On Clarification Algorithm of the Teaching Video Dynamic Image in Massive Open Online Course

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Abstract

Due to factors as long distance transmission, complex and varied transmission environment, teaching video dynamic image transmission signals in Massive Open Online Course become attenuated in various levels. A large number of random, multi-dimensional noise signals and distortion has been generated in teaching video dynamic image (Yao and Yuan, 2015). The traditional methods which used in teaching video image denoising are difficult to deal with random, multi-dimensional noise signal by setting dynamic and reasonable threshold and achieve efficient denoising effect. Since the traditional method which used in teaching video image denoising can’t solve such problems, it is difficult to achieve efficient denoising effect. Therefore, a dynamic image clarification algorithm for teaching video is proposed based on discrete wavelet transform. Firstly, the discrete wavelet transform algorithm is applied to de-noising the teaching video dynamic image of Massive Open Online Course, eliminating the interference to teaching video signal by the external factors of transmission distance and complex environment. And then the method of histogram equalization is used to teaching video dynamic image for enhancement processing in order to achieve the clarification of teaching video in Massive Open Online Course, transfer and present teaching contents scientifically and efficiently. Experimental results show that the algorithm can effectively enhance the clarity of teaching video in Massive Open Online Course, transfer and present teaching contents scientifically and efficiently. Therefore, the learning interest and the enthusiasm of learners will be stimulated and the online learning effect will be improved.

Keywords: Massive Open Online Course, teaching video, image denoising, discrete wavelet transform, histogram equalization

1. INTRODUCTION

In 2012, Massive Open Online Course which likes a digital tsunami has brought a huge impact on high education and triggers an educational storm, known as “the most important innovation of education since the invention of printing” (Zhang and Jiao, 2015). Countries around the world have promoted rapidly the development, construction and application of Massive Open Online Course, Which has a blowout-type development in various fields and has become a fashionable and efficient Internet learning model (Guo, 2016). Tracing back to the source, Massive Open Online Course is actually the development and breakthrough of Open Course Ware (OCW) and Open Educational Resources (OER) in the new educational philosophy and information technology environment, and its main learning resources and materials of are the online teaching videos (Wang, 2015). The smooth implementation of all teaching and learning activities will base on the effective dissemination and learning of teaching video. At present, the main transmission methods of online video education resource include online video transmission method basing on wireless sensor network, online video transmission method basing on neural network algorithm, online video transmission method basing on ant colony algorithm (Wu, 2012). The effective transmission of Online teaching video becomes the initial logical starting point for the success of teaching activities in Massive Open Online Course (Beldame et al., 2014), thus becoming one of the hot topics of online education (Qin, 2015).

Massive Open Online Course is an open educational form spreading all over the world, its learners are free to learn at any time and anywhere as long as they need and wish (Yin et al., 2015). Therefore, teaching videos as main learning materials must take into account the problems of long distance and complex environments in the process of transmission (Chen et al., 2014). For long-distance transmission, teaching videos need to be compressed generally in the process of shooting and editing. This will reduce the clarity of the teaching videos dynamic
image. And the follow-up transmission and other links, teaching video dynamic image signals immediately present random, multi-dimensional noise signals. The noise characteristic attribute presents the multiplicity(Yuan,2011). For the denoising of the teaching video dynamic image, the traditional transmission methods are difficult to set dynamic and reasonable threshold for random, multi-dimensional noise signals. So the denoising effect of image is poor. The clarity of the teaching video reduces.

Therefore, this paper presents a clarification method of the teaching video dynamic image basing on discrete wavelet transform algorithm in Massive Open Online Course. It can remove the interference by using the discrete wavelet transform algorithm to teaching video signals by the external factors of transmission distance, complex environment. At the same time, the histogram equalization is used to enhance the image processing of the teaching video signals in order to achieve the clarification of teaching video dynamic image. Experimental results show that the algorithm can effectively improve the clarity of teaching video in Massive Open Online Course.

2. THE INFLUENCES OF NOISE SIGNALS ON TEACHING VIDEO DYNAMIC IMAGE IN MASSIVE OPEN ONLINE COURSE

Teaching video is the main carrier and medium in carrying out teaching activities in Massive Open Online Course. Under the influence of long-distance and complex environment in transmission process, there are a large number of noise signals in the teaching video. However, the noise signals are random, complex and unpredictable which will hinder the learning terminal to receive the teaching video accurately and affect the online learning effect.

(1) Noise signals reduce the clarity of the teaching video dynamic image in Massive Open Online Course. Once teaching video dynamic image contains the noise signals, not only nonlinear deformation but also fuzzy and distorted situation will occur (Ghosal and Mandal, 2014), which will lead to the decline of the teaching video quality. Learners are therefore hard to concentrate on their studies and lose interest in learning.

(2) Noise signals influence the color reproduction of the teaching video dynamic image in Massive Open Online Course. Once the teaching video dynamic image contains the noise signals, the brightness distribution will be disturbed to the original image, which will lead to image color difference and difficult restoration of true color structure and characteristics of object. This will make learners misunderstand the teaching content and influence the learning effect.

(3) Noise signals influence the target accuracy of the teaching video dynamic image in Massive Open Online Course. Once the teaching video dynamic image contains the noise signals, the phenomenon of nonlinear deformation and brightness distribution interference is prone to occurring. This will cause the image contour area to be blurred which is difficult to form clear target recognition. It ultimately affects the presentation of the learning content and makes learners have the learning tiredness.

3. THE NOISE SIGNAL MODEL AND COMMON TYPES OF THE TEACHING VIDEO DYNAMIC IMAGE IN MASSIVE OPEN ONLINE COURSE

Noise refers to random signals interference when image signals are ingested or transmitted. These random signals are “a variety of factors in the image that prevent people from receiving information about it” (Hu et al., 2016). Noise is unpredictable in theory, and it is stochastic errors that can only be understood by probabilistic statistical methods. So the generation process of the image noise can be regarded as multi-dimensional, random process. All the processes such as the production, editing, transmission and so on of the teaching video dynamic image in Massive Open Online Course can produce the noise signals.

3.1 The noise signal model of teaching video dynamic image in Massive Open Online Course (Ai, 2010)

The teaching video is composed of two-dimensional image sequence arranged in succession. With the size of \(a \times b\), the image sequence \(g(x, y)\) \((x=0, 1, 2, \ldots, a-1; y=0, 1, 2, \ldots, b-1)\) is superimposed by the ideal image sequence \(f(x, y)\) and the noises signals \(n(x, y)\) which shown in Figure 1.
3.2 The Common types for noise signal of teaching dynamic video image in the Massive Open Online Course (Sun et al., 2014)

Common noise signals of the teaching video dynamic image in Massive Open Online Course mainly include the following types (Wang et al., 2012).

1. **Additive noise**

The strength of the additive noise signals have nothing to do with the signals of the teaching video dynamic image itself. They come mainly from the scanning image by camera. The relationship between additive noise signals and the signals of the teaching video dynamic image is addition. Noise signals always exist whether or not there are image signals. The signals of the teaching video dynamic image “a” can be regarded as the sum of the signals of noise-free dynamic image “b” and the noise signals “n”, this can be explained by formula 1.

\[
a = b + n
\]

2. **Multiplicative noise**

The generation of multiplicative noise signals is caused by the unsatisfactory channel. They occur mainly in the radio communication transmission channel. “For example, it constitutes the interference to the signals that the ionosphere and the troposphere random changes cause the signals do not respond to random changes any message meaning.” (Miu et al., 2015) In light of this, these noise signals are only manifested when the signals of the teaching video dynamic image appear channel mentioned above. Whether they exist or not depends on the generation of the signals of the teaching video dynamic image. The relationship between the signals of the teaching dynamic image “a”, the signals of noise-free dynamic image “b” and the noise signals “n” can be expressed by formula 2.

\[
a = b + bn
\]

3. **Quantization noise**

The quantization noise is an important noise source of the signals of the teaching video dynamic image. The size of the quantization noise reflects the difference between the signals of the teaching video dynamic image and their original signals. Gray level probability formula is generally used to data optimization in order to reduce the incidence this type of noise. Assuming that the number of pixels in the teaching video dynamic image is “a”, the number of pixels of the original signals is “b”, the remote transmission distance of the teaching video dynamic image is “c”, the transmission speed of the teaching video dynamic image is “v”. The quantization noise can be expressed by formula 3.

\[
y = \frac{a - b}{s^2 + 2v}
\]

4. **Salt and pepper noise**

Salt and pepper noise, also known as impulse noise, is “a typical noise that has a large impact on image quality” (Li and Wang, 2016), randomly black or white pixels appearing in the image which are caused by image sensors, transport channels, and decoding processes. The black point is as petter and the white point as salt so that it is called salt and pepper. Assuming that the number of the pixels of is “a”, the original teaching video dynamic image will be subjected to a cutting process. The number of regions after cutting is “b”. The number of
whitepoints in the teaching video dynamic image is “n”, and the black one is “m”. Then the salt and pepper noise can be expressed by formula 4.

\[ y = \frac{a^2 + b^2}{\sqrt{m^2 + n^2}} \]  

(4)

4. THE FUNDAMENTAL PRINCIPLE OF TEACHING VIDEO DYNAMIC IMAGE TRANSMISSION IN MASSIVE OPEN ONLINE COURSE

4.1 The transmission theory of teaching video dynamic image in Massive Open Online Course

In the transmission process of the teaching video, the first step is to compress the dynamic image, and then go to the next step of remote transmission. It mainly involves the following two steps and relevant parameters (Li and Yang, 2013).

(1) Compression coefficient calculation of the teaching video dynamic image in Massive Open Online Course

Assuming that the pixels number is "a" of the teaching video dynamic image signals, the transmission distance of the dynamic image is "s", the initial time of the dynamic image transmission is "t1", the time at which the dynamic image is transmitted to the terminal is "t2", the number of pixels for any one frame of the dynamic image "Ci" is "b" and its gray level is "Di". The data compression processing of the teaching video dynamic image can be explained by formula 5. According to the formula, the compression coefficient \( \partial_i \) of the teaching video dynamic image can be calculated, and then the compression degree of the signals of the teaching video dynamic image is obtained.

\[ \partial_i = \frac{|a-b|}{\sqrt{b^2 + t_2 - t_1}} \times Ci \times Di \]  

(5)

(2) Resolution calculation of the teaching video dynamic image in Massive Open Online Course

Based on transmission conditions mentioned above, the resolution parameter "\( \gamma_i \)" of the dynamic image signals can be calculated according to the degree of compression and be expressed by formula 6.

\[ \gamma_i = \frac{\delta_a(b^2)}{Ci \times Di} \]  

(6)

4.2 The traditional transmission disadvantages of the teaching video dynamic image in Massive Open Online Course

According to the analysis above, the formula 5 shows that the dynamic image signals compression coefficient decreases with the dynamic image signal transmission distance increases and that the compression coefficient of the dynamic image signals reduces with the transmission distance of the dynamic image signals increases. It also can be known from formula 6 that the clarity of teaching video will decline as well as the resolution’s declining with the reducing of the compression coefficient of dynamic image signals.

The traditional image denoising process mainly follows the principle that the dynamic image signals and the noise signals are distributed in different frequency domain, that is, the dynamic image signals mainly concentrate on the low frequency part and the noise signals mainly distribute in the high frequency part and finally realized by the filtering of frequency domain. At present, the main denoising methods used in the video transmission algorithms such as mean filtering, median filtering (Guan, 2016), are difficult to set dynamic and reasonable threshold for multi-dimensional noise to achieve the efficient denoising of the dynamic image. Sometimes the image denoising effect is poor and affect to the normal image information. This results in the declining of the clarity of the teaching video dynamic image and influencing learning effects of Massive Open Online Course.

5. THE CLARIFICATING PROCESS OF THE TEACHING VIDEO DYNAMIC IMAGE IN MASSIVE OPEN ONLINE COURSE
5.1 The idea and conceiving of the teaching video dynamic image

The process that removes the noise signals of the teaching video dynamic image is called dynamic image denoising. The main purpose of noise reduction is to effectively reduce the noise signals of the dynamic image while ensuring that the details of the image as much as possible without loss of information.

In the process that noise signals are removed, there are probabilities that the normal signals of the teaching video dynamic image are filtered out at the same time. Therefore, the issue that how to effectively remove the noise signals while protecting the normal dynamic image signals in order to improve the image signal-to-noise ratio and highlight the desired characteristics of the image is worthy of being studied and discussed. The basic idea that the noise signals of the dynamic image are filtered is as follows: First, the total signals are divided into two categories which are noise signals “A” and the normal signals of dynamic image “B”. The signals of normal dynamic image certainly should be retained. For the noise signals, it is necessary to preserve the dynamic picture signals which may be included in noise signals, and remove the pure noise signals part, as specifically shown in Figure 2. The dynamic image signals including the noise signals can be classified into the normal dynamic image signals and the dynamic image signal including noise after being classified and recognized. The dynamic image signals including noise signals are analyzed, the noise signals are effectively filtered, and the effective dynamic image signals are maximized and retained. (Wang et al., 2012)

![Figure 2 Switch filter structure](image)

5.2 Discrete wavelet transform denoising for the teaching video dynamic image in Massive Open Online Course

Wavelet transform is a new exchange analysis method which continues and develops the idea of localized short-time Fourier transform. As an ideal tool for video signal analysis and processing, it can overcome the shortcoming that the window size does not change with frequency and provide a time-frequency window with frequency change. Typical wavelet transform can be divided into two categories: discrete wavelet transforms (DWT) and continuous wavelet transforms (CWT). The main difference between them is that the continuous transform operates on all possible scaling and translation, and the discrete transform uses a specific subset of all the scaling and translation values. (Zhang et al., 2013) Signal denoising of teaching video dynamic image mainly uses discrete wavelet transform.

It presents different rules at different resolutions, sets the threshold and adjusts the wavelet coefficients to achieve the wavelet de-correlation basing on the characteristics of multi-resolution, de-correlation and selection flexibility (Wang et al., 2014). This method preserves most of the wavelet coefficients including the signals, so it can preserve the details of the image and avoid the contradiction that the traditional method can’t save the dynamic image information better when the noise signals are removed.

According to the feature that the wavelet spectrum of the noise signal and normal image signals in different scale (frequency band) have different demonstration. Then the wavelet spectral components generated by noise at all scales, especially the ones of which the noise spectrum dominates the scale are removed. If so, the retained wavelet spectrum is basically the one of the original image signals. Then using the wavelet transform reconstruction algorithm to reconstruct the original image signals. Then signals after denoising can be obtained. The specific process is shown in Figure 3.
For teaching video dynamic image in Massive Open Online Course, it can be regarded as a sequence of two-dimensional images, and can be described by \( f(a) \). The transformation pair of the teaching video image sequence can be calculated using formula 7 (Sun, 2013).

\[
X_\phi(e,s) = \frac{1}{\sqrt{F}} \sum_a f(a) \delta_{e,s}(a), \quad X_\theta(e,s) = \frac{1}{\sqrt{F}} \sum_a f(a) \theta_{e,s}(a)
\]  

(7)

In the above formula, assuming that the parameters \( e_0 \geq e \), formula 8 can be get as follows.

\[
f(a) = \frac{1}{\sqrt{F}} \sum_a X_\delta(e_0,s) \delta_{e_0,s}(a) + \frac{1}{\sqrt{F}} \sum_{s=e_0}^e \sum_a X_\theta(e,s) \theta_{e,s}(a)
\]  

(8)

In this formula, \( \delta_{e_0,s}(a) \) and \( \theta_{e,s}(a) \) are the functions of discrete variable \( a=1,2,\ldots,F \). Selecting any sample \( a_0, \Delta a_0, a=1,2,\ldots,F \), \( f(a)=f(a_0, a_0 \Delta a_0) \), setting \( e_0=0, F=-2' \), it can sum up against \( a=1,2,\ldots,F \), \( e=1,2,\ldots,E \) and \( s=1,2,\ldots,2' \). In any image, select four pixels \( f(0)=1, f(1)=4, f(2)=-3, f(3)=0 \), and make summation against \( a=1,2,3,4 \), \( e=1,2 \), then substituted the four pixel pixels into the above formula, formula 9 will be got as follows.

\[
X_\delta(0,0) = \frac{1}{2} \sum_{a=1}^4 f(a) \delta_{(0,0)}(a) = \frac{1}{2} [1 \cdot 1 + 4 \cdot (-3) \cdot 1 + 1 \cdot 1] = 2
\]  

(9)

Using the same method, balanced spatial sample can be collected on the teaching video dynamic image in Massive Open Online Course. The similar intervals sample collection can also be performed by using formula 10.

\[
X_\delta(0,0) = \frac{1}{2} \sum_{a=1}^4 f(a) \delta_{(0,0)}(a) = \frac{1}{2} [1 \cdot 1 + 4 \cdot (-3) \cdot 1 + 1 \cdot 1] = -6
\]

(10)

Using formula 11, discrete wavelet transform processing can be carried out for the teaching video dynamic image in Massive Open Online Course, and the dynamic image denoising can be realized.

\[
f(a) = \frac{1}{2} [X_\delta(0,0) \delta_{0,0}(a) + X_\delta(0,0) \theta_{0,0}(a) + X_\delta(1,0) \theta_{1,0}(a) + X_\delta(1,1) \theta_{1,1}(a)]
\]  

(11)

By the method described above, the discrete wavelet transform can be used to denoise the teaching video dynamic image in Massive Open Online Course, and eliminate the unnecessary interference factors to improve the image quality.

5.3 The histogram equalization processing of the teaching video dynamic image in Massive Open Online Course.
Dynamic image enhancement processing can be used in order to bring the teaching video dynamic image more optimized details and better clarity. Histogram equalization is one of the most common and important methods in image enhancement (Chen et al., 2015).

Histogram equalization is a transform function that automatically achieves this effect by inputting image histogram information. Its basic idea is to broaden the gray level with more pixels and compress the gray level with fewer pixels, then expanding the dynamic range as the original value and improving the variety of contrast and gray tone.

For the teaching video dynamic image in Massive Open Online Course, the specific procedures and steps of the histogram equalization processing are as follows. Assuming that \( f(a,b) \) is the teaching video dynamic image denoised. After histogram equalization processing, the image is \( g(a,b)(a=1,2,3,\ldots,M,b=1,2,3,\ldots,N) \). The gray level rang of the image is \([0,255]\). It means that the image gray level \( k \) is 256. Based on the above conditions the teaching video dynamic image can be processed as follows (Gao, 2011).

1. Calculate the histogram of the original teaching video dynamic image \( f(a,b) \mid_{M \times N} \)

The “\( r \)” is any gray level in the image gray range. The “\( P(r) \)” is the probability of the pixel with gray level “\( r \)”. The graph of the function is the histogram of the image, and a concrete image can be obtained from formula 12 (Xia et al., 2016).

\[
\sum_{k=1}^{a} P(r_k) = 1
\]  
(12)

2. Calculate the gray distribution coefficient \( P_r \) of the original teaching video dynamic image \( f(a,b) \mid_{M \times N} \)

In formula 13, \( M \times N \) (\( M \) is the length and \( N \) is the width) is the number of pixels in original teaching video dynamic image. The “\( r_k \)” is the \( k \)-th gray level, “\( l_k \)” is the number of pixels in the \( k \)-th gray level and the “\( P_r(r_k) \)” represents the probability of the gray level.

\[
P_r(r_k) = \frac{l_k}{M \times N}, \quad k=0,1,2,3,\ldots,255
\]  
(13)

3. Calculate the distribution coefficient \( P_s \) of different gray levels of the original teaching video dynamic image

Use the cumulative distribution function to transform according to the statistical histogram. In the formula 14, \( P_s(0) \) is assumed to be 0.

\[
P_s(r_k) = \sum_{j=0}^{r_k} P_s(j), \quad r_k=1,2,3,\ldots,255
\]  
(14)

4. The histogram equalization processing is carried out on the teaching video dynamic image

Using the formula 15, the teaching video dynamic image can be can be equalized and the final enhancement image can be obtained.

\[
g(a,b) = 255 \cdot P_s(j)
\]  
(15)

6. THE EXPERIMENTAL SIMULATION OF THE TEACHING VIDEO DYNAMIC IMAGE IN MASSIVE OPEN ONLINE COURSE

In order to illustrate the effectiveness of this algorithm, it needs to be verified by the simulation results. Transmissions of the teaching video dynamic image have been carried out for 150 times with the traditional algorithms and the algorithm of this paper. It explained by the denoising visual effect with different algorithms through the lean image with the contamination rate of 20%. It is shown specifically in Figure 4. From denoising effect of the image, it can be known that the algorithm of this paper is better than the traditional image transmission algorithms (Wang et al., 2012).
Figure 4 The visual contrast diagram of image denoising effect

Figure 5 shows the denoising and transmission effect of the teaching video dynamic image under different algorithms. The horizontal axis in the image is the distance of the teaching video dynamic image transmission in Massive Open Online Course and the vertical axis is the resolution parameter of the teaching video dynamic image. Through the comparison of the image quality of different algorithms in the figure, it can be known that the discrete wavelet transform used to clarify the teaching video dynamic image can overcome the shortcomings of denoising effect caused by the factors such as long transmission distance and complicated transmission environment. Through the analysis of the experimental data, Table 1 can be obtained (Wu, 2012).

Figure 5 The visual contrast diagram of image denoising effect

From the data in Table 1, it can be known that with the distance of the video transmission, the discrete wavelet transform has more advantages than other traditional algorithms in denoising and stabilizing the image transmission quality.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Video transmission distance (km)</th>
<th>Image resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless sensor networks algorithm</td>
<td>280</td>
<td>68</td>
</tr>
<tr>
<td>Neural network algorithm</td>
<td>230</td>
<td>70</td>
</tr>
<tr>
<td>Ant colony algorithm</td>
<td>350</td>
<td>74</td>
</tr>
<tr>
<td>Discrete wavelet transform</td>
<td>260</td>
<td>95</td>
</tr>
</tbody>
</table>

Table 1 The transmission data of the teaching video dynamic image in Massive Open Online Course

7. CONCLUSION

This paper proposes a denoising method based on discrete wavelet transform of the teaching video dynamic image in Massive Open Online Course. Discrete wavelet transform algorithm performs well in denoising dynamic image and maintains high quality transmission for teaching video dynamic image since it can solve the
denoising problem that the traditional transmission algorithm can’t effectively in the transmission of the teaching video dynamic image due to the large transmission distance and complex transmission environment. At the same time, based on the effective de-noising of dynamic image by discrete wavelet transform algorithm, the implement histogram equalization processing to the teaching video dynamic image can further enhance the image, maintain and highlight the details of the image features. Then it can efficiently and scientifically transmit and present the teaching content, stimulate and maintain the learners' interest and enthusiasm and improve the online learning effect.

REFERENCES