



Concept of JAMA HUD Guideline

GRSG TF-FVA 09
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JAMA delegate of GRSG Driver Vision related items
Akinari Hirao, Ph. D. (akinari.hirao@aist.go.jp)

*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+3deg ~ V2-1deg (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.**

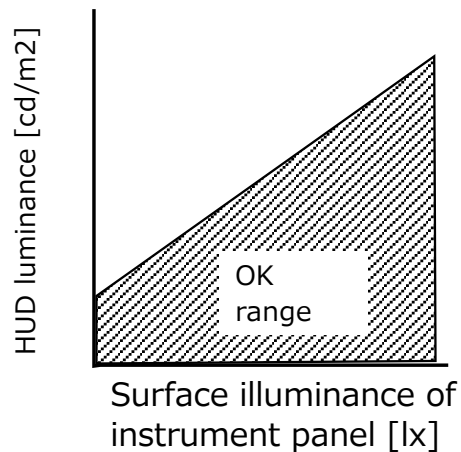
We propose to use both guidelines choice with the kind of overlaid images.

Upcoming guideline (Ver.4) *under study

The concept

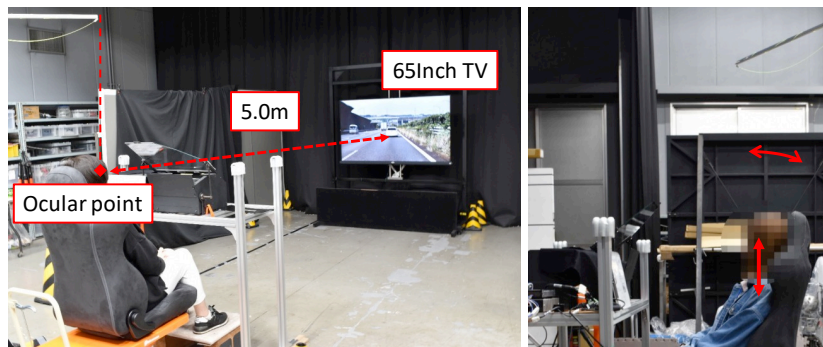
- Overlaid image transparency condition: considered as the contrast between HUD and background scenes.
- To determine the threshold of image luminance that can keep driver's awareness with overlaid image.

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

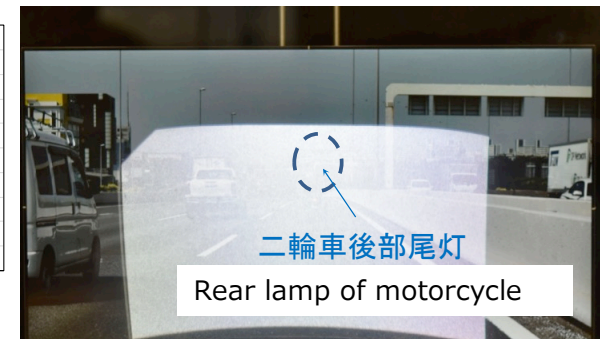
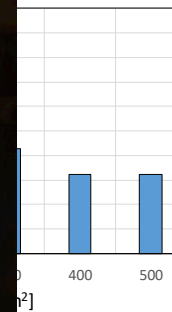
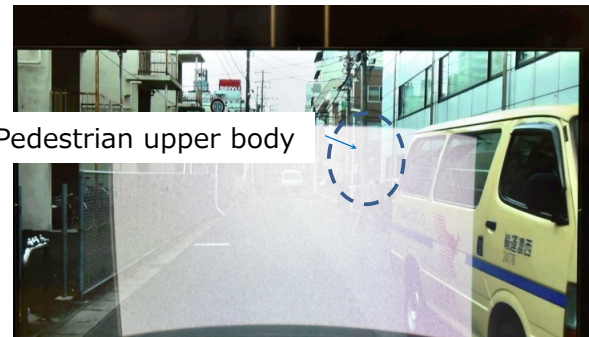
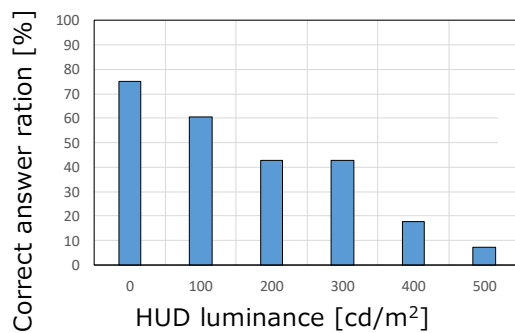


50m pedestrian crossing from left daytime and twilight

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.



比較する群		比率		比率の差	Required diff.	P	名義的有意水準	判定
A	B	p[A]	p[B]					
500	0	0.07143	0.75	0.67857	0.38593	0.00000	0.00333**	
500	100	0.07143	0.60714	0.53571	0.36349	0.00002	0.00417**	
400	0	0.17857	0.75	0.57143	0.38253	0.00002	0.00417**	
500	300	0.07143	0.42857	0.35714	0.33157	0.00282	0.00556**	
400	100	0.17857	0.60714	0.42857	0.36459	0.00112	0.00556**	
500	200	0.07143	0.42857	0.35714	0.29499	0.00140	0.00833**	

比較する群		比率		比率の差	Required diff.	P	名義的有意水準	判定
A	B	p[A]	p[B]					
400	100	0.32143	0.78571	0.46429	0.39087	0.00049	0.00333**	
400	0	0.32143	0.78571	0.46429	0.38285	0.00051	0.00417**	
500	100	0.32143	0.78571	0.46429	0.37722	0.00042	0.00417**	
500	0	0.32143	0.78571	0.46429	0.36960	0.00050	0.00556**	
300	100	0.42857	0.78571	0.35714	0.35306	0.00503	0.00556**	
300	0	0.42857	0.78571	0.35714	0.34436	0.00622	0.00833**	

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

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

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



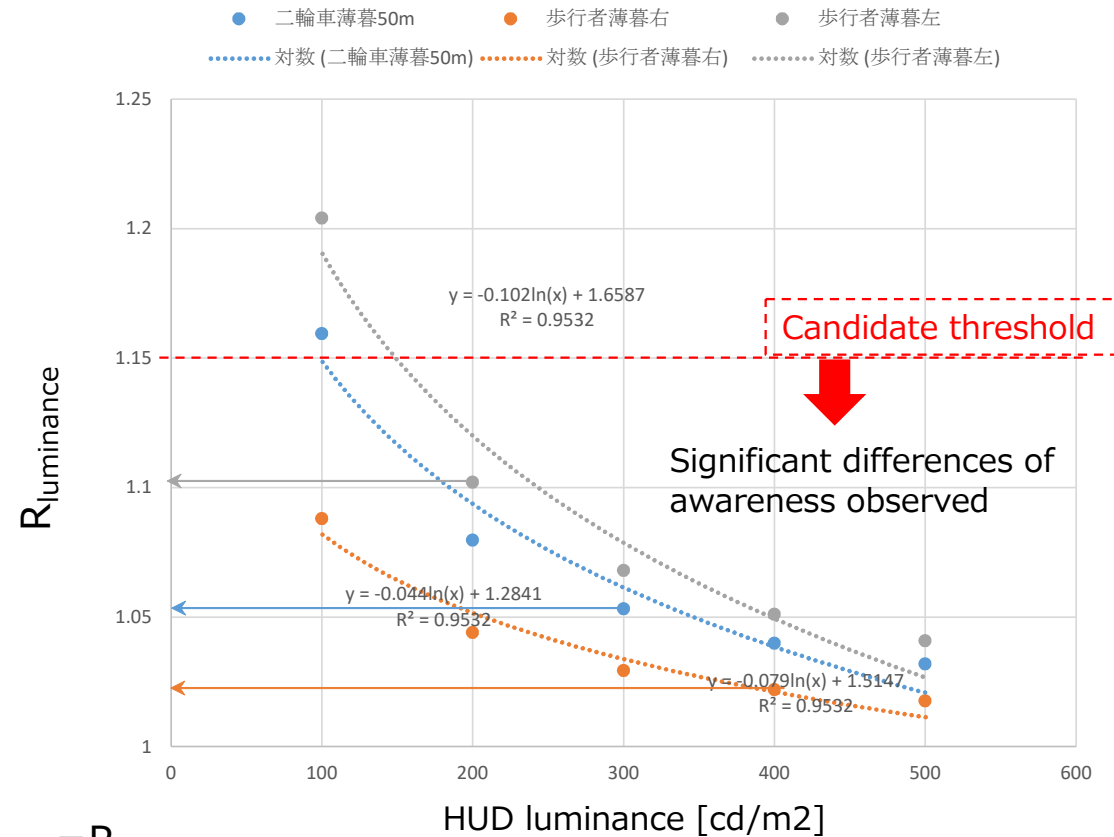
In the case $L_{object} + L_{HUD} > L_{road} + L_{HUD}$

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

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

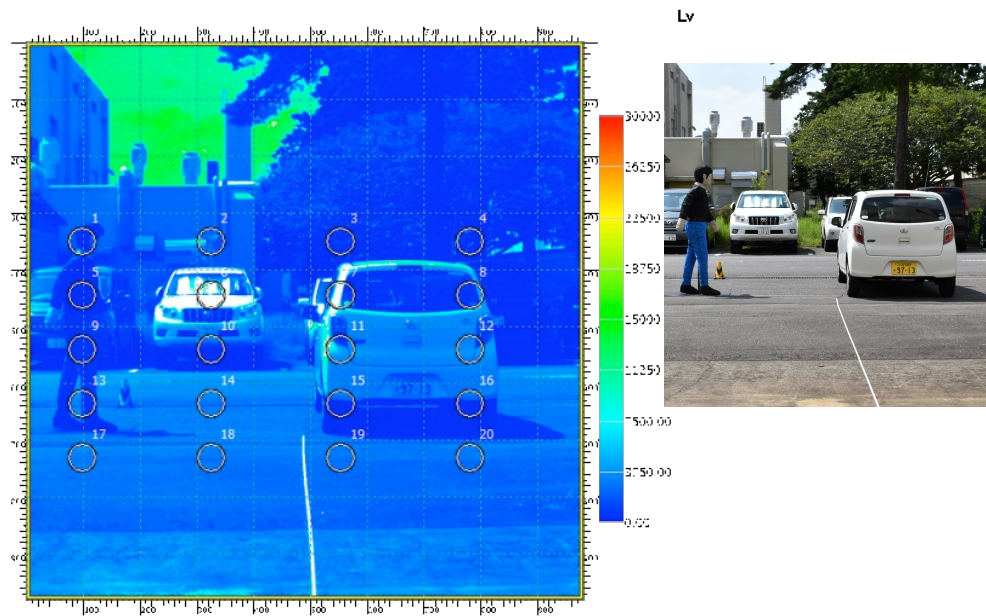
$$L_{ratio} = \frac{L_{road} + L_{HUD}}{L_{object} + L_{HUD}}$$

$$*L_{ratio} = R_{luminance}$$



Upcoming guideline (Ver.4) – Study method

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



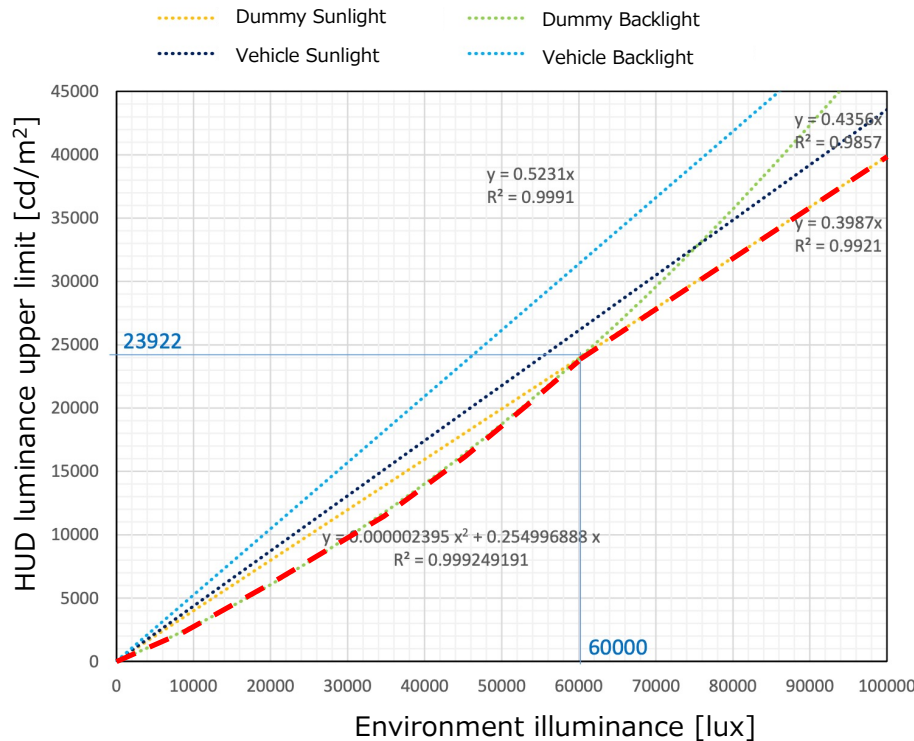
Spot	Lv (cd/m ²)	Spot	Lv (cd/m ²)
1	885.79	11	2912.76
2	1556.52	12	2981.1
3	264.32	13	1869.99
4	482.49	14	3678.65
5	354.29	15	1205.78
6	2376.12	16	1105.84
7	2281.79	17	1183.22
8	887.69	18	2955.46
9	575.84	19	2032.46
10	684.86	20	548.6

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

Latest information of JAMA study (updated)

Measurements under various environment conditions finished.
Temporary idea of HUD luminance upper limit was calculated.

**Tentative results
(Not proposal)**



<-These cases are extracted as worst conditions from many cases.

Candidate of threshold is lower case of many cases.

x: Environment illuminance [lux]

y: HUD luminance upper limit [cd/m²]

If $0 < x < 60000$

$$L_{HUD_Limit} = 2.395 \times 10^{-6}x^2 + 0.255x$$

If $x \geq 60000$

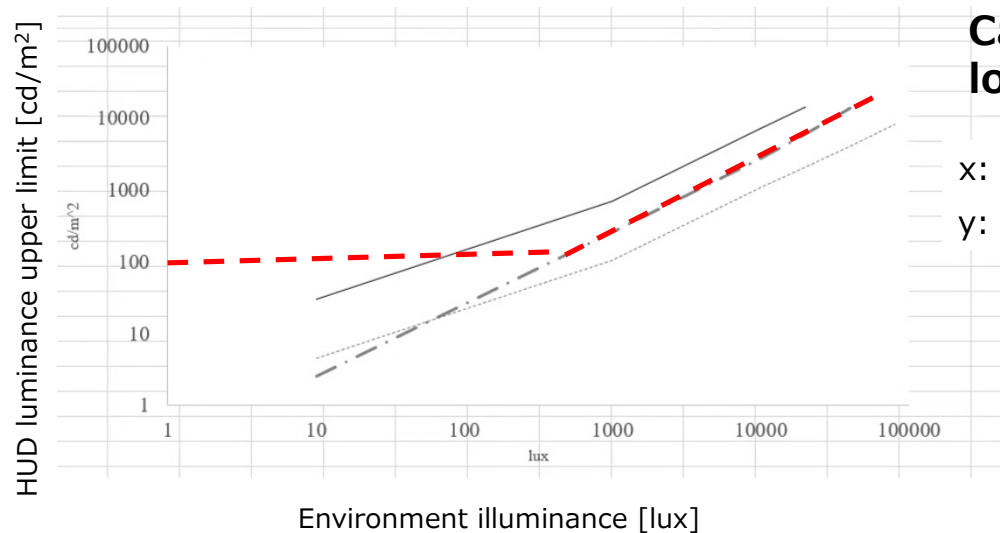
$$L_{HUD_Limit} = 0.3987x$$

Updated since last report (Dec. 2020)

Latest information of JAMA study (updated)

HUD luminance upper limit below 10000 lux environment is still under discussion.

**Tentative results
(Not proposal)**



Candidate of threshold is lower case of many cases.

x: Environment illuminance [lux]

y: HUD luminance upper limit [cd/m²]

If $0 < x < 500$

$L_{\text{HUD_Limit}} = 100$ **Added.**

If $500 \leq x < 60000$

$L_{\text{HUD_Limit}} = 2.395 \times 10^{-6} x^2 + 0.255x$

If $60000 \leq x$

$L_{\text{HUD_Limit}} = 0.3987x$

Also, environment luminance is defined at vehicle roof.

Most of vehicle luminance sensor is located on instrument panel.

Therefore, luminance differences between vehicle roof and interior instrument panel are under study.