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Research on Appraising of Tactical Internet Simulative Training

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Abstract. Appraising is an important work of Tactical Internet (TI) simulative training. As a new type of network, the appraising of TI training needs to be solved by new method. Therefore, the paper set up a new index system firstly, laid the foundation for the appraising of Tactical Internet simulative training. Secondly, the paper used a Petri net method, which solved the acquisition problem for those indexes that are dynamic changed and not easy to be directly calculated. Thirdly, the paper used a BP neural network method, which solved the calculation of index weights. Finally, based on the method of satisfaction degree, the paper set up an appraising model which realized the appraising of trainees' training level. The paper's work has been applied in practice and achieved good results.

Introduction

As a communication network for digitized battlefield and network-centric warfare, Tactical Internet (TI) represents the development direction of future mobile communication [1]. Tactical Internet has novel techniques, complex protocols and multitudinous equipments. For mastering the operation skills of TI effectively, it is necessary to carry out its simulative training.

TI simulative training includes the training of equipment operation, network management (NM) operation, communication command and theory learning [2], shown as Fig.1. TI simulative training appraising is to assess trainees' operation situation in these areas. According to the assessment results, the trainees can ascertain the focus of training in the future, and then improve their training level scientifically. Appraising is an important work of TI simulative training.

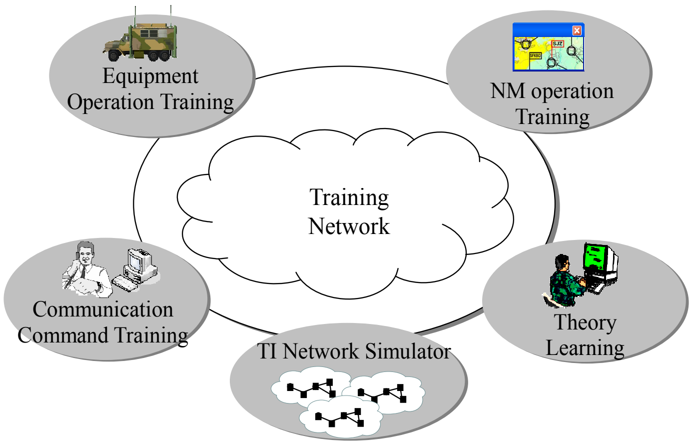

Figure 1 The areas of TI simulative training

The appraising of TI simulative training should solve the problems such as construction of appraising index, index acquisition, weight calculation and construction of appraising model. These problems will be solved by the following studies.

Construction of Appraising Index System

In order to appraise the trainees' training level of TI simulative training, it needs to construct the index system for measuring training level firstly. Index system is the foundation to establish appraising model of training and will directly affect the effectiveness of appraising results [3].

According to the hierarchy of index system and the areas of TI simulative training, the paper constructed the appraising index system, shown as Table 1.

Table 1 The appraising index system of TI simulative training

Training Level of Trainees (A)	Communication Command (B_1)	Scheme Planning Ability (B_{11})	Survivability of Network Designing (C_1)
			Redundancy of Network Designing (C_2)
			Time Effectiveness of Working (C_3)
		Organizing and Commanding Ability (B_{12})	Accuracy of Commanding Process (C_4)
			Time Effectiveness of Commanding (C_5)
			Exhibition Degree of Commanding (C_6)
	Network Monitoring (B_2)	Parameter Configuration Ability (B_{21})	Fitness of Configuration Steps (C_7)
			Time Effectiveness of Parameter Configuration (C_8)
		Faults Handling Ability (B_{22})	Accuracy of Faults Handling (C_9)
			Time Effectiveness of Faults Handling (C_{10})
	Equipment Operation (B_3)	Equipment Operation Ability (B_{31})	Fitness of Equipment Operation (C_{11})
			Time Effectiveness of Equipment Operation (C_{12})
		Communication Service Ability (B_{32})	Accuracy of Circumstances Processing (C_{13})
			Time Effectiveness of Communication Service (C_{14})
	Theory Learning (B_4)	Professional Knowledge Level (B_{41})	
		Basic Knowledge Level (B_{42})	

In Table 1, index B_1 used for appraising the training level of communication command personnel, index B_2 used for appraising the training level of network management personnel, index B_3 used for appraising the training level of equipment operation personnel, index B_4 used for appraising the training level of theory learning personnel. Due to a training team is composed of the personnel above, therefore, index A used for appraising the training level of whole team.

Index Acquisition Based on Petri Net

After the construction of appraising index system, it is necessary to seek suitable acquisition method for index value. In Table 1, indexes as C_3, C_4, C_5, C_7, C_8, C_{10}, C_{11} and C_{12} are dynamic changed, they can't be calculated directly, they need to be acquired and measured dynamically. Therefore, the acquisition of these indexes' value is a difficulty. The paper adopted the method based on Petri net [4] to solve this problem.

Petri net model is built firstly, for example, we can build Petri net model of "communication commanding process" as Fig.2.

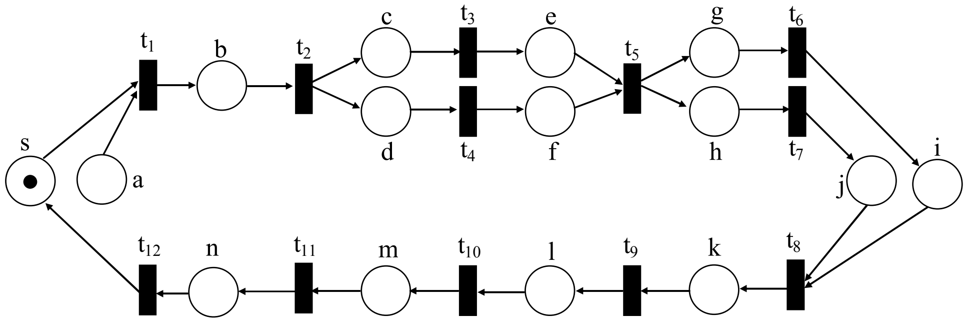

Figure 2 The Petri Net model of communication commanding process

After the construction of Petri net model, we can use the trainees' current operation to match the corresponding sets of operation of Petri net model. If the operation match is completely same, we consider that the current operation is correct. Otherwise it is a wrong operation and then return to the former step, the operation steps accumulated "1", the operation time of this step continues, their formulas are as (1) and (2):

$$P = N + a\ . \tag{1}$$

$$T = \sum_{i=1}^{P} t_i\ . \tag{2}$$

In formula (1), P is the actual operation steps, N is the standard operation steps of current training content, a is the wrong operation times. In formula (2), T is the actual operation time, t_i is the specific operation time of each step.

According to the Petri net model and the method above, we can get the steps and time of operation training, then we solve the acquisition of index value.

Weights Determining Based on BP Neural Network

Determining the weights is an important issue. In the process of determining, the weights will bring into lots of uncertainty if the man-made factors are great. Therefore, the paper adopts BP neural network [5] to determine the weight of each index. Based on the known training samples, we can obtain the experience and knowledge from appraising experts and weight coordination ability compare to the importance of targets, eliminate the man-made impact in determining weights method as far as possible, and then ensure the effectiveness and practicability.

The learning process of BP neural network is as formula (3) and (4):

$$\omega_{ji}(n+1) = \omega_{ji}(n) + \Delta\omega_{ji}\ . \tag{3}$$

$$\Delta\omega_{ji}(n+1) = \eta\sigma_j x_j + \alpha\Delta\omega_{ji}(n)\ . \tag{4}$$

When the BP neural network complete training using the unified samples, and then proceed as follows. Firstly, obtaining the correlation coefficients as formula (5):

$$r_{ij} = \sum_{k=1}^{p} \omega_{ki}(1-e^{-x})/(1+e^{-x}), \qquad x = \omega_{jk}\ . \tag{5}$$

In the formula(5), k is the hidden units in neural networks, ω_{ki} is the weight index between the neuron i in the input layer and neuron k in the hidden layer, ω_{jk} is the weight index between the neuron j in the output layer and neuron k in the hidden layer.

Then obtaining the relevant exponent as formula (6), and finally obtaining the absolute influence coefficient as formula (7), W_{ij} in formula (7) is just the required weight.

$$R_{ij} = |(1-e^{-y})/(1+e^{-y})|, \qquad y = r_{ij}\ . \tag{6}$$

$$W_{ij} = R_{ij} / \sum_{i=1}^{n} R_{ij}\ . \tag{7}$$

Appraising model of TI simulative training

In TI simulative training appraising, all indexes in Table 1 are required to adopt the same dimension. This paper uses the satisfaction degree [6] to unify dimension of all indexes. Thus, the appraising model of TI simulative training can be established.

Let $u(\bullet)$ denotes the satisfaction degree of an index, then the satisfaction appraising models of index B_1, B_2, B_3, B_4, are as formula (8), (9), (10) and (11) respectively.

$$u(B_1) = \sum_{i=1}^{3} W_{11} W_i u(C_i) + \sum_{i=4}^{6} W_{12} W_i u(C_i)\ . \tag{8}$$

$$u(B_2) = \sum_{i=7}^{8} W_{21} W_i u(C_i) + \sum_{i=9}^{10} W_{22} W_i u(C_i)\,. \tag{9}$$

$$u(B_3) = \sum_{i=11}^{12} W_{31} W_i u(C_i) + \sum_{i=13}^{14} W_{32} W_i u(C_i)\,. \tag{10}$$

$$u(B_4) = W_{41} u(B_{41}) + W_{42} u(B_{42})\,. \tag{11}$$

For the $u(C_i)$ in the formulas above, they are all calculated by some form of satisfaction degree function. Take an example, for the index C_3, the satisfaction degree $u(C_3)$ adopted partial small satisfaction degree function, shown as the formula (12):

$$u(C_4) = \begin{cases} 1 & t < T_1 \\ \dfrac{t - T_1}{T_2 - T_1} & T_1 \le t \le T_2 \\ 0 & t > T_2 \end{cases}\,. \tag{12}$$

In the formula (12), t is the time cost by working. T_1 and T_2 are the standard limit time of this working. However, the formulas (8) ~ (11) are all appraising models for individual. When the training is implemented by team mode, the team's training level should be denoted with the average satisfaction degree, shown as formula (13):

$$\overline{u(B_i)} = \frac{\sum_{j=1}^{n} u_j(B_i)}{n}\,. \tag{13}$$

In formula (13), $\overline{u(B_i)}$ is the average satisfaction degree of team, $u_j(B_i)$ is the individual satisfaction degree of no. j in team, n is the number of team members. Then, we can get the training level of whole team with the following satisfaction degree model, shown as formula (14):

$$u(A) = \sqrt[4]{\overline{u(B_1)} \bullet \overline{u(B_2)} \bullet \overline{u(B_3)} \bullet \overline{u(B_4)}}\,. \tag{14}$$

In the formula (14), $u(A)$ is the satisfaction degree of whole team, $\overline{u(B_1)}$, $\overline{u(B_2)}$, $\overline{u(B_3)}$ are the satisfaction degree of communication commanding team, network management team and equipment operation team respectively. $\overline{u(B_4)}$ is the satisfaction degree of theory learning of whole team.

References

[1] Jianjun Shen, Chule Yang, Yuqing Xu. Research on Terrain Environment and Maneuver Simulation for Tactical Internet, Advanced Material Research, Vols.846 (2014), pp1368~1371.

[2] Jianjun Shen, Zhichun Gan, Xiaohu Yu. The Research on Tactical Internet Simulative Training and its Dynamic Real-time Network Simulation, International Conference on Information Management and Engineering, Beijing, Apr. 2010, pp.354~358.

[3] Dong Han. Study on Tactical Internet Simulation Training Appraising [D], Communication Command Academy, Wuhan, Mar. 2008.

[4] Xiaowei Wang. Research on Workflow Modeling and Application Based on Petri Net [D], Huazhong University of Science and Technology, Wuhan, Apr. 2005.

[5] Yubin He, Xinzhong Li. The Control Technology and its Application of Neural Network, The Press of Science, Beijing, 2000. (In Chinese)

[6] Lilun Yao, Jingxue Liu. The optimization method for Military Communication, Communication Command Academy, Wuhan, 2002. (In Chinese)