



HM reference software bug fixes and enhancements to address the HDR/WCG CfE

10/23/2014

HM software

- Several limitations and problems discovered in the HM software during our CfE response development
 - Issues with motion estimation - potential of getting trapped at local minima
 - Bi-predictive ME performed with no iterations
 - Weighted Prediction performance issues (and bugs)
 - Rate Distortion Optimization behavior
 - etc

HM Improvements - Motion Estimation

- New Motion Estimation Engine
 - Again based on zonal techniques/EPZS (TZSearch variant)
 - However, new engine performs improved refinements with additional predictors
 - Dual Refinement
 - Added early termination (for speed up purposes)
- Common conditions also specify the use of FEN = 1
 - Subsamples distortion space and disables bi-predictive refinement iterations
 - FEN = 1 also disables bi-predictive refinement iterations.
Can hurt performance on some material, especially during illumination changes
- New ME allows disabling FEN with better performance and similar or faster speed
 - Variants (FEN=2/3) also implemented

HM Improvements - Motion Estimation Limitations

- Unfortunately HM architecture makes it difficult to implement better architectures
 - ◆ Ideally, hierarchical scheme would be preferred
 - ◆ Hierarchical ME engines are commonly superior than block based schemes
 - ◆ Allow for better analysis of motion, given the ability to better analyze motion of the entire scene
 - ◆ Less biased to raster scan encoding/searches (depends on ME design)
 - ◆ Allows for better motion vector regularization
 - ◆ Works as a denoiser during ME decision in low resolutions. Better for noisy content
 - ◆ Could be used to perform adaptive list modification and weighted prediction decision.
 - ◆ Chroma ME not currently supported

Weighted Prediction

- Current HM scheme based on Image DC analysis
 - Single set of illumination parameters computed (per color component)
 - One decision for all components based on zero motion compensation distortion vs no WP
 - Scheme may not find good WP parameters
 - Decision could be unstable

Weighted Prediction

- 2 major bugs discovered

- ◆ Single list WP in B slices only performed if both `weighted_pred_flag` and `weighted_bipred_flag` enabled

```
Void TComPrediction::motionCompensation ( TComDataCU* pcCU, TComYuv* pcYuvPred, RefPicList eRefPicList, Int
iPartIdx )
{
    Int          iWidth;
    Int          iHeight;
    UInt         uiPartAddr;

    if ( iPartIdx >= 0 )
    {
        pcCU->getPartIndexAndSize( iPartIdx, uiPartAddr, iWidth, iHeight );
        if ( eRefPicList != REF_PIC_LIST_X )
        {
            if( pcCU->getSlice()->getPPS()->getUseWP() ) //<= Only checks for P slice weighting
            {
                xPredInterUni (pcCU, uiPartAddr, iWidth, iHeight, eRefPicList, pcYuvPred, true );
            }
            else
            {
                xPredInterUni (pcCU, uiPartAddr, iWidth, iHeight, eRefPicList, pcYuvPred );
            }
            if ( pcCU->getSlice()->getPPS()->getUseWP() ) //<= Only checks for P slice weighting. Code could be moved
            {
                xWeightedPredictionUni( pcCU, pcYuvPred, uiPartAddr, iWidth, iHeight, eRefPicList, pcYuvPred );
            }
        }
    }
}
```

Weighted Prediction

- ◆ Weight range clipping inverted, i.e. [-127, 128] instead of [-128, 127]

```
// Weighting factor limitation
const Int defaultWeight = (1<<log2Denom);
//const Int deltaWeight = (defaultWeight - weight); //<< Bug impacting encoder
const Int deltaWeight = (weight - defaultWeight);

if(deltaWeight >= range || deltaWeight < -range)
    return false;
```

- Clipping also not considered during Motion Estimation
 - WP can result in out of range values
 - Clipping added for single list WP
 - More difficult to add for bi-prediction due to ME strategy employed
 - “Single list normalized source”

Weighted Prediction Extensions

- Extend Weighted Prediction with the use of a histogram search
 - Uses histograms of current and reference picture/plane
 - Easy to apply weighted prediction parameters on histograms
 - Fast search technique to refine weighting
 - Can detect global illumination changes if motion is relatively minor
- Dual histogram refinement around DC based weights and default
- Use of zero motion compensated images to make decisions across multiple weights
- Separation of color plane decisions
- Obviously not the best technique (non-compensated method; cannot detect local illumination changes), but better than HM method
- Also provide fix for WP reference clipping for ME

Other Enhancements

- Remove rounding in RDCost computation
- Add Lambda control support for Intra picture (similar to m36184)
- Separate lambda consideration for luma and chroma
- Recommendation also to increase number of references for prediction

sequence	BD-PSNR Y	BD-PSNR U	BD-PSNR V	BD-PSNR YUV
FireEater	-1.9%	-1.4%	0.9%	-1.8%
Autowelding	-8.7%	0.3%	0.9%	-5.5%

Conclusion

- Several enhancements to the HM reference software were performed
- Can improve coding performance and speed
- Allow better handling of cases with illumination changes
- Can be used to improve anchor encodings for HDR/WCG
 - Obviously techniques could potentially help various proposals as well
 - However this makes this comparisons more fair and provides a better bound for our analysis
- Further enhancements possible
- We should encourage more non-normative contributions