Mixed-Excitation Linear Predictive (MELPe) 1200 and 2400 bps Vocoder Algorithm

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The MELPe (Mixed-Excitation Linear Predictive) Vocoder Algorithm is the new 1200 and 2400 bps Federal Standard speech coder. The United States Department of Defense (DoD) Digital Voice Processing Consortium (DDVPC) selected it after a multi-year extensive testing program.

MELPe vocoder is also known as military standard MIL-STD-3005 and NATO STANAG 4591 operates at 1200 and 2400 bps and also compressed bit-stream transcoding between the two rates as well as optional Noise Pre-Processor

The selection test concentrated on four areas: intelligibility, voice quality, talker recognizability, and communicability. The selection criteria also included hardware parameters such as processing power, memory usage, and delay. MELPe was selected as the best of the seven candidates and even beat the FS1016 4800 bps vocoder, a vocoder with twice the bit-rate.

MELPe is robust in difficult background noise environments such as those frequently encountered in commercial and military communication systems. It is very efficient in its computational requirements. This translates into relatively low power consumption, an important consideration for portable systems.

MELPe Terminology:

- Traditional pitched-excited LPC vocoders use either a periodic pulse train or white noise as the excitation for an all-pole synthesis filter. These vocoders produce intelligible speech at very low bit rates, but they sometimes sound mechanical or buzzy and are prone to annoying thumps and tonal noises.
- These problems arise from the inability of a simple pulse train to reproduce all kinds of voiced speech. The MELPe Vocoder uses a mixed-excitation model that can produce more natural sounding speech because it can represent a richer ensemble of possible speech characteristics.

MELPe Features:

- The MELPe Vocoder is based on the traditional LPC parametric model, but also includes five additional features. They are mixed excitation, aperiodic pulses, adaptive spectral enhancement, pulse dispersion, and Fourier magnitude modeling. A MELP frame interval is 22.5 ms+/-0.01 percent in duration and contains 180 voice samples (8,000 samples/second).
  - The mixed-excitation is implemented using a multi-band mixing model. This model can simulate frequency dependent voicing strength using a novel adaptive filtering structure based on a fixed filterbank. The primary effect of this multi-band mixed-excitation is to reduce the buzz usually associated with LPC vocoders, especially in broadband acoustic noise.
  - When the input speech is voiced, the MELP vocoder can synthesize speech using either periodic or aperiodic pulses. Aperiodic pulses are most often used during transition regions between voiced and unvoiced segments of the speech signal. This feature allows the synthesizer to reproduce erratic glottal pulses without introducing tonal noises.
  - The pulse dispersion is implemented using fixed pulse dispersion filter based on a spectrally flattened triangle pulse. This filter has the effect of spreading the excitation energy with a pitch period. This, in turn, reduces the harsh quality of the synthetic speech.
  - The adaptive spectral enhancement filter is based on the poles of the LPC vocal tract filter and is used to enhance the formant structure in the synthetic speech. This filter improves the match between synthetic and natural bandpass waveforms, and introduces a more natural quality to the speech output.
  - Ten Fourier magnitudes are coded with an 8-bit vector quantizer. The index of the code vector, which minimizes the weighted Euclidean distance between the input and code vectors, is transmitted.

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