Evaluation of Radiometric Camera Response Recovery Methods

Aslı Gencjav and Ahmet Özüz Akyüz*
Middle East Technical University

1 Introduction

The camera response function determines the relationship between the incident light on the camera sensor and the output pixel values that are produced. For most consumer cameras, this function is proprietary and needs to be estimated to create HDR images that accurately represent the light distribution of the captured scene. Several methods have been proposed in the literature to estimate this unknown mapping using multiple exposures techniques. In this study, we compare three of the most commonly used methods namelyDebevec and Malik’s [1997], Mitsunaga and Nayar’s [1999], and Robertson et al.’s [2003] response curve estimation algorithms in terms of how precisely they estimate an unknown camera response.

2 Comparison

We implemented all three algorithms in C++ using the exact procedures outlined in the respective papers. We selected around 300 distinct sample positions from the uniform regions of the individual exposures. In that we had 9 exposures, this amounted to a total of 2700 samples. We ensured that we had at least one sample for every intensity level and the samples are not clumped together. A representative set of samples is shown in Figure 1. As Mitsunaga and Nayar’s algorithm does not have a weighting mechanism to underplay the influence of under- and over-exposed samples, we discarded the samples outside the range [5, 250] only for that algorithm.

The recovered response curves of a Canon EOS 550D is shown in Figure 1. As Mitsunaga and Nayar’s method does not have a weighting mechanism to underplay the influence of under- and over-exposed samples, we discarded the samples outside the range [5, 250] only for that algorithm. The recovered response curves of a Canon EOS 550D using three methods (right) using the samples (middle) from the exposures (left).

The error produced by each algorithm as well as their running times are listed in Table 1. We used 9 exposures shown on the left of Figure 1. The error produced by Robertson et al.’s method is similar to Debevec and Malik’s which may be expected as their problem formulations are similar. We can observe an inverse relation between the fidelity of each method and their running times.

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Table 1: Comparison of the response recovery methods. Performance testing was made on an Intel Core i7 CPU at 3.20GHz.

<table>
<thead>
<tr>
<th>Method</th>
<th>Error</th>
<th>Performance (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debevec and Malik</td>
<td>5538.77</td>
<td>74.68</td>
</tr>
<tr>
<td>Mitsunaga and Nayar</td>
<td>11803.23</td>
<td>0.29</td>
</tr>
<tr>
<td>Robertson et al.</td>
<td>6145.13</td>
<td>8.39</td>
</tr>
<tr>
<td>sRGB assumption</td>
<td>77697.70</td>
<td>N/A</td>
</tr>
</tbody>
</table>

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References


*e-mail: {asli, akyuz}@ceng.metu.edu.tr