A Real-Time RGB-NIR Imaging System Using a Single Image Sensor
Kazunori Yoshizaki, Munenori Fukunishi, Yasuhiro Komiya, Yusuke Monno, Masayuki Tanaka, Masatoshi Okutomi, Steven Lansel
Olympus R&D Group, Tokyo Institute of Technology, Olympus Communication Technology of America
Website: http://www.ok.ctrl.titech.ac.jp/res/MSI/MSI_e.html

Our Prototype RGB-NIR Imaging System

Example Applications
Medical Imaging (ICG fluorescence observation)

Food Inspection
Superimposition of NIR on RGB (with thresholding and false color assignment)

RGB-NIR Sensor Design
- We investigated the performance of three patterns.
- Simulation performance for noise-free case (see [4] for details)

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Uniform</th>
<th>Proposed 1</th>
<th>Proposed 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>R G B NIR</td>
<td>1/4</td>
<td>1/5/2</td>
<td>1/5/5/50</td>
</tr>
<tr>
<td>Uniform</td>
<td>1/8/2</td>
<td>1/8/1/5/2</td>
<td>1/8/1/5/2</td>
</tr>
</tbody>
</table>
| High sampling density of the G band → Utilize for demosaicking like Bayer CFA

| Color PSNR (sRGB) | 32.25 | 34.48 | 34.02 |
| Color PSNR (NIR)  | 33.87 | 38.37 | 40.22 |
| Average           | 33.06 | 36.43 | 37.12 |

Proposed Demosaicking Algorithm [3-4] (to be implemented on hardware)

Image Processing
Overall pipeline
- Camera RGB
- Camera NIR
- Demosaicking

Linear Color Correction
\[
\begin{align*}
& sR = \frac{m_{11}m_{12}m_{13}m_{14}}{m_{15}m_{16}m_{17}m_{18}}, \\
& sG = \frac{m_{21}m_{22}m_{23}m_{24}}{m_{25}m_{26}m_{27}m_{28}}, \\
& sB = \frac{m_{31}m_{32}m_{33}m_{34}}{m_{35}m_{36}m_{37}m_{38}}.
\end{align*}
\]

(a) Kiku et al., “Simultaneous Capturing of RGB and Additional Band Images Using Hybrid Color Filter Array,” IS&T/SPIE Electronic Imaging 2014.