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| Question: | 6/21 (VCEG) | | |
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| Title: | **Improvement of the LMS Predictor Implementation in H.BWC** | | |
| Purpose: | Proposal | | |

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# Abstract

In the H.BWC software, the adaptive Least Mean Square (LMS) Predictor Coefficients are not limited which might result in unstable and unexpected encoding and decoding. It is proposed to add the missing limitation of LMS prediction coefficients.

# Proposed change

It is proposed to limit the LMS prediction coefficient to the range of , where corresponds to 1.0 in a floating-point implementation. This limitation ensures that the prediction signal cannot exceed the allowed number range of a 32-bit integer given the maximum total LMS order of 72. In addition, it has been verified that any prediction coefficient used for coding the CTC is much smaller () than the proposed limitation. Therefore, all bitstreams and decoded outputs with the proposed limitation are bit-identical to the baseline. The computational complexity impact is negligible. The limitation must be implemented identically in the encoder and decoder. Therefore, the according specification change is highlighted below.

## Proposed Specification Change

In Section 8.4.2 **Backward Adaptive Prediction,** yellow markedpseudo code shall be added.

Coeff\_max = (1<<(19+5))-1

Coeff\_min = 1-(1<<(19+5))

energy = 0;

accum = 0;

// Compute inter-channel prediction

for(k = start\_channel; k < stop\_channel; k ++){

accum += (int64\_t)signal[k][n] \* IC\_pred\_lms\_coeff [k];

energy += (int64\_t)(signal[k][n] >> energy\_shift);

}

//compute intra-channel predition

pointer = buffer\_pointer - 1;

iBufferPointer2 &= buffer\_mask;

**for**(k = 0; k < lms\_order; k ++){

accum += (int64\_t) AR\_pred\_lms\_coeff[k] \* buffer[pointer];

pointer --;

pointer &= buffer\_mask;

}

energy += buffer\_energy;

~~prediction = (int32\_t)((accum + (1 << (19 – 1))) >> 19);~~

accum = accum + (1 << (19 – 1))) >> 19;

accum = (accum < INT32\_MAX)? accum : INT32\_MAX;

accum = (accum > INT32\_MIN)? accum : INT32\_MIN;

prediction = (int32\_t)accum;

// Additional steps not shown same as original specification

// update inter-channel prediction coeff

for(k = start\_channel; k < stop\_channel; k ++){

accum = (int64\_t)gain \* signal[k][n];

accum += round\_offset;

accum >> log2\_energy;

IC\_pred\_lms\_coeff [k] += (int32\_t)accum;

IC\_pred\_lms\_coeff [k] = (IC\_pred\_lms\_coeff [k] > Coeff\_min) ? IC\_pred\_lms\_coeff [k]: Coeff\_min;

IC\_pred\_lms\_coeff [k] = (IC\_pred\_lms\_coeff [k] < Coeff\_max) ? IC\_pred\_lms\_coeff [k]: Coeff\_max;

}

//update intra-channel prediction coeff

pointer = buffer\_pointer - 1;

iBufferPointer2 &= buffer\_mask;

for(k = 0; k < lms\_order; k ++){

accum += (int64\_t)gain\* buffer[pointer];

accum += round\_offset;

accum >> log2\_energy;

AR\_pred\_lms\_coeff[k] += (int32\_t)accum;

AR\_pred\_lms\_coeff [k] = (AR\_pred\_lms\_coeff [k] > Coeff\_min) ? AR\_pred\_lms\_coeff [k]: Coeff\_min;

AR\_pred\_lms\_coeff [k] = (AR\_pred\_lms\_coeff [k] < Coeff\_max) ? AR\_pred\_lms\_coeff [k]: Coeff\_max;

pointer --;

pointer &= buffer\_mask;

}

# Conclusion

A limitation of LMS prediction coefficients is proposed which does not alter the output for the CTC working points but adds a necessary check to prevent any instable and unexpected encoding and decoding.

# Patent rights declaration(s)

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