OF THE INVENTION

It is the first object of the present invention to
5 provide a photographing apparatus, which can reduce a
blur amount occurring during a zooming operation by
effectively using both optical and electronic zoom
functions, and can perform the zooming operation while
maintaining an in-focus state to the highest degree
10 possible.

In order to achieve the first object, a
photographing apparatus according to the first aspect
of the present invention comprises a rear-focus type
zoom lens, image pickup means for converting an optical
15 image formed by the zoom lens into an electrical
signal, signal processing means for executing signal
processing of the electrical signal so as to obtain an
electronic zooming effect, focus detection means for
detecting a focus adjustment state of the zoom lens,
20 storage means for storing information associated with
movement of a focusing lens group in accordance with
lens positions of a variable magnification lens group
and the focusing lens group of the zoom lens, and
control means for, when it is determined based on an
25 output from the focus detection means that the zoom
lens is in an in-focus state during a zooming
operation, moving the focusing lens group on the basis

1 of the position of the variable magnification lens
group and the information stored in the storage means,
and for, when it is determined that the zoom lens is
not in an in-focus state, executing the zooming
5 operation on the basis of a signal processing result of
the signal processing means, and moving the focusing
lens group on the basis of information detected by the
focus detection means.

It is the second object of the present invention
10 to provide a photographing apparatus, which
switches functions between electronic and optical zoom
functions, so that a stable zooming operation can be
continuously performed when both the electronic and
optical zoom functions are used.

15 In order to achieve the second object, a
photographing apparatus according to the second aspect
of the present invention comprises a rear-focus type
zoom lens having a variable magnification lens group
and a focusing lens group, image pickup means for
20 converting an optical image formed by the zoom lens
into an electrical signal, and signal processing means
for processing the electrical signal so as
to obtain an electronic zoom effect, the
apparatus having an optical zoom function realized by
25 moving the variable magnification lens group, and the
electronic zoom function, wherein when a zooming
operation is switched between the optical and

1 electronic zoom functions, a zooming operation of one
function is started before a zooming operation of the
other function is stopped.

It is the third object of the present invention to
5 provide a photographing apparatus which can perform a
high-speed zooming operation by simultaneously using
both optical and electronic zoom functions. In order
to achieve the third object, according to the third
aspect of the present invention, a photographing
10 apparatus comprises a rear-focus type zoom lens having
a variable magnification lens group and a focusing lens
group, image pickup means for converting an optical
image formed by the zoom lens into an electrical
signal, and signal processing means for
15 processing the electrical signal so as to
obtain an electronic zoom effect, the apparatus having
an optical zoom function realized by moving the
variable magnification lens group, and ~~the~~^{an} electronic
zoom function, wherein the optical and electronic zoom
20 functions are simultaneously operated.

It is the fourth object of the present invention
to provide an image pickup apparatus, which facilitates
so-called tilt correction by utilizing an electronic
zoom function.

25 In order to achieve the fourth object, according
to the fourth aspect of the present invention, there is
provided an image pickup apparatus, which adopts a zoom

1 lens in an image pickup optical system, and has an
electronic zoom function for electronically performing
a zoom operation of a signal read from an image pickup
element,

5 wherein after a magnification of a composition is
determined by the electronic zoom function, a
magnification of the zoom lens is changed to a
magnification attained by the electronic zoom function.

According to the fifth aspect of the present
10 invention, there is also provided an image pickup
apparatus having the same function as that of a tilt
lens by means of image processing,

wherein when tilt adjustment is performed, a
reference line is displayed on an electronic view
15 finder so as to assist the tilt adjustment.

A limitation on the zooming speed of a
conventional zoom lens disturbs quick determination of
a composition by a photographer. However, according to
the fourth aspect, a composition can be instantaneously
20 determined using the electronic zoom function, which
can desirably set a zooming speed, and the optical zoom
lens is finally moved to a magnification position
determined by the electronic zoom function, thereby
eliminating deterioration of image quality caused by
25 the electronic zoom function.

Furthermore, according to the fifth aspect, a
reference line (the reference line means a line such as

1 a solid line, broken line, or the like serving as a
reference for tilt adjustment, and a vertical line and
lines including vertical lines, e.g., lattice lines,
can be used) is generated in an electronic view finder
5 (EVF), and tilt (shift) adjustment is performed with
reference to the reference line, so that a
high-precision composition setting operation can be
easily attained. When it is difficult to perform a
high-precision composition setting operation due to a
10 small screen of the EVF, an enlarged display may solve
this problem.

The above and other objects and features of the
present invention will become apparent from the
specification and the drawings.

15 BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a photographing
apparatus according to the present invention;

Fig. 2 is a flow chart showing control of the
photographing apparatus according to the present
20 invention;

Fig. 3 is a block diagram showing an arrangement
for processing an output from an image pickup element;

Fig. 4 is a view showing the principle of an
electronic zoom function;

25 Fig. 5 is a view showing a switching state between
optical and electronic zoom functions according to the
present invention;

1 Fig. 6 is a view showing a state wherein optical
and electronic zoom functions are simultaneously driven
according to the present invention;

5 Fig. 7 is a block diagram showing an arrangement
of an embodiment of an image pickup apparatus according
to the present invention;

Fig. 8 is a flow chart for explaining an operation
of the embodiment shown in Fig. 7;

10 Fig. 9 is a flow chart showing another embodiment
of an image pickup apparatus according to the present
invention;

Fig. 10 is a block diagram showing still another
embodiment of an image pickup apparatus according to
the present invention;

15 Fig. 11 is a flow chart for explaining an
operation of the image pickup apparatus according to
the embodiment shown in Fig. 10;

20 Fig. 12 is a view for explaining tilt adjustment
in an image pickup apparatus according to still another
embodiment of the present invention;

Figs. 13A and 13B are views for explaining tilt
adjustment in an image pickup apparatus according to
still another embodiment of the present invention;

25 Figs. 14A and 14B are views for explaining tilt
adjustment in an image pickup apparatus according to
still another embodiment of the present invention; and

1 Fig. 15 is a view for explaining tilt adjustment
in an image pickup apparatus according to still another
embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5 An embodiment of a photographing apparatus
according to the present invention will be described
below. Fig. 1 is a control block diagram of a
photographing apparatus according to the present
invention. Referring to Fig. 1, lens groups 1, 2, 3,
10 and 4 respectively have positive, negative, positive,
and positive refracting powers in the order named. The
second lens group 2 as a variator and the fourth lens
group 4 as a compensator are moved along the optical
axis to perform a zooming operation, and the fourth
15 lens group 4 is moved to attain a focusing operation.
Note that the first and third lens groups 1 and 3
always stand still. An iris 6 is arranged between the
second and third lens groups 2 and 3. The second and
fourth lens groups are respectively driven by motors 5
20 and 9. In particular, the motor 9 comprises a stepping
motor. A zoom encoder 7 and an iris encoder 8 are
volume-type encoders, and respectively detect the
positions of the second lens group and the iris 5.

 An image pickup element 13 such as a CCD (charge
25 coupled device) converts an optical image formed by a
zoom lens into an electrical signal. A high-pass
filter 14 passes only a high-frequency component of

1 the electrical signal. An image signal processing
circuit 15 processes a signal output from the image
pickup element 13, and processes
the electrical signal output from the filter 14 on the
5 basis of a known contrast method, thereby detecting the
focus adjustment state of the zoom lens. An operation
switch 16 is used for generating a zooming designation
output, and can select whether the zooming speed is set
to be a standard speed or a high speed although not
10 shown. An E²PROM 17 stores information associated with
H a position where the ^{fourth}four lens group is located
according to the object distance and the position of
the second lens group. A so-called rear-focus zoom
lens according to the present invention has
15 characteristics in that an in-focus state cannot be
obtained unless the fourth lens group (focusing lens)
is moved along a predetermined zoom path during a
zooming operation even when the object distance remains
the same, unlike in a conventional front focus type
20 zoom lens. The focusing lens has different extension
amounts at the wide-angle side and telephoto side. In
particular, the focusing lens must have a small
extension amount at the wide-angle side and a large
extension amount at the telephoto side. In
25 consideration of such characteristics, the E²PROM stores
the focusing position of the fourth lens group
according to the object distance and the position of

1 the second lens group. Note that the storage
information is determined in a lens design stage. A
microcomputer 20 performs processing to be described
later.

5 Fig. 3 is a block diagram showing an arrangement
for realizing an electronic zoom function. The image
pickup element 13 is driven by the microcomputer, and a
digital signal output from the image pickup element is
supplied to a signal processing circuit after A/D
10 conversion. The signal processing circuit executes
known line memory line matrix processing, and an
electronic zoom operation is performed, as shown in
Fig. 4, upon interfacing with a digital LSI for
executing electronic zoom processing. In this manner,
15 the central portion on the photo-sensitive surface of
the image pickup element is displayed on a TV monitor in
an enlarged scale, thereby obtaining the same change in
magnification as in an optical zoom function.

When a zoom magnification attained by the optical
20 zoom function is represented by A, and a zoom
magnification attained by the electronic zoom function
is represented by B, a magnification ^{based a} upon combination
H of these two functions becomes $A \times B$ times. For
example, when a $\times 6$ optical zoom lens and a $\times 2$
25 electronic zoom function are combined, a camera having
a $\times 12$ zoom ratio can be obtained.

1 A change in magnification between a Wid
(wide-angle) end (x1) and a Tel (telephoto) end (x12)
is attained by combining the optical and electronic
zoom functions, as shown in Fig. 5.

5 The control flow of the photographing apparatus
according to the present invention will be described
below with reference to Fig. 2.

It is checked if a zoom instruction is currently
output by a zoom switch during a normal photographing
10 operation (#001). It is then checked if the zoom
instruction is a high speed instruction or a standard
speed instruction (#002).

If it is determined that zoom instruction is not a
high-speed instruction, the driving operation of the
15 second lens group at a standard speed is started via
the motor 3 (#003).

When the focus adjustment state of the zoom lens
is discriminated, if the blur amount is equal to or
smaller than a predetermined threshold level, i.e., if
20 it is determined that an in-focus state is attained,
the positions of the second and fourth lens groups are
detected (#005).

Note that the position of the fourth lens group
can be detected by counting the number of pulses of the
25 motor 9.

Position information corresponding to the zoom
position and indicating a position to which the fourth

1 lens group is to be moved is read out from the E²PROM on
the basis of the zoom position information (#006). The
fourth lens group is then moved on the basis of the
readout information and the zoom detection information
5 (#007). In this manner, the fourth lens group can
correctly trace a cam path in an in-focus state. If
the end of zoom is reached, the second lens group is
stopped; otherwise, the flow returns to step #002
(#008).

10 A flow (#010 to #012) executed when it is
determined upon detection of a previous focus state
that the blur amount is large will be described below.
In this case, after the speed of the second lens group
is reduced, the electronic zoom processing based on
15 video signal processing is started. Then, the second
lens group is completely stopped (#010 to #012). The
reason why the optical zoom function is switched to the
electronic zoom function is as follows. That is, if
the lens traces the above-mentioned stored cam path
20 according to the zoom position in a largely blurred
state, the second and fourth lens groups are
continuously moved always in an out-of-focus state. In
particular, when a zooming operation is performed from
the wide-angle side to the telephoto side, the fourth
25 lens group is moved in a direction to increase the blur
amount. On the other hand, in a zooming operation from
the telephoto side to the wide-angle side, the lens

1 traces the cam path in a direction to converge the blur
amount. However, a shift in cam path may occur due to
a change in environmental temperature, and the lens
cannot often trace the cam path correctly.

5 The reason why the optical zoom function is not
instantaneously switched to the electronic zoom
function is as follows. That is, it is practically
difficult to immediately stop the second lens group or
to move the second lens group at a constant speed, and
10 a time lag is generated. When an abrupt switching
operation is performed, the zoom speed is immediately
increased or decreased, resulting in an unstable state.
In this embodiment, in order to prevent such an
unstable operation upon switching from the optical zoom
15 function to the electronic zoom function or vice versa,
and to allow a smooth zooming operation, control is
made in such a manner that one zooming operation is
started before the other zooming operation is
completely stopped, as shown in Fig. 5, and the two
20 zooming operations overlap each other.

When the second lens group is stopped, i.e., when
the optical zoom function is completely switched to the
electronic zoom function, the fourth lens group is
moved, and it is then checked if an in-focus state is
25 attained (#013 and #014). When the focusing lens
enters an in-focus region, since it is determined that
the fourth lens group can trace a predetermined zoom

1 path, the electronic zoom function is switched to the
optical zoom function. At this time, for the same
reason as that mentioned above, the speed of the
electronic zooming operation is reduced, the driving
5 operation of the second lens group is then started, and
thereafter, the electronic zooming operation is
completely stopped (#015 to #017).

In the above embodiment, the switching operation
between the optical and electronic zoom functions has
10 been mainly described. When the high-speed zooming
operation is to be performed over the entire zoom
region of the optical and electronic zoom functions,
the photographing apparatus of this embodiment has a
mode for simultaneously driving the optical and
15 electronic zoom functions, as shown in Fig. 6 (#002 to
#020 and #021).

As described above, according to this embodiment,
when a focus detection device determines an
out-of-focus state during a zooming operation, the
20 optical zoom function is switched to the electronic
zoom function, and the focusing lens is moved based on
the output from the focus detection device to enter the
in-focus region. Thus, the photographing apparatus
which is free from a largely blurred state, and has
25 good followability can be obtained.

Upon switching between the optical and optical
zoom functions, one zooming operation is started before

1 the other zooming operation is stopped, thus allowing a
continuous, smooth zooming operation.

A photographing apparatus which can attain a
high-speed zooming operation by simultaneously driving
5 the electronic and optical zoom functions can be
provided.

Another embodiment of the present invention will
be described below.

Since the above-mentioned "electronic zoom
10 function" performs thin-out processing upon reading
signals from the image pickup element, some
deterioration of image quality inevitably occurs.
However, since a zooming operation can be completely
electronically realized, the zooming speed can be
15 arbitrarily increased (or decreased). Therefore, there
is almost no limitation upon setting of the zooming
speed.

A limitation on the zooming speed of a
conventional zoom lens disturbs quick determination of
20 a composition by a photographer. However, according to
this embodiment, a composition can be instantaneously
determined using the electronic zoom function, which
can desirably set a zooming speed, and the optical zoom
lens is finally moved to a magnification position
25 determined by the electronic zoom function, thereby
eliminating deterioration of image quality caused by
the electronic zoom function.

1 This embodiment will be described below with
reference to the accompanying drawings.

Fig. 7 is a block diagram showing an arrangement
of an image pickup apparatus according to the
5 embodiment of the present invention. Referring to
Fig. 7, an optical system 1 forms an object image on a
photoelectric conversion surface of an image pickup
element (to be described later). Note that the optical
system 1 has a magnification (focal length) change
10 (zoom) function. A zooming mechanism is driven by a
zoom motor 2, which is driven by a zoom driver 3. A
zoom encoder 4 detects the current magnification (focal
length) value.

An image pickup element 5 (comprising, e.g., a CCD
15 type sensor, a MOS type sensor, an image pickup tube,
or the like) converts an optical image of an object
into an electrical signal. A sample & hold (S/H)
circuit 6 samples and holds a signal read from the
image pickup element 5. A process circuit 7 performs
20 pre-processing of a signal. An A/D conversion circuit
8 converts a pre-processed signal into a digital
signal. An image memory 9 stores a digital image
signal A/D converted by the A/D conversion circuit 8
for one frame. A memory controller 10 controls a
25 read/write access to the image memory 9.

A D/A conversion circuit 11 converts a digital
image signal read out from the image memory 9 into an

1 analog signal. An operation circuit 12 executes an
interpolation operation for a partial (thin-out) read
access to the image memory 9 to attain an enlargement
function (to be described later). An encoder circuit
5 13 converts the analog signal output from the operation
circuit 12 into a standard video signal such as an NTSC
signal. The standard video signal is output onto a
signal line 14.

An electronic view finder (EVF) 15 is used for
10 determining a composition, and confirming an object to
be photographed. A system controller 16 detects and
controls the states of the circuit components, and can
be constituted by a versatile microprocessor.

A zooming operation member 17 has three states,
15 i.e., a telephoto side, a wide side, and a
non-operation state. An operation member 18 is used
for designating a zoom operation mode, i.e.,
designating whether a normal zooming operation is
performed using only the zoom motor 2 or the so-called
20 "electronic zoom function" for changing the read
magnification from the image memory 9 is used together
with a normal zooming operation.

The operation will be described below with
reference to the block diagram of Fig. 7 and the flow
25 charts of Figs. 8 and 9.

For the sake of simplicity, this embodiment adopts
the image memory 9 for storing information for the

1 entire frame. However, a line memory for one line or
several lines may be used to simplify the circuit
arrangement, and a low-cost apparatus may be provided.

Fig. 8 is a flow chart for explaining the
5 operation of an image pickup apparatus according to the
embodiment shown in Fig. 7.

When the operation member 18 is not set in a mode
for using an electronic zoom function together with a
normal zoom function, a known operation is performed by
10 a known circuit. For this reason, a case will be
mainly described below wherein the operation member 18
is set in the mode for using the electronic zoom
function together with the normal zoom function.

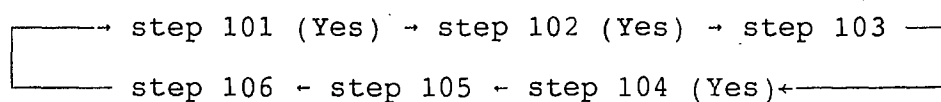
As shown in Fig. 8, the system controller 16
15 checks the state of the operation member 18, and checks
if the mode for using the electronic zoom function
together with an optical zoom function is set (step
101). If NO in step 101, since a known operation mode
is set, the operation is ended.

20 If the mode for using the electronic zoom function
together with the optical zoom function is set (YES in
step 101), the operation state of the operation member
17 is detected, and it is checked if the operation
member 17 is operated to the telephoto side (step 102).
25 If the operation member 17 is operated to the telephoto
side (YES in step 102), the system controller 16 issues
an instruction to the memory controller 10 and the

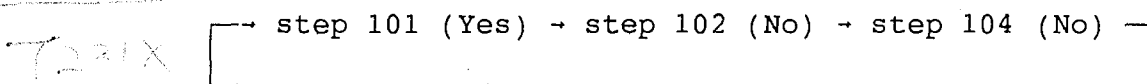
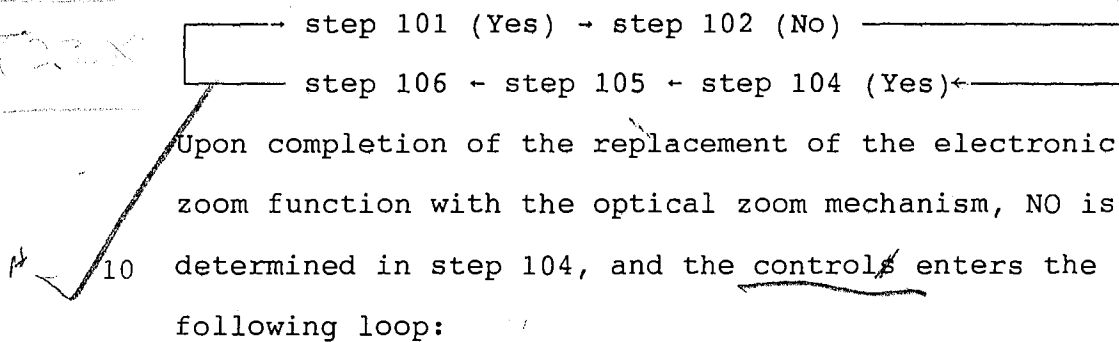
1 operation circuit 12 to shift the electronic zoom
function to the telephoto side (enlargement side) by n
steps (step 103). In this case, n is an integer larger
than 1. If the operation member 17 is not operated to
5 the telephoto side (NO in step 102), the flow skips
step 103.

It is then checked based on the states of internal
variables of the system controller 16 if the electronic
zoom function is active (step 104). If the electronic
10 zoom function is active (YES in step 104), the optical
zoom mechanism is shifted toward the telephoto side by
one step (step 105), and at the same time, the
electronic zoom function is shifted toward the smaller
side (wide side) by one step to cancel the telephoto
15 shift of the optical zoom mechanism (step 106).
Thereafter, the flow returns to step 101. If the
electronic zoom function is not active (NO in step
104), the flow returns to step 101.

With the above-mentioned operation, when the
20 operation member 18 is set in the mode for using the
electronic zoom function together with the optical zoom
function, and the operation member 17 is operated
toward the telephoto side, a zooming operation can be
quickly attained by mainly the electronic zoom function
25 in the following loop:



1 After the zooming operation by the electronic zoom
function is completed, when the operation member 17 is
returned to a non-operation state, the electronic zoom
function is replaced with the optical zoom mechanism in
5 the following loop:



However, in practice, no operation is made.

15 Fig. 9 is a flow chart showing another embodiment
of an image pickup apparatus according to the present
invention. In the above embodiment, the electronic
zoom function is effective for only the telephoto side.
However, in this embodiment, a high-speed zooming
20 operation can be performed toward both the telephoto
and wide sides using only the electronic zoom function.
The arrangement of an image pickup apparatus of this
embodiment is the same as that of the image pickup
apparatus shown in Fig. 7.

25 The operation of this embodiment will be described
below with reference to Fig. 9.

1 In the image pickup apparatus shown in Fig. 7, an
optical focal length is set at the most wide side (not
the wide end) which can be used without using an
electronic zoom function.

5 Then, as shown in Fig. 9, the system controller 16
checks the state of the operation member 18, and
determines if an electronic zoom mode is selected (step
201). If NO in step 201, since a known operation mode
is started, the operation is ended.

10 However, if the electronic zoom mode is selected
(YES in step 201), the system controller 16 checks the
operation state of the operation member 17 to determine
if the operation member 17 is operated toward the
telephoto side (step 202). If the operation member 17
15 is operated toward the telephoto side (YES in step
202), the system controller 16 issues an instruction to
the memory controller 10 and the operation circuit 12
to shift the electronic zoom function toward the
telephoto side by one step (step 203), and thereafter,
20 the flow returns to step 201.

 If it is determined in step 202 that the operation
member 17 is not operated toward the telephoto side (NO
in step 202), the system controller 16 then checks if
the operation member 17 is operated toward the wide
25 side (step 204). If the operation member 17 is
operated toward the wide side (YES in step 204), the
electronic zoom function is shifted toward the wide

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1 side by one step like in step 203 (step 205), and
thereafter, the flow returns to step 201.

If it is determined in step 204 that the operation
member 17 is not operated toward the wide side (NO in
5 step 204), since the operation member 17 is operated
toward neither the telephoto side nor the wide side,
the operation is ended.

Still another embodiment of the present invention
will be described below.

10 Tilt (shift) adjustment is originally an operation
for correcting an inclined vertical line to a vertical
state.

In this embodiment of the present invention, a
reference line (the reference line means a line such as
15 a solid line, broken line, or the like serving as a
reference for tilt adjustment, and a vertical line and
lines including vertical lines, e.g., lattice lines,
can be used) is generated in an electronic view finder
(EVF), and tilt (shift) adjustment is performed with
20 reference to the reference line, so that a
high-precision composition setting operation can be
easily attained. In this embodiment, when it is
difficult to perform a high-precision composition
setting operation due to a small screen of the EVF, an
25 enlarged display may solve this problem.

An image pickup apparatus of this embodiment will
be described in detail below.

25

1 Fig. 10 is a block diagram showing an electrical
circuit arrangement of an image pickup apparatus of
this embodiment.

Referring to Fig. 10, an optical system 21 forms
5 an object image on the surface of an image pickup
element (to be described below). An image pickup
element 22 converts an optical image obtained by the
optical system 21 from an optical signal into an
electrical signal, and comprises a CCD type sensor, a
10 MOS type sensor, or the like. A signal processing
circuit 23 processes a sequential signal associated
with an object image obtained from the image pickup
element 22. An A/D converter 24 converts an electrical
signal (analog signal) processed by the signal
15 processing circuit 23 into a digital signal. An image
memory 25 stores image information for one frame. An
image processing circuit 26 performs the same image
conversion processing as an operation of a tilt (shift)
lens. Since such coordinate conversion processing can
20 be easily realized by a known digital operation
circuit, a detailed description thereof will be
omitted.

A D/A converter 27 converts the image processed
digital signal into an analog signal. An encoder
25 circuit 28 converts the D/A-converted analog signal
into a standard video signal 29 such as an NTSC/PAL
signal, or the like. An electronic view finder (EVF)

1 30 is used for confirming a photographing frame. A
system controller 31 checks the operation state of an
operation member (to be described later), and the like,
and controls the respective elements according to the
5 state of the operation member. The system controller
31 can be easily realized using a versatile
microprocessor.

An operation member 32 is used for selecting
whether a tilt (shift) operation is performed (ON) or
10 not (OFF). An operation member 33 is used for
performing the tilt operation when the operation member
32 is ON. The operation member 33 can be either an
independent operation member or an existing operation
member (e.g., a power zoom or power focus operation
15 member) having an up/down function. If the operation
member 33 is exclusively used for the tilt operation,
the operation member 32 can be omitted.

The operation of the above-mentioned electrical
circuit arrangement of the image pickup apparatus of
20 this embodiment will be described below.

Note that the arrangement of this embodiment is a
very ordinary known image pickup apparatus, except for
the operation member associated with the tilt operation
and an image processing section therefor. In the
25 following description, a portion associated with the
tilt operation will be mainly described below.

1 Fig. 11 is a flow chart for explaining the
operation of the image pickup apparatus of the
embodiment shown in Fig. 10.

As shown in Fig. 11, the system controller 31
5 checks the state of the operation member 32 for
selecting the tilt operation, and determines if a tilt
operation mode is ON (step 301).

If the operation member 32 for selecting the tilt
operation does not indicate that the tilt operation
10 mode is OFF (NO in step 301), the operation is ended.

However, if the operation member 32 for selecting
the tilt operation indicates that the tilt operation
mode is ON (YES in step 301), the system controller 31
then checks the state of the operation member 33.

15 The system controller 31 checks if the operation
member 33 instructs an up operation (step 302). If the
operation member 33 instructs an up operation (YES in
step 302), the tilt level is enlarged by one step, i.e.,
the correction amount is increased (step 303).

20 Thereafter, the flow returns to step 301.

If the operation member 33 does not instruct an up
operation (NO in step 302), the system controller 31
then checks if the operation member 33 instructs a down
operation (step 304).

25 If the operation member 33 instructs a down
operation (YES in step 304), the tilt level is reduced

1 by one step, i.e., the correction amount is decreased
(step 305). Thereafter, the flow returns to step 301.

If the operation member 33 does not instruct a
down operation (NO in step 304), since the operation
5 member 33 instructs neither the up operation nor the
down operation, the flow returns to step 301 without
any operation.

A display on the EVF 30 during tilt adjustment
will be described below.

10 The image processing circuit 26 (Fig. 10) can
easily have a function for generating reference
vertical lines, as shown in Fig. 12, by a known
technique. With this function, since vertical (tilt)
adjustment can be performed with reference to these
15 reference vertical lines, tilt adjustment can be easily
performed with high precision.

In this case, the two reference vertical lines are
generated. However, the number of reference lines can
be arbitrarily set, and the positions of the reference
20 lines can be easily changed by a known method.

As shown in Fig. 13B, when a portion around the
reference vertical line is displayed in an enlarged
scale in the horizontal direction from a state shown in
Fig. 13A, a shift from the vertical direction can be
25 displayed in an enlarged scale, thus facilitating
adjustment. Note that the reference vertical line may

1 be displayed in an enlarged scale in the vertical
direction, as a matter of course.

When an adjustment target portion is only a small
part in a frame, as shown in Fig. 14A, it may be
5 displayed in an enlarged scale in both the vertical and
horizontal directions, as shown in Fig. 14B, thus
allowing easy adjustment.

In addition, a lattice reference pattern may be
employed, as shown in Fig. 15.

10 Note that the image processing circuit 26 is
assumed to have the reference line generation function
in the above description. However, if it is not
preferable that signals indicating the above-mentioned
reference lines are mixed in the signal 29 on the
15 signal output line, a reference line insertion circuit
may be added at a position 26' in Fig. 10 (immediately
before the EVF 30).

As can be apparent from the above description,
when the image pickup apparatus of the embodiment shown
20 in Fig. 7 is used, a composition can be quickly
determined by the electronic zoom function, and at the
same time, the electronic zoom function is gradually
replaced with the optical zoom mechanism while
maintaining the composition. For this reason,
25 deterioration of image quality caused by the electronic
zoom function occurs for only a short period of time.
When a quick composition setting operation is most

1 important, the electronic zoom function may be enabled
in both the telephoto and wide directions without being
replaced with the optical zoom mechanism.

When the image pickup apparatus of the embodiment
5 shown in Fig. 10 is used, since tilt adjustment can be
performed with respect to the reference lines while
observing a small screen of the EVF, high-precision
adjustment can be quickly performed.

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