P-frame Base Q Estimation

In x265, the frame level $Q$ is derived from the long-term complexity.
The main drawback is that, as the increase of encoded frame number, the
frame level $Q$ becomes more insensitive to the current frame
complexity change. In our algorithm, the base quantization $Q$ considers
both effects of the long-term complexity history and the low resolution
motion estimation costs in the current MiniGOP.
Let $\Delta C_U$ denote the number of B-frames in the current MiniGOP. If
the prediction residue complexities of the P-frame and B-frames in the
current MiniGOP are $C_{P}$ and $C_{B}$, respectively, the short-term P-frame
base quantization step $\Delta Q^P$ is expressed as

$$Q = \frac{\Delta C_U}{\Delta Q^P} \min\left(1, \frac{C_{P} + C_{B}}{2\Delta Q^P}\right)$$

The term $\Delta C_U / \Delta Q^P$ denotes how much we can borrow in
the future mini-GOP. The higher dependency, more we can borrow. $\tau$ is
a parameter derived by regression.

Quantiﬁcation Strength based Slice Type Decision

If one of the following three conditions is satisﬁed, it is claimed that
the next P frame or frames are found:
• First, $PM(E,-1,1)$ is carried out. If $N_{PM}(E,-1,1) > 0.5 N_{PM}(E,-1,1) + 0.5 N_{PM}(E)$, $f_0$ and $f_1$ in $F$ are decided as P-frames.
• Second, if $C(E,-1,1) > C(E) > C(E,-1,1) + 3 C(U)$ and $f_0$ is determined as one P-frame.
• Finally, we deﬁne the low threshold as $T_{\Delta Q} = \max(300 \times 50C_{P}, 30)$ and
the high threshold as $T_{\Delta Q} = \max(C_{P}, Q_{B})$, where $Q_{B}$ is the last P-frame
base $Q$. The applied threshold is

$$T = \min(C(E), \max(50C_{P}, 300))$$

We process $PM(E,-1,1)$ for each $\psi_k < 0$ in sequence. Once
$C(E) - \psi > 0.5 C(U)$, $T$ is deﬁned as the P-frame and its leading underdetermined frames are deﬁned as B-type. The middle
position B-frame is the reference B-frame. By introducing $Q$ in
the threshold $T$, with the increase of quantization, more frames could be identiﬁed as B-frames properly.

Results

The proposed methods were conducted on x265 version 2.4.1. The
coding performance results of the overall rate control optimizations
are shown in Table 1. We applied present medium in these tests. On aver-
age, +0.994dB quality gain, i.e., 17.67% rate reduction, was achieved by
our methods. The coding time was reduced by 1.52%.

Table 1: Coding Quality of Whole Rate Control Algorithm

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Rate Gain (dB)</th>
<th>Rate Reduction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vipero7</td>
<td>0.7858 -28.52 -0.47</td>
<td>13.72</td>
</tr>
<tr>
<td>Vipero8</td>
<td>0.5723 -22.76 +1.34</td>
<td>15.73</td>
</tr>
<tr>
<td>Vipero9</td>
<td>0.4367 -15.62 +0.23</td>
<td>16.62</td>
</tr>
<tr>
<td>PM(E,-1,1)</td>
<td>0.1358 -04.61 -3.38</td>
<td>17.67</td>
</tr>
<tr>
<td>PM(E,-1,1)</td>
<td>0.4208 -40.76 +1.94</td>
<td>18.68</td>
</tr>
<tr>
<td>PM(E,-1,1)</td>
<td>0.6406 -22.33 +0.80</td>
<td>19.61</td>
</tr>
<tr>
<td>PM(E,-1,1)</td>
<td>0.5878 -14.61 +0.41</td>
<td>20.64</td>
</tr>
<tr>
<td>PM(E,-1,1)</td>
<td>0.5209 -65.97 +3.74</td>
<td>21.67</td>
</tr>
</tbody>
</table>

Figure 11: Subject Comparisons

References