QoE-oriented Resource Management Strategy by considering user preference for Video Content

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***Abstract*—The user's Quality of Experience (QoE) is an assessment of the human experience. It's not only influenced by Quality of Service (QoS) parameters but also influenced by user's preference for video content. This article studies user's preference for video content and how user's QoE changes on account of their biases. Through two experiments, it is concluded that the higher the user's preference score is, the higher the user rate MOS and the less MOS reduces when the resolution of video decrease. That is, the more user likes the video content, the more tolerant they will be to quality reduction of videos. Then a network resource management strategy is proposed based on the conclusion, and a web site platform is established for the test. Eventually we get the result that 87.0% of the participants have their MOS value increased after using the strategy.**

***Keywords*—Quality of Experience (QoE), Resource Management, User Preference**

I. INTRODUCTION

In recent years, the network video service traffic grows larger and larger and will reach 55% of the total Internet traffic in 2016. On the other side, although the bandwidth is increasing continually, reaching users' demands of video/ High Definition (HD) video streaming services is difficult. In order to describe user's QoE while watching videos, Mean Opinion Score (MOS) is proposed and used in subjective tests. It is descriptive of the average human response to a given video flow. A mass of methods is proposed to increase user's QoE, but most of them investigate the relationship between QoE and Quality of Service (QoS). QoS parameter is object, which includes network layer (jitter, delay and packet loss, etc) and application layer (resolution, frame rate and sampling rate, etc) parameters. [1]. However, QoE is set of human-centric factors, not technology-centric parameters [2]. Therefore, QoS parameters are not enough to reflect QoE. The user's preference of video content may influent their perception of the video quality.

However, few model has been designed to consider human physical and psychophysical layer factors. Human layer factors include user expectations, user experiences, user's physical and psychological conditions and background (such as age, gender, level of education, values, etc.) when they watch the videos. In [3], it is analyzed and discussed how those factors interact each other. In [4], the author considers the influence factors of user preference for different types of video content. They obtain a set of correction factors named Preference factors (Pf) and add it to [5] in which they proposed a metrics named VsQM to consider the importance of temporal location of pauses to assess the user QoE of video streaming service. In [6], it proposed a service delivery method on per user and per service biases.

Considering the above situation, this paper designs and implements tests to investigate user preference for video content. Standing on the point of view of content service providers, we investigate the difference in MOS values grading by different user with different video content biases, and implement a network resource management strategy by considering it.

In the second section, the user preference characteristics and the network resource management mechanism based on user preference characteristics are analyzed. In the third section, the experiment investigated how user preference MOS value and the result of the experiment are introduced. We propose a network resource management strategy based on the result in the fourth section. And the fifth section summarizes the work of the article and presents the next phase of the research.

II. ANALYSIS ON CHARACTERISTICS OF USER PREFERENCE AND MECHANISM OF STRATEGY BASED ON USER PREFERENCES

A. Analysis on Characteristics of User Preferences

Users' evaluation of video is closely related to many factors. Besides QoS factors, environmental factors and the user preference can also influence QoE. This paper attempts to define user preference for video content as: video user's preference and tastes of certain video categories, and user can form a kind of behavior, which can lead to a subjective, produce behavioral, continuous ratings migration among objective videos. It is mainly in connection with video content type, user's personality, grade habits and appreciation ability, etc. Environmental factors include the current emotional state, current psychological states, and the test environment, etc.

User preference can combine various parameters in the network

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layer, application layer and pixel layer to influent video MOS all together. Fig. 1 shows how user preference influents MOS together with other parameters.

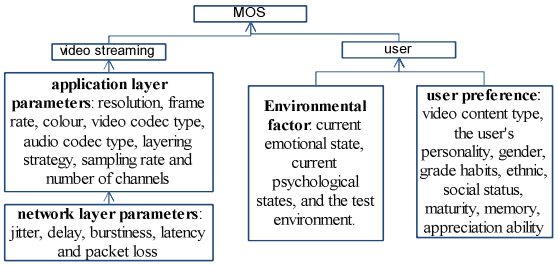

Fig. 1. MOS influence model

Because the influence of environmental factor on MOS value score is relatively random. It is not considered in this article. In fact, we observe ITU-T Recommendation P.910 [8] to avoid its influence. Besides, this article introduces preference score to quantify the user preference degree. The point is to investigate how user preference influence the MOS of video under different resolution. So we defined the criteria of preference score. As well as MOS, the range of preference score is 1 to 5, and fractional numbers are allowed. Table I shows the preference score criteria and Table II shows the MOS score criteria.

TABLE I
PREFERENCE SCORE CRITERIA

Score	Describe
5	Very much like
4	Like
3	Do not like nor dislike
2	Dislike
1	Very much dislike

TABLE II
PREFERENCE SCORE CRITERIA

Score	Describe
5	Imperceptible
4	Perceptible but not annoying
3	Slightly annoying
2	Annoying
1	Very annoying

B. Mechanism of Network Resource Management Strategy

Due to the influence of user preference on MOS value, this article introduces a network resource management strategy based on user preference for video content. Resources here refer to network bandwidth. In the case of limited network resources, our method will address the challenge to use service control to reallocate the network resource and get a higher MOS of the whole users in a long term.

The process of network resource management strategy based on preference, is as follows:

1) Collect User Preference Information: user grades preference score according to the preference score criteria, while watching videos with same objective quality.

2) Execute the Resource Management Strategy: When the user watches video, user's preference score is used to control video resolution.

III. TEST SETUP

A. Aim of the Test

The main purpose of this experiment is to explore how the user preference for video content influents MOS. In particular, we studied the user preference for anime, news, funny video, and MV, 4 types of video content. How user scores toward different content categories when the resolution varies is also investigated. All of the videos have the same Statistic Bit Rate (SBR) and Frame Rate (FR), Thus the PSNR value of each video can be thought the same. The value of PSNR (General Movement) is:

$$PSNR_{GM} = 19.75 + 0.0022FR + 3.76\ln(SBR) \quad (1)$$

We use the schema proposed in [9] to classify all videos used in the test in advance, insuring that every test video has the same level of movement. At this test, it is, General Movement (GM).

B. Subjective Test Procedure

There are 51 participants recruited for the test. Among them 23 are male and 28 are female, 44 are between 18 to 25 years old, 7 are between 29 to 42 years old. In the process of the whole experiment we obey ITU-T Recommendation P.910 [8].

In the test, each category contains 8 one-minute videos. Each video is produced in three resolution: 360P, 480P and 720P as these are widely used. At the same time, the videos in a same category are from same video series and have high correlation with each other, to guarantee that the participant has same preference degree to all videos in the same category. Meanwhile, each one-minute video has a set beginning and ending point to ensure that the participant can form a clear preference after watching the videos. The features of test videos are as Table III shows.

TABLE III
VIDEOS USED IN TEST 1

Item	Value
Category	Anime, News, Funny Video, MV
Amount of videos in each category	8
Amount of videos in each category for reference test	4
Amount of videos in each category for MOS test	4
Resolution	720P, 480P, 360P
Length of each video	1 minute

The test consists of two processes:

1) Participant Grade Preference Score: Let participant watches 4 one-minute videos per category and all those videos have the

same video resolution (says, 720P). Then grades those videos using the criteria set in Table I.

2) Participant Grade MOS Score: Let participant chooses 4 videos per category randomly. For each video, they needs to watch 3 times in 3 resolutions (says, 720P, 480P, 480P). Then, let participant grades those videos using the criteria set in Table II.

C. Test Result

From step 1) and 2), we get participant's preference score and MOS score of each video. We mapped the participant's preference and MOS for each preference grade and three resolution levels in Fig. 2. Founding that user' preference scores were positively correlated with the subjective MOS in three resolution levels. And the data basically concentrate in the preference range of 3.1 to 4.5.

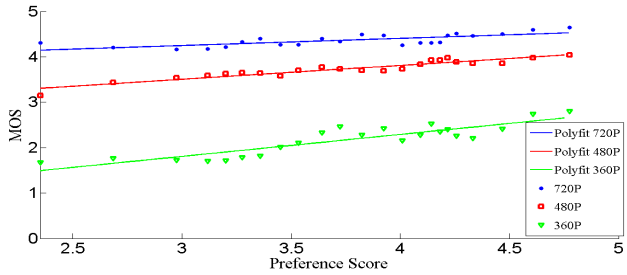

Fig. 2. Relation between subjective MOS and Preference Score

By linear fitting the data, we get the formula (2) to (4) for three different resolutions.

$$M_{720P} = 0.1577\ p + 3.7737 \quad (2)$$

$$M_{480P} = 0.3045\ p + 2.5904 \quad (3)$$

$$M_{360P} = 0.4840\ p + 0.3531 \quad (4)$$

To investigate the relationship between the D-value of the the subjective MOS between 720P, 480P and 360P videos, we draw Fig. 3 to show how the D-value decreases when the user's preference score increases.

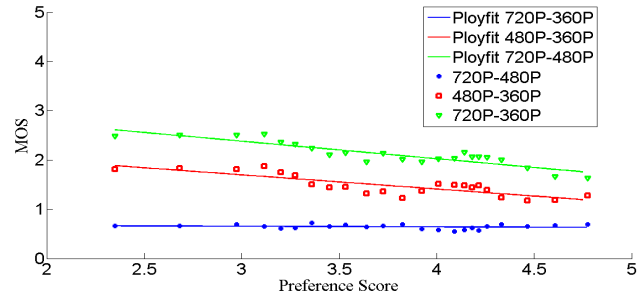

Fig. 3. Relation between the differences of subjective MOS of three kind of resolution videos and Preference Score

Where M720P is the MOS of 720P video, M480P is the MOS of 480P video and M360P is the MOS of 360P video; p is the preference score of the video.

D. Testify the Test Result

We also take into account users' different rating styles may influence the test result. That is, some participants are accustomed to give a score on the high side of other participants both in MOS score and preference score. So we designed Test 2 to testify the result of Test 1. Test 2 requests participant to rank their preference for the four video categories rather than rate the videos. Thus the rating styles won't influence the test result. We make four categories of videos with six kind of video resolutions. They are180P, 240P, 360P, 480P, 540P, 720P. Participants are asked for ranking their preference and rating the MOS values under the same environment as Test 1. The result is shown in Fig. 4.

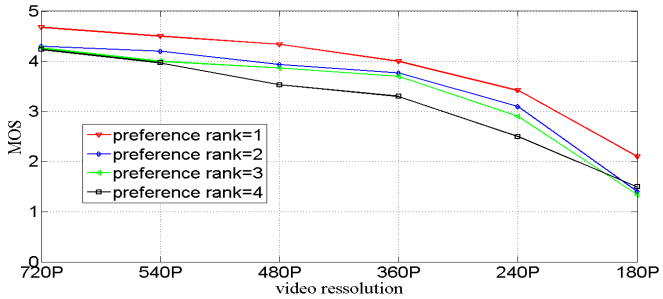

Fig. 4. Relation between subjective MOS and video resolution in different preference rank

It can be found, under the situation of all six resolution, the higher the participant ranks the video, the higher the subjective MOS is. From Test 1 and Test 2 we drew the following conclusion: the higher the degree of user preference for video content is, the better quality the user perceive, and the participant is less sensitive of the reduction of the video quality.

IV. Resource Management Strategy Based on User Preferences

As we know, network resources are limited. We hope to improve user's overall QoE under a situation of limited and certain amount of network resources in a long term as far as possible. The third section of this paper shows that the same resolution reduction of a user-prefer video will cause less MOS decrease than of a user-dislike video. So we can propose a network management strategy to reduce the video resolution of "some" videos by considering user preference for video content.

A. Building Platform of Resource Management

Our platform adopts BS model. In the platform, user watches and rates the MOS through browsers. While SQL server is used as database to record users' personal information and all ratings.

We preset 4 levels of resolution (says, 720P, 480P, 360P and 180P) for each video in the platform.

B. Procedure of Resource Management Test

Each category in the platform contains about 15 one-minute videos. Participants are asked to watch 4 videos, and rate their preference score for each category, then watch 4 videos with random resolution (each of them with distinct level of resolution)

and rate their MOS scores, finally watch 4 videos as Table IV shows. The strategy means to decrease the resolution level of user preference videos at the same time raise the resolution level of user dislike videos. If Test 1 is correct, we can raise the overall MOS of each user with same amount of network resources.

TABLE IV
STRATEGY TO MANAGEMENT RESOURCE

Preference Score Rank	Video resolution
1st	180P
2nd	360P
3rd	480P
4th	720P

At last, the platform will figures out the overall MOS of each participant with or without the strategy.

C. *Result of the Test*

We retrieved totally 31 pairs of data, of which 23 are valid after using ITU-R BT.500 [10] to remove invalid ones. Table V shows the test result. From the results, it is observed that 20 pairs of data obtain higher score after using the strategy. Only 2 of 23 are opposite, and 1 of 23 is equal (highlighted). Thus, we may safely draw the conclusion: the network resource management strategy to improve user's QoE is effective. After using the strategy, the average MOS value increased about 0.17, the proportion of participants, who has rated increased or equal MOS is 91.3%, the proportion of participants who has rated increased MOS is 87.0%.

TABLE V
RESULT OF TEST 3

Serial No	MOS without the strategy	MOS with the strategy
1	3.235416667	3.272916667
2	**2.99375**	**2.897916667**
3	**3.84375**	**3.84375**
4	3.825	4.00625
5	3.5875	3.9625
6	3.44375	3.61875
7	3.58125	3.76875
8	3.95625	4
9	3.25	3.375
10	3.03125	3.09375
11	3.275	3.3375
12	4.0125	4.10625
13	3.7375	3.797916667
14	3.60625	3.754166667
15	**4.025**	**3.7375**
16	3.9375	4.1875
17	3.035416667	3.141666667
18	3.55625	3.85625
19	3.39375	4.01875
20	3.202083333	3.288888889
21	3.3125	3.975
22	3.375	3.5625
23	3.44375	3.922916667
average	3.506974638	3.675060387

V. CONCLUTION

In this paper, we designed 2 tests to explore the relationship between user preference for video content and subjective MOS score. Through Test 1, we obtain two conclusions. 1) The higher the user preference score is, the higher the user rate the video; 2) The higher the user preference score is, the less the MOS score reduces when the quality of video decreases. Through Test 2, we testified the result of Test 1.

In the fourth section, we propose a strategy of network resource management and try to build a test platform which is very similar to real video website. In the platform, under same amount of network resource, we collect the data of user's subjective MOS with or without our strategy and calculate everyone's average MOS of two situations separately. The test shows that our strategy has played a role, 87.0% of user's average MOS improved.

However, in this article, we considered only one single QoS factor named video resolution. In the actual application environment, the subjective MOS scores is highly influenced by other influence factors such as pause. Thus resolution changing should be made considering the limitation of user's bandwidth firstly. So the next step of our work is to take the influence of bandwidth and other influence factors into consideration, improve our strategy and make it more close to reality.

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