Batch Video Quality Metric (BVQM) User's Manual

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handbook series

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BATCH VIDEO QUALITY METRIC (BVQM) USER'S MANUAL

Mark A. McFarland, Margaret H. Pinson, Stephen Wolf[1]

This handbook provides a user's manual for the batch video quality metric (BVQM) tool. BVQM runs under the Windows XP® operating system. BVQM performs objective automated quality assessments of processed video clip batches (i.e., as output by a video system under test). BVQM reports video calibration and quality metric results such as: temporal registration, spatial registration, spatial scaling, valid region, gain/level offset, and objective video quality estimates. BVQM operates on original and processed video files only, and has no video capture capability.

BVQM compares the original video clip to the processed video clip and reports quality estimates on a scale from zero to one. On this scale, zero means that no impairment is visible and one means that the video clip has reached the maximum impairment level (excursions beyond one are possible for extremely impaired video sequences).

Key words: automatic measurements; batch video clip processing; digital video; metrics; objective video quality performance; video calibration; video quality

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1.   INTRODUCTION

The Institute for Telecommunication Sciences (ITS) has developed a video quality metric (BVQM) software tool that performs automated batch processing of multiple video clips to objectively assess their video quality.   Section 7 describes the video quality measurement options BVQM implements, including how to:

- Perform calibration of the sampled video files (i.e., spatial scaling, spatial registration, valid region estimation, gain/level offset, and temporal registration)
- Determine which video quality models to use for estimating the overall quality perception

This user's guide does not specify the algorithms BVQM utilizes. If you need more information about the algorithms that are used, see the references given in Section 7.

BVQM provides a graphical user interface (GUI) to select the video clips you want to batch process.   Processing consists of calibrating the processed video clips and calculating their associated video quality metrics.   You can manually set calibration values, or choose between several automated calibration options. Multiple video quality model options are also available.   After processing, BVQM displays the results graphically and provides text file reports. All results are available for viewing or export to Microsoft Excel or other spreadsheet software.

This user manual is written for the Windows XP platform. There are differences in the installation procedure, screenshots, and known issues (Section 10) for the Linux version of BVQM. Please see the Linux readme file for more information.

2.   REQUIREMENTS

BVQM requires one computer with the following minimum criteria:

- 3 GHz Pentium Processor
- Windows XP, Service Pack 2
- 2 GB RAM
- 4 GB free disk space (depends on video clips being processed)
- 1600 x 1200 pixel resolution monitor
- MATLAB Component Runtime (MCR) library

For 10-second video scenes sampled in accordance with Rec. 601 [1], BVQM requires approximately 1 GB of free memory. Otherwise, an "out of memory" error may result. Disk drive speed impacts performance.

<u>Warning:</u> Insufficient disk space or memory will prevent BVQM from running successfully.

3.   INSTALLATION PROCEDURE

If a prior version of BVQM was installed, you must first uninstall the old version of the MATLAB Component Runtime Library before proceeding and install the version supplied with the BVQM software. To uninstall the old MATLAB Component Runtime Library, from the Windows **Start** menu, select **Control Panel** > **Add/Remove Programs**. From the list of programs, select **MATLAB Component Runtime**, then click **Remove**.

Follow these steps to install BVQM:

1. Copy the files on the BVQM installation CD to a directory on your computer. This directory will be denoted as C:\bvqm for the rest of the installation instructions given below, but any directory may be chosen.

2. Double-click MCRInstaller.exe in C:\bvqm and follow the instructions to install the MCR library on your computer.

3.   After completing installation, check to make sure that the MCR library is installed properly. From the Windows **Start** menu, select **Control Panel**, then double-click **Add or Remove Programs** and see if the MATLAB Component Runtime library appears in the list of installed programs. If not, repeat step 2.

4.   OPERATIONAL OVERVIEW

You can process multiple video clips at once with BVQM in six steps:

1. <u>Select a results directory</u>. The BVQM software will start and display the browse window for the Results directory. This directory stores temporary files and report files that contain BVQM results. See Section 4.5.

2. <u>Select a video clip directory</u>. This directory contains all the video clip files that will be examined by BVQM. See Section 4.5

3. <u>Select the video files</u>. Select the original and processed video files to be analyzed by BVQM. BVQM might request additional information on the video clips (e.g., field ordering) when video files are selected. See Section 5.

4. [*Optional*] <u>Enter manual calibration settings</u>. You can enter additional information for each video sequence. Settings in this window control manual calibration specifications. See Section 6.

5. <u>Select calibration type and model</u>. Select the calibration option and video quality model that you want BVQM to use. See Section 7.

6. <u>Wait for results</u>. BVQM reports results to the results window and saves them to the results directory. See Section 8.

Steps 3 to 6 are fully documented in Section 5 through Section 8, respectively.

4.1   Video File Constraints

BVQM can only operate on video files that are saved in certain formats. The first format supported by BVQM is Audio Video Interleave (AVI). Only <u>uncompressed</u> AVI files are supported. These uncompressed AVI files must contain either the RGB24 format or the UYVY format.   BVQM will run slightly faster on AVI files containing UYVY. Compressed AVI files must be converted into uncompressed AVI files prior to use by BVQM. Note, however, that the video distortions caused by the compression will influence the results.

The second format, called "Big YUV" in this document, is a convenient binary file format for storing Rec. 601 sampled video [1]. In the Big YUV format all the frames are stored sequentially in one big binary file. The sampling is 4:2:2 and image pixels are stored sequentially by video scan line as bytes in the following order: Cb_1 Y_1 Cr_1 Y_2 Cb_3 Y_3 Cr_3 Y_4…, where Y is the luminance component, Cb is the blue chrominance component, Cr is the red chrominance component, and the subscript is the pixel number. The Y signal is quantized into 220 levels where black = 16 and white = 235, while the Cb and Cr signals are quantized into 225 levels with zero signal corresponding to 128. Occasional excursions beyond these levels may occur. For example, Y=15 may be

produced by a real system, but in any case, Y, Cb, and Cr values are always between 0 and 255. The two chrominance components are sub-sampled by two horizontally. BVQM will run faster on Big-YUV files than on uncompressed AVI files.[2]

Converting video from other formats into the formats required for BVQM to operate is outside the scope of this document. Video conversion issues can be quite complex. Care should be taken to preserve field ordering (i.e., field one remains in field one, and field two remains in field two). If video is acquired via frame grabbing, make sure there are no missing or dropped video frames, as this will affect the video quality measurement. Unnecessary color space conversions (e.g., from RGB24 to UYVY and vice versa) should also be avoided.

4.2   File Naming Convention for Automated Processing

BVQM automatically determines how to process video files by examining the video file names. Setup time is therefore greatly reduced when standard file names are used for all video files. The standard filename convention for the BVQM software is *"scene_hrc"* followed by the suffix ".avi" for AVI files or ".yuv" for Big-YUV files. The "scene" and "hrc" names are short strings containing only letters and numbers. The user may specify an alternate standard naming convention of the form "test_scene_hrc.avi" or "test_scene_hrc.yuv". However, the current version of BVQM can only analyze one video test (i.e., a batch of video clip files from one experiment or test) at a time.

"Scene" identifies a single video sequence (e.g., segment of video). All versions of the same scene should be given the same name.

"HRC" or "Hypothetical Reference Circuit" indicates a video system under test such as a coder operating at a certain bit rate over a digital transmission channel and being decoded by a decoder. Whenever any parameter is changed on the coder, transmission channel, or decoder, this should be named as a different HRC. BVQM obtains increased accuracy by examining multiple scenes that have been passed through the same HRC. Thus, HRC names must be used carefully and accurately.

The HRC name "original" refers to the highest quality version of the "scene" that is available, and this will be used as the reference sequence for the measurements for that scene. The original is normally the input video sequence that was passed through the HRCs to create the processed video sequences. Preferably, the original video should never have been compressed. Original video sequences should appear to have either "Excellent" or "Good" quality when examined visually. Poor quality original video sequences (e.g., with visible compression artifacts) may reduce BVQM accuracy. **The original video sequence must be available to BVQM.**

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[2] Examples of video sequences in the Big YUV format may be obtained at www.vqeg.org.

If non-standard file names are used, you must enter the scene and HRC naming information manually for each clip. The original must be identified with an HRC name of "original". Use of clip files that do not follow the standard naming convention will slow down setup and may result in errors due to manual entry mistakes. Therefore, use of the standard naming conventions given above are highly encouraged and recommended.

4.3   Long Video Files

Clips over 15 seconds in length are truncated to 15 seconds (i.e., only the first 15 seconds of the clip is used). Quality estimation on video sequences longer than 15 seconds will be available on future releases of BVQM.

4.4   Starting BVQM

Follow these steps to start BVQM:

1. From the Windows **Start** menu, select **All Programs** > **Accessories** > **Command Prompt**.

2. Change to the C:\bvqm installation directory in step 1 of Section 3, for example, by typing **cd C:\bvqm** at the command prompt. Alternately, you may set up your command window to start in directory C:\bvqm.

3. Type **bvqm** at the command prompt, then press **Enter**.

Note: Please wait patiently for the initial BVQM window to appear. BVQM needs to load several dynamic linked libraries into memory when it runs.

4.5   Specifying the Results Directory and Clips Directory

When you start BVQM you must specify the results directory and the clips directory. The results directory stores temporary files and report files that contain BVQM results. Ensure you have write permission for the results directory you specify. The clips directory contains all the video clips files to be examined in one pass through BVQM. Follow these steps to specify the results and clips directories.

1. Start BVQM as described in section 4.4.

   Once BVQM starts, it displays a browse window to specify the results directory. (see Figure 1)
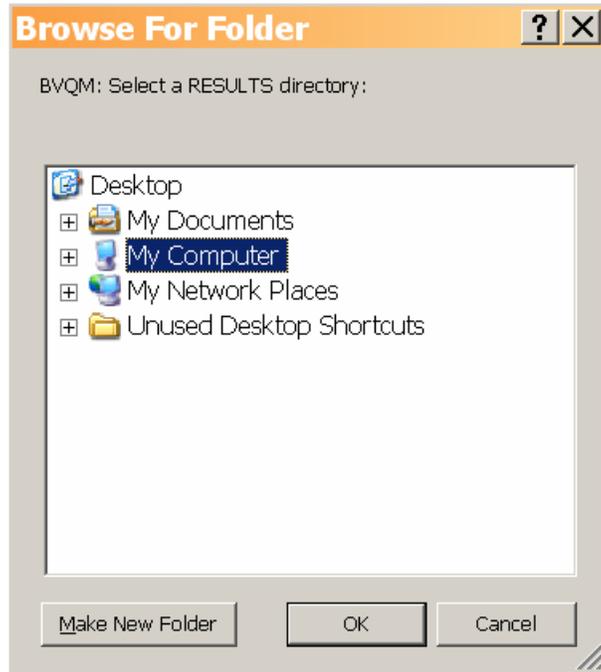
Figure 1. Results directory selection window.

2. Navigate the directory structure, make a new folder if necessary, and then click **OK** after you specify the results directory.

3. BVQM displays a browse window to specify the clips directory as shown in Figure 2. Note: Figure 2 differs from Figure 1 in that the text under the titlebar indicates that you are selecting a "CLIP" directory.
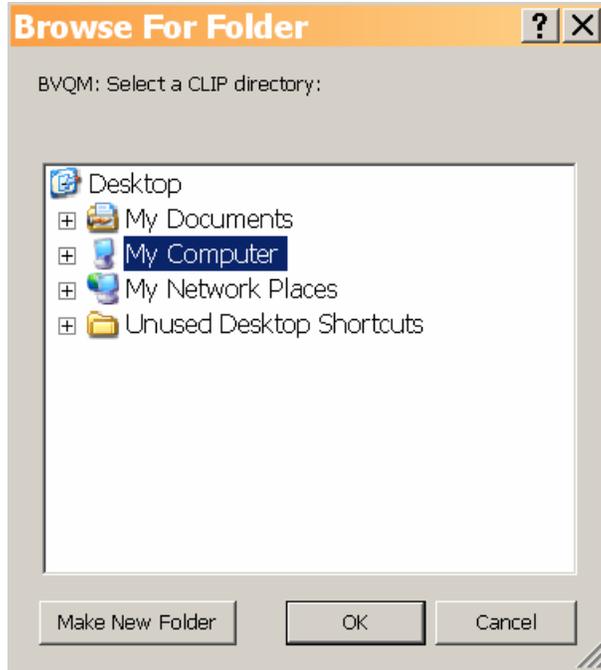
Figure 2. Video clip directory selection window.

4. Navigate the directory structure, make a new folder if necessary, and then click OK after you specify the clips directory.

The main BVQM window displays. See Section 5.1 for information about selecting video clips to process.

4.6   Automatic Crash Recovery

If incomplete data from previous BVQM operations are found in the selected results directory, BVQM will display an alert and commence with automatic crash recovery. Hence, very little processing time is lost in the event of a system crash or power failure. When the crash recovery is complete, BVQM will continue where it left off.

5.   PROCESSING VIDEO CLIPS

Once you have specified the results directory and the clips directory as described in Section 4.5, the main BVQM window (see Figure 3) displays and you are ready to select the video clips you want to analyze.
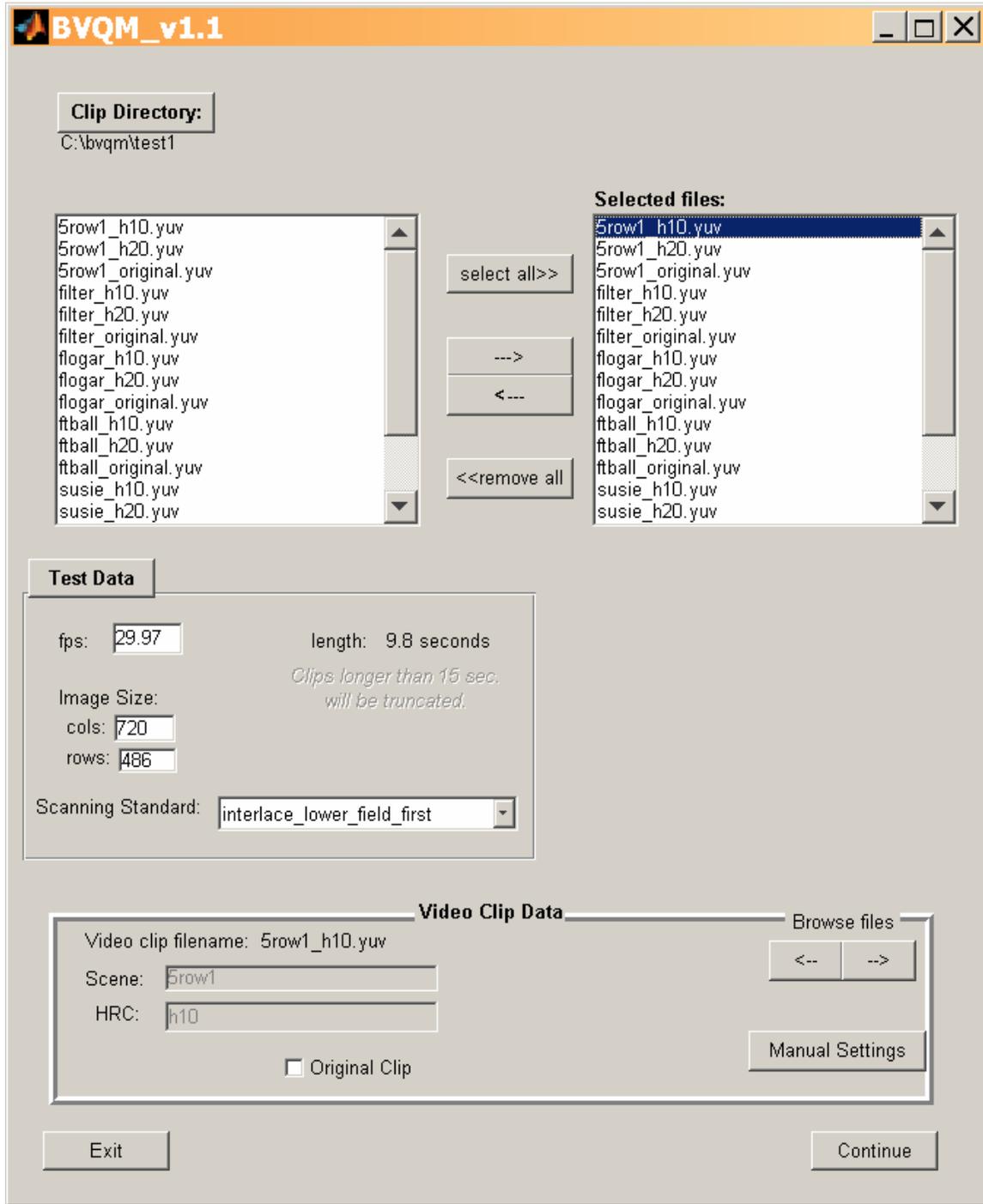
Figure 3. Main BVQM window.

5.1   Selecting Video Clips to Analyze

The listbox on the upper left hand side of the main BVQM window lists all the video clip files in the clip directory (see Section 4.5). To change the clip directory, click **Clip Directory**.

The listbox on the upper right hand side of the window lists all the video clip files currently selected for processing. To select an individual video clip file, click it in the Clip Directory listbox, then click the right arrow. The selected clip file appears in the Selected Files listbox. Video files in the Big-YUV format require you to provide information about the video sequences as described in Section 5.2. To select all clip files in the clip directory simultaneously, click **Select All**.

To remove a video clip file from the Selected Clips list, click it and then click the left arrow. To remove all clip files in the Clip Directory simultaneously, click **Remove All**.

5.2   Specifying Image Size

When video files you select for analysis are in the Big-YUV format, you must provide information about the video sequences. The first video clip you select in the Big-YUV format initiates a window to input the image size and frame rate (see Figure 4).
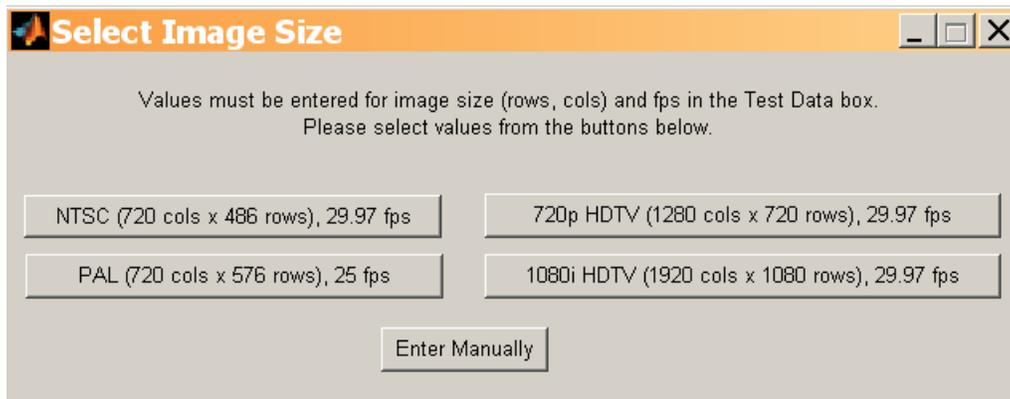
Figure 4. Select image size window.

Selecting one of the following four options will automatically set the **Scanning Standard** in the main BVQM window to the most likely value (i.e., interlace lower field first, interlace upper field first, or progressive):

- NSTC
- PAL

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- 720p
- 1080i

If clips in the Big-YUV format are a different size or frame rate than the available options, click **Enter Manually** to input the image size (columns and rows) and frame rate in the main BVQM window. The scanning standard in this case will be set to progressive. If this default scanning standard is incorrect, use the **Scanning Standard** pull-down menu in the main BVQM window to change it. Once the image size and frame rate data are entered, BVQM displays the length (in seconds) of the selected video clip in the Test Data section of the main BVQM window. The Test Data section presents information that is identical for all selected video clips: image size (rows & columns), frame rate, and scanning standard. These data are set when selecting the first clip, and they cannot be manually adjusted by the user after the first clip is entered.

To change the image size or frame rate, click on the **Test Data** button. This will clear the current values and query you to reenter them. The scanning standard will be reset to the most appropriate value based upon the new data entered.

Important Note: All selected clip files must have the same image size, frame rate and scanning standard. BVQM initializes the default scanning standard value depending on the identified image size and frame rate. However, this value may be incorrect for some video capture systems. Always verify the scanning standard and manually change it as necessary.

5.3   Specifying Video Clip Data

The Video Clip Data section at the bottom of the main BVQM window contains information for the clip file currently selected in the Selected Files listbox. When standard file names are used, values for **Scene**, **HRC**, and the **Original Clip** checkbox display for each clip file as you click the Browse Files left or right arrows. Alternatively, you can double-click the file in the Selected Files listbox to select the file. When non-standard file names are loaded, you will be asked to enter the scene and HRC values manually in a pop-up window for each video clip file. Ensure that you identify Scene and HRC values accurately for each clip file, otherwise BVQM will not be able to accurately estimate the calibration or quality of the selected video clips and HRCs.

You can fine-tune clip file information and calibration settings for each clip file by clicking **Manual Settings**. See Section 6 for more information.

Once you have selected the clip files you want and are satisfied with all parameters for the clips, click **Continue** in the lower-right corner of the main BVQM window. BVQM will display the calibration and model selection window (see Section 7) unless there is an error.

6. MANUAL SETTINGS WINDOW

You can adjust calibration settings and optional settings for each clip file listed in the Selected Files listbox in the main BVQM window. To access these settings, double-click the desired clip in the Selected Files listbox, then click **Manual Settings**, or alternatively use the Browse Files left or right arrows in the Video Clip Data section. The Manual Settings window displays (see Figure 5).

Figure 5. Manual Settings window.

6.1   Start and Stop Frames

At the top of the Manual Settings window, you can enter **Start Frame** and **Stop Frame** values to specify the portion of video you want to consider within the file. Frames outside of this range will be ignored. Following are **Start Frame** and **Stop Frame** definitions:

- **Start Frame**   Number of the first frame to consider in the video file. For short files, this value defaults to one. For files longer than 15 seconds in length, see Section 4.3.

- **Stop Frame**   Number of the last frame to consider in the video file. For short files, this will be the last frame in the file. For long files, see Section 4.3.

You can use the **Start Frame** and **Stop Frame** values to discard the beginning or end of the video file from consideration without editing the file. For example, the first second may not be of interest or may contain atypical video quality (e.g., very low quality due to video codec initialization).

6.2   Optional Settings

You can use the Optional Settings section in the Manual Settings window to enter the subjective video quality mean opinion score (MOS) and other descriptive information. If you enter a MOS, BVQM considers it in plot comparisons between subjective scores and their objective quality estimates in the Results Window (Section 8). If you specify subjective scores for all processed clips, then additional options and information will be available on the results window. Following are definitions for the optional settings you can specify:

- **Viewers**   Number of viewers who rated this video clip.

- **Stdev**   Standard deviation of the opinion scores for the clip.

- **MOS**   Mean Opinion Score (MOS) of the clip.

- **INLSA MOS**   Alternate MOS, for example, scaled by the Iterative Nested Least Squares Algorithm (INLSA) [2].

- **Subjective Method** Text description of the subjective test method.

- **HRC Description**   Text description of the HRC.

- **Scene Description** Text description of the scene.

6.3   Manual Calibration Settings

If you know the clip file's actual calibration values, you might choose to enter those values in the Manual Calibration Settings section in the Manual Settings window. The Manual Calibration Settings are only used when the Manual Calibration option is selected on the Calibration and Model Selection screen (see Figure 6). All other calibration options will discard these settings. Following are definitions for the calibration parameters:

- **Horizontal Shift** Specifies the horizontal shift (in pixels) between the fields (interlace) or frames (progressive) of the processed video. Value must be an integer. A positive horizontal shift is associated with a processed field or frame that has been moved to the right (with respect to the original) by that number of pixels.

- **Vertical Shift** Specifies the vertical shift in frame lines between the processed video. Value must be an integer. A positive vertical shift is associated with a processed field or frame that has been moved down (with respect to the original) by that number of frame lines.

- **Luminance Gain** A multiplicative scaling factor applied by the HRC to all pixels of the luminance image (i.e., the Y component). Gain of the luminance signal is commonly known as contrast. System gains greater than 1.0 may produce processed video that has amplitude clipping (clipped whites).

- **Luminance Offset** An additive factor applied by the HRC to all pixels of the luminance image (i.e., the Y component). Offset of the luminance signal is commonly known as brightness. Offset is specified in Rec. 601 quantization levels, where an offset of 1 is one quantization level. This is a real number that can be either positive or negative. Large system offsets (positive or negative) may produce processed video that has amplitude clipping at the high or low end (clipped whites or clipped blacks).

- **Align Start** The alignment start point of the video clip, in frames, where 1 is the first frame in the file. The "align start" frame of the processed clip time aligns to the "align start" frame of the original clip. This value is not auto-populated but estimated by the temporal registration routines of BVQM and output to the results report (see Section 8). You can manually enter a value and select the Manual Calibration option on the Calibration and Model Selection window. The "align start" is always greater than or equal to the "start frame" and provides the first frame over which the video quality estimate will be computed.

- **Align Stop** The alignment stop point of the video clip, in frames, where 1 is the first frame in the file. The "align stop" frame of the processed clip time aligns to the "align stop" frame of the original clip. This value is not auto-populated but estimated by the temporal registration routines of BVQM and output to the results report (see Section 8). You can manually enter a value and select the Manual

Calibration option on the Calibration and Model Selection window. The "align stop" is always less than or equal to the "stop frame" and provides the last frame over which the video quality estimate will be computed.

- **Horizontal Scale** The horizontal scaling factor (referenced to 1000, where 1000 is no scaling) of the processed video image. A scale factor greater than 1000 represents image stretching, while a scale factor less than 1000 represents image shrinkage. For example, a scale factor of 1010 represents scaling by 101%.

- **Vertical Scale** The vertical scaling factor (referenced to 1000, where 1000 is no scaling) of the processed video image. A scale factor greater than 1000 represents image stretching while a scale factor less than 1000 represents image shrinkage. For example, a scale factor of 1010 represents scaling by 101%.

- **Valid Region Top** Specifies the first or top-most line of the frame that contains valid video. This value must be an even number, where pixel number one is the top-most line of the frame. This value is referenced to the original frame (i.e., for processed video, spatial scaling and shift must first be removed – see [3]).

- **Valid Region Left** Specifies the first or left-most pixel of the frame that contains valid video. This value must be an even number, where pixel number one is the left-most pixel of the frame. This value is referenced to the original frame (i.e., for processed video, spatial scaling and shift must first be removed – see [3]).

- **Valid Region Bottom** Specifies the last or bottom-most line of the frame that contains valid video. This value must be an even number, where 1 is the top-most line of the frame, and is referenced to the original frame (i.e., for processed video, spatial scaling and shift must first be removed – see [3]).

- **Valid Region Right** Specifies the last or right-most pixel of the image frame that contains valid video. This value must be an even number, where 1 is the left-most pixel of the frame, and is referenced to the original frame (i.e., for processed video, spatial scaling and shift must first be removed – see [3]).

When viewing the manual settings for *original* clips, note that it is not possible to change the horizontal shift, vertical shift, luminance gain, luminance offset, horizontal scale, or vertical scale.

When you finish entering settings for the clip file, click **Close** to return to the main BVQM window. Once you have selected the clips you want and are happy with all parameters for the clips, click **Continue** in the lower-right corner of the main BVQM window. BVQM displays the calibration and model selection window (see Section 7) unless there is an error (see Section 6.4).

6.4   Error Troubleshooting

If there is an error or inconsistency with the selected clips (e.g., if the valid region for a processed clip does not match the valid region for the corresponding original clip), a warning is displayed with information about what to correct. The following restrictions apply to video clips chosen for a single run of the BVQM software:

- For each processed video clip, there must be a matching original video clip with the same scene name and similar time extent (e.g., visually, the sequence starts and stops at approximately the same point).

- There must be one and only one original video clip for each scene. The "original clip" check button will automatically be selected for all original clips.

- All video clips must have the same frame rate and image size.

- All video clips must have the same scanning standard (i.e., 'progressive', 'interlace lower field first' or 'interlace upper field first').

All video files must be saved in one of the file formats specified in Section 4.1.

7.   SPECIFYING CALIBRATION AND A VIDEO QUALITY MODEL

The last step in the video clip analysis setup process is to specify a calibration algorithm and a video quality model (see Figure 6). See Sections 7.1 and 7.3 for information about calibration and video quality model options, respectively.
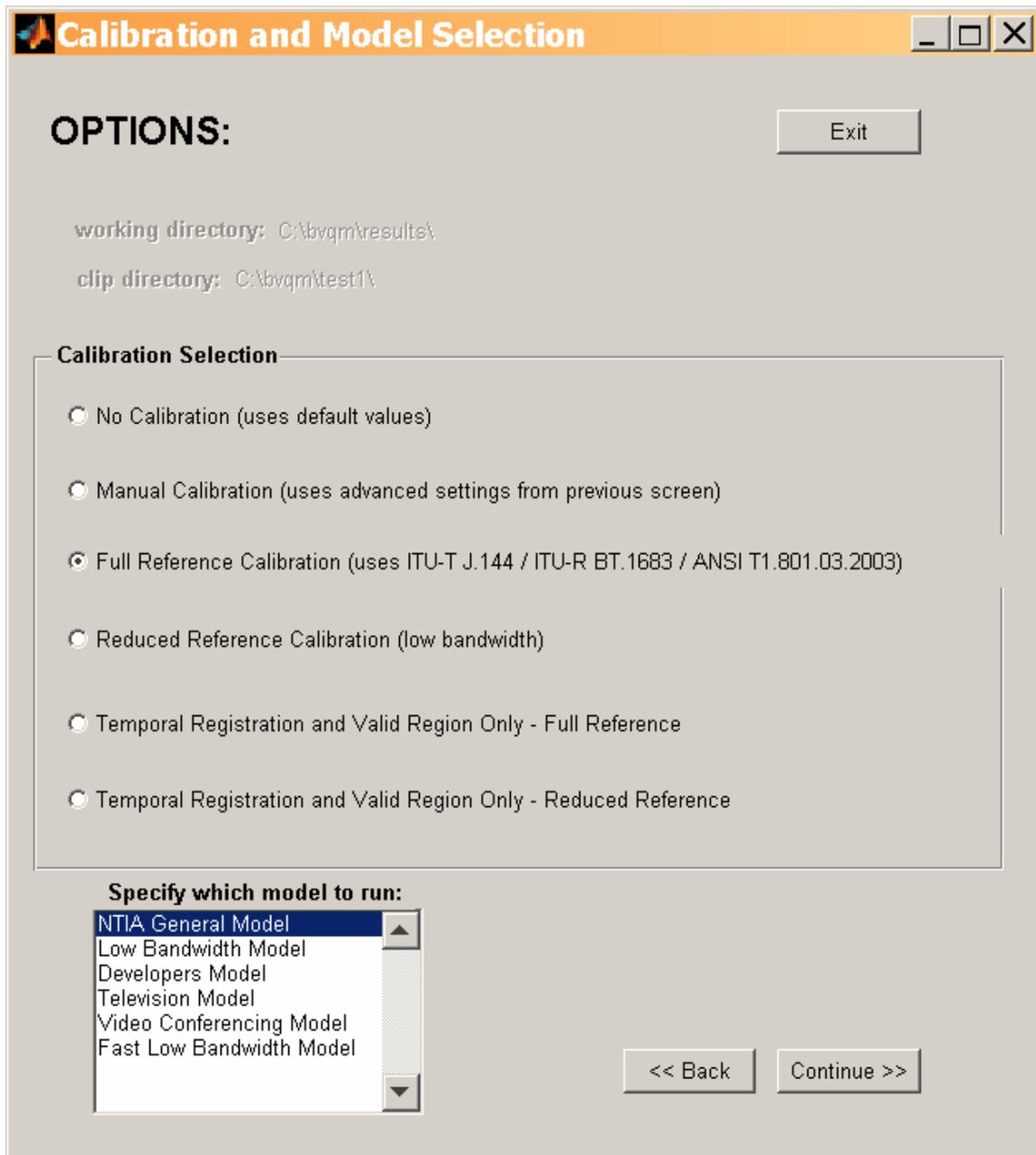
Figure 6. Calibration and model selection window.

After you have made your selections, click **Continue** in the Calibration and Model Selection window to start the computations. If you select Full Reference or Reduced Reference calibration, pop-up windows display additional options described in Section 7.2.

Once BVQM begins processing the clips, a status bar shows the relative time until completion of the calibration and model algorithms. Note that processing can take several hours. For example, one processed video sequence of eight seconds duration, 30 fps, and 720 x 486 resolution run with manual calibration and the NTIA General Model might take up to five minutes to run on a 3 GHz Pentium Processor.

When BVQM finishes processing, the Video Quality Measurement Results window displays the video quality metric results of the batch processing. See Section 8 for more information.

7.1   Calibration Selection

Calibration attempts to remove impairments from the processed video sequence that viewers either don't see or don't care about. Impairments include, for example, a spatial shift of the entire video sequence a few pixels to the right. If an HRC has induced such a shift, and it is not removed prior to model calculation, then the model's quality estimates may be significantly less accurate (i.e., the model will normally over-penalize in this case).

The Full Reference and Reduced Reference calibration algorithms become more accurate when you run BVQM with multiple scenes associated with the same HRC. Some calibration parameters are systematic – that is, constant for each HRC – and thus improved accuracy is obtained by simultaneously examining all scenes associated with a single HRC. Preferably, a minimum of five unique scenes should be run through each HRC to obtain robust calibration estimates; and preferably the scenes should be visually very different (e.g., varying amounts of motion, varying amounts of spatial detail, varying patterns and textures and colors). The ordering of the scenes for each HRC will not affect the results.

The Calibration and Model Selection window provides the following calibration options:

- **No Calibration** Performs no calibration. BVQM assumes that the start frames in original and processed video files align temporally, and runs the model with default calibration values. This assumes that the processed video file is perfectly calibrated.
- **Manual Calibration** Reads the calibration quantities from the user-input settings that were entered in the Manual Settings window (see Section 6).
- **Full Reference Calibration** Performs full reference calibration as given in ANSI T1.801.03-2003 [4], ITU-T J.144 (03/04) [5], and ITU-R BT.1683 (06/04) [6]. You will be prompted for the temporal registration uncertainty (see Section 7.2).

The default value is plus or minus one second. This calibration option cannot detect spatial scaling of the processed video.

- **Reduced Reference Calibration**   Performs reduced reference calibration as given in [3]. These algorithms use random processes, which may yield slightly different results from one run to another. You will be prompted for the temporal registration uncertainty (the default value is plus or minus one second) and asked whether spatial scaling should be performed (the default selection is 'no', see Section 7.2). The reduced reference algorithms can exhibit poor behavior for scenes with nearly constant motion throughout the entire clip (e.g., a smooth continuous pan). If problems occur, try using full reference calibration instead. The reduced reference calibration's spatial scaling estimation algorithm is valuable for HRCs that perform spatial scaling (i.e., stretching or shrinkage) of the image. This algorithm may exhibit poor behavior for some types of scene content and thus should only be utilized when five or more video scenes are associated with each HRC.
- **Temporal Registration and Valid Region Only - Full Reference**   Performs only the temporal registration and valid region estimation algorithms of full reference calibration (i.e., no spatial registration, gain, or offset).
- **Temporal Registration and Valid Region Only - Reduced Reference**   Performs only the temporal registration and valid region estimation algorithms of reduced reference calibration (i.e., no spatial registration, scaling, gain, or offset).

7.2   Temporal Registration Uncertainty and Spatial Scaling Options

If you select Full Reference or Reduced Reference calibration in the Calibration and Model Selection window, dialogue windows provide temporal registration uncertainty and spatial scaling options. Temporal registration uncertainty indicates the maximum expected uncertainty (in seconds) of the temporal registration between the processed and original video files. Temporal registration uncertainty is bi-directional (i.e., plus or minus). The value specified should be slightly larger than the maximum delay expected or the temporal registration routines will not be able to find the proper delay. The default value for the temporal registration uncertainty is plus or minus one second.

Spatial scaling issues may not be obvious when a processed video sequence is viewed. Spatial scaling problems may produce video quality metric scores that indicate significantly lower quality than expected from a visual inspection of the video. BVQM does not perform spatial scaling estimation by default for the reduced reference calibration (you must select it manually in the pop-up window).

7.3   Video Quality Model Selection

The video quality models estimate the mean of a group's opinions of the overall quality experience when watching a video clip. The Calibration and Model Selection window provides the following video quality models:

- **NTIA General Model** The NTIA General Model has been standardized by ANSI [4] and included in two ITU Recommendations ([5] and [6]). The General Model provides a set of parameters and parameter weightings you can use to accurately evaluate video quality over a wide range of quality and bit rates. The NTIA General Model is also fully documented in [7] and summarized in [8].
- **Low Bandwidth Model** This model utilizes reduced reference features that minimize the required IP network bandwidth (for Rec. 601 video [1], approximately 10 kbits/sec are required to transmit the reduced reference features). The run-speed of this model is comparable to that of the General Model. An overview of the Low Bandwidth Model is given in [9]. This model is approximately as fast as the NTIA General Model.
- **Developer's Model** The Developer's Model minimizes CPU usage and is an approximation of the NTIA General Model. This model is approximately six times faster than the NTIA General Model. The Developer's model is fully documented in [7], which includes accuracy comparisons for the two models.
- **Television Model** This model is specifically optimized for higher video quality typically found in television applications (bit rates greater than 1.5 Mbits/sec). This model is fully documented in [7].
- **Video Conferencing Model** This model is specifically optimized for lower video quality typically found in video conferencing applications (bit rates from 10Kbits/sec to 1.5 Mbits/sec). This model is fully documented in [7].
- **Fast Low Bandwidth Model** This model minimizes CPU usage and is an approximation of the Low Bandwidth Model.[3] This model is approximately four times faster than the Low Bandwidth Model.

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[3] The Fast Low Bandwidth model differs from the Low Bandwidth model in the following ways: (1) Each second of video is averaged prior to calculating the spatial information features, (2) The temporal information features utilize only the luminance image, and (3) The temporal information features use a sub-sampling of pixels rather than the entire image.

8. VIEWING RESULTS

The Video Quality Measurement Results window displays the results from the test. Results may be viewed either graphically (see Figure 7) or as text.

Use the pull-down menu in the top half of the results window to select a specific graphical summary to view. For example, you can select summaries to show video quality vs. clip, HRC, or scene. You can also view detailed results for each individual clip by selecting **Details: Single-Clip Results** from the pull-down menu and then selecting the clip of interest. Results graphs show the overall video quality metric score along with the parameters that comprise the chosen model, such as si_loss, hv_gain, etc. To export the graph that is currently displayed, click **Export Graph** below the pull-down menu.

The bottom half of the results window is labeled "Report"; it displays the data in text format. In the Report Type section, click **Summary** or **Detailed** to view either the summary report or the detailed report. BVQM saves all data in the results directory. The full path and filename of the report are shown above text. To view this data in Excel, click **View in Excel**. To save results as an Excel file, click **Export to Excel**, then enter a path and file name for the file.
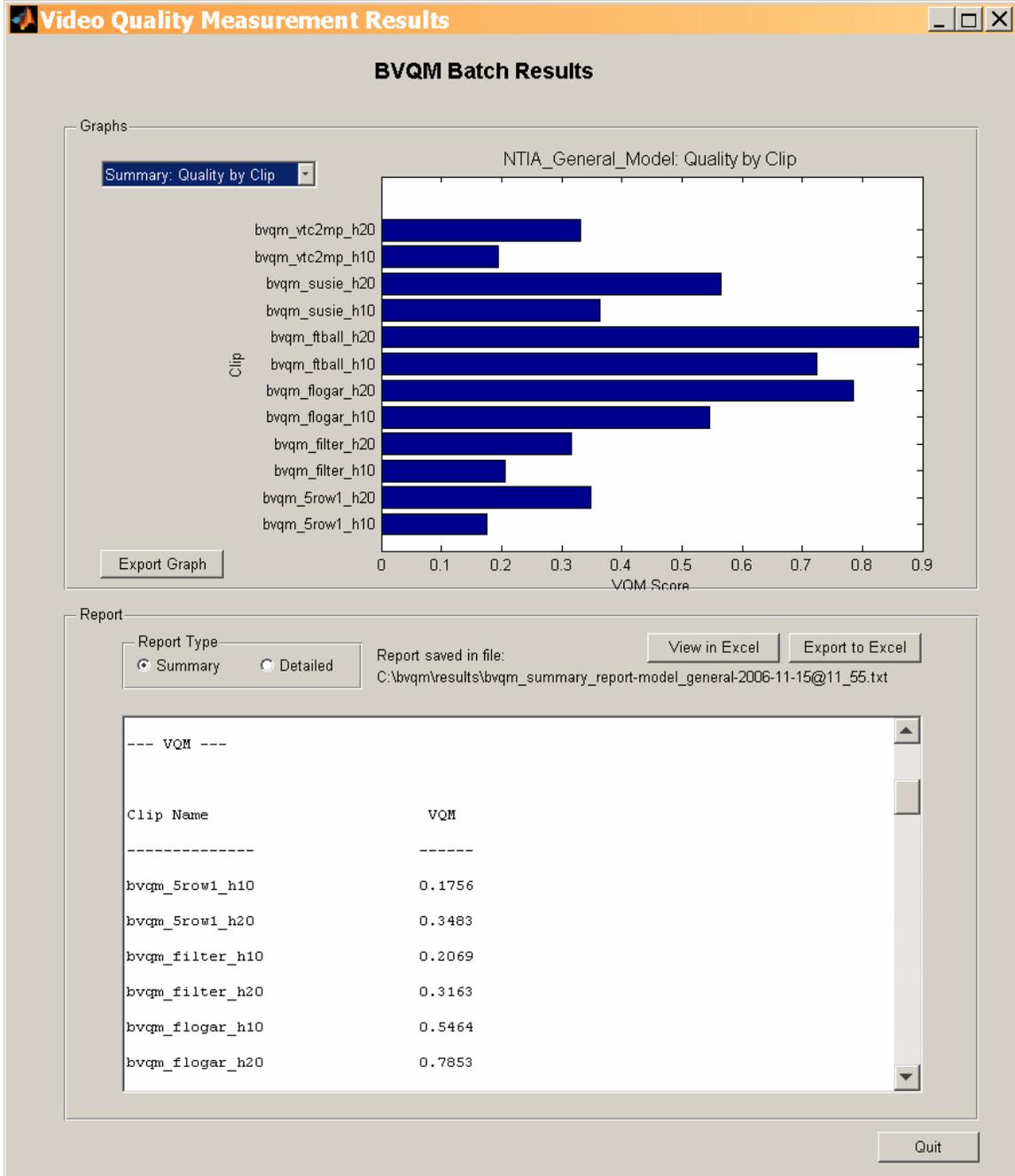
Figure 7. Video Quality Measurement Results window.

9.   EXITING BVQM

To quit BVQM from the Video Quality Measurement Results window (Figure 7), click **Quit**. You will be asked if you want to save intermediate results before quitting. The intermediate results consist of the temporary files and directories that were created and used during processing (e.g., quality features stored in *.mat MATLAB files). If you choose to save the intermediate results, they will be stored in the results directory. Choosing not to save intermediate results will erase all of the temporary files and directories that were created during processing. The summary and detail reports will remain in the results directory.

You can also quit by clicking **Exit** in the main BVQM window (Figure 3), or by clicking the upper-right corner **X** of the main BVQM window or the Calibration and Model Selection window (Figure 6).

10. KNOWN ISSUES

Following is a list of the known issues in the BVQM software.

Issue #   **Description**

1. <u>Out of Memory</u>. Insufficient memory (e.g., less than 1 GB free system memory) may cause BVQM to fail during processing. Modifying your computer's memory usage performance options may increase the amount of contiguous memory available to BVQM. Follow these steps to perform this modification: a) Right-click **My Computer**, and select **Properties.** b) In the System Properties window that appears, click the **Advanced** tab, then click **Settings** in the Performance section. c) In the Performance Options window that appears, click the **Advanced** tab, then in the Memory usage section, select **System cache** and click **OK**. d) Reboot your computer.

2. The calibration summary information given for each clip is actually the filtered results for the HRC through which the clip was passed (i.e., the calibration results from all clips for a given HRC are examined and the median value is calculated; this single value is displayed for each clip). Future releases will also give the unfiltered calibration information for each clip that was passed through the HRC.

3. Clips longer than 15 seconds are truncated. Future releases will allow processing of clips longer than 15 seconds.

4. Clicking a file in the Selected Files listbox of the main BVQM window (see Figure 3) does not update the Video Clip Data section of the main BVQM window even though the clip appears to be selected. To update the Video Clip Data section, either double-click the file, or use the "Browse Files" buttons.

5. When many clips are processed, the results graphs may not display properly.

6. Processing a set of AVI files through BVQM (in a single run) that contain different fps, image cols, or image rows is currently not detected by the BVQM software. BVQM will use the fps, image cols, and image rows of the first AVI file that is selected and produce erroneous results for the clips that have different fps, image cols, or image rows.

11. REFERENCES

[1] ITU-R Recommendation BT.601, "Encoding parameters of digital television for studios," Recommendations of the ITU, Radiocommunication Sector.

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[3] M. Pinson and S. Wolf, "Reduced reference video calibration algorithms," NTIA Report TR-06-433a, Jul. 2006. Available at www.its.bldrdoc.gov/pub/n3/video/index.php.

[4] ANSI T1.801.03 – 2003, "American National Standard for Telecommunications – Digital transport of one-way video signals – Parameters for objective performance assessment," American National Standards Institute. Available at www.ansi.org.

[5] ITU-T Recommendation J.144, "Objective perceptual video quality measurement techniques for digital cable television in the presence of a full reference," Recommendations of the ITU, Telecommunication Standardization Sector.

[6] ITU-R Recommendation BT.1683, "Objective perceptual video quality measurement techniques for standard definition digital broadcast television in the presence of a full reference," Recommendations of the ITU, Radiocommunication Sector.

[7] S. Wolf and M. Pinson, "Video quality measurement techniques," NTIA Report 02-392, Jun. 2002. Available at www.its.bldrdoc.gov/pub/n3/video/index.php.

[8] M. Pinson and S. Wolf, "A new standardized method for objectively measuring video quality," *IEEE Transactions on Broadcasting*, v. 50, n. 3, pp. 312-322, Sept. 2004. Available at www.its.bldrdoc.gov/pub/n3/video/index.php.

[9] S. Wolf and M. Pinson, "Low bandwidth reduced reference video quality monitoring system," in *Proc. First International Workshop on Video Processing and Quality Metrics for Consumer Electronics*, Scottsdale, Arizona, Jan. 23-25, 2005. Available at www.its.bldrdoc.gov/pub/n3/video/index.php.