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Investigation on the QOE and Packet Loss Rate of the IOT Network

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Abstract: The Internet of things, including Internet technology, including wired and wireless networks. In this paper, we investigate on the QOE and packet loss rate of the network because QOE is important in the network and packet loss rate is the key point in many papers. In order to study the influence of packet loss on the users' quality of experience QoE and establish the Mapping model of the two when the video transmit in the network, building a NS2+ MyEvalvid simulation platform, by the method of modifying QoS parameters to simulate different degrees of packet loss, focus on the influence of packet loss on QoE and establish the mapping model between them. Experimental results show that, packet loss has an significant influence on Quality of experience. Packet loss rate and the Quality of experience presents a nonlinear relationship, and use matlab to establish the mapping model, this model's accuracy is high, easy to operate, can real-time detect packet loss has influences on the user's quality of experience (QoE).

Keywords: Packet Loss Rate, Influence, Quality of Experience, Mapping Model

1. Introduction

At present, the development of international information prompted the international people's exchanges widely, network video business is increasing. In the information industry, network video business has become the most popular application of computer network field, from the international and domestic exchanges to life and entertainment, video penetrated into every aspect of our lives.

But the network itself is not perfect, in essence is a kind of distortion network. Therefore, causes the academia and industry professionals think that, what causes the decrease of the quality of the video and how to evaluate the quality of the network video. So, we set up the video quality assessment model to evaluate the quality of video. Network TCP/ IP protocol itself is only a best effort protocol [1], in this service model, all the business flows fair competition to network resources, can not meet the bandwidth, delay, jitter and other special requirements of the new application. These new applications contributed to QoS (Quality of Service, QoS) concept appears. In addition, QoS and man-made factors together determine the user's Quality of Experience (Quality of Experience, QoE) [2]. Network video distortion will seriously affect the user's Quality of experience QoE. Therefore, in order to meet the needs of the user's Quality of experience, needs establish a optimization model of the video quality evaluation. In QoE evaluation methods the subjective method is very difficult to operate, therefore, the objective evaluation method of QoE is namely make the packet loss rate which is obtained by measuring mapped into QoE is a new method. Through in-depth analysis of network video distortion, we can know the major form of network video transmission distortion is delay, packet loss and jitter. Among them, delay almost has no effect on the quality of the video, and the effect caused by the network jitter is packet loss, so unified used the packet loss rate to measure the performance of the influence on the users' Quality of experience. Therefore, we study the influence of packet loss on QoE and establish the Mapping model of packet loss rate and the Quality of experience.

2. Method

2.1. Related Work

Reference [3] presented a set of video evaluation framework EvalVid based on PSNR value through coding, transmission, repair, comparative evaluation module to source video to realize the video transmission and evaluate the whole process of simulation. Reference [4] successfully apply Evalvid framework to NS2. Implements the simulation of video transmission process, but there is no in-depth analysis of packet loss effects on QoE. Reference [5, 6, 7] shows in H.264 video distinguishes the I, P, B frames' priority and improve the quality of the video, but there is no in-depth analysis of each frame's influence on the users' Quality of experience. Reference [8] conclued that affecting MPEG2 video quality's main factors are coding rate and packet loss and so on, but there is no mapping model of packet loss rate and the Quality of experience. Reference [9] choose MPEG4, H. 264, H.263 three kinds of video format analysis of different packet loss location has influences on QoE in Evalvid framework. Reference [10] in order to support large-scale deployment, improve the accuracy and feasibility, establish a evaluation model of packet loss and the distortion video. Reference [11] shows that due to video packet loss in the process of grouping,QoE and QoS (quality of experience/ quality of service) services can strong degradation. It is verified that a single I frame packet loss resulting video impairment, and significantly reduce the video quality. Reference [12] in order to illustrate packet loss on the quality of the video, designs a real-time packet analysis system to monitor packets lost. Reference [13] puts forward packet loss information including different kinds of frames, different locations of image and different distribution and focus on the distribution of the packet loss, under the different distributions of packet loss, the same packet loss rate will leads to a MOS flow. Reference [14] in order to explain the video stream's user's quality of experience how to change and how the QoS parameters fluctuations, packet loss as one QoS parameter, puts forward a general quantitative relationship between video streaming QoE and a QoS parameter (packet loss). Reference [15] introduces under different packet loss models obtains the high definition video flow quality of experience evaluation model, goal is to achieve using SSIM video quality measurement, time sharing technology and content characteristics. It is common, has high correlation with the subjective results, and this model has been used in the quality of experience (QoE) domain. Reference [16] introduces a model to illustrate the QoS parameters have influences on the user's perceived video quality, analysis of the MPEG-4 video transmission QoS parameters under various network configurations, obtains the QoS parameters how to affect the user's perceived video quality. Reference [17, 18] puts forward that affecting the video quality's main network QoS parameters delay and jitter are characterized by packet loss, therefore, adopts packet loss rate for a unified measure of the quality of the video, combined with the human visual characteristics, proposes a real-time video quality assessment model based on network packet loss. Reference [19] describes the factors affecting QoE include the perception the user 's emotional state to the video, also include packet loss. Therefore, in order to be able to accurately assess the user's quality of experience. Focusing on study the influence of packet loss on the user's quality of experience and establish the mapping model of packet loss rate and the user's quality of experience.

In general, research on packet loss mainly concentrated on the influence of packet loss on the user's quality of experience and quality of service, the main field is in the codec and transmission field, and consider the single frame such as I-frame's effect are the most, few consider the packet loss concentration and different distribution of packet loss on the video's quality, lack of research on combine packet loss rate and other indicators to assess the impact of data loss on QoE, for each frame of packet loss on the quality of the video's study also not many. In early days focused on the assessment of full reference considering packet loss, later consider starting involved packet loss of no-reference assessment method. The beginning of the study without considering the packet loss characteristics, later began to study the no-reference assessment method. Study on the mapping model of packet loss rate and the Quality of experience on the influence of packet loss on QoE is mainly for give the majority of the users bring good visual experience, for optimization of digital video assessment system, communication quality monitoring, provide theory, technology and method of support for the area of consumer media grading.

2.2. Influences of Packet Loss on Qoe

First of all, the cause of focus on packet loss is through in-depth analysis of distortion network, we know that the main form of network video transmission distortion are delay, packet loss and jitter. Among them, delay has little effect on the quality of the video, while network jitter causes the effect of network packet loss, so unified used the packet loss rate to measure the performance of the network. Secondly, the definition of the user's quality of experience is in the certain objective environment users' overall approval degree of the use of services or business is the user's quality of experience. Influence factors of QoE are mainly QoS and human factors. The quantization methods of QoE mainly includes MOS method, paired comparison method, two categories method and PSNR method. This part mainly uses the MOS method and PSNR method, and the two methods are compared. At last, this part is mainly based on use MPEG4 encoder to study the influence of packet loss on QoE, mainly study whether there is a significant influence on packet loss and to what extent. At present what is widely used is MOS method which is recommend by the International Telecommunication Union ITU. This is a kind of order quantity expression which QoE subjective feeling can be divided into 5 levels and a detailed description of the user's subjective feeling. The following are shown in table 1 [20]. PSNR and MOS corresponding relation are shown in table 2 below [21].

Table 1. MOS method.

MOS	QoE	Impairment
5	Excellent	imperceptible
4	Good	Perceptible, not annoying
3	Fair	Slightly annoying
2	Poor	Annoying
1	Bad	Very annoying

Table 2. PSNR to MOS.

PSNR	MOS
>37	5
31-37	4
25-31	3
20-25	2
<20	1

2.2.1. Experimental Environment

Because in the real network, unable to quantify to simulate the network with different degree of damage. Therefore, network simulation environment is built on cygwin+ NS2 at windows, through the method of changing QoS parameters to simulate different levels of network damage. Then NS2 and Evalvid integration MyEvalvid. The MyEvalvid through the myEvalvid, my_UDP, my_Evalvid_Sink three interface programs to communicate with NS2, NS2 simulation network can simulate the OSI seven layers architecture, introduced as follows. MyEvalvid system structure diagram is shown in figure 1.

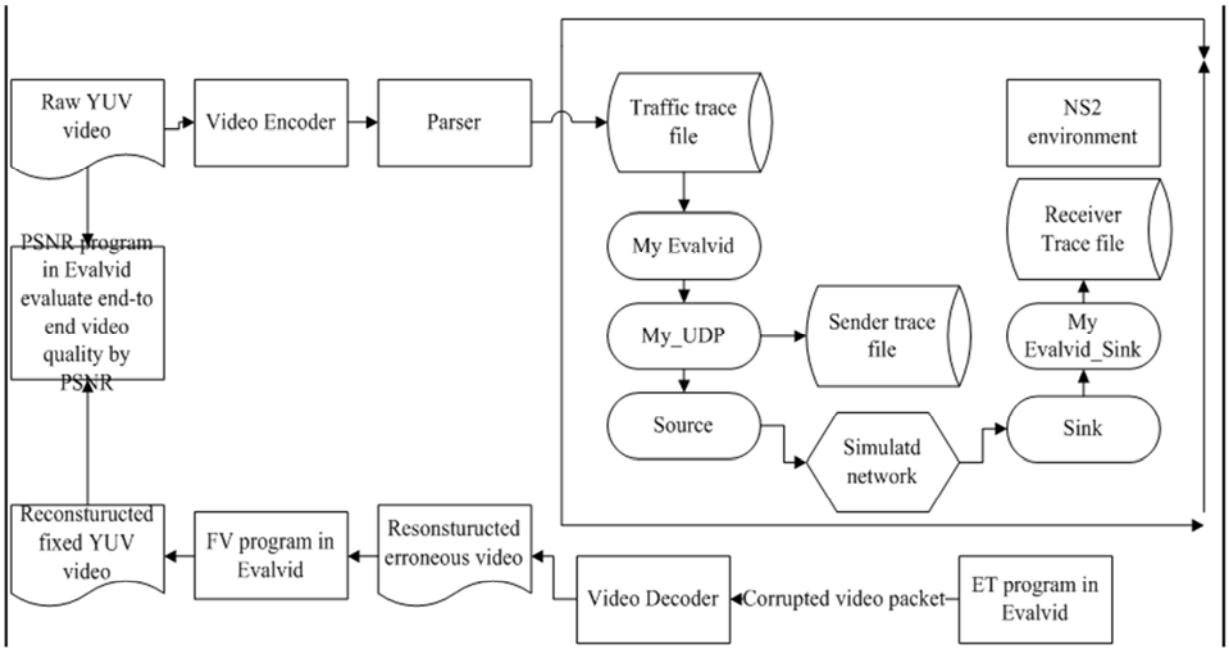

Figure 1. MyEvalvid system structure.

(1) myEvalvid: the interface program's main job is to learn to read VS procedures after the film log files, the log files of each picture was cut into smaller segments, and in the user in Tcl Script set in good time to the section is the bottom of the UDP layer sends out.

(2) my_UDP: Basically my_UDP Agent is the extension of UDP Agent. The new Agent the packet transmission time, packet identification and packet load size recorded in the files which was setted up by Tcl Script.

(3) myEvalvid_Sink: It is responsible for the work that receives packet which is transfer out by my_UDP, and record the receive time, packet identification and packet load size, recorded in the files which was setted up by Tcl Script.

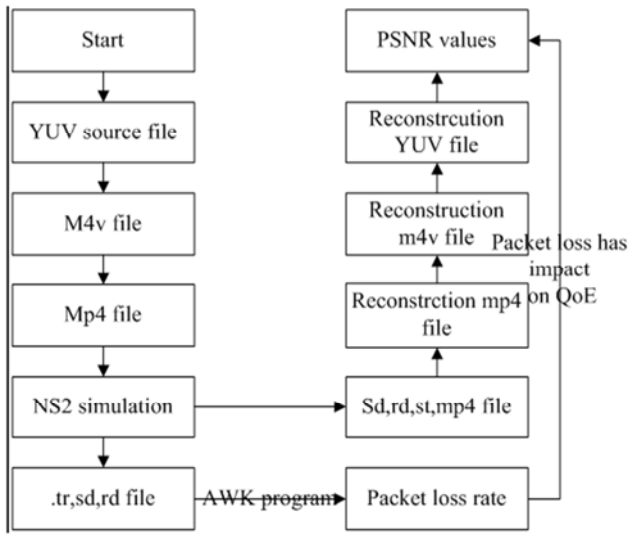

Figure 2. The experimental principle figure.

The experimental principle figure as shown in figure 2, focusing on the influences of packet loss on QoE, and with AWK analysis of experimental results, in order to get the packet loss rate.

2.2.2. Pre-experiments

(1) Explore the different packet loss rate has an effect on QoE Do pre-experiments using football. yuv video, assuming concluded that different packet loss rate has impact on QoE. Use psnr calculate the psnr value of each frame of the video after reconstruction. As shown in Figure 3.

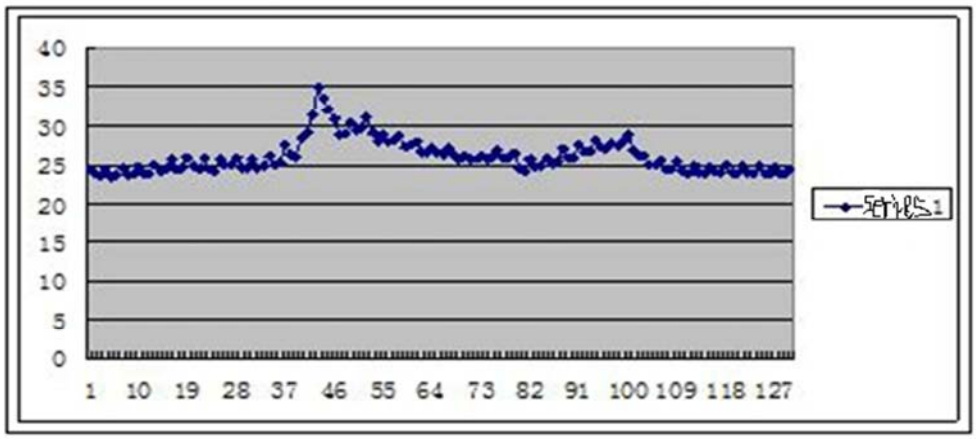

Figure 3. *Psnr value of each frame of the video after reconstruction.*

Using YUV viewer to view the source files and rebuild files' 6 frame. YUV viewer as shown in figure 5. The 6th frame PSNR value is 23.56. As shown in figure 4.

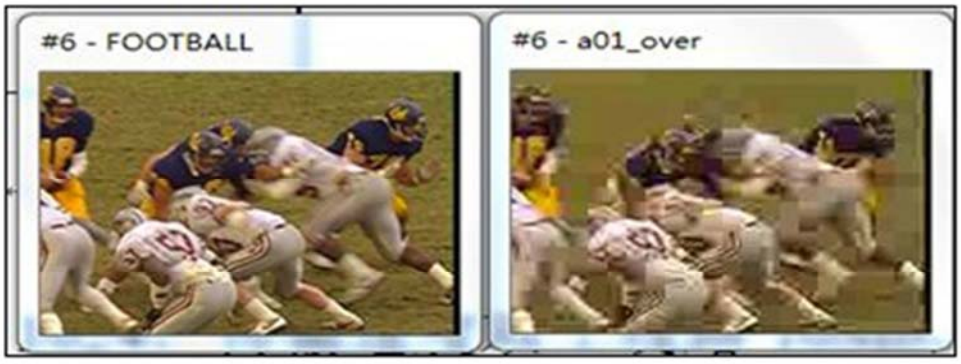

Figure 4. *The source files and rebuild files' 6 frame.*

Figure 5. *YUV viewer.*

Using YUV viewer to view the source files and rebuild files' 43 frame. The 43th frame PSNR value is 34.98. As shown in figure 6.

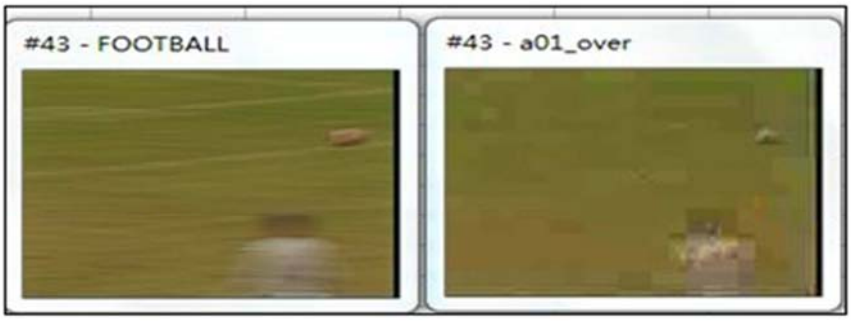

Figure 6. *The source and rebuild files' 43 frame.*

From the comparison of image frames 6 and 43, we can find that the 6th frame distortion is more serious. This is because in the process of network transmission, different picture have different packet loss rate. Thus, different packet loss rate has a great influence on the quality of video transmission, thus affecting the quality of experience QoE. That is the assume is right.

(2) The influence of different factors on QoE

Through many experiments on football. yuv and forman_qcif. yuv and mother-daughter. yuv, the use of quantitative parameters Q is larger, the users' quality of experience will be getting worse. When the packet length is longer and Gop length is shorter, the packet loss rate is small, the users' quality of experience will be more high. In a certain range, duplex and simplex link speed is greater, the packet loss rate is small, the users' quality of experience is better.

Contrast table 3 and table 4, can find Foreman_qcif. yuv PSNR values change is larger than Football. yuv, contrast table 4 and table 5 can find Foreman_qcif. yuv PSNR values change is larger than mother-daughter_qcif. yuv, that is the more complex video content motion is, the large sensitivity of the quantitative parameters. And in the same experimental conditions, obtain the Foreman_qcif. yuv PSNR values are most bigger than Football. yuv PSNR values, as a result, the more complex video content motion is, the greater the time complexity is,and it can hava masking effects on coding distortion, so, the better the video quality is.

For football. yuv video (Strenuous exercise, the camera translation and rotation), foreman_qcif.yuv video (Movement direction, scene transitions) and mother-daughter.yuv video (Slow motion, Stationary background) these three videos, duplex link speed is 10 MB, simplex is 0.64 MB, packet size is 1024 KB, GOP is 9, quantitative parameters on the users' quality of experience as shown in table3， table 4 and table 5. Table 3 is football. yuv video's quantitative parameters changes, and table 4 is foreman_qcif. yuv video's quantitative parameters changes, and table 5 is mother-daughter. yuv video's quantitative parameters changes.

Table 3. *football. yuv video.*

Experiment number	video	Quantitative parameters	avgpsnr
1	FOOTBALL	31	26.017445
2	FOOTBALL	20	29.200301
3	FOOTBALL	10	31.500689

Table 4. *Foreman_qcif. yuv video.*

Experiment number	video	Quantitative parameters	avgpsnr
1	Foreman_qcif	31	26.828076
2	Foreman_qcif	20	28.818952
3	Foreman_qcif	10	32.275925

Table 5. *Mother-daughter. yuv video.*

Experiment number	video	Quantitative parameters	avgpsnr
1	mother-daughter	31	29.135065
2	mother-daughter	20	31.337936
3	mother-daughter	10	34.653800

2.2.3. Topology Description and HD Video Options

Default network includes wired and wireless environment, but in the end, most adopted wired experimental environment, and experimenting under the same topology structure, mainly consider the principle of a single variable. Wired topology structure consists of 4 nodes, between n0 and n1, n2 and n3 are duplex links, link bandwidth is 10 MBPS, delay time is set to 1 ms. Between n1 and n2 is simplex link, the bandwidth is 640 KB, delay time is set to 1 ms. Simplex or duplex queue management mechanism adopts DropTail, and the length of queue is 50 packet size. Establish UDP Agent on n0, the packet size is set to 1500 bytes, establish a NULL Agent on n3, the packet size is set to 1500 bytes. The simulation time is 10s. The wired experimental environment topology structure as shown in figure 7. With the rapid development of wireless applications, people look to the wireless network communication. But wireless environment compared with wired environment, usually has a high bit error rate, big time delay, low bandwidth, channel asymmetry and frequent mobile features. As a result, under the environment of wireless network congestion can no longer be seen as the only reason for the loss of data, there are a large number of datas are due to the switch, channel fading, interference and so on to be discarded, the packet loss due to wireless environment called wireless packet loss. In a word, under the environment of the wired, congestion loss is the only cause of the loss of data, while in the wireless environment, congestion loss and wireless loss both can cause data loss.

As a result, the study of the wireless network will be more

complicated than the wired network environment. Wireless topology consists of 4 nodes, n0-n3 these four wireless nodes, n0(200, 400), n1(200, 300), n2(400, 300), n3(400, 400). n0 settings for the mobile node, at the simulation time of 5s, from the starting position at a speed of 5 m/s move to the ending position (300, 400), then at the simulation time of 25s, to (200, 400), that is the starting position of n0. Establish udp1 Agent on the n0 node, establish null1 Agent on the n3 node, then set up online above. The simulation time is 50s. The wireless experiment environment topology structure as shown in figure 8. The establishment of the topology structure is mainly by writing TCL code, under wireless environment establish udp's TCL code as shown below:

```
set udp1 [new Agent/myUDP]
$ns attach-agent $n0 $udp1
$udp1 set_filename sd_a01
$udp1 set packetSize_ $packetSize
```

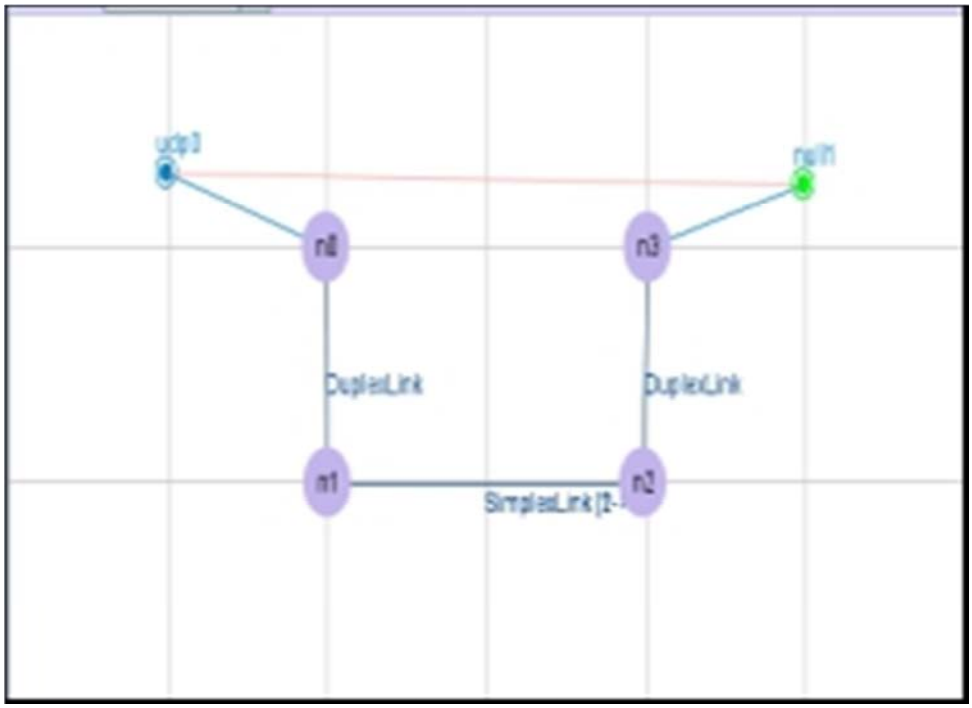

Figure 7. *Wired topology.*

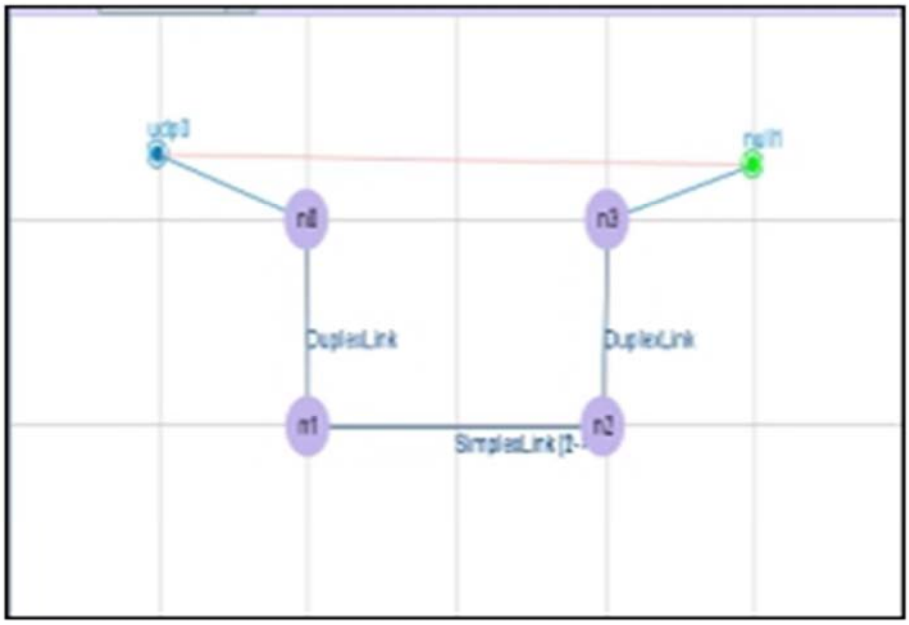

Figure 8. *Wireless topology.*

Figure 9. *Src13_hrc1_525. yuv.*

Figure 10. *Src22_hrc1_525. yuv.*

We select the HD video sources to conduct the experiment, HD video sources mainly have 525 series and 625 series. These two sequences are both the video quality experts group VQEG's test sequence, 525 sequence containing ref and HRC two series, 625 also includes ref and HRC two series. Ref is the reference state sequence, each HRC is a defect of the original reference sequence. Among them, the 525 sequence frequency is 60HZ, The frame size is 1440 x 486 or 699840 bytes per frame, the 625 sequence frequency is 50HZ, the size is 1440 * 576 or to say 829440 bytes per frame. YUV format is 4:2:2 format, a pixel are two bytes. Hd video is divided into two kinds in total, a video is strenuous exercise, video's content complexity is high, another video is the scenery, video's content complexity is low. On the basis of fully understand the HD video, select human strenuous exercise, high content complexity video src13_hrc1_525. yuv and the scenery, low content complexity src22_hrc1_525. yuv these two videos. Two selected video src13 as shown in figure 9, src22 as shown in figure 10. This selection is mainly in order to choose the video with different content complexity, facilitate through the contrast, judge different video content complexity whether have influences on the user's quality of experience or not.

3. Result

3.1. The Simulation Experiment

In order to eventually establish a mapping model of packet loss rate and QoE, need to understand the relationship between y and x, x as the horizontal axis is the packet loss rate, y as the vertical axis is PSNR values, finally uses matlab to make the scatter plot of the relationship between the packet loss rate and the PSNR values. Through the scatterplot, can find the scatter distribution, and then to study the effect of packet loss on QoE and lays the foundation for establishing a mapping model of the packet loss rate and the PSNR values.

This experiment first using HD video src13_hrc1_525. yuv and src22_hrc1_525. yuv using MPEG4 coding under the environment of the wired. First of all, we assume that the packet loss rate has no influences on user's quality of experience. Second, we assume that the video content complexity has no influences on user's quality of experience. PSNR quantitative QoE method's experimental results as shown in figure 11 and figure 12. The fitting curves as shown in figure 13 and figure 14. MOS value quantitative QoE method's experimental results are shown in figure 15 and 16. The fitting curves as shown in figure 17 and 18.

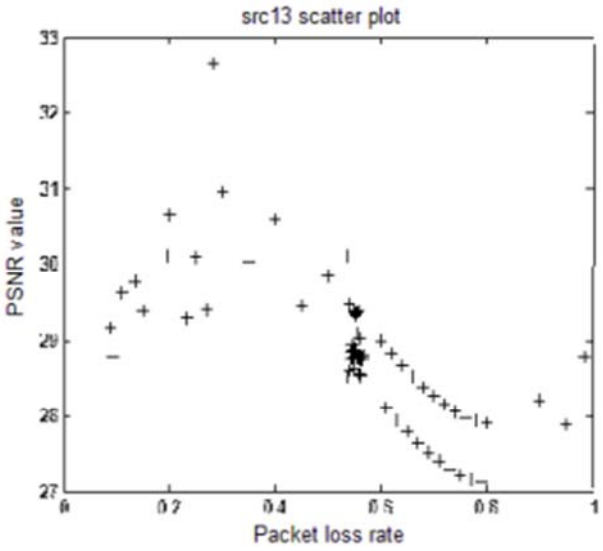

Figure 11. *Scatter plot of src13(PSNR).*

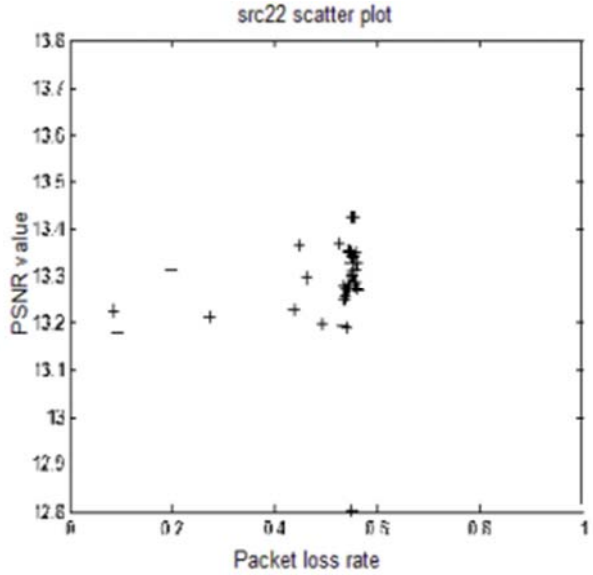

Figure 12. *Scatter plot of src22(PSNR).*

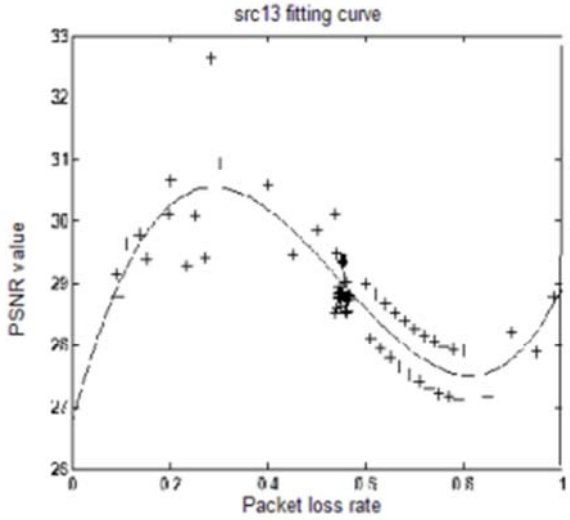

Figure 13. *Src13 fitting curve(PSNR).*

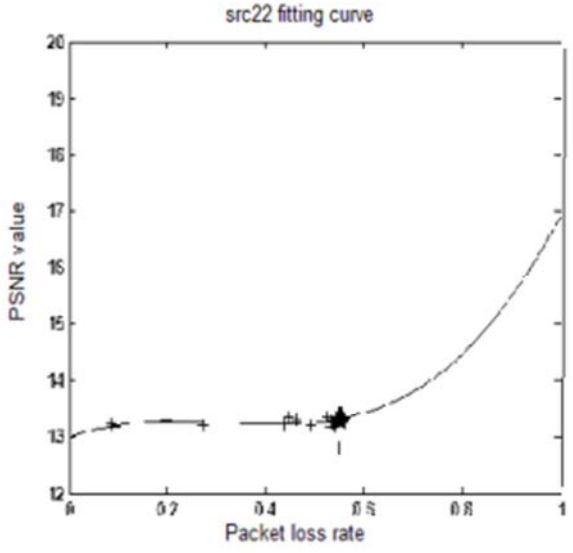

Figure 14. *Src22 fitting curve(PSNR).*

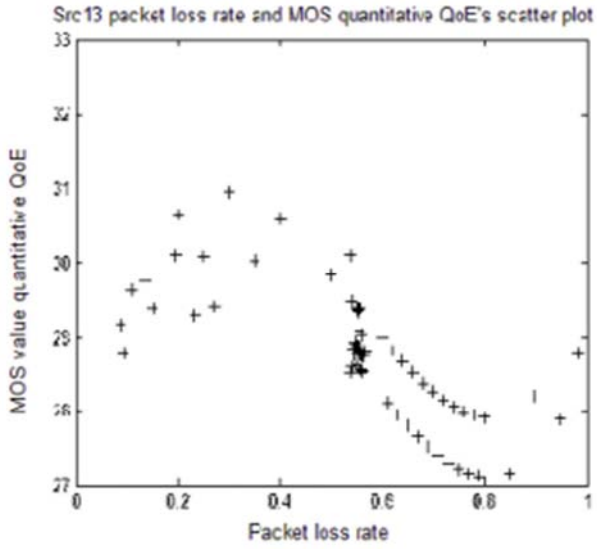

Figure 15. *Scatter plot of src13(MOS).*

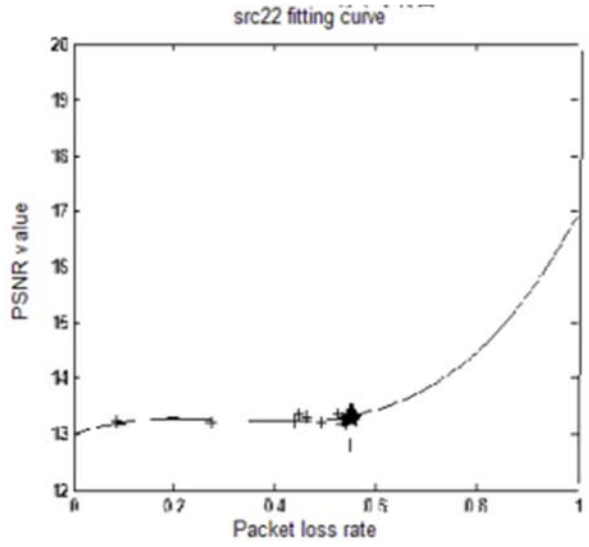

Figure 16. *Scatter plot of src22(MOS).*

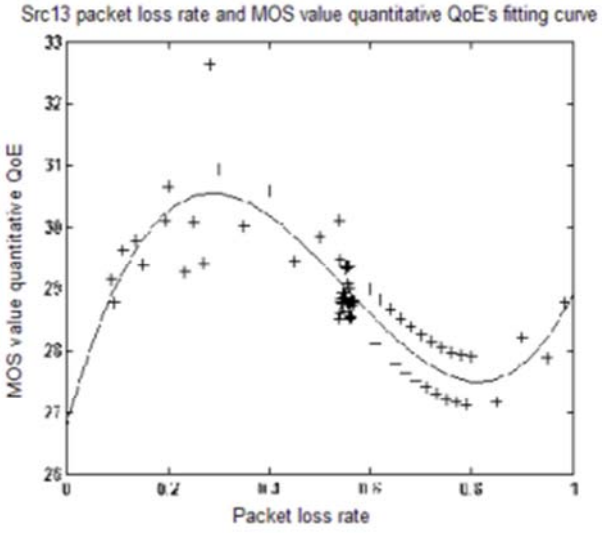

Figure 17. *Src13 fitting curve(MOS).*

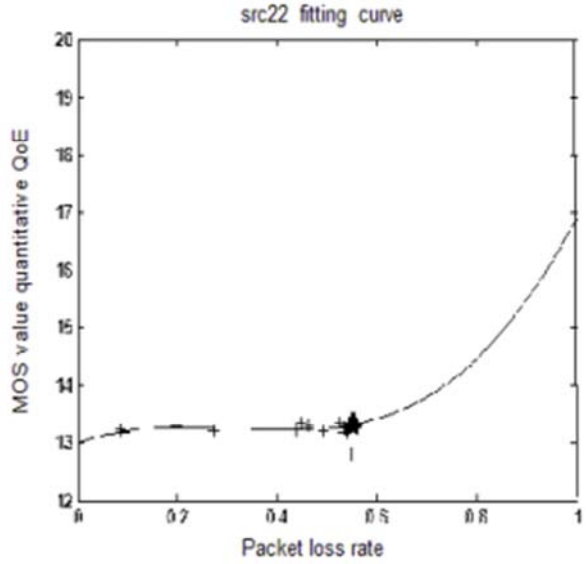

Figure 18. *Src22 fitting curve(MOS).*

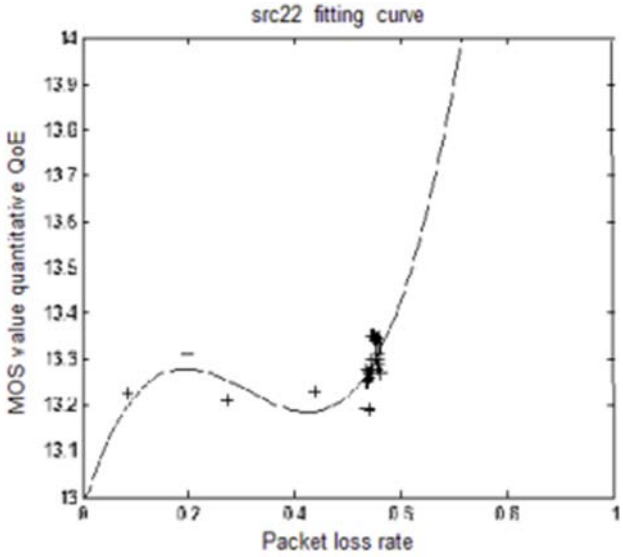

Figure 19. *Src22 the vertical axis decreases after fitting curve.*

3.2. The Analysis of Simulation Results

In general, this figure is several packet loss rate to QoE's scatter plots, is different with the figures which most of the references inside describe the horizontal axis is the objective score, vertical axis is subjective score, whether turning points or sparse data points are different, very few references research on Mapping model of packet loss rate and the Quality of experience on the influence of packet loss on QoE. For the figure 11 and figure 12, the two figures'horizontal axis are the packet loss rate, the vertical axis are PSNR values, no linetypes, show the datas in the form of a scatter figure. Observe the two figures we can be found, if packet loss rates are not the same, the user's quality of experience are not the same, so the assumption 1 is not found, that is the packet loss rate has influences on the user's quality of experience. From comparing two figures we can find, when the packet loss rates are the same, the user's quality of experience are not the same, this is because two video content complexity are different, so the assumption 2 is not found, that is video content complexity has influences on the user's quality of experience. Observe the two results figures figure 13 and figure 14's linetypes, otherwise known as the curve's trend, found that the two figures are both as packet loss rate increases, user's quality of experience first increase, then decrease, finally increase, and there are two knee points, and contrast the two figures we can know, video content complexity is smaller, the user's quality of experience is worse. But the first knee point of src22_hrc1_525. yuv video is not very clear. Two figures' abscissa is the packet loss rate, ordinate is PSNR value. For src13 video, data points looks less, the reason is in the process of experiment, first has carried on the exploratory experiments, in the process of experiment, because of the need to use a single variable method to modify the QoS parameters, therefore, exploring the parameter values each time how much interval once can not affect obtain the final turning point, and in the case of reduce test times as much as possible to get the packet loss rate's turning points between 0 and 1, mainly using the vernier caliper's main ruler and the principle of the vernier. For src22 video, delay time setting has no effects on the user's quality of experience and packet loss rate. Link speed lower limits are 10 MB and 74 KB. Packet size lower limit is 540kb, upper limit is 2050kb. Quantization parameter ranges from 0.01 to 255. So, packet loss rate very few take between 0.6-1, in the same way, using the basic principle of the vernier that is use as little as datas possible to avoid influencing turning points of data points. Because of using a single variable method, use this way to find how to make the packet loss rate dispersion exists between 0 and 1 and better single variable step size of the data values change, better single variable data values change step, mainly in order to better artificial control the distribution of data positions, improved random parameter combinations leading to the final results before it is the distribution of data uncertainty and no regularity and without purpose, can be more rules more objective for parameter setting and let the results interval can be controlled.

At the left side of the first turning point and the right side of the second turning point, the packet loss rate is greater, the better the user's quality of experience. This is because video content features such as the larger space complexity and time complexity would have coding distortion masking effect, and the video distortion is mainly composed of coding distortion and transmission distortion. Here we use the time complexity and space complexity representing video content features, using packet loss rate measuring network transmission distortion, when the video content complexity is greatly that is a higher time complexity and a higher spatial complexity, its coding distortion masking effect is far greater than the sum of coding distortion and network transmission distortion, therefore, the packet loss rate is greater, the user's quality of experience is greater.

At the right side of the first turning point and the left side of the second turning point, the packet loss rate is greater, the video quality is worse. This is because when the duplex and

simplex link speeds are small, especially within the range of less than the actual transmission speed, duplex and simplex link speeds setting are smaller, network will be more congestion, the greater the packet loss rate is, the user's quality of experience is worse. In the case of packet error rate is the same, the smaller the size of the packet set, the more the number of the packets, the greater the packet loss rate is, the smaller the user's quality of experience. The greater the quantitative parameters of compression, so needs more packets to send, the greater the packet loss rate, compression of video quality is worse. The longer the GOP length, it waiting for the next I frame coming time is long, the recovery time is longer, So the video user's quality of experience is relatively bad. And when the time complexity and space complexity are not big, its coding distortion masking effect is far less than the sum of coding distortion and network transmission distortion, therefore, the packet loss rate is greater, the user's quality of experience is worse.

Through the above figure 13 and figure 14 we can find that, in the case of different videos, under the condition of the same packet loss rate, different video's users' quality of experience QoE values are different, the influences degrees of the packet loss on QoE is different, that is at the left of the second turning point, under the condition of the same packet loss rate, src13 video users' quality of experience QoE values greater than src22 users' quality of experience QoE, this is because the src13 video content complexity is high. As a result, the more complex the content of the video, video QoE is larger. We can come to the conclusion that different video content have impacts on the video QoE. This is because the more complex video content motion, the larger the space complexity and the time complexity, so would have coding distortion masking effect, therefore, user's quality of experience is greater.

For figure 15, figure 16 and figure 17, figure 18, the horizontal axis are packet loss rate, the vertical axis are to use MOS quantitative QoE, the first two are scatter plots, the latter two are curve figures. Through the above four figures we can find that MOS method and PSNR method's shape of the curve is roughly similar, just the scope of Y axis is different. This is because one is using the MOS quantitative QoE, one is using the PSNR quantitative QoE. Figure 19 is src22 vertical axis decreases after fitting curve.

In general, we can came to the conclusion that different content complexity and different packet loss rates have a significant impact on the user's quality of experience. This part's study laid a foundation of establish the mapping model of the packet loss rate and QoE.

4. Discussion

4.1. Establish Mapping Model of Packet Loss Rate and the Quality of Experience

Due to study the effect of packet loss on the user's quality of experience QoE's purpose is to allow users to obtain good quality of experience, so needs to establish mapping model of packet loss rate and the Quality of experience by modifying the QoS parameters of the methods to make the packet loss rate small and user's quality of experience large. As is known to all, QoE evaluation methods mainly include subjective methods and objective methods, the subjective method is very difficult to operate. So objective QoE evaluation method make the packet loss rate get from measure mapping into the user's quality of experience QoE become one new kind of thought.

4.1.1. The Related Theory

In the mapping model of packet loss rate and QoE's problem, in the same process of these two variables are linked to each other, restrict each other. The relationship between the common variable has two categories: A class called deterministic relationship, the relationship between the variables called the function relation. A class is called non deterministic relationship or correlation relationship, this class of non deterministic relationship between variables called correlation relationship. Analysis of the mathematical model established for studying the relationship between one or more independent variables and a random variable and the statistics when done called regression analysis There is only one independent variable in the regression analysis called a regression analysis, if the model is nonlinear, called nonlinear regression analysis. In the regression analysis is usually need to discuss 3 questions: To solve regression coefficient, reliability test, prediction and control of the use of regression equation.

For the current mainstream video on demand application of PPLIVE, Optimal library and so on the relationship between PSNR and packet loss rate when 400k code, through the linear, square, hybrid, logarithmic, power, third power after model match found between the packet loss rate and the PSNR value (MOS value) has third power relations,establish the regression equation like: y=ax+bx 2 +cx 3 +d [7]. In this paper, uses src13_hrc1_525. yuv as an example, the establishment of scattered plot this video's packet loss rate and PSNR value, observe the scatterplot namely figure 11 can be found, packet loss rate and the PSNR values are presented a nonlinear relationship, reference PPLIVE packet loss rate and the PSNR values relation model, under wired and wireless environment establish the regression equation like: $y=ax^3+bx^2+cx+d$. First of all, we use of matlab conduct a nonlinear fitting to compute the coefficients of the regression equations and conduct the fitting curve of the src13_hrc1_525. yuv video's packet loss rate to the PSNR value's scatterplot. The second, we have the reliability test and the performance evaluation of the model. At last, using the regression equation to forecast and control. Experiment environment and topology description and HD video options are the same with the packet loss on QoE's Part.

4.1.2. The Simulation Experiments

(1) Regression equation coefficient and its confidence interval. For src13_hrc1_525. yuv video, establish the regression equation as follows, the mapping model of packet loss rate and the Quality of experience are as shown below.

PSNR quantitative QoE method, establish regression

equation as shown below:

Wired environment: $y=20.87x^3-34.48x^2+14.65x+13.41$

Wireless environment: $y=13090x^3-150.4x^2+21.31x+11.86$ In order to make more precise quantitative of QoE, MOS

quantitative QoE method, establish regression equation as shown below:

Wired environment:

$$y=41.7383x^3-68.9554x^2+29.2980x+26.8264$$

Wireless environment:

$$y=18450x^3-211.3x^2+72.35x+23.61$$

For the src13_hrc1_525. yuv video, wired and wireless environment PSNR method and MOS method's regression coefficient and its confidence interval as shown in tables 6 and table 7 respectively.

Table 6. *Src13 wired environment regression coefficients and its confidence interval.*

Para meter	Regression coefficient(PSNR)	confidence interval(PSNR)	Regression Coefficient (MOS)	confidence interval(MOS)
beta(1)	20.87	(16.41,25.34)	41.7383	(32.81，50.67)
beta(2)	-34.48	(-41.62,-27.35)	-68.9554	(-83.23,-54.68)
beta(3)	14.65	(11.32,17.98)	29.2980	(22.64,35.96)
beta(4)	13.41	(12.98,13.84)	26.8264	(25.96,27.69)

Table 7. *Src13 wireless environment regression coefficient and its confidence interval.*

Para meter	Regression coefficient (PSNR)	confidence interval (PSNR)	Regression Coefficient (MOS)	confidence interval(MOS)
beta(1)	13090	(-1548000,1574000)	18450	(-2.187e+006,2.224e+006)
beta(2)	-150.4	(-18670，18360)	-211.3	(-2.638e+004,2.595e+004)
beta(3)	21.31	(-34.83，77.45)	72.35	(-6.977，151.7)
beta(4)	11.86	(11.81，11.9)	23.61	(23.55, 23.68)

(2) Fitting curves

For the src13_hrc1_525. yuv video, packet loss rate and the PSNR value relationship's scatter plot under the environment of the wired using a nonlinear regression analysis PSNR quantitative method after fitting the fitted curve is as shown in figure 20. Wireless environment as shown in figure 21. Two figures' horizontal axis is packet loss rate, the vertical axis represents the PSNR values. Figure 20 curves first increased and then decreased and then increased, there are two turning points. Figure 21 that is why the src13 wireless environment data points less is that when obtained different packet loss rate in modifying parameters, in the case of different multiple parameter settings, the packet loss rate and the PSNR values are repeat in cycles. As a result, the final shape of the curve is roughly on the rise, no obvious turning point, can be thought of as in the wireless environment src13 with the increase of packet loss rate, PSNR value increased gradually. In the end, by comparing figure 20 and figure 21 we can be found, use the same video such as are all src13 video, can be thought of as due to the different topology structure and network environment which is the difference between wired and wireless environment resulted in the wire environment has two turning points and wireless environment do not hava a turning point. The topology structure and different network environment has impact on users' quality of experience QoE. MOS quantitative QoE method are as shown in figure 22 and 23. Two figures' horizontal axis are packet loss rate, the vertical axis are MOS quantitative QoE values. Two figures' linear and PSNR method quantitative QoE is basically the same.

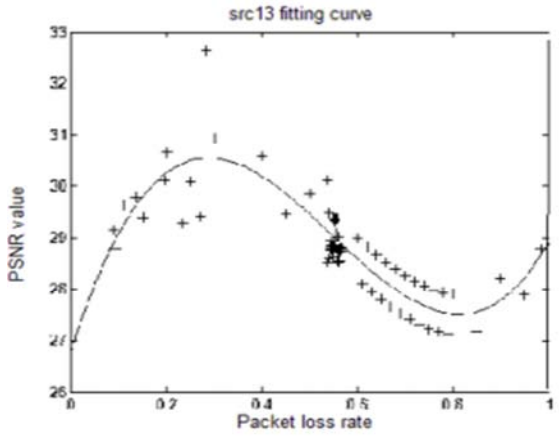

Figure 20. *Src13 wired Network environment.*

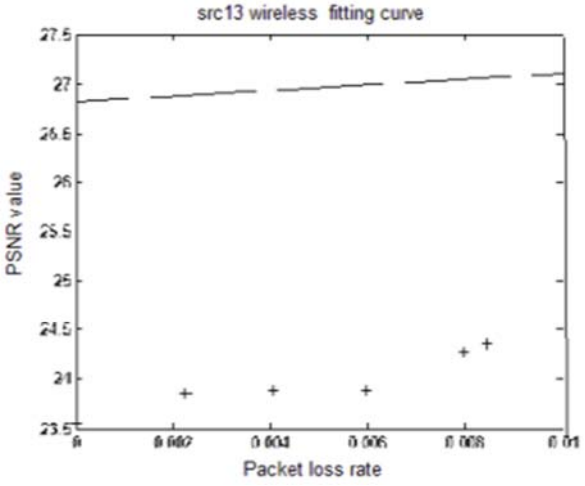

Figure 21. *Src13 wireless network environment.*

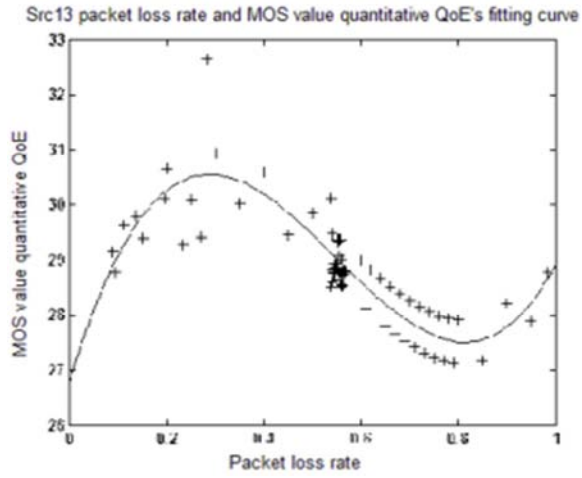

Figure 22. *Src13 wired Network environment.*

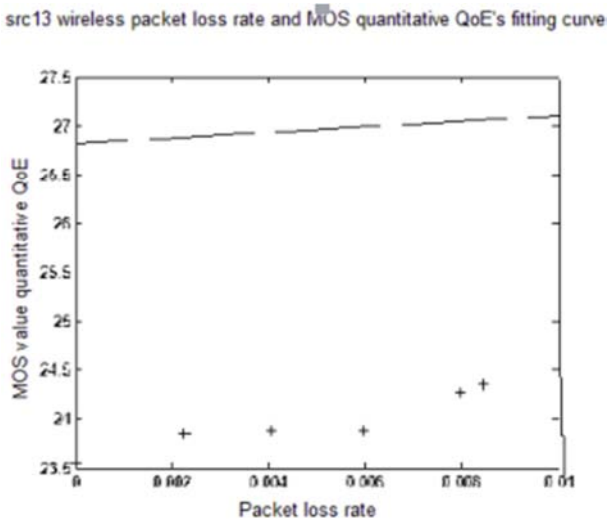

Figure 23. *Src13 wireless network environment.*

4.2. Analysis of the Model

By observing the fitting curve, we can find that packet loss rate and the user's quality of experience QoE presents a nonlinear relationship. For src13_hrc1_525. yuv video, make the fitting curve of the scatter plot, wired and wireless environments respectively using PSNR method and MOS method quantitative QoE's performance index as follows in Table 8 and Table 9. The evaluation indexes are mainly R-square, RMSE (Root Mean Square Error, RMSE), SSE, SROCC (Spearman Rank Order Correlation Coefficient, SROCC), Pearson, OR (Outlier Ratio), Spearman, and these values are between 0 and 1. Which R-Square is called the adjusted coefficient of determination, the greater the valuen is, believe that the better the fitting effect of the model. RMSE is called the root mean square error, it is a kind of numerical indicators measuring accuracy of measurement, the smaller this value is, believe that the better fitting effect of the model. SSE is the sum of squared residuals, it is also a kind of numerical indicators measuring accuracy of measurement, the smaller this value is, believe that the better fitting effect of the model. SROCC is the spearman correlation coefficient (SROCC) between objective and subjective score, used to detect the monotonicity of model prediction, the greater the coefficient is, the change trend increasingly relevant, methods are more good. Pearson correlation coefficient is used to measure whether the two data sets on a line, it is used to measure linear relationship between the distance variables, the greater the correlation coefficient, the stronger the correlation. OR said out rate, a measure of the stability of model prediction, this value is small, the better the performance of the model. The greater the Spearman coefficient, the better the performance of the model.

Table 8. *PSNR quantitative QoE method.*

Video	R-square	RMSE	SSE	SROCC	Pearson	OR	Spearman
Src13(Wired)	0.7271	0.2188	4.69	0.8884	0.9917	0	0.9832
13(wireless)	0.6779	0.06808	0.1669	0.8659	1	0	0.9789
PSNR	_0.588	0.16	0.2	0.634	0.71	0.5428	0.688
SSIM	0.666	0.15	0.18	0.815	0.83	0.7441	0.766

Table 9. *MOS quantitative QoE method.*

Video	R-square	RMSE	SSE	SROCC	Pearson	OR	Spearman
Src13(Wired)	0.7271	0.4375	18.76	0.9998	0.9917	0	0.9832
Src13(Wireless)	0.8392	0.096	0.3332	1	0.9163	0	0.9789
PSNR	0.588	20.16	0.2	0.634	0.71	0.5428	0.688
SSIM	0.666	0.15	0.18	0.815	0.83	0.7441	0.766

Comprehensive look at table 8 and table 9 can be found, the horizontal header is coefficient of each measures, the vertical header is a variety of methods, discovered by table 8 src13 wired indicators better than src13 wireless indicators, prove src13 wired fitting effect is better, discovered by table 9 src13 wired indicators better than src13 wireless indicators. Contrast table 8 and 9 can be found, MOS quantitative QoE method better than the PSNR quantitative QoE method. Due to the sum of squared residuals SSE is small, so the root mean square error RMSE is small, the adjust coefficient of determination R-Square is bigger, so you can think the fitting effect is better, the fitting is effective. The inspection of the fitting equation is

mainly through the test of goodness of fit (Determination coefficient R-square test). Among them, determination coefficient R square is the most commonly used indicators used to determine regression model fitting degree pros and cons, the more close to 1, the higher of the degree of the fitting model. For src13_hrc1_525. yuv video, in the wired and wireless environment, in the case of using PSNR quantitative QoE method, determination coefficient R-square is 0.7271 and 0.6779, close to 1, the model is of good performance. SROCC is respectively 0.8884 and 0.8659, bigger than the traditional evaluation method PSNR and SSIM's SROCC, so think this model's fitting effect is well. In the case of using MOS quantitative QoE method, determination coefficient R-square is 0.7271 and 0.8392, close to 1, the model is of good performance. SROCC is respectively 0.9998 and 1, bigger than the traditional evaluation method PSNR and SSIM's SROCC, so think this model's fitting effect is well. At the same time, compared with PSNR quantitative QoE, SROCC is bigger than that one, so think MOS value quantitative QoE method is better than the PSNR value quantitative QoE. The experimental results show that the model accuracy is high, easy to operate, can real-time detect packet loss has influences on the user's Quality of experience. For PSNR method, src13 in wired and wireless environment, by observing the wired environment figure 24 and figure 25, wireless environment figure 26 and figure 27, also can find the confidence interval of observation is greater than predicted confidence interval, the predicted value is more accurate than the observed value. May safely draw the conclusion that, predicted value is more accurate than the observed value. That is to say establish the mapping model of packet loss rate and the user's quality of experience QoE, in the case of given a packet loss rate, to predict more accurately, that is to say the correctness of this model is high, easy to operate. In the same way for MOS quantitative QoE method [22].

In the end, for PSNR quantitative QoE method src13 wired and wireless's fitting subjective and objective, as shown in Figure 28 and Figure 29, for MOS quantitative QoE method src13 wired and wireless's fitting subjective and objective, as shown in Figure 30 and Figure 31. The horizontal axis expresses the objective score of the objective quality evaluation, the vertical axis represents the value of the subjective scores. The subjective and objective video fitting figure is different with image, most video take on the shape of a straight line, most images show the shape of the curve. Through the four figures can be obviously found that, MOS quantitative QoE method and PSNR quantitative QoE method have better subjective and objective consistency, the former the subjective and objective consistency is stronger than the latter, MOS quantitative QoE degree of polymerization is better than the method of PSNR, therefor, MOS quantitative QoE method is better. By moving the QoE models in IPTV network application tests, found the detection bandwidth is at least a minimum of 2Mbps [23].

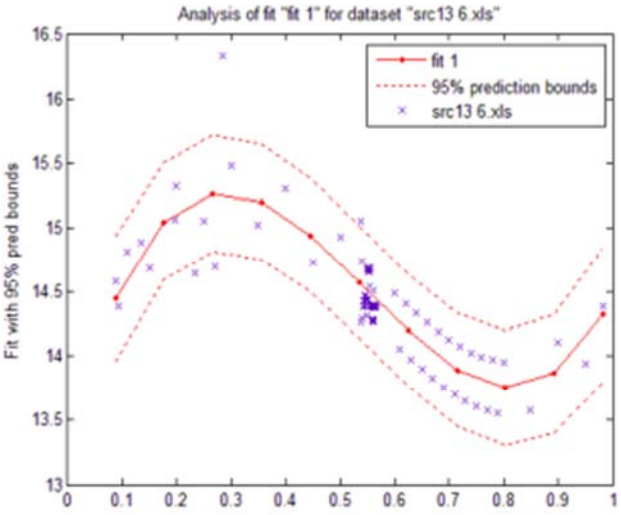

Figure 24. *Src13 wired prediction confidence interval (PSNR).*

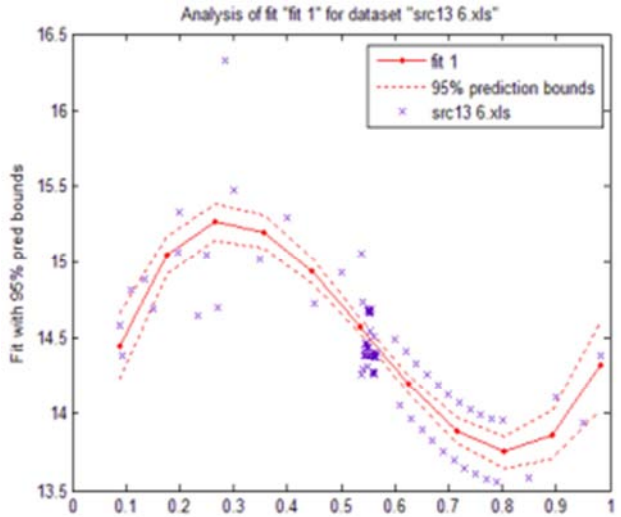

Figure 25. *Src13 wired observation confidence interval (PSNR).*

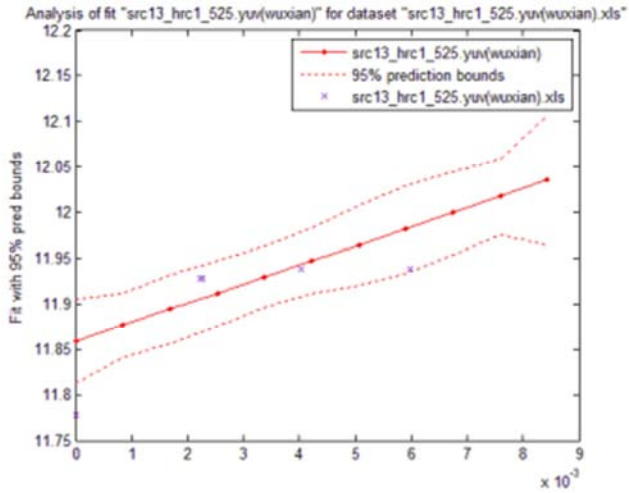

Figure 26. *Src13 wireless prediction confidence interval (PSNR).*

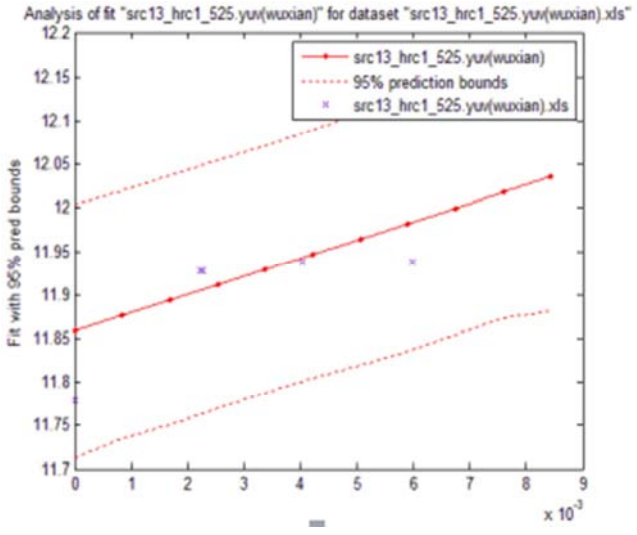

Figure 27. *Src13 wireless observation confidence interval (PSNR).*

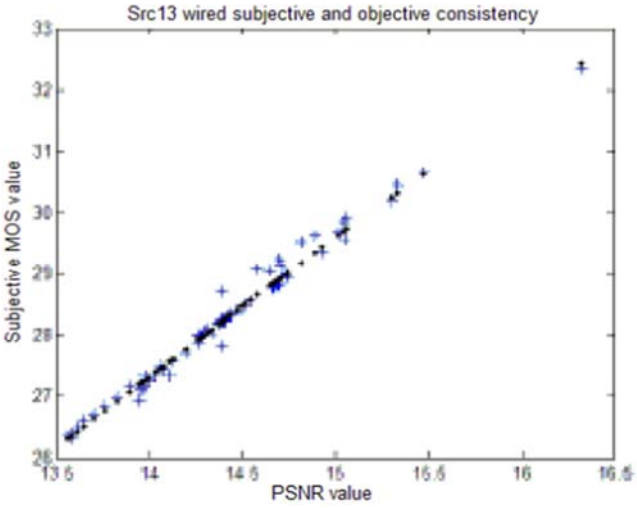

Figure 28. *Src13 wired subjective and objective consistency (PSNR).*

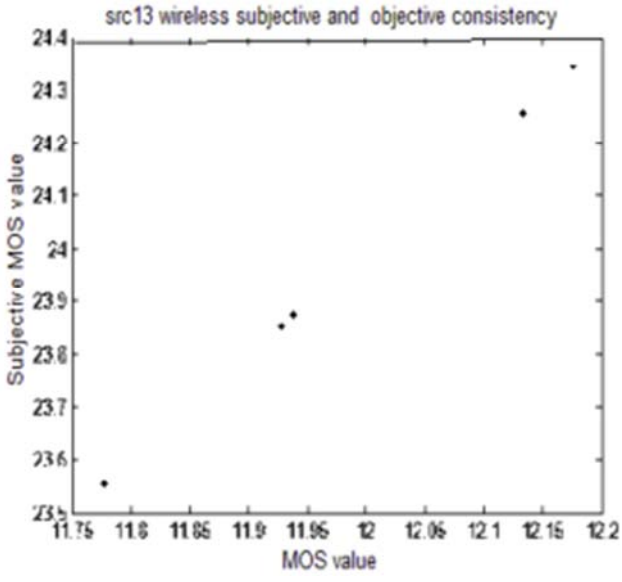

Figure 29. *Src13 wireless subjective and objective consistency(PSNR).*

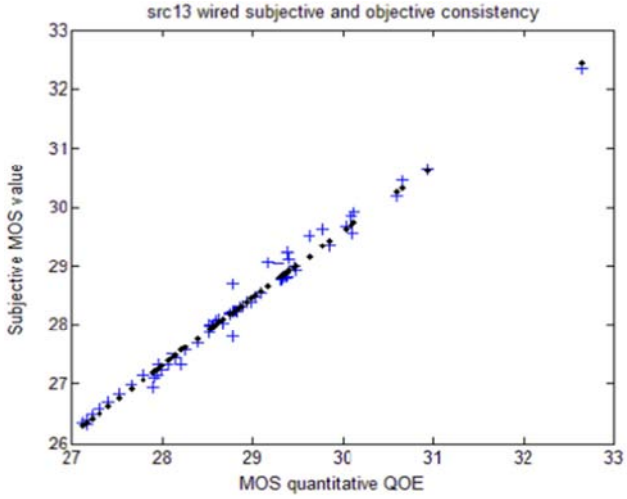

Figure 30. *Src13 wired subjective and objective consistency (MOS).*

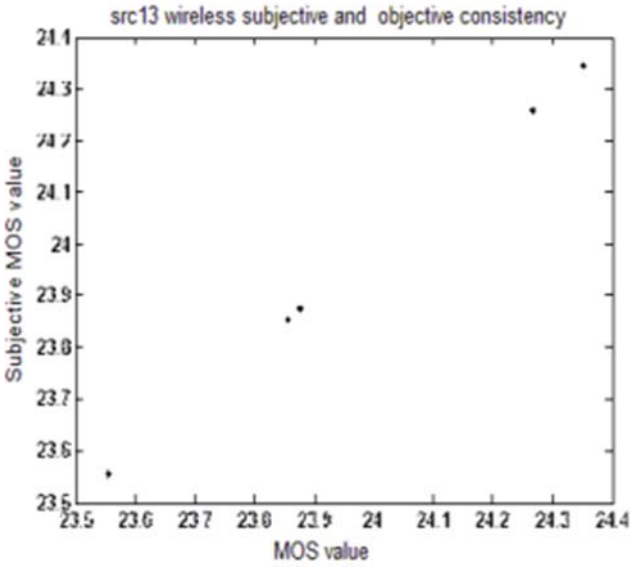

Figure 31. *Src13 wireless subjective and objective consistency(MOS).*

5. Conclusion

In summary, this paper mainly studies mapping model of packet loss rate and the Quality of experience on the influence of packet loss on QoE. The contribution of this paper is first through research obtain packet loss has a significant effect on video. Second, based on received the packet loss has a significant effect on QoE study and establish the mapping model of packet loss rate and the user's quality of experience QoE. Next step is to set up considering network packet loss of video quality evaluation model, on the basis of considering different packet loss rate and different content complexity has effects on QoE which conclude from packet loss has effects on QoE's part, combine consider other factors such as different packet loss models to establish video quality evaluation model consider the network packet loss, more accurate prediction of user's quality of experience QoE is the future work direction [24].

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Biography

Yi bin Hou graduated from xi'an jiaotong university computer science department, with a master's degree in engineering, graduated from the Netherlands EINDHOVEN university of technology department, received a doctor's degree from the department of engineering. From 2002 to 2013 as vice President of Beijing university of technology. The Beijing university of technology, professor, doctoral supervisor, dean of the school of software, embedded computing, director of the institute, Beijing university of technology, deputy director of academic committee and secretary-general, Beijing Internet software and systems engineering technology research center director. He research interests are the Internet of things and software engineering.

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