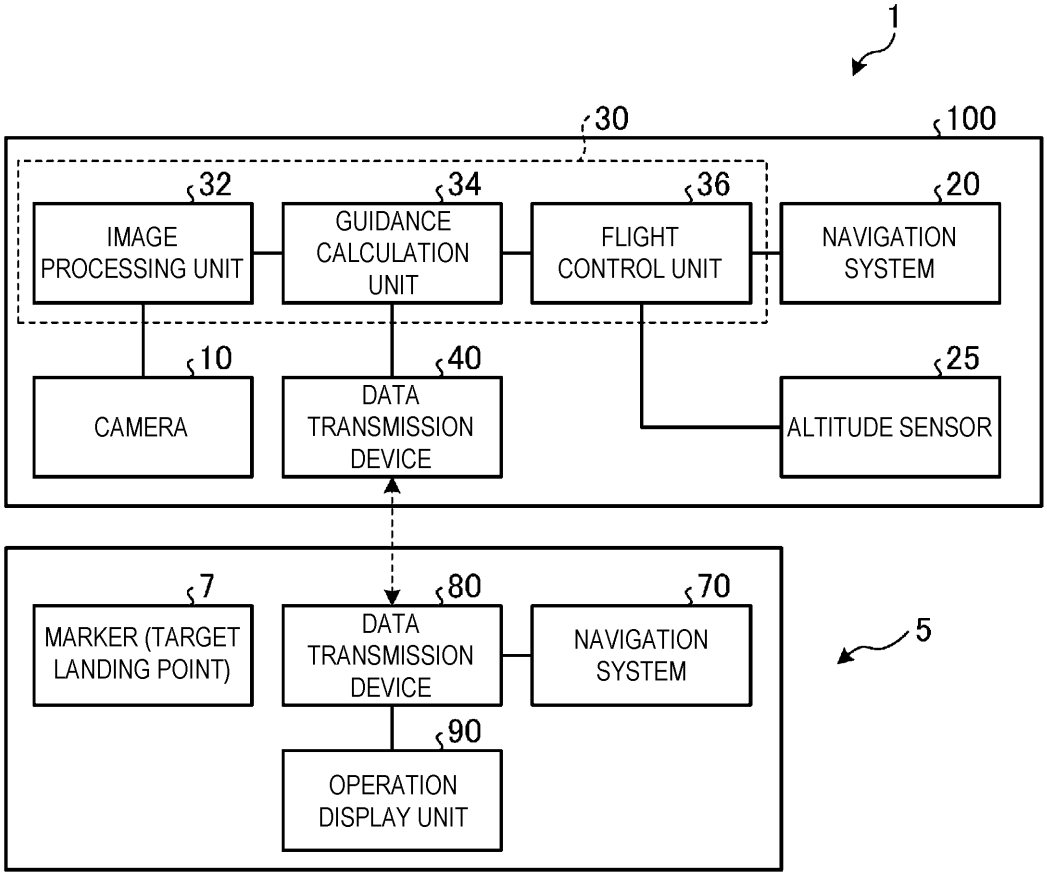

1
30
100
32
IMAGE PROCESSING UNIT
34
GUIDANCE CALCULATION UNIT
36
FLIGHT CONTROL UNIT
20
NAVIGATION SYSTEM
10
CAMERA
40
DATA TRANSMISSION DEVICE
25
ALTITUDE SENSOR
7
MARKER (TARGET LANDING POINT)
80
DATA TRANSMISSION DEVICE
70
NAVIGATION SYSTEM
5
90
OPERATION DISPLAY UNIT

FIG. 1

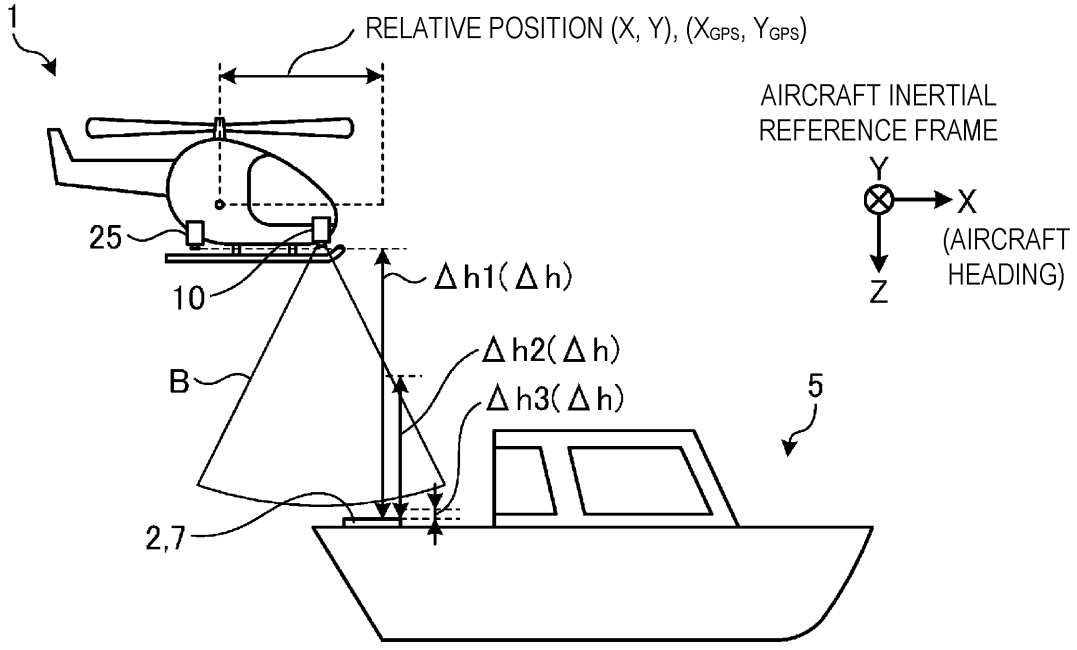

1
RELATIVE POSITION (X, Y), (X_{GPS}, Y_{GPS})
AIRCRAFT INERTIAL REFERENCE FRAME
Y
X
Z
(AIRCRAFT HEADING)
25
10
Δh1(Δh)
B
Δh2(Δh)
Δh3(Δh)
5
2,7

FIG. 2

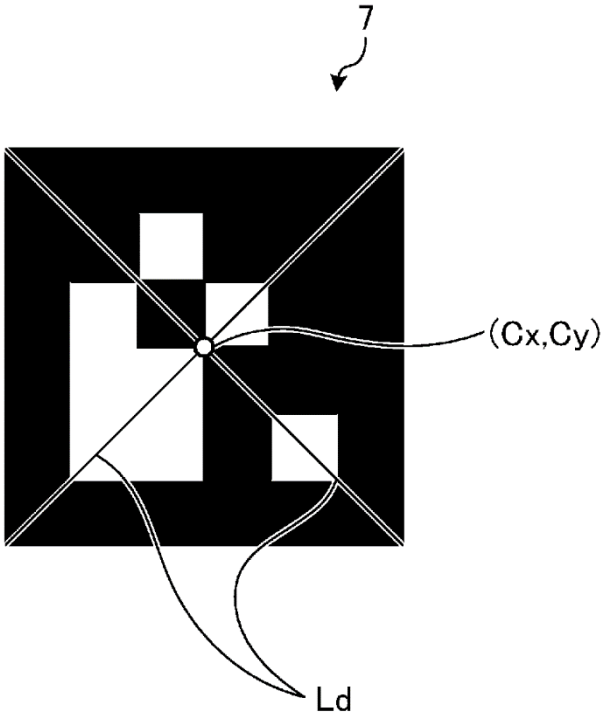

7
(Cx,Cy)
Ld

FIG. 3

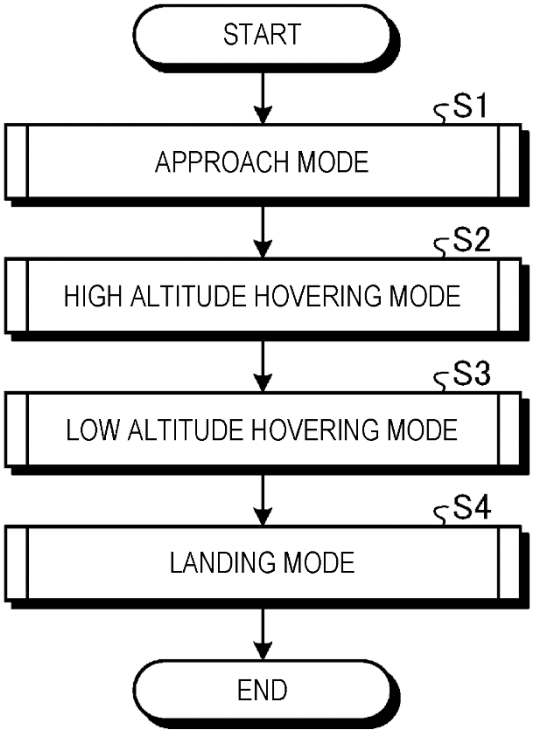

START
S1
APPROACH MODE
S2
HIGH ALTITUDE HOVERING MODE
S3
LOW ALTITUDE HOVERING MODE
S4
LANDING MODE
END

FIG. 4

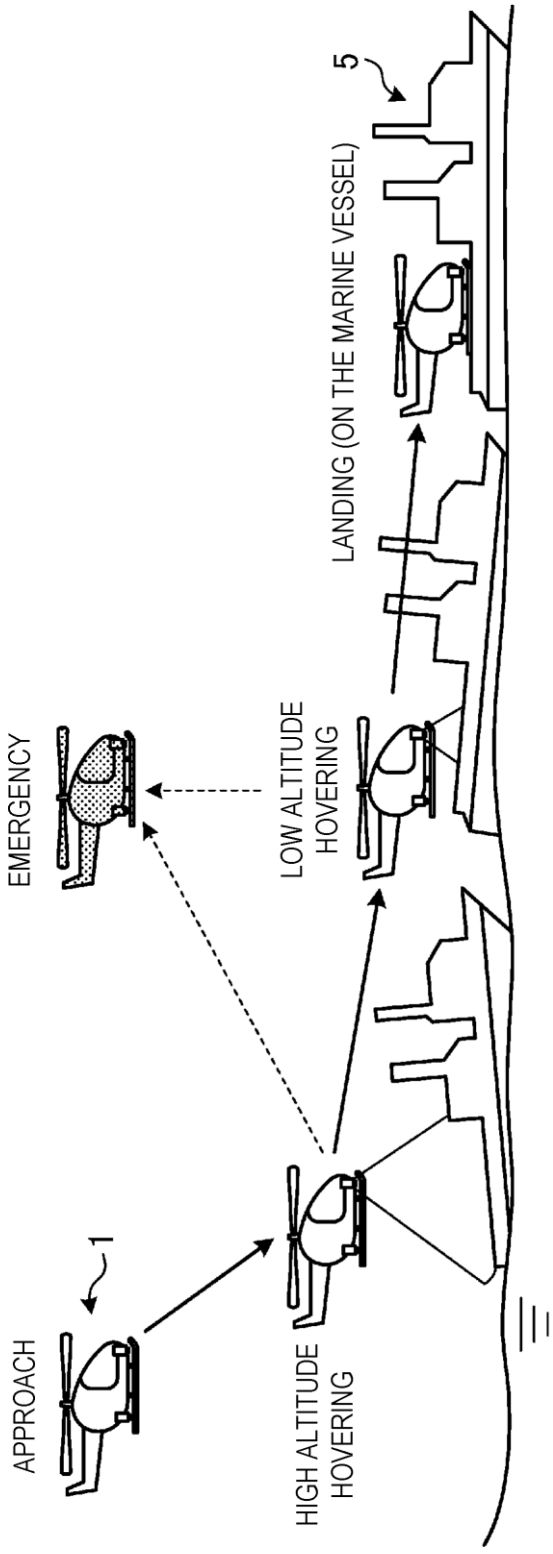

APPROACH
1
HIGH ALTITUDE HOVERING
EMERGENCY
LOW ALTITUDE HOVERING
LANDING (ON THE MARINE VESSEL)
5

FIG. 5

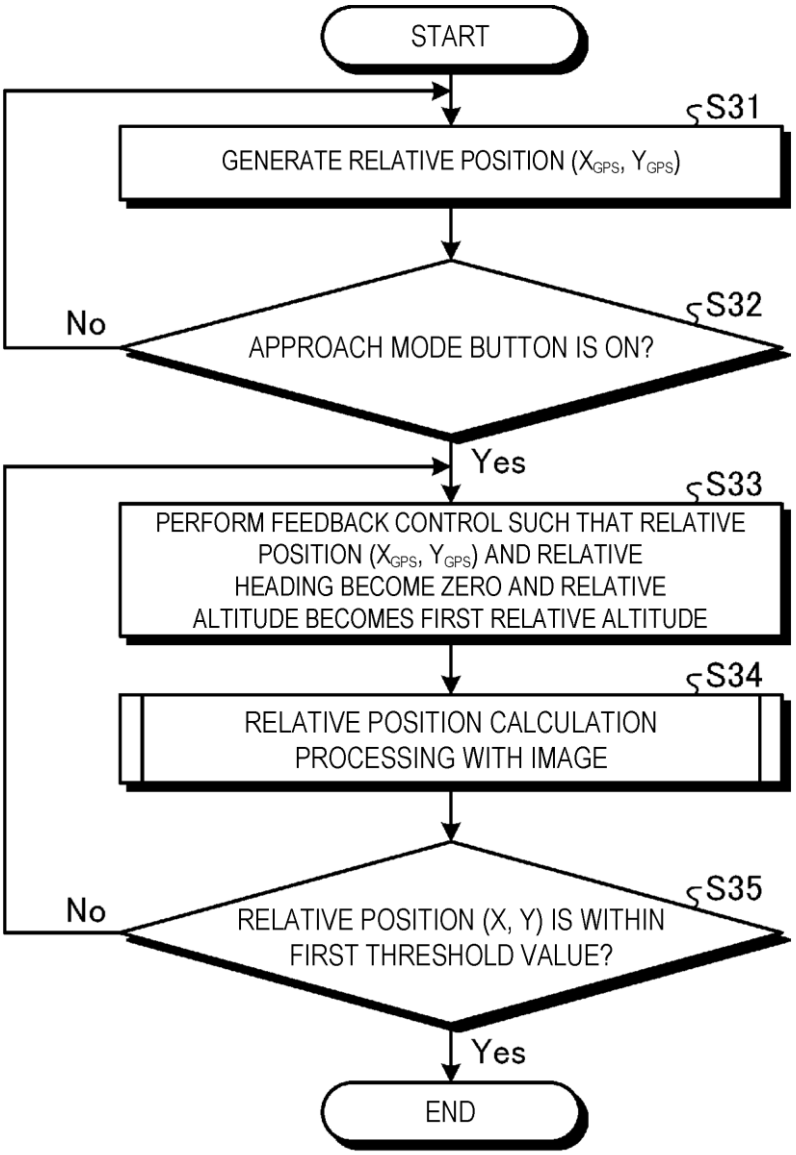

START
S31
GENERATE RELATIVE POSITION (X_{GPS}, Y_{GPS})
S32
No
APPROACH MODE BUTTON IS ON?
Yes
S33
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X_{GPS}, Y_{GPS}) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES FIRST RELATIVE ALTITUDE
S34
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S35
No
RELATIVE POSITION (X, Y) IS WITHIN FIRST THRESHOLD VALUE?
Yes
END

FIG. 6

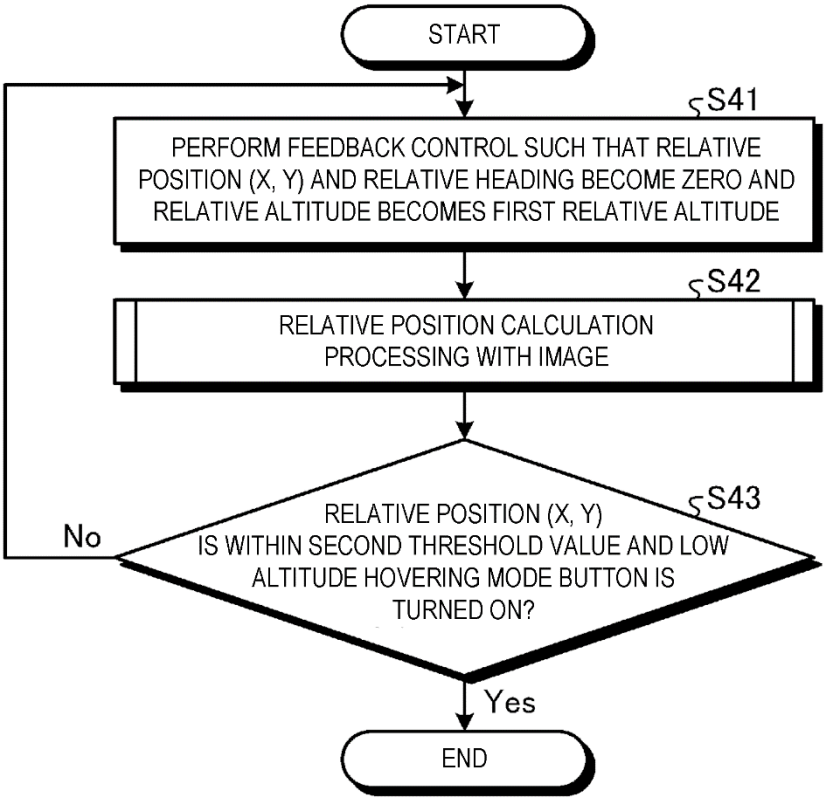

START
S41
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES FIRST RELATIVE ALTITUDE
S42
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S43
RELATIVE POSITION (X, Y) IS WITHIN SECOND THRESHOLD VALUE AND LOW ALTITUDE HOVERING MODE BUTTON IS TURNED ON?
No
Yes
END

FIG. 7

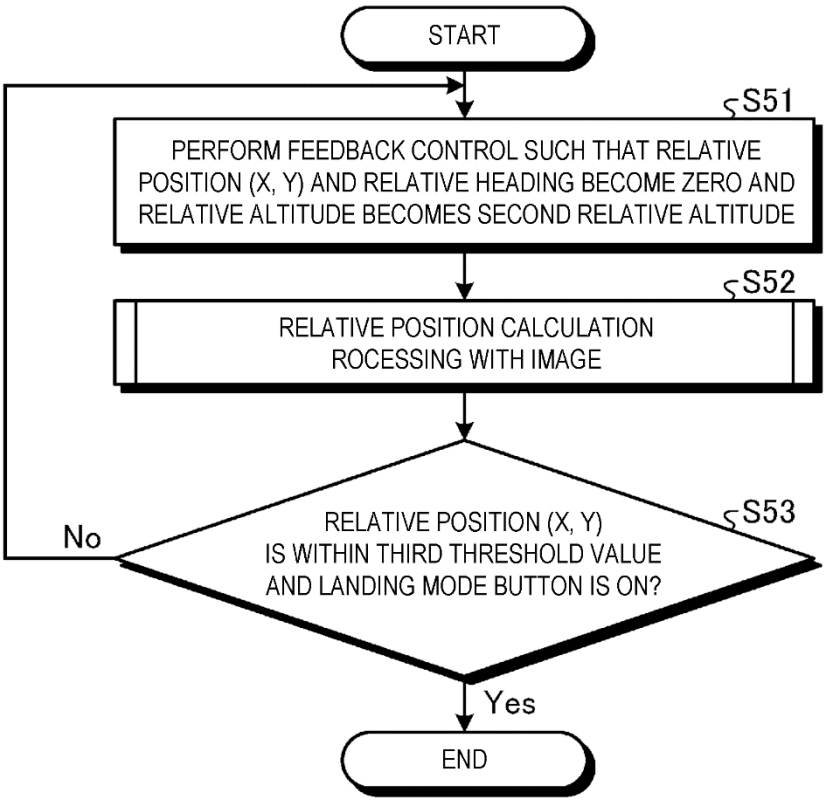

START
S51
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES SECOND RELATIVE ALTITUDE
S52
RELATIVE POSITION CALCULATION ROCESSING WITH IMAGE
S53
RELATIVE POSITION (X, Y) IS WITHIN THIRD THRESHOLD VALUE AND LANDING MODE BUTTON IS ON?
No
Yes
END

FIG. 8

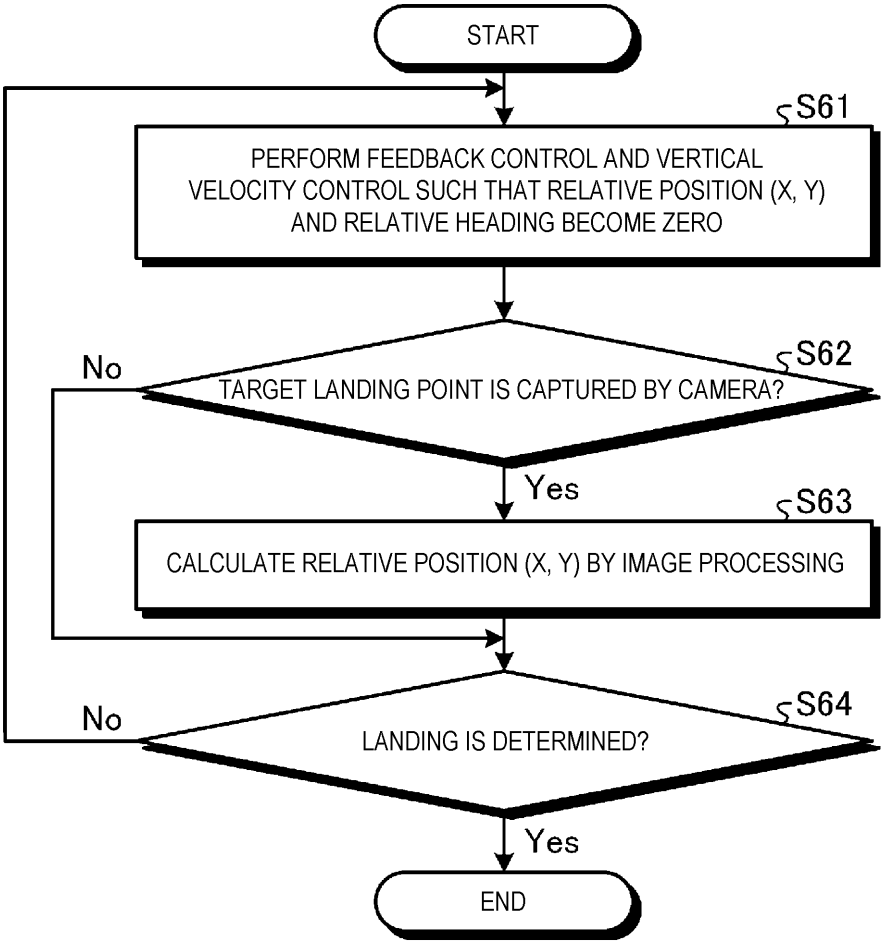

START
S61
PERFORM FEEDBACK CONTROL AND VERTICAL VELOCITY CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO
S62
No
TARGET LANDING POINT IS CAPTURED BY CAMERA?
Yes
S63
CALCULATE RELATIVE POSITION (X, Y) BY IMAGE PROCESSING
S64
No
LANDING IS DETERMINED?
Yes
END

FIG. 9

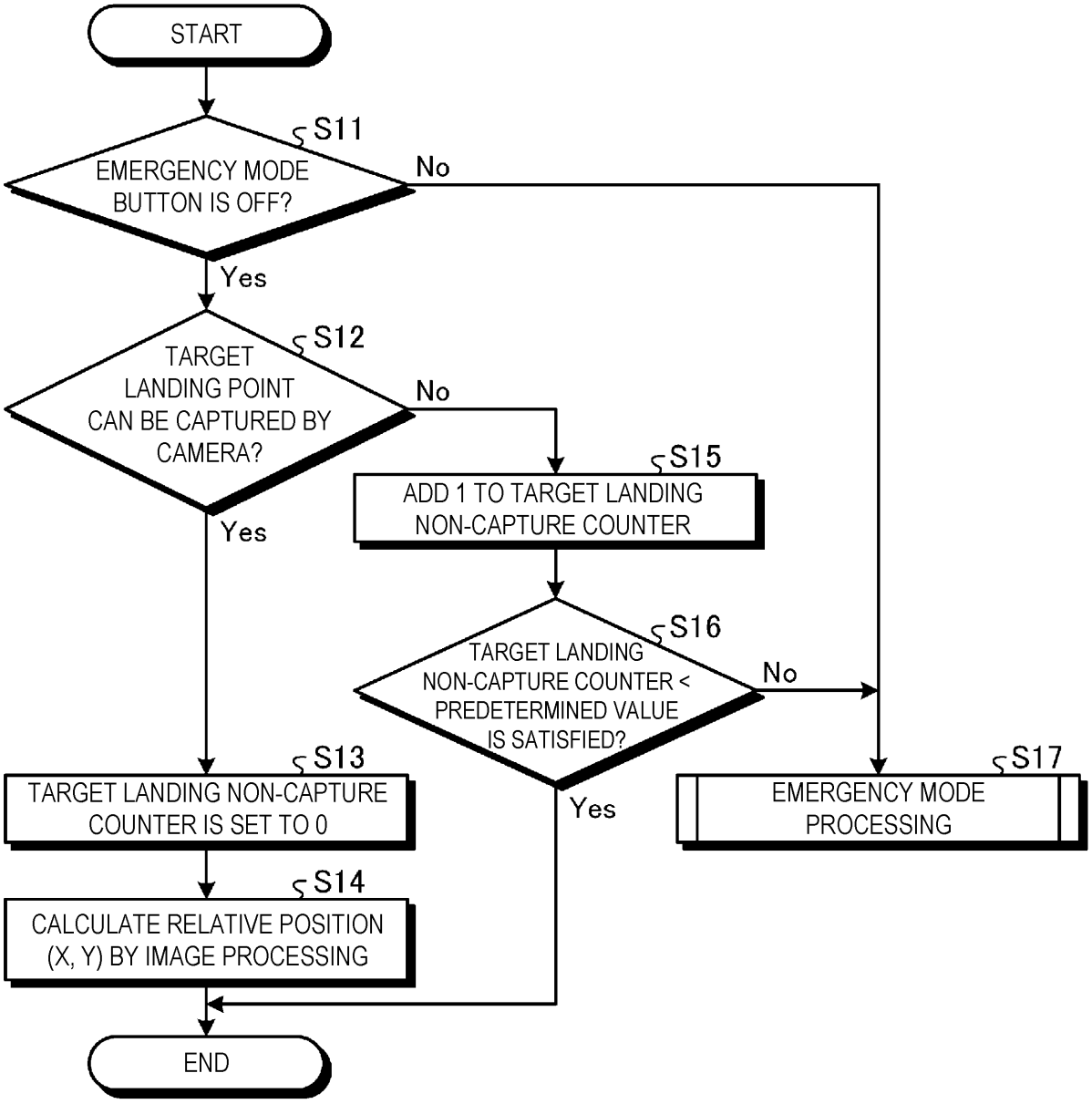

START
S11
EMERGENCY MODE BUTTON IS OFF?
No
Yes
S12
TARGET LANDING POINT CAN BE CAPTURED BY CAMERA?
No
Yes
S15
ADD 1 TO TARGET LANDING NON-CAPTURE COUNTER
S16
TARGET LANDING NON-CAPTURE COUNTER < PREDETERMINED VALUE IS SATISFIED?
No
Yes
S13
TARGET LANDING NON-CAPTURE COUNTER IS SET TO 0
S14
CALCULATE RELATIVE POSITION (X, Y) BY IMAGE PROCESSING
S17
EMERGENCY MODE PROCESSING
END

FIG. 10

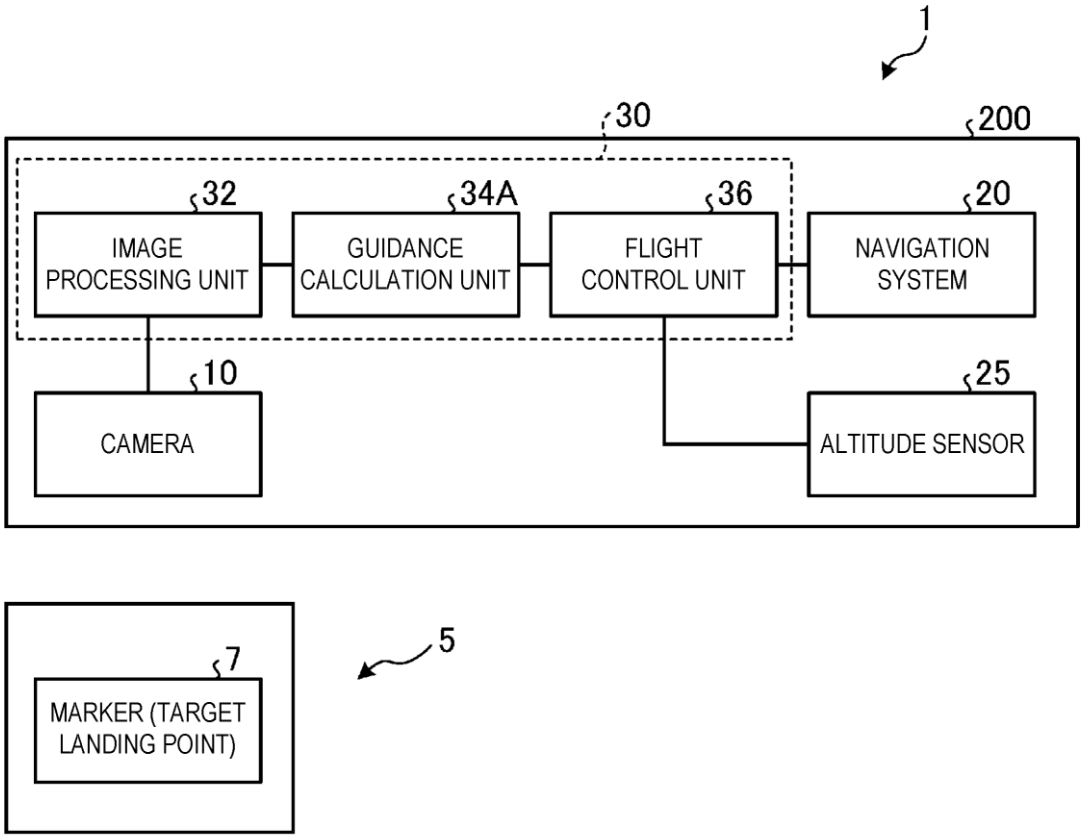

1
30
200
32
34A
36
20
IMAGE PROCESSING UNIT
GUIDANCE CALCULATION UNIT
FLIGHT CONTROL UNIT
NAVIGATION SYSTEM
10
25
CAMERA
ALTITUDE SENSOR
5
7
MARKER (TARGET LANDING POINT)

FIG. 11

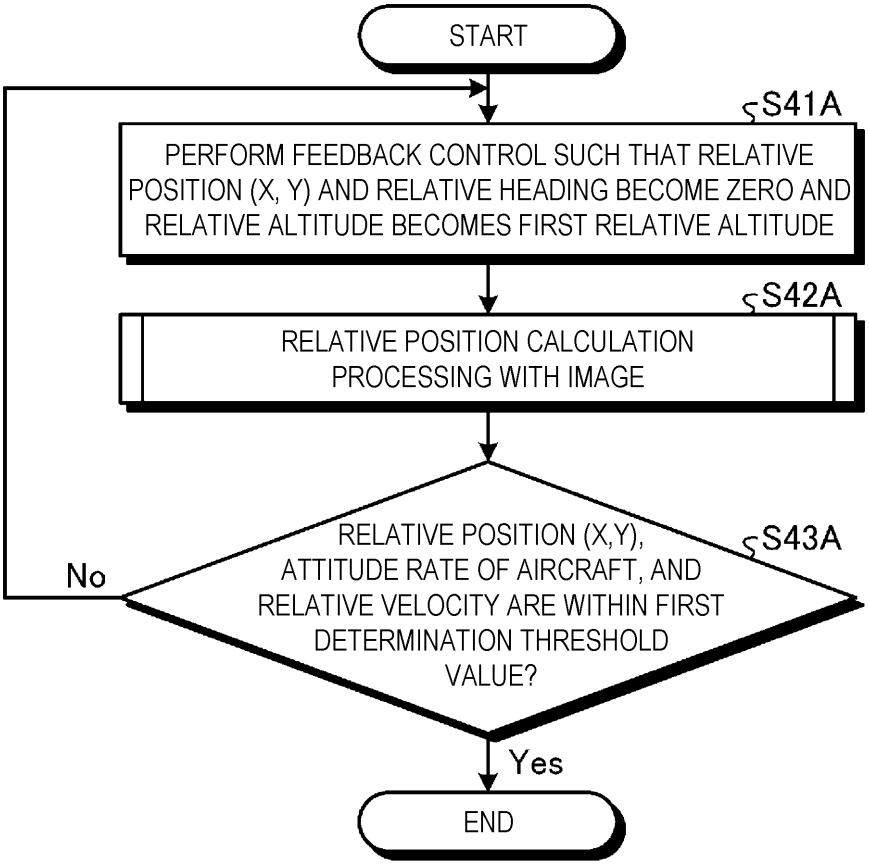

START
S41A
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES FIRST RELATIVE ALTITUDE
S42A
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S43A
RELATIVE POSITION (X,Y), ATTITUDE RATE OF AIRCRAFT, AND RELATIVE VELOCITY ARE WITHIN FIRST DETERMINATION THRESHOLD VALUE?
No
Yes
END

FIG. 12

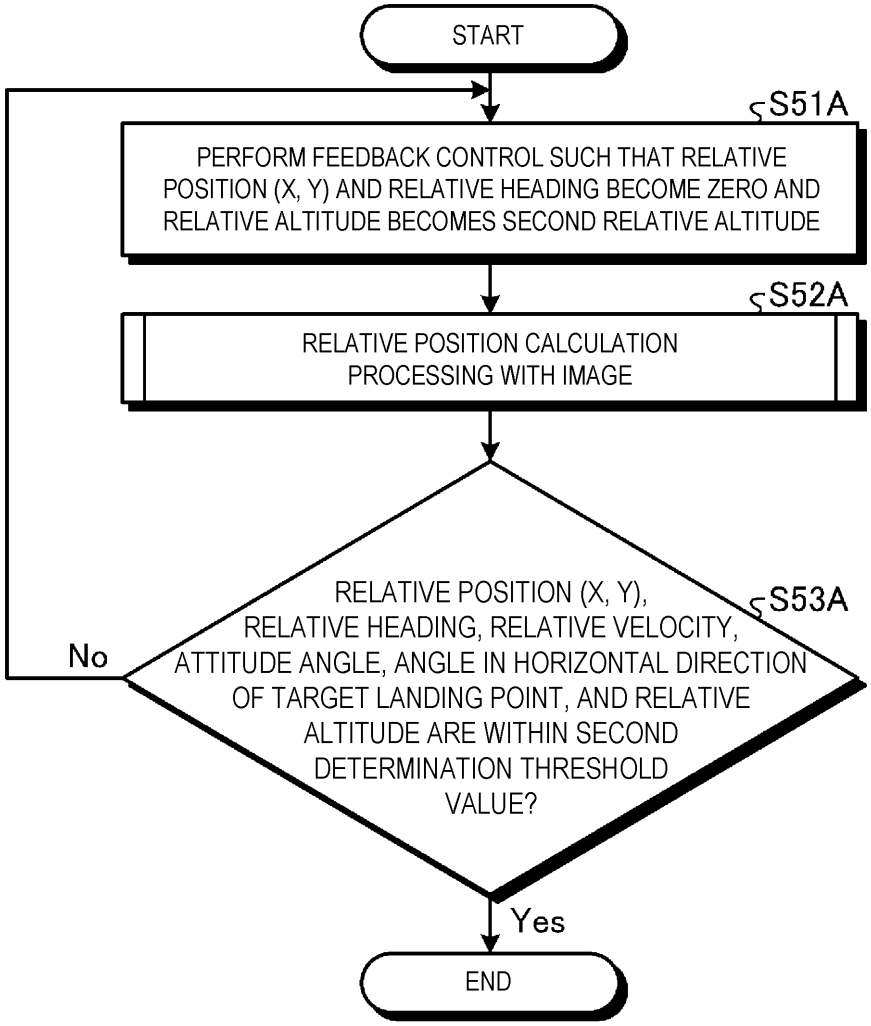

START
S51A
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES SECOND RELATIVE ALTITUDE
S52A
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S53A
RELATIVE POSITION (X, Y), RELATIVE HEADING, RELATIVE VELOCITY, ATTITUDE ANGLE, ANGLE IN HORIZONTAL DIRECTION OF TARGET LANDING POINT, AND RELATIVE ALTITUDE ARE WITHIN SECOND DETERMINATION THRESHOLD VALUE?
No
Yes
END

FIG. 13

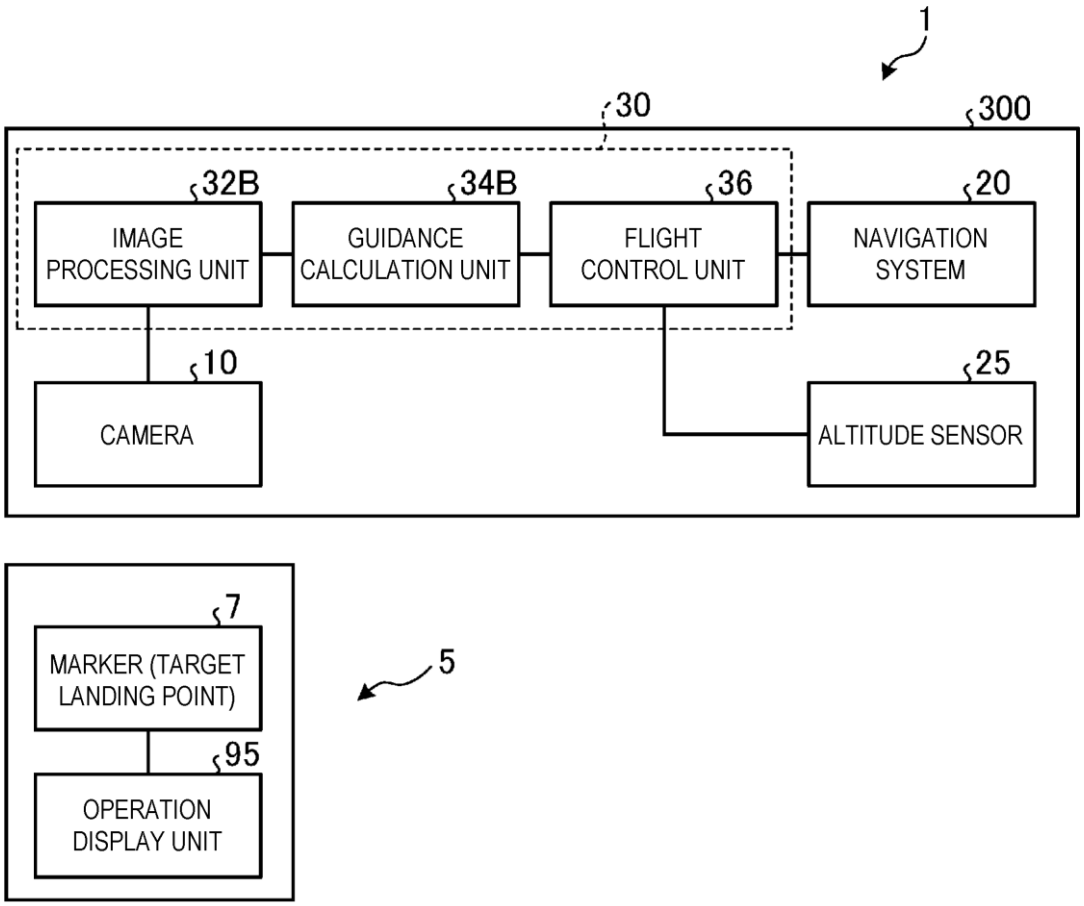

1
30
300
32B
34B
36
20
IMAGE PROCESSING UNIT
GUIDANCE CALCULATION UNIT
FLIGHT CONTROL UNIT
NAVIGATION SYSTEM
10
25
CAMERA
ALTITUDE SENSOR
7
MARKER (TARGET LANDING POINT)
5
95
OPERATION DISPLAY UNIT

FIG. 14

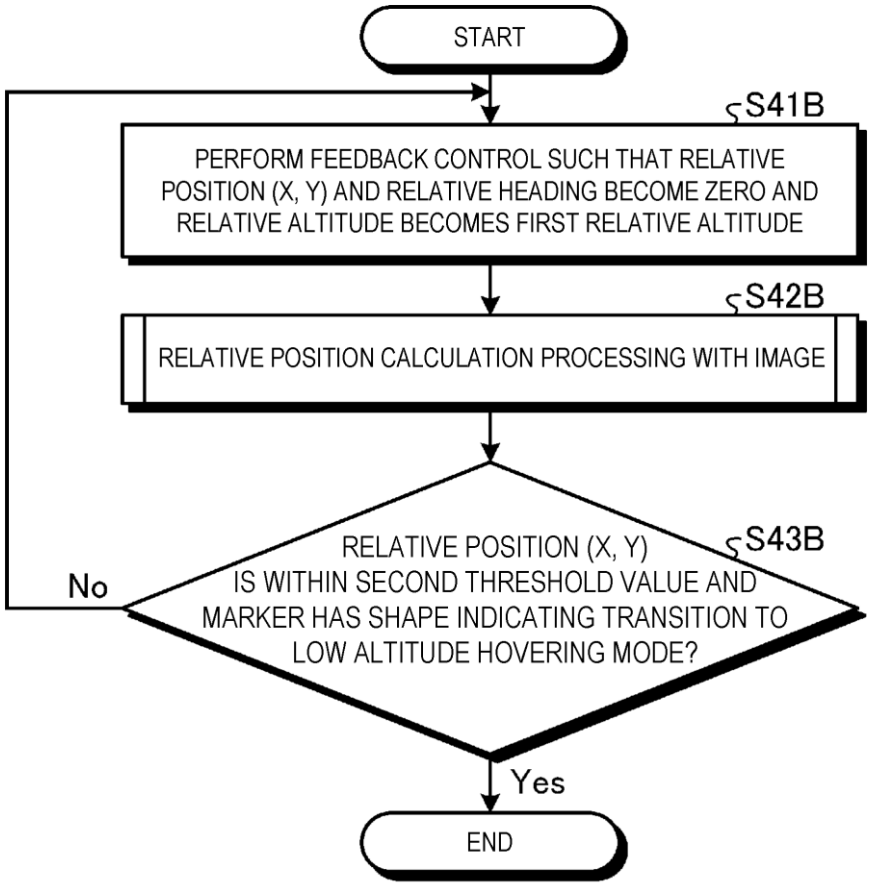

START
S41B
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES FIRST RELATIVE ALTITUDE
S42B
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S43B
RELATIVE POSITION (X, Y) IS WITHIN SECOND THRESHOLD VALUE AND MARKER HAS SHAPE INDICATING TRANSITION TO LOW ALTITUDE HOVERING MODE?
No
Yes
END

FIG. 15

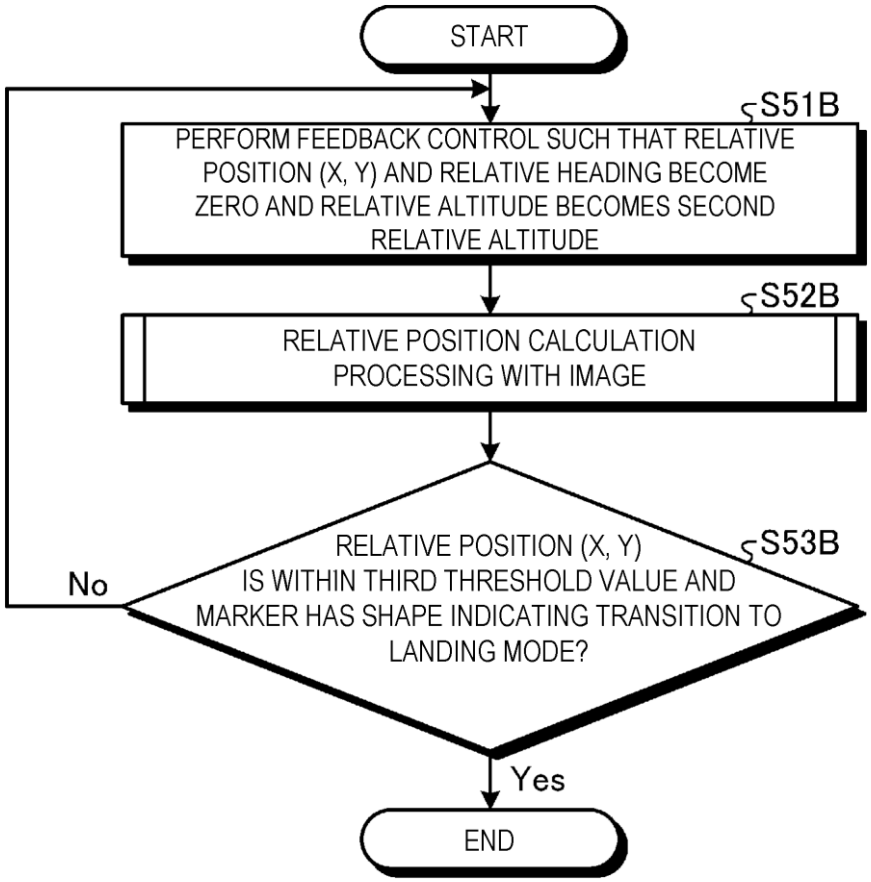

START
S51B
PERFORM FEEDBACK CONTROL SUCH THAT RELATIVE POSITION (X, Y) AND RELATIVE HEADING BECOME ZERO AND RELATIVE ALTITUDE BECOMES SECOND RELATIVE ALTITUDE
S52B
RELATIVE POSITION CALCULATION PROCESSING WITH IMAGE
S53B
RELATIVE POSITION (X, Y) IS WITHIN THIRD THRESHOLD VALUE AND MARKER HAS SHAPE INDICATING TRANSITION TO LANDING MODE?
No
Yes
END

FIG. 16