

## FORWARD SENSING CAMERA (FSC)

id092200029300

### Purpose

- The camera recognizes light-emitting objects and vehicle lane lines based on the images picked up at the front of the vehicle, and controls the high beam control (HBC) system and lane departure warning system (LDWS).

### Function

#### Light-emitting object (on-coming vehicle, vehicle ahead, street lights) recognition function

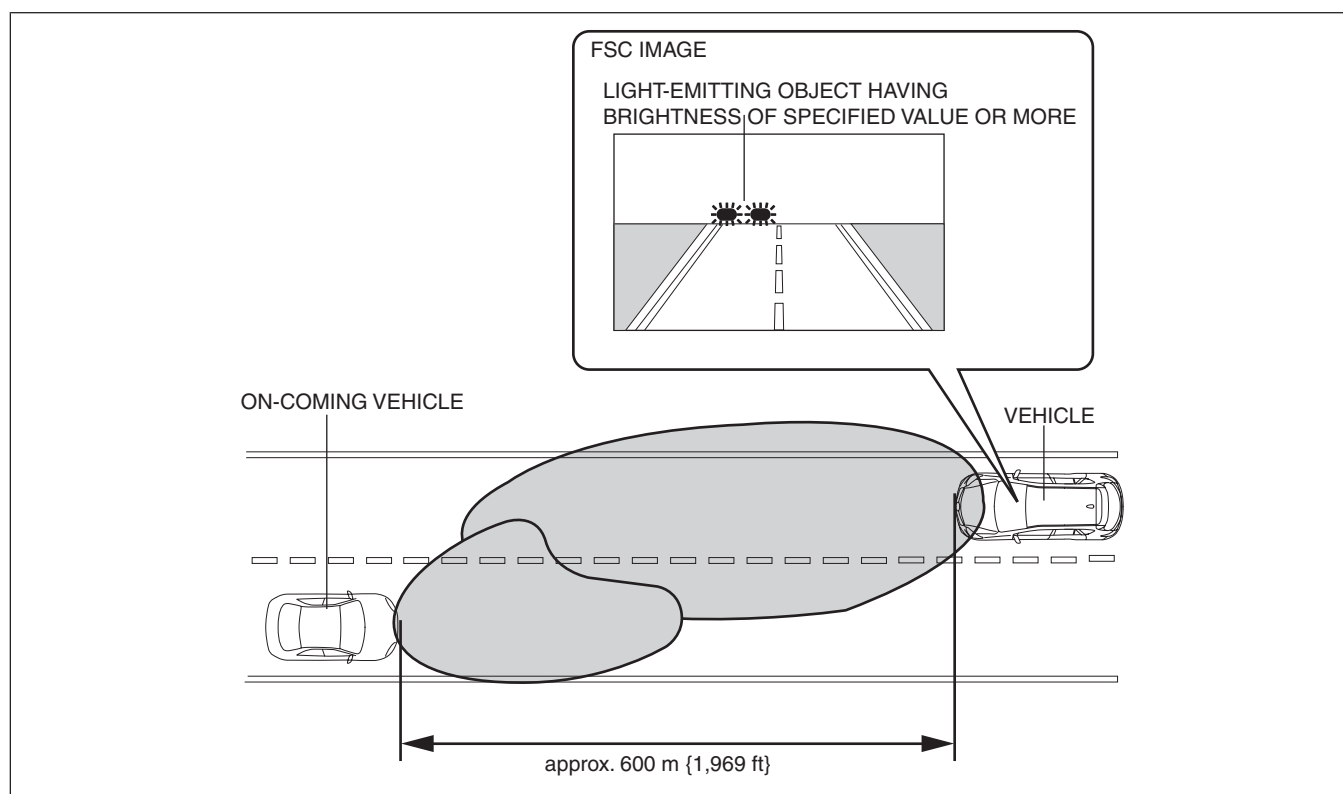
- The camera analyzes the light-emitting object it picks up and recognizes it as an on-coming vehicle, vehicle ahead, or street lights (traveling on town/city streets).

#### On-coming vehicle recognition function

- The FSC recognizes a light-emitting object that is at least approx. 600 m {1,969 ft} from the detecting vehicle as an on-coming vehicle when any of the following conditions are met:
  - Light-emitting object approaches having brightness of specified value or more
  - Light-emitting object approaches having white color and certain level of brightness or more (if it approaches and brightness changes, determination made at point of image capture)

### Note

- If the on-coming vehicle and the surrounding conditions are as follows, the FSC may require time until it recognizes an on-coming vehicle.
  - Poor visibility due to rain and fog
  - On-coming vehicle is travelling with only TNS or fog lights
  - Brightness of light source, such as vehicle, lowers



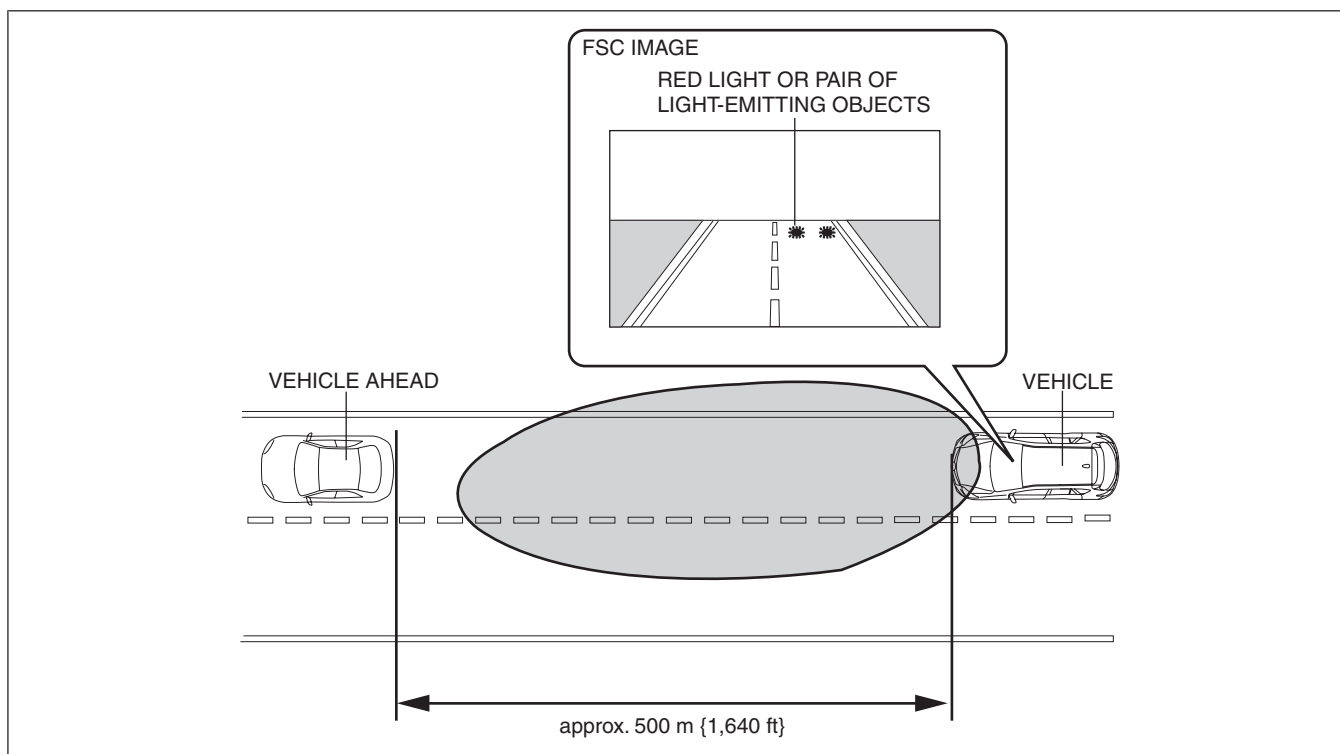
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#### Vehicle ahead recognition function

- The FSC recognizes a light-emitting object that is at least approx. 500 m {1,640 ft} of the detecting vehicle as a vehicle ahead, and when any of the following conditions is met:
  - Red light emitted from light-emitting object is detected
  - Determines that there is a pair of light-emitting objects

### Note

- To make prevention of dazzling other vehicles a priority, the system could recognize reflecting objects on the road surface or a guard rail as a vehicle ahead (switches to low beams).
- If visibility is poor due to rain or fog, a vehicle ahead may not be recognized even though one may exist (maintains high beams).



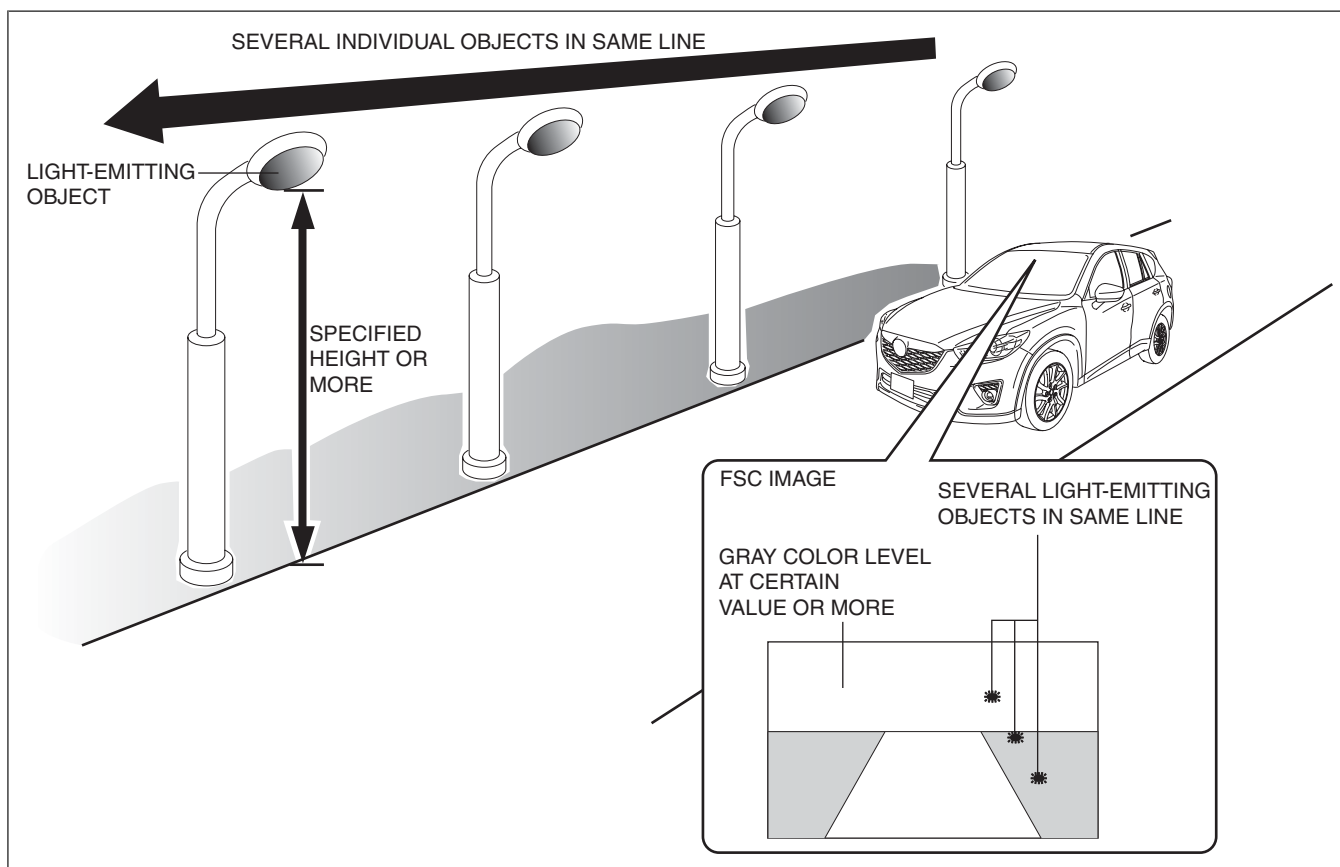
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### Town/city streets recognition function

- Travel on town/city streets is recognized in the following cases:
  - Several light-emitting objects of certain height or more from road surface along same line are detected
  - Camera image gray color is certain level or more

#### Note

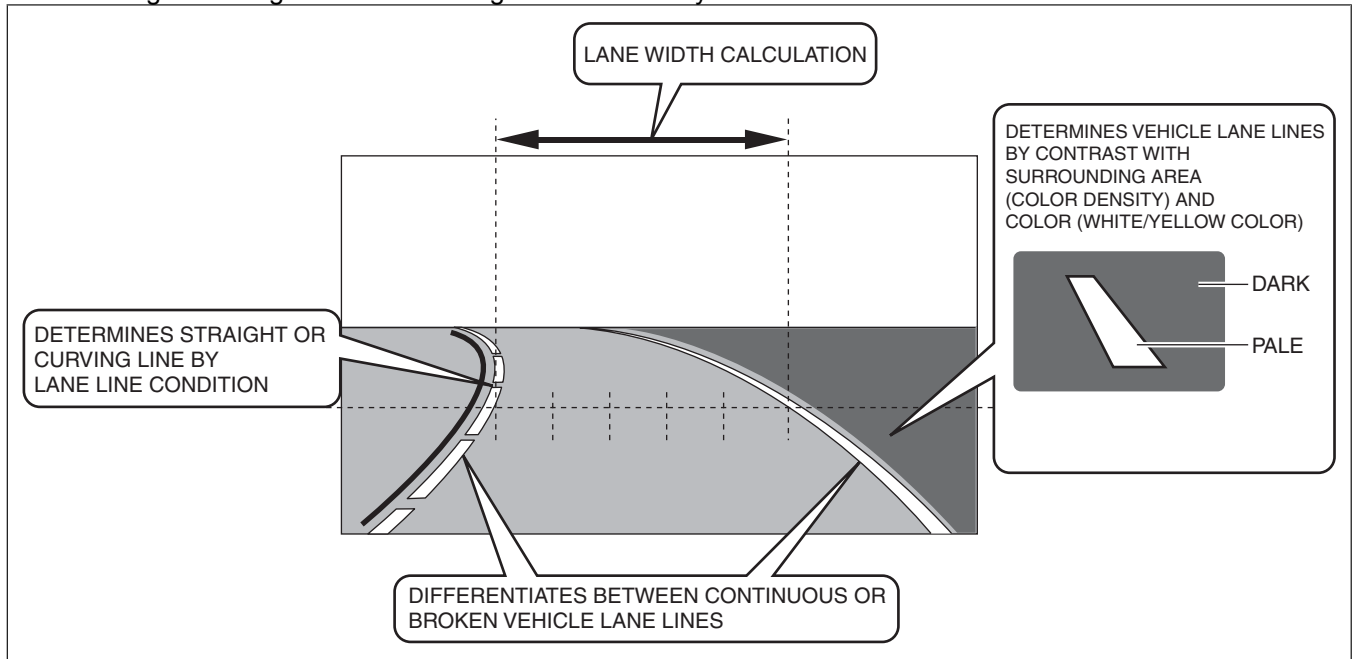
- Even during travel other than at night or on town/city streets, if the road surface is bright from moonlight, the system may recognize that the vehicle is traveling on town/city streets (switches to low beams).



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### Vehicle lane lines and travel lane recognition function

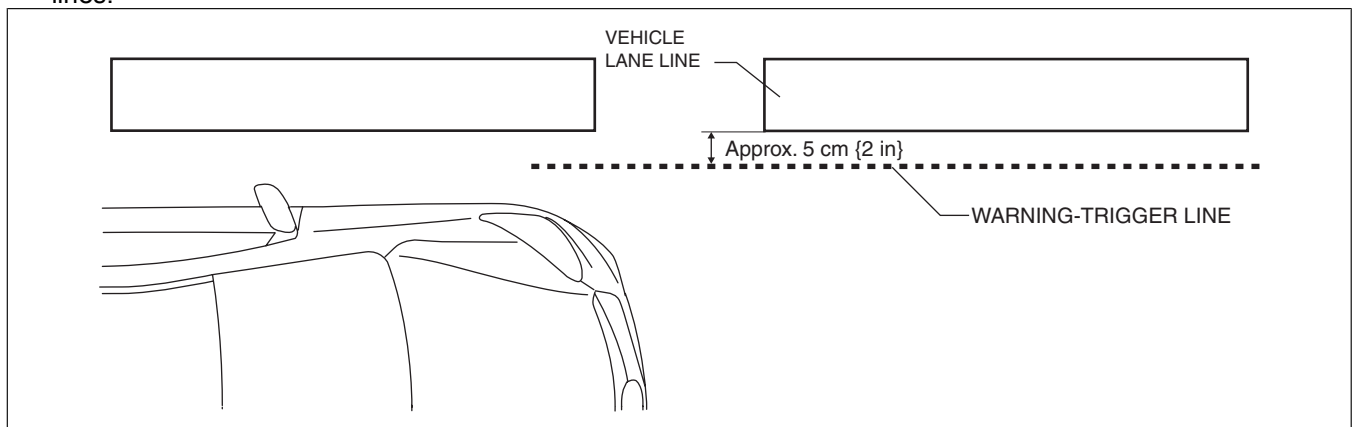
- The FSC recognizes line shapes which are paler than the surrounding color, and white/yellow lines as vehicle lane lines from the contrast (color density) of the camera image.
- If the vehicle lane lines are continuous they are recognized as actual lines, if discontinuous they are recognized as broken lines.
- The travel lanes recognized from the vehicle lane lines on the left and right of the vehicle are used to calculate the width.
- Traveling in a straight line or cornering is determined by the status of the vehicle lane lines.



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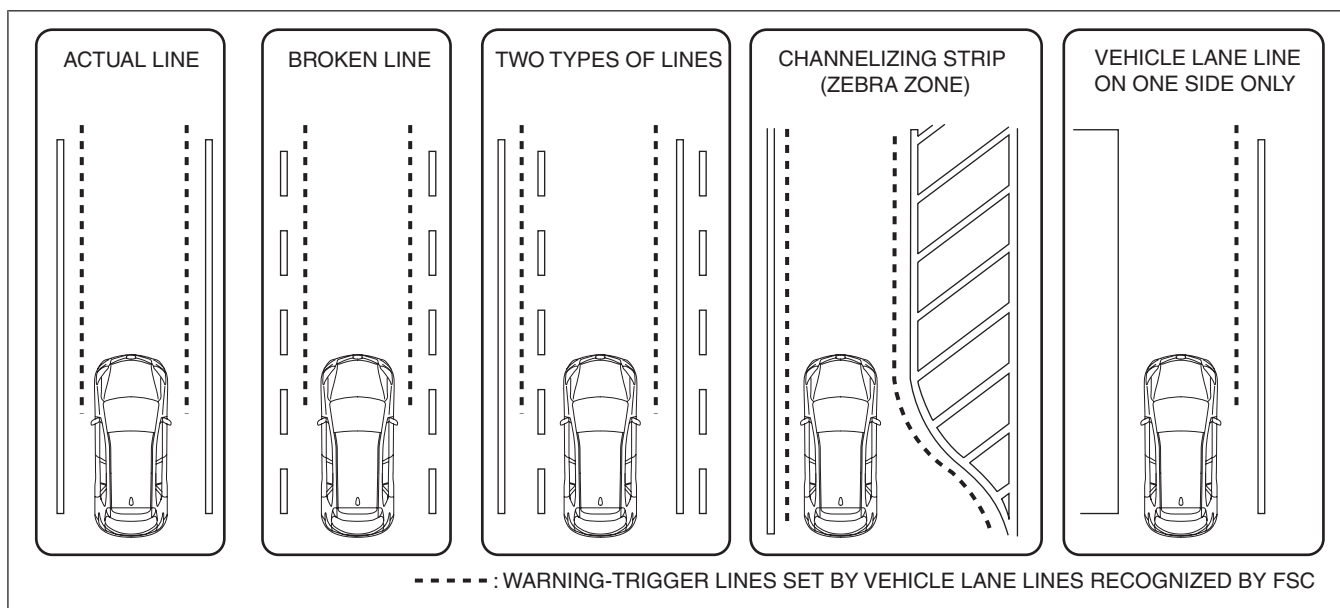
### LDWS warning-trigger line setting function

- The FSC sets the LDWS warning-trigger lines <sup>\*1</sup> at approx. 5 cm {2 in} inside of the recognized vehicle lane lines.



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- If there is only one vehicle lane line or only one vehicle lane line can be recognized, the warning-trigger line is set to only the recognized vehicle lane line.
- If the FSC recognizes both broken vehicle lane lines and actual vehicle lane lines, the warning-trigger line is set to the actual vehicle lane line.



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\*1 : The distance from the vehicle lane lines to the warning-trigger lines can be changed using the customization. Refer to INSTRUMENTATION/DRIVER INFO. PERSONALIZATION for details.

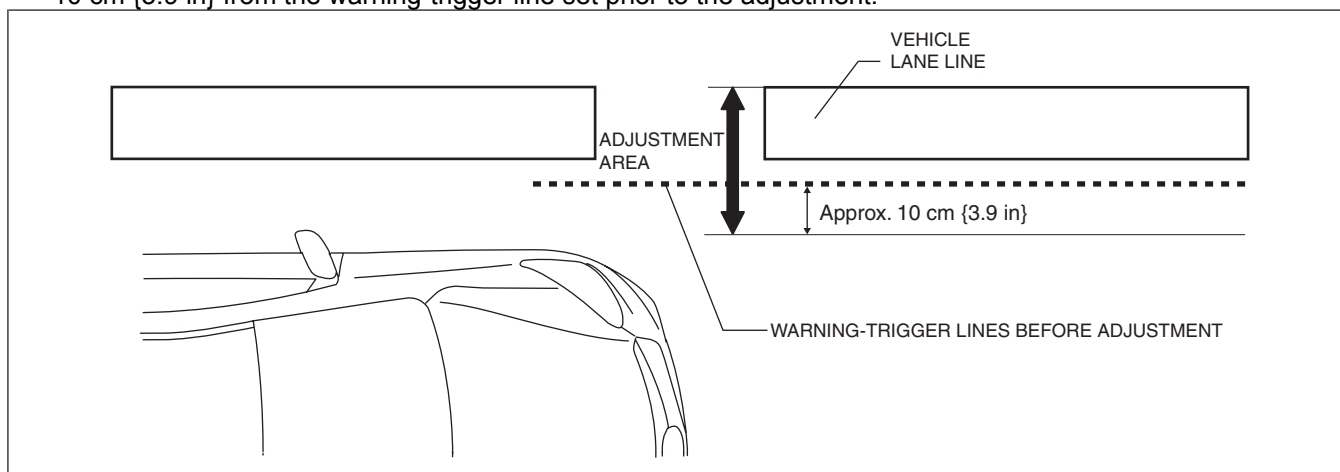
### LDWS warning-trigger line auto-adjust function

#### Note

- The LDWS warning-trigger line auto-adjust function operates when "Adaptive" is selected using the personalization feature, which can be used to change the distance between the LDWS vehicle lane lines and the warning-trigger lines. For details on the personalization features, refer to INSTRUMENTATION/DRIVER INFO. PERSONALIZATION.
- If any of the following conditions is met after the vehicle is driven for a certain period of time or more during 1 drive-cycle <sup>\*2</sup>, the FSC automatically adjusts the LDWS warning-trigger lines to control unnecessary warnings.
  - Vehicle is driven continuously under driver's intentions (such as staying to left) while distance between vehicle lane line and vehicle is close for certain period of time or more
  - FSC recognizes travel lane width as decreasing from certain width
  - FSC recognizes travel lane as curving at certain value or more and determines that vehicle is cornering (out-in-out travel)
- If the travel lane recognized by the FSC is wider than the certain width after the vehicle is driven for a certain period of time or more during 1 drive-cycle <sup>\*2</sup>, the FSC automatically adjusts the LDWS warning-trigger lines according to the change in the width of the travel lane.

\*2 : One drive cycle means the period from when the ignition is switched ON (engine on) to when the ignition is switched off (engine off).

- The FSC adjusts the warning-trigger line on the outer side of the vehicle lane line automatically to within approx. 10 cm {3.9 in} from the warning-trigger line set prior to the adjustment.



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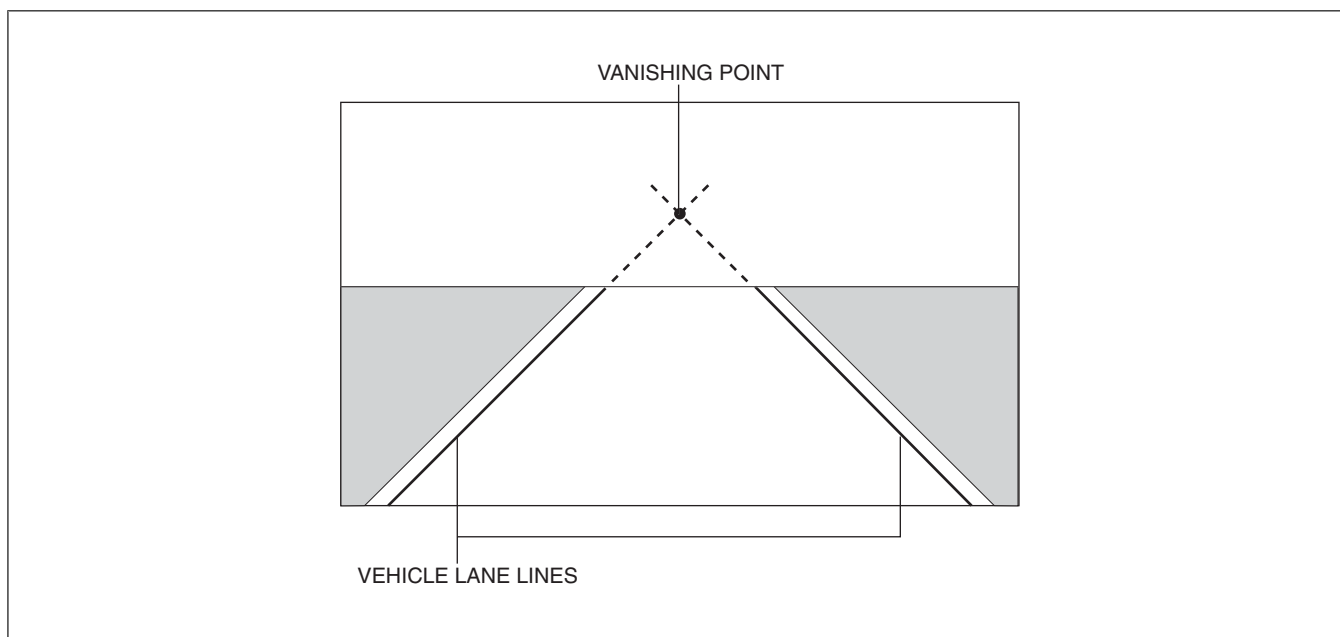
- The FSC automatically adjusts the set warning-trigger lines within the adjustment range in the following cases:

Detection state	Adjustment
Distance of vehicle to vehicle lane line recognized by FSC detected (such as staying to left) continuously as closer than specified value for certain period of time.	
Recognized travel lane width decreases to certain width or less	
Recognized vehicle lane line curves for certain period of time or more and system determines that vehicle is cornering (out-in-out travel)	
Recognized travel lane width is wider than certain width	

### Aiming correction function

- The FSC adjusts the camera shot angle by aiming, and stores the vanishing point <sup>\*1</sup>. The stored vanishing point and the current vanishing point are compared and if there is a deviation of a certain value or more in the vanishing point, the current vanishing point is stored as the new vanishing point.

<sup>\*1</sup> : The vehicle lane lines on the road surface are parallel and do not intersect, however, when viewed by the camera image, the lines converge in the distance and eventually cross. The point at which the lines cross is called the vanishing point.



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#### **HBC indicator light (green)/HBC warning light (amber) and LDWS indicator light (green)/LDWS warning light (amber) blown fuse check function**

- When the ignition is switched ON, the FSC illuminates the HBC indicator light (green)/LDWS warning light (amber) for approx. 3 s and performs a blown fuse check of each indicator light/warning light.

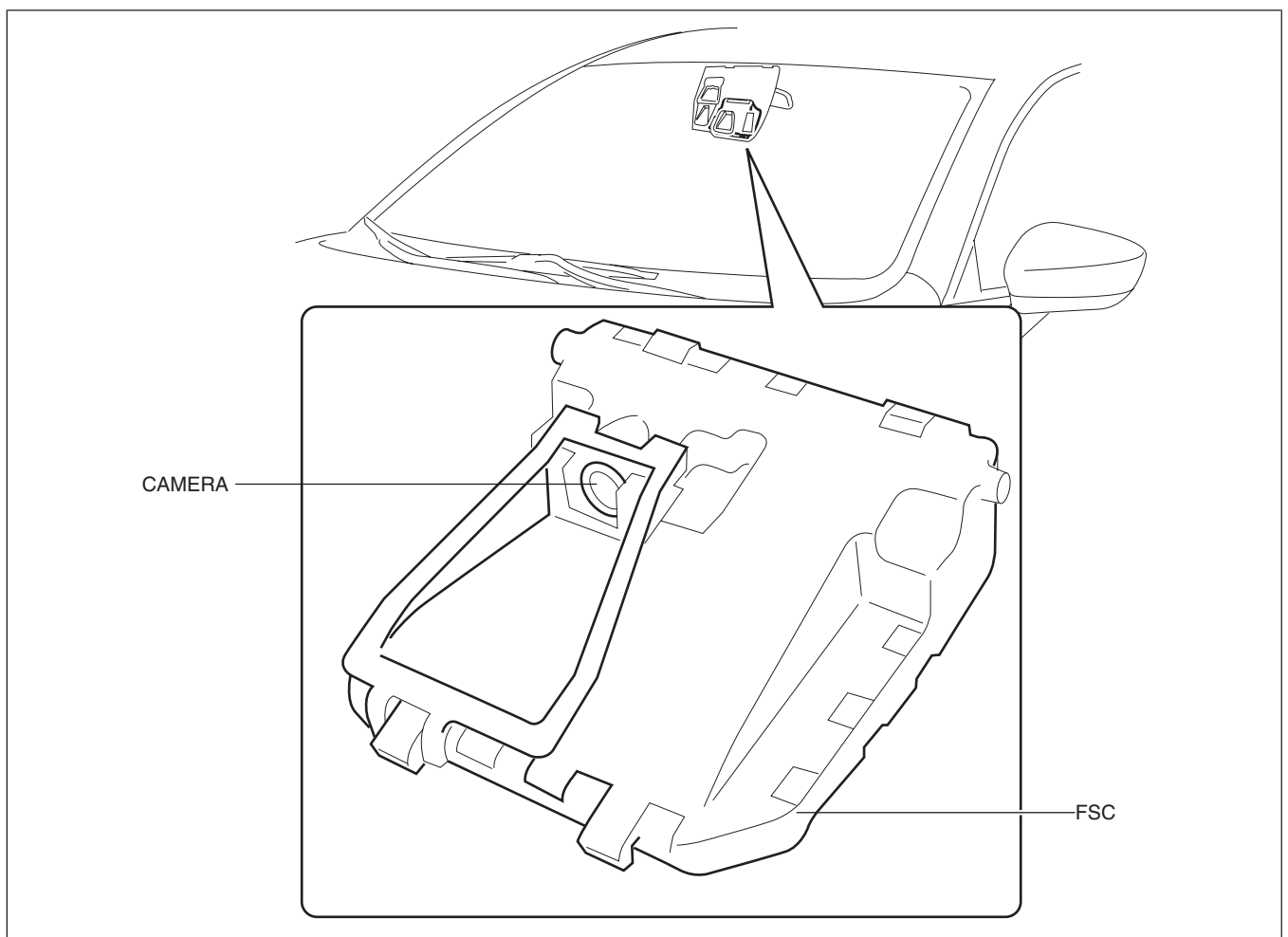
#### **On-board diagnostic function**

- The FSC detects soiling and fogging of the camera lens and windshield glass, FSC transmission errors, FSC internal malfunctions, and outputs DTCs. For DTC details, refer to ON-BOARD DIAGNOSTIC [FORWARD SENSING CAMERA (FSC)].

#### **Construction**

- Installed to the windshield.
- By integrating a small, color CMOS camera <sup>\*1</sup> with the control module, lightness and size reduction have been achieved.
- The FSC transmits between other modules using CAN.

<sup>\*1</sup> : Camera with high sensitivity CMOS (Complementary Metal-Oxide Semiconductor) picture element



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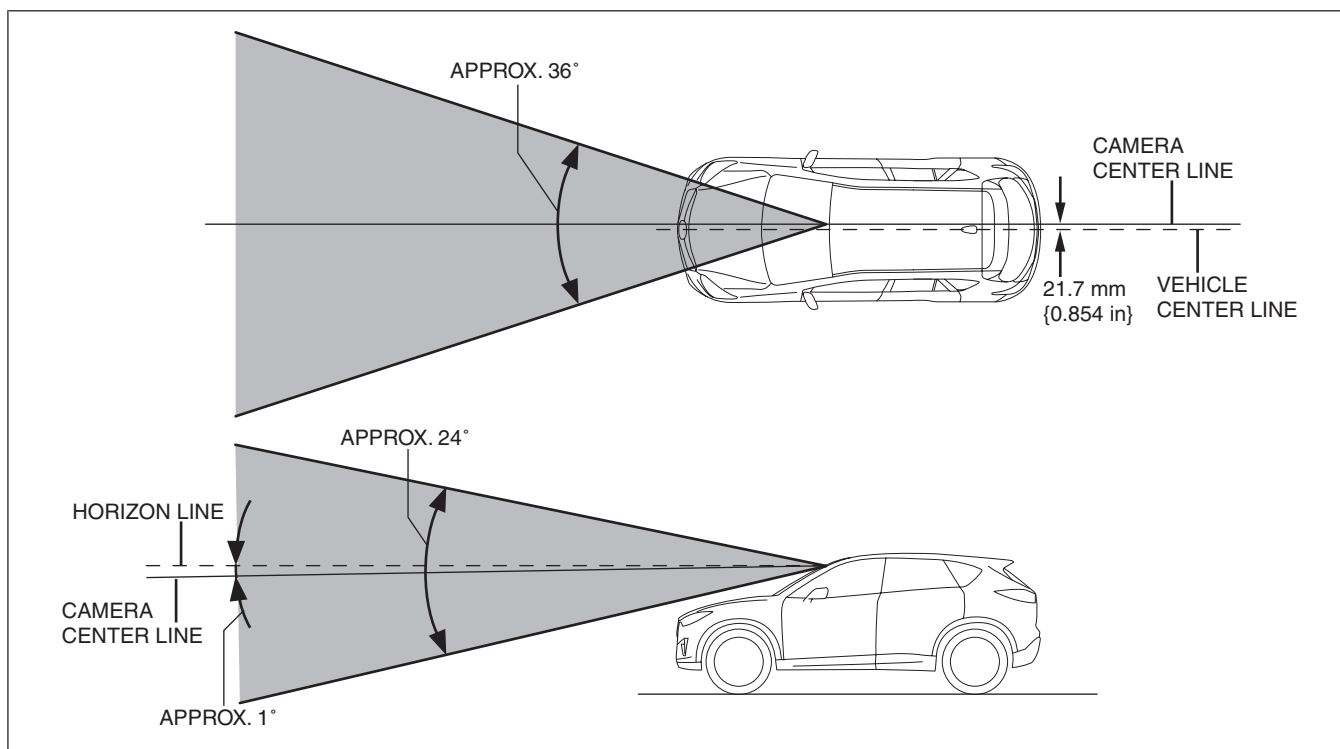
## Operation

### Camera range

- The FSC camera shoots in the following range.

### Note

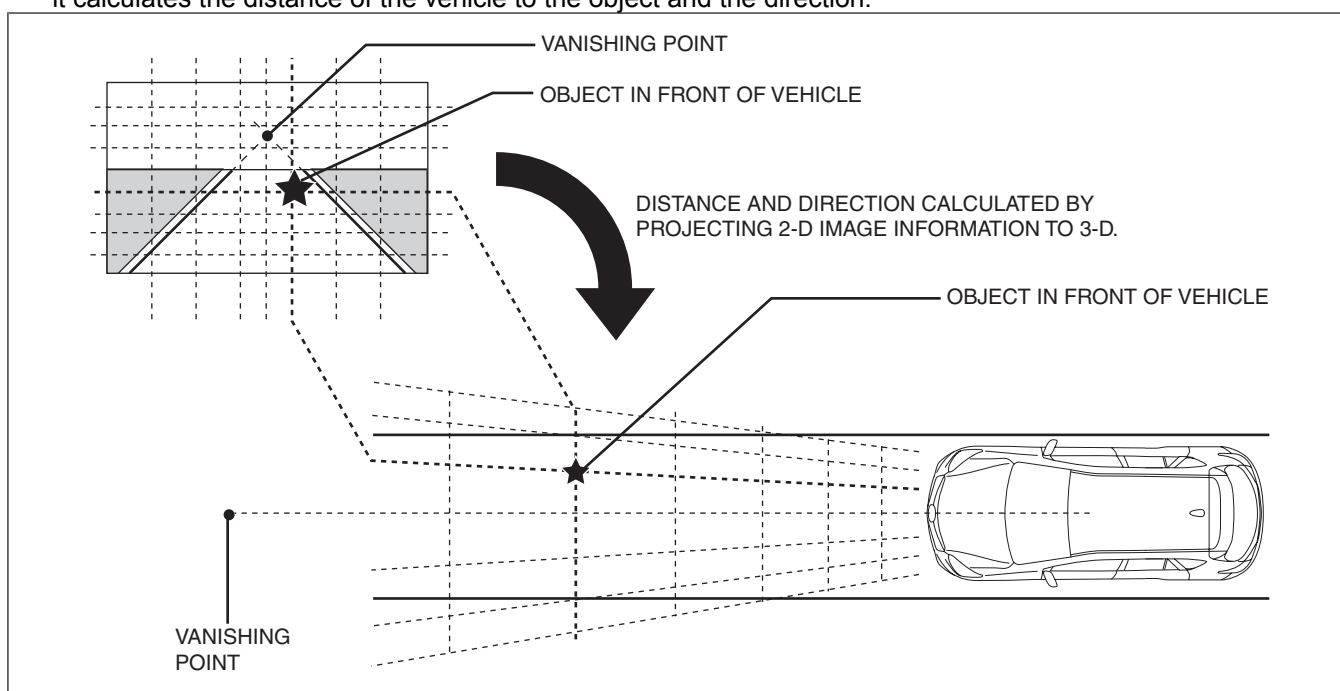
- Direction, depending on the surrounding conditions (ascending roads, winding roads, walls), the camera may be unable to pickup an object within the camera range in front of the vehicle, and not recognize it as a controlled target object.



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### Position calculation

- When an object appears on the screen, the FSC determines the position coordinates, and from the coordinates it calculates the distance of the vehicle to the object and the direction.



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### Fail-safe

DTC No.	Fail-safe function
B115E:54	<ul style="list-style-type: none"> <li>Inhibits the lane departure warning system (LDWS).</li> <li>Inhibits the high beam control system (HBC).</li> </ul>
B13A6:11	<ul style="list-style-type: none"> <li>Inhibits the lane departure warning system (LDWS).</li> </ul>
C1001:92	<ul style="list-style-type: none"> <li>Inhibits the lane departure warning system (LDWS).</li> <li>Inhibits the high beam control system (HBC).</li> </ul>
C1001:97	<ul style="list-style-type: none"> <li>Inhibits the lane departure warning system (LDWS).</li> <li>Inhibits the high beam control system (HBC).</li> </ul>



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DTC No.	Fail-safe function
U0001:88	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0100:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0121:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0131:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li></ul>
U0140:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0155:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0214:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0401:68	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0415:68	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U0420:68	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li></ul>
U0423:68	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li></ul>
U0515:68	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U2005:86	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U2100:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U2101:00	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3000:04	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3000:09	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3000:42	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3000:49	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3003:16	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>
U3003:17	<ul style="list-style-type: none"><li>• Inhibits the lane departure warning system (LDWS).</li><li>• Inhibits the high beam control system (HBC).</li></ul>