(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 396 650 A1

(12) EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
31.10.2018 Bulletin 2018/44

(21) Application number: **16878147.4**

(22) Date of filing: **28.10.2016**

(51) Int Cl.:
G08G 1/16 *(2006.01)* ***A61G 5/04*** *(2013.01)*

(86) International application number:
PCT/JP2016/082137

(87) International publication number:
WO 2017/110249 (29.06.2017 Gazette 2017/26)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

(30) Priority: **24.12.2015 JP 2015251947**

(71) Applicants:
- **Aisin Seiki Kabushiki Kaisha**
  Kariya-shi, Aichi 448-8650 (JP)
- **Chiba Institute of Technology**
  Narashino-shi, Chiba 275-0016 (JP)

(72) Inventors:
- **ANDO Mitsuhiro**
  Kariya-shi
  Aichi 448-8650 (JP)
- **YAN Sonjun**
  Kariya-shi
  Aichi 448-8650 (JP)
- **OCHIAI Hirotoshi**
  Kariya-shi
  Aichi 448-8650 (JP)
- **NAGAMINE Noboru**
  Kariya-shi
  Aichi 448-8650 (JP)
- **TAKAYANAGI Wataru**
  Kariya-shi
  Aichi 448-8650 (JP)
- **FURUTA Takayuki**
  Narashino-shi
  Chiba 275-0016 (JP)
- **SHIMIZU Masaharu**
  Narashino-shi
  Chiba 275-0016 (JP)
- **YAMATO Hideaki**
  Narashino-shi
  Chiba 275-0016 (JP)
- **TODA Kengo**
  Narashino-shi
  Chiba 275-0016 (JP)
- **KODACHI Takashi**
  Narashino-shi
  Chiba 275-0016 (JP)

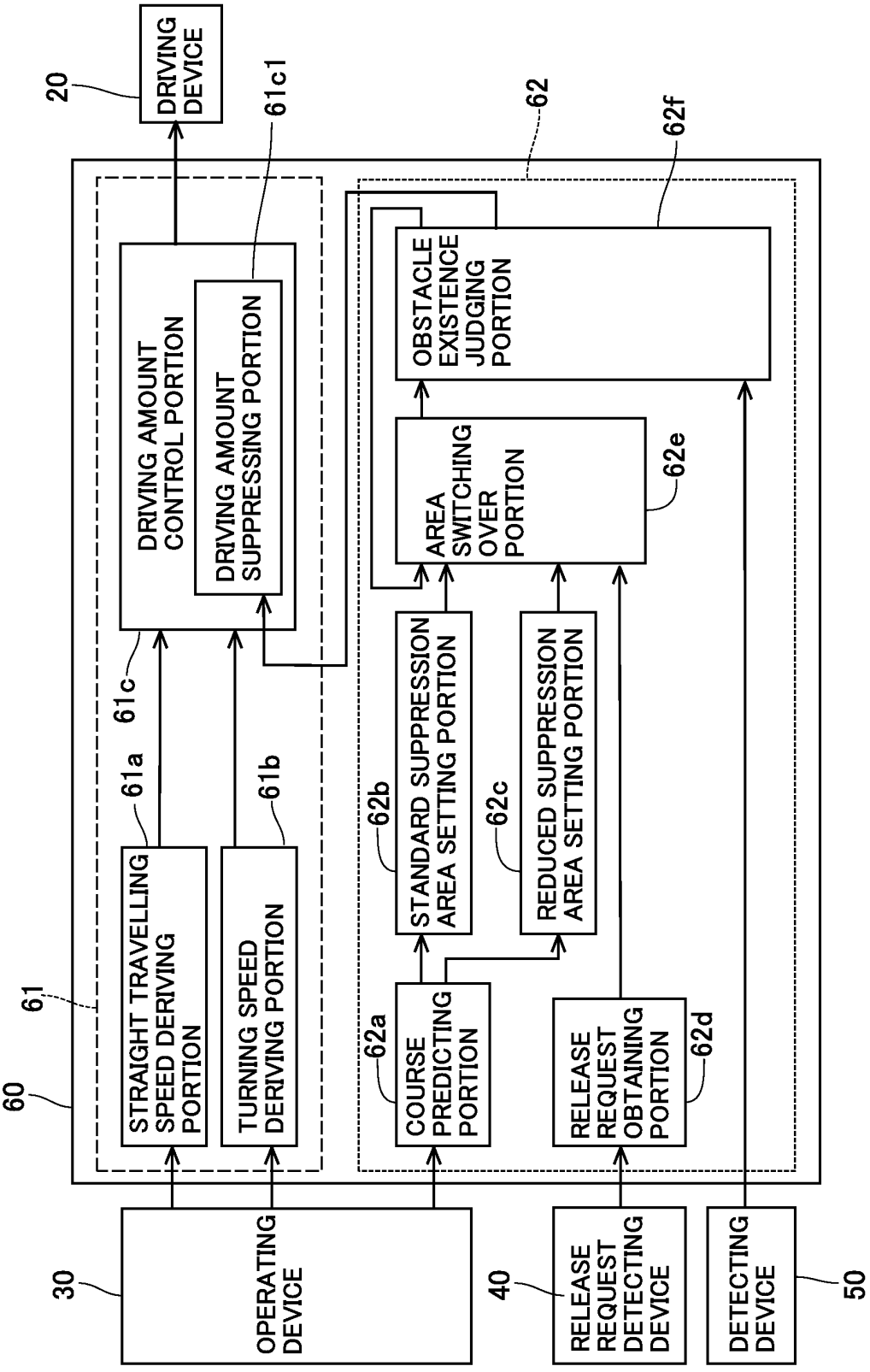
(74) Representative: **Kramer Barske Schmidtchen Patentanwälte PartG mbB**
European Patent Attorneys
Landsberger Strasse 300
80687 München (DE)

(54) MOBILE BODY

(57) The purpose of the present invention is to suppress travel of a mobile body, reflective of the intentions of a passenger, in a mobile body for which travel is suppressed on the basis of a detected object around the mobile body, in order to reduce collisions between the mobile body and a detected object around the mobile body. In the present invention, a control device of an electric wheelchair is provided with: a standard suppression region setting unit that sets a standard suppression region to serve as a standard, the standard suppression region being a suppression region in which travel of the electric wheelchair is suppressed when a detected object detected by a detecting device is positioned within the region; and a reduced suppression region setting unit that sets, on the basis of an intention of the passenger or the type of a detected object located in a peripheral region, which is a region on both sides of a predicted travel region of the electric wheelchair 1, a reduced suppression region, which is a suppression region that has been reduced in size, in respect to the standard suppression region set by the standard suppression region setting unit.

EP 3 396 650 A1

【FIG4】


20
DRIVING DEVICE
61c1
62
62f
DRIVING AMOUNT CONTROL PORTION
DRIVING AMOUNT SUPPRESSING PORTION
OBSTACLE EXISTENCE JUDGING PORTION
AREA SWITCHING OVER PORTION
62e
61c
61a
61b
62b
62c
STANDARD SUPPRESSION AREA SETTING PORTION
REDUCED SUPPRESSION AREA SETTING PORTION
61
60
STRAIGHT TRAVELLING SPEED DERIVING PORTION
TURNING SPEED DERIVING PORTION
62a
COURSE PREDICTING PORTION
RELEASE REQUEST OBTAINING PORTION
62d
30
OPERATING DEVICE
40
RELEASE REQUEST DETECTING DEVICE
DETECTING DEVICE
50

Description

[Technical Field]

[0001] This invention relates to a mobile body, particularly to a mobile body that travels by an operation of an occupant thereof.

[Background Art]

[0002] As one form of a mobile body which travels by an operation of an occupant thereof, a mobile body disclosed in Patent Literature 1 has been known. The mobile body disclosed in the Patent Literature 1 (for example, an electric wheel chair) is equipped with a surrounding object detecting device which detects a surrounding object (detected object) existing around the mobile body and an upper limit speed setting device which sets the upper limit speed of the mobile body. The upper limit speed setting device sets the upper limit such that the upper limit speed is suppressed when a detected object exists in the area of the travelling course of the mobile body and in an area which is the sideward (periphery) of the travelling course of the mobile body. This can avoid the collision between the detected object and the mobile body. Further, the upper limit speed setting means sets the upper limit speed in response to the area where the detected object positions and the relative speed between the mobile body and the detected object.

[Citation List]

[Patent Literature]

[0003] [Patent Literature 1] JP5338398

[Summary of Invention]

[Technical Problem(s)]

[0004] According to the mobile body disclosed in the Patent Literature 1, when a stationary object such as a plant or the like positioning in the side area of the travelling course is detected as a detected object when the mobile body is travelling on a road which is relatively narrow in width, the upper limit speed setting device suppresses the upper limit speed of the mobile body. Under such situation, since only the stationary object, such as plant, is detected, the occupant of the mobile body feels to operate the mobile body faster than the suppressed upper limit speed. Thus, a gap between the speed suppressed travelling of the mobile body and the occupant's intended travelling is generated.

[0005] Accordingly, this invention was made in consideration with the above-mentioned situation and the objective of the invention is to provide a mobile body which can suppress the travelling speed thereof, which suppression reflects the intention of the occupant of the mobile body, subject to the detection of the object which is existing around the mobile body in order to avoid collision with the detected object positioned in the surrounding area of the mobile body.

[Solution to Problem(s)]

[0006] In order to solve the above problems, the mobile body according to claim 1 is characterized in that the mobile body which travels driven by a driving device according to an input to an operating device by an occupant of the mobile body, includes a detecting device which detects an object existing around the mobile body and a control device which controls the mobile body to travel by controlling a driving amount of the driving device based on an input information which is an information inputted to the operating device. The control device includes a standard suppression area setting portion which sets a standard suppression area which is a criteria for determining a suppression area where a travelling of the mobile body is suppressed when the object positioning in the suppression area is detected by the detecting device and a reduced suppression area setting portion which sets a reduced suppression area which area is reduced relative to the standard suppression area set by the standard suppression area setting portion based on an intention of the occupant of the mobile body or a type of the object positioning in a surrounding area of the mobile body at both side areas of a predicted travelling course area of the mobile body.

[Advantageous Effect of Invention]

[0007] According to the invention described above, a reduced suppression area setting portion sets the reduced suppression area which area is reduced relative to the standard suppression area based on the intention of the occupant. In other words, the suppression area is reducible and accordingly, when the travelling of the mobile body is suppressed due to a detected object positioning in the standard suppression area, the standard suppression area is changed to (reduced to) the reduced suppression area and accordingly, the suppression of travelling of the mobile body is released when the detected object, which had been positioned within the standard suppression area, moves outside of the reduced suppression area. In this situation, a gap between the suppressed travelling of the mobile body and the travelling intended by the occupant can be reduced by releasing the suppression of the travelling of the mobile body when the travelling of the mobile body is suppressed against the intended travelling by the occupant because of existing of a detected object within the standard suppression area. Further, the reduced suppression area setting portion sets the reduced suppression area which area is reduced relative to the standard suppression area based on the type of the object positioning in a surrounding area. When the suppression area is set to the reduced sup-

pression area, the detected object can be hardly positioned in the suppression area. Thus, when the detected object is not positioned in the suppression area, the travelling of the mobile body is not suppressed and accordingly, the travelling according to the intention of the occupant can be possible. Then the gap between the suppressed travelling of the mobile body and the travelling intended by the occupant can be reduced. Accordingly, the suppression of travelling of the mobile body can be made which reflects the intention of the occupant of the mobile body.

[Brief Explanation of Drawings]

[0008]

[Fig. 1] Fig. 1 is an outline view of a structure of a mobile body according to a first embodiment of the invention;
[Fig. 2] Fig. 2 is a partially enlarged cross section view showing an operating device and a release request detecting device shown in Fig. 1;
[Fig. 3] Fig. 3 is a schematic view of an input information inputted to the operating device of Fig. 1 and vertical axis indicates a front/rear direction of a mobile body and a horizontal axis indicates a right/left direction of the mobile body;
[Fig. 4] Fig. 4 is a block diagram of the mobile body shown in Fig. 1;
[Fig. 5A] Fig. 5A is a first map memorized in a control device shown in Fig. 4, indicating a relationship between a desired or intended straight traveling speed and a straight traveling speed of the mobile body;
[Fig. 5B] Fig. 5B is a second map memorized in a control device shown in Fig. 4, indicating a relationship between a desired or intended turning speed and a turning speed of the mobile body;
[Fig. 6] Fig. 6 is a schematic view of a predicted travelling course area and the surrounding area of travelling of the mobile body formed on the polar coordinates by the course predicting portion shown in Fig. 4, wherein the vertical axis indicates a front/rear direction of the mobile body and the horizontal axis indicates the right/left direction of the mobile body;
[Fig. 7] Fig. 7 is a schematic view showing the standard suppression area on the polar coordinates set by the standard suppression area setting portion shown in Fig. 4;
[Fig. 8] Fig. 8 is a schematic view showing the reduced suppression area on the polar coordinates set by the reduced suppression area setting portion shown in Fig. 4;
[Fig. 9] Fig. 9 is a third map memorized in the control device shown in Fig. 4, indicating a relationship between a minimum distance between the mobile body and the detected object when the detected object is positioned within the suppression area and the restricting driving amount of the driving amount by the driving device;
[Fig. 10] Fig. 10 is a flowchart of a program executed by the control device shown in Fig. 4;
[Fig. 11] Fig. 11 is another flowchart of a program executed by the control device shown in Fig. 4;
[Fig. 12] Fig. 12 is a schematic view of the suppression area on the polar coordinates set by the standard suppression area setting portion and the reduced suppression area setting portion shown in Fig. 4, but showing a modified embodiment;
[Fig. 13] Fig. 13 is a block diagram of the mobile body associated with a second embodiment;
[Fig. 14] Fig. 14 is a schematic view of the standard suppression area on the polar coordinates set by the standard suppression area setting portion shown in Fig. 13;
[Fig. 15A] Fig. 15A is a schematic view of the reduced suppression area on the polar coordinates set by the reduced suppression area setting portion shown in Fig. 13 and a grid for a detected object appearing on the polar coordinates when the mobile body travels on a road which width is relatively narrow;
[Fig. 15B] Fig. 15B is a schematic view of an occlusion grid used in a modified example of the deriving method of occupation ratio by the occupation ratio deriving portion shown in Fig. 13;
[Fig. 16] Fig. 16 is a fourth map memorized in the control device shown in Fig. 13, indicating a relationship between the surrounding object and the suppression area;
[Fig. 17] Fig. 17 is a schematic view indicating an area expanding control executed by the area expanding control portion shown in Fig. 13;
[Fig. 18] Fig. 18 is a fifth map memorized in the control device shown in Fig. 13, indicating a relationship between the acceleration, the surrounding object and the occupation ratio and the execution of the area expanding control;
[Fig. 19] Fig. 19 is a flowchart of a program executed at the control device shown in Fig. 13;
[Fig. 20] Fig. 20 is a fourteenth map memorized in the control device of a mobile body associated with a modified example of the second embodiment of the invention, indicating a relationship between the occupation ratio and the suppression area;
[Fig. 21] Fig. 21 is a twenty-fourth map memorized in the control device of a mobile body associated with a modified example of the second embodiment of the invention, indicating a relationship among the surrounding object, the occupation ratio and the suppression area; and
[Fig. 22] Fig. 22 is a fifteenth map memorized in the control device of a mobile body associated with a modified example of the second embodiment of the invention, indicating a relationship between the surrounding object and the occupation ratio and the execution of the area expanding control.

[Preferred Embodiments Implemented by Invention]

<First Embodiment

[0009] First embodiment of the mobile body according to the invention will be explained hereinafter with reference to the attached drawings. As an example of the mobile body according to the embodiment, an electric wheel chair 1 shown in Fig. 1 will be explained. It is noted that for the purpose of illustration, the explanation will be made assuming that the top side and bottom side of Fig. 1 indicate the upper side and lower side of the electric wheel chair 1. Similarly, the bottom left side and the top right side of Fig. 1 indicate the front side and rear side of the electric wheel chair 1 and the top left side and the bottom right side of Fig. 1 indicate the right side and the left side of the electric wheel chair 1, respectively. The arrows in Fig. 1 indicate respective directions.

[0010] As shown Figs.1 and 2, the electric wheel chair 1 includes a wheel chair main body 10, a driving device 20, an operating device 30, a release request detecting device 40, a detecting device 50 and a control device 60. The electric wheel chair 1 corresponds to the mobile body which travels, driven by the driving device 20 which is driven based on the input to the operating device 30 by an occupant of the mobile body. The driving device 20, the operating device 30, the release request detecting device 40, the detecting device 50 and the control device 60 are installed on the wheel chair main body 10.

[0011] The wheel chair main body 10 includes a frame 11, a seat 12 on which the occupant is seated and wheels 13. The seat 12 and the wheels 13 are assembled to the frame 11. The wheels 13 are structured to be rotatable about respective rotation axes. The wheels 13 are arranged at the right side and the left side of the wheel chair main body 10 and includes a left drive wheel 13a and a right drive wheel 13b which are driven by the driving device 20 and a left auxiliary wheel 13c and a right auxiliary wheel 13d for auxiliary supporting the traveling of the electric wheel chair 1.

[0012] The driving device 20 drives the electric wheel chair 1 by rotatably driving the respective driving wheels 13a and 13b. The driving device 20 is, for example, structured by a combination of an electric motor (not shown) and reduction gear mechanism (not shown). The driving device 20 is provided at respective driving wheels 13a and 13b (total number of the driving device 20 is two).

[0013] The operating device 30 is operated by the occupant of the electric wheel chair 1 to give instructions regarding to the straight traveling speed "v" and the turning speed "w" of the electric wheel chair 1. The straight traveling speed "v" is a speed of the electric wheel chair 1 traveling in a forward direction (front direction) with respect to the electric wheel chair 1. The turning speed "w" is an angular speed of the electric wheel chair 1 turning around the center of gravity thereof, as a turning center at the location where the electric wheel chair 1 is located. In this embodiment, a joystick is used as the operating device 30. As shown Fig. 2, the operating device 30 includes a lever portion 31 and a base portion 32 which tiltably supports the lever portion 31

[0014] The operating device 30 is positioned in a state in which the lever portion 31 is erected upright in the vertical direction at a position where the lever portion 31 is the non-operated position (hereinafter, referred to as a neutral position) shown with a broken line in Fig. 2. The operating device 30 is operated by the occupant of the wheel chair 1 by inclining the lever portion 31 from the neutral position to an angular position. The operated state of the lever portion 31 is indicated by the coordinates of the tip end of the operating device 30, when the operating device 30 is projected onto the X-Y plane which is in parallel with the horizontal plane as shown in Fig. 3. The X-axis is the same direction with the front/rear direction of the electric wheel chair 1 and positive direction of the X-axis is the same with the front direction of the electric wheel chair 1. The Y-axis is the same direction with the right/left direction of the electric wheel chair 1 and the positive direction of the Y-axis is the same with the right direction of the electric wheel chair 1. The value of the X-coordinates indicates a desired straight traveling speed "xjs" of the electric wheel chair 1 corresponding to the straight traveling speed desired by the occupant of the wheel chair 1. The value of the Y-coordinates indicates a desired turning speed "yjs" of the electric wheel chair 1 corresponding to the turning speed desired by the occupant of the wheel chair 1. The values of the desired straight traveling speed "xjs" and the desired turning speed yjs" are outputted to the control device 60, every first predetermined time as the input information inputted to the operating device 30. The first predetermined time is set to be, for example, 1 / 25 second.

[0015] The release request detecting device 40 is a device which detects how strong the release request is by the operation of the occupant. The release request is a request for releasing the suppression of the travelling of the electric wheel chair 1, which will be explained later. The release request detecting device 40 detects the strength of the release request based on the magnitude of pushing load which will be explained later. In other words, the greater the pushing load, the larger the release request becomes. The release request detecting device 40 includes a projecting portion 41 and the load detecting portion 42.

[0016] The projecting portion 41 is formed at the lower end of the lever portion 31 to be projecting forward as shown in Fig. 2. The load detecting portion 42 is provided on the base portion 32 at a position where the projecting portion 41 is brought into contact with the lever portion 31 when the lever portion 31 is tilted forwardly. The load detecting portion 42 detects the load from the projecting portion 41 when the projecting portion 41 is in contact with the load detecting portion 42. This detected load corresponds to the operating load (hereinafter referred to as pushing load) generated when the occupant of the mobile body operates the lever portion 31 to be tilted

forwardly to push the projecting portion 41 toward the load detecting portion 42. As the load detecting portion 42, for example, a strain gage type load sensor can be used. The load detecting portion 42 sends the detected result to the control device 60.

[0017] The detecting device 50 detects the object existing around the electric wheel chair 1. The detecting device 50 is formed by a 3D (three dimensional) measurement area sensor (laser range scanner (3D scanner)). The detecting device 50 obtains the information of the detected object on whether or not a detected object exists and the distance from the detecting portion 51 to the detected object, by (three dimensionally) emitting three laser beams, one dimension in a horizontal direction, the rest two dimensions in up/down directions from the detecting portion 51 and receiving the reflected waves from the detected object at the detecting portion 51. The laser beams are emitted towards the front side of the electric wheel chair 1 in a radial direction. The detecting device 50 obtains the information on the detected object, for example, every first predetermined time. The obtained information on the detected object by the detecting device 50 is outputted to the control device 60.

[0018] The control device 60 drives the electric wheel chair 1 to travel by controlling the driving amount of the driving device 20 based on the input information. The driving device 20, the operating device 30, the release request detecting device 40 and the detecting device 50 are connected to the control device 60 as shown in Fig. 4. The control device 60 includes a travelling control portion 61 and a collision suppressing control portion 62.

[0019] The travelling control portion 61 executes a traveling control which lets the electric wheel chair 1 to travel. The travelling control portion 61 includes a straight travelling speed deriving portion 61a, a turning speed deriving portion 61b and a driving amount control portion 61c.

[0020] The straight travelling speed deriving portion 61a derives the straight travelling speed "v" of the electric wheel chair 1. The straight travelling speed deriving portion 61a converts the input information which is a desired straight traveling speed "xjs" obtained from the operating device 30 into the straight traveling speed "v". The straight travelling speed deriving portion 61a calculates the straight traveling speed "v" from the desired straight traveling speed "xjs" based on the first map M1 shown in Fig. 5A. The first map M1 indicates the relationship between the desired straight traveling speed "xjs" and the straight traveling speed "v". The first map M1 includes proportional portions mv1 in which the desired straight traveling speed "xjs" and the straight traveling speed "v" are proportional and dead zone portions mv2 in which the straight traveling speed "v" is constant regardless of the magnitude of the desired straight traveling speed "xjs" as shown in Fig. 5A. When the straight traveling speed "v" is a positive value, the electric wheel chair 1 moves forward. On the other hand, when the straight traveling speed "v" is a negative value, the electric wheel chair 1 moves rearward. The straight travelling speed deriving portion 61a outputs the derived straight travelling speed "v" to the driving amount control portion 61c.

[0021] The turning speed deriving portion 61b derives the turning speed "w" of the electric wheel chair 1. The turning speed deriving portion 61b obtains the desired turning speed "yjs" which is the input information from the operating device 30 and converts to the turning speed "w". In more detail, the turning speed deriving portion 61b derives the turning speed "w" based on the second map M2 shown in Fig. 5B from the obtained desired turning speed "yjs". The second map M2 indicates the relationship between the desired turning speed "yjs" and the turning speed "w". Further, the second map M2 includes proportional portions mw1 in which the desired turning speed "yjs" and the turning speed "w" are proportional and dead zone portions mw2 in which the turning speed "w" is constant regardless of the magnitude of the desired turning speed "yjs". When the turning speed "w" is a positive value, the electric wheel chair 1 turns in the right direction. On the other hand, when the turning speed "w" is a negative value, the electric wheel chair 1 turns in the left direction. The turning speed deriving portion 61b outputs the derived turning speed "w" to the driving amount control portion 61c.

[0022] The driving amount control portion 61c controls the driving amount (rotation number) of the driving device 20 based on the straight traveling speed "v" obtained from the straight travelling speed deriving portion 61a and the turning speed "w" obtained from the turning speed deriving portion 61b. The driving amount control portion 61c derives the rotation speed of the left drive wheel 13a and the rotation speed of the right drive wheel 13b based on the obtained the straight traveling speed "v" and the turning speed "w". The magnitude of the straight traveling speed "v" is proportional to the magnitude of the rotation speed of the left drive wheel 13a and the magnitude of the rotation speed of the right drive wheel 13b. Further, the magnitude of the turning speed "w" is proportional to the magnitude of the difference in rotation speed between the left drive wheel 13a and the right drive wheel 13b. The relationship between the straight traveling speed "v" and the turning speed "w" and the rotation speed of the left drive wheel 13a and the right drive wheel 13b is obtained in advance by calculation through the experimental work or the like. It is noted that since the driving device 20 is PWM (Pulse Width Modulation) -controlled, the control instruction value of the driving device 20 is calculated based on the duty ratio (cycle). Further, the driving amount control portion 61c includes a driving amount suppressing portion 61c1. The driving amount suppressing portion 61c1 suppresses the driving amount of the driving device 20 based on the suppression instructions from the collision suppressing control portion 62 (explained later).

[0023] The collision suppressing control portion 62 performs the collision suppressing control for avoiding the collision between the electric wheel chair 1 and the

detected object. The collision suppressing control portion 62 includes a course predicting portion 62a, a standard suppression area setting portion 62b, a reduced suppression area setting portion 62c, a release request obtaining portion 62d, an area switching over portion 62e and an obstacle existence judging portion 62f, as shown Fig. 4.

[0024] The course predicting portion 62a predicts the traveling course of the electric wheel chair 1 based on the input information (desired straight travelling speed "xjs" and desired turning speed "yjs") from the operating device 30. The course predicting portion 62a predicts the course of the electric wheel chair 1 on the polar coordinates C, as shown in Fig. 6. The polar coordinates C is arranged in parallel with the horizontal plane, having a point of origin C0 at the front end central position of the electric wheel chair 1 and at the same time the polar coordinates of Fig. 6 indicates the top side of the coordinates corresponding to the front side of the electric wheel chair 1. The angular range of the polar coordinates C corresponds to the angular range within which a detected object can be detected by the detecting device 50. The polar coordinates C includes a plurality of grids G, each delimited in both radial and circumferential directions with a predetermined distance apart from each other in radial and circumferential directions (for example, having an interval of 1 meter (m) in a radial direction and five (5) degrees in a circumferential direction).

[0025] The predicted travelling course area Wy which is the travelling course of the electric wheel chair 1 predicted by the course predicting portion 62a is indicated concretely as a traveling trace of the electric wheel chair 1 from the time when the control device 60 obtains the input information to the time when the second predetermined time (for example, five seconds) has passed. In other words, the width of the predicted travelling course area Wy corresponds to the width of the electric wheel chair 1. The predicted travelling course area Wy is formed based on a predetermined function derived from an actual measurement by an experimental work or the like in advance from the straight traveling speed "v" and the turning speed "w". The predicted travelling course area Wy is formed (renewed) every first predetermined time from the time when the control device 60 obtains the input information from the operating device 30. Further, the areas existing at both sides of the predicted travelling course area Wy in the area of the polar coordinates C are generated as the surrounding area Rs.

[0026] The standard suppression area setting portion 62b sets the standard suppression area Rb as a standard, which is the suppression area in which the travelling of the electric wheel chair 1 is suppressed when an object detected by the detecting device 50 is positioned in this area. As shown in Fig. 7, the standard suppression area Rb extends along the predicted travelling course area Wy and the width thereof is wider than the width of the predicted travelling course area Wy. The standard suppression area Rb is in a sector shape having a standard width Bb which is defined to be the standard value. The shape of the standard suppression area Rb varies according to the change of the predicted travelling course area Wy which varies according to the change of the input information. As shown in Fig. 7, the shape of the standard suppression area Rb is the shape of the predicted travelling course area Wy being extending straight forward. The travelling of the electric wheel chair 1 is suppressed when the object detected by the detecting device 50 is positioned within the standard suppression area Rb, which will be explained later. The standard suppression area Rb set by the standard suppression setting portion 62b is outputted to the area switching over portion 62e.

[0027] The reduced suppression area setting portion 62c sets the reduced suppression areas Rr1, Rr2 which are the reduced suppression areas relative to the standard suppression area Rb set by the standard suppression area setting portion 62b. The reduced suppression area setting portion 62c sets the first reduced suppression area Rr1 and the second reduced suppression area Rr2 and as show in Fig. 8, the first reduced suppression area Rr1 extends along the predicted travelling course area Wy and is formed in a sector shape with a first width Br. The value of the first width is set to be a value between the width of the predicted travelling course area Wy and a standard width Bb. In other words, the first reduced suppression area Rr1 is an area included in the standard suppression area Rb. The shape of the first reduced suppression area Rr1 varies in accordance with the change of the predicted travelling course area Wy which varies in accordance with the change of the input information. As shown in Fig. 8, the shape of the first reduced suppression area Rr1 is the shape of the predicted travelling course area Wy at the time when the predicted travelling course area Wy is extending straight forward.

[0028] Further, the second reduced suppression area Rr2 is set in the same area with the predicted travelling course area Wy. In other words, the widths of the standard suppression area Rb, the first reduced suppression area Rr1 and the second reduced suppression area Rr2 become stepwise narrowing in this order. The travelling of the electric wheel chair 1 is suppressed when the object detected by the detecting device 50 is positioned within the first reduced suppression area Rr1 and the second reduced suppression area Rr2, which will be explained later. Each reduced suppression areas Rr1 and Rr2 set by the reduced suppression setting portion 62c is outputted to the area switching over portion 62e. Thus, according to the suppression area of the first embodiment, three suppression areas are formed which are the standard suppression area Rb, the first reduced suppression area Rr1 and the second reduced suppression area Rr2.

[0029] The release request obtaining portion 62d obtains the magnitude of strength of the release request. In concrete, the release request obtaining portion 62d obtains the pushing load operated by the occupant and detected by the load detecting portion 42. The pushing

load obtained by the release request obtaining portion 62d is outputted to the area switching over portion 62e.

[0030] The area switching over portion 62e switches over the suppression area from the standard suppression area Rb set by the standard suppression area setting portion 62b to the reduced suppression area Rr1 and Rr2 set by the reduced suppression area setting portion 62c based on the strength of the release request detected by the release request detecting device 40 (release request obtaining portion 62d) and the judgement result of the obstacle existence judging portion 62f. In detail, the area switching over portion 62e switches over from the standard suppression area Rb to each reduced suppression area Rr1 and Rr2 based on whether any obstacle exists or not and the strength of the pushing load from release request obtaining portion 62d. According to this embodiment, the area switching over portion 62e switches over (selects) between the standard suppression area Rb and each reduced suppression area Rr1 and Rr2 by the area switching over control (later explained). Each reduced suppression area Rr1 and Rr2 which is switched over by the area switching over portion 62e is outputted to the obstacle existence judging portion 62f. When the area switching over portion 62e does not switch over the suppression area from the standard suppression area Rb, the standard suppression area Rb is outputted to the obstacle existence judging portion 62f.

[0031] The obstacle existence judging portion 62f judges whether any obstacle exists or not based on the obstacle detecting information detected by the detecting device 50 and the suppression area from the area switching over portion 62e. The obstacle means any detected object which positions in the suppression area. In other words, the obstacle existence judging portion 62f judges that an obstacle exists when the obstacle detected by the detecting device 50 is positioned in the suppression area selected by the area switching over portion 62e. On the other hand, the obstacle existence judging portion 62f judges that an obstacle does not exist when the obstacle detected by the detecting device 50 is not positioned in the suppression area (i.e., is positioned outside of the suppression area) selected by the area switching over portion 62e.

[0032] The obstacle existence judging control whether an obstacle exists or not performed by the obstacle existence judging portion 62f will be explained hereinafter. First, the detected object information is projected from the detecting device 50 on the polar coordinates C. The detected object information is a coordinates data of a group of points PG formed by a plurality of points P which is a 3D positioning information of the detected object. As shown in Figs. 7 and 8, a grid G which includes at least a predetermined number of points P in the group of points PG projected on the polar coordinates C is defined to be the object detected grid in which an object exists. The predetermined number is, for example, set to be three (3). The obstacle existence judging portion 62f judges that an object exists when the object detected grid and the suppression area overlap with each other. In more detail, as shown in Fig. 7, in a case where three object detected grids Gk1, Gk2 and Gk3 are detected based on the detected object information from the detecting device 50 and at the same time when the suppression area agrees with the standard suppression area Rb set by the standard suppression area setting portion 62b, the obstacle existence judging portion 62f judges that an object exists when the two object detected grids Gk2 and Gk3 overlap with the standard suppression area Rb.

[0033] On the other hand, the obstacle existence judging portion 62f judges that an object does not exist when the object detected grid and the suppression area do not overlap with one another. In more detail, as shown in Fig. 8, in a case where three object detected grids Gk1, Gk2 and Gk3 are detected based on the detected object information from the detecting device 50 and at the same time when the suppression area agrees with the reduced suppression area Rr1 set by the reduced suppression area setting portion 62c, the obstacle existence judging portion 62f judges that an object does not exist when the three object detected grids Gk1, Gk2 and Gk3 do not overlap with the reduced suppression area Rr1. It is noted here that since the detected object information is obtained every first predetermined time, the judgement by the obstacle existence judging portion 62f is made per every first predetermined time. The judgement result by the obstacle existence judging portion 62f is outputted to the area switching over portion 62e and the driving amount suppressing portion 61c1.

[0034] The driving amount suppressing portion 61c1 suppresses the travelling of the electric wheel chair 1 while an object is judged to be existing by the obstacle existence judging portion 62f. In more detail, the driving amount suppressing portion 61c1 suppresses or restricts the driving amount of the driving device 20. According to this embodiment, the driving amount control portion 61c suppresses the maximum driving amount of the driving device 20 to suppress the maximum speed of the straight travelling speed "v". The driving amount suppressing portion 61c1 suppresses the maximum speed of the straight travelling speed "v" to the maximum straight travelling speed "vx" while an object is judged to be existing by the obstacle existence judging portion 62f. The maximum straight travelling speed "vx" is derived based on the third map M3 shown in Fig. 9, from the minimum distance Dmin (See Fig. 7) which is the shortest distance from the electric wheel chair 1 (the front end central position of the electric wheel chair 1: point of origin C0) to the detected object which positions in the suppression area. The minimum distance Dmin can be derived from the detected object information. The minimum distance Dmin is derived from the driving amount suppressing portion 61c1 while an object is judged to be existing by the obstacle existence judging portion 62f. The third map M3 indicates the relationship between the minimum distance Dmin and the maximum straight travelling speed "vx". This relationship is set so that the shorter the minimum distance Dmin,

the smaller the maximum straight travelling speed becomes. On the other hand, when an object is judged to be not existing by the obstacle existence judging portion 62f, the driving amount suppressing portion 61c1 releases the suppression of travelling of the electric wheel chair 1 when the travelling speed is being suppressed.

[0035] The travelling control for the electric wheel chair 1 by the control device 60 will be explained hereinafter. From the time when the occupant of the electric wheel chair 1 operates the operating device 30 and the control device 60 obtains the input information from the operating device 30, the control device 60 starts travelling control. As explained above, based on the input information from the operating device 30, the straight travelling speed deriving portion 61a derives the straight travelling speed "v" and the turning speed deriving portion 61b derives the turning speed "w". Based on the result of the derivation by the straight travelling speed deriving portion 61a and the turning speed deriving portion 61b, the driving amount control portion 61c controls the driving amount of the driving device 20 to make the electric wheel chair 1 travel. While the control device 60 is controlling the travelling of the electric wheel chair 1, if the occupant shifts the operating device 30 to the neutral position, the straight travelling speed "v" and the turning speed "w" become zero and the electric wheel chair 1 stops its movement. Thus, the traveling control by the control device 60 ends.

[0036] Next, the collision suppression control by the control device 60 will be explained with reference to the flowchart shown in Fig. 10. The collision suppression control is a control for avoiding collision between the electric wheel chair 1 and the detected object by suppressing the travelling speed of the electric wheel chair 1 to provide a time sufficient for the occupant to avoid collision with a detected object, if an object is detected in the suppression area, while the travelling control of the electric wheel chair 1 is being executed. The suppression area is set to the standard suppression area Rb at the start of travelling of the electric wheel chair 1.

[0037] If the electric wheel chair 1 is in traveling control, the control device 60 predicts the traveling course of the electric wheel chair 1 at the step S102 (course predicting portion 62a). The control device 60 sets the standard suppression area Rb and the reduced suppression areas Rr1 and Rr2 at the step S104 (standard suppression area setting portion 62b and each reduced suppression area setting portion 62c). Then, the control device 60 executes the area switching over control at the step S106 (area switching over portion 62e). The area switching over control will be explained with reference to the flowchart shown in Fig. 11.

[0038] Then, the control device 60 judges whether an obstacle exists or not at the step S202 (obstacle existence judging portion 62f). When the control device 60 judges that an obstacle does not exist, the control device 60 judges "NO" at the step S202 and the control device 60 sets the suppression area to the standard suppression area Rb and ends the area switching over control at the step S204. When the control device 60 judges that an obstacle does not exist, the travelling of the electric wheel chair 1 is not suppressed (driving amount suppressing portion 61c1) and any gap (hereinafter, referred to as simply referred to as "traveling gap") between the intended travel of the occupant and the actual travelling of the electric wheel chair 1 is not generated. Accordingly, the suppression area is set to be the standard suppression area Rb which is the largest area of the suppression area. On the other hand, if an obstacle is detected, the control device 60 judges that an obstacle exists (obstacle existence judging portion 62f), the control device 60 judges YES" at the step S202 and the program goes to the step S206.

[0039] The control device 60 judges whether or not the magnitude of strength of the release request is equal to or less than a first release request judgement value at the step S206. In detail, the control device 60 judges whether or not the pushing load is equal to or less than the first release request judgement value. The first release request judgement value is set to the value corresponding to the pushing load applied when the travelling gap is very small. The first release request judgement value is set to, for example, one (1) N (newton). The pushing load is very small when the travelling gap is very small, or zero. When the pushing load is equal to or less than the first release request judgement value, the control device 60 judges "YES" at the step S206 and the control device 60 sets the suppression area to the standard suppression area Rb at the step S204. Then the area switching over control ends.

[0040] On the other hand, when the travelling gap is relatively large, the pushing load becomes relatively large. When the pushing load is larger than the first release request judgement value, the control device 60 judges "NO" at the step S206 and advances the program to the step S208.

[0041] The control device 60 judges whether or not the magnitude of strength of the release request (the pushing load) is equal to or less than a second release request judgement value at the step S208. The second release request judgement value is set to a value larger than the first release request judgement value (for example, ten (10) N). Under the situation that the travelling gap is relatively large, if the pushing load is equal to or less than the second release request judgement value, the control device 60 judges "YES" at the step S208 and sets the suppression area to the first reduced suppression area Rr1 at the step S210. Then the area switching over control ends. On the other hand, when the travelling gap is relatively large and when the pushing load is larger than the second release request judgement value, the control device 60 judges "NO" at the step S208. Then the control device 60 sets the suppression area to the second reduced suppression area Rr2 at the step S212. Then the area switching over control ends.

[0042] Returning now back to the flowchart in Fig. 10,

the explanation of the operation of the control device 60 will continue hereinafter. The control device 60 judges whether an obstacle exists or not at the step S108. When the obstacle is positioned in the suppression area switched over by the switching over control, the obstacle is judged to be existing (obstacle existence judging portion 62f). In such case, the control device 60 judges "YES" at the step S108 and suppresses the travelling speed of the electric wheel chair 1 at the step S110 (driving amount suppressing portion 61c1). The program returns to the step S102.

[0043] On the other hand, when the obstacle is positioned outside of the suppression area which has been switched over by the switching over control (is not positioned in the suppression area), the obstacle is judged to be not existing (obstacle existence judging portion 62f). In such case, the control device 60 judges "NO" at the step S108 and judges whether or not the travelling speed of the electric wheel chair 1 is suppressed at the step S112. If the travelling of the electric wheel chair 1 is not suppressed, the control device 60 judges "NO" at the step S112 and returns the program to the step S102. On the other hand, if the suppression of travelling of the electric wheel chair 1 has been already made, the control device 60 judges "YES" at the step S112 and releases the travelling suppression of the electric wheel chair 1 (driving amount suppressing portion 61c1) at the step S114. Then the program returns to the step S102.

[0044] Next, the operation of the electric wheel chair 1 according to the flowchart above will be explained hereinafter. The explanation will be made for a case of the electric wheel chair 1 being travelling with the maximum speed (such as, for example, 10 km/h) without any suppression of travelling speed due to the forward inclination of the lever portion 31 of the operating device 30 by the occupant. Under such situation, the predicted travelling course area Wy is formed straight forward (step S102; course predicting portion 62a). Then, based on the predicted travelling course area Wy, the standard suppression area Rb and the reduced suppression areas Rr1 and Rr2 are set (step S104; standard suppression area setting portion 62b and reduced suppression area setting portion 62c). When an obstacle is judged to be not existing, the suppression area is set to the standard suppression area Rb (S106; area switching over portion 62e).

[0045] When an obstacle is detected by the detecting device 50 and the detected object is positioning in the standard suppression area Rb as shown in Fig. 7, the maximum speed of the straight travelling speed "v" is suppressed according to the minimum distance Dmin between the electric wheel chair 1 and the detected object (step S110; driving amount suppressing portion 61c1). When the electric wheel chair 1 is travelling with the suppressed straight travelling speed "v", if the detected object is a stationary object, the occupant of the electric wheel chair 1 wishes to travel faster than the suppressed straight travelling speed "v" and a travelling gap is generated due to such desire or feeling of the occupant. In such case, the occupant inclines the lever portion 31 further forwardly to request a release of suppression of the travelling speed of the electric wheel chair 1. By this further forward inclination operation, when the pushing load becomes a value between the first release request judgment value and the second release request judgment value, the standard suppression area Rb is changed to the first reduced suppression area Rr1 as shown in Fig. 8 (step S106; area switching over portion 62e).

[0046] By this operation, the detected object goes out of the first reduced suppression area Rr1 and positions outside of the suppression area. Accordingly, the suppression of travelling of the electric wheel chair 1 is released (step S114; driving amount suppressing portion 61c1). Thus, the occupant can move the electric wheel chair 1 with a non-suppressed intended speed. As explained, by suppressing or releasing the travelling gap, the travelling of the electric wheel chair 1 reflecting an occupant's intension can be suppressed.

[0047] It is noted that even when the standard suppression area Rb has been changed to the first reduced suppression area Rr1 (step S106; area switching over portion 62e), if the detected object is positioning in the first reduced suppression area Rr1, the travelling of the electric wheel chair 1 can be suppressed (step S110; driving amount suppressing portion 61c1). Further, when the strength of the release request by the occupant becomes relatively large, and the suppression area is changed to the second reduced suppression area Rr2, if the detected object is positioning in the second reduced suppression area Rr2, the travelling of the electric wheel chair 1 can be suppressed. As explained above, even the occupant requests a release of suppression, as long as the detected object is positioning in the suppression area, the travelling of the electric wheel chair 1 is suppressed. Thus, a collision of the electric wheel chair 1 with a detected object can be suppressed or avoided. Further, if the pushing load becomes relatively large against the intention of the occupant, or if the strength of the release request becomes larger than the respective release request judgment values due to a failure in the operating device 30, the release request detecting device 40 or in the control device 60, as long as the detected object is positioning in the suppression area, the travelling of the electric wheel chair 1 is suppressed. Accordingly, under such cases, the collision between the electric wheel chair 1 and a detected object can be avoided.

[0048] According to the first embodiment, the electric wheel chair 1 travels driven by a driving device 20 according to an input to an operating device 30 by an occupant, wherein the electric wheel chair 1 includes a detecting device 50 which detects an object existing around the electric wheel chair 1 and a control device 60 which controls the electric wheel chair 1 to travel by controlling a driving amount of the driving device 20 based on an input information which is an information inputted to the operating device 30. The control device 60 includes a

standard suppression area setting portion 62b which sets a standard suppression area Rb which is a criteria for determining a suppression area where a travelling of the electric wheel chair 1 is suppressed when the object positioning in the suppression area is detected by the detecting device 50 and a reduced suppression area setting portion 62c which sets a reduced suppression area Rr1 and Rr2 which area is reduced relative to the standard suppression area Rb set by the standard suppression area setting portion 62b based on an intention of the occupant of the electric wheel chair 1.

[0049] According to the first embodiment described above, the reduced suppression area setting portion 62c sets the reduced suppression area Rr1 and Rr2 which area is reduced relative to the standard suppression area Rb based on the intention of the occupant. In other words, the suppression area can be reducible and when the travelling of the electric wheel chair 1 is suppressed due to a detected object positioning in the standard suppression area Rb, the standard suppression area Rb is switched over to (reduced to) the reduced suppression area Rr1 and Rr2 and accordingly, the suppression of travelling of the electric wheel chair 1 is released when the detected object which had been positioned within the standard suppression area Rb positions outside of the reduced suppression area Rr1 and Rr2. In this situation, since the detected object positions within the standard suppression area Rb, a gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be suppressed by releasing the suppression of the travelling of the electric wheel chair 1, if the travelling of the electric wheel chair 1 has been suppressed against the intended travelling by the occupant. Accordingly, the suppression of travelling of the electric wheel chair 1 can be made reflecting the intention of the occupant of the electric wheel chair 1.

[0050] Further, the intension of the occupant means a request for releasing the suppression of travelling speed of the electric wheel chair 1 and the electric wheel chair 1 further includes a release request detecting device 40 which detects the strength of the release request by the operation of the occupant. The control device 60 further includes an area switching over portion 62e which switches over the suppression area from the standard suppression area Rb set by the standard suppression area setting portion 62b to the reduced suppression area Rr1 and Rr2 set by the reduced suppression area setting portion 62b, based on the strength of the release request detected by the release request detecting device 40. According to the structure explained above, by the operation of the release request detecting device 40 by the occupant, the release request against the suppression of travelling of the electric wheel chair 1 can be surely transmitted to the electric wheel chair 1 and a suppression area switching over control by the area switching over portion 62e from the standard suppression area Rb to the reduced suppression area Rr1 and Rr2 can be surely performed. Accordingly, the gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be surely suppressed. Accordingly, the suppression of travelling of the electric wheel chair 1 can be executed, reflecting the intention of the occupant of the electric wheel chair 1.

[0051] Further, the reduced suppression area setting portion 62c sets the reduced suppression area Rr1 and Rr2 so that the reduced suppression area reduces, as the strength of the release request detected by the release request detecting device 40 increases. Accordingly, since the reduced suppression area setting portion 62c sets the reduced suppression area so that the reduced suppression area reduces, as the strength of the release request detected by the release request detecting device 40 increases, more objects to be detected may become positioned outside of the reduced suppression area. Accordingly, the travelling gap between the travelling intended by the occupant and the suppressed travelling of the electric wheel chair 1 can be further suppressed and the suppression of travelling of the electric wheel chair 1 which reflects the intension of the occupant can be further made.

[0052] It is noted that according to the first embodiment, the suppression area is formed such that the width thereof becomes narrower stepwise in response to the strength of the release request (pushing load). However, such shape of the suppression area may be differently formed from the shape explained in the first embodiment as far as such shape is formed within the subject matter of the invention. For example, as shown in Fig. 12, supposing that four areas R1 through R4 are set, the widths of which become narrower towards frontward from the point of origin C0, the standard suppression area Rb may be set to the area including all four areas R1 through R4. Then, the first reduced suppression area Rr1 may be set to the area including three areas R2 through R4 and the second reduced suppression area Rr2 may be set to the area including two areas R3 and R4. Further, when a third reduced suppression area which area is smaller than the second reduced suppression area Rr2 is set by the reduced suppression area setting portion 62c, such third reduced suppression area may be set to include one area R4. As explained, the reduced suppression area is set such that the length in the front/rearward direction becomes shortened stepwise with respect to the standard suppression area Rb. Further, the reduced suppression area is set such that the length in the front/rearward direction becomes shortened stepwise and at the same time the width thereof in the front/rearward direction becomes narrowed stepwise with respect to the standard suppression area Rb, when the reduced suppression area setting portion 62c sets such that the reduced suppression area becomes reduced stepwise with respect to the standard suppression area Rb. As explained, the reduced suppression area is set such that the length in the front/rearward direction becomes shortened stepwise and at the same time the width thereof in the front/rearward direction becomes narrowed stepwise

with respect to the standard suppression area Rb.

<Second Embodiment

[0053] Next, the mobile body according to the second embodiment of the invention will be explained hereinafter, mainly regarding to the different points from those of the first embodiment. The mobile body of the second embodiment does not include the release request detecting device 40 and the collision suppressing control portion 62 is different in structure from that of the first embodiment. According to the collision suppressing control portion 62 of the first embodiment, the suppression area is switched over based on the release request by the occupant. However, the collision suppressing control portion 162 according to the second embodiment second embodiment the suppression area is switched over based on the type of the detected object positioned in the surrounding area Rs. Further, according to the collision suppressing control portion 162 executes an area expanding control which deforms the suppression area to be expanding based on the type of the detected object. The type of the detected object is a stationary object and a moving object.

[0054] The collision suppressing control portion 162 according to the second embodiment includes, as shown in Fig. 13, a course predicting portion 162a, a standard suppression area setting portion 162b, a reduced suppression area setting portion 162c, a surrounding object existence judging portion 162g, a surrounding object type judging portion 162h, an occupation ratio deriving portion 162k, an area switching over portion 162e, an acceleration deriving portion 162m, an area expanding control portion 162n and an obstacle existence judging portion 162f. A straight travelling speed "v" derived from the straight travelling speed deriving portion 61a and a turning speed "w" derived from the turning speed deriving portion 61b are inputted to the surrounding object type judging portion 162h and the acceleration deriving portion 162m every first predetermined time.

[0055] Similar to the first embodiment, the course predicting portion 162a forms the predicted travelling course area "Wy" and the surrounding area "Rs". The predicted travelling course area "Wy" and the surrounding area "Rs" are inputted to the standard suppression area setting portion 162b, the reduced suppression area setting portion 162c and the surrounding object existence judging portion 162g.

[0056] The standard suppression area setting portion 162b sets the standard suppression area Rb. The standard suppression area Rb according to the second embodiment is formed in parallel with the predicted travelling course area "Wy", as shown in Fig. 14. The standard width Bb of the standard suppression area Rb according to the second embodiment is set to be about four times of the width of the electric wheel chair 1. The reduced suppression area setting portion 162c sets the reduced suppression area Rr. The reduced suppression area Rr of the second embodiment includes only one reduced suppression area Rr. The reduced suppression area Rr according to the second embodiment is set to the same area with the predicted travelling course area "Wy".

[0057] The surrounding object existence judging portion 162g judges whether or not a surrounding object exists based on the detected object information detected by the detecting device 50 and the surrounding area Rs defined by the course predicting portion 162a. The surrounding object is defined to be an object to be detected which positions in the surrounding area Rs. In detail, the surrounding object existence judging portion 162g judges that the surrounding object exists when the surrounding object positions in the surrounding area Rs, in this situation the surrounding area Rs and the object detected grid Gk overlap with one another, as shown in Fig. 14.

[0058] On the other hand, the surrounding object existence judging portion 162g judges that the surrounding object does not exist when the surrounding object positions outside of the surrounding area Rs, under such situation, the surrounding area Rs and the object detected grid Gk do not overlap with one another. The meaning that the surrounding area Rs and an object detected grid Gk do not overlap with one another is that any object detected grid Gk does not exist on the polar coordinates C or that the object detected grid Gk overlaps only with the suppression area. The judgement result of the surrounding object existence judging portion 162g is outputted to the surrounding object type judging portion 162h, the area switching over portion 162e and the area expanding control portion 162n. Further, the surrounding object existence judging portion 162g outputs the information on the surrounding area Rs and the object detected grid Gk (the position and the number on the polar coordinates C) to the occupation ratio deriving portion 162k.

[0059] The surrounding object type judging portion 162h judges whether the detected surrounding object type is a stationary object or a moving object after the surrounding object existence judging portion 162g judged that the surrounding object exists. Since the coordinates of the detected object is obtained every first predetermined time, the speed of the detected object can be calculated on the polar coordinates C. This speed of the detected object on the polar coordinates is a relative speed with the speed of the electric wheel chair 1. Further, surrounding object type judging portion 162h calculates the speed of the electric wheel chair 1 based on the straight travelling speed "v" derived from the straight travelling speed deriving portion 61a and the turning speed "w" derived from the turning speed deriving portion 61b. When the speed of the detected object is the same with the speed of the electric wheel chair 1, the surrounding object type judging portion 162h judges that the detected object type is a stationary object. On the other hand, if the speed of the detected object is different from the speed of the electric wheel chair 1, the surrounding object type judging portion 162h judges that the detected object

type is a moving object. The detected result of the surrounding object type judging portion 162h is outputted to the area switching over portion 162e and the area expanding control portion 162n.

[0060] The occupation ratio deriving portion 162k derives the occupation ratio which is a ratio of an area occupied by the detected object relative to the surrounding area Rs. The occupation ratio deriving portion 162k derives the occupation ratio based on the surrounding area Rs from the surrounding object existence judging portion 162g and the information on the detected object grid Gk. In detail, the occupation ratio is a ratio of the number of the detected object grid Gk which overlaps with the surrounding area Rs relative to the number of grid G which overlaps with the surrounding area Rs. For example, under the situation that the electric wheel chair 1 is travelling straight forward on a straight road with a relatively narrow width, if a plurality of stationary objects, such as plants, is arranged at both sides of the road in parallel with each other, the group of points PG arranged in parallel with each other along in a front/rear direction appear on the polar coordinates C, as shown in Fig. 15A. In this case the number of grid G which over laps with the surrounding area Rs is 162. The number of the object detected grid Gk which overlaps with the surrounding area Rs is 18. Therefore, the occupation ratio of this case is 11.1 (= 18 / 162)%. For example, if any detected object does not exist in the surrounding area Rs, the number of the object detected grid Gk which overlaps with the surrounding area Rs becomes zero. Therefore, in this case, the occupation ratio is zero (0) %. The occupation ratio deriving portion 162k outputs the derived occupation ratio to the area switching over portion 162e and the area expanding control portion 162n.

[0061] It is noted that the occupation ratio deriving portion 162k may derive the occupation ratio based on the surrounding area Rs from the surrounding object existence judging portion 162g, the information on the detected object grid Gk and the information on an occlusion grid Go (See Fig. 15B). The occlusion grid Go is the grid G corresponding to the occlusion area on the polar coordinates C. When the detecting device 50 detects an object, due to the specific characteristics of the detecting device 50, the detecting device 50 cannot detect another object which positions behind (in a direction away from the electric wheel chair 1) the detected object. The area where such another object cannot be detected is defined to be the occlusion area. In the polar coordinates C, as shown in Fig. 15B, if the detected object grid Gk, same as in Fig. 15A, exists, the grid G positioned frontward of the detected object grid Gk becomes the occlusion grid Go. The occupation ratio deriving portion 162k may derive the occupation ratio as the ratio of the number of detected object grid Gk which overlaps with the surrounding area Rs relative to the number of the grid G which overlaps with the surrounding area Rs from which the number of occlusion grid Go which overlaps with the surrounding area Rs is subtracted.

[0062] The area switching over portion 162e switches over the suppression area based on the judgement result of the surrounding object existence judging portion 162g, the judgement result of the surrounding object type judging portion 162h and the occupation ratio derived from the occupation ratio deriving portion 162k, based on the predetermined map. According to the second embodiment, the predetermined map is the fourth map M4 shown in Fig. 16. In detail, the area switching over portion 162e switches over the suppression area to the standard suppression area Rb when the surrounding object existence judging portion 162g judges that the surrounding object does not exist and when the surrounding object type judging portion 162h judges that the type of the surrounding object is a moving object. It is noted that when a plurality of surrounding objects exists, if one of these objects is judged as a moving object, the suppression area is changed to the standard suppression area Rb. Further, the area switching over portion 162e switches over the suppression area to the reduced suppression area Rr when the surrounding object type judging portion 162h judges that the detected object is a stationary object. It is noted here that when a plurality of surrounding objects exists, if all of these objects is judged as the stationary objects, the suppression area is changed to the standard suppression area Rb.

[0063] The acceleration deriving portion 162m derives the acceleration of the electric wheel chair 1. The acceleration deriving portion 162m calculates the speed of the electric wheel chair 1 based on the straight travelling speed "v" derived from the straight travelling speed deriving portion 61a and the turning speed "w" derived from the turning speed deriving portion 61b every first predetermined time and the calculated speed is memorized as the time series data. The acceleration deriving portion 162m judges whether the electric wheel chair 1 is accelerating or not based on the current speed in the time series data and each speed from the time before the second predetermined time, which is longer than the first predetermined time, up to the current time. The result of deriving by the acceleration deriving portion 162m is outputted to the area expanding control portion 162n.

[0064] The area expanding control portion 162n executes the area expanding control which expands the suppression area. The area expanding control is a control where the suppression area which has been switched over by the area switching over portion 162e is expanded. According to this embodiment, as shown in Fig. 17, the area expanding control expands (deforms) the width of the suppression area to be expanded in a right/left direction. The expanding amount which is the expanded amount of the suppression area is calculated by the area expanding control. In detail, the expanded amount ΔRL which is an area expanded to the left side of the suppression area can be calculated by the formula (1) as follows. Further, the expanded amount ΔRR which is an area expanded to the right side of the suppression area can be calculated by the formula (2) as follows. The expanded

amount ΔRL and the expanded amount ΔRR are calculated every first predetermined time and the suppression area expands by the amount ΔRL and ΔRR.

[M1]

$$\Delta RL = HL \times ((A / B) + C) \ldots. (1)$$

[M 2]

$$\Delta RR = HR \times ((A / B) + C) \ldots. (2)$$

[0065] The "HL" in the formula (1) represents the length in the right/left direction from the left end of the current suppression area to the left end of the left side surrounding area Rs. "A" in the formula (1) represents the current acceleration of the electric wheel chair 1 and "B" represents the maximum acceleration of the electric wheel chair 1. The "HR" in the formula (2) represents the length in the right/left direction from the right end of the current suppression area to the right end of the right side surrounding area Rs. It is noted that the "C" is set to a predetermined value when the speed of the electric wheel chair 1 is the maximum speed. When the speed of the electric wheel chair 1 is the maximum speed, the predetermined value is determined such that when the expanded amount ΔRL has not reached to the left end of the surrounding area Rs, the expanded amount ΔRL is expanded to reach to the left end of the surrounding area Rs and, at the same time, when the expanded amount ΔRR has not reached to the right end of the surrounding area Rs, the expanded amount ΔRR is expanded to reach to the right end of the surrounding area Rs. It is also noted that the value "C" is set to zero when the speed of the electric wheel chair 1 is not the maximum speed.

[0066] Further, when the suppression area is expanded, if the detected object positions in the suppression area, the area expanding control portion 162n maintains the current suppression area without expanding thereof and if the detected object positioned in the suppression area has left the suppression area, the area expanding control portion 162n expands the suppression area according to the manner explained above. When the suppression area has been expanded and both of the right and left ends of the suppression area have reached to the right and left ends of the surrounding area Rs, the area expanding control portion 162n returns the suppression area to the initialized original shape and repeatedly continues the expansion of the suppression area.

[0067] Further, the area expanding control portion 162n decides whether the area expanding control shall be executed or not based on the derivation result of the acceleration deriving portion 162m, the judgement result of the surrounding object existence judging portion 162g, the judgement result of the surrounding object type judging portion 162h and the occupation ratio derived from the occupation ratio deriving portion 162k, based on the fifth map shown in Fig. 18. In detail, when the acceleration derived by the acceleration deriving portion 162m is equal to or less than zero, the area expanding control is not executed, regardless of the type of the surrounding object and the occupation ratio. Further, the area expanding control portion 162n does not execute the area expanding control when the acceleration derived by the acceleration deriving portion 162m is more than zero, when the type of the surrounding object is a stationary object and the occupation ratio is equal to or more than the occupation ratio judging value. The occupation ratio judging value is set so that the occupation ratio becomes equal to or more than the occupation ratio judging value when the electric wheel chair 1 is travelling on a relatively narrow road. The occupation ratio judging value is set for example, eight (8) %.

[0068] On the other hand, the area expanding control portion 162n executes the area expanding control under the condition that the acceleration derived from the acceleration deriving portion 162m is more than zero, when the surrounding object does not exist, when the type of the surrounding object is a moving object, or when the type of the surrounding object is a stationary object and the occupation ratio is less than the occupation ratio judging value. The area expanding control portion 162n outputs the suppression area expanded by the area expanding control to the obstacle existence judging portion 162f when the area expanding control is executed. On the other hand, the area expanding control portion 162n outputs the suppression area without expanding the area to the obstacle existence judging portion 162f when the area expanding control is not executed. The obstacle existence judging portion 162f judges whether the obstacle exists or not based on the detected object information detected by the detecting device 50 and the suppression area from the area expanding control portion 162n.

[0069] Next, the collision suppression control (step S300 in Fig. 19) by the control device 60 according to the second embodiment will be explained with reference to the flowchart shown in Fig. 19. In the flowchart in Fig. 19, the step S102 and the steps S108 and the steps thereafter which are the processes after the step S320 are the same with the flowchart shown in Fig. 10. The control device 60 predicts the travelling course of the electric wheel chair 1 and the predicted travelling course area Wy is formed at the step S102 (course predicting portion 162a). Then the control device 60 forms the surrounding area Rs at the step S304 (course predicting portion 162a). Then, at the step S306, the control device 60 sets the standard suppression area Rb and the reduced suppression area Rr (standard suppression area setting portion 162b and the reduced suppression area setting portion 162c).

[0070] The control device 60 judges whether a surrounding object exists or not at the step S308 (surrounding object existence judging portion 162g). When an ob-

ject does not exist in the surrounding area Rs, the control device 60 judges "NO" at the step S308 since the surrounding object is not found and the program goes to the step S312. On the other hand, when a detected object exists in the surrounding area Rs, the control device 60 judges "YES" at the step S308 since the surrounding object is found. The control device 60 judges the type of the surrounding object at the step S310 (surrounding object type judging portion 162h) and advances the program to step S312. The control device 60 derives the occupation ratio at the step S312 (occupation ratio deriving portion 162k).

[0071] Then, the control device 60 derives the acceleration of the electric wheel chair 1 at the step S314 (acceleration deriving portion 162m). Further, the control device 60 switches over the suppression area at the step S316 (area switching over portion 162e). Then, the control device 60 decides whether the area expanding control shall be executed or not (area expanding control portion 162n). When the area expanding control is decided to be executed, the control device 60 judges "YES" at the step S318 and executes the area expanding control at the step S320. The program goes to the step S108. On the other hand, when the area expanding control is decided not to be executed, the control device 60 judges "NO" at the step S318 and does not execute the area expanding control and the program goes to the step S108. The control device 60 returns the program to the step S102 after executing the procedure of the step S110, when the judgement of the step S112 is "NO" and after executing the procedure of the step S114.

[0072] Further, according to the flowchart of Fig. 19, the operation of the electric wheel chair 1 will be explained. First, the explanation will be given under the situation that the electric wheel chair 1 is travelling straight on a relatively large place or road. Under such situation, when the object is not detected by the detecting device 50, since no surrounding object exists (step S308; surrounding object existence judging portion 162g), the suppression area is set to the standard suppression area Rb (step S316; area switching over portion 162e). Then, at this time if the electric wheel chair 1 is not in acceleration, the acceleration is equal to or less than zero (step S314; acceleration deriving portion 162m) and no area expanding control is executed (step S318; area expanding control portion 162n). On the other hand, if the electric wheel chair 1 is in acceleration, the acceleration is more than zero (step S314; acceleration deriving portion 162m). At this time, since the detected object does not exist, the area expanding control is executed (step S320; area expanding control portion 162n). Due to the non-existence of the detected object, any object is not positioned in the standard suppression area Rb. Therefore, no obstacle exists (step S108; obstacle existence detecting portion) and no suppression of travelling is executed (driving amount suppressing portion 61c1).

[0073] When the electric wheel chair 1 is travelling straight on a relatively broad place, as shown in Fig. 14, if an object is positioned in the surrounding area Rs (step S308; surrounding object existence judging portion 162g) and the type of the detected object is a moving object (step S310; surrounding object type judging portion 162h), the suppression area is set to the standard suppression area Rb (step S316; area switching over portion 162e). When the electric wheel chair 1 is in acceleration (acceleration > zero), the area expanding control is executed (step S320; area expanding control portion 162n). Then, if the moving object is positioned in the standard suppression area Rb, the area of the standard suppression area Rb at the time when the moving object enters into the standard suppression area Rb is maintained and at the same the travelling of the electric wheel chair 1 is suppressed (step S110; driving amount suppressing portion 61c1).

[0074] Further, when the electric wheel chair 1 is travelling straight on a relatively broad place, as shown in Fig. 14, if the type of the detected object is a stationary object (step S310; surrounding object type judging portion 162h), the suppression area is set to the reduced suppression area Rr (step S316; area switching over portion 162e). When the number of detected object grid Gk formed by the stationary object is two (2), the occupation ratio is smaller than the occupation ratio judging value. Therefore, when the electric wheel chair 1 is in acceleration (acceleration > zero), the area expanding control is executed (step S320; area expanding control portion 162n). Then, if the stationary object is positioned in the reduced suppression area Rr, the area of the reduced suppression area Rr at the time when the stationary object positions in the reduced suppression area Rr is maintained and at the same the travelling of the electric wheel chair 1 is suppressed (step S110; driving amount suppressing portion 61c1).

[0075] Next, the operation of the electric wheel chair 1 at the time when the electric wheel chair 1 is travelling straight on a relatively narrow street, and a plurality of stationary objects such as plants is arranged along both sides of the narrow street, will be explained hereinafter. As shown in Fig. 15A, in this situation, the detected objects are positioned in the surrounding area Rs (step S308; surrounding object existence judging portion 162g) and the type of the detected objects is a stationary object (step S310; surrounding object type judging portion 162h) therefore, the suppression area is set to the reduced suppression area Rr (step S316; area switching over portion 162e). Further, at this time, the occupation ratio becomes equal to or more than the occupation ratio judging value (step S312; occupation ratio deriving portion 162k). Therefore, even when the electric wheel chair 1 is in acceleration (acceleration > zero), the area expanding control is not executed (step S318; area expanding control portion 162n).

[0076] Further, in this case, even when the electric wheel chair 1 is not in acceleration (acceleration $\leq$ zero (0)) the area expanding control is not executed (step S318; area expanding control portion 162n). Accordingly,

in this situation, as long as the electric wheel chair 1 is travelling straight, the stationary objects do not exist in the surrounding area Rs and no suppression of travelling is performed (driving amount suppressing portion 61c1).

[0077] Further, according to the second embodiment, the electric wheel chair 1 travels driven by a driving device 20 according to an input to an operating device 30 by an occupant and the electric wheel chair 1 includes a detecting device 50 which detects an object positioning in a surrounding area of the electric wheel chair 1 and a control device 60 which controls the electric wheel chair 1 to travel by controlling a driving amount of the driving device 20 based on an input information which is an information inputted to the operating device 30. The control device 60 includes a standard suppression area setting portion 162b which sets a standard suppression area Rb which is a criteria for determining a suppression area where a travelling of the electric wheel chair 1 is suppressed when the object positioning in the area is detected by the detecting device 50 and a reduced suppression area setting portion 162c which sets a reduced suppression area Rr which area is reduced relative to the standard suppression area Rb set by the standard suppression area setting portion 162b based on a type of the detected object positioning in the surrounding area Rs which is an area located at both sides of the predicted travelling course area Wy of the electric wheel chair 1. According to this structure of the second embodiment, a reduced suppression area setting portion 162c sets the reduced suppression area Rr based on the type of the object positioning in the surrounding area Rs. When the suppression area is set to the reduced suppression area Rr, the detected object can be hardly positioned in the suppression area. Thus, when the detected object is not positioned in the suppression area, the travelling of the electric wheel chair 1 is not suppressed and accordingly, the travelling according to the intention of the occupant can be possible. Then the gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be suppressed. Accordingly, the suppression of travelling of the electric wheel chair 1 can be made, reflecting the intention of the occupant of the electric wheel chair 1.

[0078] Further, type of the detected object is defined to be a stationary object or a moving object. The control device 60 further includes a surrounding object type judging portion 162h which judges whether the type of the detected object positioning in the surrounding area Rs is a stationary object or a moving object, and an area switching over portion 162e which switches over the suppression area from the standard suppression area Rb set by the standard suppression area setting portion 162b to the reduced suppression area Rr set by the reduced suppression area setting portion 162c when the surrounding object type judging portion 162h judges that the type of the detected object positioning in the surrounding area Rs is the stationary object. According to this structure, when the object in the surrounding area Rs is judged to be only the stationary object, the occupant may feel to let the electric wheel chair 1 to travel with a relatively fast speed. Under such situation, comparing to the case when an object in the surrounding area Rs is judged to be a moving object, a gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant may frequently occur. However, in the case when the object in the surrounding area Rs is judged to be the stationary object, the area switching over portion 162e changes the suppression area from the standard suppression area Rb to the reduced suppression area Rr. Therefore, the detected object can hardly position in the suppression area. When the object is not positioned in the suppression area, the travelling speed of the electric wheel chair 1 is not suppressed and the occupant of the electric wheel chair 1 can operate the electric wheel chair 1 according to the occupant's intention. Thus, the gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be suppressed. Accordingly, the suppression of travelling of the electric wheel chair 1 can be made, reflecting the intention of the occupant of the electric wheel chair 1.

[0079] The control device 60 further includes an area expanding control portion 162n which executes an area expanding control which expands the suppression area when the type of the detected object in the surrounding area Rs is judged to be a moving object by the surrounding object type judging portion 162h. When the type of the detected object in the surrounding area Rs is judged to be a moving object, the behavior of the moving object is difficult to predict, compared to the case when the type of the detected object is the stationary object. Under such situation, by expanding the suppression area by the area expanding control portion 162n, the moving object can be easily positioned in the suppression area. When the moving object is positioned in the suppression area, the travelling of the electric wheel chair 1 is suppressed. Thus, the collision of the electric wheel chair 1 with the moving object can be further suppressed. The amount of suppression of the travelling of the electric wheel chair 1 can be adjusted according to the distance between the electric wheel chair 1 and the detected object so that an abrupt suppression control can be avoided even when the detected object positions in the expanded suppression area.

[0080] The control device 60 further includes an occupation ratio deriving portion 162k which derives the occupation ratio which is a ratio of area occupied by the detected object relative to the surrounding area Rs. The area expanding control portion 162n executes the area expanding control when the occupation ratio derived from the occupation ratio deriving portion 162k is less than the occupation ratio judging value, when the type of the object positioned in the surrounding area Rs is judged to be a stationary object by the surrounding object type judging portion 162h. Even when the type of the detected object in the surrounding area Rs is a stationary object,

if the occupation ratio derived from the occupation ratio deriving portion 162k is less than the occupation ratio judging value, in other words, if the space through which the electric wheel chair 1 is travelling is relatively broad or large, a possible collision between the electric wheel chair 1 and the object may arise due to a sudden appearing of a moving object. In such case, by expanding the suppression area by the area expanding control portion 162n, the detected object can be easily positioned in the suppression area. This can further avoid the collision between the electric wheel chair 1 and the object. On the other hand, when the type of the object positioning in the surrounding area Rs is the stationary object and the occupation ratio is equal to or more than the occupation ratio judging value, in other words, the space through which the electric wheel chair 1 is travelling is relatively narrow (for example, narrow lane or the like), a possibility of occurrence of collision caused by a sudden appearance of an object between the electric wheel chair 1 and the object is relatively low. Accordingly, the area expanding control portion 162n does not expand the suppression area. Thus, the gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be suppressed. Thus, a travelling of the electric wheel chair 1 which reflects the occupant's intension can be more controlled.

[0081] One example of the mobile body is explained in each embodiment, but the invention is not limited to this example and other structures may be adopted. For example, each embodiment, shows the electric wheel chair 1 as an example of the mobile body, but any other boarding type movable bodies, such as a compact car or a movable robot may be adopted instead of the electric wheel chair 1.

[0082] It is also noted that release request detecting device 40 according to the first embodiment is equipped with the load detecting portion 42 which detects the pushing load, but instead of this structure, a plurality of switches is provided in the release request detecting device 40, wherein the area switching over portion 62e may switch over the reduced suppression areas Rr1 and Rr2 in response to the switch(es) which has (have) been turned on. Further, the release request detecting device 40 may include a microphone or the like, in which the voice of the occupant may be inputted, wherein the area switching over portion 62e may switch over the reduced suppression area Rr1 and Rr2 in response to the volume of the voice of the occupant.

[0083] Further, according to the first embodiment, the area switching over portion 62e switches over the suppression area considering the judgement result of the obstacle existence judging portion 62f. However, the area switching over portion 62e may switch over the suppression area based on only the detection result of the release request detecting device 40, without any consideration of the judgement result of the obstacle existence judging portion 62f.

[0084] Further, according to the second embodiment, the area switching over portion 162e switches over the suppression area based on the fourth map M4 illustrated in Fig. 16. However, instead of forming this structure, it may be possible to form that the area switching over portion 162e switches over the suppression area based on the fourteenth map M14 illustrated in Fig. 20, wherein the area switching over portion 162e switches over the suppression area from the standard suppression area Rb to the reduced suppression area Rr when the occupation ratio is equal to or more than the occupation ratio judging value. As explained, the control device 60 further includes an occupation ratio deriving portion 162k which derives the occupation ratio that is a ratio of area occupied by the detected object relative to the surrounding area Rs and an area switching over portion 162e which switches over the suppression area from the standard suppression area Rb set by the standard suppression area setting portion 162b to the reduced suppression area Rr set by the reduced suppression area setting portion 162c, when the occupation ratio derived from the occupation ratio deriving portion 162k is equal to or more than the occupation ratio judging value. When the occupation ratio exceeds the occupation ratio judging value, i.e., when the electric wheel chair 1 is travelling through a relatively narrow space, the detected object can be easily positioned in the suppression area, comparing the case when the electric wheel chair 1 is travelling through a relatively broad space. Accordingly, when the occupation ratio exceeds the occupation ratio judging value, a gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant may be easily generated. Thus, the area switching over portion 162e switches over the suppression area from the standard suppression area to the reduced suppression area Rr. By this switching over control, the travelling of the electric wheel chair 1 is not suppressed when the detected object is not positioned in the suppression area and the occupant can intendedly operate the electric wheel chair 1. Thus, the gap between the suppressed travelling of the electric wheel chair 1 and the travelling intended by the occupant can be suppressed. Thus, a travelling of the electric wheel chair 1 which reflects the occupant's intension can be controlled.

[0085] Further, according to the second embodiment, the area switching over portion 162e switches over the suppression area based on the fourth map M4 illustrated in Fig. 16. However, instead of forming this structure, it may be possible to form that the area switching over portion 162e switches over the suppression area based on the twenty-fourth map M24 illustrated in Fig. 21. Under such case, as compared to the second embodiment, even when the type of the surrounding object is a moving object, if the occupation ratio is equal to or more than the occupation ratio judging value, the suppression area is switched over to the reduced suppression area Rr.

[0086] Further, according to the second embodiment, the area expanding control portion 162n judges whether or not the area expanding control is to be executed, based

on the fifth map M5 shown in Fig. 18. In this situation, the area expanding control portion 162n judges whether or not the area expanding control is to be executed based on the acceleration. However, instead of judging by the acceleration, if the electric wheel chair 1 is travelling with the maximum speed, the area expanding control portion 162n judges whether or not the area expanding control is to be executed, from the surrounding object and the occupation ratio, based on the case "the acceleration > zero (0)" indicated in the fifth map M5, regardless of the acceleration of the electric wheel chair 1. Further, the area expanding control portion 162n may judge whether or not the area expanding control is to be executed, based on the fifteenth map M15 shown in Fig. 22, instead of the fifth map M5 in Fig. 18. In this situation, the area expanding control portion 162n judges whether or not the area expanding control is to be executed from the occupation ratio only, regardless of the state whether or not the electric wheel chair 1 is in acceleration.

[0087] Further, according to the second embodiment, the area expanding control portion 162n calculates the expanding amount based on the acceleration of the electric wheel chair 1. However, instead of this, the area expanding control portion 162n may expand the area based on a fixed expanding amount, regardless of the acceleration of the electric wheel chair 1.

[0088] Further, according to the embodiments, the operating device 30 is a joystick. However, instead of use of joystick, the operating device can be formed by an accelerator which indicates the straight travelling speed "v" of the electric wheel chair 1 and a handle or a wheel which indicates turning direction of the electric wheel chair 1.

[0089] Further, according to the embodiments above, the reduced suppression areas Rr, Rr1 and Rr2 are determined in advance by the reduced suppression area setting portions 62c and 162c. However, instead of this structure, the standard suppression area Rb is formed to be deformable to set the set reduced suppression areas Rr, Rr1 and Rr2, by deforming.

[0090] Further, according to the embodiments above, the detecting device 50 is a three-dimensional area measuring sensor which detects a three-dimensional position information of the detected object. However, instead of using the three-dimensional area measuring sensor, a two-dimensional area measuring sensor may be used which detects the two-dimensional position information of the detected object. Further, the electric wheel chair 1 according to the embodiments above includes one detecting device 50. However, a plurality of detecting devices 50 may be provided. Compared to the provision of one detecting device 50, the plurality of detecting devices can widen the area to detect an object.

[0091] Further, according to the embodiments above, the suppression area is formed on the polar coordinates C in a planar shape. However, instead of this structure, the suppression area may be formed three-dimensionally. In detail, instead of using the polar coordinates C, the suppression area can be formed on the spherical coordinates centering on the electric wheel chair 1. According to this structure, the height of the standard suppression area Rb and the height of the reduced suppression area Rr can be set differently within the detectable range of the object by the detecting device 50.

[0092] Further, according to the embodiments above, when an object exists in the suppression area, the maximum speed of the straight travelling speed "v" restricted by the driving amount suppressing portion 61c1 varies in response to the minimum distance Dmin. However, instead of this structure, the maximum speed varies depending on the relative speed between the electric wheel chair 1 and the detected object and a concentration of the detected object in the grid G (concentration of group of points PG). Further, when an object exists in the suppression area, the driving amount suppressing portion 61c1 may restrict the maximum speed of the straight travelling speed "v" to a fixed speed, regardless of the minimum distance Dmin. Still further, according to the embodiments above, the straight travelling speed "v" is restricted by restricting the driving amount of the driving device 20 by the driving amount suppressing portion 61c1. However, instead of this structure, the straight travelling speed "v" may be uniformly reduced at a fixed rate. Or, the time change rate (acceleration) of the straight travelling speed may be restricted.

[Brief Explanation of Symbols and Signs]

[0093] 1; electric wheel chair (mobile body), 10; wheel chair main body, 20; driving device, 30; operating device, 40; release request detecting device, 50; detecting device , 60; control device, 61; travelling control portion, 61c; driving amount control portion, 61c1; driving amount suppressing portion, 62; collision suppressing control portion, 62a; course predicting portion, 62b; standard suppression area setting portion, 62c; reduced suppression area setting portion, 62d; release request obtaining portion, 62e; area switching over portion, 62f; obstacle existence judging portion, 162g; surrounding object existence judging portion, i162h; surrounding object type judging portion, 162k; occupation ratio deriving portion, 162n; area expanding control portion, C; polar coordinates, Rb; standard suppression area, Rr; reduced suppression area, Rs; surrounding area, Wy; predicted travelling course area.

Claims

1. A mobile body which travels, driven by a driving device according to an input to an operating device by an occupant of the mobile body, wherein the mobile body includes:

   a detecting device which detects an object existing around the mobile body and

a control device which controls the mobile body to travel by controlling a driving amount of the driving device based on an input information which is an information inputted to the operating device, wherein the control device includes:
a standard suppression area setting portion which sets a standard suppression area which is a criteria for determining a suppression area where a travelling of the mobile body is suppressed when the object positioning in the suppression area is detected by the detecting device; and
a reduced suppression area setting portion which sets a reduced suppression area which area is reduced relative to the standard suppression area set by the standard suppression area setting portion based on an intention of the occupant of the mobile body or a type of the object positioning in a surrounding area of the mobile body at both side areas of a predicted travelling course area of the mobile body.

2. The mobile body according to claim 1, wherein
the intention of the occupant corresponds to a release request to a suppression of the travelling of the mobile body;
the mobile body further includes a release request detecting device which detects a strength of the release request by an operation of the occupant; and
wherein
the control device further includes
an area switching over portion which switches over the suppression area from the standard suppression area set by the standard suppression area setting portion to the reduced suppression area set by the reduced suppression area setting portion, based on the strength of the release request detected by the release request detecting device.

3. The mobile body according to claim 2, wherein,
The reduced suppression area setting portion sets the reduced suppression area such that the stronger the release request detected by the release request detecting device, the smaller the reduced suppression area becomes.

4. The mobile body according to claim 1, wherein
the type of the object corresponds to a stationary object and a moving object;
the control device further includes a surrounding object type judging portion which judges whether the type of the object positioning in the surrounding area of the mobile body is the stationary object or the moving object; and
an area switching over portion which switches over the suppression area from the standard suppression area set by the standard suppression area setting portion to the reduced suppression area set by the reduced suppression area setting portion, when the type of the object in the surrounding area is judged to be the stationary object by the surrounding object type judging portion.

5. The mobile body according to claim 4, wherein the control device further includes:
an area expanding control portion which executes an area expanding control which expands the suppression area when the type of the object in the surrounding area is judged to be the moving object by the surrounding object type judging portion.

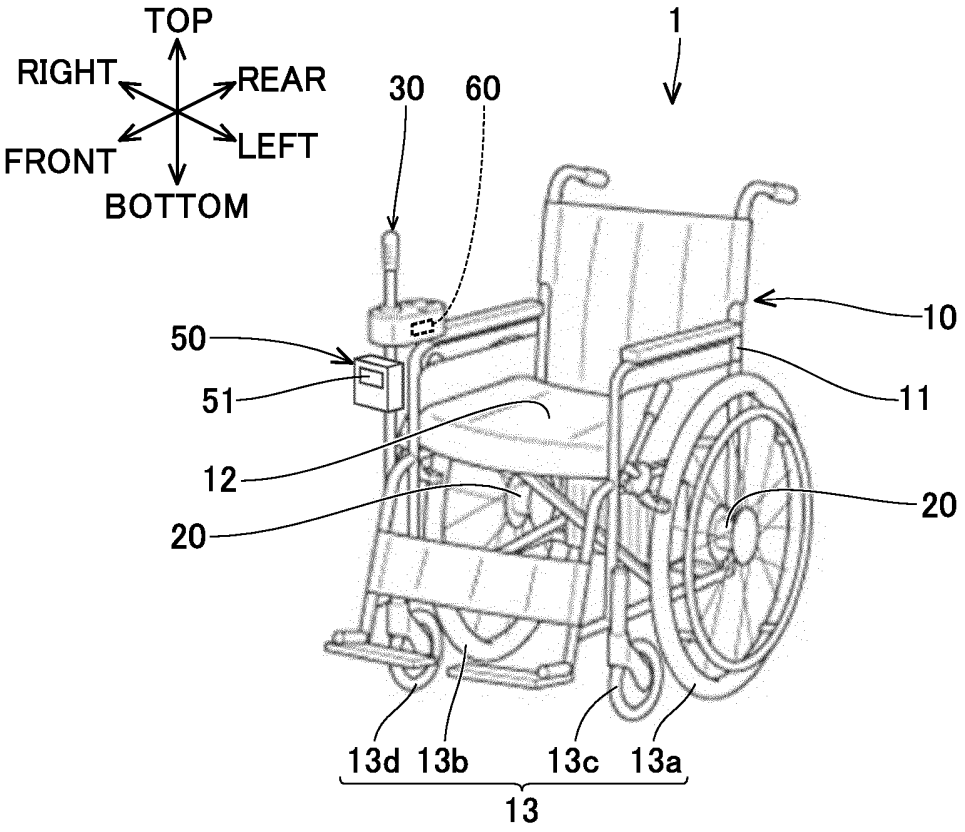
6. The mobile body according to claim 5, wherein the control device further includes:

an occupation ratio deriving portion which derives an occupation ratio which is a ratio of area occupied by the object relative to the surrounding area; wherein
the area expanding control portion executes the area expanding control when the occupation ratio derived by the occupation ratio deriving portion is smaller than an occupation ratio judging value, when the type of the object in the surrounding area is judged to be the stationary object by the surrounding object type judging portion.

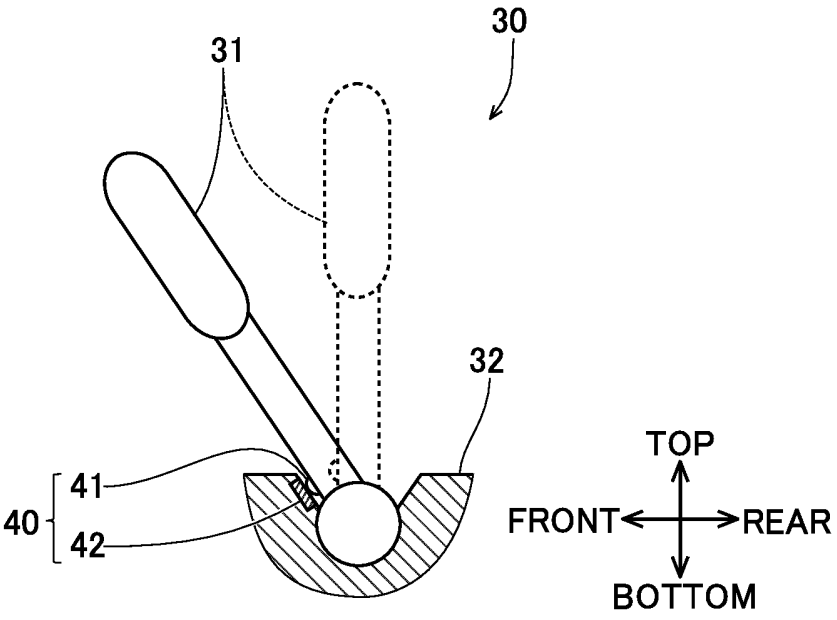
7. The mobile body according to claim 1, wherein the control device further includes:

an occupation ratio deriving portion which derives an occupation ratio which is a ratio of area occupied by the object relative to the surrounding area; and
an area switching over portion which switches over the suppression area from the standard suppression area set by the standard suppression area setting portion to the reduced suppression area set by the reduced suppression area setting portion, when the occupation ratio derived by the occupation ratio deriving portion is equal to or more than an occupation ratio judging value.

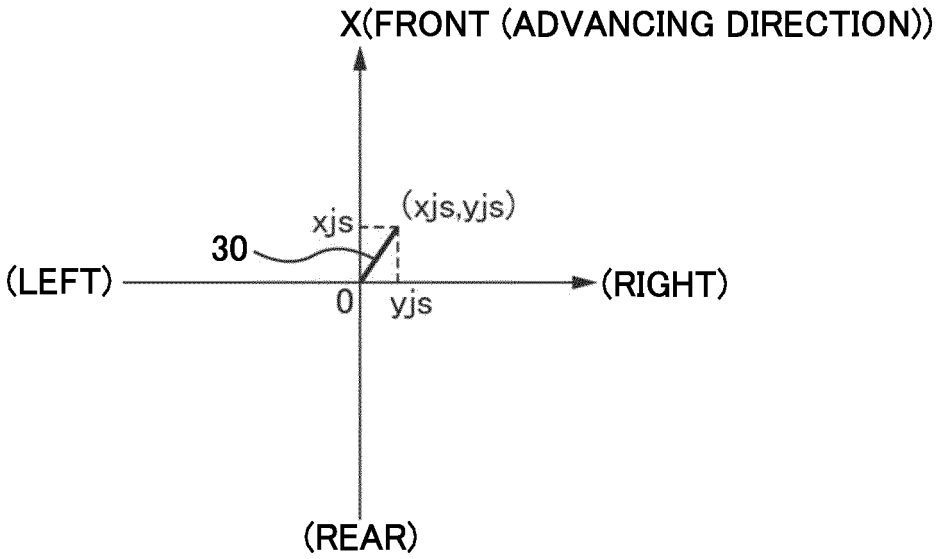
【FIG1】


TOP
RIGHT
REAR
FRONT
LEFT
BOTTOM
1
30
60
50
51
12
20
10
11
20
13d
13b
13c
13a
13

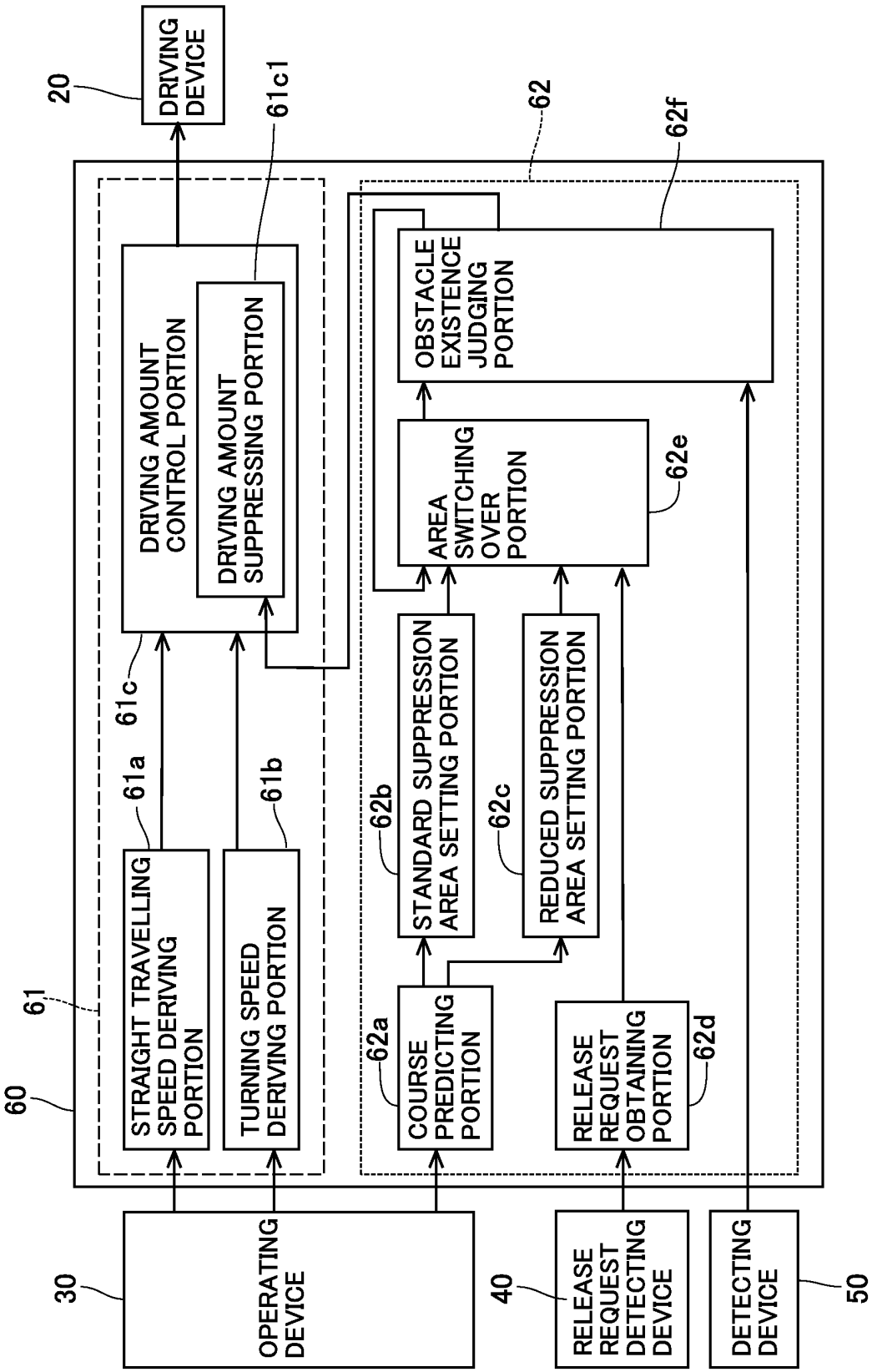
【FIG2】


30
31
32
41
40
42
TOP
FRONT
REAR
BOTTOM

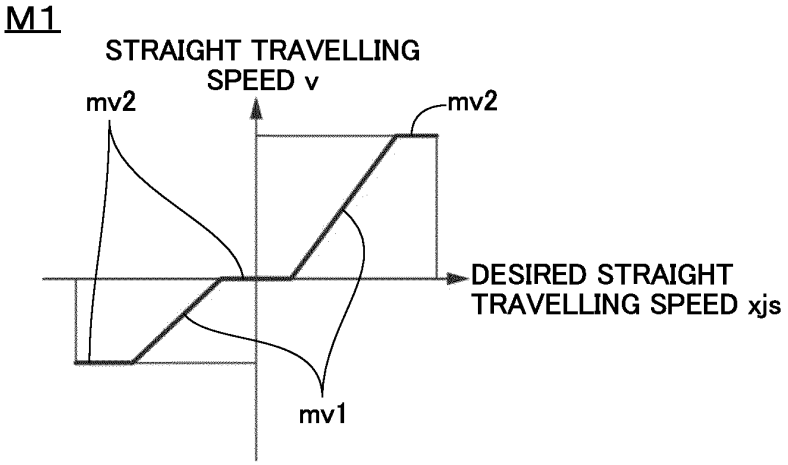
【FIG3】


X(FRONT (ADVANCING DIRECTION))
(xjs,yjs)
xjs
30
(LEFT)
0
yjs
(RIGHT)
(REAR)

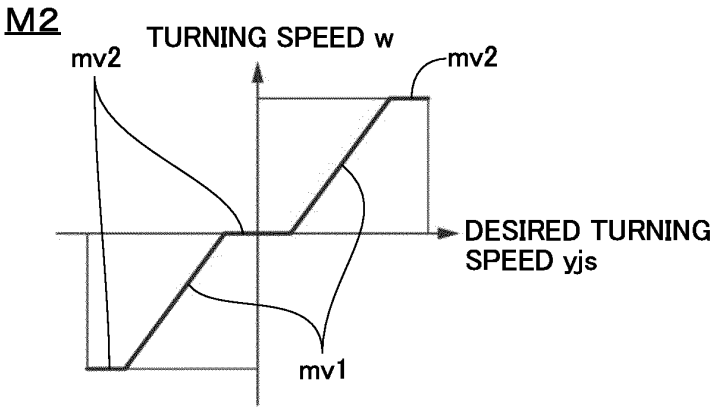
【FIG4】


20
DRIVING DEVICE
61c1
62
62f
OBSTACLE EXISTENCE JUDGING PORTION
DRIVING AMOUNT CONTROL PORTION
DRIVING AMOUNT SUPPRESSING PORTION
AREA SWITCHING OVER PORTION
62e
61c
61a
61b
62b
62c
STANDARD SUPPRESSION AREA SETTING PORTION
REDUCED SUPPRESSION AREA SETTING PORTION
61
60
STRAIGHT TRAVELLING SPEED DERIVING PORTION
TURNING SPEED DERIVING PORTION
62a
COURSE PREDICTING PORTION
RELEASE REQUEST OBTAINING PORTION
62d
30
OPERATING DEVICE
40
RELEASE REQUEST DETECTING DEVICE
DETECTING DEVICE
50

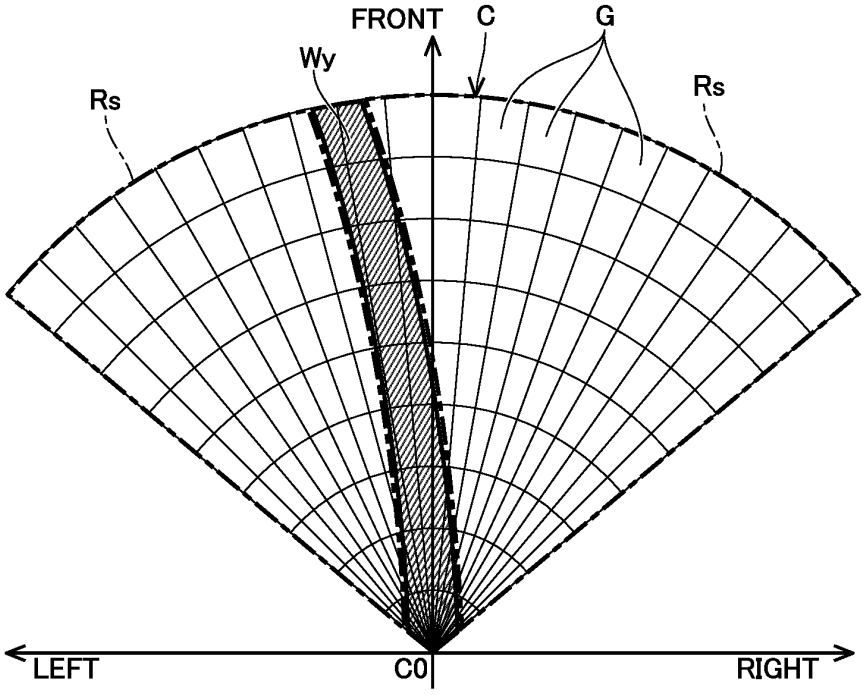
【FIG5A】



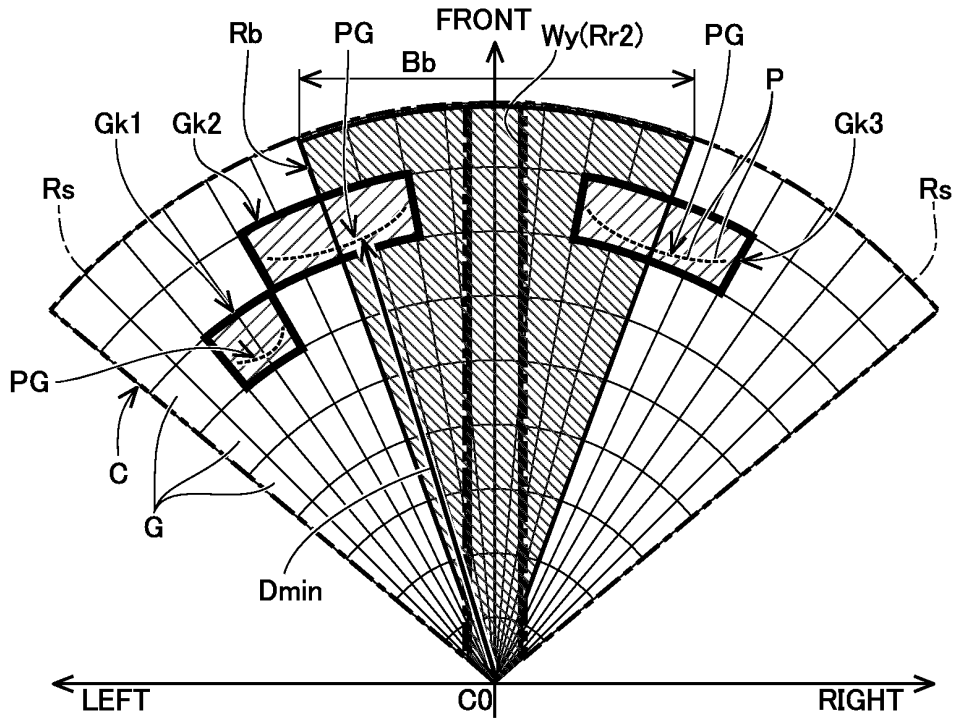
【FIG5B】



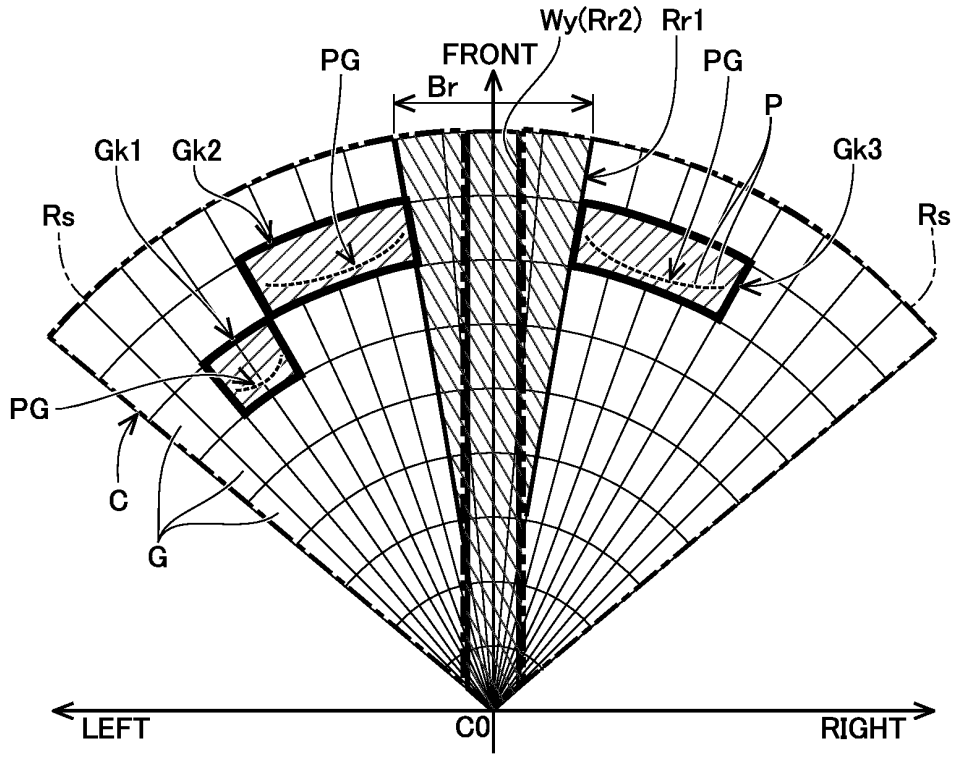
【FIG6】



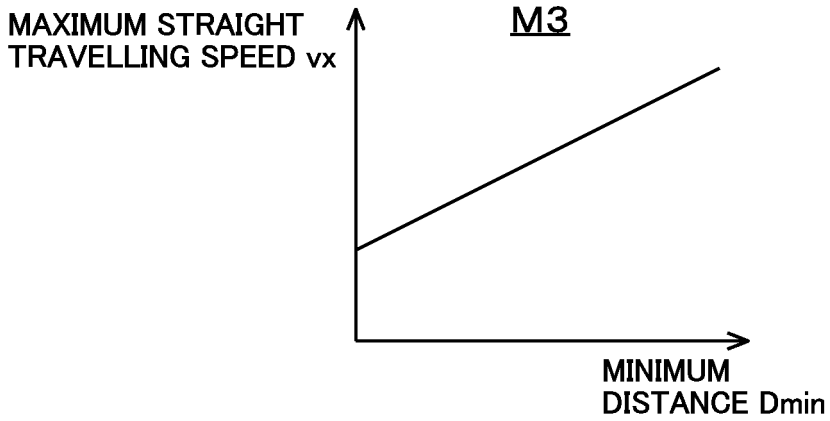
【FIG7】


Rb
PG
FRONT
Wy(Rr2)
PG
Bb
P
Gk1
Gk2
Gk3
Rs
Rs
PG
C
G
Dmin
LEFT
C0
RIGHT

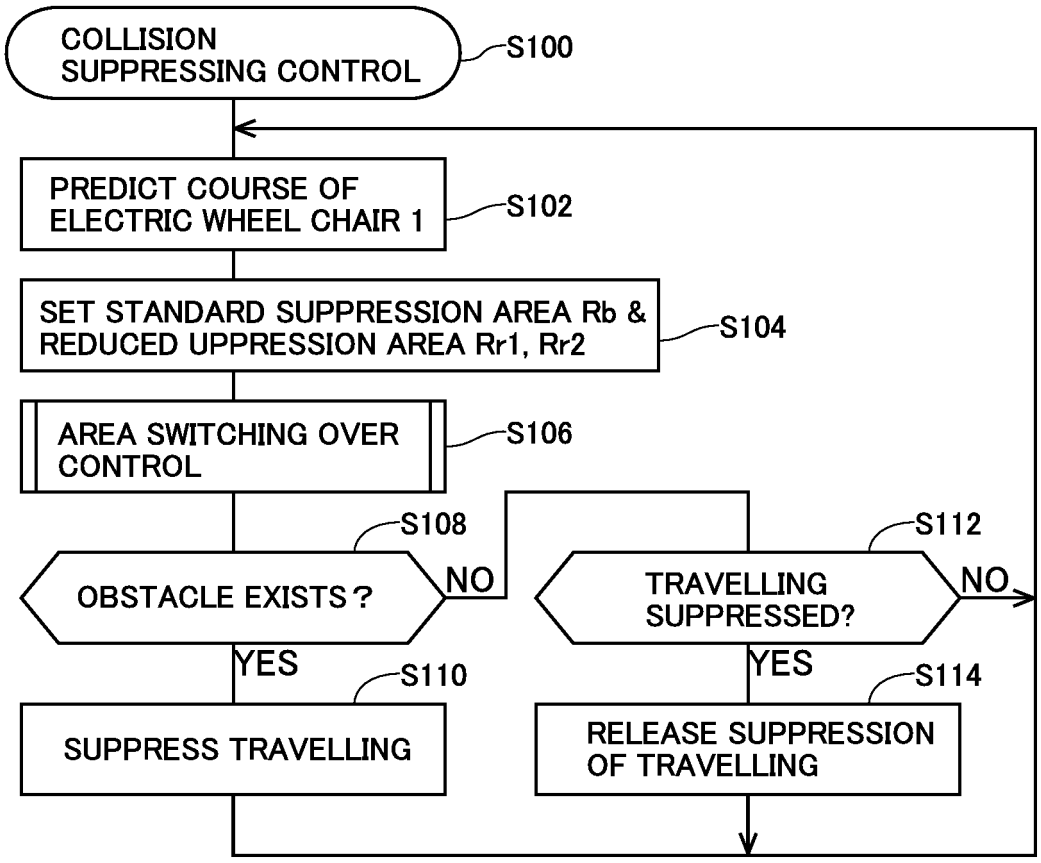
【FIG8】


Wy(Rr2)
Rr1
PG
FRONT
PG
Br
P
Gk1
Gk2
Gk3
Rs
Rs
PG
C
G
LEFT
C0
RIGHT

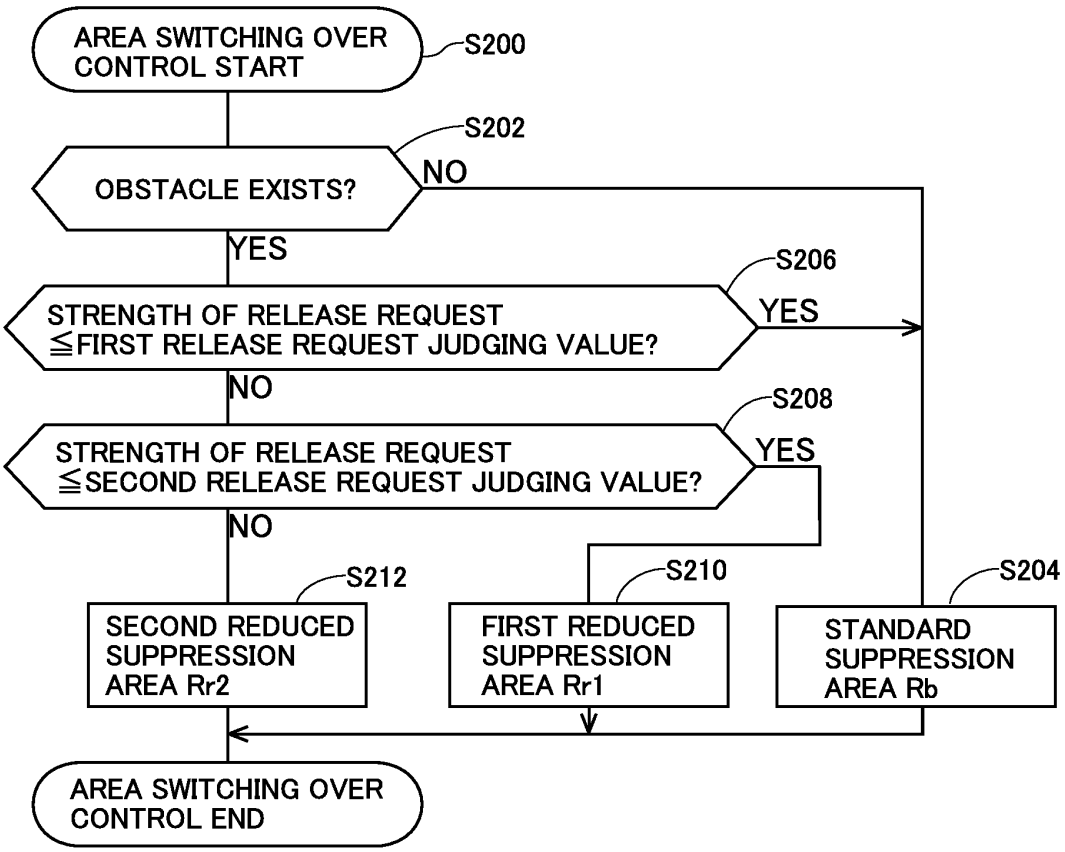
【FIG9】


MAXIMUM STRAIGHT
TRAVELLING SPEED vx
M3
MINIMUM
DISTANCE Dmin

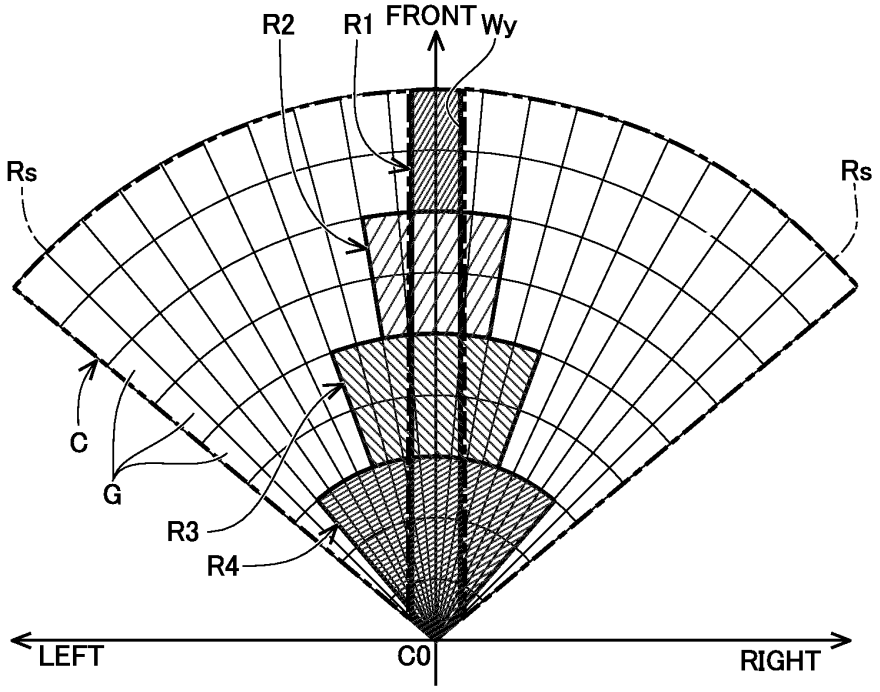
【FIG10】


COLLISION
SUPPRESSING CONTROL
S100
PREDICT COURSE OF
ELECTRIC WHEEL CHAIR 1
S102
SET STANDARD SUPPRESSION AREA Rb &
REDUCED UPPRESSION AREA Rr1, Rr2
S104
AREA SWITCHING OVER
CONTROL
S106
S108
OBSTACLE EXISTS ?
NO
YES
S110
SUPPRESS TRAVELLING
S112
TRAVELLING
SUPPRESSED?
NO
YES
S114
RELEASE SUPPRESSION
OF TRAVELLING

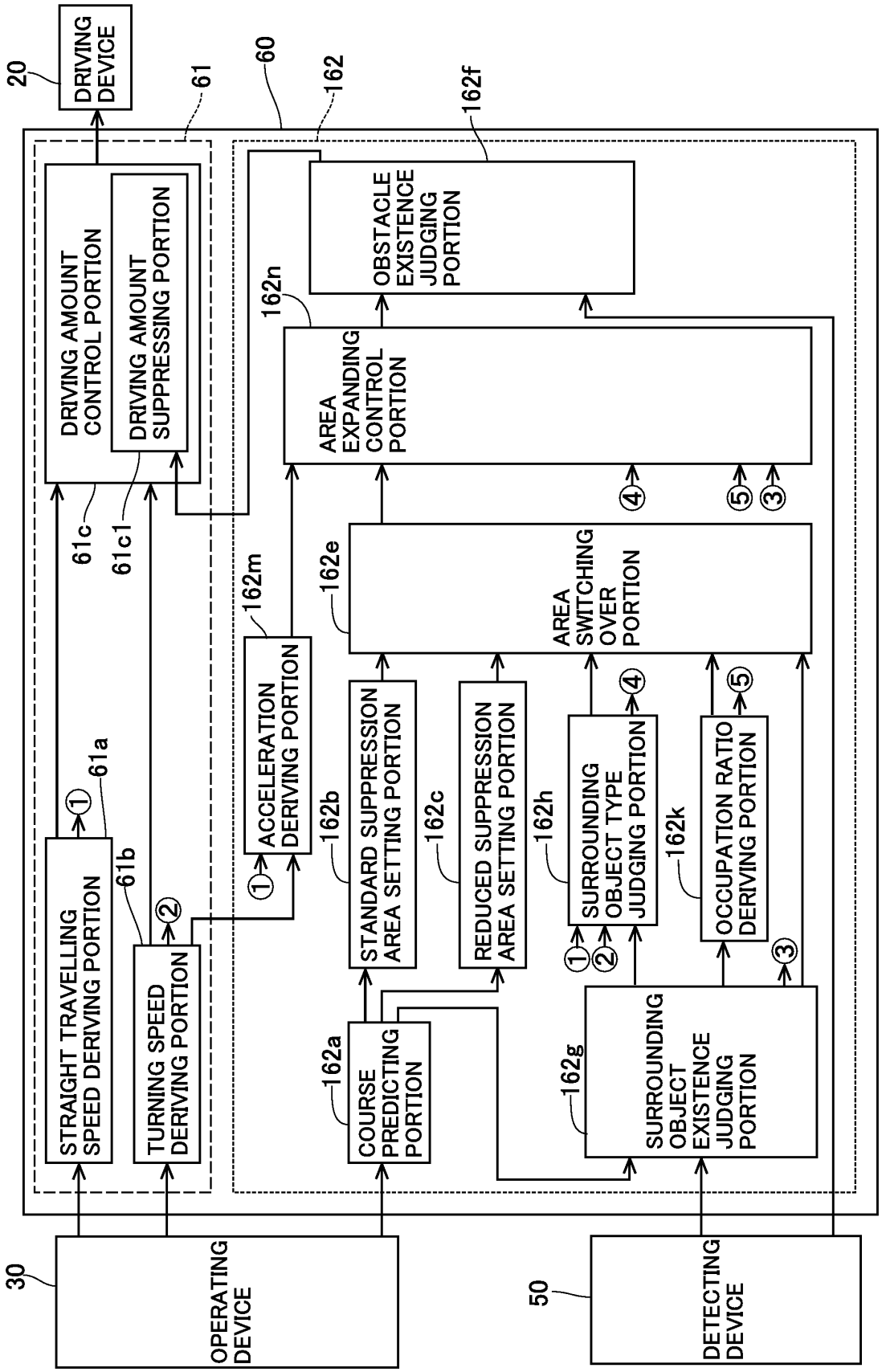
【FIG11】


AREA SWITCHING OVER CONTROL START
S200
S202
OBSTACLE EXISTS?
NO
YES
S206
STRENGTH OF RELEASE REQUEST ≦FIRST RELEASE REQUEST JUDGING VALUE?
YES
NO
S208
STRENGTH OF RELEASE REQUEST ≦SECOND RELEASE REQUEST JUDGING VALUE?
YES
NO
S212
S210
S204
SECOND REDUCED SUPPRESSION AREA Rr2
FIRST REDUCED SUPPRESSION AREA Rr1
STANDARD SUPPRESSION AREA Rb
AREA SWITCHING OVER CONTROL END

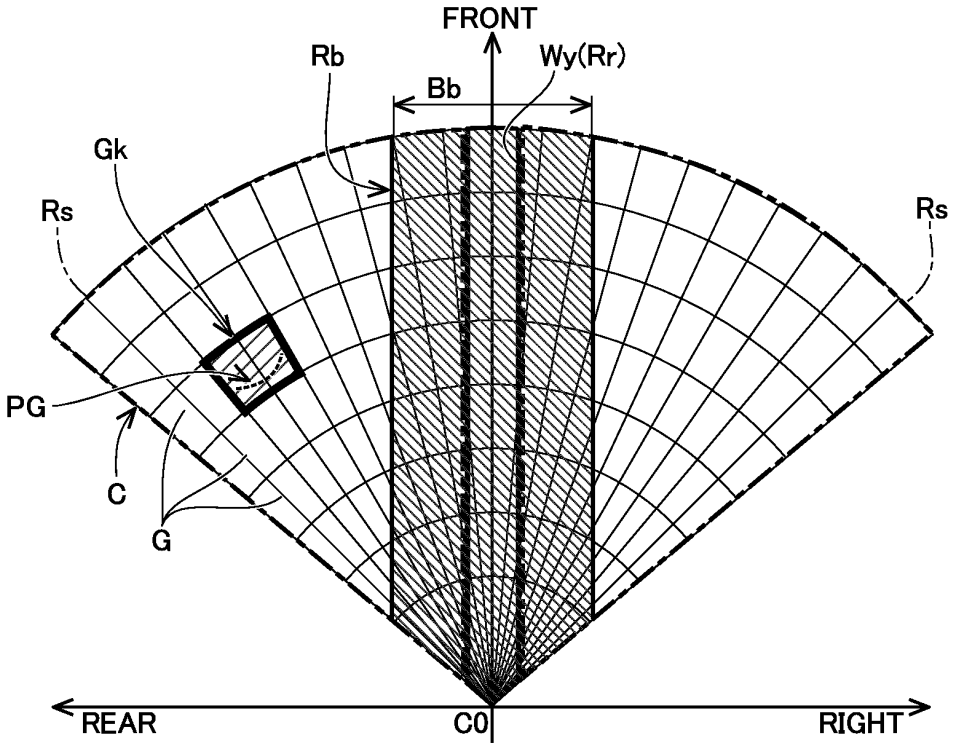
【FIG12】


R2
R1
FRONT
Wy
Rs
Rs
C
G
R3
R4
LEFT
C0
RIGHT

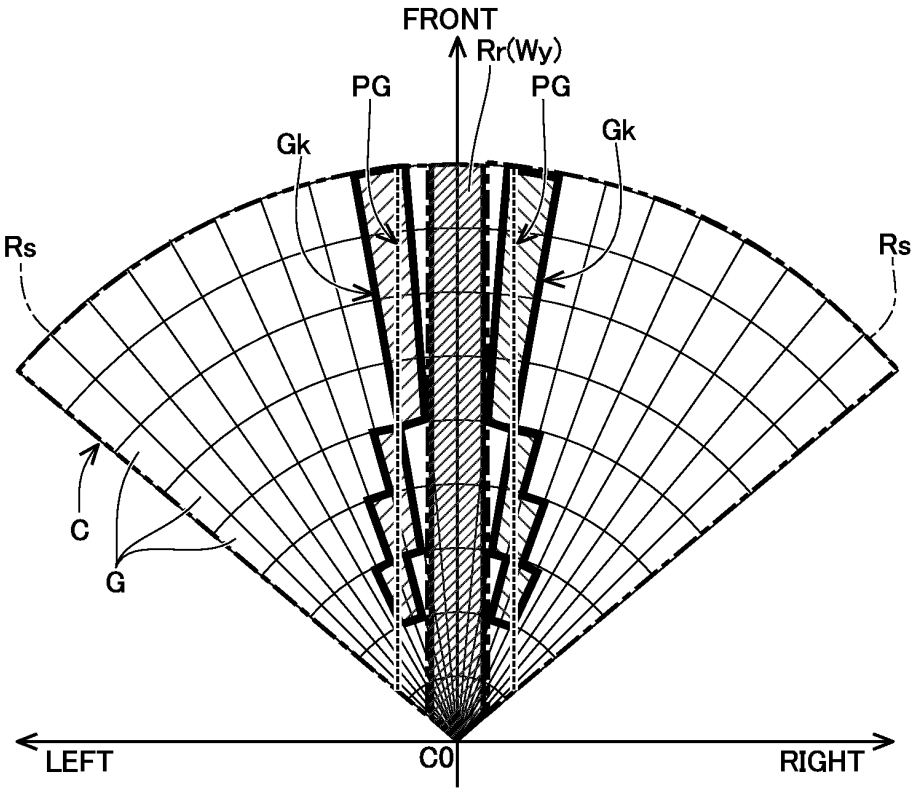
【FIG13】


20
DRIVING DEVICE
61
60
162
162f
DRIVING AMOUNT CONTROL PORTION
DRIVING AMOUNT SUPPRESSING PORTION
OBSTACLE EXISTENCE JUDGING PORTION
162n
AREA EXPANDING CONTROL PORTION
61c
61c1
162m
162e
AREA SWITCHING OVER PORTION
ACCELERATION DERIVING PORTION
61a
61b
162b
162c
162h
162k
STRAIGHT TRAVELLING SPEED DERIVING PORTION
TURNING SPEED DERIVING PORTION
STANDARD SUPPRESSION AREA SETTING PORTION
REDUCED SUPPRESSION AREA SETTING PORTION
SURROUNDING OBJECT TYPE JUDGING PORTION
OCCUPATION RATIO DERIVING PORTION
162a
162g
COURSE PREDICTING PORTION
SURROUNDING OBJECT EXISTENCE JUDGING PORTION
30
50
OPERATING DEVICE
DETECTING DEVICE

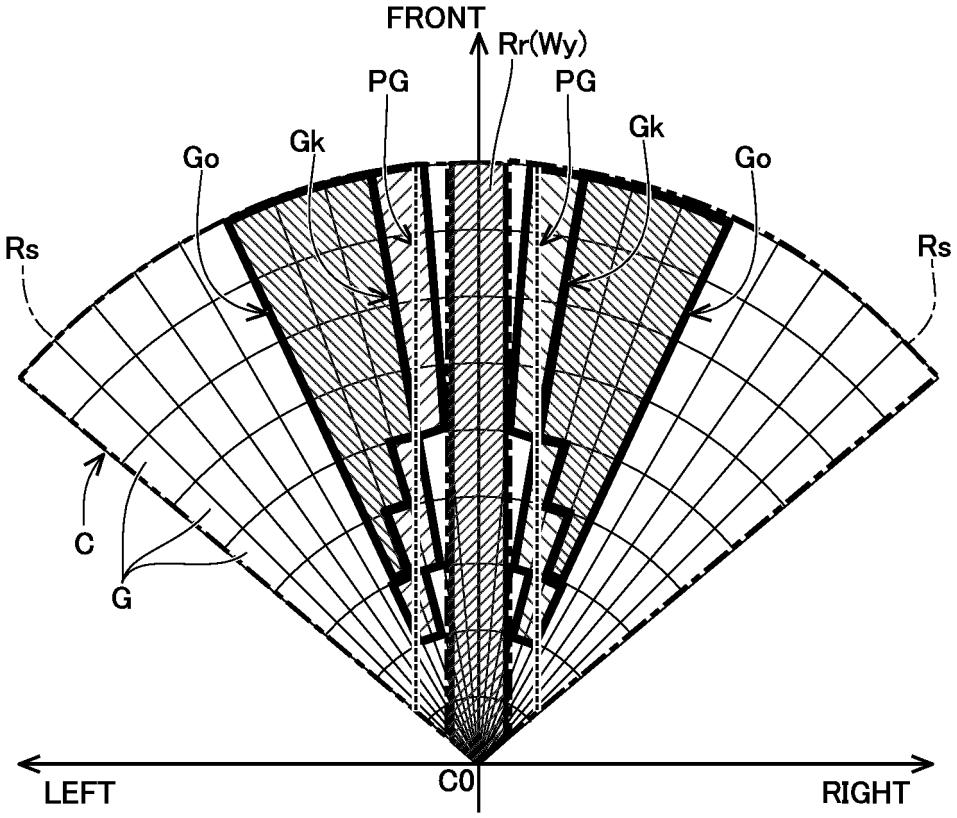
【FIG14】



【FIG15A】



【FIG15B】

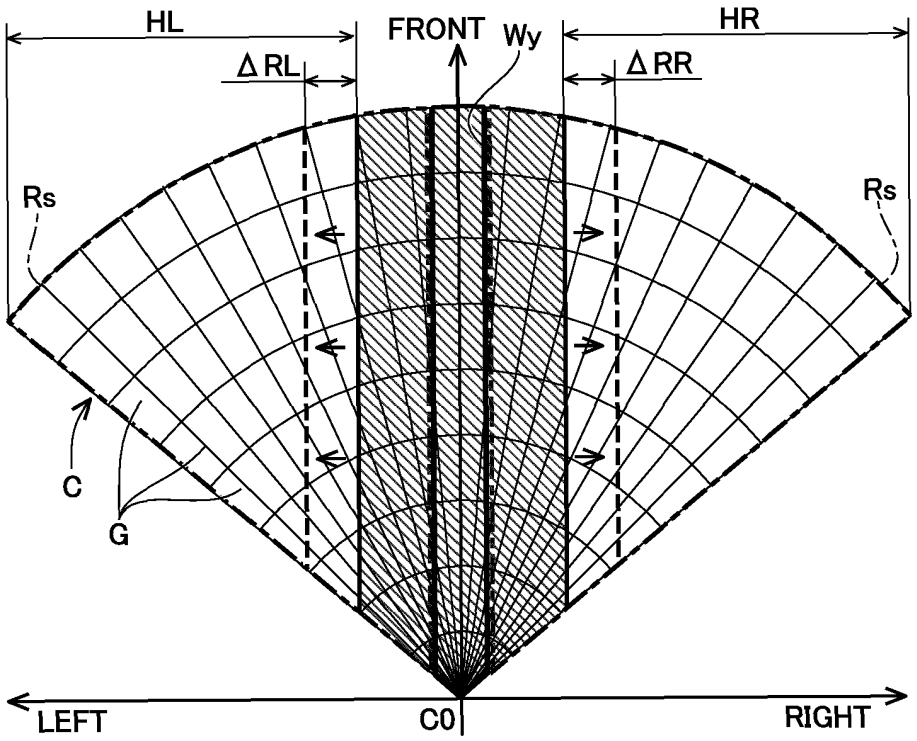


【FIG16】

M4

SURROUNDING OBJECT	SUPPRESSIO AREA
NOT EXISTING	STANDARD SUPPRESSION AREA Rb
MOVING OBJECT	STANDARD SUPPRESSION AREA Rb
STATIONARY OBJECT	REDUCED SUPPRESSION AREA Rr

【FIG17】

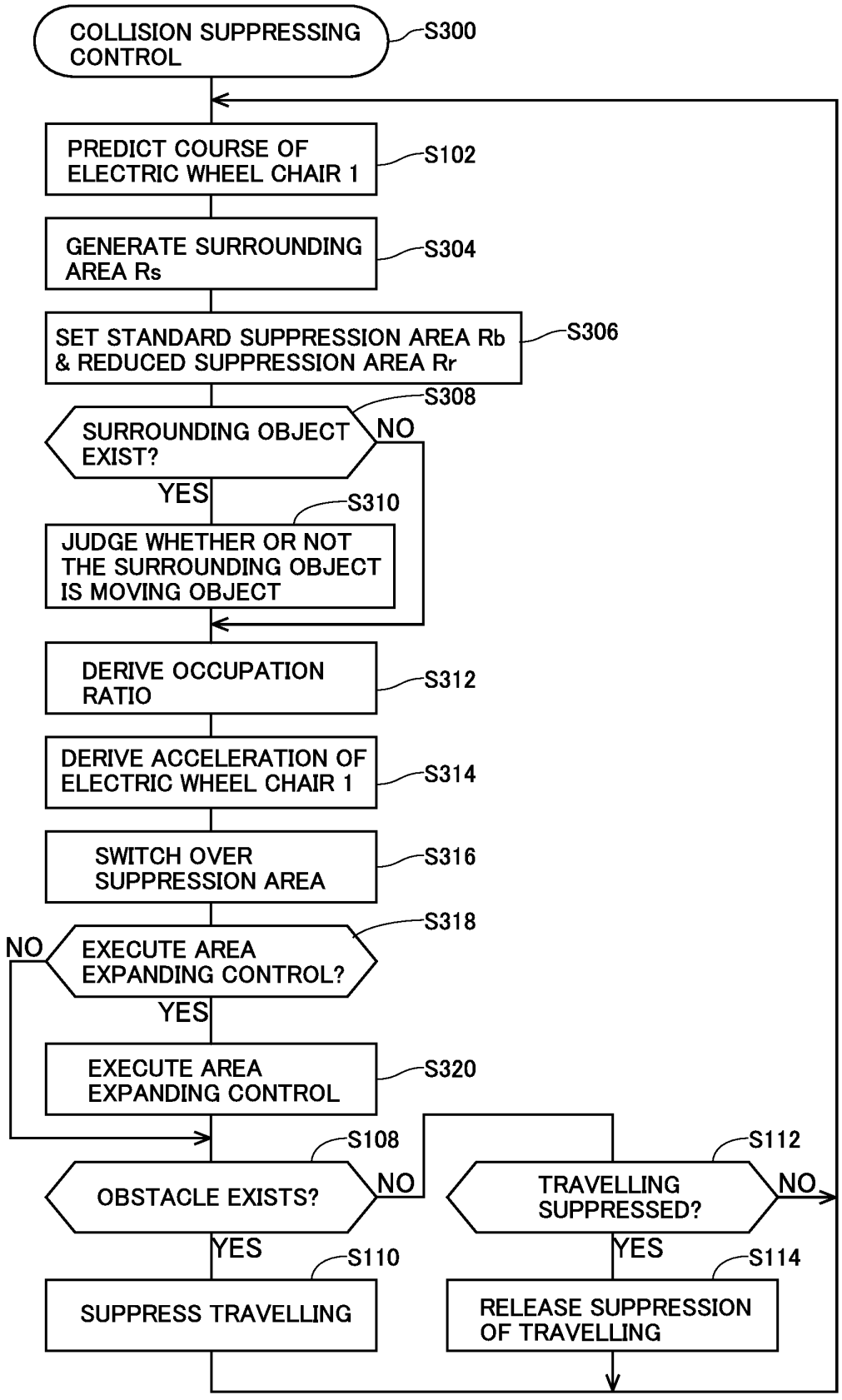


【FIG18】

M5

		OCCUPATION RATIO	
	SURROUNDING OBJECT	OCCUPATION RATIO <OCCUPATION RATIO JUDGING VALUE	OCCUPATION RATIO JUDGING VALUE ≦OCCUPATION RATIO
ACCELERATION >ZERO	NOT EXISTING	EXECUTE	
	MOVING OBJECT	EXECUTE	EXECUTE
	STATIONARY OBJECT	EXECUTE	NOT EXECUTE
ACCELERATION≦ZERO		NOT EXECUTE	

【FIG19】


COLLISION SUPPRESSING CONTROL
S300
PREDICT COURSE OF ELECTRIC WHEEL CHAIR 1
S102
GENERATE SURROUNDING AREA Rs
S304
SET STANDARD SUPPRESSION AREA Rb & REDUCED SUPPRESSION AREA Rr
S306
S308
SURROUNDING OBJECT EXIST?
NO
YES
S310
JUDGE WHETHER OR NOT THE SURROUNDING OBJECT IS MOVING OBJECT
DERIVE OCCUPATION RATIO
S312
DERIVE ACCELERATION OF ELECTRIC WHEEL CHAIR 1
S314
SWITCH OVER SUPPRESSION AREA
S316
S318
NO
EXECUTE AREA EXPANDING CONTROL?
YES
EXECUTE AREA EXPANDING CONTROL
S320
S108
OBSTACLE EXISTS?
NO
YES
S110
SUPPRESS TRAVELLING
S112
TRAVELLING SUPPRESSED?
NO
YES
S114
RELEASE SUPPRESSION OF TRAVELLING

【FIG20】

M14

OCCUPATION RATIO	SUPPRESSIO AREA
OCCUPATION RATIO <OCCUPATION RATIO JUDGING VALUE	STANDARD SUPPRESSIO AREA Rb
OCCUPATION RATIO JUDGING VALUE ≦OCCUPATION RATIO	REDUCED SUPPRESSIO AREA Rr

【FIG21】

M24

SURROUNDING OBJECT	OCCUPATION RATIO	
	OCCUPATION RATIO <OCCUPATION RATIO JUDGING VALUE	OCCUPATION RATIO JUDGING VALUE ≦OCCUPATION RATIO
NOT EXISTING	STANDARD SUPPRESSION AREA Rb	
MOVING OBJECT	STANDARD SUPPRESSION AREA Rb	REDUCED SUPPRESSION AREA Rr
STATIONARY OBJECT	REDUCED SUPPRESSION AREA Rr	REDUCED SUPPRESSION AREA Rr

【FIG22】

M15

SURROUNDING OBJECT	OCCUPATION RATIO	
	OCCUPATION RATIO <OCCUPATION RATIO JUDGING VALUE	OCCUPATION RATIO JUDGING VALUE ≦OCCUPATION RATIO
NOT EXISTING	EXECUTE	
MOVING OBJECT	EXECUTE	NOT EXECUTE
STATIONARY OBJECT	EXECUTE	NOT EXECUTE

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2016/082137

A. CLASSIFICATION OF SUBJECT MATTER
G08G1/16(2006.01)i, *A61G5/04*(2013.01)i

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)
G08G1/16, A61G5/04

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 2012-106722 A (Panasonic Corp.), 07 June 2012 (07.06.2012), paragraphs [0018] to [0050], [0058] to [0065]; fig. 1A to 4B & US 2012/0095633 A1 paragraphs [0037] to [0070], [0078] to [0085]; fig. 1A to 4B & EP 2444274 A2 & CN 102452394 A	1-3 4-7
A	JP 2010-208583 A (Toyota Motor Corp.), 24 September 2010 (24.09.2010), paragraphs [0032] to [0035], [0055] to [0056]; fig. 2 (Family: none)	4-7

☐ Further documents are listed in the continuation of Box C. ☐ See patent family 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 application or patent 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
11 January 2017 (11.01.17)	24 January 2017 (24.01.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 5338398 B **[0003]**