IEC 63033-1

Edition 1.0 2022-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Multimedia systems and equipment for vehicles – Surround view system – Part 1: General

Systèmes et équipements multimédias pour véhicules – Système de vision panoramique – Partie 1: Généralités

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**MULTIMEDIA SYSTEMS AND EQUIPMENT FOR VEHICLES –
SURROUND VIEW SYSTEM –**

Part 1: General

FOREWORD

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IEC 63033-1 has been prepared by technical area 17: Multimedia systems and equipment for vehicles, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This first edition cancels and replaces IEC TS 63033-1 published in 2017. This edition constitutes a technical revision.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/3728/FDIS	100/3751/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 63033 series, published under the general title *Multimedia systems and equipment for vehicles – Surround view system*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

The purpose of this document is to specify the model for generating the surrounding visual image of the surround view system, which provides drivers with an image of the car's surroundings. The surround view system is characterised by audio-visual monitoring and recording, which is part of the car's multimedia equipment.

When manoeuvring, the driver relies on the images provided by the rear-view monitor for parking assistance, the blind spot monitor for displaying views of the blind spots at intersections with poor visibility, and the bird's-eye view monitor. But each surround view system provides a different viewpoint to the driver. It's a heavy burden for a car driver to switch between these systems and quickly recognize the multiple fields of view. And the fields of view are limited to these camera systems, and they cannot freely change the viewpoint depending on the driving situation. Thus, the usage range of these systems is limited to such manoeuvres as parking assistance. Furthermore, on commercial vehicles such as trucks and buses, and special vehicles such as construction machinery and agricultural machinery, the usage range of these systems is even more limited. Nobody can assist drivers of large vehicles in ensuring the car's correct position.

With a surround view system, it is possible to quickly ensure the car's proper positioning in various driving situations. And not only for passenger cars, but good positioning can also be quickly ensured for commercial vehicles and special vehicles.

This document specifies the model for generating the surrounding visual image of the surround view system. IEC 63033-2 specifies the information sets that are provided by the surround view system, and recording methods for that information and visual images. IEC 63033-3 specifies the measurement methods of surrounding visual images for the surround view system.

MULTIMEDIA SYSTEMS AND EQUIPMENT FOR VEHICLES – SURROUND VIEW SYSTEM –

Part 1: General

1 Scope

This part of IEC 63033 specifies the model for generating the surrounding visual image of the surround view system.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Terms and definitions

3.1.1
car
powered wheeled vehicle of any kind

3.2 Abbreviated terms

3D	three dimensional
camera ECU	camera electronic control unit
CAN	controller area network
GUI	graphical user interface
AD	analogue-to-digital
DA	digital-to-analogue

4 System model

4.1 General

The system model of the surround view system is described in Figure 1. Cameras, which are mounted on the outside of the car, capture the visual image of the area surrounding the car and these visual data are projected onto a 3D projection surface. The visual image can then be displayed as a composite image. The images can be rendered from various viewpoints with the parameters for capture. The number of cameras required on vehicles other than automobiles can be more than four depending on the size and shape of the car. This model defines a system with four cameras for general application. The number of cameras actually used for each composite image changes depending on the viewpoint. The mounting positions and angles for the four cameras should be calibrated in accordance with the data described in 4.2 and 4.3.

See Annex D for information about display attributes and Annex E for information about the reactivity of the system.

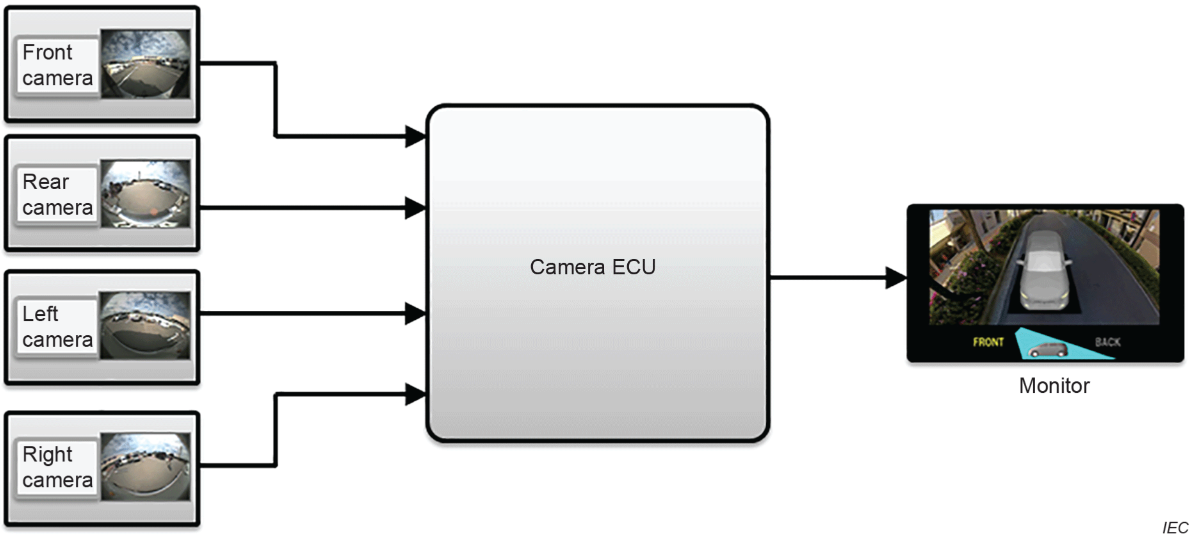

Figure 1 – System model for surround view system

4.2 Number of cameras and camera field of view

The horizontal angle of view of the camera is described in Figure 2. Overlapping areas and blind spots on the horizontal field of view change depending on the number of cameras and the horizontal angle of view of the camera. Overlapping areas should be wide for getting better composite views. The number of cameras and the horizontal angle of view of the camera shall be determined to ensure that there are no blind spots.

The vertical angle of view and the tilt angle ψ_{Front} of the front camera and the vertical angle of view and the tilt angle ψ_{Rear} of the rear camera are described in Figure 3. The blind spot of the vertical field of view changes depending on the vertical angle of view of the camera and the tilt angle ψ. The vertical angle of view of the camera and the tilt angle ψ shall be chosen to ensure that no blind spots are generated. The details are described in Annex A.

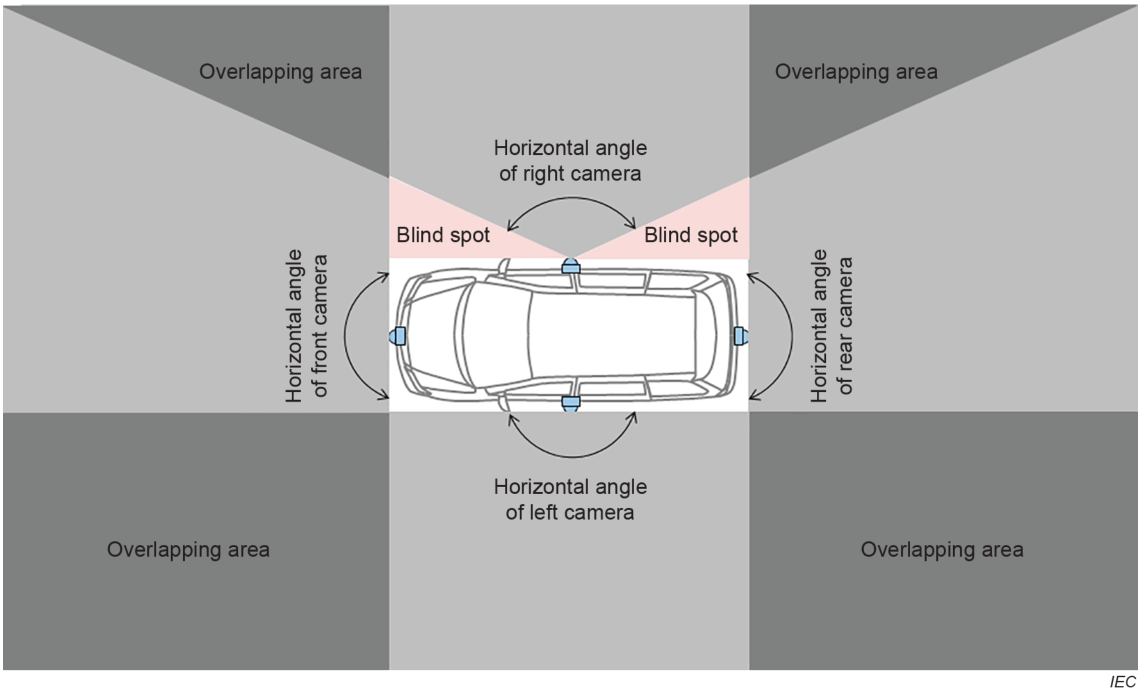

Figure 2 – Horizontal angle of view of the camera

Figure 3 – Vertical angles of view at the camera

4.3 Method for projecting visual image to 3D projection surface

Following the right-handed coordinate system, the length of the car is the Y_{car} axis, the width direction of the car is X_{car} axis, and the direction of the height of the car is the Z_{car} axis. The projection surface of the camera video image is $Z_V = 0$, the road surface. The 3D projection surface that shall be used is shown in Figure 4. Projecting to a 3D projection surface is described in Figure 5. The 3D projection surface should cover the 3D surface as the polygon model is similar to a polyhedron. The coordinate P_V of the one point of the 3D projection surface is converted to the coordinate P_C according to the camera's coordinate system based on the origin of the optics of the car's cameras. This coordinate conversion is defined as:

$$P_C = M_{V\to C} \times P_V$$

$M_{V \rightarrow C}$ is the coordinate conversion matrix to the car's coordinate system, which is determined by the camera's mounting position and the angle. The incident vector V_i when the car's camera photographs the subject at position P_C is defined as:

$$V_i = -\frac{P_C}{|P_C|}$$

The coordinates of the car's camera image record the subject of incident vector V_i calculated by the internal parameter of the car's camera. Projecting the car's cameras to a 3D projection surface is realized by arranging the pixels of four cameras with the relations mentioned above.

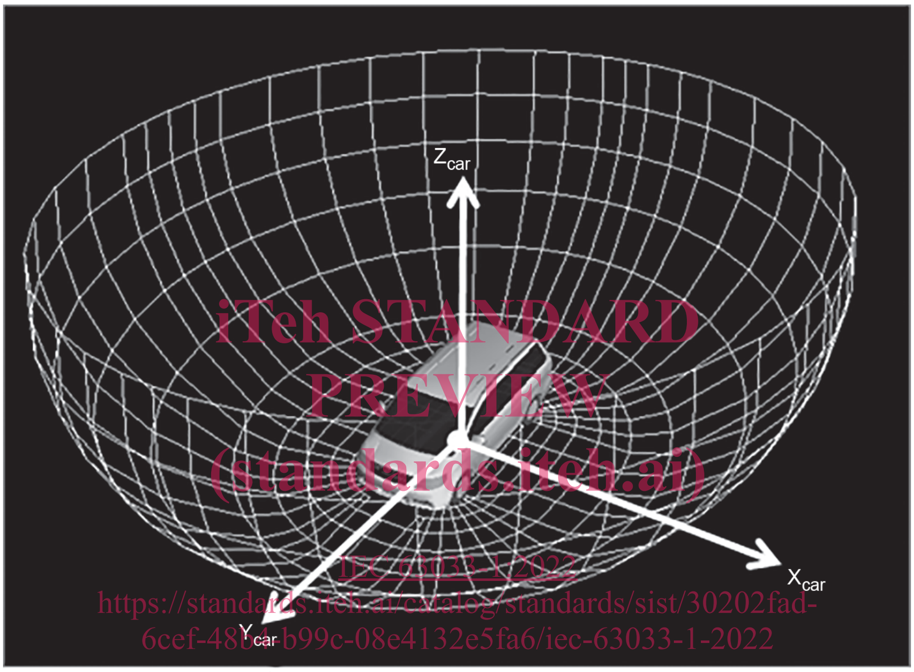

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Figure 4 – 3D projection surface

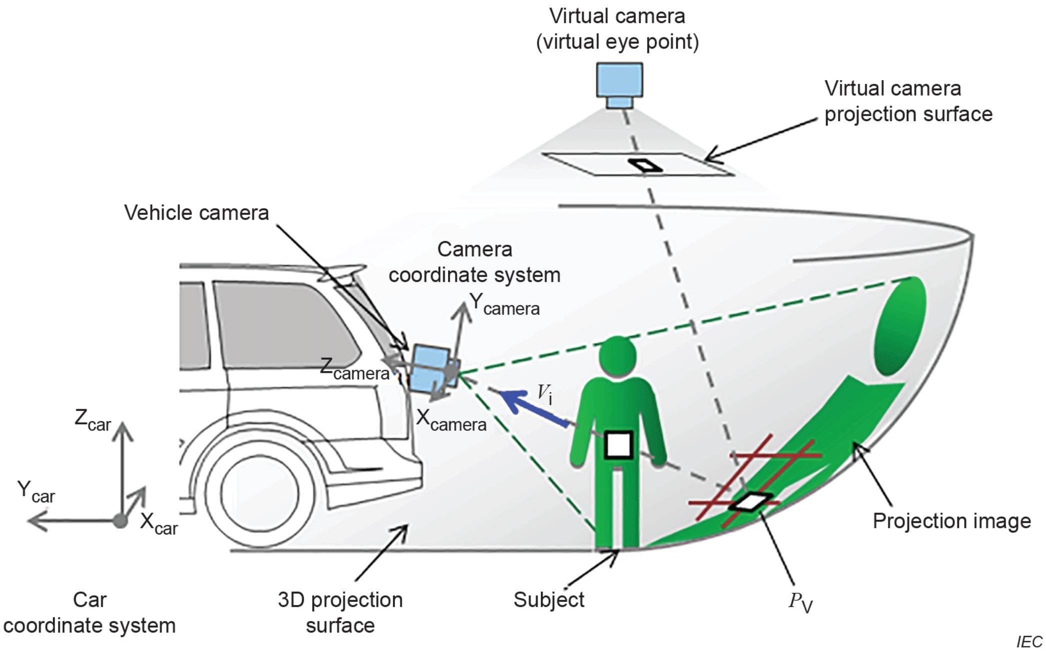

Figure 5 – Projecting to 3D projection surface

4.4 Visualizing the projection image at free eye point

The polygon model constituting the 3D projection surface can be visualized from any virtual eye point. Visualizing the polygon model uses 3D computer graphics technology. The texture image is the car's camera image updated at the system's video rate. The wrap-around view image is composed by performing the polygon rendering and the texture coordinate is the car's camera image coordinate that corresponds to the top of the polygon.

4.5 Free eye point capability

The parameters of the eye point, direction and field of view of the virtual camera are freely changed during polygon rendering. The eye point can be changed by changing the parameters of the virtual cameras, the car's surroundings and the driving situation for the same 3D projection surface. The animated image tied between individual eye points is smoothly adjusted by changing these parameters continually.

5 Camera configuration

5.1 Camera

The lens of the camera should be isotropic and have a rotary symmetric distortion characteristic in an optical axis. The details are described in Annex B.

5.2 Lens distortion data

5.2.1 General

Lens distortion data should be used during calibration. Lens distortion data should be arranged according to the coordinate data of the height of the real image corresponding to the incidence angle value in ascending order. The type of lens distortion data is either of rotationally symmetric lenses or of non-rotationally symmetric lenses.

5.2.2 Distortion data of rotationally symmetric lens

Distortion data of rotationally symmetric lenses is described in Figure 6. It is composed of the angles of incidence a_1 and a_2 between the optical axis's centre and their distances d_1 and d_2 from the centre. The distortion data format of a rotationally symmetric lens is described in Figure 7.

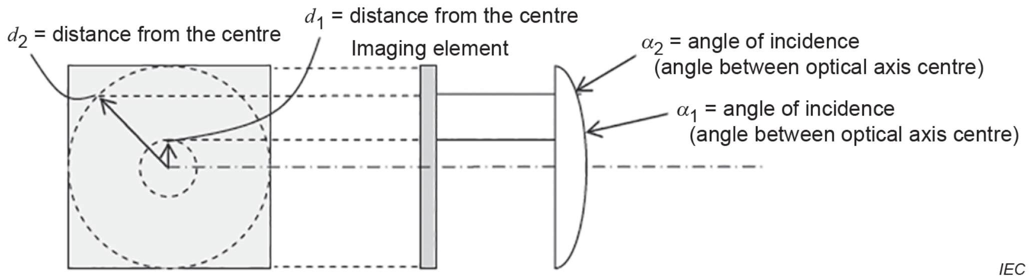

Figure 6 – Distortion data of a rotationally symmetric lens

```
File identifier             : [#        ]
Camera element size         : [Width, height]
Camera element dot pitch    : [Dot pitch X, dot pitch Y]
Number of array data        : [ n ]
Array definition            : [Angle of incidence, height of real image]
                                (unit: degree)        (unit: mm)
                              [a0                   ,:                  ]
                              [a0                   ,:                  ]
                              [a0                   ,:                  ]
                              [:                    ,:                  ]
                              [:                    ,:                  ]
                              [:                    ,:                  ]
                              [:                    ,:                  ]
                              [an-2                 ,:                  ]
                              [an-1                 ,:                  ]
```

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Figure 7 – Distortion data format of rotationally symmetric lens

5.2.3 Distortion data of non-rotationally symmetric lens

Distortion data of non-rotationally symmetric lenses is described in Figure 8. It is composed of an angle of incidence (pan angle and tilt angle) and the location (x,y) on the imaging element. The distortion data format of a non-rotationally symmetric lens is described in Figure 9.

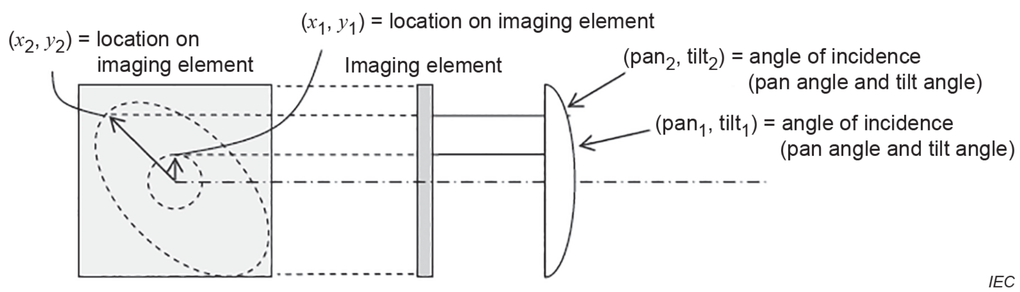

Figure 8 – Distortion data of a non-rotationally symmetric lens

File identifier	: [#]
Camera element size	: [Width, height]
Camera element dot pitch	: [Dot pitch X, dot pitch Y]
Number of array data (lines, rows)	: [n, m]
Array definition	: [Pan angle of incidence, tilt angle of incidence, real image x coordinate, real image y coordinate]

(unit: degree)	(unit: degree)	(unit: mm)	(unit: mm)	
$[p,t_{(0,0)}$	,:	,:	,:	]
$[p,t_{(0,1)}$	,:	,:	,:	]
$[p,t_{(0,2)}$	,:	,:	,:	]
[:	,:	,:	,:	]
[:	,:	,:	,:	]
$[p,t_{(0,m-1)}$	,:	,:	,:	]
$[p,t_{(1,0)}$	,:	,:	,:	]
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$[p,t_{(n-2,m-1)}$	,:	,:	,:	]
$[p,t_{(n-1,0)}$	,:	,:	,:	]
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[:	,:	,:	,:	]
$[p,t_{(n-1,m-2)}$	,:	,:	,:	]
$[p,t_{(n-1,m-1)}$	,:	,:	,:	]

IEC

Figure 9 – Distortion data format of a non-rotationally symmetric lens

5.3 Optical axis shift data

Optical axis shift data should be used at calibration. Optical axis shift includes optical axis shift of camera, shift by AD or DA conversion, and shift from the ideal captured image. The optical axis shift adjusts the shift from the central coordinates and the captured image's width and height as an input. Optical shift data that should be matched on the texture coordinate is described in Figure 10. The format of optical shift data is described in Figure 11.

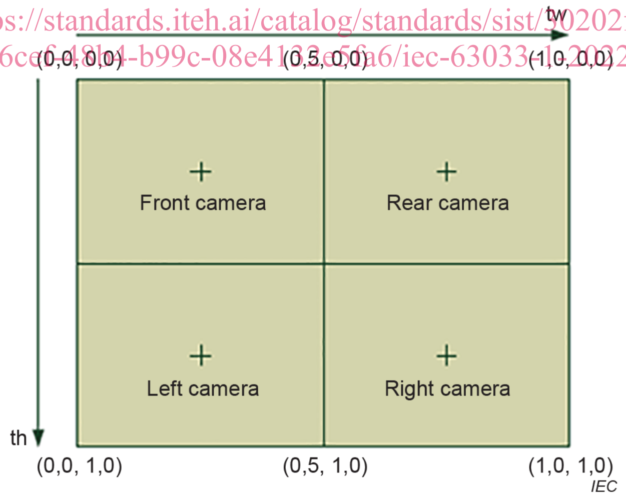

Figure 10 – Texture normalization coordinate at the centre of each optical axis