Hidden Pitfalls in Medical Application of Multispectral Color Imaging

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Have you ever wondered?

• why medical practitioners who must be most nervous about erroneous diagnosis do not seem to mind inaccurate color reproduction.

• why specialists of medical imaging seem to have little interest in multispectral imaging technology.

If never, you may have trapped in some pitfall...
### Evaluation of quality of medical images displayed with various devices

<table>
<thead>
<tr>
<th>Image No.</th>
<th>Image</th>
<th>Display equipment</th>
<th>CRT1</th>
<th>CRT2</th>
<th>CRT3</th>
<th>CRT4</th>
<th>LCD1</th>
<th>LCD2</th>
<th>LCD3</th>
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<tr>
<td>M-01</td>
<td><img src="image1" alt="Image" /></td>
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Tested displays have almost the same resolution, and the major difference among them is the performance of color reproduction. The highest grade was determined as ‘6’, and grade lower than ‘3’ means unusable. Beyond prior expectation, a grade of equipment No. 7 was varied from the highest to unusable. Specimen M-01 etc. got the highest grade with all devices, but specimen M-06 varied from the highest to unusable depending on used devices. Usually a user watches only one display, so may not notice this fact, which may incidentally cause erroneous diagnoses depending on the combination of medical images and display devices.
Color precision and medical diagnosis

• In most medical sub-fields, digital color imaging does not cause serious problems at present.

• But inaccurately reproduced colors may accidentally cause erroneous diagnoses.

• Skin color cannot be successfully recorded with any imaging media available at present.

But these are not the only answers to the first questions.
Medical pitfalls (1)

• The three primary colors can reproduce every color because we have only three kinds of cone cells.

• In reality, because spectral sensitivity characteristic curves of three kinds of cone cells overlap with each other, RGB values calculated by color matching functions for some light wavelengths become negative numbers and they actually cannot be displayed.
RGB values calculated by color matching functions

RGB values for some light wavelengths become negative numbers.
Medical pitfalls (2)

• Because spectral sensitivity characteristic curves of cone cells spread over a wide range of light wavelengths, improvement of color accuracy will have only small effect.

• Human visual recognition of vital information must be highly developed by means of real-time combined analysis of various kinds of signals. Therefore, reproduction of accurate color reflectance may have a serious effect.
Medical pitfalls (3)

• Complete color reproduction is impossible because no display equipment is free from physical limitations.

• Because we have only three kinds of cone cells, colorimetric color reproduction using three primary colors may reproduce a considerable range of visible colors very precisely.
Medical pitfalls (4)

• It is not realistic to replace present infrastructures based on the RGB color system.

• If estimation of spectral reflectance based on three principal components will succeed in making sufficient approximation, color data acquired by present imaging devices that have three channels may be also used for estimation of spectral reflectance. And also, present display devices that have three channels may well reproduce tristimulus values of the original spectral reflectance, if they are properly calibrated.
Engineering pitfalls (1)

• There does not seem to be serious requests for color accuracy from most of medical professionals, therefore need for accurate color representation is considered to be little.

• For example, there is a huge demand for recording precise images of skin lesions in the fields of dermatology and nursing, but most dermatologists fall into the aforementioned pitfalls and give up to pursue any technological solution.
Engineering pitfalls (2)

• Quality required for medical imaging is so high that any technology would not satisfy medical professionals.

• Very high quality is not required in all cases. Required quality depends greatly on medical findings that should be detected in each case and that quality has large variety among key findings of each case.

• An imaging technology should be selectively applied to cases that have high frequencies and the quality of diagnostic imaging required will be available.
Recommendation

• Give sufficient attention to pitfalls.
• Provide medical practitioners with tools to plug them.
• Thereafter, find and understand the medical demands.
• Then, apply your technology to satisfy them.

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