We developed a practical method to derive response functions which convert the amount of incident light to the A/D counts of cameras for scientific imaging [1]. Some cameras do show non-linear responses, and we have to know them to carry out photometric analysis with the data taken by such cameras. We applied this method for an InGaAs near-infrared camera, XEVA-CL-640 (XENICS), and succeeded to derive a response function, even though it was complicated non-linear one. In principle, such response functions can be derived from the output A/D counts, $S$, measured at various incident light levels, $I$, which are accurately controlled over the whole dynamic range. However, it is not easy to actually do such measurements with high accuracy. Then we developed a new practical method to derive non-linear response functions. In this method, we need a mechanism to accurately control the amount of incident light into cameras just within a limited dynamic range and at a limited number of steps (relative light level $T$, which may be exposure time, transparency, etc.). A variable brightness light source (brightness $B$), which supplies the incident light into cameras, is also necessary, but we do not need to know its accurate brightness.

Figure 1(a) shows the raw results measured under such conditions; output A/D values, $S$, are measured at several $T$’s under various unknown $B$’s (the brightness of the incident light, $I$, is written as $I = BT$). It seems that without knowing $B$’s, it is difficult to derive the relation between $I$ and $S$ from the results shown in Figure 1(a). However, we can derive $dS/dT$, because the relation $dl = BdT$ based on $I = BT$ brings $dS/dT = BdS/dI$, and this means $Tds/dT = TBdS/dI = IdS/dI$. The value $Tds/dT$ can be derived from the known values, $T$ and $S$, and therefore, without knowing $B$, we can derive a unique relation between $T$ and $TdS/dT(= IdS/dI)$ as shown in Figure 1(b). The relation seen in Figure 1(b) can be converted to the relation between $I$ and $S$ through the numerical integration. Figure 1(c) shows the derived relation between $I$ and $S$, namely the response function of the camera. Obviously the function is non-linear. Figure 1(d) shows a close-up of the low-light level portion of Figure 1(c), and we can find a complex non-linear behavior.

We are using a XEVA camera for the polarimetry of the infrared solar light, which requires high accuracy measurements. Compensation of the non-linearity based on the derived function works well, and we have quantitatively high-quality observational data.

**Reference**