Study of Comprehensive Evaluation for L2 Automated Vehicles on Field Test

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***Abstract*—In addition to some test standards in the level 1 automated vehicles, it still lacks perfect test evaluation procedures for level 2 automated vehicles. The evaluation method of vehicle field test for L2 automated vehicles is studied, and the multi-level automated vehicles evaluation index system is preliminarily established from the aspects of safety, intelligence and experiential. The order relationship and the analytic hierarchy process are applied to empower the automated vehicles evaluation indicators at all levels. A comprehensive evaluation model of L2 automated vehicles was established by using fuzzy comprehensive and grey comprehensive evaluation method. Taking the test results of the three models of vehicles on ACC mode as an example, a multi-level fuzzy comprehensive evaluation and a gray comprehensive evaluation were carried out to conduct a single evaluation and comprehensive evaluation on the three aspects of safety, intelligence and experiential of the automated vehicles.**

Keywords—Automated Vehicles, Fuzzy Comprehensive Evaluation, Field Test, Order Relationship Analysis, Analytic Hierarchy Process

I. INTRODUCTION

In recent years, the automatic driving technology has become a hotspot for major automotive companies due to the rapid development of artificial intelligence, visual computing and vehicle network. Automated vehicles can operate vehicles automatically, freeing humans from cumbersome and boring driving, improving the efficiency of urban traffic and reducing or voiding the occurrence of traffic accidents[1]. However, automatic driving technology is immature and traffic accidents are frequent. A research report in 2015 pointed out that the accident rate of automated vehicles is twice that of ordinary vehicles [2]. Therefore, the test verification of the automated vehicles is particularly important in order to ensure the safety and reliability of the automatic driving system.

Automated vehicles tests include virtual tests, driving simulator tests, closed field tests and open road tests. Tests include sensors, algorithms, actuators, and human-machine interfaces for testing purposes including application functionality, performance, stability, robustness, functional security, and type certification. Simulation test and driving simulator test are generally carried out in the early stage of development, using virtual scenes and vehicles to quickly evaluate some of the performance of the automatic driving system. After the system development, real vehicle testing, such as controlled field testing and open road testing, must be carried out to evaluate the actual performance of the vehicle-level system and the performance effectively at the user level.

In terms of real vehicle testing, foreign countries mainly conduct research on automatic driving test scenarios based on large-scale natural driving tests, automatic driving tests, and traffic accident databases. The EU's FESTA project is used to evaluate the empirical test of intelligent transportation systems. Barnard have concluded a complete set of FOT methods, namely the FESTA method[3] . Based on this, the large-scale FOT method for test verification of automated vehicles is studied, and the three objectives and focus of automated vehicle FOT test are respectively driver-centric test, vehicle-centric test and scene-centric test [4]. The AdaptIVe project in Europe has carried out empirical tests on the automatic driving function of L2 and above from the technical evaluation. A comprehensive assessment of the automatic function of the test is presented from user-related assessments, traffic assessments and impact assessments[5] .

Domestic research on test scenarios and comprehensive evaluation methods is based on the “Future Challenge Competition of China Intelligence Vehicles ”and China's deep accidents library. The 5th Challenge Competition of China Intelligent Vehicles, held in 2013, was comprehensively evaluated from the 4S performance of automated vehicles (i.e. safety, intelligence, stability and speed).In the ninth competition in 2017, in addition to the real comprehensive road test, the offline test of complex environmental cognition ability was added[6-7] . Li proposed a method combining the advantages of the existing two test methods (scenario-based test and function-based test)[8]. Xiong and the scholars represented by Sun proposed a set of hierarchical comprehensive evaluation system for automated vehicles. The analytic hierarchy process (AHP) and scalable analytic hierarchy process were used to determine the index weights, the cost function method and fuzzy comprehensive evaluation method were used to quantitatively evaluate the intelligent level of automated vehicles[9-12] . Dong used the 3-scale AHP to determine the weight of each evaluation index based

2016 Industrial strong foundation project-intelligent vehicle and smart transportation application demonstration project and product engineering public service platform based on broadband mobile internet（0714-EMTC02-5593/20）.

on the evaluation of the driving quality of automated vehicles in the curved road, and constructed a grey correlation quantitative evaluation model based on the grey theory[13] .

From the above mentioned research on automated driving testing, the real vehicle test is an indispensable part of the automated driving test verification process, and the closed field test is the first step in the real vehicle test and plays a decisive role. This paper studies the comprehensive evaluation method of the field test for partly automated driving systems, aiming to establish a test and verification system based on closed test field for L2 automated vehicles.

II. ESTABLISHMENT OF EVALUATIN INDEX SYSTEM AND DETERMINATION OF INDEX WEIGHT

A. *Indicator Selection Principles and Methods*

According to the general principle of index selection, the following principles should be followed when establish an automated vehicle evaluation index system:

- Systematic: The selected evaluation indicators should cover all aspects of the automated vehicles evaluation objectives. The indicator system should be hierarchical and intrinsically linked to fully reflect the comprehensive performance of the system.
- Scientific: The selected evaluation indicators must have a scientific basis to objectively and truly reflect the performance of all aspects of the system.
- Feasibility: Specific evaluation indicators should be able to make quantitative measurements or qualitative estimates.
- Comparability: The evaluation indicators should have obvious differences to facilitate the reflection of the differences among various automatic driving systems.
- Independence: The indicators should be clearly defined and relatively independent, and the indicators should not overlap as much as possible.
- Simplicity: Selecting the main factors to determine the indicator system, covering the basic content required for the purpose of evaluation.

There are empirical and mathematical methods for index selection. The empirical method is using expert experience and knowledge to conduct rational analysis to determine indicators. The mathematical method is used to analyze the similarity and correlation among indicators and then select key indicators in the set of alternative indicators.

B. *Establish Indicator System and Pretreat Indicator*

According to the experience of automated vehicles evaluation, combined with the L1-L2 automated vehicles field test characteristics, the performance evaluation of L2 automatic driving system is carried out in three aspects: safety, intelligence and experiential. Safety includes functional and collision safety. Functional safety means safety of automated vehicles in case of system failure or defect; Collision safety refers to collision among automated vehicles, surrounding vehicles, transportation facilities and other traffic participants. Intelligence is evaluated from four aspects: perception, path planning, behavioral decision and control. The perceptual aspect refers to the identification of traffic signs, vehicles, other traffic participants and road conditions; Path planning refers to requirements for local and global path planning; Behavioral decisions include requirements for target selection, mode selection, whether to change lanes, etc.; Control is a requirement for system control, such as speed control, distance control, trajectory tracking, response time and so on. The experiential is evaluated in terms of the ride and the interactive experiential. The ride experiential is ride comfort; the interactive experiential is the performance of the system human interaction, including the requirements of operation quality, operation logic, image prompts, and voice prompts. The above three aspects are summarized through the hierarchical structure to form an performance evaluation system of L2 automated vehicles as shown in Fig.1.

In addition, the evaluation of automated vehicles also includes its impact on the surrounding environment and traffic, generally from the energy consumption, emissions, parking space, impact on traffic flow of automated vehicles, which can be carried out by the traffic flow simulation. Therefore, this paper does not evaluate the performance of these two aspects.

It is necessary to carry out the specification of the indicator type and the dimensionless treatment of the specific indicators after the evaluation target and indicator system is determined.

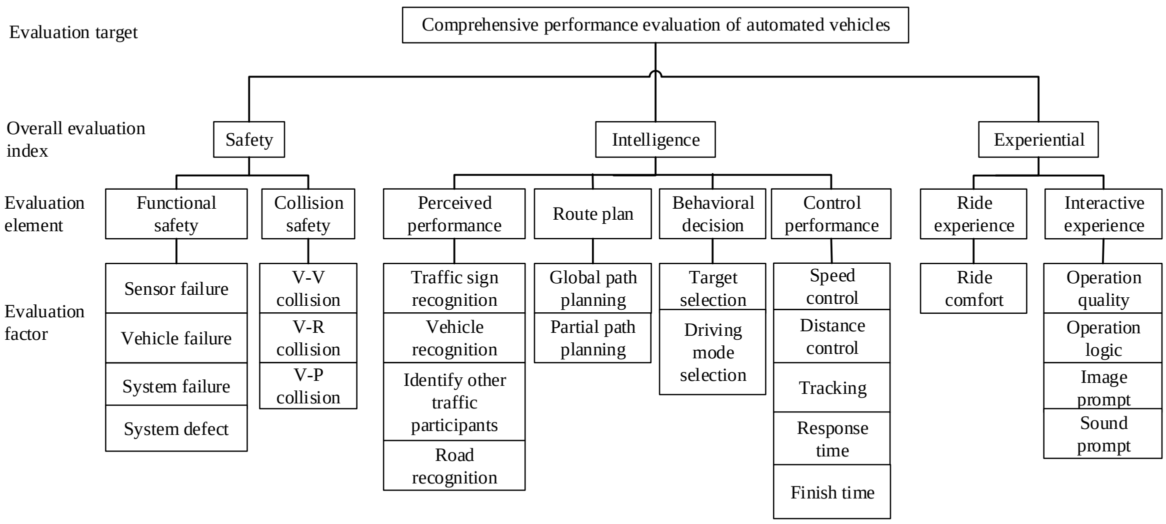

Fig.1 Automated vehicle performance evaluation system

① V-V means vehicle to vehicle; V-R means vehicle to road; V-P means vehicle to person.

The commonly used normalization method is as shown in (1).

$$x_{ij}{}^{*}=\frac{x_{ij}}{\sum_{i=1}^{n}x_{ij}} \tag{1}$$

Where x_{ij} is the indicator observation, x_{ij}^{*} is the observed value after normalization of the indicator, $\sum_{i=1}^{n}x_{ij}^{*}=1$.

C. Determine Indicator Weights

The determination of the indicator weight affects the evaluation of the automated vehicles. The method of weight determination include weight determination method based on "function-driven" principle, weight determination method based on "difference-driven" principle, and comprehensive integrated weight determination method .The test evaluation of the automated vehicle needs to reflect the performance difference of all aspects of the automated vehicle according to the importance degree of the indicator. The weighting method based on the “function-driven” principle is used to determine the weight of each indicator.

The weighting methods based on the "function-driven" principle include eigenvalue method, order relationship analysis (ORA) method, and set value iterative method. The eigenvalue method is to compare all the indicators in pairs, obtain the judgment matrix, and find the feature vector corresponding to the eigenvalue of the judgment matrix, and normalize it into the indicator weight coefficient. A typical representative of this method is the AHP. The ORA is a method for calculating the weighting coefficient of each index by analyzing the importance ranking relationship among the evaluation indexes relative to an evaluation criterion and calculating the importance degree. In this study, ORA method is used to prioritize the given elements, and then the evaluation indicators are weighted according to the corresponding importance degree with AHP.

III. ESTABLISH A COMPREHENSIVE EVALUATION MODEL FOR AUTOMATED VEHICLES

A. Select Comprehensive Evaluation Method

Common comprehensive evaluation methods include AHP, fuzzy comprehensive evaluation, data envelopment, artificial neural network, grey comprehensive evaluation and comprehensive method. The fuzzy comprehensive evaluation method can synthesize various types of index information (qualitative, quantitative, interval indicators, etc.), which can solve the ambiguity and uncertainty of judgment well. The results are informative, simple and easy to apply, and widely used. The grey comprehensive evaluation method uses the gray correlation degree model for evaluation, and it is necessary to select the optimal value of each index as the evaluation standard. The method solves the problem that the evaluation index is difficult to accurately quantify and count, eliminates the influence caused by human factors, and the evaluation result is more objective, and can identify the advantages and disadvantages of the evaluation object.

The comprehensive evaluation of automated vehicles test needs to be carried out in different levels and with multiple criteria. it is necessary to combine the quantitative and qualitative indicator information to comprehensively reflect the performance level of all aspects of the automatic driving system. Therefore, the multi-level fuzzy comprehensive evaluation is selected to comprehensively evaluate the automatic driving system, and the availability of the fuzzy comprehensive evaluation method is verified by the results of the gray comprehensive evaluation method.

B. Establish Fuzzy Comprehensive Evaluation Model

In the first step, on the basis of the determination of the indicator system, the single factor u_i(i=1, 2, 3, ..., m, m is the number of factors) is evaluated by single factor, and the membership degree of the corresponding evaluation level v_i(j=1,2,3,...,n, n is the grade) is obtained. Thus, the evaluation results of the m factors constitute an evaluation matrix $\boldsymbol{R}$, that is, the fuzzy relationship $\boldsymbol{R}$ from $\boldsymbol{U}$ to $\boldsymbol{V}$ is determined, as shown in (2). Normally $\boldsymbol{R}$ is normalized by row or column.

$$\boldsymbol{R}=(\mathrm{r}_{ij})_{m\times n}=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} \tag{2}$$

The second step is to determine the weight and the single factor evaluation model. First, the weight set **A** is obtained by the AHP or ORA, and then it is combined with the evaluation matrix $\boldsymbol{R}$ to obtain the fuzzy comprehensive evaluation model of each factor, as shown in (3).

$$\boldsymbol{C}=\boldsymbol{A}\cdot\boldsymbol{R}=(a_1,a_2,\cdots,a_m)\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}=(c_1\ c_2\cdots c_n) \tag{3}$$

For a multi-level evaluation system, a multi-level fuzzy evaluation model is required. Starting from the bottom layer, the obtained result constitutes the evaluation matrix of the upper evaluation factor, and the total evaluation model $\boldsymbol{C}$ is derived by analogy.

The third step is to calculate the comprehensive evaluation score. The corresponding score set μ = [1.0 0.8 0.6 0.4 0.2] is determined by determining the membership level (good, better, medium, poor, worse). The composite score $\boldsymbol{G}$ under the percentile score is calculated by (4).

$$\boldsymbol{G}=100\boldsymbol{C\mu}=(c_1\ c_2\cdots c_n)\cdot[\mu_1\ \mu_2\cdots\mu_n]^T\times 100 \tag{4}$$

IV. TAKE THE ACC SYSTEM PERFORMANCE TEST EVALUATION AS AN EXAMPLE

Taking the ACC system in the L1 automatic driving system as an example, the test results of the actual vehicle site of the ACC system of the three models are comprehensively evaluated. All three models have ACC function and are equivalent in configuration, all adopt millimeter wave radar scheme. The actual vehicle test site is the China Automotive Research and Test Field, and the Chongqing Western Automobile Test Field. The test equipment used is the Racelogic VBOX positioning data acquisition system.

The main functions of ACC system are: fixed speed cruise, adaptive cruise, stop and go function. The ACC test system mainly tests and evaluates the operating conditions, such as the cruise control, following the vehicle, stop-and-go control, target vehicle cut in and out, following the vehicle in curve road, and the human-machine interaction. According to the framework of the comprehensive performance evaluation index system of the automated vehicle, the indicator system of the ACC system is determined as shown in Fig.2. Functional safety, collision safety, perceived decision performance and interactive experiential are qualitatively evaluated from the overall operating condition; The control performance and experiential are evaluated and determined from the quantitative indicators in specific operating conditions such as cruising, following, stopping and going, cutting in and out, and following the curve.

Qualitative indicators include whether the system can guarantee safety in case of system failure or defect, whether collision or pre-crash occurs during the test, the system identifies the vehicle and other traffic parameters, and the target selection or other decision performance, whether human interaction interface or operational quality of button , operational logic, image or sound prompts are reasonable and acceptable.

The quantitative indicators are speed control accuracy, following distance, response time, maximum acceleration, and minimum deceleration. Among them, the speed control accuracy refers to the maximum value of the difference between the test vehicle stability speed and the set speed (cruise condition) or the target vehicle speed (follow-vehicle condition). The response time refers to the time difference between the time when the target vehicle starts to accelerate, decelerate, or cut in and out, until the test vehicle begins to follow or respond to the acceleration and deceleration.

After the establishment of the indicator system, the ORA and AHP are used to empower the elements, indicators and factors at all levels to determine their importance.

A. *Ordering Relationship Empowerment*

The ratio of the degree of importance between the evaluation indicator X_{k-1} and X_k is $r_k(w_{k-1}^*/w_k^*)$, and the assignment reference table is shown in Table I. In the first level, the ACC performance evaluation criteria determine the order relationship among security, intelligence and experiential: security > intelligence > experiential, the importance r_2 and r_3 is 1.2, 1.4 respectively. A set of weights A= [0.41 0.34 0.25] is for safety, intelligence, and experiential from (5) and (6).

$$w_m^* = (1+\sum_{k=2}^{m}\prod_{i=k}^{m} r_i)^{-1} \tag{5}$$

$$w_{k-1}^* = r_k w_k^*, k = m, m-1, \cdots, 3, 2 \tag{6}$$

In the second level, the order relationship between functional safety and collision safety is determined by the safety criterion: collision safety > functional safety, and the importance r_2 is 1.2, then the weight set A_1 = [0.55 0.45]. The order relationship between control performance and perceived decision performance is determined by the intelligence criterion as control performance>decision performance and the importance r_2 is 1.4, then the weight set A_2= [0.58 0.42]. The experiential criterion determines the order relationship between the ride experiential and the interactive experiential, with the ride experiential>interactive experiential, with an importance r_2 of 1.4, then the weight set A_3= [0.58 0.42]. In the third level, the order relationship is determined by the control performance criterion as speed control accuracy> response time> following distance, and the importance degrees r_2 and r_3 is 1.2 and 1.6 respectively, then the weight set A_{22}= [0.43 0.35 0.22].

Similarly, A_{31}= [0.55 0.45], A_{32}= [0.41 0.34 0.25]; in the fourth level, the weight set A_{221}= [0.48 0.30 0.22], A_{222} = [0.58

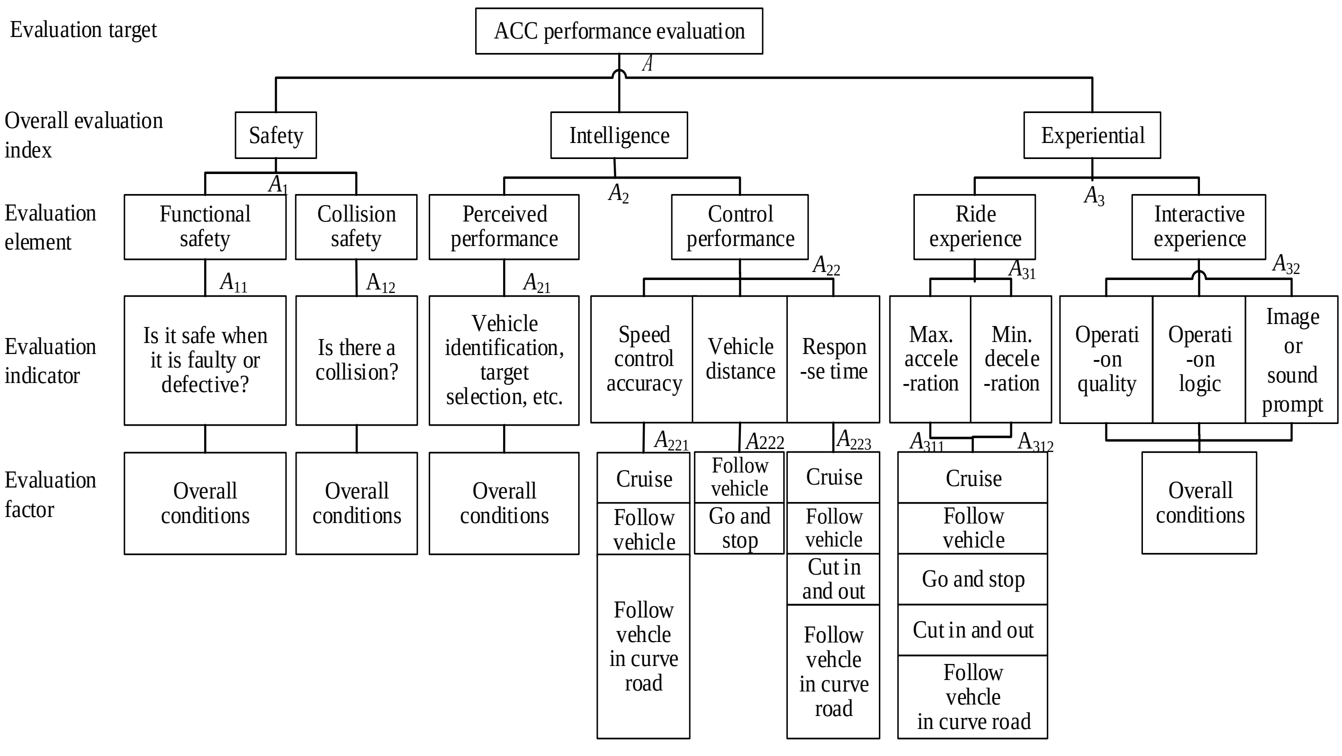

Fig.2 ACC performance evaluation index system

TABLE I. ASSIGNMENT REFERENCE TABLE

r_k	Description
1.0	$x_{k-1}$is as important as x_k
1.2	$x_{k-1}$is slightly more important than x_k
1.4	$x_{k-1}$is more important than x_k
1.6	x_{k-1} is significantly more important than x_k
1.8	x_{k-1} is extremely more important than x_k

0.42], A_{223} = [0.34 0.28 0.20 0.18], A_{311}= A_{312} = [0.19 0.31 0.11 0.13 0.26].

B. Analytic Hierarchy Process Empowerment

The judgment matrix of each level of the analytic hierarchy process is as follows. At the first stage, the judgment matrix of safety, intelligence and experiential is [1 3 7; 1/3 1 5; 1/7 1/5 1], and the weight set A=[0.64 0.28 0.08] is calculated by(7), and the C.I/C.R = 0.06 < 0.1, passing the consistency test. In the second stage, the judgment matrix between collision safety and functional safety is [1 3; 1/3 1], and the weight set A_1 = [0.75 0.25]. The judgment matrix between control performance and perceived decision performance is [1 5; 1/5 1], and the weight set A_2 = [0.83 0.17]. The judgment matrix between the ride experiential and the interactive experiential is [1 5; 1/5 1], and the weight set A_3 = [0.83 0.17],with all consistency test passed.

$$\bar{W}_i = \frac{W_i}{\sum_{i=1}^{n} W_i} (i = 1, 2, \cdots, n) \tag{7}$$

Where W_i is the sum vector obtained by adding the normalized judgment matrix by i line.

Similarly, the weight set in the third stage is A_{22}=[0.67 0.27 0.06], A_{31}=[0.75 0.25], A_{32}=[0.64 0.28 0.08],the weight set in the fourth level is A_{221}=[0.78 0.15 0.07] , A_{222} = [0.83 0.17], A_{223} = [0.57 0.29 0.09 0.05], A_{331} = A_{312} = [0.49 0.27 0.15 0.06 0.03], with all consistency test passed.

C. Fuzzy Comprehensive Evaluation Calculation

1 *1) Establish a fuzzy evaluation matrix **R** for three vehicles models.* According to the results of the actual vehicle test , the experts in the field of experiment or automatic driving evaluated the ACC systems of the three vehicles separately, and expressed the fuzzy matrix ***R*** by the proportion of the fuzzy membership(“good”, “better”, “medium”, “poor”, “worse”). The part of evaluation results of the vehicle 2 is described as an example, as shown in Table II.

2) Calculate the evaluation results of each element in turn according to the weight coefficient. Taking the order relationship analysis method as an example, the determined weight coefficients are used to calculate the evaluation results of each element in turn.

In the safety, the fuzzy matrix composed of collision safety and functional safety is R_1=[R_{11}; R_{12}], and the weight coefficient matrix is A_1, then the comprehensive evaluation matrix C_1 of safety is calculated by(8).

$$C_1 = A_1 \cdot R_1 = [0\ 0.60\ 0.31\ 0.09\ 0] \tag{8}$$

In the comprehensive evaluation process of intelligence, the third layer element speed control precision comprehensive evaluation matrix C_{221} is calculated by the weight coefficient matrix A_{221} and the fuzzy evaluation matrix R_{221} according to (9); similarly, the following distance comprehensive evaluation matrix C_{222}=[0.60 0.26 0.14 0 0] is calculated by the weight coefficient matrix A_{222} and the fuzzy evaluation matrix R_{222}; the response time comprehensive evaluation matrix C_{223}=[0.28 0.49 0.19 0.04 0] is calculated by the weight coefficient matrix A_{223} and the fuzzy evaluation matrix R_{223}. The second layer element control performance comprehensive evaluation matrix C_{22} is calculated from the fuzzy evaluation matrix R_{22}= [C_{221}; C_{222}; C_{223}] and the weight coefficient matrix A_{22} according to (10). Thus, the first layer elemental intelligence comprehensive evaluation matrix C_2 is calculated from the fuzzy evaluation

TABLE II. PART OF FUZZY EVALUATION TABLE FOR VEHICLE 2

Overall evaluation index	**Evaluation element**	**Evaluation index**	**Evaluation factor**	**Evaluation level**				
				good	***better***	***medium***	***poor***	***worse***
Safety (R_1)	Collision safety (R_{11})	Is there a collision?	Overall conditions	0	0.6	0.4	0	0
	Functional safety (R_{12})	Is it safe when it is faulty or defective?	Overall conditions	0	0.6	0.2	0.2	0
Intelligence (R_2)	Perceived decision performance	Vehicle, target recognition	Overall conditions	0	0.7	0.2	0.1	0
	Control performance (R_{22})	Speed control accuracy (R_{211})	cruise	0.1	0.8	0.1	0	0
			Veicle following	0.2	0.6	0.2	0	0
			Vehicle following in curve road	0.6	0.4	0	0	0
		Vehicle distance (R_{212})	Vehicle following	0.6	0.2	0.2	0	0
			Go and stop	0.6	0.3	0.1	0	0
		Response time (R_{213})	Vehicle following	0.5	0.5	0	0	0
			Go and stop	0.3	0.5	0.2	0	0
			Cut in and out	0.2	0.3	0.4	0.1	0
			Vehicle following in curve road	0.2	0.8	0	0	0

TABLE III. RESULTS OF THE FUZZY COMPREHENSIVE EVALUATION METHOD

	Safety		Intelligence		Experiential		Total score	
	AHP	***ORA***	***AHP***	***ORA***	***AHP***	***ORA***	***AHP***	***ORA***
1	68.5	67.3	77.6	75.0	77.5	71.8	71.7	71.0
2	71	70.2	89.7	79.4	72.1	70.8	76.4	73.5
3	70	68.4	81.6	76.0	83.7	77.4	74.3	73.2

TABLE IV. RESULTS OF THE GREY COMPREHENSIVE EVALUATION METHOD

	Safety		Intelligence		Experiential		Total score	
	AHP	***ORA***	***AHP***	***ORA***	***AHP***	***ORA***	***AHP***	***ORA***
1	0.50	0.49	0.64	0.66	0.63	0.56	0.50	0.50
2	0.52	0.51	0.73	0.71	0.54	0.53	0.67	0.68
3	0.51	0.50	0.70	0.67	0.68	0.61	0.61	0.56

matrix R_2= [C_{21}; C_{22}] and the weight coefficient matrix A_2 according to (11).

$$C_{221} = A_{221} \cdot R_{221} = [0.37\ 0.55\ 0.08\ 0\ 0] \tag{9}$$

$$C_{22} = A_{22} \cdot R_{22} = [0.39\ 0.46\ 0.13\ 0.02\ 0] \tag{10}$$

$$C_2 = A_2 \cdot R_2 = [0.23\ 0.56\ 0.16\ 0.05\ 0] \tag{11}$$

For the same reason, a comprehensive evaluation of experiential can be obtained $C_3 = A_3 \cdot R_3$ = [0.08 0.47 0.35 0.08 0.02].

3) Calculate individual performance scores and composite scores. From (4), the single item scores of safety, intelligence and experiential are obtained G_1=70.18, G_2=79.36, G_3=70.84, and the three scores are combined with the weight $\boldsymbol{A}$ to calculate the comprehensive performance score of ACC on the vehicle 2. It is 73.5 as shown in (12).

$$G_c = 100 A \cdot G = [0.41\ 0.34\ 0.25][70.18\ 79.36\ 70.84]^T \times 100 = 73.5 \tag{12}$$

Table III shows the results of the ACC system in the three models using the AHP and the ORA combined with the fuzzy comprehensive evaluation model. It can be seen that the comprehensive scores obtained by the two weighting methods are ranked in the same order, Vehicle 2>Vehicle 3>Vehicle 1. In the ranking of the safety and intelligent scores, it is also the vehicle 2>vehicle 3>vehicle1. However, the experiential ordering is the vehicle 3>vehicle 1>vehicle2. As the safety is more important, so that the total score of the vehicle 2 is ranked highest.

It can also be seen from Table Ⅲ, compared with ORA weighting method , that the difference among the comprehensive scores of the ACC performance of the three vehicles is greater by the AHP weighting method and the fuzzy comprehensive evaluation, which better reflects the difference among the aspects of the ACC system and the overall performances of vehicles.

Table IV shows the relative scoring results of the three vehicles obtained by the gray comprehensive evaluation method. The comprehensive rankings of the three vehicles in Table IV and Table III are consistent, indicating the correctness of the availability and evaluation results of the fuzzy comprehensive evaluation method.

V. CONCLUSIONS

Through the analysis of the comprehensive evaluation process and the key link methods, according to the characteristics and requirements of the automated driving test evaluation, the multi-level evaluation index system of the L2 automated vehicles is established from the aspects of safety, intelligence and experiential. The comprehensive evaluation model of L2 automated vehicles was established by multi-level fuzzy and grey comprehensive evaluation method. The method was applied to the actual vehicle test results of the L1 ACC system. The research shows that it is more conducive to the index weighting calculation using the AHP based on the ORA method. Compared with the ORA method, the fuzzy comprehensive evaluation of the automated vehicle with the AHP method can better reflect the difference among the aspects of the ACC system and the overall performances of vehicles. The gray comprehensive evaluation method can be used to obtain the relative score results of the vehicles, and the comprehensive evaluation ranking is consistent with the fuzzy comprehensive evaluation method, which verifies the availability of the fuzzy comprehensive evaluation method. Since the operating conditions of L2 automated vehicles are relatively complex, the established comprehensive evaluation model needs further improvement.

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