

Observation environment for diagnostic imaging: Illuminance in image interpretation

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Introduction

- Ambient light level $< 50 \text{ lx}$ for hard copy mammogram
- Increase in filmless diagnostic imaging in Japan
 - New illuminance standards are needed for soft-copy mammographic readings.

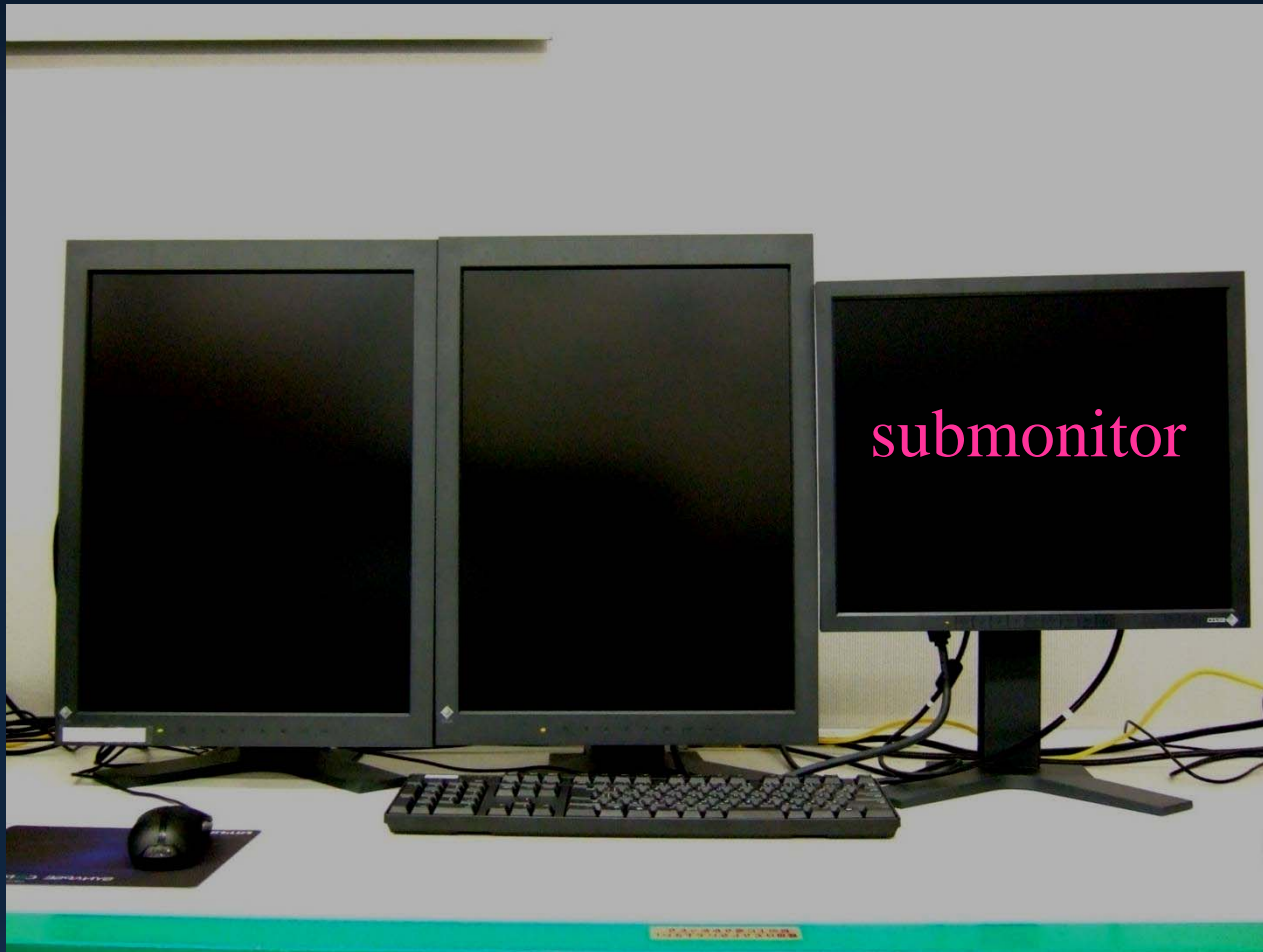
What degree of darkness is acceptable for interpreting soft-copy mammography images?

Objectives

1. To clarify the effects of illuminance on image display
2. To determine optimal illuminance for soft-copy mammogram readings

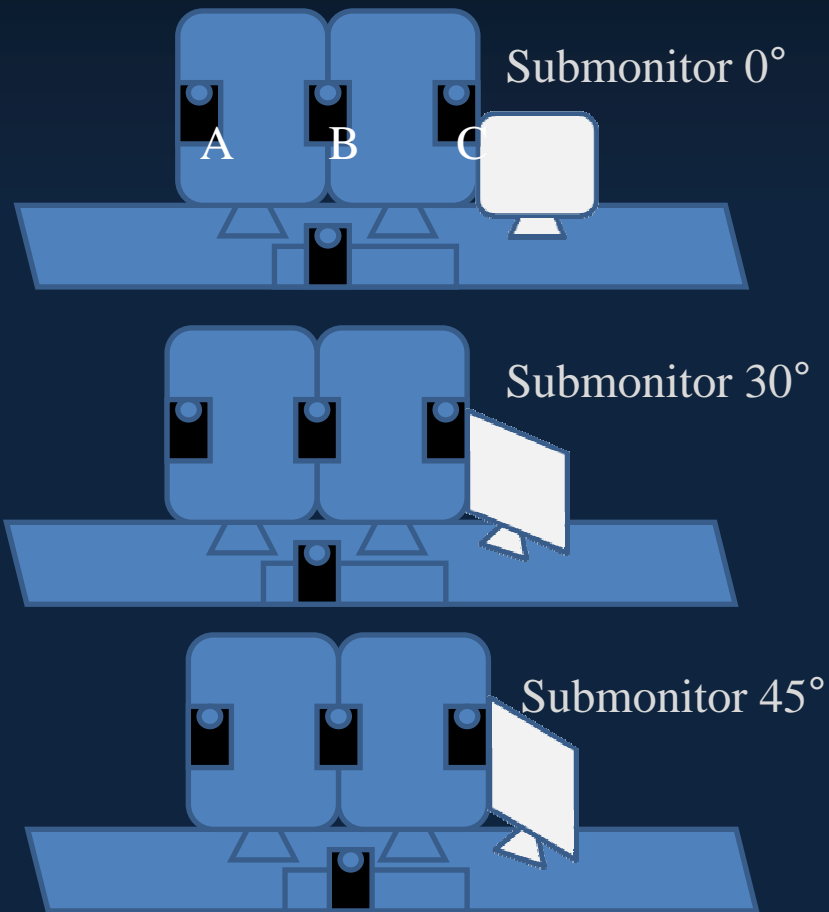
Objective 1 Methods

Evaluating the effects of illuminance on image display



Objective 1 Methods

Evaluating the effects of illuminance on image display



- Submonitor settings

- Brightness

- 0% ($L_{max} 22\text{cd/m}^2$),
- 100% ($L_{max} 192\text{cd/m}^2$)

- Angle to monitors

- 0°
- 30°
- 45°

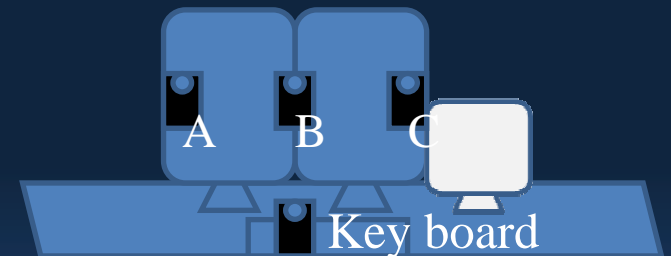
- Illuminance measurement points

- Three points on the monitors
- One point on the keyboard

Objective 1 Results

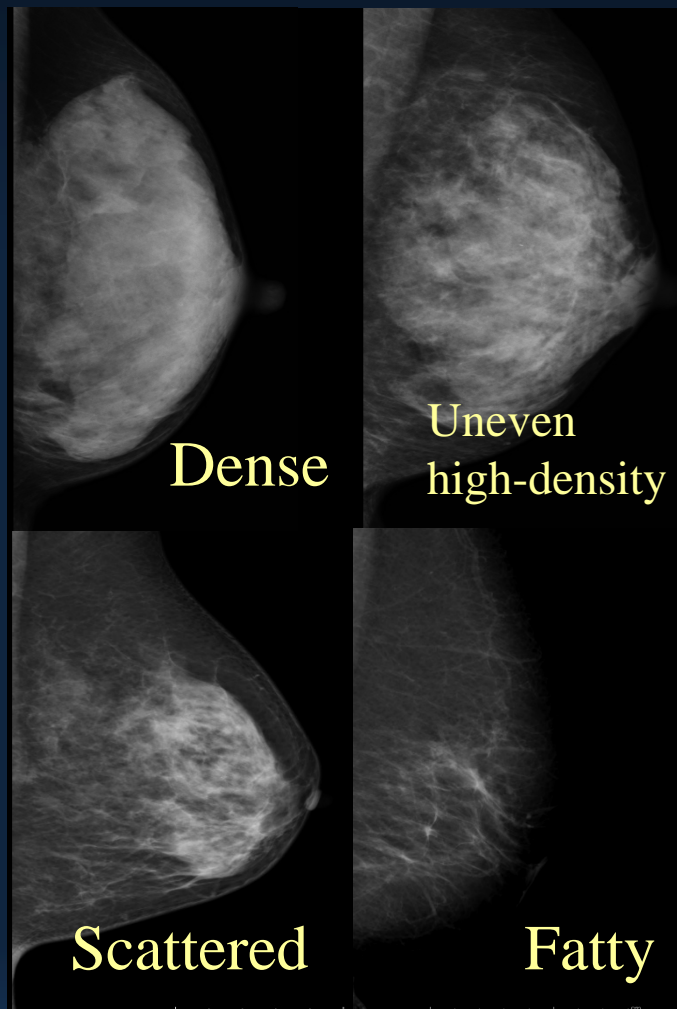
submonitor effects on the monitors and keyboard

Submonitor brightness	Submonitor angle (°)	Illuminance (lx)			
		A	B	C	key board
0 % (Lmax 22 cd/m2)	0	0.6	0.7	0.8	0.8
	30	0.6	0.8	1.0	1.3
	45	0.7	0.9	1.0	1.5
100 % (Lmax 192 cd/m2)	0	1.2	2.0	5.0	2.8
	30	1.5	3.7	7.0	6.8
	45	2.3	5.8	9.8	9.4



Objective 2 Methods

Determining optimal illuminance



- Mammogram
 - Fujifilm's Amulet FFDM system
 - 4 kinds of breast structure
 - 12 cases total
- Image interpreters
 - Nine doctors has a A ranking

Objective 2 Methods

Observed and measured parameters

- Observed parameters
 - Contrast inside and outside the mammary gland
- Measured and evaluated parameters
 - Compared acceptable illuminance for observing images between breast structures (t-test).
 - Determined the limit of illuminance necessary to perform manual operations during image interpretation
- Illuminance measurement points
 - Center of the right monitor
 - On the keyboard



Objective 2 Results

acceptable illuminance during image interpretation

Breast structures	Acceptable illuminance (lx): Mean (standard deviation)	
	Inside the mammary gland	Outside the mammary gland
Overall	21.4 (17.7)	17.1 (15.0)
Dense	17.5 (13.4)	10.3 (7.0)
Uneven high-density	22.4 (20.8)	18.5 (16.8)
Scattered	24.4 (18.1)	20.6 (16.3)
Fatty	21.5 (17.9)	18.9 (16.1)

- Observations outside the mammary gland
The acceptable illuminance for **dense mammary gland** was **significantly lower** than that of the three other breast structures (t-test: $p < 0.05$)
- The mean acceptable limit for illuminance on the keyboard was **17.6 lx**.

Discussion

We found that:

1. the brightness of the submonitor had a strong effect on illuminance.
2. the angle of the submonitor relative to the interpretation monitors was also important.

Submonitors should be used at lower brightness settings. Even when submonitor brightness was at its lowest, this was not problematic when used exclusively as a computer terminal for writing reports.

Discussion

- The acceptable illuminance for observations inside the mammary gland
→17–25 lx
- The acceptable limit for illuminance on the keyboard → 17.6 lx



This suggests that 17–25 lx is a good range of illuminance for a work environment.

BUT

For observations outside the mammary gland, the acceptable illuminance for dense mammary glands was significantly lower (approximately 10 lx).

‘Ambient light should be less than 10 lx’

European guidelines for quality assurance in breast cancer screening and diagnosis *Fourth edition*

Conclusion

- Ambient light exerts a significant impact on observed images.
- It is necessary to arrange the environment so that it does not reduce diagnostic accuracy or burden the image interpreter.
- We plan to carry out follow-up examinations that consider dense mammary gland structure, which requires lower illuminance.