ISSN: 2664-9640

Research on scene classification and subjective evaluation of forward-looking application challenge based on information entropy algorithm

Zonghao Ma [a], Shunkai Wang [b],Yunhui Jia [c], Shuangshuang Liu [d], Yuchen Ma [e], Hongyu Niu [f]

China Auto Information Technology Co., Ltd.,Tianjin, China

[a]mazonghao@catarc.ac.cn, [b]wangshunkai@catarc.ac.cn, [c]jiayunhui@catarc.ac.cn, [d]liushuangshuang@catarc.ac.cn, [e]mayuchen@catarc.ac.cn, [f]niuhongyu@catarc.ac.cn

Abstract

In order to solve the problems of unclear prospect application challenge scene, lack of typical competition scene and lack of subjective evaluation in the intelligent networked automobile industry, this paper proposes the prospect application challenge scene classification based on the scene complexity model, and uses the combination of information entropy algorithm and gravity model to classify the stadium scene and subjective evaluation of the event. The algorithm is verified through the real competition. The results show that the scene classification method and subjective evaluation under the algorithm are more reasonable. The algorithm improves the operation and rules of the forward-looking application challenge, and helps intelligent network enterprises or third-party evaluation institutions to select typical scenes, so as to promote the process of intelligent network vehicle testing and evaluation.

Keywords

WLTC; Information entropy; Scene; Intelligent networked vehicle.

1. Introduction

In order to actively respond to the action plan for the development of the Internet of vehicles (smart connected vehicles) industry issued by the Ministry of industry and information technology of the people's Republic of China and the strategic deployment of provincial governments to build the pilot area of the Internet of vehicles (smart connected vehicles), vigorously develop the innovation driven, open and collaborative smart connected vehicle industry, carry out the research on the construction scheme and operation mode of the smart connected vehicle test area, and support the transformation, upgrading and innovative development of the automobile industry. Smart connected vehicles (including smart cars, driverless cars and smart connected vehicles) have become the key support objects of the state, and smart connected related events have also emerged.[1] By holding relevant events, we can not only test and verify the new technology and promote the development of technology, but also test the safety of intelligent connected vehicles, so as to promote the development of the whole industry.[2]

In the existing technology, the scene complexity model does not comprehensively analyze the data of the autopilot car. The scene classification is mostly based on the dimensions of autopilot, accident and so on. It does not distinguish the difficulty or complexity of different types of scenes, so that it can not select the suitable match for the intelligent network race. The lack of subjective evaluation leads to the low technical content of the event, which can not directly reflect the technical level of the industry and distinguish the advantages and disadvantages of vehicles.[3] Therefore, based on the existing technology, studying the scene classification and subjective evaluation in line with the intelligent online games is one of the difficulties that need to be broken through in the operation of intelligent online games.

This paper proposes a classification and subjective evaluation method for the assessment scenes of intelligent online events, so as to solve the problem that the existing road test scenes can not distinguish the complexity, let alone select the scenes suitable for intelligent online events, and solve the problem that intelligent online events lack subjective evaluation and can not distinguish the advantages and disadvantages of teams. [4][5]By determining one or more pre created event scenes and determining the scene components used to create road scenes; Obtain the information corresponding to the scene elements, and divide the scene information elements into static elements and dynamic elements; Further calculate the scene complexity corresponding to static scene elements and dynamic scene elements, and comprehensively obtain the scene complexity score corresponding to the scene. Finally, the event scenes are classified according to the scene complexity score, so that the final classification results can not only reflect the complexity of the event scene, reasonably set the game subjects, but also reflect the categories of different event scenes. At the same time, according to the subjective evaluation method, the rationality of the event scene setting and the evaluation effect can be greatly improved.[6]

2. Scene design scheme

Based on the international and domestic standards and specifications of automatic driving test scenarios, road traffic accident scenarios and the test regulations of the national intelligent vehicle and intelligent transportation (Beijing Hebei) demonstration area, combined with the domestic and foreign intelligent Internet connection event scenarios, sort and combine the intelligent Internet connection scenarios from the functional and logical aspects, extract the domestic intelligent Internet connection event scenarios, and build and classify the scene Library Based on this.[7]

2.1. Scene component library

By analyzing the standard and standard scenes, including ISO, nthsa, SAE, encap, FMCSA and ADAS scenes, and combining the road traffic accidents and human driving experience such as relevant intelligent online events, network accident videos, public security traffic management road traffic accident data and accident restoration, the scene elements of intelligent online events are divided into static scene elements and dynamic scene elements. The static elements include road sections, lanes, road traffic signs, road traffic markings, traffic lights, other facilities and weather, and the dynamic elements include scene participants.[8] The classification of scene element library is shown in Table 1.

Table 1. Intelligent network event scene element library

Basic elements	Element composition
Road section	Two way, three-way (T-junction), four-way (intersection)
Vehicle Lane	Two lane (centerline), four lane (centerline), single lane (roundabout)
Road traffic signs	Prohibition signs, warning signs, indication signs, direction signs, construction signs and auxiliary signs
Road traffic marking	Indication marking, prohibition marking and warning marking

Traffic light	Motor vehicle signal lamp, non motor vehicle signal lamp, crosswalk signal lamp, direction indicator signal lamp, lane signal lamp, flashing warning signal lamp, road and railway level crossing signal lamp
Other facilities	Toll station, bus stop, deceleration belt, parking lot, charging station, anti-collision bucket, conical bucket
weather	Daytime, sunny, rainy and foggy days
Scene participants	Motor vehicles (ordinary motor vehicles, ambulances, school buses, buses, garden buses), pedestrians, non motor vehicles
Networking equipment	RSU (roadside unit), OBU (on-board unit)

2.2. Extraction of event scenes

According to the constituent elements of the above scene library, combing and combining from the types of single vehicle intelligence and Internet connection intelligence, single vehicle intelligence assesses the ability of automatic driving of vehicles through cameras, radar and other sensors as well as efficient and accurate algorithms, including starting, going straight at the intersection, avoiding pedestrians, passing through congested areas and other scenes.[9] The intelligent assessment of vehicle road coordination by Internet connection, that is, it mainly senses the road conditions through 5g and high-precision map, so as to have the function of driverless, including assisted priority vehicle passage, station path guidance, queue driving and other scenes. Considering the natural environmental conditions, road attributes and sports status, it is divided into different weather conditions, road grades, road lengths, traffic participants, single vehicle intelligence or Internet connection intelligence, etc.[10] the competition scene is designed and formed, and the extraction process is shown in the figure 1 below:

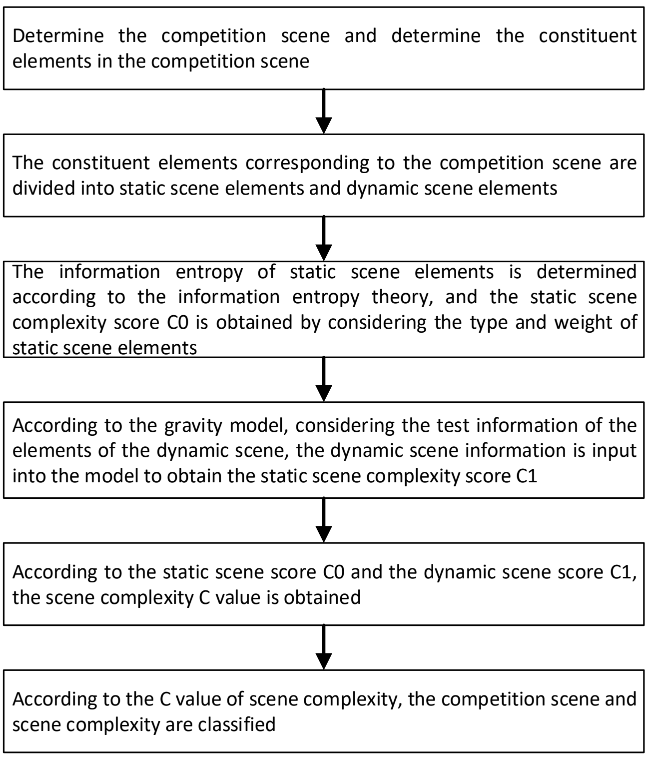

Fig. 1 Flow chart of event scene extraction

ISSN: 2664-9640

3. Scene classification method

This paper proposes a scene complexity model, which establishes an evaluation model to evaluate the complexity of intelligent online events according to the influence of scene elements, which is used to reflect the difficulty of scene elements to the event scene, and to evaluate whether the scene can reflect the technical level of participating vehicles.[11]

In this paper, the scene complexity of intelligent networked vehicle events is divided into static scene complexity and dynamic scene complexity. The static scene complexity introduces the information entropy theory to calculate the total amount of information of discrete information sources, and considers the types and weights of static scene elements; [12]The gravity model is introduced into the dynamic scene complexity to consider the interaction factors between scene participants and participating vehicles, background vehicle type and so on. Scene complexity is obtained from the comprehensive evaluation results of static scene complexity and dynamic scene complexity.

3.1. Static scene complexity

Static scene complexity introduces information entropy theory to determine the information entropy of static scene elements. Considering the type and weight of static scene elements, the calculation formula of static complexity coefficient (information entropy) is:

$$\theta_1 = -\sum_{i=1}^{h} p_i \log_2 p_i \tag{1}$$

Where: θ_1 is the complexity coefficient of static scene; h is the total number of types of grouping labels corresponding to each scene component in the static scene complexity; p_i is the ratio of the number of nodes of the same type to the total number of nodes in the graphic structure constructed according to the complexity of the static scene. The weights of different static environment elements are determined according to the scores of experts:

$$\begin{aligned} C_0 = \theta_1 \times (\beta_1 \sum Y_1 + \beta_2 \sum Y_2 + \\ \beta_3 \sum Y_3 + \beta_4 \sum Y_4 + \beta_5 \sum Y_5) \end{aligned} \tag{2}$$

Where: C_0 is the complexity of static scene; β N is the weight corresponding to the nth group of static scene elements; Y_n is the sum of preset scores corresponding to each scene component in the nth group of static scene components.

3.2. Dynamic scene complexity

Based on the research of gravity model, it is proposed that the complexity of dynamic scene is related to the dynamic factors in the scene, and there is a mathematical function relationship between the complexity and the speed of test vehicle and scene participants, the distance and angle between them. [13]The influence of dynamic factors on the test vehicle is regarded as the field effect mechanism of environmental complexity. The relative speed and distance between the test vehicle and scene participants are used as the indicators to measure the field intensity. The field distribution of environmental complexity is mathematically described, and the dynamic factors are abstracted and summarized. According to the attributes of test vehicles and traffic participants, a complex gravity model structure system with field effect is preliminarily formed. The basic form of the model is

$$C_1 = c \cdot K_1 \cdot K_2 \tag{3}$$

Where: C_1 is the complexity of dynamic scene; K_1 is the attribute value of the test vehicle; K_2 is the attribute value of traffic participants; C is a constant. The formula for calculating the attribute value of the test vehicle is:

$$K_1 = at_1 \frac{v_1}{d_1} cos\theta \tag{4}$$

Where: a is a constant coefficient, which is a constant to adjust the model specification; t_1 is the reaction time of the test vehicle; v_1 is the driving speed of the test vehicle; d_1 is the distance between the test vehicle and the traffic participants; θ Is the angle between the test vehicle and other traffic participants. The calculation formula of attribute value of traffic participants is:

$$K_2 = pt_2 \frac{v_2}{d_2} \tag{5}$$

Where: p is a constant; t_2 is the sensed time of the traffic participant; v_2 is the speed of traffic participants; d_2 is the movement distance of traffic participants. The complexity of road test scene is calculated according to the complexity of static scene and dynamic scene, i.e:

$$C = C_0 \cdot C_1 \tag{6}$$

Where C is the complexity of road test scenario.

4. Subjective evaluation

Build a complete set of evaluation system of forward-looking application challenge from the four parts of human-computer interaction, ecological service, scene service and product compliance; Taking the user experience as the core and starting from the actual use scenario, the car cabin products are evaluated in an all-round way. Through the authority and professionalism of the subjective evaluation results and the improvement of the product competitiveness of the anti drive industry, we will promote the reform and development of China's automobile intellectualization. Taking user experience as the core and starting from the actual use scenario, studying how each function creates value is the most effective way for us to face the "smart car reform" and manage the innovation process and "addition process". Through systematic evaluation methods, we can bring users a comprehensive and deep-seated experience, and build a platform for participating racing enterprises to identify product advantages and improve anti drive product experience.[14] Help car companies pre identify product regulations and industry regulations.

Based on the intelligent cockpit evaluation system and the user portrait and product positioning of the participating models, through the real vehicle evaluation of professional teams and public users, the racing intelligent cockpit products are evaluated in four aspects: human-computer interaction, ecological service, scene service and product compliance.

Construction of evaluation system

(1) Input of basic functional specifications of each participating car type

(2) User portrait information of vehicle model

(3) Constructing the game user experience evaluation system: indicators and weights

Build evaluation environment

Build evaluation environment (weather, different traffic environment, different road conditions, etc.)

(2) Test vehicle / bench

(3) Define the sample quantity and evaluation target group.

(4) Evaluator: professional team + public jury

Evaluation execution

(1) Evaluation standard: evaluation index system based on the Games

(2) Evaluation process: comprehensively evaluate the evaluation results through the evaluation of the professional team of the competition and the evaluation of the public jury.

(3) Evaluation output

(4) Quantitative / rational / perceptual evaluation results: analyze the evaluation results of the competition through the scoring system and give improvement suggestions.

(5) Data assets: evaluation sample data assets

(6) Competition awards: awards will be given according to the award settings of the competition.

5. Experimental verification

The experimental verification takes the practical prospective application challenge as the method, uses the algorithm proposed in this paper for in-depth combination, and carries out 14 dimension tests, mainly including:

Account 1 (start I2V)

The participating vehicles are ready in the second lane of the gantry departure area. After receiving the referee's "flag waving" command to start the competition, the vehicles turn on the automatic driving mode, start automatically within 2 minutes and go straight smoothly. (the RSU of the starting point informs the end of the competition. The starting point locates itself and needs to store the coordinates of the end point, which will not be sent during subsequent driving.) As shown in the figure 2:

scoring rubric

1) If you start early without receiving the referee's instruction to "wave the flag", no points will be deducted and the total time will be increased by 30 seconds;

2) If the starting is not smooth (flameout, multiple starts, and electric vehicles are powered on and off for many times), 10 points will be deducted per time;

3) If you fail to cross the starting point within 5 minutes, it will be regarded as a departure failure, and the departure will be postponed to the end of the participating team, and 200 points / time will be deducted from the total score of the competition.

Fig. 2 start (I2V)

Subject 2 (turn right to yield to pedestrians V2P)

Participating vehicles turn right in any lane and slow down to avoid zebra crossing pedestrians (V2P scene). They can pass only after confirming safety. See Figure 3 for details:

Scoring rules:

1) If the participating vehicles do not slow down to avoid pedestrians at zebra crossings, 60 points will be deducted;

2) 30 points will be deducted if the pedestrian stops and passes the zebra crossing without obstacles in front and fails to start within 10 seconds;

3) If you stop to avoid pedestrians at zebra crossings, 50 points will be added.

Account 3 (yield ambulance V2V)

When the participating vehicles are driving on the road, they perceive or receive the rear emergency vehicle passage reminder (V2V communication), and the participating vehicles change lanes to give way or slow down to give way. The schematic diagram of the stadium is shown in Figure 4:

Scoring rules:

1) 100 points will be deducted for those who fail to slow down or change lanes to give way to ambulances performing emergency tasks;

2) 20 points will be deducted per time if the lane change does not turn on the turn signal;

3) 50 points for lane change and yield.

Fig. 3 turn right to yield to pedestrians (V2P)

Fig. 4 yield ambulance (V2V)

Subject 4 (car hailing I2V)

After receiving the simulated pick-up instruction (I2V communication), the participating vehicles turn on the right turn signal, stop in the specified area on the roadside, start within 30 seconds after parking, turn on the left turn signal and drive out of the parking area. (there are two parking spots, which are located at the midpoint of the curb of the parking area. The RSU sends the parking area information randomly. The parking area is a 10m * 3.5m rectangular box)

Scoring rules:

1) 40 points will be deducted if the car body projection exceeds the specified area when parking in the specified area;

2) Deduct 30 points for those who do not leave within 30 seconds after parking;

3) If the steering light is not used as required (turn right first and then turn left, twice), 20 points will be deducted per time.

Subject 5 (fixed-point parking)

When the participating vehicles arrive at the end of the task, they shall stop within 0.5m of the parking point (the distance between the center point of the front edge of the vehicle and the end point).

Scoring rules:

0 point will be given if the center of the vehicle front is 1m away from the designated parking point;

40 points will be deducted if the center of the vehicle head is 0.5-1m away from the designated parking point;

No point will be deducted if the center of the front is 0.5-1m away from the designated parking point.

6. Experimental result

Through the verification of this experiment, the application of this algorithm in the forward-looking application challenge not only makes up for the lack of standardized scenes of the event, but also can well restrict the whole link of the event, achieve leapfrog improvement in technology, meet the various scenes required by the event, including static scenes and dynamic scenes, and make the event system more perfect and the management more strict in terms of management. Therefore, in the forward-looking application challenge, the introduction of information entropy and gravity algorithm can improve the competition step by step and make the competition more mature both in technology and management.

7. Conclusion

This paper proposes a forward-looking application of challenge scene classification based on scene complexity model, and uses the combination of information entropy algorithm and gravity model to classify the scene and subjective evaluation of the event. The algorithm is verified through the real competition. The results show that the scene classification method and subjective evaluation under the algorithm are more reasonable. The algorithm improves the operation and rules of the forward-looking application challenge, and helps intelligent network enterprises or third-party evaluation institutions to select typical scenes, so as to promote the process of intelligent network vehicle testing and evaluation.

Acknowledgment

First of all, I would like to thank China Auto Information Technology Co., Ltd. for providing such a good platform. At the same time, I would like to thank director Ma Yuchen for his technical guidance and control of key nodes. Finally, I would like to thank my colleagues Jia Yunhui, Liu Shuangshuang for their help and guidance.

References

[1] Bao xiao'an, Li Gang, Wen Yi Fei, Li Jia Yu, Chen Di Rong, Du Peng. Design and analysis of remote update of embedded platform based on compression and differential algorithm [J]. Journal of Zhejiang University of Technology (NATURAL SCIENCE EDITION), 2020,43 (04): 535-541

[2] Yan Juan, Zhang Yuchuan, Yang Pengxiang, Li Xin, Wei Minghui. Research on remote upgrade of Ota based on Ethernet [J]. SAIC, 2020 (03): 15-18 + 27

[3] .Ryozo Kiyohara, Mariko Kurihara, Satoshi Mii and Shigenori Kino, "A delta representation scheme for updating between versions of mobile phone software", Electronics and Communications in Japan, vol. 90, no. 7, pp. 26-37, 2007.

[4] Ryozo Kiyohara, Satoshi Mii, Koichi Tanaka, Yoshiaki Terashima and Hidetoshi Kambe, "Study on Binary Code Synchronization in Consumer Devices", IEEE Transactions on Consumer Electronics, vol. 56, no. 1, pp. 254-260, 2010

[5] Onuma, M. Nozawa, Y. Terashima and R. Kiyohara, "Improved Software Updating for Automotive ECUs: Code Compression," 2016 IEEE 40th Annual Computer Software and Applications Conference (COMPSAC), Atlanta, GA, 2016, pp. 319-324, doi: 10.1109/COMPSAC.2016.134.

[6] D.J. Evans, and A and R.B. Abdullah, "Group explicit method for parabolic equation", Intern. J. Computer Math, vol. 14, pp. 73-105, 1983.

ISSN: 2664-9640

[7] Ryozo Kiyohara, Mariko Kurihara, Satoshi Mii and Shigenori Kino, "A delta representation scheme for updating between versions of mobile phone software", Electronics and Communications in Japan, vol. 90, no. 7, pp. 26-37, 2007.

[8] Ryozo Kiyohara, Satoshi Mii, Mitsuhiro Matsumoto, Masayuki Numao and Satoshi Kurihara, "A new method of fast compression of program code for OTA updates in consumer devices", IEEE Transactions on Consumer Electronics, vol. 55, no. 2, pp. 812-817, 2009.

[9] Ryozo Kiyohara, Satoshi Mii, Koichi Tanaka, Yoshiaki Terashima and Hidetoshi Kambe, "Study on Binary Code Synchronization in Consumer Devices", IEEE Transactions on Consumer Electronics, vol. 56, no. 1, pp. 254-260, 2010.

[10] J.W. Hunt and T.G. Szymanski, "A fast algorithm for computing longest common subsequences", Commun. ACM, vol. 20, no. 5, pp. 351-353, 1977

[11] N. Balasubramanian, A. Balasubramanian and A. Venkataramani, "Energy consumption in mobile phones: A measurement study and implications for network applications," Proceedings of ACM SIGCOMM Conference on Internet Measurement Conference, pp. 280-293, 2009.

[12] H. Falaki, D. Lymberopoulos, R. Mahajan, S. Kandula and D. Estrin, "A first look at traffic on smart phones," Proceedings of the 10th Annual Conference on Internet Measurement, pp. 281-287, 2010.

[13] K. H. Kim, A. W. Min, D. Gupta, P. Mohapatra and J. P. Singh, "Improving energy efficiency of wi-fi sensing on smart phones," Proceedings of IEEE INFOCOM, pp. 2930-2938, 2011.

[14] I. Zahid, M. A. Ali and R. Nassr, "Android smart phone: Battery saving service," Proceedings of International Conference Research and Innovation in Information Systems (ICRIIS), pp. 1-4, 2011.