COMPARISON OF AUDIO CODECS USING PEAQ

ALGORITHM

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COMPRESSION

STATE-OF-THE-ART TECHNOLOGY IN MODERN AUDIO COMMUNICATIONS: •MOBILE PHONES •RADIO AND TV SATELLITE NETWORKS •INTERNET AUDIO •DIGITAL AUDIO BROADCASTING BELOW 30 MHz (DRM – DIGITAL RADIO MONDIALE) AND OVER 30 MHz (DAB - DIGITAL AUDIO BROADCASTING) •DVD (DIGITAL VERSATILE DISC) •VOIP (VOICE OVER INTERNET PROTOCOL)

ESTING THE QUALITY

LOWERING DATA RATES TO A MINIMUM IS CONTRADICTORY TO CLARITY AND FIDELITY OF SOUND AND THE INTELLIGIBILITY OF SPEECH.

TODAY AUDIO ENCODERS THAT USES COMPRESSION, OR BETTER TO SAY - REDUCTION, USES PSYCHOACOUSTIC MODELS OF HUMAN HEARING

IT IS NECESSARY TO SIMULATE THE SUBJECTIVE EVALUATION OF HUMAN SUBJECTS IF WE WANT TO JUDGE THESE SYSTEMS. THE PSYCHOACOUSTIC MODELS ARE DEVELOPED UPON INVESTIGATIONS WITH THE REAL SIGNAL, AND THE CONTEMPORARY MEASUREMENTS HAVE TO USE THE SAME NATURAL STIMULUS FOR MEASUREMENT: HUMAN VOICE AND MUSIC PROGRAM MATERIAL.

EMPLOYMENT OF SUCH STIMULUS MAKES IT POSSIBLE TO MONITOR THE QUALITY DURING NORMAL OPERATION OF SYSTEM UNDER TEST. AS A CONSEQUENCE OF THIS APPROACH THAT MEASURES THE PERCEIVED AUDIO QUALITY INSTEAD OF SIGNAL CHARACTERISTICS, IT IS POSSIBLE TO GAIN AN OBJECTIVE METRICS, WHICH TRULY CHARACTERIZES THE QUALITY OF SERVICE ("QOS") OF A SYSTEM OR A NETWORK.

STANDARDIZATION

THE LACK OF INTERNATIONAL STANDARDS AND RECOGNIZED MEASUREMENT PROCEDURES, THE ONLY ACCEPTED ASSESSMENT PROCEDURES FOR AUDIO OR SPEECH CODECS WERE:

LISTENING TESTS

- 1993. ITU-T RECOMMENDATION P.800: THE FIRST METHODS FOR TESTING TELEPHONE BAND SPEECH SIGNALS - 1994. ITU-R REC.BS.1116: A TEST

PROCEDURE TO ASSESS WIDE BAND AUDIO

CODECS ON THE BASIS OF SUBJECTIVE TESTS

BJEBTIVE TESTING METHODS

- 1996. ITU-T REC. P.861: DEFINES THE METHOD FOR THE OBJECTIVE ANALYSIS OF SPEECH CODECS, IT IS CORRELATED UP TO 98% WITH THE SCORES OF SUBJECTIVE LISTENING TESTS. IT USES THE PSQM ALGORITHM FOR COGNITIME PERCEPTUAL MODEL.

- 2001. ITU-T REG. P.862: FOR SPECIFIC APPLICATIONS, SUCH AS VOIP, IT USES THE PESQ ALGORITHM FOR COGNITIVE PERCEPTUAL MODEL.

- 2001. ITU-R REC BS.1387: IT USES THE PEAQ ALGORITHM FOR PERCEPTUAL MODEL THE ANALYSIS OF THE RESULTS FROM A SUBJECTIVE LISTENING TEST IS BASED ON THE SUBJECTIVE DIFFERENCE GRADE (SDG) DEFINED AS:

SDG = GRADE SIGNAL UNDER TEST - GRADE REFERENCE SIGNAL

THE VALUES OF THE SDG RANGE FROM O TO -4, WHERE O CORRESPONDS TO AN "IMPERCEPTIBLE IMPAIRMENT" AND -4 TO A "VERY ANNOYING

IMPAIRMENT".

IMPAIRMENT	GRADE	SDG
IMPERCEPTIBLE	5.00	0.00
PERCEPTIBLE, BUT NOT ANNO	4.00	-1.00
SLIGHTLY ANNOYING	3.00	-2.00
ANNOYING	2.00	-3.00
VERY ANNOYING	1.00	-4.00

THE PROCESS OF COMPARATION IN OBJECTIVE

DIVIDED INTO SEVERAL PHASES,
EACH PHASE GIVES US AS A RESULT ONE OR MORE MODEL OUTPUT VARIABLES (MOV), I.E.
DESCRIPTORS FOR VARIOUS COGNITIVE PROCESSES,
THE FINAL QUALITY FIGURE TAKES INTO ACCOUNT ALL MOVS AND IS REPRESENTED AS SINGLE NUMBER OBJECTIVE DIFFERENCE GRADE (ODG).

MODEL OUTPUT VARIABLES (MOV):

> MOVS ARE EXTRACTED FROM THE COMPARISON OF THE EAR MODEL OUTPUT

OPERA NAME	BS.1387 NAME	
AvgBwRef	Average Bandwidth of the Reference Signal	
AvgBwTst	Average Bandwidth of the output signal of the device under test	
NMRTOTB	Total Noise-to-Mask Ratio	
ADB	AVERAGE DISTORTED BLOCK (FRAME), TAKEN AS THE LOGARITHM OF THE RATIO OF THE TOTAL DISTORTION TO THE TOTAL NUMBER OF SEVERELY DISTORTED FRAMES	
MFPD	MAXIMUM OF THE PROBABILITY OF DETECTION AFTER LOW PASS FILTERING	
EHS	HARMONIC STRUCTURE OF ERROR OVER TIME	
RDF	RELATIVE FRACTION OF FRAMES FOR WITCH AS LAST ONE FREQUENCY BAND	
WModDif18	WINDOWED AVERAGED DIFFERENCE IN MODULATION (ENVELOPES) BETWEEN Reference Signal and Signal under Test	
AModDif 1 B	Averaged modulation difference	
AModDif2B	Averaged modulation difference with emphasis on introduced modulations and modulation changes where the reference contains little or no modulations	
NLOUDB	RMS VALUE OF THE AVERAGED NOISE LOUDNESS WITH EMPHASIS ON	

DDG (DBJECTIVE DIFFERENCE GRADE):

- OUTPUT VALUE FROM THE OBJECTIVE MEASUREMENT METHOD THAT CORRESPONDES TO THE SDG IN THE SUBJECTIVE DOMAIN

DI (DISTORTION INDEX)

-SIMILAR MEANING AS ODG



COMPARISON OF THE DI AND THE ODG. LEFT DIAGRAM DI, RIGHT DIAGRAM ODG

GENERAL RULE: USE THE ODG AS THE QUALITY MEASURE FOR ODG VALUES GREATER THAN -3.6, AND DI WHEN THE ODG VALUE IS LESS THAN -3.6

MEASUREMENTS

IN THIS PAPER WE SHOW THE RESULTS OF TESTS MADE ON 4 CODECS: MP2 AND MP3 (MPEG 1 LAYER 2 AND LAYER 3, ACCORDING TO ISO/IEC 11172/3), AAC (ADVANCED AUDIO CODING OR MPEG 2 AAC, ACCORDING TO ISO/IEC 13818/3, 1994.) AND OGG VORBIS (FREE CODEC FROM XIPH.ORG)

THE TESTS WERE DONE USING THE PEAQ MEASUREMENT ALGORITHM ACCORDING TO ITU-R BS.1387. IMPLEMENTED IN THE COMPUTER MEASURING SYSTEM OPERA FROM OPTICOM.

TEST PROCEDURE

1. ENCODING OF REFERENTIAL AUDIO CLIP* ON ALL CODECS AND ON ALL MOST COMMON BITRATES

 DECODING ALL OF THE COMPRESSED CLIPS TO WAV
 PERFORMING TESTS IN OPERA COMPARING THEM WITH THE REFERENTIAL UNCOMPRESSED

CLIP

ALL MEASUREMENTS WERE DONE IN STEREO SO THE BIT RATES ARE SHOWED ACCORDINGLY (I.E. 128 KBPS REFERS TO TWO [LEFT AND RIGHT] 64 KBPS ENCODED AUDIO CHANNELS). * THE AUDIO CLIP USED FOR ENCODING AND TESTING WAS RIPPED FROM AUDIO CD IN WAV FORMAT (16 BIT, 44.1 KHZ), IT WAS 5

SECONDS IN DURATION

FOR THE BRIEF OVERALL COMPARISON THE FINAL ODG VALUE FOR DIFFERENT BIT RATES ARE SHOWN. FOR DEEPER ANALYSIS THE MOVS OBTAINED DURING THE MEASUREMENTS ARE SHOWN ON THE NEXT SLIDE.







OPTICOM







ODG(BV) DI(BV) AvgBwTst RDF AvgBwRef NMRtot<u>B</u> WModDif1B AModDif2B EHS AModDif1B NLoudB

Osa Trigger: Off -0.10d8 Rel Time: 0:05.085



CONCLUSION

•ALL CODECS ACT SIMILARLY AT HIGHER (≥160 KBPS) BITRATES - THE DIFFERENCES ARE MINIMAL EXCEPT FOR THE MP2

•ON THE LOWER BITRATES (<160 KBPS) ON THE OTHER HAND, WE CAN SEE DIFFERENT BEHAVIOR OF ALL FOUR CODECS, ESPECIALLY IN THE MOST INTERESTING 128 KBPS. THE BEST IS OGG VORBIS AND THE AAC IS VERY NEAR. FROM THESE RESULTS WE CAN CONCLUDE THAT IT IS VERY IMPORTANT TO PICK THE RIGHT CODEC AT LOWER BITRATES WHILE IT IS NOT SO IMPORTANT ON HIGHER BITRATES IN THE TERMS OF AUDIO QUALITY. HOWEVER, DUE TO THE POPULARITY OF SOME CODECS, I.E. MP3, THE CHOICE IS OFTEN NOT ONLY BASED ON QUALITY AND THAT IS WHY IT IS VERY HARD TO RECOMMEND ANY IN PARTICULAR.