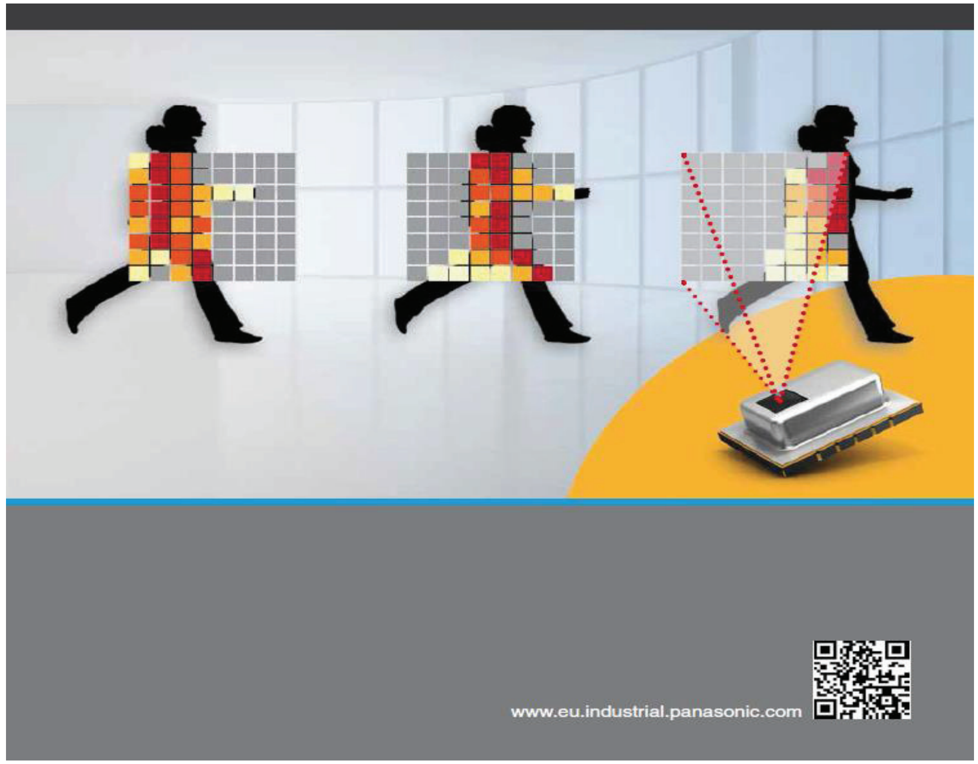
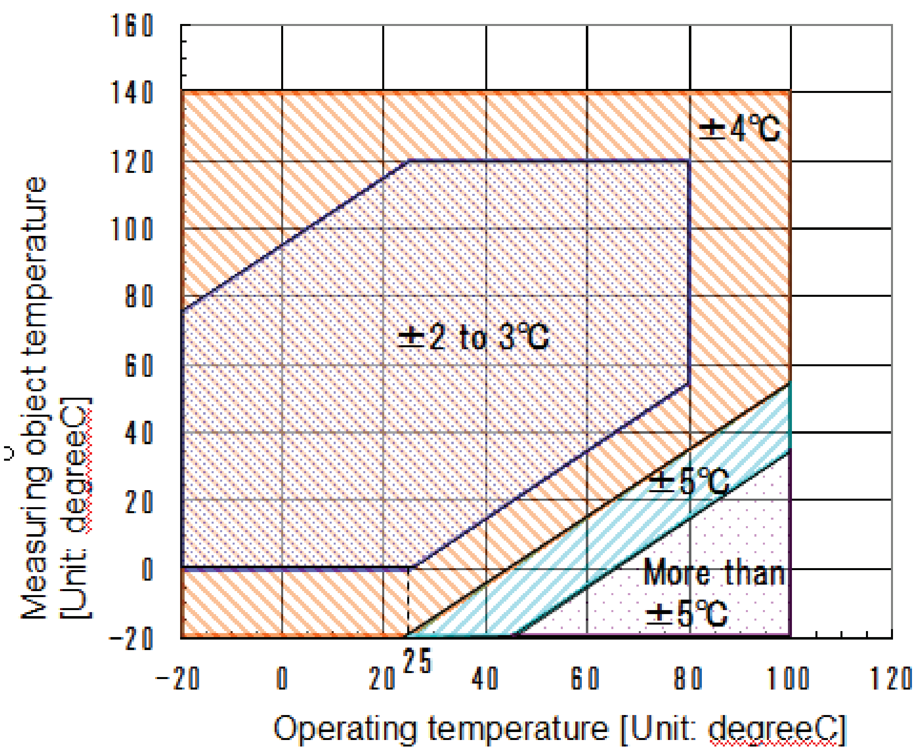
Panasonic



Grid-Eye Characteristics

Panasonic Automotive & Industrial Systems Europe

Typical measurement accuracy vs. ambient temperature & temperature of measurement object

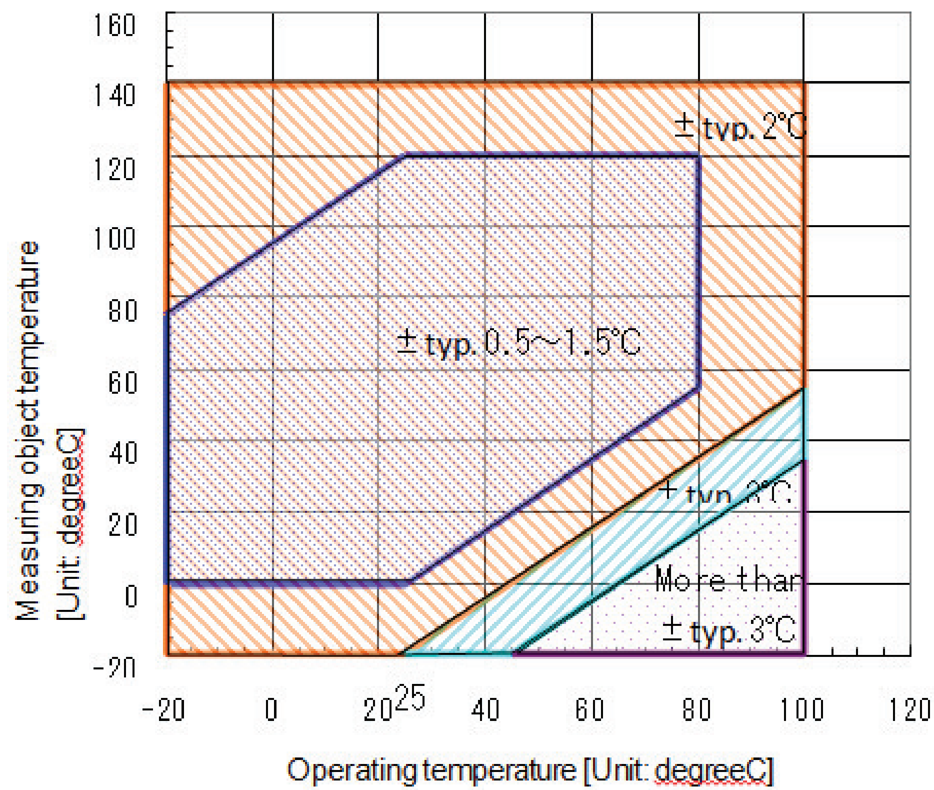


Condition:
frame rate: 1fps
moving average: Yes

Characteristics after Calibration of the Pixels

Typical measurement accuracy vs. ambient temperature & temperature of measurement object after calibration of the pixels.

The calibration just can be done by customer.
If customer adjust each pixel's output within the software the accuracy between the pixels can be increased like shown in the diagram.



Condition:
frame rate: 1fps
moving average: Yes

Example:
All pixes does see a heat source of 35.0 ° C.
Customer an adjust the output to become 35.0 ° C for all pixels.

Before)
Pixel 1 ; 34.5 ° C
Pixel 2 ; 35.25 ° C
Pixel 3 ; 36.75 ° C...

Adjustment by software)
Pixel 1 ; +0.5 ° C
Pixel 2 ; -0.25 ° C
Pixel 3 ; -1.75 ° C ...

After)
Pixel 1 ; 35.0 ° C
Pixel 2 ; 35.0 ° C
Pixel 3 ; 35.0 ° C

Measurement of a high temperature object

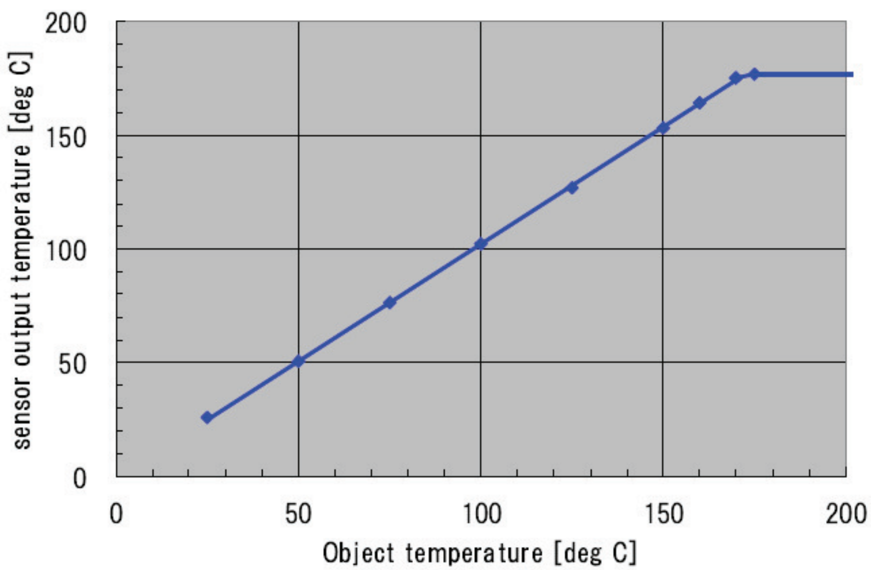
Standard type Grid-EYE (AMG8852, low gain type) saturates when object temperature exceeds 170 degreeC.

By lowering gain amplification in IC, Grid-EYE (custom type) can detect the object which is higher than 200degreeC.

When gain amplification is set up low, a noise increases relatively, and the accuracy gets worse.

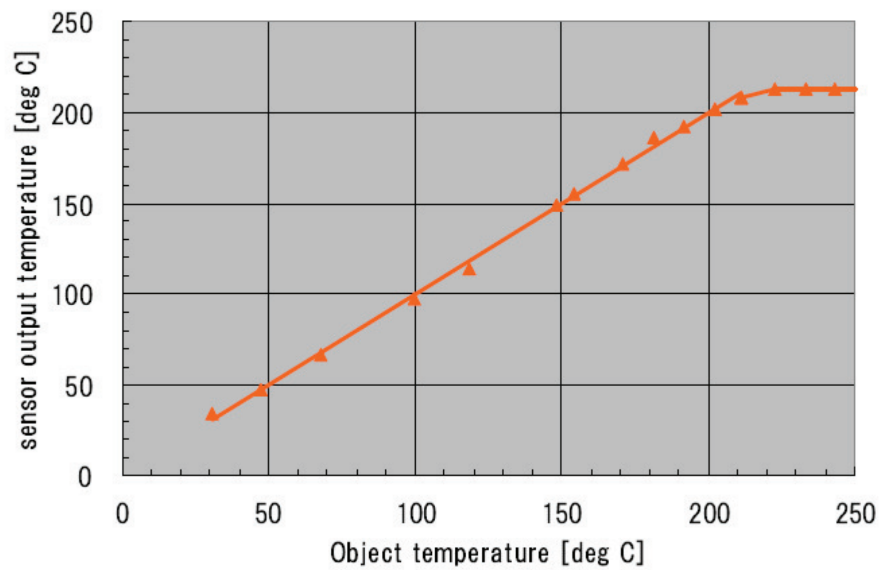
The accuracy and object temperature range expansion have a relation of trade-off.

Grid-EYE (AMG8852, standard type)



*Ambient temperature is 25 degC

Grid-EYE (custom type)



*Ambient temperature is 25 degC

Moving Average Register

Average Register

Register for setting moving average Output Mode.

bit5: MAMOD

1: Twice moving average Output Mode

address	register	R/W	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Initial value
0x07	AVE	R/W	-	-	MAMOD	-	-	-	-	-	0x00

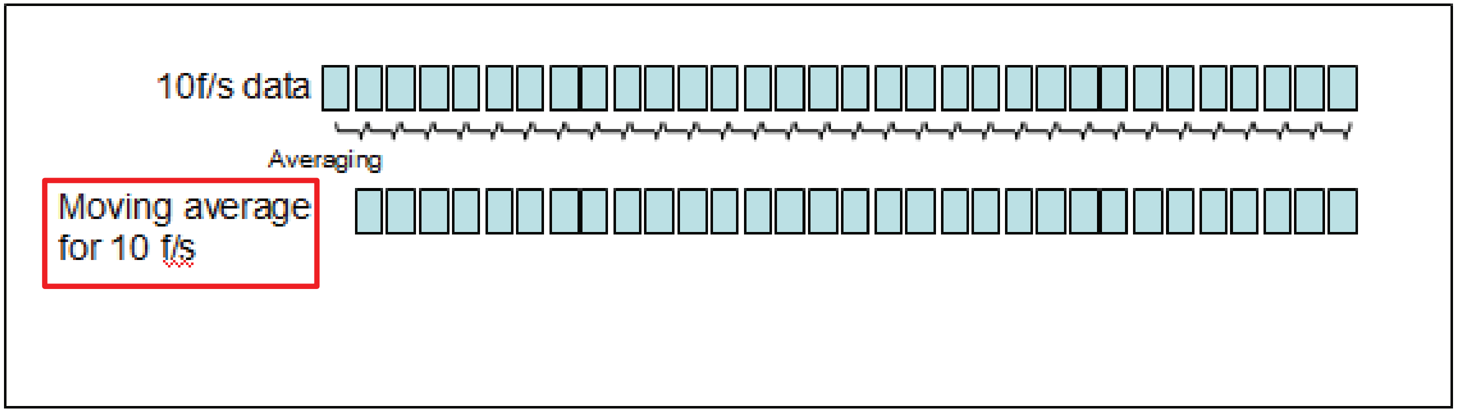
Noise will decrease to 1/sqrt2 by using moving average function.

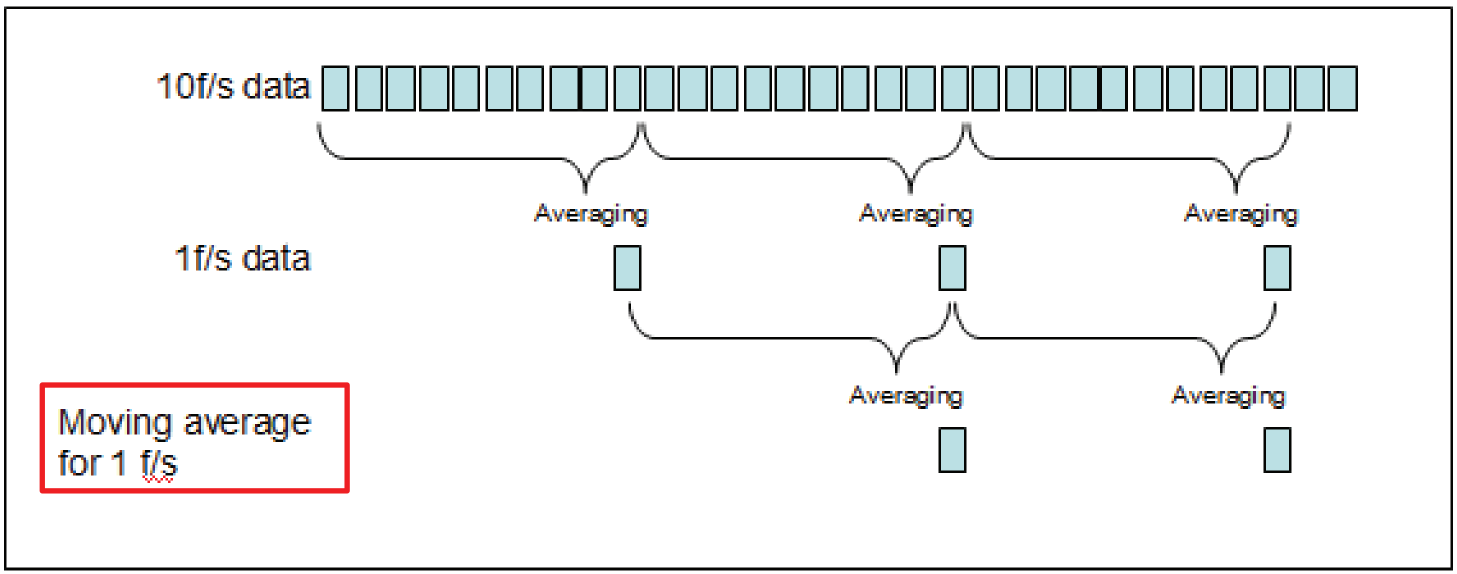
$$V_o(t) = \{V_{out}(t) + V_{out}(t-1)\}/2$$

$V_{out}(t)$: *output data*

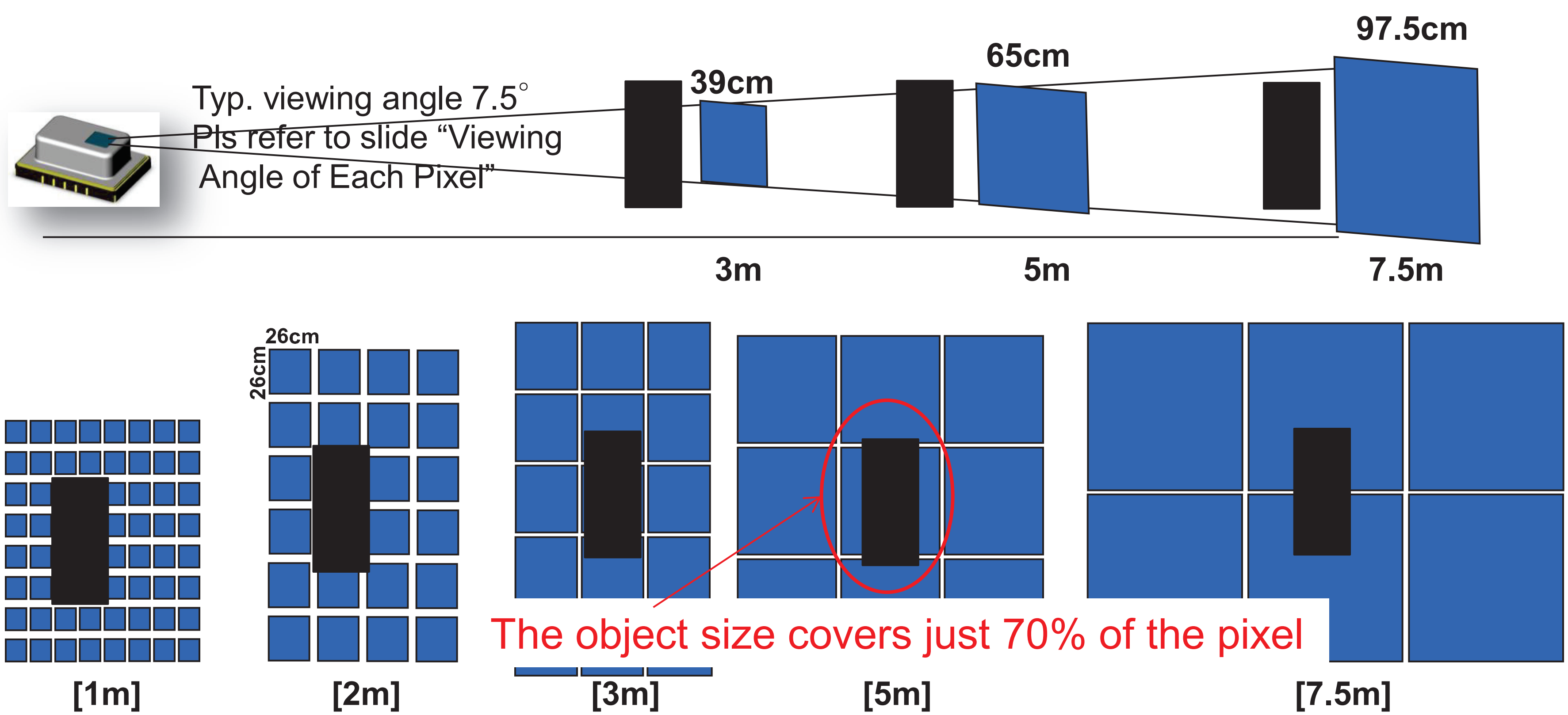
$V_o(t-1)$: *moving average data*

How Moving Average Works



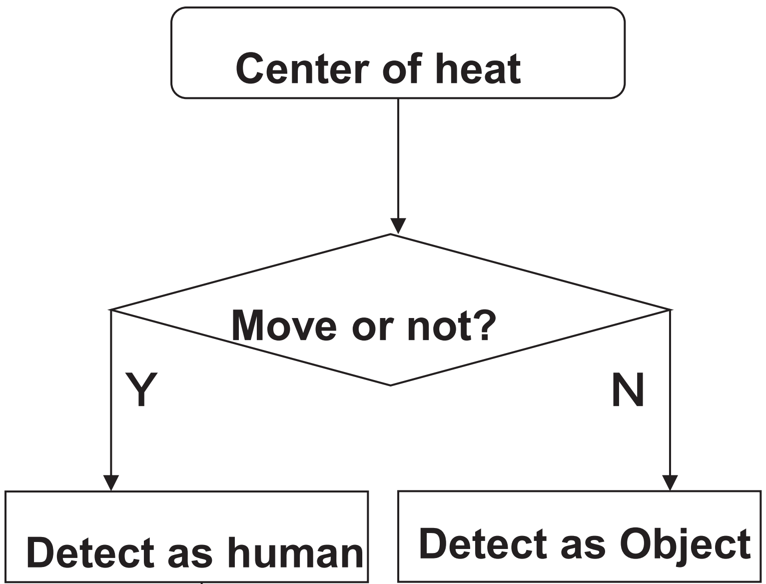


Example pixel size vs. distance vs. object size

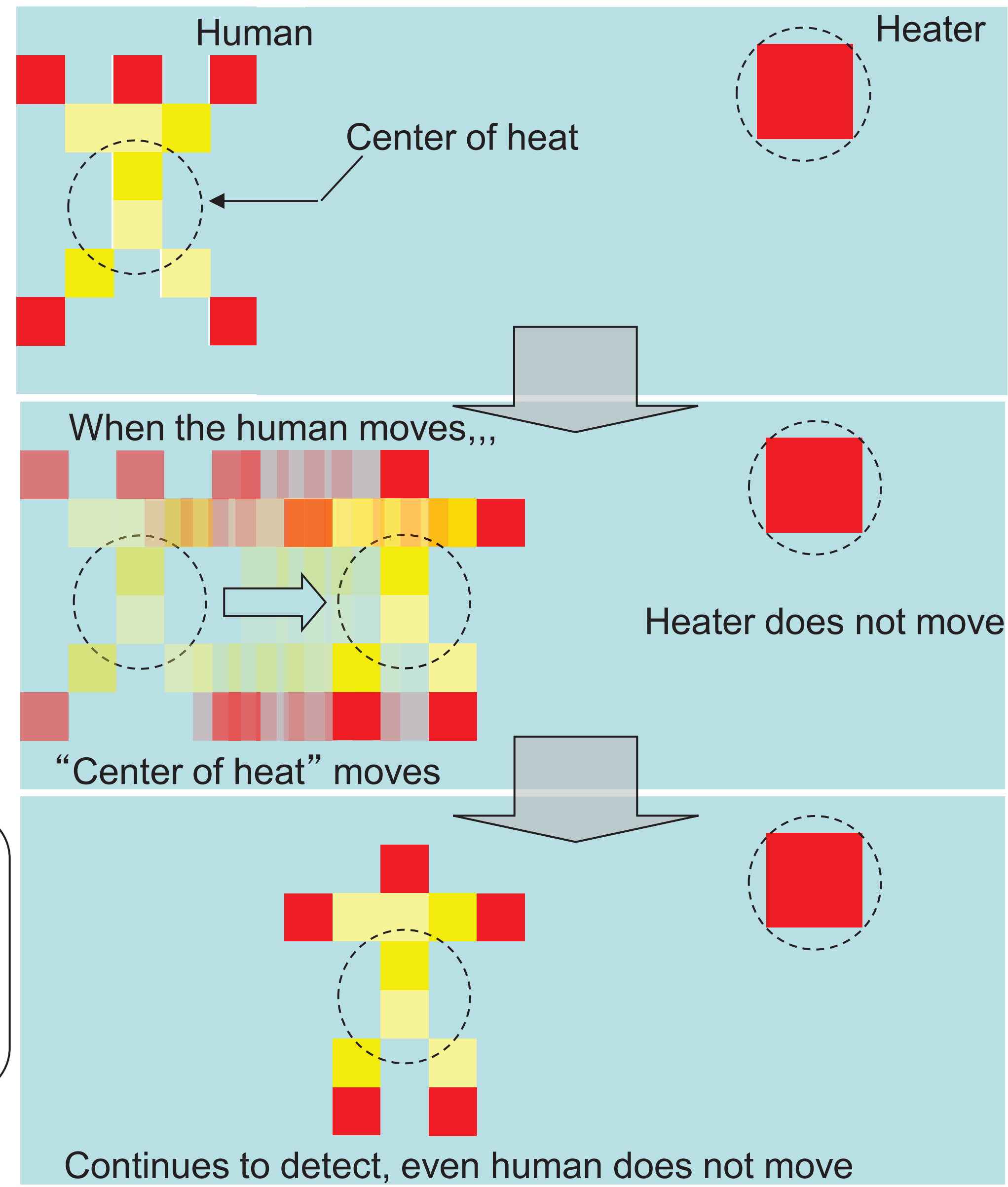


Ambient temperature	= 25°C
Temperature of measurement object	= 34°C
ΔT	= 9°C
ΔT * 70% (@5m)	= 6,3°C
→ Measured value	= 25°C + 6,3°C = 31,3°C

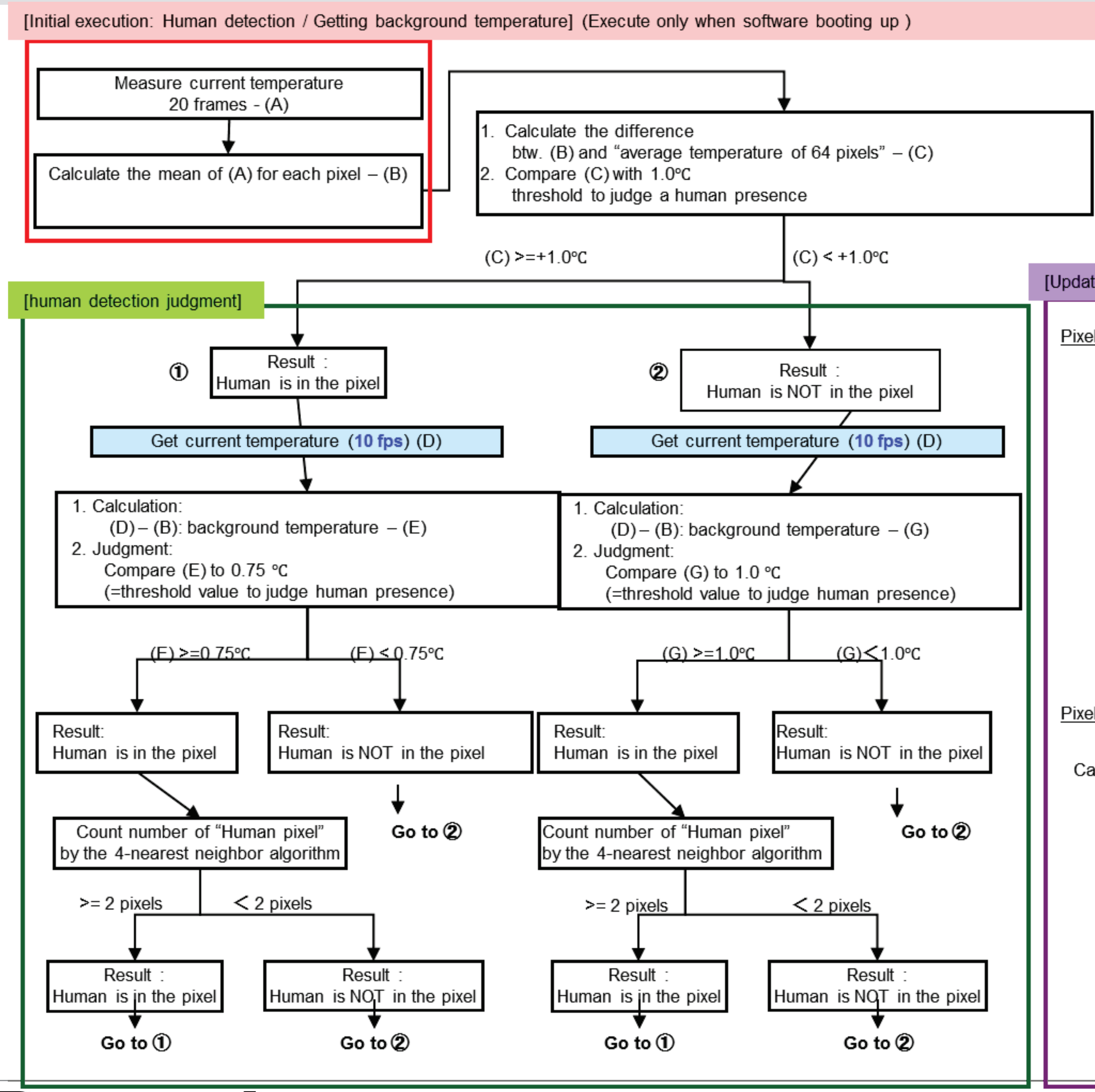
Thermal Human Detection



Once it detects as Human,
Even when he stops, it continues
to detect as human
⇒Unmovable Detection possible



Flowchart Human Detection with Background Subtraction



Execute these process for each pixel

Settings

-Frame rate: **10 fps**
-Calculate mode: ON

[Update background data] (execute at every frame)

Pixel which is judged as "non-human pixel"

Use "current temperature value: (X)" for updating background data

↓

Updating background data using data (X) by 1/128 %

Calculation Process

Previous background data * 127/128
+
(X) * 1/128

= new background data

Pixel which is judged as "human pixel"

Calculate "average temperature value of all non-human pixels" (Y), and use it for updating background data

↓

Updating background data using data (Y) by 1/128 %

Calculation Process

Previous background data * 127/128
+
(Y) * 1/128

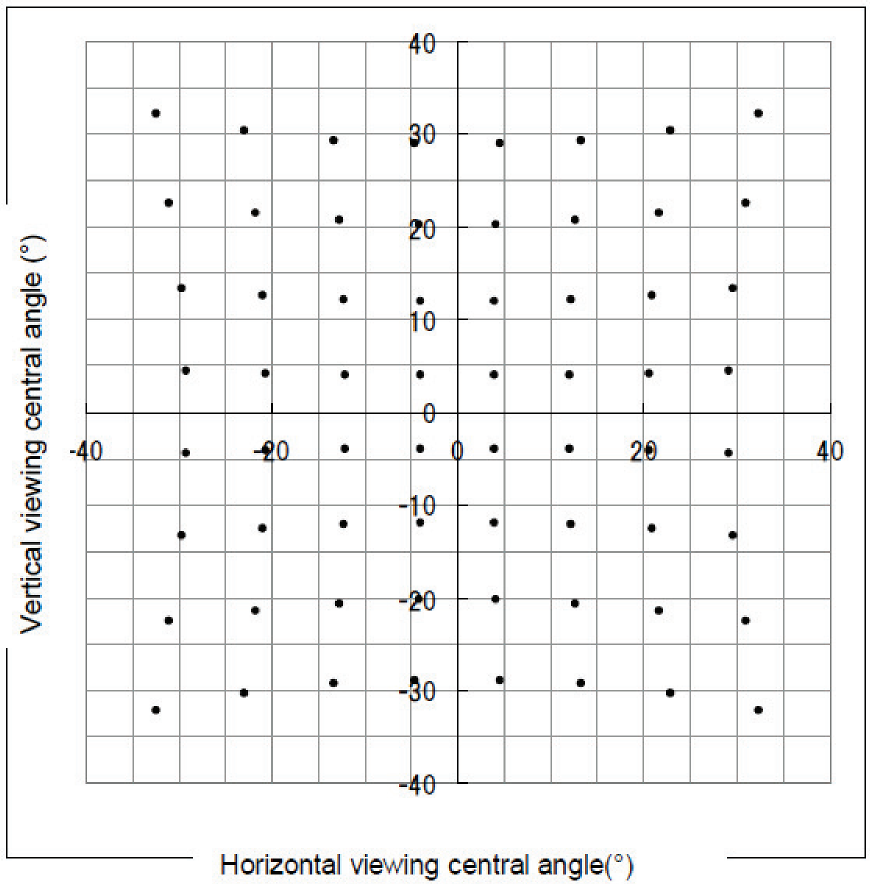
= new background data

(3) Typical characteristics : Each pixel's viewing central angle

*Regarding of Pixel Array, please refer to 4-7(1).

Sensor's optical center (the origin of graph below) gap

: within Typ. ±5.6° (Both of horizontal and vertical directions)

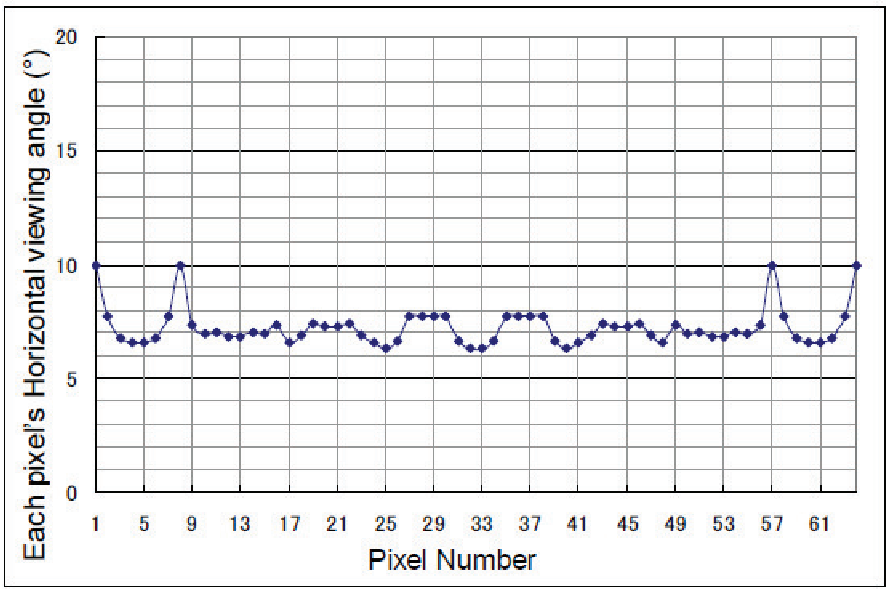


(4) Typical characteristics : Each pixel's viewing angle (half angle)

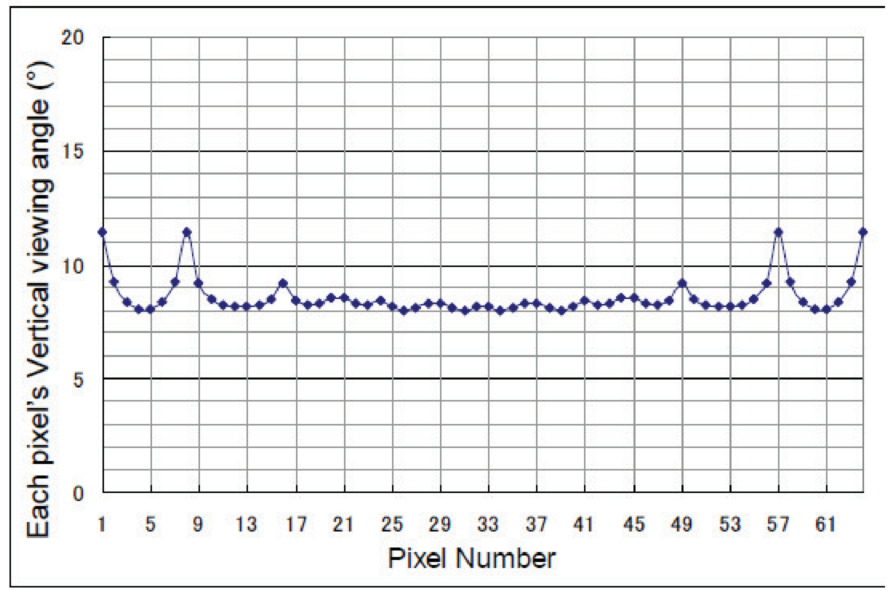
Central 4 pixels (Pixel No. 28, 29, 36, 37) viewing angle (half angle) :

horizontal direction Typ. 7.7°

vertical direction Typ. 8°



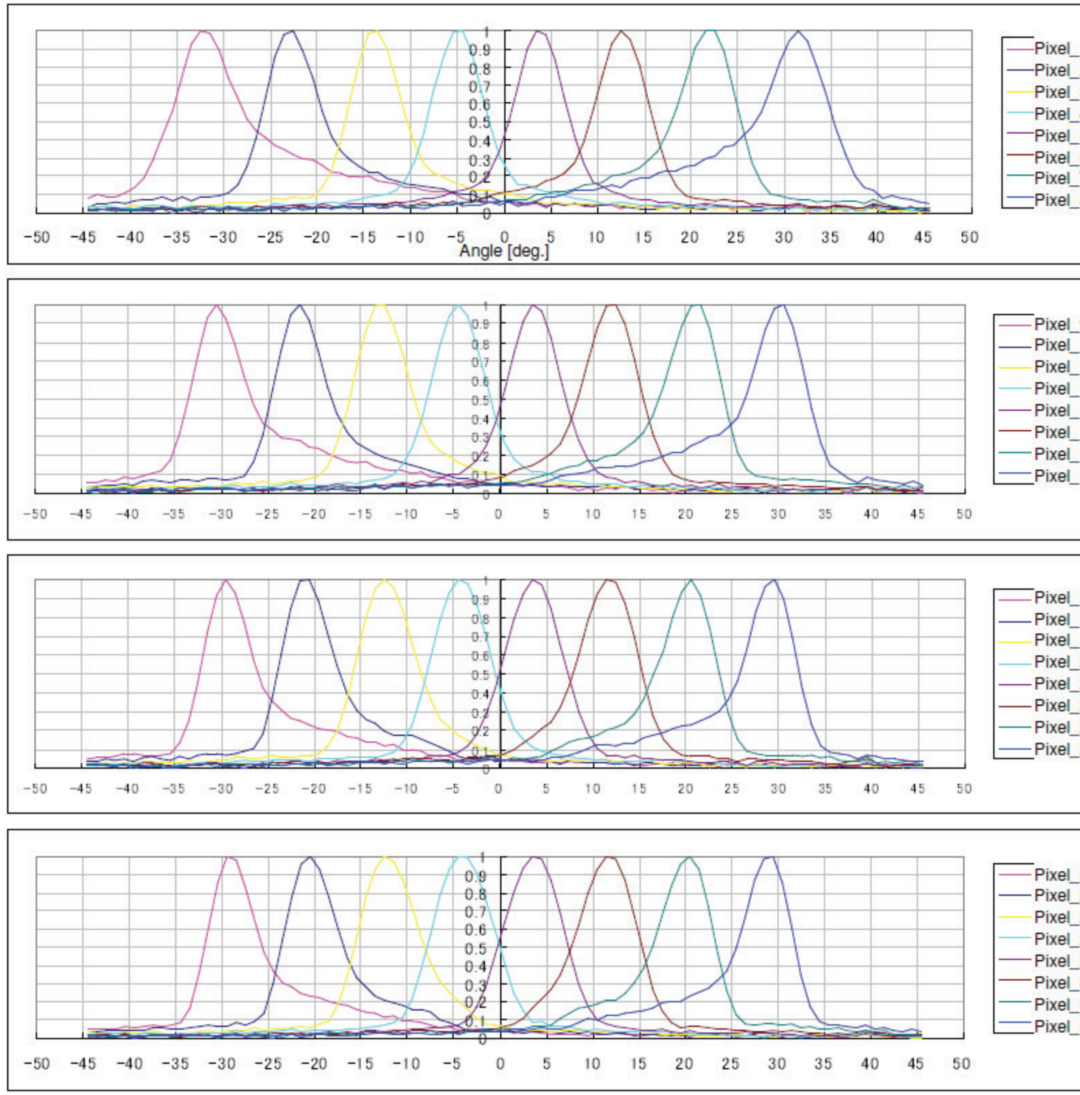
Each pixel' s Horizontal viewing angle



Each pixel' s vertical viewing angle

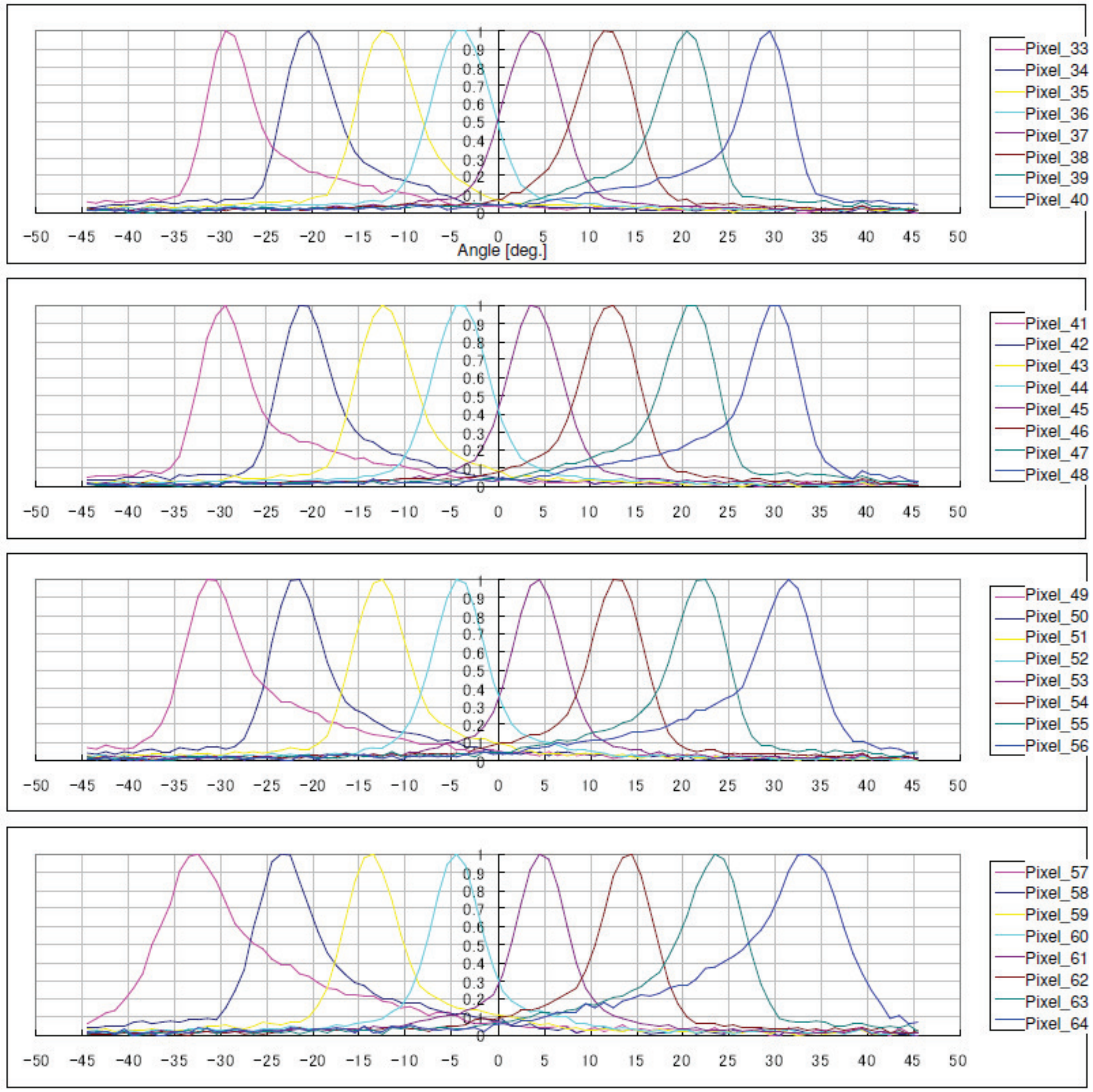
Detailed viewing angle data „Horizontal“

64	63	62	61	60	59	58	57
56	55	54	53	52	51	50	49
48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33
32	31	30	29	28	27	26	25
24	23	22	21	20	19	18	17
16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

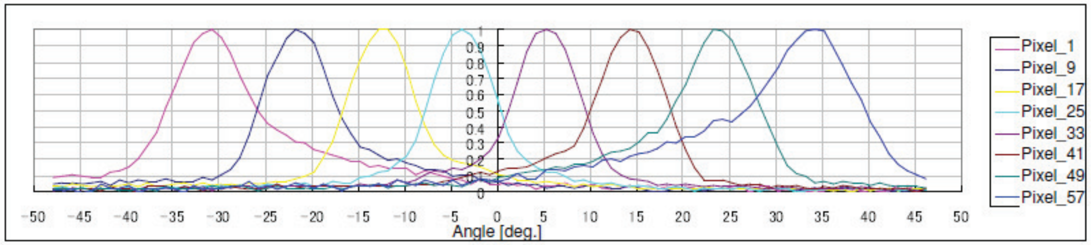


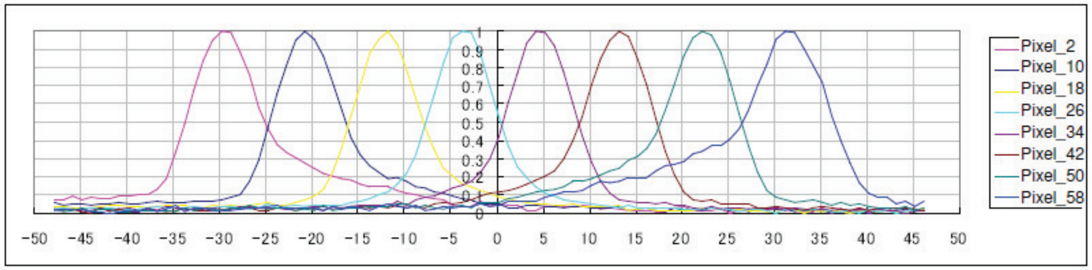
Detailed viewing angle data „Horizontal“

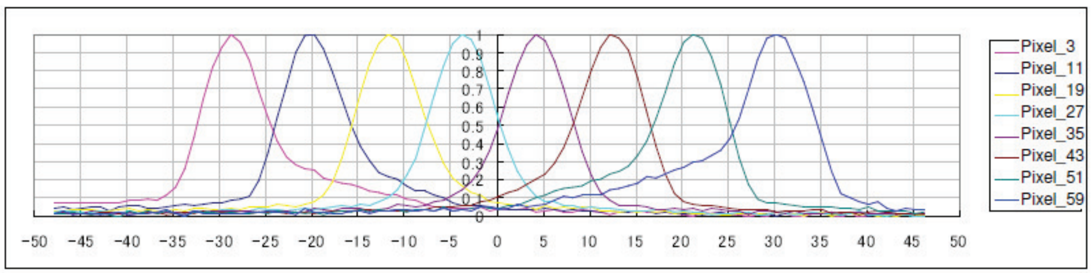
64	63	62	61	60	59	58	57
56	55	54	53	52	51	50	49
48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33
32	31	30	29	28	27	26	25
24	23	22	21	20	19	18	17
16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1

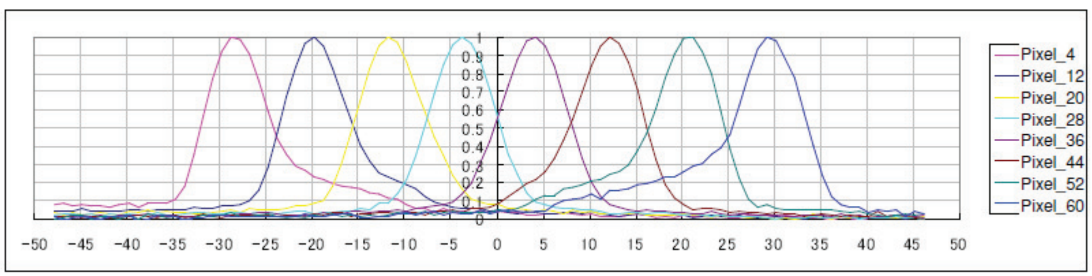


64	63	62	61	60	59	58	57
56	55	54	53	52	51	50	49
48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33
32	31	30	29	28	27	26	25
24	23	22	21	20	19	18	17
16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1



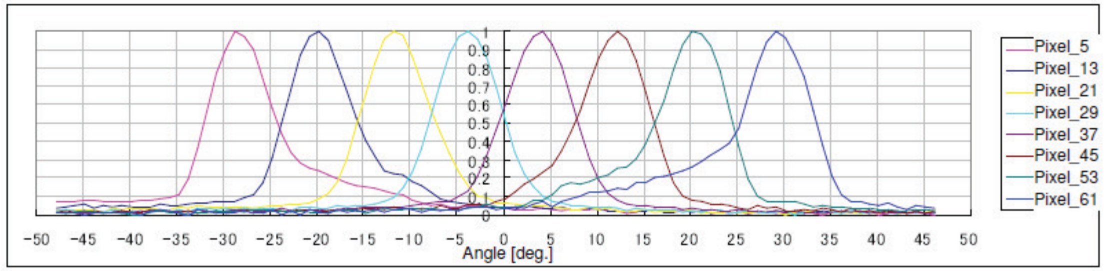


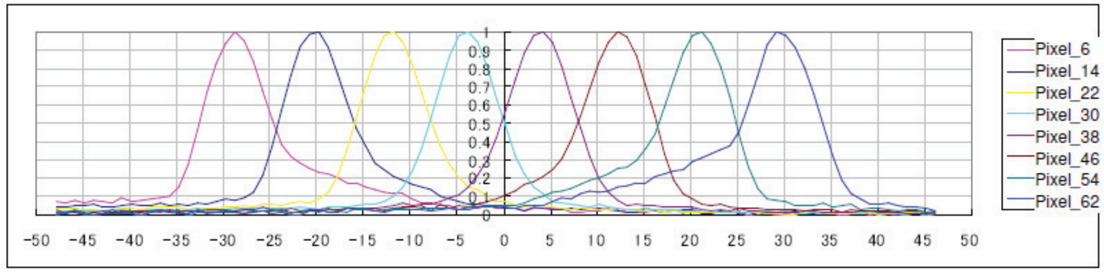


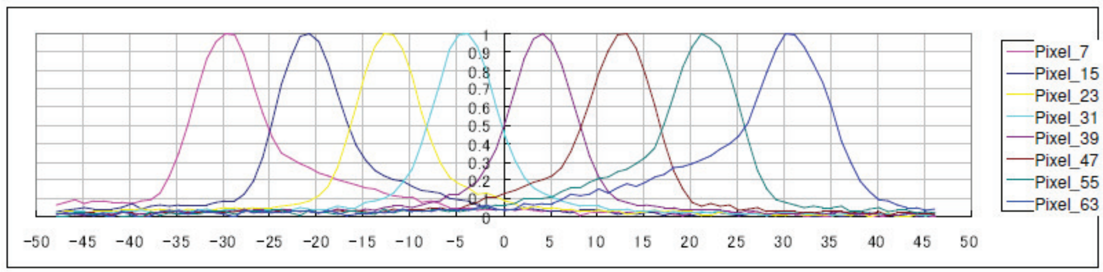


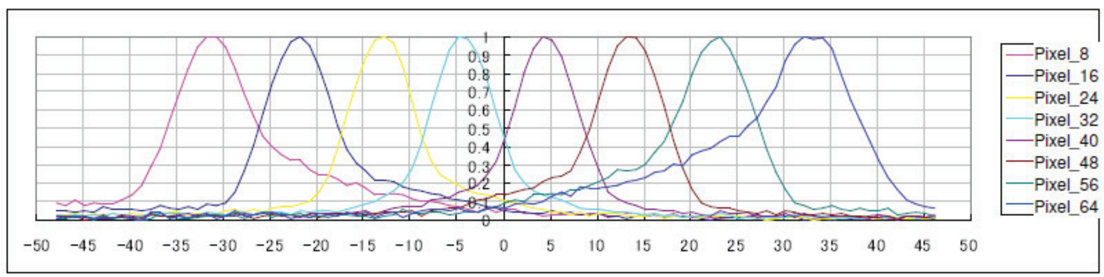
Detailed viewing angle data „Vertical“

64	63	62	61	60	59	58	57
56	55	54	53	52	51	50	49
48	47	46	45	44	43	42	41
40	39	38	37	36	35	34	33
32	31	30	29	28	27	26	25
24	23	22	21	20	19	18	17
16	15	14	13	12	11	10	9
8	7	6	5	4	3	2	1





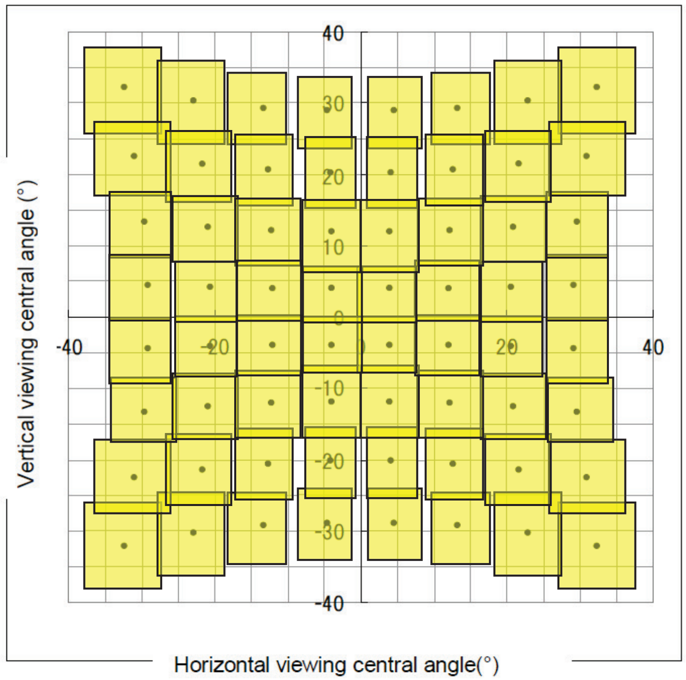


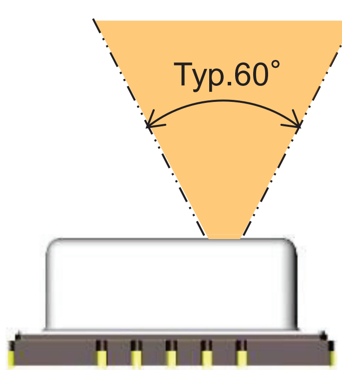


Tolerance of FOV

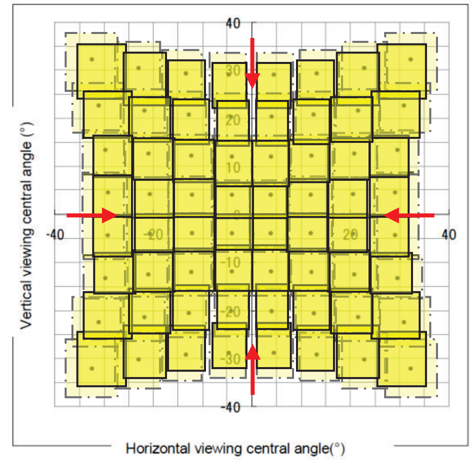
=> Tolerance of FOV is approx. 3°. (Typ.60±3°)

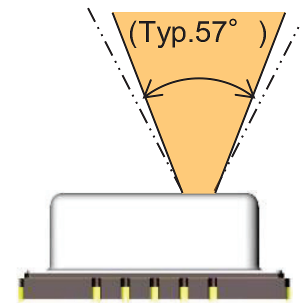
Detection area of each pixels (Typical data)



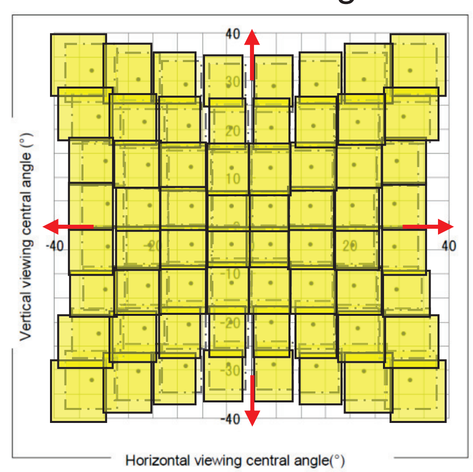


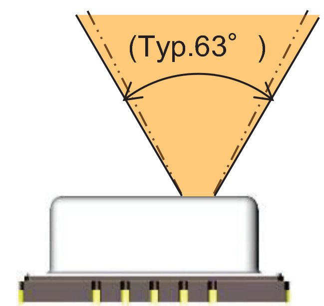
The case of narrow angle





The case of wide angle

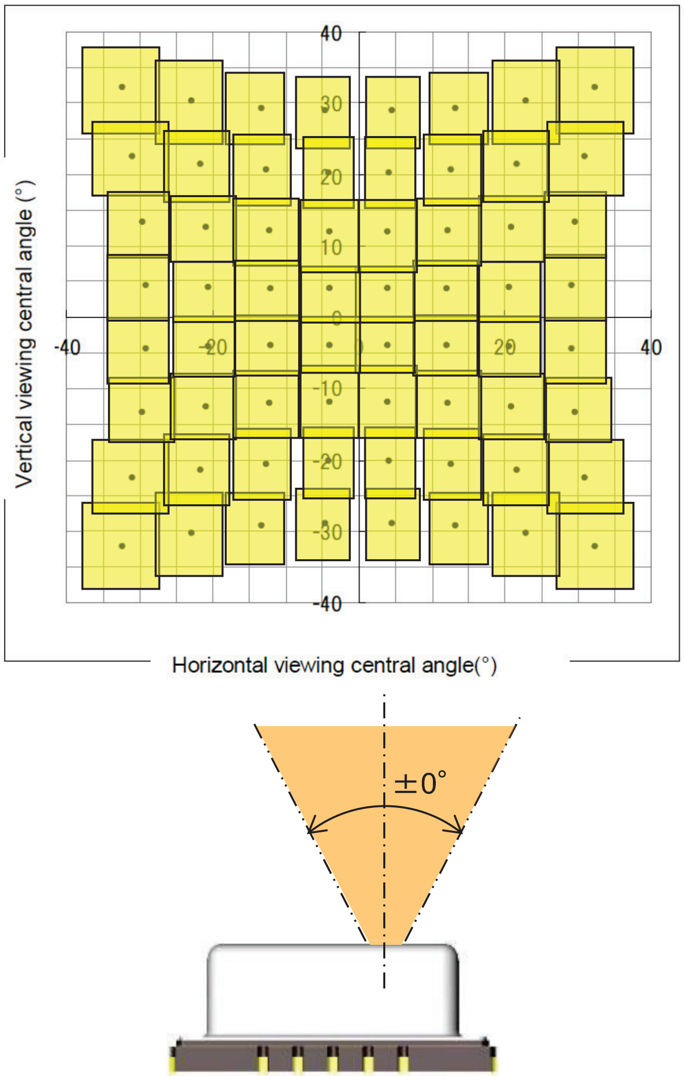


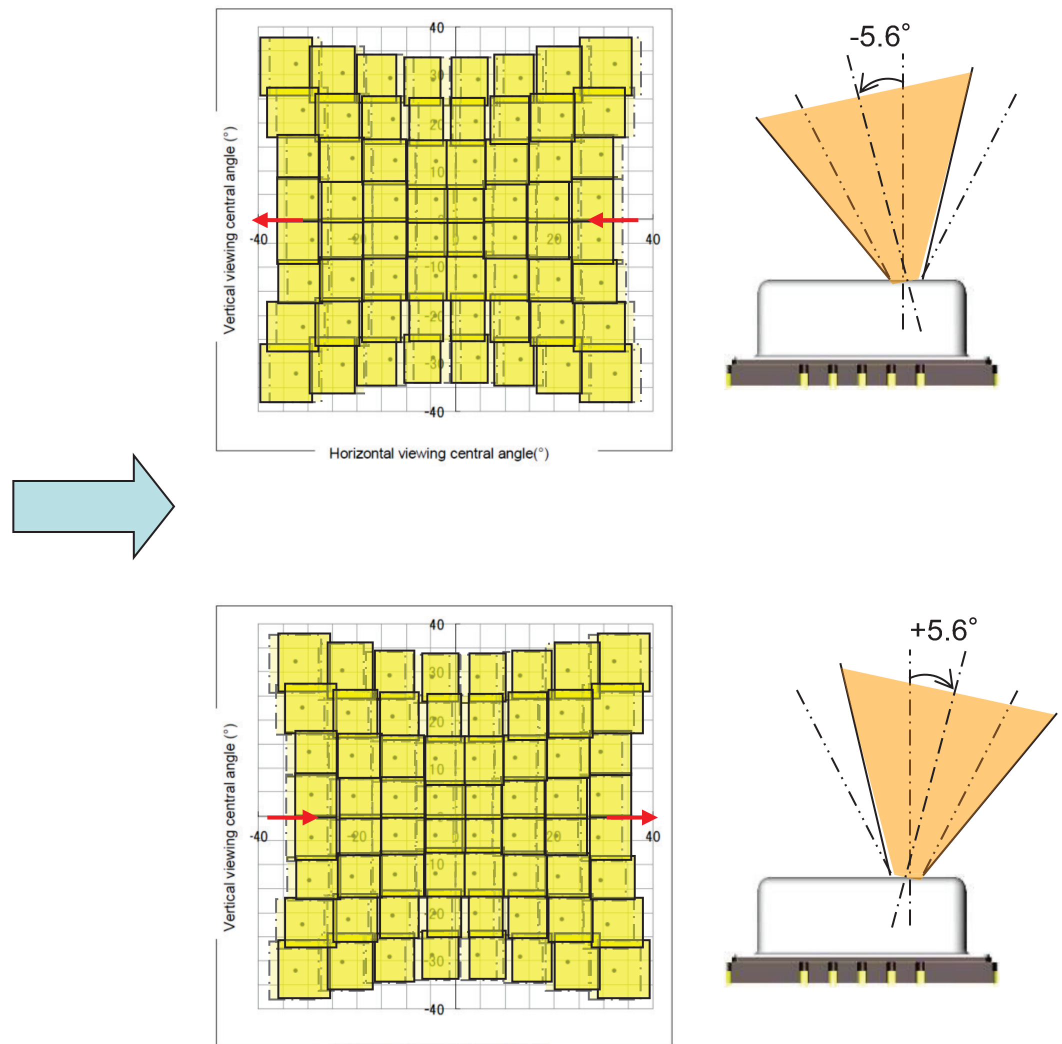


Optical center gap

=> Optical center gap is within typ.5.6° .

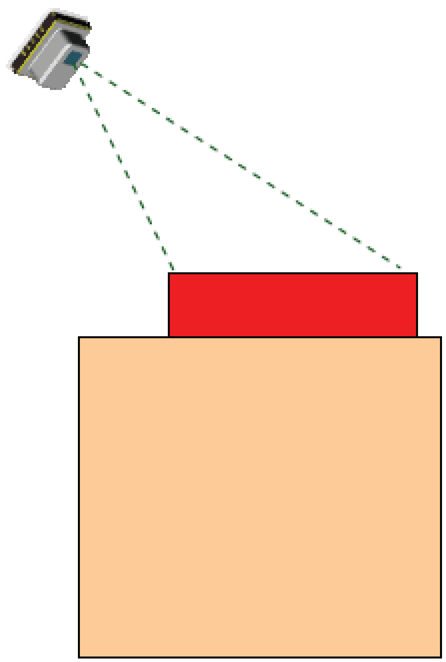
Detection area of each pixels (Typical data)





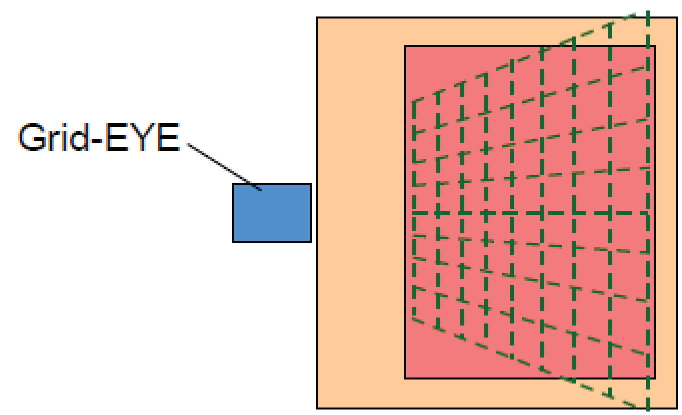
Field of view concept, if Grid-EYE is mounted like following.
→ No rectangular matrix

<SIDE VIEW>



Result: Trapezoidal shape

<TOP VIEW>

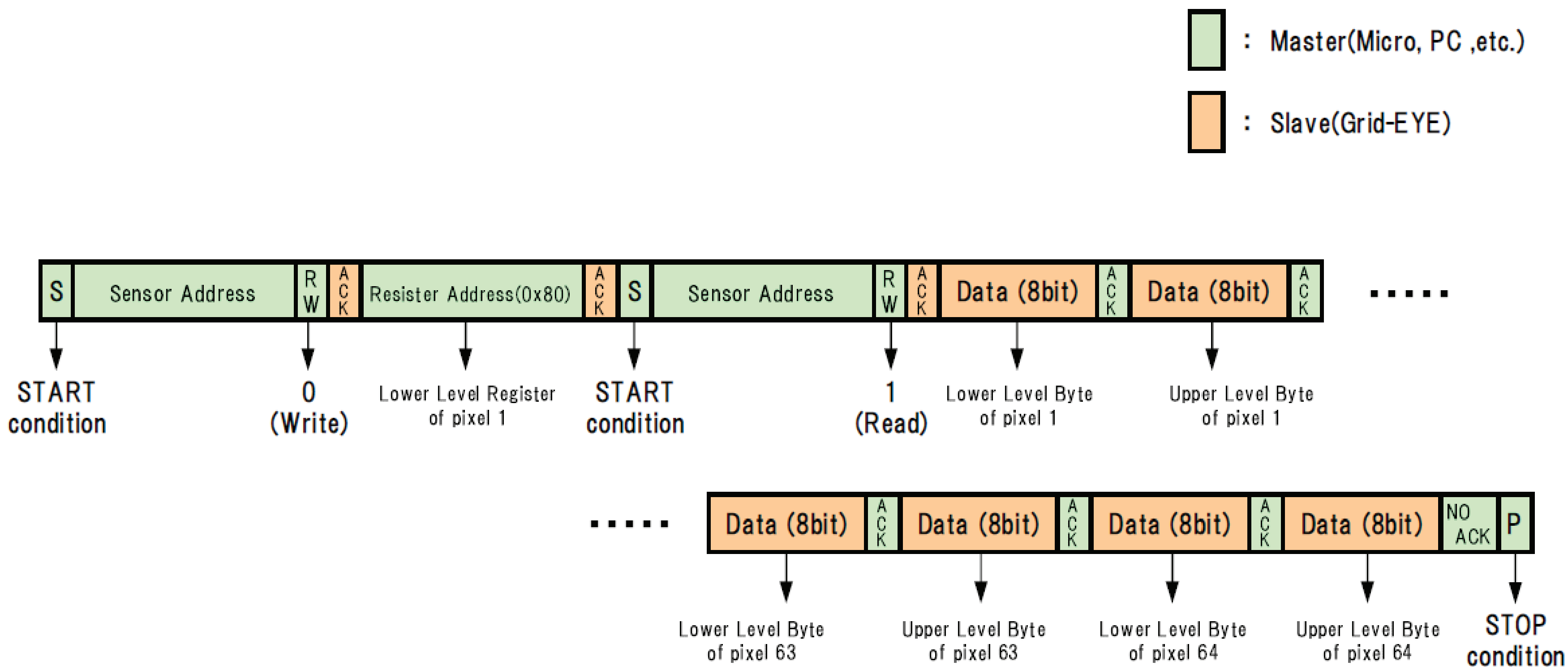


Emissivity

- The **emissivity** of a material (usually written ε or *e*) is the relative ability of its surface to emit energy by radiation.
- It is the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature.
- A true black body would have an $\varepsilon = 1$ while any real object would have $\varepsilon < 1$. Emissivity is a dimensionless quantity.

→ Grid-EYEs is adjusted to an $\varepsilon \geq 0.93$

●How to get data of 64 pixels



Grid-EYE communication

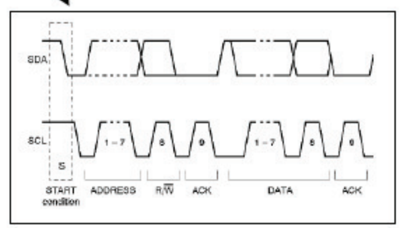
-1. Master send "Start conditon" to Grid-EYE
- SCL : High
- SDA : Low

-2. Master send "Sensor address" and "Write" to Grid-EYE on SDA
- SDA : 11010000 (Sensor address 1101000, Write 0) or 11010010 (Sensor address 1101001, Write 0)

-3. Master receive "ACK" from Grid-EYE on SDA

-4. Master send "Register address" to Grid-EYE on SDA
- SDA : 0x80 ex. Lower Level Register of pixel 1

-5. Master receive "ACK" from Grid-EYE on SDA



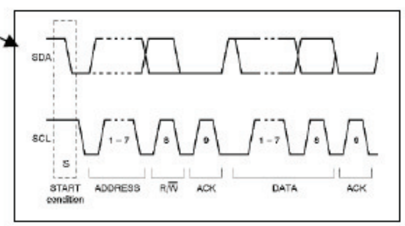
-6. Master send "Start condition" to Grid-EYE on SDA
- SCL : High
- SDA : Low

-7. Master send "Sensor address" and "Read" to Grid-EYE on SDA
- SDA : 11010001 (Sensor address 1101000, Read 1) or 11010011 (Sensor address 1101001, Read 1)

-8. Master receive "ACK" from Grid-EYE

-9. Master receive data of Lower Level Byte of pixel1

-10. Master send "ACK" on SDA



-11. Master receive data of Upper Level Byte of pixel1

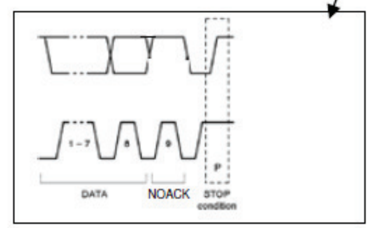
-12. Master send "ACK" on SDA

Repetition of 11, 12

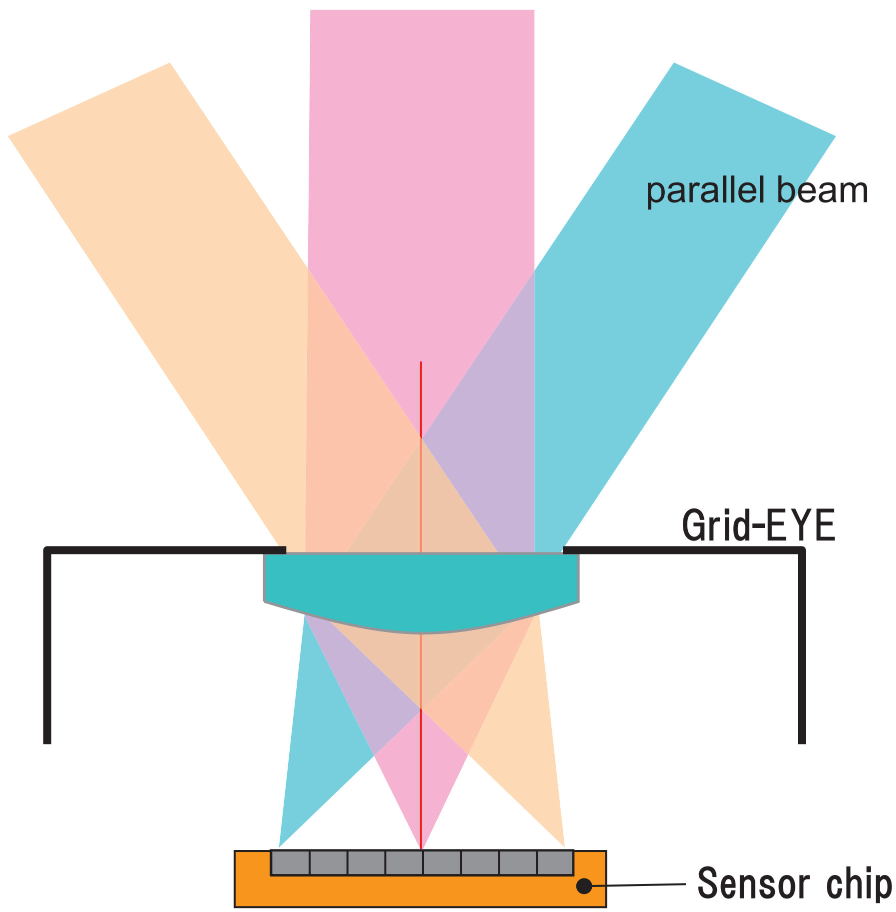
-13. Master receive data of Upper Level Byte of pixel64

-14. Master send "NOACK" on SDA

-15. Master send "Stop condition"
- SCL : High
- SDA : High



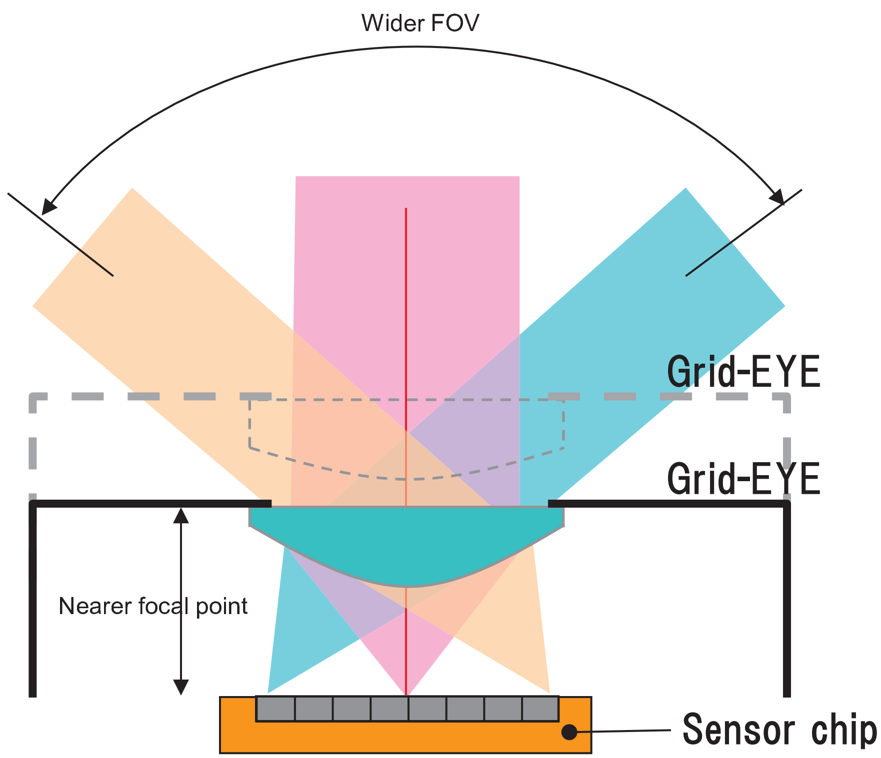
Is it possible to use an additional lens to increase the FOV?



An infrared image is formed on the sensor chip through the Silicon lens.
In the case of Grid-EYE, sensor chip is placed on the focal point.
So only parallel infrared beam can be formed.

If an additional lens is placed in front of the sensor, focal point is changed.
Then infrared image is out of focus.

Is it possible to use an additional lens to increase the FOV?



Wider viewing angle…..

The nearer focal point means wider viewing angle.
In this case, Grid-EYE package height and lens shape need to be changed.