Requirements For A JND Based Video Quality Measurement Method

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1. Scope and Objectives:

1.1 The scope of this project is intentionally narrow. The purpose is to prove that degraded video images and sequences can be scored by subjective testing and used as a calibration reference. If the results prove favorable, this concept can be expanded to include other artifacts of compression. Testing can also continue into other scan rates and resolutions.

1.2 Objective 1: To develop a set of video sequences with induced artifacts typical of those resulting from DCT based compression systems.

1.3 Objective 2: To refine the definition of a JND to quantify subjective levels of video degradation.

1.4 Objective 3: To benchmark the video sequences in objective 1 into JND units as defined in objective 2.

1.5 Objective 4: To disseminate test sequences obtained in objective 3 to interested parties.

1.6 Objective 5: To recommend methods for the correlated test sequences of objective 4 to be used as industry standard benchmarks to calibrate video quality analysis tools.

2. Application:

2.1 A great deal of research has been done in the field of video quality analysis using algorithms which simulate the human visual system. A typical measurement system will derive the difference between an original video sequence and the same sequence degraded by a device under test. By analysis of the difference signal through a human visual model, it is possible to quantify the degree of impairment.

2.2 Although analysis tools have made substantial breakthroughs, a common need is to calibrate objective measurements to subjective test results. It is impractical for each entity to conduct subjective viewer tests and maintain consistent quantitative results. By providing tapes of sequences with known degradation to all manufacturers and laboratories, it may be possible to calibrate many

instruments to a common reference. This will allow the video industry to establish uniform metrics and set specification limits for DCT based compression equipment.

3. Video Sequence Requirements:

3.1 Test sequences must have monotonically increasing degradation of at least 3 JNDs. This is necessary to calibrate instruments to the test sequences.

3.2 Test tapes must contain sequences which demonstrate the predominant compression defects of blocking, mosquito noise, and contouring. Each sequence shall emphasize one predominant defect at a time. Combinations of defects will be avoided.

3.3 For each defect type, there will be several pairs of sequences recorded onto the test tape with varying degrees of degradation. The test sequences will be arranged in a psudo-random pattern. The test tape can be used to determine the one, two, and three JND points and correlate results with other subjective testing labs.

3.4 Reference sequences must be based on 525 line Rec. 601 digital video and archived on a medium suitable for distribution with minimal generational loss such as digital video tape without compression. Tests on other standards including 625 lines will be deferred to future projects.

3.5 Video content must be available to the public on a royalty free basis.

3.6 A candidate sequence for blocking will contain a fixed camera position on a rapidly flowing stream of water. To a compression system, the moving water will present a moving picture with little correlation. To a human observer, there will be a highly predictable pattern. Squares or straight lines resulting from compression will be easily seen as compression artifacts.

3.7. A candidate sequence for mosquito noise will contain a still image with text characters superimposed or keyed over a background image. The text will consist of white characters over a uniform dark gray background on some portions of the scene. The human observer will look for artificial vertical or horizontal edges surrounding the text characters.

3.8 A candidate sequence for contouring will consist of a still image with a smooth gradation in the luminance level. A scene with a background wall with non-uniform lighting is suitable for this test. The human observer will look for contour lines on the background wall compared to the original scene which has a smooth change in the gray scale. If noise is present, the contour line will appear ragged.

3.9 Standard line 21 closed captioning will be used in the lower portion of the screen to identify the test sequences. The closed caption information will be turned on for subjective viewer tests. Each sequence will be identified with the sequence number, the defect to be evaluated, and identification showing whether it is the A or B test segment.

Examples of viewer information:

Sequence #13
Blocking
A

Sequence #20
Mosquito Noise
B

4. Subjective Testing Requirements:

4.1 The primary objective is to have repeatable results and therefore to minimize uncertainty in the testing and analytical processes.

4.2 Trained viewers shall be used. All viewers will be trained by showing them what type of defect to look for in each sequence to minimize confusion with extraneous factors.

4.3 Viewers shall be tested for proper vision at the specified distance.

4.4 The viewing distance shall be three screen heights. This distance is intended to allow clear focus on edges and small objects without eye strain while still maintaining peripheral vision of the full image. For consistency, the screen size shall be not less than 19" nor more than 21" measured diagonally on a 4x3 display.

4.5 Viewers shall observe one screen with alternating sequences of A and B video. Each test sequence shall have the following pattern:

	Duration	Start Time
A video	5 Sec.	00 Sec.
Gray	1	05
B video	5	06
Gray	1	11
A video	5	12
Gray	1	17
B video	5	18
Gray	1	23
A video	5	24
Gray	1	29
B video	5	30

Gray	1	35
A video	5	36
Scoring and rest	19	41

4.6 The viewer shall have three choices; 1) A is better, 2) B is better, or 3) No preference. Better is defined as less of the distortion of interest.

4.7 There shall be no more than three simultaneous viewers assigned to each screen and the viewing angle shall be as direct as possible. Only direct view CRTs shall be used.

5. Definition of a JND:

5.1 One JND is the point where 75% of the viewers prefer A video over B video or vice versa. The viewer will not be told whether the A or B video has been degraded. This must be determined statistically. With this method, it is possible to have one JND of impairment between any two video sequences as long as there is a 75/25 ratio of viewers.

5.2 The two and three JND points are defined by a step and repeat process. When the one JND point is identified in 5.1 above, it becomes the new baseline for comparison. When 75% of the viewers can see further degradation of the same imparment parameter, the two JND point is determined. The process can continue to three JNDs or more.

5.3 Fractional JNDs are not defined at this time. It may be possible to extrapolate a curve to obtain measurements below one JND but this analysis will be deferred until after the testing phase.

6. Glossary of Acronyms:

CRT	Cathode Ray Tube
DCT	Discrete Cosine Transform
JND	Just Noticeable Difference
MPEG	Moving Pictures Experts Group