TWELP 300 bps Vocoder

Provides voice communication in hardest conditions where it was impossible before.

For Digital HF Radio and other markets.

TWELP Technology Features. The vocoder is based on newest technology of speech coding called "Tri-Wave Excited Linear Prediction" (TWELP) that was developed by experts of DSPINI.

TWELP technology is a new class of vocoders that differs from any other LPC-based vocoders by:

- advance reliable method of pitch estimation
- pitch-synchronous analysis
- advance tri-wave model of excitation
- newest quantization schemes
- pitch-synchronous synthesis

Thanks to these unique features, TWELP technology provides much better speech quality in comparison with any well-known technologies, including AMBE+2, MELPe, ACELP, etc. on the same bit rate in range from 300 bps up to 9600 bps and more. Moreover, in contrast to other LBR vocoders (like MELPe, etc.) TWELP provides much better quality for non-speech signals like sirens, background music, etc.

 Please visit: http://twelp.pro for details.

Speech Quality. Here is the comparison with MELPe vocoder, operating on twice higher bit rate 600 bps. TWELP 300 bps vocoder and MELPe 600 bps vocoder were tested, using ITU-T P.50 speech base for 20 different languages. ITU-T P.862 utility was used for estimation of the speech quality in PESQ terms:

Speech Quality Comparison
TWELP 300 bps vs MELPe 600 bps
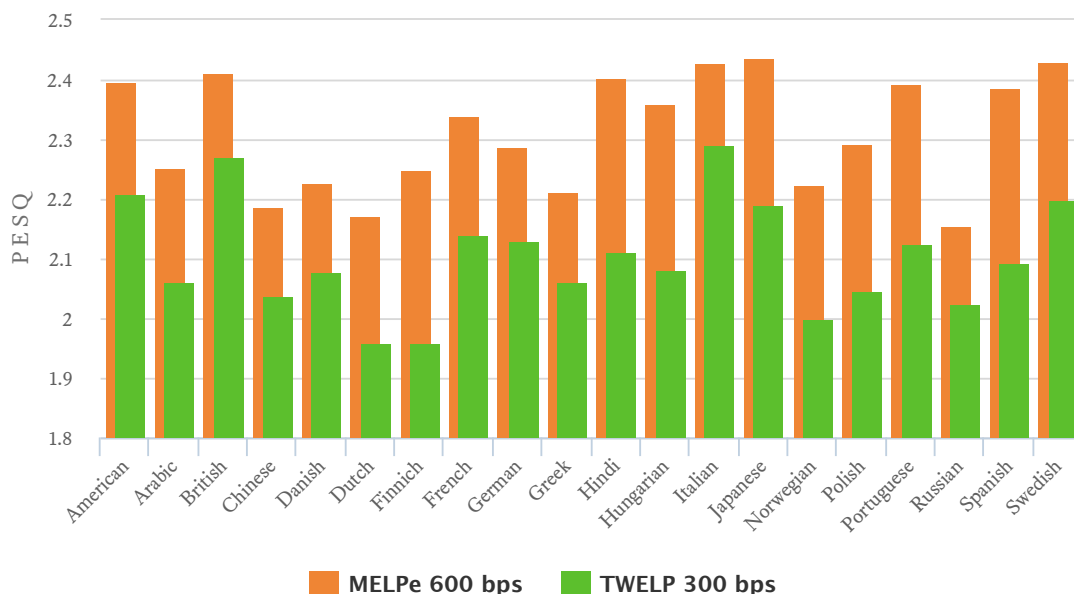
A diagram just demonstrates a difference in speech quality for TWELP 300 and MELPe 600 vocoders. Exact numbers are shown in the table below.

Language	MELPe 600 bps	TWELP 300 bps
American	2.397	2.208
Arabic	2.254	2.063
British	2.414	2.272
Chinese	2.189	2.038
Danish	2.227	2.079
Dutch	2.173	1.959
Finnich	2.249	1.959
French	2.34	2.141
German	2.287	2.131
Greek	2.212	2.061
Hindi	2.403	2.114
Hungarian	2.359	2.082
Italian	2.428	2.292
Japanese	2.436	2.192
Norwegian	2.225	1.999
Polish	2.294	2.046
Portuguese	2.393	2.126
Russian	2.156	2.024
Spanish	2.389	2.093
Swedish	2.43	2.199
Average	**2.31275**	**2.1039**

A difference is in average 0.209 PESQ

 Speech Samples (WAV-files). A few independent experts in HF-radio communication listened TWELP 300 bps vocoder and found that this vocoder provides a satisfactory intellegibility of voice for communication channels with very low (negative) SNR, where analogue radio provides no voice at all, where you can hear a noise only.

You can play and listen short samples of the source speech as well as the speech processed by Analogue Radio and Digital Radio (TWELP 300 bps vocoder + modem) for exactly the same AWGN channel with negative SNR, using links in the table below.

Also, you can download full set of the P.50 samples as zip-files for all languages simultaneously, using the links in the "Downloads" para in a bottom of the page.

Source Speech	Analogue Radio	Digital Radio
▶	▶	▶

Superiority In Quality Of The Non-speech Signals. In contrast to other LBR vocoders (MELPe, AMBE+2, etc.), TWELP vocoders provide high quality of non-speech signals, including police, ambulance, fire sirens, etc. This feature in conjunction with high quality natural human-sounding of voice makes TWELP vocoders well suitable for replacement of analog radio by digital radio and also for other applications where high quality transmitting of non-speech signals is relevant along with high quality transmitting of speech signals.

| Source type	Source signal	MELPe 600 bps	TWELP 300 bps
Siren only	▶	▶	▶
With voice	▶	▶	▶

High Robustness To Acoustic Noise. In contrast to other LBR vocoders, TWELP vocoders are well robust to acoustic noise thanks to robust reliable method of pitch estimation and other features of TWELP technology.

Moreover, vocoder includes in-built Noise Cancellation — Speech Enhancement (NCSE) functionality that improves speech quality in noisy acoustic environment.

NCSE Mode	Source signal	MELPe 600 bps	TWELP 300 bps
Disabled	▶	▶	▶
Enabled	▶	▶	▶

High Robustness To The Channel Errors. The diagram and table below show a dependence of the averaged speech quality for AWGN-noisy channel for different BER in comparison with other vocoders.

Special "robust" versions of the TWELP vocoders include FEC that are integrated with vocoder on base of "joint source-channel coding" approach that provides high speech quality simultaneously in noisy channel as well as in noiseless channel. FEC can operate with "soft decisions" as well as with "hard decisions" from a modem. "Soft decisions" mode provides much better robustness in comparison with the "hard decisions" mode.

Averaged Speech Quality in AWGN channel
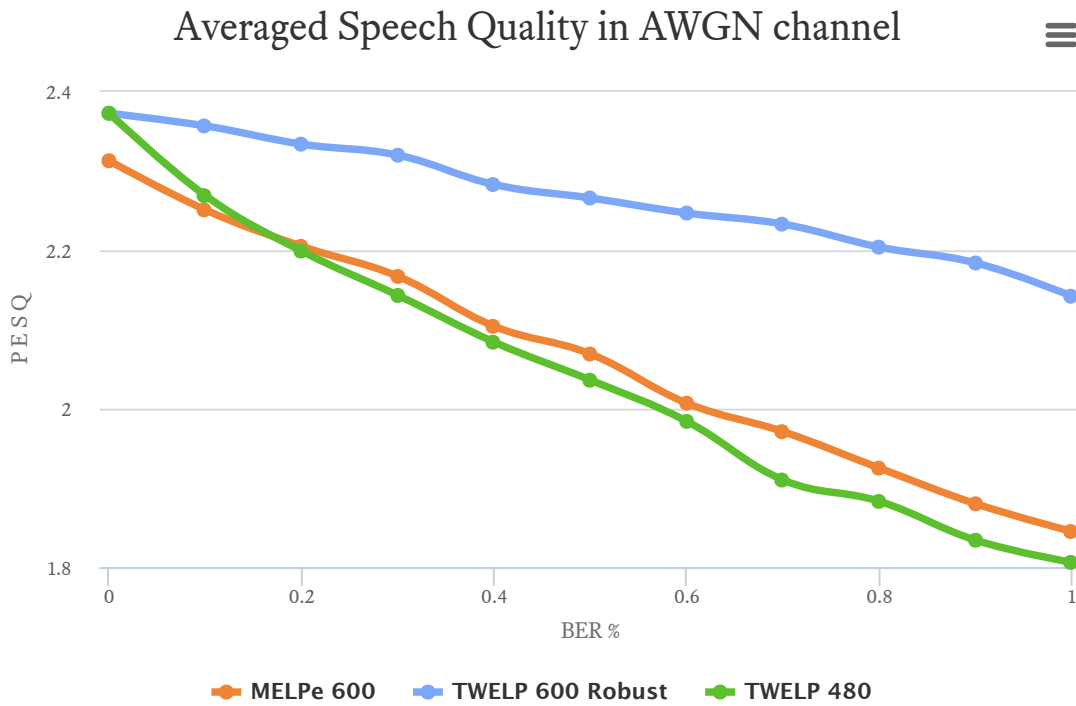
BER %	MELPe 600	TWELP 600 Robust	TWELP 480
0.00	2.313	2.373	2.373
0.10	2.251	2.357	2.269
0.20	2.205	2.334	2.199
0.30	2.167	2.32	2.143
0.40	2.104	2.283	2.084
0.50	2.069	2.266	2.036
0.60	2.007	2.247	1.984
0.70	1.971	2.233	1.910
0.80	1.925	2.204	1.883
0.90	1.880	2.184	1.834
1.00	1.845	2.142	1.806

Additional Functionalities. The following additional functionalities are developed by DSPINI and integrated into TWELP vocoders:

- Automatic Gain Control (AGC),
- Noise Cancellation for Speech Enhancement (NCSE)
- Voice Activity Detector (VAD),
- Tone Detection/Generation (Single tones and Dual tones). The tones are transmitted by the vocoder facilities.

Each functionality has unique features, performance and characteristics, providing significant superiority over any well-known implementations on the market.

Technical Characteristics And Resource Requirements:

Technical characteristics

Bit Rate (bps)	Algorithm	Frame size (ms)	Algorithmic delay (including frame size) (ms)	Sampling rate (kHz)	Signal format	Bit stream format
300	TWELP	320	340	8	Linear 16-bit PCM	96

Additional functionalities

Name	Functionality	Technical characteristics	
		Name	Value
AGC	Automatic Gain Control	Control range:	0 ... +20 dB
NCSE	Noise Canceller - Speech Enhancer	SNR increasing	> 6 dB
		Speech quality improvement	> 0.1 PESQ
Tone Detector	Single/Dual tones detection	In accordance with international standards	
Tone Generator	Single/Dual tones generation	Special generator, kept continuity of signal (phase and amplitude of signal of previous frame)	
VAD	Voice Activity Detection	Reliable detection speech in background noise	
CNG	Comfort Noise Generation	Type of noise	"white"
		Level	- 60 dB

Resources for ARM Cortex-M4 platform

Module	MIPS* peak	Memory (KBytes)					
		Program	Data				
			Constants	Channel	Heap	Stack
Voice Encoder	72.5	41	197	4.7	11.3	1.0
NCSE	6.4					
AGC	0.2					
Voice Decoder	13.3					
Voice Encoder + Voice Decoder	85.8					
Total	92.4					

Resources for TI's C64 DSP platform

Module	MIPS* peak	Memory (KBytes)					
		Program	Data				
			Constants	Channel	Heap	Stack
Voice Encoder	25.9	79	197	4.7	11.3	1.0
NCSE	2.8					
AGC	0.1					
Voice Decoder	3.8					
Voice Encoder + Voice Decoder	29.7					
Total	32.6					

Resources (estimated) for TI's C55 DSP platform

Module	MIPS* peak	Memory (KBytes)					
		Program	Data				
			Constants	Channel	Heap	Stack	
Voice Encoder	44	51	197	4.7	11.3	1.0	
NCSE	6.8						
AGC	0.2						
Voice Decoder	9.0						
Voice Encoder + Voice Decoder	53						
Total	60						

* DSPINI continues optimization of the TWELP algorithm and code in order to minimize computational complexity of the vocoder.

Guarantee And Support. DSPINI guarantees a quality and accordance of all technical characteristics of the product to requirement of current specifications. Testing and other method of quality control are used for guarantee support.

Any Platforms. DSPINI can port this vocoder software into any other DSP, RISC or general- purposes platform inshort time: 1-2 months.

Licensing Terms. To use the vocoder, customer should obtain a license from DSPINI only.

Adequate Price of the license is another advantage of this vocoder. Please contact us to find out.

Customization. The vocoder can be customized under any specific requirements- other bit rate, frame size, any other robustness to channel errors, etc. Please contact with us for details.

Prospects. DSPINI is impoving and developing continuously a set of new vocoders with range from 300 bps up to 9600 bps, based on TWELP technology.

Related Software. This vocoder may be effectively used in a bundle with other DSPINI's products:

- Linear and acoustic echo cancellers,
- Multichannel noise cancellers (including two-microphone adaptive array),
- Wired or radiomodems for any types of channels and bitrates,
- Other products.

Downloads:

- <u>Datasheet (pdf)</u>
- <u>ITU-T P.50 source speech samples (zip)</u>
- <u>MELPe 600 bps speech samples (zip)</u>
- <u>TWELP 300 bps speech samples (zip)</u>
- PC-evaluation package (zip) — on request
- User′s Guide document (pdf) — on request

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