Standardization Trends on QoE Evaluation in ITU-T Study Group 12

Masanori Koike, Noritsugu Egi, and Kazuhisa Yamagishi

Abstract

This article introduces recent standardization activities related to the evaluation of the quality of experience (QoE) of speech, audiovisual, and other new services such as object recognition for autonomous driving. The article focuses on the activities of the Study Group 12 of the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T SG12), which is responsible for standardization work on performance, quality of service, and QoE.

Keywords: ITU-T SG12, quality of experience, autonomous driving

1. ITU-T SG12

The Study Group 12 of the International Telecommunication Union - Telecommunication Standardization Sector (ITU-T SG12) is the lead SG in ITU-T on quality of service (QoS) and quality of experience (QoE) in the worldwide standardization of media-quality evaluation that takes into account achievements in regional standardization bodies such as the European Telecommunications Standards Institute (ETSI) and Alliance for Telecommunications Industry Solutions (ATIS). Standardization work on network QoS is carried out in various standardization organizations such as the Internet Engineering Task Force (IETF) and 3rd Generation Partnership Project (3GPP). These organizations have confirmed that their work matches that of SG12.

2. Technologies for estimating effective equipment impairment factor for speech quality (Recommendation G.113, P.833.2, P.834)

Recommendation G.107 (E-model) has been standardized as a transmission-planning tool for Internet protocol (IP) telephony services and is used worldwide. SG12 has standardized Recommendation G.107.1 (Wideband (WB) E-model), which is a 100–7000 Hz speech-extension version of the E-model, and G.107.2 (Fullband (FB) E-model), which is a 50–14,000 Hz and 20–20,000 Hz speech-extension version of the E-model. In JJ-201.01 and JJ-201.11, which regulate the speech quality of IP telephony and IP mobile telephony in Japan, the speech quality is regulated using a rating factor *R*, which is calculated on the basis of the E-model, WB E-model, and FB E-model.

In E-model, WB E-model, and FB E-model, to calculate the effective equipment impairment factors (Ie,eff/Ie,eff,WB/Ie,eff,FB), which are intermediate parameters of *R*, equipment impairment factor *Ie* and packet-loss robustness factor *Bpl*, which are defined corresponding to the codec and bit rate in Recommendation G.113, are used. The *Ie* and *Bpl* for the LC3plus codec standardized by ETSI have been added to Recommendation G.113.

In the E-model and WB E-model, the methods for calculating the effective equipment impairment factor are specified in Recommendations P.833 and P.833.1, which are derived from the results of subjective quality-evaluation experiments, and Recommendations P. 834 and P.834.1, which are derived from the output results of an objective quality-evaluation model that estimates subjective quality by speech-signal analysis. With the standardization of Recommendation G.107.2, the FB E-model version of Recommendation P.833 had been studied and was standardized as a new Recommendation P.833.2. The FB E-model version of Recommendations P.834 and

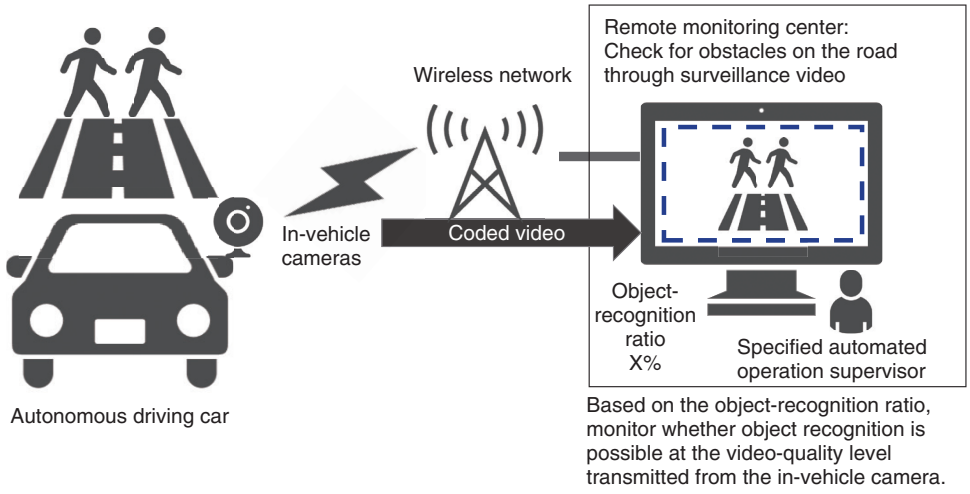


Fig. 1. Remote-monitoring-system configuration.

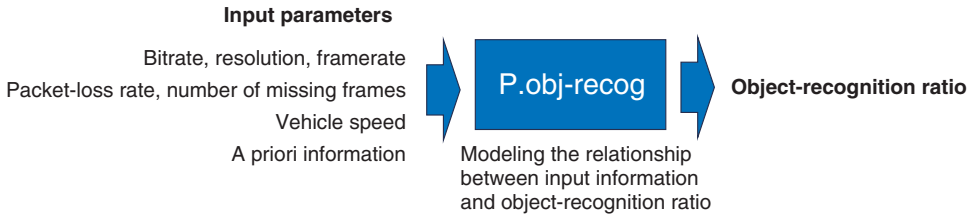


Fig. 2. Input/output of Recommendation P.obj-recog.

P.834.1 is also under study.

3. Object-recognition-rate-estimation model in surveillance video of autonomous driving (Recommendation P.obj-recog)

The Society of Automotive Engineers (SAE) has defined six levels of autonomous driving, Levels 0 to 5, depending on the driver and area where the autonomous car can be driven [1].

In autonomous driving without a driver (specified automated operation), which corresponds to Level 4, a remote monitoring center must be set, and a person who carries out remote monitoring (specified automated operation supervisor) must be assigned [2]. The specified automated operation supervisor checks for objects on the road on the basis of the video from the autonomous car's surveillance camera that is encoded and transmitted to the remote monitoring center.

Therefore, the quality of the videos transmitted from the autonomous car's surveillance camera must be clear enough for the specified automated operation supervisor to recognize objects. To confirm that the video is always clear enough for object recognition, a model to derive the probability that the specified automated operation supervisor can recognize an object from the encoded video has been studied, as shown in **Fig. 1**. This technique enables the monitoring of whether object recognition is possible at the video-quality level transmitted from the autonomous car's surveillance camera.

As shown in **Fig. 2**, parameters related to video encoding (bitrate, framerate, resolution), data loss during transmission (packet-loss rate, number of missing frames), and vehicle velocity are defined as inputs of the model, and the model outputs the object-recognition ratio. Since the quality of the video transmitted from the autonomous car's surveillance camera depends on day/night, weather conditions during operation, as well as surveillance camera settings, it is assumed that the coefficients in the estimation

technique are optimized for each of the a priori information. With this framework, we aim to establish a model that can respond to various situations expected in autonomous driving. At the most recent meeting, a test plan for obtaining the object-recognition ratio through subjective evaluation experiments was discussed, and the results of experiments conducted on the basis of this test plan were presented. After the model proposal is made, the accuracy of the object-recognition-ratio estimation for each model will be verified. This recommendation is scheduled to be established in 2025.

4. Future outlook

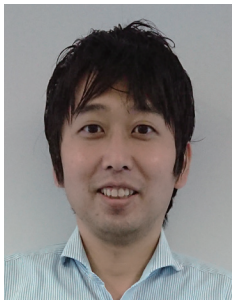
This article described subjective assessment and quality-estimation models for speech and object recognition for autonomous driving. SG12 has recently studied the extension of recommendations, such as revision of the FB E-model. A study on the quality of transmitted monitoring video for automated driving services has also been launched.

Since various services are expected to be launched along with the deployment of the fifth/sixth-generation mobile communication systems, the design and management of QoS/QoE for various services should be considered. Therefore, it will be important to investigate the activities of SG12.

References

[1] SAE International, "Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-road Motor Vehicles," 4970.724, pp. 1–5, 2018.
[2] National Police Agency, "The Act Partially Amending the Road Traffic Act (Act No. 32 of 2022)," Apr. 2022.

Masanori Koike
Researcher, NTT Network Service Systems Laboratories.
He received a B.E. in mathematical engineering and information physics in 2015 and M.S. in information science and technology in 2017 from the University of Tokyo. Since joining NTT in 2017, he has been engaged in research related to video quality.



Noritsugu Egi
Senior Research Engineer, NTT Network Service Systems Laboratories.
He received a B.E. and M.E. from Tohoku University, Miyagi, in 2003 and 2005. In 2005, he joined NTT laboratories, where he has been engaged in the quality assessment of speech and audio. He is currently investigating the quality assessment of video and web-browsing services over IP networks. He received the Young Researchers' Award from the Institute of Electronics, Information and Communication Engineers (IEICE) in 2009.

Kazuhisa Yamagishi
Senior Research Engineer, NTT Network Service Systems Laboratories.
He received a B.E. in electrical engineering from Tokyo University of Science in 2001 and M.E. and Ph.D. in electronics, information, and communication engineering from Waseda University, Tokyo, in 2003 and 2013. In 2003, he joined NTT, where he has been engaged in the development of objective quality-estimation models for multimedia telecommunications. He has been contributing to ITU-T SG12 since 2006. He has been a rapporteur of Question 13/12 since 2017, vice-chair of Working Party 3 in SG12 since 2021, and the vice-chair of SG12 for 2022–2024 Study Period.