BIOSCIENCES BIOTECHNOLOGY RESEARCH ASIA, November 2014. Vol. **11**(Spl. Edn.), p. 265-268

Modern Methods of Processing of Video Information and Evaluating the Quality of Streaming Video Perception

Tatyana Sergeevna Abbasova,
Vladimir Mikhailovich Artyushenko and Kim Leonidovich Samarov

Financial and Technical Academy, 141070, 42

doi: http://dx.doi.org/10.13005/bbra/1473

(Received: 27 September 2014; accepted: 10 October 2014)

Various metrics of evaluation of the quality of the transmitted video information are considered. Algorithms for calculating the objective and subjective ratings of the video information are described, including RMSE, PSNR, PQR, VQM. The main problems are given that appeared in the process of quality assessment and related to the desyncronization of the images and other negative effects associated with the transmission of the video information over the wireless communication channels. In conclusion, a brief comparison of the considered metrics is performed.

Key words: Quality of the video information, Subjective metric, objective metric.

Digital video information transmitted over a telecommunications network, passes a distortion occurring the process of digitization, compression, transmission, decoding and reproducing of video signals. Thus, when video is compressed quality reduction occurs due to the reduction of amount of information about the image structure. Parameters, which remain unchanged, are used to assess the quality[1-3]. This article analyzes the most common metrics to evaluate the quality of the video.

1. Subjective metrics

Subjective metrics use features of human vision. These metrics are described in the standard ITU-R BT.500-8-11. The standard contains such measurement techniques as SSCQE, DSIS, DSCQS. SSCQE (Single-Stimulus Continuous Quality Evaluation) is a continuous quality assessment during a single viewing. Observer is shown a few videos. The amount of distortion in these videos can be different. Grades range from 0 (for the worst quality) to 1 (for best quality). The rating is exhibited only once and can not be changed in the future.

DSIS (Double Stimulus Impairment Scale) - pair evaluation of the deterioration of video quality. Observer is invited to compare two video sequences - distorted and original. Test duration is 8 seconds. The observer estimates the visual distortions on a five-mark scale. The maximum score 5 - corresponds to the imperceptible distortion, an average score 3 – to distortions that prevent to see, minimum 1 - viewing is not possible.

DSCQS (Double Stimulus Continuous Quality Scale) - continuous quality evaluation based on the results of the two views. This method is based on two previously described metrics, has been widely used and allows to evaluate the video streaming with high degree of accuracy. The image quality is assessed in the same way as in the method DSIS. A distinctive feature is that the video is played in a pseudo-random order, and then repeats. After finished viewing the observer is given some

* To whom all correspondence should be addressed.

time to put up evaluation. The technique is also a five-mark scale: 5 - excellent quality, 4 - good quality, 3 - satisfactory quality, 2 - bad 1 - very poor quality. The observer writes the rating items in a special form or enters data in a specialized program. Then, all the estimates are averaged and converted to a standard scale (0 to 100). Thus, you can always appreciate the differences between the original and distorted visual rate. After finishing gathering information from all experts data is processed using statistical algorithms[4-10].

Objective metrics

To automate the quality assurance processes of streaming video objective metrics were developed which made it possible to measure the quality of the video in two modes. In the first mode all the available video sequence is available for analysis, in the second - evaluation forms for each frame. There are following objective metrics: RMSE (Root Mean Square Error) - the mean square error that defined as the distance between two pixels. To calculate this parameter, you need to average the value of the difference between the readings of the original and distorted sequences.

$$E_{RSM} = \sqrt{\frac{1}{M*N}\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}[f^{`}(m,n) - f(m,n)]^2}$$

Here *f* - the original frame, *f* ' - distorted, N, and M - the parameters responsible for the aspect ratio.

SNR (Signal-to-Noise Ratio) - the ratio between the signal level and the noise level calculated for the current image and defined by the formula

$$SNR = \frac{\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}[f^{`}(m,n)]^2}{\sum_{m=0}^{M-1}\sum_{n=0}^{N-1}[f^{`}(m,n) - f(m,n)]^2}$$

PSNR (Peak Signal-to-Noise Ratio) - peak (logarithmic) signal to noise ratio is used to determine the quality of the encoding algorithm and depends on the magnitude of the differences between the original and distorted image. PSNR is calculated using equation

$$PSNR = 20*\log_{10}(\frac{255}{RSME})$$

The main drawback of the described metrics is that they do not correlate with subjective and greatly dependent on the spatial and temporal redundancy of images[11,12]. That's why more efficient quality metric have been developed.

PQR (Picture Quality Ratio) - quality image rating. This metric takes into account some of features of human vision. Two video sequences are compared, each of which has an arbitrary duration. Each frame is divided into three regions counts (counts luminance Y, chrominance blue (Cb '), and chrominance red (Cr'). Based on these data color components are generated: red R, green G, blue B. The processing unit of the front image is used to generate from the RGB components the signal of the luminance and making the dichromatic image (u *, v *), which is used in the underlying units. Processing unit of luminance samples retrieves the parameter Y for the two types of images (the original video sequence and the distorted video sequences). Then a map of samples PQR is created. This map is an image consisting of halftones, the level of which is proportional to the difference between the pixels of the analyzed frames. This scheme also includes a processing unit of the chroma components that generates at its output a map of the intensities of color. The process of processing chromatic data and information on the intensity of the color begins at the entrance of the luminescence channel and allows to determine differences in the structure of the original and distorted frame. Besidesthe data on the counts of brightness and color intensity of the samples are selected from small areas of the projected image and applied to the appropriate card. Analysis of these cards allows to determine more detail the distortion of the received image. Method PQR requires a mandatory synchronization between analyzed and the original video sequences. After the formation of PQR maps comparison of the calculated parameters with the subjective evaluation of users is taken place.

VQM (Video Quality Metric) - a metric that uses the discrete cosine transform to exactly match human perception. The principle of operation is as follows. Original and distorted video sequences pass the same set of functional units which carry out data selection, their correlation, calculation of various indicators of quality, and, finally, the calculation of the parameter VQM. The parameter itself estimates the distortion caused by the passage through a variety of digital video transmission system blocks. These distortions are coding errors, errors in the discrete communication channel and errors of the decoding. For the evaluation of such distortions as a "slowdown" frames, blur, blocking - effect the probabilistic model is used. Probability of the occurrence of distortion equal to 1 indicates that the image has a very poor quality. Probability of 0.5 corresponds to serious distortions, however, allow to see the details of the image. VQM metric allows to determine the quality of the received image, but does not solve the problem of synchronization between the original and distorted video sequence. MPQM (Moving Picture Quality Metric) - evaluation of the quality of moving images. This metric uses the features of perception of the human visual system video. The process of forming quality metrics consists of several steps. On the first step the entire video sequence is analyzed. It passes through a set of special filters, which measure the amount of distortions. As a result a few channels form. For each channel, the contrast sensitivity and a mask are calculated that is needed for the distortion correction. Overlapping of the mask occurs only if the error exceeds a predetermined threshold value, that allows to eliminate the most noticeable distortion. Calculating the metric MPQM occurs on the basis of the parameters obtained at the output of the filters. MPQM is calculated for each data block using the expression

$$E = \left(\frac{1}{N}\sum_{c=1}^{N}\left(\frac{1}{NxNyNt}\sum_{t=1}^{Nt}\sum_{x=1}^{Nx}\sum_{y=1}^{Ny}|e[x,y,t,c]|\right)^{\beta}\right)^{\frac{1}{\beta}}$$

Here e [x, y, t, s] - the error signal, which has coordinates (x, y), occurred at the time t in the current block of data and processed in the channel C, N_x, N_y - distance horizontally and vertically, N_t - the time of the transmission of the data block, N - the number of channels (filter set) necessary for data processing; β - Minkowski parameter, it is usually equal to the 4. Image scale is usually measured in decibels. Additional metric used to assess the quality of video is a masked peak signal to noise ratio (MPSNR)

$$MPSNR = 10 * \log_{10}\left(\frac{255^2}{E^2}\right)$$

CONCLUSIONS

Thus, the comparative analysis of different methods of evaluation of the perceptual quality of streaming video during transmission over wireless networks has shown that using subjective metrics can only estimate the visual quality of the image and can not be implemented in the software, which does not allow to automate the process of calculating quality metrics of the video. Objective metrics, even with the limited set of data allow definitely to determine the amount of distortion of the received frame. The simplest methods of determining the quality are the calculations of the relations PSNR, SNR and RMSE, but they have low accuracy. Metrics PQR, VQM, MPQM are more similar to the subjective perception in a real test.

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