서비스 이용자의 선호도를 반영한 IPTV QoE 측정 방안

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IPTV QoE Evaluation Method Reflecting Subscriber's Preference

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Abstract

In this paper, we propose the IPTV QoE evaluation method reflecting service user's preference. This method can evaluate the IPTV service QoE using the fuzzy integral because it usefully employs a subjective decision for QoE(Quality of Experience) evaluation. IPTV subscribers can prepare a criterion to select an IPTV provider who provides high quality QoE.

1. Introduction

IPTV service environment has been under a dramatic change along with the IPTV market growth and customer's demanding requirements. In this situation, it is necessary to IPTV service the viewpoint of the quality that maximizes the customer experience. Like this, as various services are provided in the integrated network environment(NGN), QoS and QoE concept is introduced in the IP network to satisfy customer's requirements.

The ultimate measure of a network and the services it offers is how subscribers perceive the performance. Quality of Experience(QoE) is the term used to describe this perception and how usable the subscribers think the services are. In IPTV market, it has become very important for an operator to measure the QoE of its network accurately and improve it further to achieve customer loyalty and maintain competitive edge. A poor QoE will result in dissatisfied customers, leading to a poor market perception and ultimately, brand dilution[8].

With the growth of IPTV market, the criterion to select IPTV provider needs because IPTV subscribers want to select provider who guarantees their quality satisfaction. So we propose the IPTV QoE evaluation method using Fuzzy Integral in order to reflect user's subjective characteristic.

2. Related Works

A. Service Quality Model for IPTV

The services provided by IPTV are various and thus, the scale of IPTV service market is dramatically increasing. In this situation, it is necessary to improve IPTV service in the quality that maximizes the customer experience. So we have to identify the appropriate managed element of service quality and keep maintaining the quality level required by users.

The existing researches have deduced quality items of IPTV service, and analyzed the correlation and causation of the quality items[1][2]. It is necessary to grasp service quality core parameters for maximizing the quality management in limited network resource environment. However, existing research did not reflect a service user's personal characteristic in QoE evaluation because they allocated a relative importance of IPTV QoE items to scale.

B. Evaluation Method using Fuzzy Integrals

The fuzzy measure introduced by Sugeno[7] does not satisfy additivity, and is a set function only considering monotonicity. The fuzzy integral about the Sugeno's fuzzy measure evaluates a certain object for various viewpoints, and is used to put together its valuation when importance of evaluation items is different from each other.

Especially the fuzzy integral has been used in a variety of fields such as data mining, decision making, information fusion and nonlinear multiregression because it is utilized at evaluation that a subjective judgment is intervened. So, the fuzzy integral is proposed as non-additive evaluation method using the fuzzy measure. Even though service providers offer their subscribers a same QoS level IPTV service, subscribers have a different quality satisfaction about IPTV because their taste is different from each

other.

3. IPTV Video QoE Evaluation Method using The Fuzzy Integrals

A. IPTV Video QoE Items and Standards

IPTV service overall QoE is comprised of various QoE items such as Audio QoE, Video QoE, Multimedia QoE, Transaction QoE, Transmission QoE and Security QoE. In this paper, quality items of QoE evaluation are restricted within Video QoE in order to evade the fuzzy integral complexity.

Video QoE is divided into Resolution, Color Distortion, Shape Distortion, Persistence and Seamlessness. Here, Seamlessness generated by Jerkiness, Frame Skipping and Frame Freezing most influences in Video QoE. <Table I> shows the Video QoE items, its relative importance and weight as results analyzed by QFD(Quality Function Deployment) method[1][2]. We can allocate a valuation basis and arrange quality items using the relative importance of Video QoE items and its weight.

<Table I> Video QoE Items and Weights

Video QoE Items	Relative Importance(%)	Weight
Resolution(R)	7.2	0.14
Color Distrotion(C)	5.9	0.11
Shape Distortion(D)	10.3	0.2
Persistence(P)	6.2	0.12
Seamlessness(S)	21.9	0.43

B. IPTV Video QoE Evaluation Method

Before discussing QoE evaluation method using fuzzy integral, we introduce the fuzzy measure definition and a mathematical symbol. Assume that A is not null set but σ-algebra of a X subset. And set function g:$A \rightarrow$ [0, 1] is the fuzzy measure.

(1) g(Φ) = 0;
(2) If A, B ∈ A, A ⊂ B, then g(A)≤g(B);
(3) If An∈ A, A1⊂ A2⊂ ⋯, then

$$\bigcup\nolimits_{n-1}^{\infty} A_n \in A \quad ;$$

(4) If An∈ A, A1 ⊃ A2 ⊃ ⋯, then

$$\bigcap\nolimits_{n-1}^{\infty} A_n \in A$$

and $\quad \lim\limits_{n \to \infty} g(A_n) = g(\bigcap\nolimits_{n-1}^{\infty} A_n) \quad ;$

When g is a fuzzy measure in measurable space we name (X, A, g) as a fuzzy measure space. The evaluation algorithm by fuzzy integral is as follows.

[Step 1] Determine g(H) contributed by H to universal set X then X is finite set and H is factor of power set of X, satisfies H∈P(X).
[Step 2] Array each evaluation value (h(x$_i$)) in large order and assume x$_i$∈X (i = 1, 2, ⋯, n) then h(x$_1$) ≤ h(x$_2$) ≤⋯≤ h(x$_n$). So, we can obtain H$_i$ = {x$_i$ | k = i, i+1, ⋯, n}.
[Step 3] Calculate h(xi) Λ g(H$_i$) to each i
[Step 4] Evaluation value considers as max of calculated

Here *Sup* is used when it is a continuous function (X is an infinite set), and *Max* is used when it is a dispersion function.

C. The Example for IPTV QoE Evaluation

For example we assume that two users evaluate IPTV Video QoE. First IPTV service user allocates a relative importance of each condition after determining IPTV QoE items. Here, we only consider above mentioned Video QoE items among IPTV QoE items. <Table II> shows the importance of evaluation items to fuzzy measure.

<Table II> Importance of Evaluation Items to Fuzzy Measure

g({∅})= 0	g({R,P})=0.21	g({R,C,D})=0.72	g({C,P,S})=0.83
g({R})= 0.14	g({R,S})=0.52	g({R,C,P})=0.68	g({D,P,S})=0.87
g({C})=0.11	g({C,D})=0.27	g({R,C,S})=0.83	g({R,C,D,P})=0.78
g({D})=0.2	g({C,P})=0.14	g({R,D,P})=0.73	g({R,C,D,S})=0.93
g({P})=0.12	g({C,S})=0.49	g({R,D,S})=0.88	g({R,C,P,S})=0.89
g({S})=0.43	g({D,P})=0.35	g({R,P,S})=0.84	g({R,D,P,S})=0.94
g({R,C})=0.15	g({D,S})=0.57	g({C,D,P})=0.71	g({C,D,P,S})=0.92
g({R,D})=0.26	g({P,S})=0.50	g({C,D,S})=0.86	g(all) = 1

Here fuzzy measure g(•) does not satisfy additivity. In order words, g({D}) = 0.23 and g({S}) = 0.45, then not g({D,S}) = 0.68 but g({D,S}) = 0.57. On this wise user's the valuation of Sugeno fuzzy integral using arranged importance is as follows.

In the <table III>, although provider X's sum of QoE item valuation is larger than Y's because provider Y has more satisfaction about Seamlessness in the same network environment, we can analogize that provider Y more satisfies with the provided IPTV service quality than X. This result shows that quality satisfaction is differently measured according to user's taste even though IPTV service is provided in the same environment.

<Table III> Valuation and Integral Evaluation about IPTV Video QoE

IPTV Providers	R	C	D	P	S	Sum	Fuzzy Integral
X	0.72	0.83	0.45	0.63	0.82	3.45	0.72
Y	0.83	0.92	0.65	0.54	0.64	3.58	0.65

In order to evaluate a certain objective, not only the suitable valuation basis should be needed accordance with an evaluation objective, but also its objectivity and subjectivity should be analyzed. If the valuation basis connotes subjectivity or accompanies fuzziness, it is reasonable to use the fuzzy measure at evaluation. Like this, the IPTV subscribers can prepare a criterion to select the IPTV provider who provides high quality QoE if they can use the measurement of customers' quality satisfaction reflecting their subjectivity.

4. Conclusion

In this paper, we propose the evaluation method of experienced quality satisfaction to reflect service user's subjectivity in order to expect how a user perceives the usability of a service when in use – how satisfied he or she is with a service. Accordance with increasing IPTV providers, the criterion to select IPTV provider needs because IPTV subscribers want to select provider who guarantees their quality satisfaction. So we propose the IPTV QoE evaluation method reflecting user's subjective characteristic. Further, the research of the quality evaluation system to reflect variance QoE items is required.

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