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TITLE: Proposed Attributes of a Video Reference Unit (VRU) and the Need for a Standardized Set of Video Test Scenes

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TITLE: Proposed Attributes of a Video Reference Unit (VRU) and the Need for a Standardized Set of Video Test Scenes

ABSTRACT:

To maximize the usefulness of the video reference unit (VRU) being developed as Recommendation P.VRU by Study Group 12, this contribution proposes:

1. A set of attributes for the VRU that should be considered during its development. In particular,
   a. Considerations of digital video transmission system impairments that should be simulated by the VRU.
   b. An adjustable range of video impairment levels that should be simulated by the VRU.
2. That a separate Recommendation be developed that would specify a standardized set of video test scenes for use with the VRU and other subjective and objective digital video testing methods.

This contribution shows that the perceived level of digital video impairments (e.g., blurring, jerkiness) is highly dependent on the video scene content (i.e., the amount of spatial and temporal information in the video scene). As a consequence, the video scenes used with the VRU must also be standardized if the VRU is to be of value.

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1. Proposed Attributes of a Video Reference Unit (VRU)

1.1 Considerations of Digital Video Transmission System Impairments

We recommend that the following categories of distortions be included in the Video Reference Unit (VRU) simulation of common digital video system transmission impairments. Since the method of simulation has yet to be defined, example impairments in each video system distortion category are described from the user's viewpoint.

1. Artifacts due to conversions between analog and digital formats (e.g., blurring).
2. Artifacts due to coding and compression (e.g., color errors, jerkiness, scene cut response, smearing, tiling).
3. Artifacts due to transmission channel errors (e.g., error blocks).

From the user's point of view, the simulated video impairments generated by the VRU should visually approximate impairments generated by digital video transmission systems.

1.2 An Adjustable Range of Video Impairment Levels

In principle, the amount of distortion for each impairment should be independently adjustable. The ranges of adjustment should be sufficient to cover a full range of quality for digital video transmission systems. For each of the impairments, the adjustment step size requires further study.

2. The Need for a Standardized Set of Video Test Scenes

Two possible applications for the VRU are (1) quantifying the user-perceived quality of a video system with respect to a known reference, and (2) defining standard video impairment levels that can be used to compare subjective test results from different laboratories. For either application, standardization of the VRU alone is not sufficient. The video scenes used with the VRU must also be standardized if the VRU is to be of value. This is because the perceived level of digital video impairments (e.g., blurring, jerkiness) is highly dependent on the video scene content (i.e., the amount of spatial and temporal information in the video scene).

Figure 1 gives a diagram of the first application. Here, the same video scene is injected into the video system under test and the VRU. The video output from the video system under test and the VRU are displayed on two identical monitors. The VRU impairment level settings (given by the position of the knobs shown in Figure 1) are adjusted until a viewing test subject judges that the visual qualities are matched. The VRU impairment level settings are then used to quantify the performance of the video system under test. Since the amount of a particular impairment present in the output of a digital video transmission system could vary greatly depending on the input video scene, the impairment level settings of the VRU may have to be changed when the scene content changes. For example, given a single digital video system, a sports event scene could produce much greater impairments than a head and shoulders scene (with only the eyes and lips of the subject moving). This effect is most dramatic for low bit-rate systems such as videophones, but can also be significant for high bit-rate systems. Therefore, in general, reporting of the VRU impairment level settings is not sufficient. The video scene used to determine the VRU impairment level settings must also be reported.

The duration of appropriate scenes and possible multiple repetitions thereof is an important topic for study.

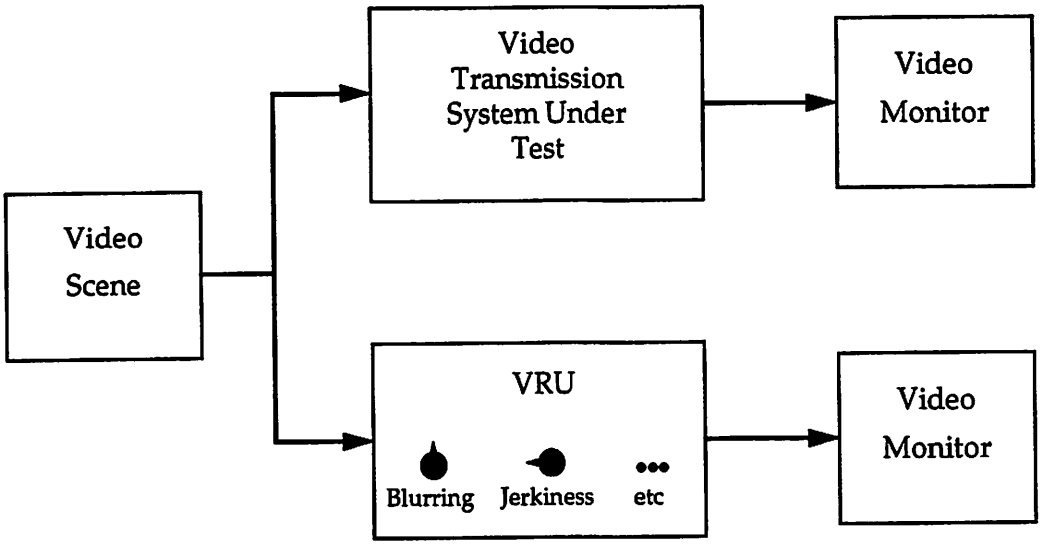

Figure 1 VRU Setup for Quantifying Performance of a Video Transmission System

For the second application, different laboratories include identical VRU settings in their subjective tests. The assumption is that the subjective scores for a particular VRU setting from each laboratory can be used to help estimate the inter-laboratory differences, thereby allowing the different laboratories to directly compare their subjective test results. The problem is that specification of the VRU impairment level settings is not, in general, sufficient to assure that the different laboratories can estimate these inter-laboratory differences. To see this, consider the following simple example. Laboratory 1 has decided to use mostly still video scenes for testing a given video system. On the other hand, laboratory 2 has decided to use mostly sports events scenes with lots of motion for testing the same video system as laboratory 1. The VRU condition was selected such that the only non-zero impairment setting was the amount of jerkiness, and this was set so that the video would be updated only 5 times per second. In this hypothetical example, the laboratory 1 scenes that went through the VRU would be judged to have much higher quality than the laboratory 2 scenes. The resulting VRU test data will not be particularly useful since it is confounded with the variability of perceived quality due to choice of scenes. Although the setting of the jerkiness knob in the VRU was used for this simple example, similar arguments can be made for the other impairment settings in the VRU. For instance, blurring of a video scene which contains fine detail (such as a map with small text) will be much more noticable and objectionable than blurring of a scene that has only coarse detail. This is true because the fine detail scene contains higher spatial frequencies and hence suffers more impairment than coarse detail when passed through a given band-limiting process.

3. Recommendation

In light of the above discussion, development of the P.VRU Recommendation should be complemented with the development of an additional Recommendation that specifies a standardized set of video test scenes for use with the VRU. This standardized set of video test scenes should include samples from a wide range of user applications. Since the dependency of perceived quality on scene content is an important characteristic of digital video systems, such a

standardized set of video test scenes will be important for other subjective and objective digital video testing methods as appropriate for various video services.

4. Glossary

These are working definitions appropriate for initial consideration and planning of the VRU system. As technical details of the VRU system mature, these definitions may need to be revised.

Block Distortion	Distortion of the received image characterized by appearance of the underlying block encoding structure.
Blurring	A global distortion over the entire image, characterized by reduced sharpness of edges and spatial detail.
Color Errors	Distortion of all or a portion of the received image in which unnatural or unexpected hues appear.
Error Blocks	A form of block distortion where one or more blocks in the received image bear no resemblance to the current or previous scene and often contrast greatly with adjacent blocks.
Jerkiness	Motion that was originally smooth and continuous is perceived as a series of distinct snapshots.
Scene Cut	Video imagery where adjacent frames are not highly correlated.
Scene Cut Response	The perceived impairments associated with a scene cut.
Smearing	A localized distortion over a subregion of the image, characterized by reduced sharpness of edges and spatial detail.
Tiling	See block distortion.