Research in Quantitative Evaluating Armored Vehicle Basic Driving Action

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Abstract. On the basis of analyzing the difficult of evaluating the basic driving factors, the evaluation index system of basic driving factors is established, while the weightiness values of the indexes are calculated out by AHP. The difficult of armored vehicles basic driving factors is quantitative evaluated by the application of similar systems theory, the quantitative evaluation results of degree of difficulty of different basis driving factors is given. And the foundation of the subsequent research on armored vehicles driving is laid.

Introduction

Armored vehicle driving training is one of the three armored forces professional and technical training, it is the important guarantee for full maneuverability of armored vehicles, training effect direct influence the generation of combat effectiveness. Therefore, the study of armored vehicle driver training law and improving the level of driver training is of great significance. Armored vehicles driving action-based training are the basis of driver training. In order to achieve the refinement of driving practice teaching and improve the quality of basic driving training, this paper analyzes the impact factors while evaluating the degree of difficulty of the basic driving action, by using similar systems theory and methods, it quantitative evaluates the degree of difficulty of the basic driving action.

Similar System Theory and Measurement Method

Similar System Analysis Method

There are some characteristics in a matter impersonally. It is called similar characteristic that there are mutual characteristics between matters while the values of them might be different. It is called that there is comparability between systems when there are similar characteristics between them, whose essential is that the attribute and the characteristic are similar between systems [1]. Similar system theory could be used for quantitative analysis of the system comparability based on system characteristic value, whose general analysis methods are as follows:

(1) Recognize the composing elements and their interrelations.

(2) Recognize the similar characteristics of systems, and the elements with similar characteristics are called similar elements, which make up of similar member u_i.

(3) Pick up the amount and the characteristic values of the similar elements to reflect the similar extent of the elements.

(4) Calculating the similar degree Q ($0 \le Q \le 1$) between system A and system B. If Q equals 1, then all of the characteristics between A and B is the same, else if Q equals 0, then it is means that every characteristic of A and B is different. The similar degree Q is a multi-variable function of the composing element amounts K, L in A and B, the similar element amount n, and the similar member degree $q(u_i)$.

$$Q = f(K, L, n, q(u_i)) \tag{1}$$

Similar System Measurement Method

Similar system measurement is the calculation process of the system similar degree Q, which could be described by the similar member amount function Q_n and the similar member similar degree function Q_c as follows [2]:

$$Q = Q_n Q_c \tag{2}$$

$$Q_n = n/K + L - n \tag{3}$$

$$Q_c = \sum_{i=1}^{n} \omega_i q(u_i) \tag{4}$$

$$q(u_i) = \min(u(a_i), u(b_i))/\max(u(a_i), u(b_i)) \tag{5}$$

Analysis of Influencing Factor of the Driving Action and Weight Calculation

Analysis of Influencing Factors

An integrated driving action is usually completed by linking up many successive steps. The number of action steps, convergence requirements between steps and the accuracy of individual action step, determine the degree of difficulty of a complete driving action. In additionally, the driving action of the real vehicle operating environment is also an important factor that influences the accomplishment of driving action. Therefore, the number of action steps, the accuracy of the actions, the convergence of the actions, as well as the comfort level of the operating environment are taken as the evaluation index of the degree of difficulty of the driving action, as Fig. 1 shows.

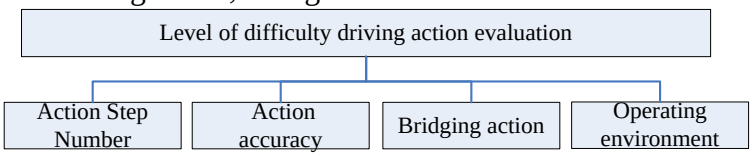

Fig. 1 Level of difficulty driving action evaluation

(1) Action steps number refers to the total number of operating the driving operation parts (such as the start button, the master clutch pedal, accelerator pedal, shift lever, etc.) by following a certain order when completes driving action (such as launch, start the car, shift gears, etc.). Obviously, the more number of operation steps are, the more difficulty of controlling driving action will be.

(2) Action accuracy refers to controlling related manipulate parts move to the accurate location by following driving action essentials when control completes the driving action. If there is an error when control the displacement of manipulate parts, which results in failure of completing the driving action, then it means the accuracy requirements of this driving action is high, on the contrary, if the displacement error of control manipulation parts within a certain range, the driving action is still able to be completed, then the accuracy requirements of this driving action is low. Therefore, the action accuracy index could be qualitative divided into high, medium and low levels.

(3) Action bridging refers to the opportunity requirements between shifting each action step when completes the driving action. If the conversion time between driving actions causes minor deviations that occurs the driving maneuver fails, indicating that the driving operation of bridging requirements is high. On the contrary, if the conversion time between driving actions within a deviation range, the driving action is still able to be completed, then it indicates that the bridging requirements of driving action is low. Therefore, the bridging qualitative indicators of action can be divided into high, medium and low levels.

(4) The operating environment refers to the external environment around driver when completes the driving action, which including space, noise, vibration, vision range. If the operating environment around driver is full with small space, noisy, strong vibration, narrow field of vision, it will affect the normal

operation of the driver, and results in operational errors. Qualitative indicators of the operating environment can be divided into good, common, and poor levels.

Index Right Weightiness Calculation

For the four difficulty degree of driving action evaluation index in1.1, using AHP to determine the index weight, it establishes a comparative judgment matrix by followed by comparative importance of each factor by expert scoring method.

$$D = \begin{bmatrix} 1 & 1/2 & 1/3 & 1/2 \\ 2 & 1 & 1/2 & 1 \\ 3 & 2 & 1 & 2 \\ 2 & 1 & 1/2 & 1 \end{bmatrix}$$

Obtaining the judgment matrix weight vector $w_D = [0.12 \quad 0.23 \quad 0.42 \quad 0.23]^T$, taking consistency test of the judgment matrix D, the judgment matrix D characteristic root $p = 4.01$, consistency index $C.I. = 0.004$, obtaining the average random consistency index $R.I. = 0.89$ by looking-up table, the proportion of consistency $C.R. = 0.005 < 0.1$,the consistency of judgment matrix is acceptable. The difficulty degree of driving action evaluation index weights of armored vehicles driving action is shown in Table 1.

Table 1 the difficulty degree of driving action evaluation index weights

Number	Index name	weight
1	Action step number	0.12
2	Action accuracy	0.23
3	Bridging action	0.42
4	Operating environment	0.23

Quantitative Evaluation of the Difficulty Degree of Basic Driving Action

Analysis of typical fundamental driving motion

Selecting a typical basic driving action of a type of armored vehicles "launch (electric start)", "change the first shift to the second (short sprinkle oil method)", " change the third shift to the first (two clutch method)" as the object of the study [3], the decomposition of action step as shown in Table 2.

Table 2 the decomposition of typical basic driving action steps of a type of armored vehicles

Driving action / Steps	Launch(electric start)	Change the first shift to the second (short sprinkle oil method)	Change the third shift to the first (two clutch method)
1	Connect the electric circuit main switch	Keep the engine in the lowest and stable rotate speed	Braking vehicle,slow dow the speed
2	Press the alarm,emit the alarm signal	Short sprinkle oil	Tread the main clutch pedal
3	Check up whether the shift pole is in the empty position	Tread the main clutch pedal rapidly	Turn the shift pole to the empty position
4	Tread the main clutch pedal	Change the first shift to the second	Loosen the main clutch pedal, refuel shortly
5	Press the launch button, tread the main clutch pedal to refuel,after launching,loosen the launch button	Loosen the main clutch pedal, rapidly and tread the accelerator pedal to refuel at the same time	Tread the main clutch pedal again
6	Loosen the main clutch pedal,	——	Turn the shift pole from the empty position to the first position
7	keep the engine in the lowest and stable rotate speed	——	Loosen the main clutch pedal and refuel at the same time

Evaluation of typical basic driving action

According to 2.1 difficulty degree of driving action evaluation index and division levels, respectively, making evaluation to the typical basic driving action in 3.1, as shown in Table 3.

Table 3 quantifying the evaluation index of typical basic driving action

Evaluation Index / Driving Action	Action step number	Action accuracy demand	Action bridging demand	Operating environment
Launch(electric start)	7	2	2	1
Change the first shift to the second	5	3	3	2
Change the third shift to the first	7	3	3	3

According to the similarity theory, regarding the evaluation of the difficulty degree of each driving action as a similar system, establishing similar elements characteristic values sequence of similar system, you can get:

$$A_1 = \{7,2,2,1\} \quad A_2 = \{5,3,3,2\} \quad A_3 = \{7,3,3,3\}$$

Calculated the similarity of A_1, A_2 correspond to A_3 by Eq. 2 to Eq. 5 and Table 1, you can get:

$$Q_{13} = 0.63 \quad Q_{23} = 0.89 \quad Q_{33} = 1$$

It can be seen that the "change the third shift to the first (two clutch method)" is the most difficult thing, "change the first shift to the second (short sprinkle oil method)" is a little easier, "launched (electric start)"is the easiest, so the difficulty degree of basic driving action can be defined into three grades as a bit difficult, moderate, easy ,which using level A,B,C to present respectively, which corresponding to different intervals of similarity values, as shown in Table 4.

Table 4 quantifying the evaluation index of typical basic driving action

The difficulty degree	Similarity values intervals	Basic driving action	Similarity values
C	0.90~	Change the third shift to the first	1
B	0.70~0.89	Change the first shift to the second	0.89
A	0~.0.69	Launched (electric start)	0.63

From Table 4, we can know that the difficulty degree of driving action by “change the third shift to the first (two clutch method)” is level C, the difficulty degree of driving action by " change the third shift to the first (two clutch method)" is level B, the difficulty degree of driving action by “launched (electric start)”is level A.

Conclusions

According to different difficulty degree of armored vehicles basic driving action, the action steps number, action accuracy, action bridging, as well as the operating environment can be regard as the evaluation index action of the difficulty degree of armored vehicles basic driving action, each index weight respectively is [0.12, 0.23, 0.42, and 0.23].

The similar system theory and its measurement method could be used to quantitative evaluation of difficulty degree of armored vehicles basic driving action, it provides a new method of studying driving law of armored vehicles.

The difficulty level of armored vehicles driving action can be divided into three levels as a bit difficult, moderate and easy. Mastering different difficulty levels of driving action, the train workload that are needed is different. The divide of difficulty degree provides a useful reference for making train plan scientifically.

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