A Self-training System Design

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Abstract. Facing the increasing demand for massive training, the existing teaching and training facilities cannot satisfy individuals' needs of self-training in terms of timetable and availability. In the field of training simulation, designing new organized training methods and systems has been introduced as a new research topic. After comprehensively analyzing the development trend of intelligent training, the functional and technical framework of a self-training system was designed and practically applied to address the practical issues of organized training based on the features of individuals' self-training. As revealed in its practical application, the proposed dialogue self-training system could simulate the entire procedure of training by allowing the voice communication between trainees and experts. Hence, this self-training system effectively overcame the defective conditions for individuals' self-training.

Keywords: intelligent simulation · interactive dialogue · self-training

1 Introduction

The booming intelligent technology has supported the innovation of training technology and pattern. Training pattern innovation and training method reform have been crucial to driving the reform of military training, education and teaching, and to realizing the more comprehensive scenario-based military training of higher level. Considering the development and simulation of military training technology, some traditional objects including equipment, operation and circumstance can be presented by virtue of game, robot, mixed reality, and other simulation technologies. Hence, "intelligent drillmasters", who can guide, organize and assess training, will be an important topic in the future military simulation research. Presently, smart technology, simulation technology, network technology, and distributed technology are utilized in the collaboration of combat positions and the intelligent learning and training guidance. This is an important task to expand the utilization model of training resources and develop innovative organized training methods [1].

2 Problem Description

Presently, all the virtual training systems used in teaching and training depend on the interaction of trainees by virtue of a mouse and a keyboard. However, trainees cannot experience the command training in this way, or feel their influence on the operation or

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battlefield situation by giving commands. The training does not provided an immersed experience for them. The trainees cannot actually experience the command process, so that it is a "learning-oriented" silent training. In the training, the trainees cannot experience the command process in an actual mission. They cannot orally give commands or make coordination for the mission. This is noticeably different from the command process in actual battles. On the other hand, the resources in the virtual training are not accurately used and positioned. The advantages of virtual training system have not been fully and clearly understood for self-training and massive organized training. Course contents and training methods are not scientifically combined, while information technology has not been accurately applied.

Considering the above problems, it is necessary to first address the basic issue, that is, command training. This training involves a variety of objects and contents, so that speech recognition and intelligent learning technologies must be utilized comprehensively to design and develop a supportive self-training system. With the system, trainees can have voice interaction with "training experts" to understand the links and command process of equipment and combat operations. Additionally, the command process by trainees can be analyzed and judged by virtue of dialogue, animation, and video. On this basis, professional advices will be provided to rectify and remind them of any incorrect or missing command. Therefore, this system can greatly improve the efficiency of learning and training, expand training objects, and resolve the problem of implementing massive training [2].

3 Functional Design

The self-training system is trainee-oriented, so that its functions must be designed for their "frequent, repeated, and independent training". Therefore, it provides a fully self-controlled professional training pattern covering all functions for trainees. Based on the self-training organization and management process, the functions of the system are divided into six functional modules, namely, natural speech recognition, business field knowledge understanding and analysis, logical interaction evaluation, training guidance, training situation display, and training log and management (see Fig. 1).

3.1 Functional Architecture

Speed recognition can be used to convert a trainee's natural speech into text or character string as the input for semantic understanding and computer intelligent evaluation. Subsequently, it is translated by business field knowledge understanding and analysis into

Fig. 1. Functional architecture of the self-training system

a recognizable text based on the terminology of business field. After comprehensively evaluating and comparing the semantics of the trainee's speech, the system can analyze and remind the trainee of any wrong or missing command or give other feedbacks on the training. In addition, the reasons for the wrong command can be analyzed and judged to call the relevant learning and training resources from a specific training resource library. In the function of training guidance, interactive training is constantly organized to repeatedly help the trainee overcome the mistakes he often makes. In the meantime, the feedback from the system is output in audio form to the user. Therefore, a training pattern is achieved with the voice interaction between the user and the system. Training situation display is mainly used to demonstrate how the training feedback to the user affects combat process and battle scene. All training contents including procedure, data and courses are recorded and filed in the module of training log and management for real-time and future statistical analysis of the training [3].

3.2 Software System

The key functionality of the self-training system is enabling an individual to complete the training independently without being guided or organized by an instructor. Hence, the software system is designed with the capability of identifying a user's interactive operation and understanding the meaning of the user's command. Additionally, it can accurately and automatically identify errors and problems in the command based on the user's operation habit and the meaning of command. On this basis, it can analyze them based on its knowledge system, and then make a judgment. In this way, the training can be automatically guided, implemented and assessed. The software architecture is divided into several modules as shown in Fig. 2, including mission scene library, speech recognition, semantic analysis, knowledge base, knowledge analysis, dialogue management, and situation display.

(1) Mission scene library module. It is an extensible module. It can be designed and configured according to the goal and mission of training. It mainly covers nine aspects as presented in Table 1.

(2) Speech recognition module. Through recognition and understanding, a machine can translate a person's audio signal into the corresponding text or command. Speech recognition is achieved in the following steps: first, a speech to be processed is broken into several segments; second, the frequency of the speech segments is extracted through Fourier transform; third, the voice varies as the time goes by, and the speed varies as

Table 1. Definition of Mission Scene Module

Item	Organized Training
Mission Number	Training Object
Profession Category	Evaluation Indicator
Course Description	Related Resource
Mission Background	Difficulty Setting

well. Thus hidden Markov model is employed to process the speech; the last step is to eliminate ambiguity.

(3) Semantic analysis module. A user's words may be standard commands or simple answers, and even contain modal particles. Therefore, keywords must be extracted from the speech to develop the capability of extracting principal information. Moreover, error tolerance must be preliminarily guaranteed. In this way, colloquial training and command training are combined for trainees.

The existing natural language understanding technology is based on command. Thus a rigid recognition model is very helpful to standard commands. Nevertheless, it is still necessary to further study the capability of language understanding, and improve the flexibility of speech. Colloquial training and command training must be combined for trainees, e.g. "Vent Off", "Shut Off Vent", "Shut Off Ventilation", "Disconnect Ventilation", "Vent On", and "Start Vent". If recognition follows too lax standards, some essential differences may be caused. However, if recognition follows too strict standards, similar but correct commands may be mistaken as wrong commands. Some solutions can be adopted as follows:

Solution 1: The speeches from many people are tested and surveyed to gather as many similar and identical command words as possible, and make them into a command language base, so as to improve the accuracy of recognition.

Solution 2: The advanced speech recognition technology in the civilian field is introduced together with the language base of the profession for secondary development, so as to improve the capability of naturally understanding the speech. The recognition of dialogue should be improved as much as possible.

Solution 3: Based on the study of natural language understanding technology, a professional command understanding system is devised and implemented on the basis of natural language. The grammatical rules are designed with the agreed atomic instruction set. The sentence-based and word-based case matching algorithms are integrated with a case matching algorithm based on the grammar tree model. The main composition of sentence is comprehensively considered with the common lexical collocation, making it easier and more practical to understand in the system.

(4) Expert knowledge base module. It is a core module for processing training inputs and generating outputs in the system. In a standardized way, it processes a variety of knowledge and data in different forms, and converts them into knowledge particles suitable for storage in the teaching resource library. The standard XML format is used for data storage and exchange. The interface design is guaranteed to be consistent for the aggregation of data and information. The interface for the translation of fundamental data and knowledge semantic information is simplified to be called by applications [4]. The knowledge base module is defined as given in Table 2.

(5) Knowledge analysis module. For a preset mission, the expert system module provides an integrated and professional handling scheme, gives supportive decisions or advices to trainees, reminds them of and records errors and omissions, and evaluates the score of trainees.

(6) Dialogue management module. It gives a correct judgment regarding the answer from the speech recognition system. Dialogue is repeated to guide a user's answer until the user gives the correct answer. It judges whether the answer is correct based on the

Table 2. Definition of Expert Knowledge Base Module

Item	Q&A Category
Teaching Resource Browse	Question
Principles and Courses Browse	Answer
Courseware File	Expert Category
Video File	Expert Information
Training Course	Keyword Search
Operation Procedure	Semantic Search
Troubleshooting	Search Results Display
Knowledge Map	Instant Messaging
Communication	

contents of dialogue and the knowledge of experts. Subsequently, the next question is generated until the training for the scene of the mission is completed. A finite state model is adopted for dialogue management. In the finite state model, dialogue is structurally represented in the form of state transfer network. Based on the type of control, dialogues are classified into system-driven and user-driven. In a system-driven dialogue, the system raises a number of questions to the user, in order to gather the required information of the mission. On the contrary, a user-driven dialogue means that the user raises a question to the system, which transfers the information to the system.

(7) Situation display module. It can display the combat situation at the battlefield, on a vessel, or in the system. Meanwhile, a standardized command marking and interaction scheme is used to display the variation of situation at the battlefield and on a vessel with the interference of various interactive commands [5].

4 Design of Organized Training

Self-training is fulfilled through the interaction of trainees with the training system. The training system is designed with training courses. Meanwhile, process tracking and result assessment are automatically carried out based on the feedbacks of trainees. The system constantly learns the operation habits and command characteristics of trainees, and adjusts the selected training courses correspondingly. In this way, training is repeated with the focus on some common errors or difficulties, so as to improve the effect of training.

(1) Guidance. A trainee selects the training course and situation, and prepares the training scheme. If there is a training record, training contents can be determined using the training assessment data.

(2) During the training, a trainee follows the instruction given by the system to engage in the training by giving commands. By comparing the trainee's command and the correct command, the system may give a hint or reminder during the training, or give hints and analysis results together after the completion of the training. Meanwhile,

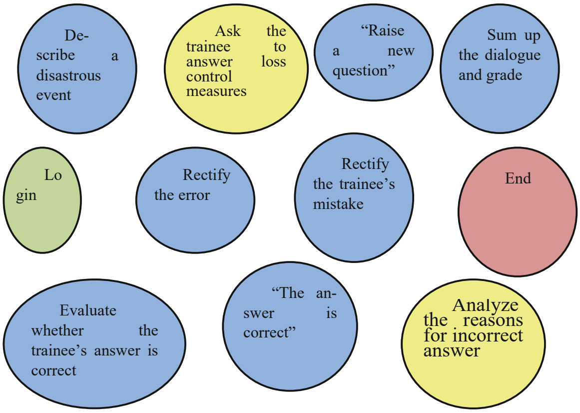

Fig. 2. Dialogue training procedure

the system can directly reflect the results of the command given by the trainee through situation display, which improves the trainee's experience in the simulated training.

(3) During problem rectification and analysis, the system receives the information, and performs the comparison, judgment, and analysis. Then it responds in voice whether the user's answer is correct. With regard to common mistakes and problems, learning resources are forwarded to guide trainees' study. Moreover, questions are asked in each link of the training according to a trainee's level, for the trainees in the entire process of training (as given in Fig. 3).

(4) At the stage of correction, the system continues to forward the specific training courses to a trainee after analyzing his weakness. The training is further strengthened until it is believed that the trainee has met the evaluation requirements for proficiency. The evaluation algorithm for correction in the training is as follows:

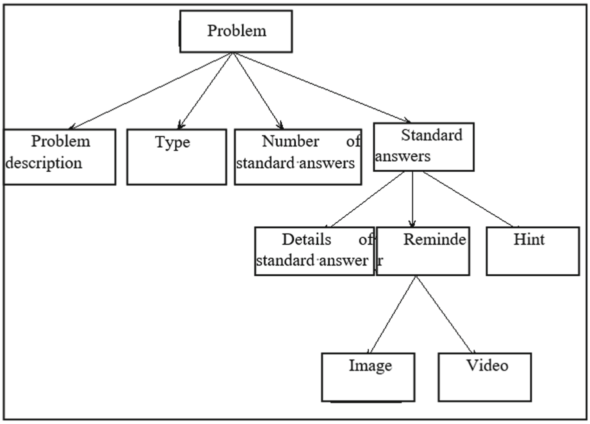

Fig. 3. Training problem rectification analysis

The initial error location algorithm is solved to find out the primary factors causing the incorrect answer given by a user. The states are combined. When a theme has standard answers (S1,S2,…Sn), the state AnsTi is defined to represent that the (1∽i-1)th answer given by the user is correct, the ith answer is incorrect, and the correctness of the (i + 1∽n)th answer is unknown. Therefore, the system will have n + 1 states. The algorithm is designed as follows:

```
k=1;
while(k>0)
{
Get the voice input, perform speech recognition, analyze and get the answers A1,A2,…Am
k=ErrorIndex(type,S1,S2,…Sn,A1,A2,…Am)
if(k>0)
  Output the hint of the k^th item in voice, and present the corresponding multimedia information (image or video)
End if
}
Return k
Identify the first incorrect answer based on the type of question, the standard answers S1,S2,…Sn, and the answers given by the user A1,A2,…Am, and return. If the first answer is correct, return k has the value 0. For different types of question, ErrorIndex handles it differently:
if(type==OR)
    k=min{i| Ai∉ {S1,…Sn}}
else if(type==AND)
    k=min{i| Si∉ {A1,…An}}
else if(type==SEQ )
    k=min{i|Si≠Ai}
```

5 Case Study

Step 1: Select the command position
Step 2: Select the training course
Step 3: The system gives the combat situation, and asks the trainee the questions in voice. The trainee gives his answers in voice. The system records the voice, and generates the character string and text.
Step 4: With the data dictionary, the natural language learning module can translate the continuous speech in Chinese language into a text recognizable by the answer evaluation module. In the answer evaluation module, the text is compared with the knowledge in

the expert knowledge module. If it is correct, the top dialogue management module will automatically organize a dialogue for the next "** command element". If it is incorrect, the bottom dialogue management module will give a hint with regard to the current "** command element".

After the correct answer is given, the top dialogue management module will automatically switch to the "** command element".

Step 5: Based on the new "** command element", the training expert system module will organize new questions in the expert question generation module, and output them to the user in voice through the speech synthesis module.

Step 6: After hearing it, the user can response in voice. This is repeated until the "** command elements" in the training course is completely trained for the trainee. The system halts the training course, and assesses the training results.

Step 7: The user may choose a new training course, or logout the training system.

6 Conclusion

Based on the demand for self-training, this paper presents a design of self-training service system and its case study. As proved in the practical application, self-training overcomes the shortcomings of the current training in space and time. Moreover, the self-training system can be deployed flexibly and conveniently, so that it is very suitable for the training subject to limited network conditions. In the future, the system must have its intelligent algorithm and computation platform upgraded to generate an organized training system with the capability of "learning". This will help trainees achieve better self-training and independent training, improve their training efficiency, and expand training objects.

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