

Concept of JAMA HUD Guideline

GRSG TF-FVA 02
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JAMA delegate of GRSG Driver Vision related items
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*JAMA: Japanese Automobile Manufacturer's Association. A member of OICA.

Basic philosophy of JAMA HUD Guideline

HUD overlays should not affect driver's awareness of VRU or hazards etc. Therefore, conditions of overlay image are defined based on recognitions of objects (correct answer ratio) by the studies using subjects.

Application field of view: $V1+3\text{deg} \sim V2-1\text{deg}$ (almost above S area)

Current guideline (Ver.3)

Issued in Mar. 2016 (now under application for Japanese vehicles)

- **Overlaid image transparency condition: 0%**
- **Size of image limited.**

New guideline (Ver.4)

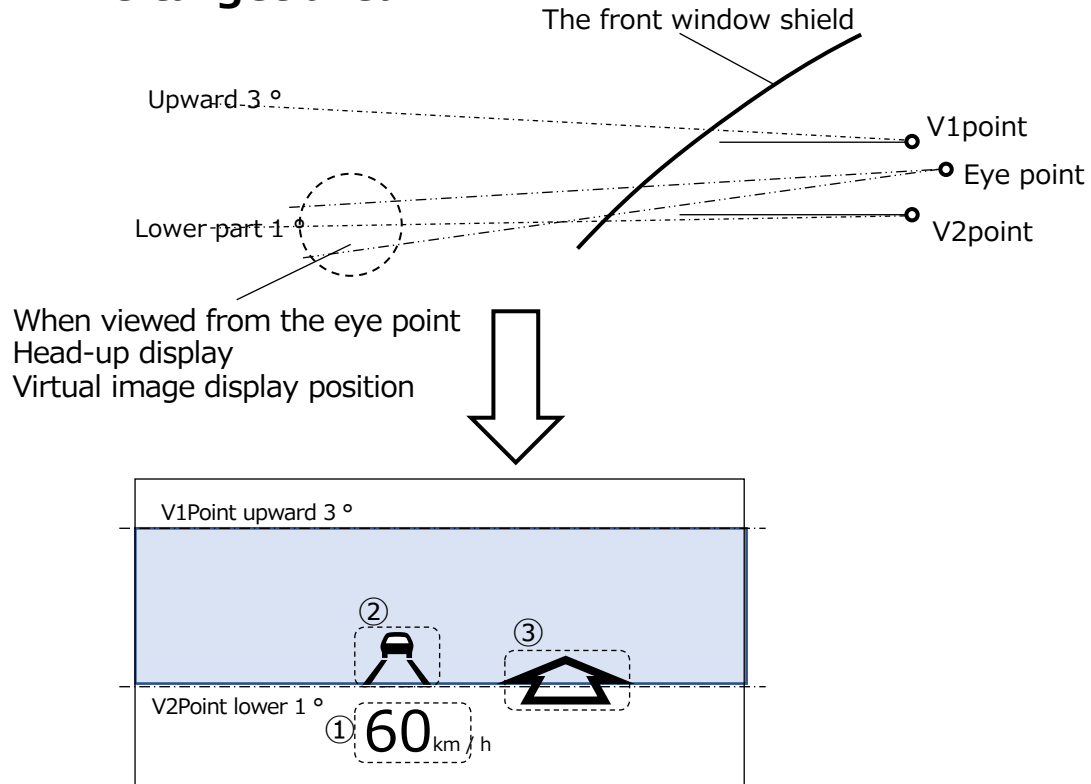
Under study since 2019, to be finalized in Mar. 2021 (Draft will be expected in Dec. 2020)

- **Overlaid image transparency condition: considered as the contrast between HUD and background scenes.**
- **Final guideline will be defined as HUD image luminance condition.**

We propose to use both guidelines choice with the kind of overlaid images.

Current guideline (Ver.3)

The target area



- ① virtual image display outside the scope (OK)
- ② when a virtual image display all does not meet -> target
- ③ If a part of the virtual image display inside -> target

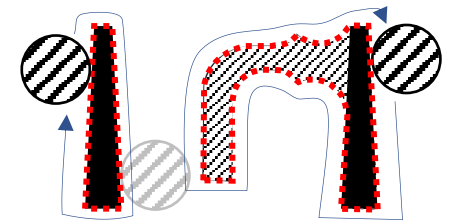
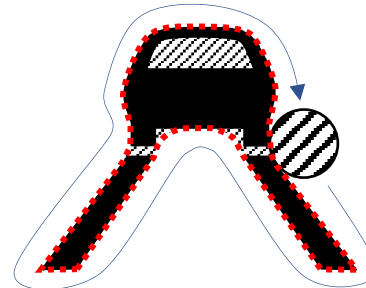
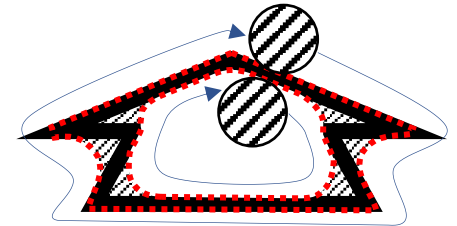
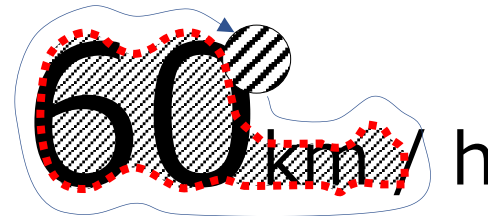
Image definition

Creation of the envelope of the display virtual image

The envelope defined by 0.85 ° diameter circle traced along the outline and inside of the virtual display image.



0.85 °Circle

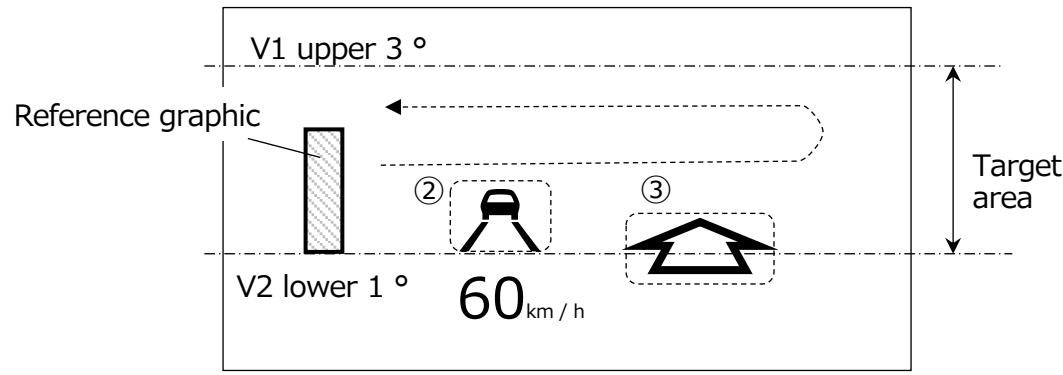


※If the gap between the virtual display image is bigger than 0.85 °, it defined as a separated image.

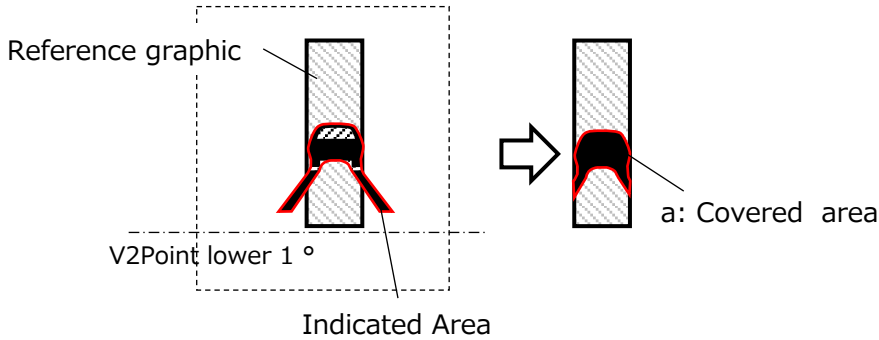
Current guideline (Ver.3)

Criteria

Calculate the ratio of the reference graphic covered by virtual display image.
(To check all the places with the reference graphic within a range of target area.)



In the case of ②

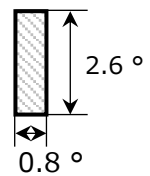


the ratio of the
reference graphic
covered by virtual
display image

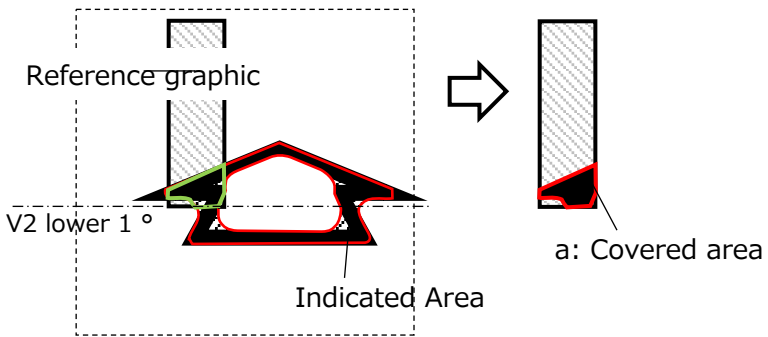
$$= \frac{a: \text{Covered area}}{b: \text{Reference graphic area}}$$

<0.35

Reference graphic



In the case of ③



Current guideline (Ver.3) – Study method

Even in display prohibited area of the previous guideline ($V1 + 3^\circ \sim V2 - 1^\circ$), requirements of forward field of view (awareness of pedestrian movements does not interfered) were examined for the requirements of the HUD display size.

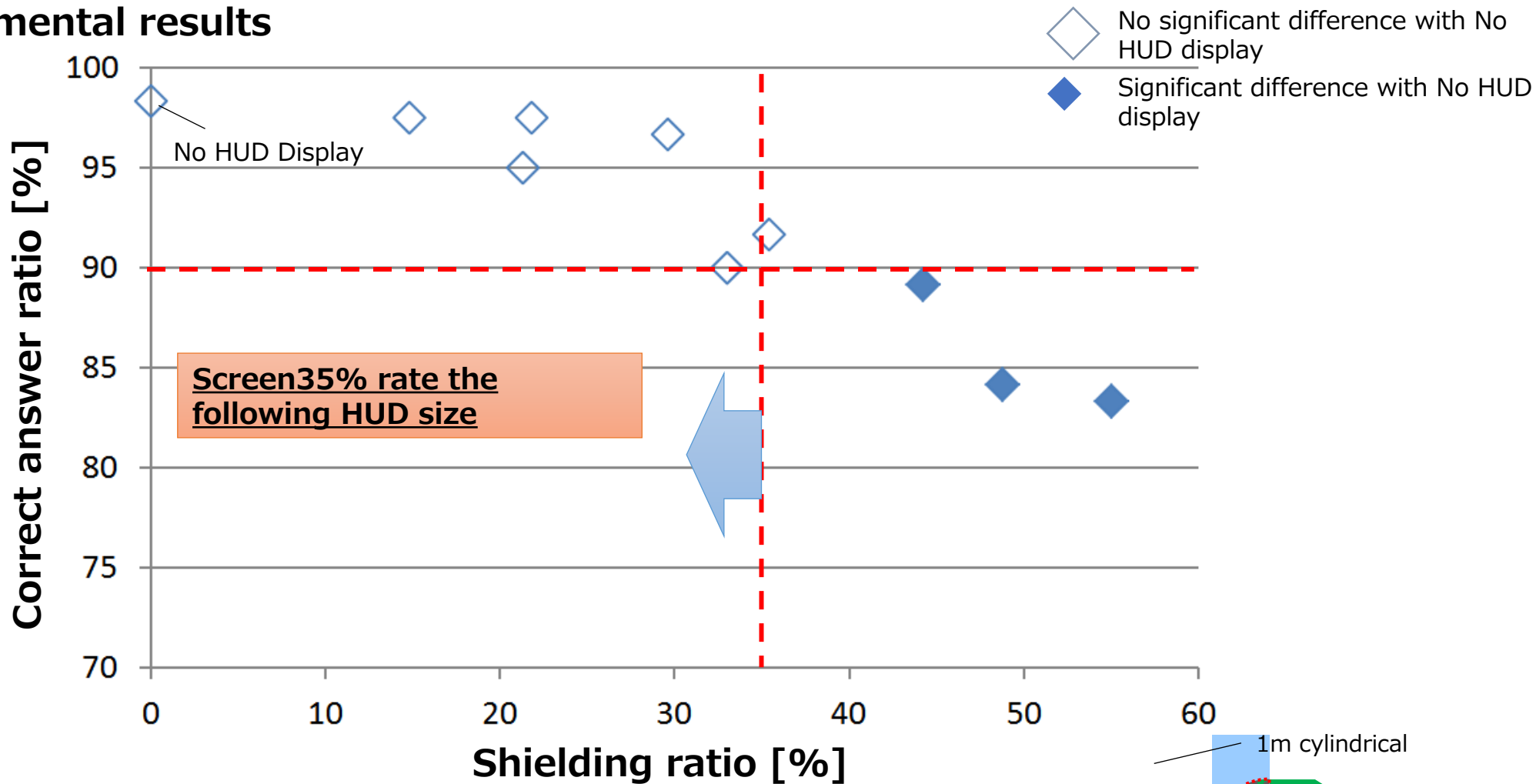


Correct answer ratio of pedestrian presence or absence, movements displayed in a commercially available HUD with actual vehicle with changing the display size and the display density of the HUD overlaid images.

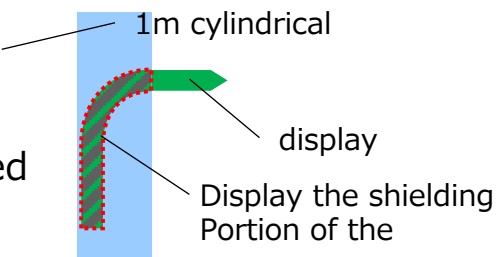


Current guideline (Ver.3) – Study method

Experimental results



Pedestrian to be seen the size of the HUD (1m × 0.3m Defined in the shielding rate of the cylinder)



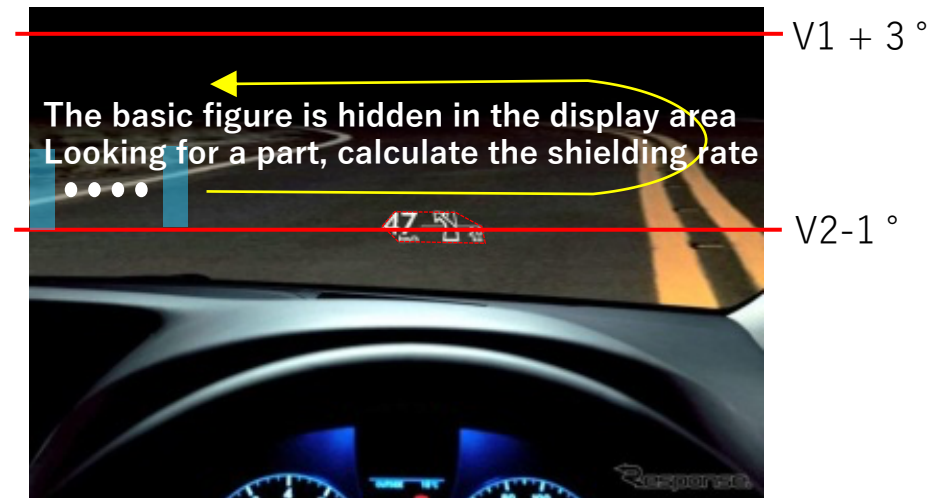
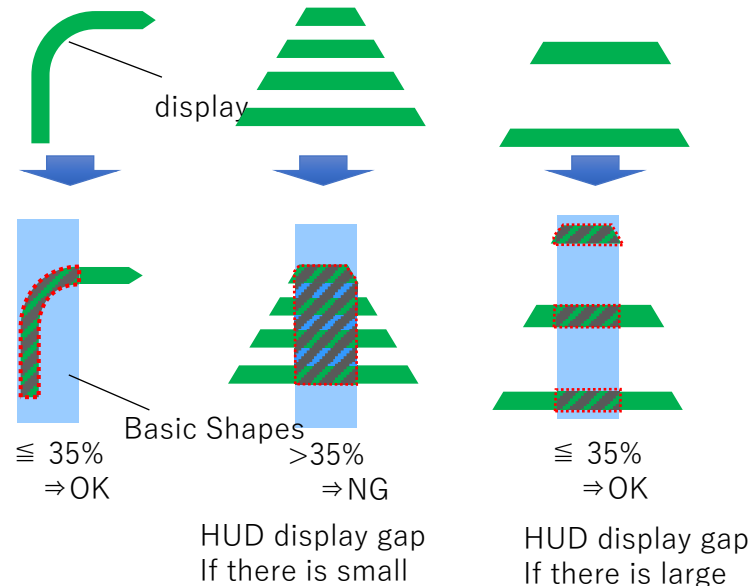
Current guideline (Ver.3) – Study method

Hidden by the HUD display of the pedestrian to be seen more than 35 percents is the less impact on the forward view.



If HUD display used for display prohibited area of previous guideline ($V1 + 3^\circ \sim V2 - 1^\circ$), Region which is surrounded by the HUD image of the envelope (Indicated Area) to be 35% or less to hide basic figure assumed pedestrian ($1\text{m} \times 0.3\text{m}$ cylinder).

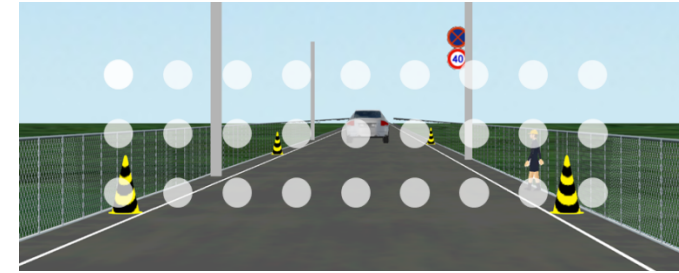
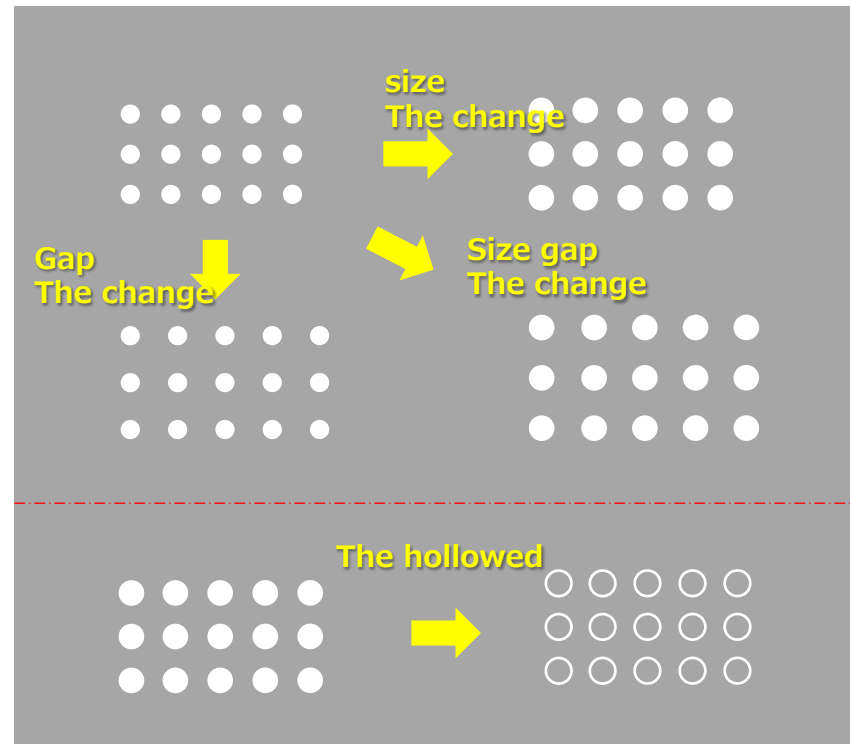
[Application Example]



Current guideline (Ver.3) – Study method

The concept of the envelope for defining a HUD display size

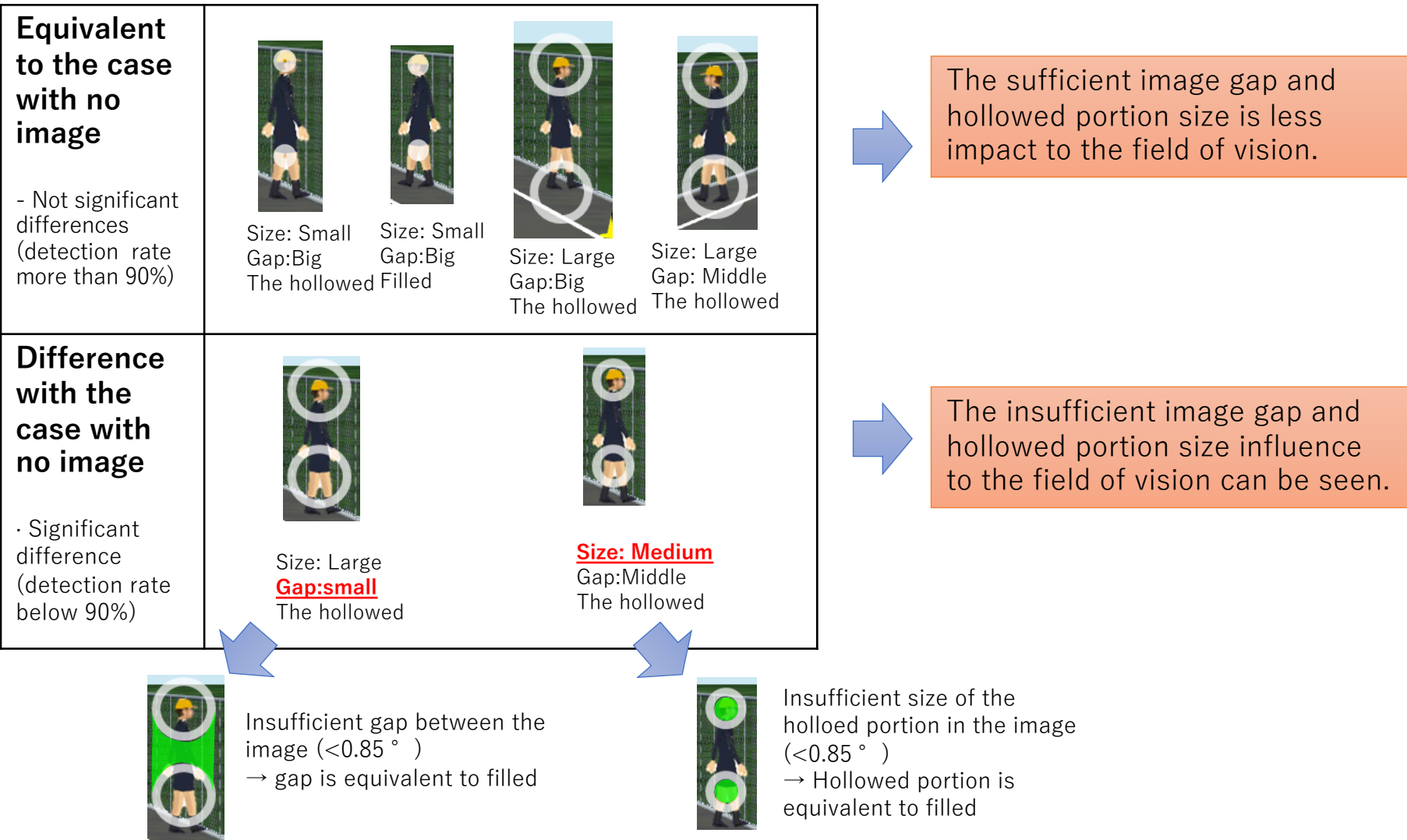
Using the same method as experiments, conditions the impact on forward view by the HUD image gaps and the free portion of the display under the conditions of **more than 35% shielding rate** were examined.



Tested image

Current guideline (Ver.3) – Study method

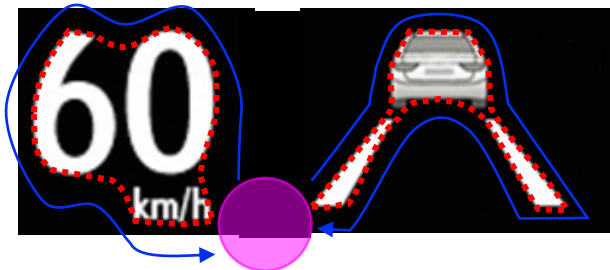
Experimental results



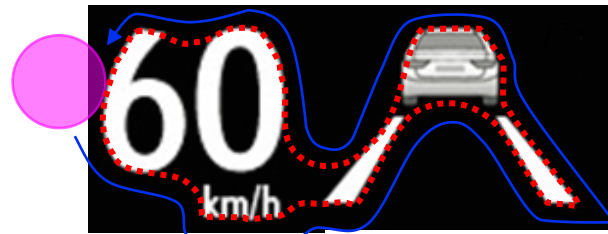
Current guideline (Ver.3) – Study method

Method for creating the envelope

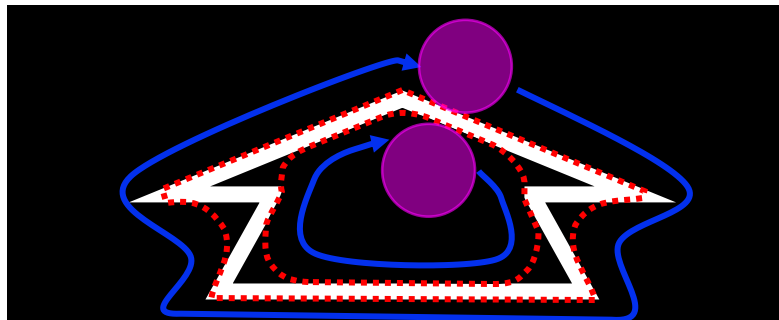
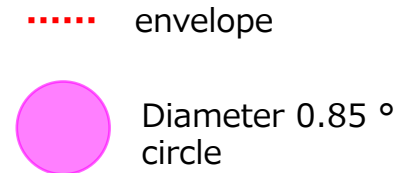
- Image envelope is defined by the trajectory of 0.85 ° diameter circle tracing around the the light emitting portion.
- It can be excluded from the image area that can include 0.85° diameter circle in the light-emitting.



Separation if passing through a circle between the display



Integrated if not pass through the circle between the display



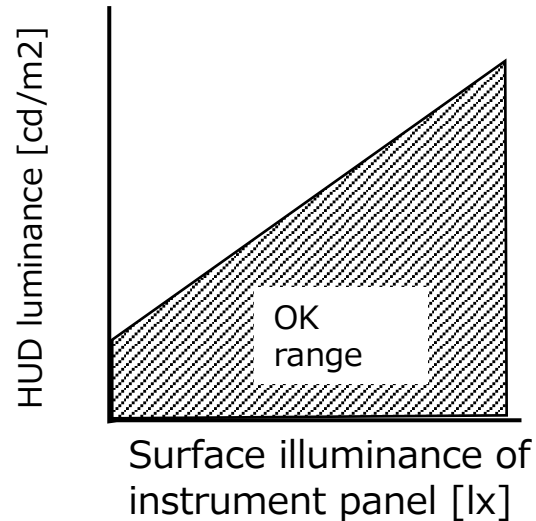
0.85 ° You can include a circle case excluded from the display area

Upcoming guideline (Ver.4) ***under study**

The concept

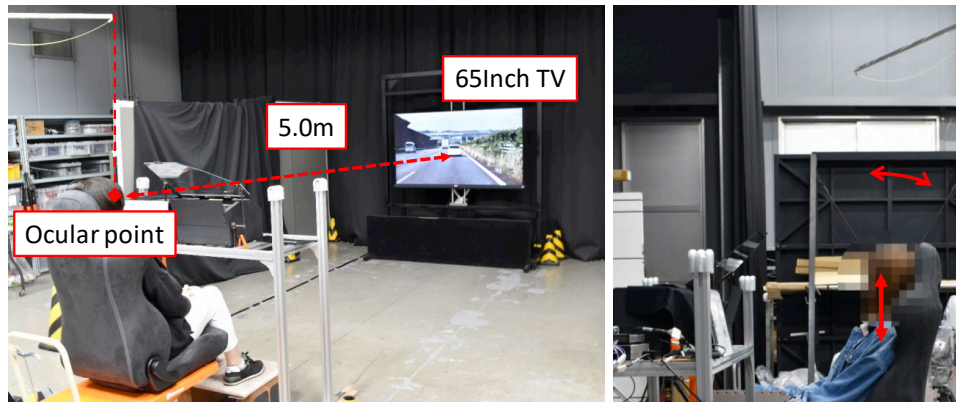
- Overlaid image transparency condition: considered as the contrast between HUD and background scenes.
- To determine the threshold of image luminance that can keep driver's awareness with overlaid image.

The idea of final figure



Upcoming guideline (Ver.4) – Study method

To check awareness of VRU or preceding vehicle using actual HUD unit and projected image.



Experiment setting



50m preceding car daytime and twilight



30m preceding motorcycle daytime and twilight

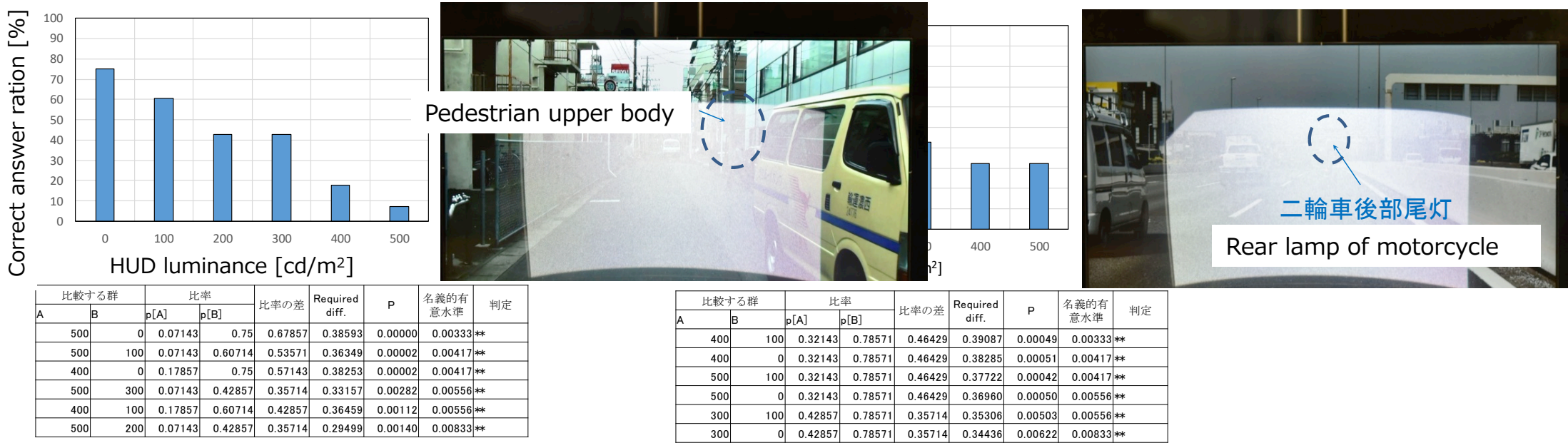


50m pedestrian crossing from left daytime and twilight

Examples of displayed images

Upcoming guideline (Ver.4) – Study method

To check awareness of VRU or preceding vehicle using actual HUD unit and projected image.



Test had done for various luminance of overlaid HUD image and determined threshold at significant statics difference of correct answer ratio.

Upcoming guideline (Ver.4) – Study status

Idea of definition for criteria

$$R_{luminance} = \frac{L_{object} + L_{HUD}}{L_{background} + L_{HUD}}$$

$$L_{HUD} = \frac{L_{object} - R_{luminance} * L_{background}}{R_{luminance} - 1}$$

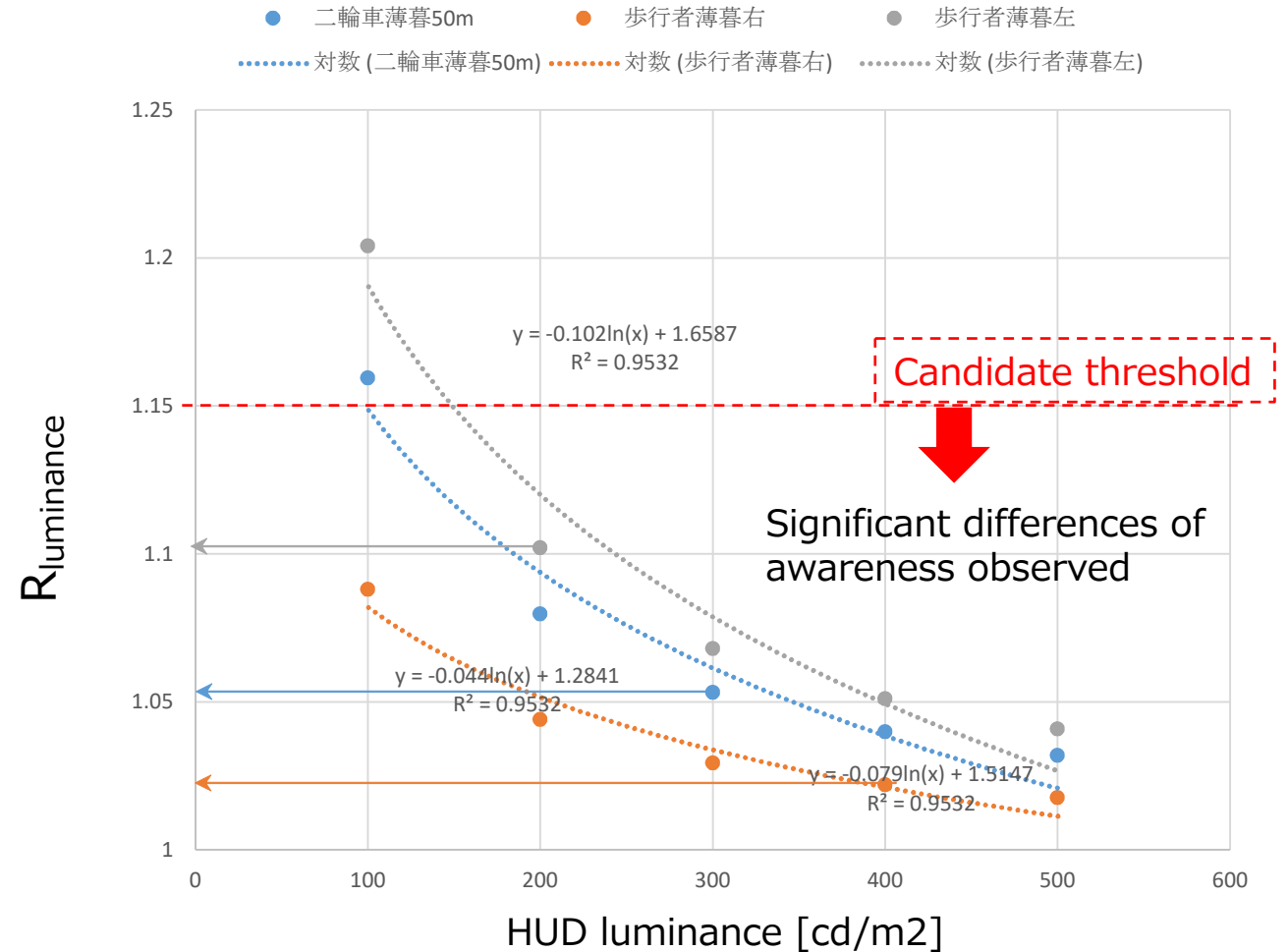


In the case $L_{object} + L_{HUD} > L_{road} + L_{HUD}$

$$L_{ratio} = \frac{L_{object} + L_{HUD}}{L_{road} + L_{HUD}}$$

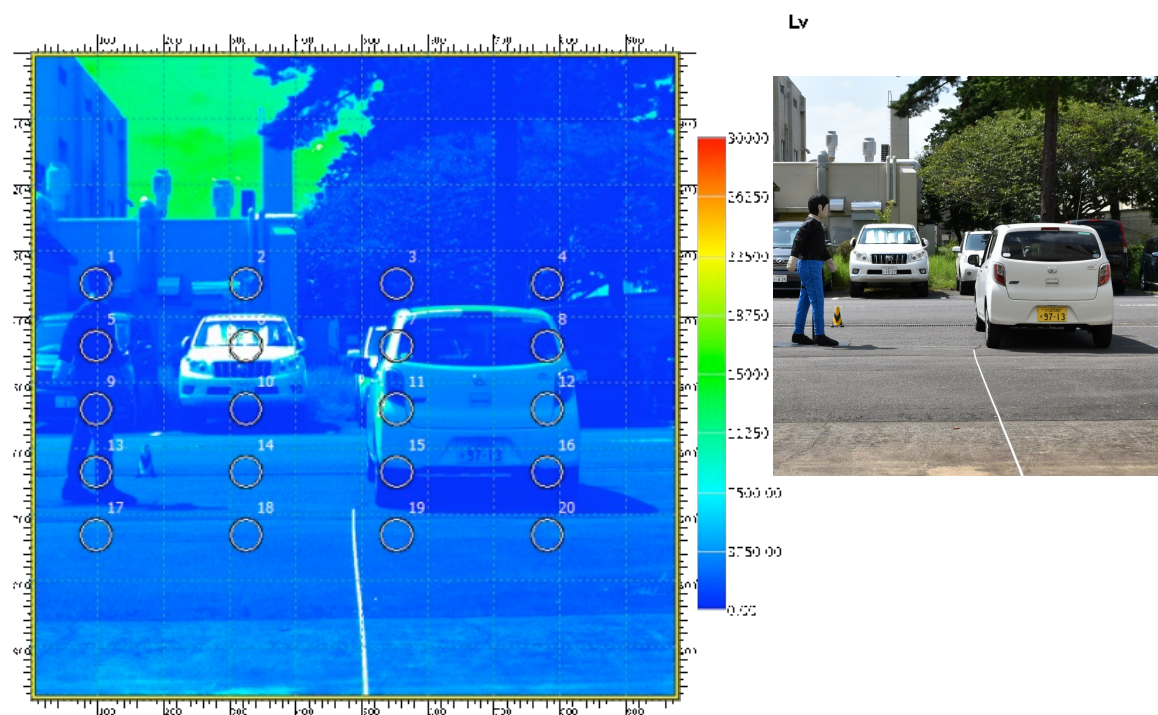
In the case $L_{object} + L_{HUD} < L_{road} + L_{HUD}$

$$L_{ratio} = \frac{L_{road} + L_{HUD}}{L_{object} + L_{HUD}}$$



Upcoming guideline (Ver.4) – Study method

On going study – determination of typical road luminance of various environment conditions (sunlight, time, road surface, object colors)



Spot	Lv (cd/m ²)	Spot	Lv (cd/m ²)
1	885.79	11	2912.76
2	1556.52	12	2981.1
3	264.32	13	1869.99
4	482.49	14	3678.65
5	354.29	15	1205.78
6	2376.12	16	1105.84
7	2281.79	17	1183.22
8	887.69	18	2955.46
9	575.84	19	2032.46
10	684.86	20	548.6

Under study since 2019, to be finalized in Mar. 2021 (Draft will be expected in Dec. 2020)