Pixel-Wise Quantization for Image Compression

Liang Wei, Fangdong Chen, Li Wang, Xiaoyang Wu and Shiliang Pu

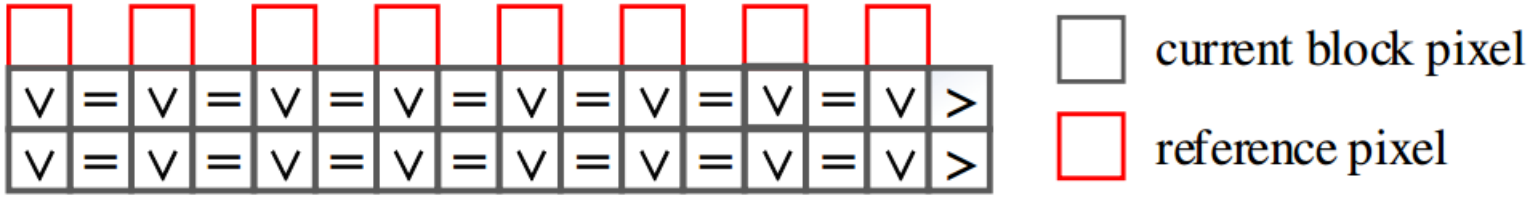
Hikvision Research Institute, Hangzhou, China

Introduction

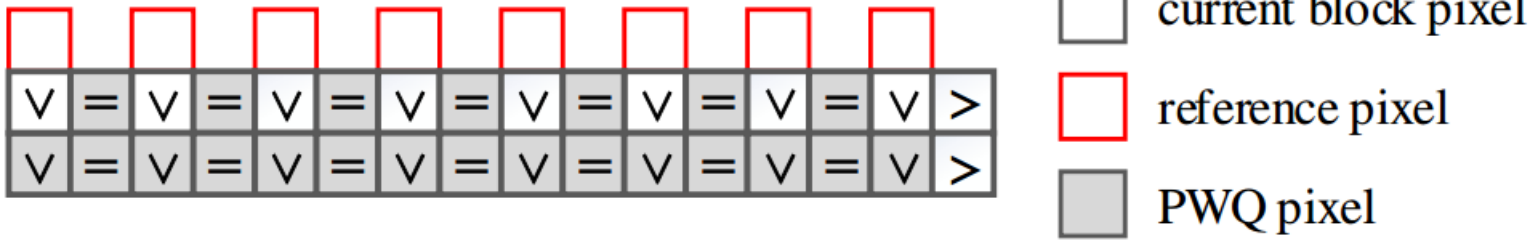
- Traditional block-level quantization： CB、QG.
- More fine-grained quantization ? -> pixel-level !
  - In frequency domain : the quantization matrix.
  - In pixel domain : the proposed PWQ.
- PWQ : pixel-wise quantization.
  - reduce simple pixels' QP adaptively to enhance subjective quality.

PWQ for pixel-wise prediction

- The pixel-wise prediction, and implemented PWQ method.
  - Pixels are reconstructed one-by-one.
  - Symbol “=” (or “∨” / “>”) means the prediction is the average of left and right reconstructions (or upper / left reconstruction).



(a) The pixel-wise prediction



(b) The PWQ method

Figure 1: The PWQ method combined with the pixel-wise prediction.

PWQ for pixel-wise prediction

- The pixel-wise prediction, and implemented PWQ method.
  - "Q" means the QP, and "T" means the texture complexity of current pixel (based on the neighbor reconstructions).
  - Condition " $T_{pred} \leq T_{thres}$ " indicates the current pixel is simple.

$$Q_{pixel} = \begin{cases} \max\left(Q_{cb} - \delta,\ Q_{jnd}\right), & if\ T_{pred} \leq T_{thres},\ Q_{jnd} < Q_{cb} \leq Q_{thres}. \\ Q_{cb}, & otherwise, \end{cases} \tag{1}$$

$$\begin{aligned} bd_{index} &= \mathrm{clip}\left(bitdepth - 8,\ 0,\ 8\right). \\ T_{thres} &= 10 << \left(bd_{index} >> 1\right). \\ Q_{thres} &= 32 + \left(\left(bd_{index} >> 1\right) << 3\right). \\ Q_{jnd} &= 16 + \left(bd_{index} << 2\right). \end{aligned} \tag{2}$$

PWQ for non-pixel-wise prediction

- For non-pixel-wise prediction, a straightforward extension of PWQ method is:
- (i). Divide current CB into simple and complex areas (i.e. A0, A1, A2), based on the gradients of above reference pixels.
- (ii). Reduce the pixels' QP in simple areas by eq. (1).

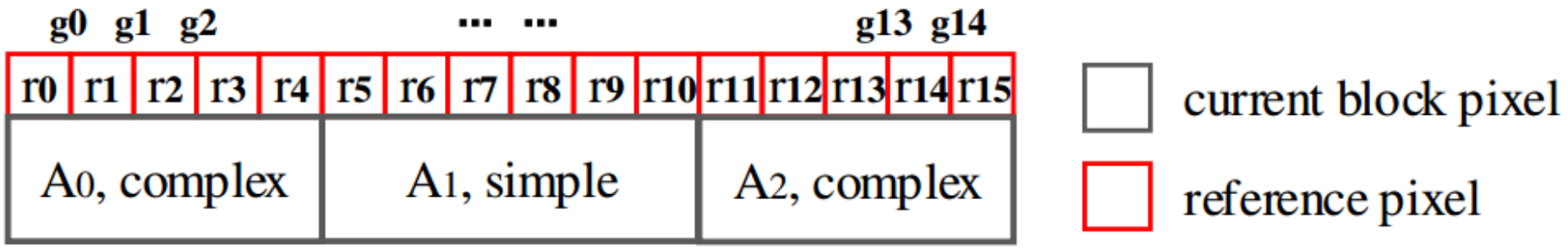
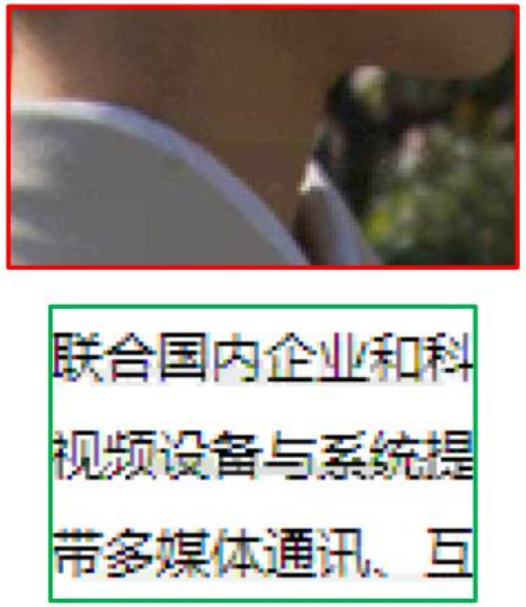


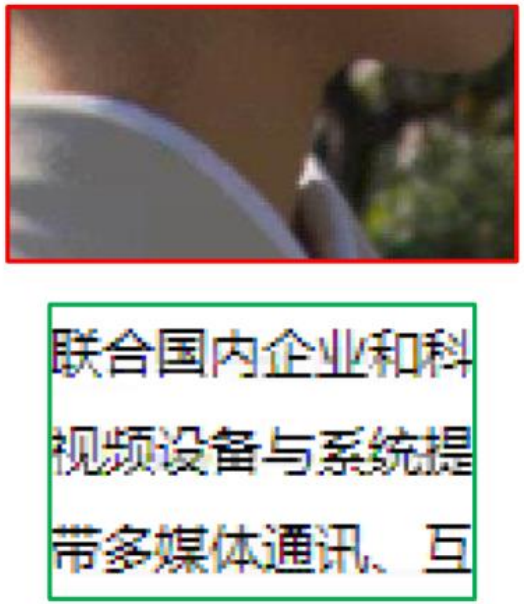
Figure 2: The PWQ method combined with the non-pixel-wise prediction.

Qualitative results

- Efficiently improve the blocking effects on the lady's neck.
- Almost eliminate the artifacts between and after the words.



(a) PWQ-off



(b) PWQ-on

Conclusion

- Advantages of the pixel-wise quantization method:

a) More fine-grained : pixel-level vs. block-level.

b) Adaptively reduce simple pixels' QP.

c) Without additional syntax for signalling.

d) Efficiently improve subjective qualities, especially:
   - in flat areas near the object edge and between the words on screen contents.