Expert System about Remote Support for Rushing to Repair the Damaged Power Equipment

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Abstract. Combined the theory of equipment battle filed damage and the information technology, the design model about remote technology support for power equipment battle field damage was put forward. The system was composed of site monitor diagnosis, network transmission gallery and the service center of remote technology support. The center of remote damage evaluation was established by using the structure of B/S and ASP+SQLServer2012. The key technologies of this system involve battle field damage data collection, data transmission, expert system and so on. It provides a good foundation for the development of repair technology through research and application of the system.

Keywords: Battlefield damage; Rushing to repair; Technology supporting; Expert system.

1. Introduction
Power equipment is very important in modern weapon system. Battle damage repair is the key factor in keeping and recovering the battle effectiveness of equipment, especially in partial war in conditions of high technology. With the development of maintainability and test ability technologies of power equipment, the rapid repair technology can greatly meet the needs of battle requirements. Because of the improvement of high integration level and high-complexity in maintenance, it is difficult to meet the needs of support requirements merely depending on basic repair power. In order to repair the battlefield damages timely, the army need a more rapid, accurate, efficient and specialized service of battle diagnosis and repair. Remote battlefield damage repair system can solve the problem effectively. With the development of communication network, computer network technology and damage diagnosis technology in recent years, remote monitoring technology has become increasingly mature in industry, which provides remote battle damage repair technology reference for army. In this paper, we do research in the using of the expert system about remote technology support for repairing the battle damaged power equipment in the army[1-3].

2. Remote Technology Support Expert System Model about Battle Damage
Remote technology support expert system of battle damage is a integrated system, which is combined by WWW information retrieval technology, database technology, artificial intelligence reasoning mechanism, equipment battle damage assessment and repair technology based on the rapid development of Internet. On the complex equipment establish state monitoring and collect equipment state data. In the scientific research institutes with strong technology force establish analysis diagnosis center and provide remote technology support.

According to the actual situation of army, we put forward the battle damage remote technology support system model for the grass roots. As shown in figure 1, the system use the remote damage
diagnosis expert system based on Browser/Server. It can be roughly divided into two parts: basic data collection sites and center sites. When the equipment is damaged, the data will be sent to the basic site first through basic WLAN and the damage will be diagnosed by local staff. Using the basic damage diagnosis expert system and equipment historical data estimate damage and repair. If there is the damage that basic diagnosis system can not solve, then the all kinds of collected information about the equipment will be uploaded to center sites. It will be solved by the damage estimate system of center sites. The damage diagnosis system of center sites collects data from basic database to obtain relevance damage information. In order to obtain the diagnosis conclusion and send the repair methods to basic sites, the filed expert knowledge, network damage diagnosis expert system and artificial intelligence reasoning mechanism will be used to analyze, compare and judge the damage information\[4,5]\.

![Figure 1](image-url) Structure of remote technology support expert system about battle damage based on B/S.

3. Design and Realization of the System

3.1. The Form and Function of the System
The system is made up of three part, including the system of primary level diagnosis, the system of network communication, and the specialist support system center of distance technical assistance.

The system of primary level diagnosis consists of the system of primary level equipment damage data collecting and the system of primary level equipment damage diagnosis, the system of primary level equipment damage data collecting is in charge of monitoring field management running information. And to finish collecting field management running information, saving running state, analyzing abnormal state, disposing emergency state. The damage of field equipment can be transferred to central station by video transmission network, estimated and guided online by specialist support system of superior servers.

The system of primary level damage diagnosis is used to analyzing and disposing common damage, including case bank of common damage, database and relevant reasoning reference. It’s in charge of providing diagnosis of common damage and essential maintaining service online. When complex damage and difficult problem appears, damage information can be transferred to damage center of distance technical assistance through distance communication system in order to get technique support. The main function is to accept the data from the system of primary level equipment damage data collecting and upload equipment information to specialist support system center.

The way of the system of network communication is combination of wired communication and wireless communication. It ensures data transmission between missile battalion and the support system center of distance technical assistance in settled battle field or maneuvering circumstance. The way of communication between the system of primary level equipment damage diagnosis and the specialist support system center of distance technical assistance is wired communication. The way of communication between the system of primary level equipment damage data collecting and the system of primary level diagnosis which participate in repairing in the place ahead depends on the circumstance for the disposition of equipment on the circle settled battle field. WLAN is suitable for maneuvering fight. During the wartime, special communication line can guarantee the communication unblocked. The specialist support system center of distance technical assistance is shown in figure 2.

It mainly includes specialist database, module of analysis and repairmen, monitoring center database, management software and communication service. It can realize functions of the central spot such as monitoring, damage diagnosis, and statistics of the damage device, person management and maintaining database. Analysis and repairmen module was designed as the core of estimate system.
Through the module of BDAR specialist analysis, it conducts input model of undamaged structure and representation of damage structure as the input, and analysis program gets comprehensive structure ability by changing inside form of damage part. The module of repairmen will automate the design of damage structure repairmen.

3.2. Specialist Estimate System

The system uses SQL Server 2000 database as the background, operated by Visual C++ 6.0 as the front desk, and it can be done in a knowledge of the editor. The system adopts hierarchical structure design ideas. When maintenance engineer is in the maintenance and repairing damage equipment, he always first obtains from the damage phenomenon, according to the damage phenomena and his knowledge, and gradually narrow the scope of the search, until find the damage position. By the same token, the damage detection process is the process of basing damage phenomenon to determine the scope of the damage, in which damage range from big to small, position to the real damage point step by step. The basic idea of the hierarchical structure is classification of objects from a high level of common mode to lower levels of the specific pattern step by step. The higher the level, the broader damage cover, the lower the level, the more targeted. The specific division is shown in figure 3.

![Figure 2. Composition principle of the specialist support system of battle field damage repairmen.](image)

![Figure 3. Tree model for basic function project structure of the power supply.](image)
3.2.1. Case representation theory. The content of the case is the record and description of a specific problem and issues in research field of the environment, status characteristics, problem solving scheme and feedback, It is specialized knowledge. And it is a collection of specific characteristic and properties which can lead to the specific result. Usually it includes three parts:
(1) problem description: describe the state of internal and external environment at the time of the problem;
(2) solution: that the solving scheme of problems;
(3) feedback: a review of the solution and summary.

The description of power equipment damage case is usually divided into external performance and attributes. External performance refers to the phenomenon and problems of form, The attributes are the basic characteristics of the problem. And it's the precondition for the occurrence and existence of the problem. It is the basic of the case retrieval, matching, and running case matching similarity computation. Due to the different role and status of these characteristics in the process of happening and existence of problems, introduce the concept of describing attributes--the characteristics of the weight--in order to quantitatively reflects the influence of different characteristics to the problem of case. Thus, attributes of the problem of the case can be expressed as[6]:

\[ C = \{M, P, E, I, R, S\} \]

In the equation,
- M—name of damage case, the unique identifier damage case;
- P—collection of damage phenomena;
- E—collection of damage reasons;
- I—collection of knowledge about the basic function project related to P;
- R—solutions of damage case;
- S—feedback of solutions.

Setting case properties should be paid attention, case properties should be able to fully define this case and draw the conclusion of the case. Properties setting should be appropriate. Too much property will reduce the case retrieval efficiency, as well as probability of matching success, increase the difficulty of the problem. Too little property will not reflects the essential characteristics of events. The actual damage assessment case should extract reasonable attributes, reorganize the contents, standardize expression. The multilevel hierarchy index map of damage case bank is shown in figure 4.

**Figure 4.** The multiple rank indexing sketch map of the power equipment.

Damage assessment case presents damage assessment knowledge, and attributes present damage assessment case. In damage assessment case, picking up the property of the case and taking it to
represent the damage information of damage assessment case are needed. There is no need to define and divide the damage information. The problem which is difficult to divide the damage phenomenon, damage model, damage evidence and damage influence in express is solved.

3.2.2. The reasoning tactics. Via the above analysis, when the case searching use analogue method merely, it will be some problems; its productivity isn’t high while it makes some similarity compute between the diagnosing case and the casing data; when the number of the attribute of the every case in the system is different, the arithmetic of the similarity will be more complicated. So, while the searching of the damage case, we should base on the theory of the case, go indexing by the injury at first, then process the multiple searching based on the key characteristic (the model and the phenomenon of the damage and so on) of the damage, then we make the matching of the similarity. On the basis of the trait of the analysis of the damage of the power equipment, we can make the similarity matching with the characteristic. On the process of the matching of the similarity, we can use the K-approaching model with power. The formula of the K-approaching express as :

$$\text{Similarity} (T, S) = \frac{\sum_{i=1}^{k} w_r V_{iS}}{\sum_{i=1}^{k} w_r}$$

(1)

In the formula, $T$ represent the target case, mean the diagnosing damage problem, $S$ represent the damage case of the power equipment in the initial matching case data. $V_{iS}$ represent the similarity of the $r_{st}$ characteristic of the target case and source case. $w_r$ represent the weight of the $r_{st}$ character in the emission equipment. And, $a_r(x)$ represent the character in the case. So, the similarity of the character $r$ in the damage case in the emission equipment is:

$$V_{iS} = (a_{r}(T) - a_{r}(S))^2$$

(2)

We add the weight to the basis, and improve the calculate of the distance between the two case, then we substitution to the formula (1), and we get the similarity between case $T$ and $S$, and the more small in the similar degree the more similar between the two case.

$$\text{Similarity} (T, S) = \sqrt{\frac{\sum_{i=1}^{k} w_r (a_{r}(T) - a_{r}(S))^2}{\sum_{i=1}^{k} w_r}}$$

(3)

Because the damage case we collected is limited now, the weight of the all damage information in this article depend on our respectful equipment specialist.

3.2.3. The explanation mechanism. In the specialist system, the explanation mechanism is a set of method and procedure modules for accomplishing the explanation duty. Because the knowledge library and reasoning machine are divided, the every working step and the rule the system running depend on the temporal whole data base, manage information and reasoning machine. In the system, we adopt restore text and the method of path tracking, for example, we put the solution of the main damage and the single device into their damage descriptions, and track its path effectively. On the basis of the above-mentioned method, we built our damage diagnosis module, and the system could have a quickly and exactly damage diagnosis(diagnosis procedure found in the Figure 5).

3.2.4. The multiple databases. The function of sever database is mainly managing data, carrying out the all manipulation of the database and offering the access to data. It includes the historical information library and the maintain message base of the equipment state, the knowledge bank of the training and so on. The server of the diagnosis is the server Web. On one hand, it realizes the connect with the basic state; on the other hand, it invoking remote damage diagnosis specialist system to analysis. Base on the Web, combining the specialist system and Internet organically, the monitoring of
the basic state could diagnosis in long distance. Its fundamental working process is: Web server monitors the internet all the time, accepting the asking of the basic state from the browser, after it answer, it built the connection and receive every message from the basic state, just as the equipment information, the equipment state message of the basic database and so on, then the damage diagnosis net specialist system analysis and after the result it query the corresponding service advise, then it reply to the basic state browser through the Web, in the same time, save it in the safeguard core database. So, basic state gets the whole damage diagnosis.

![Flowchart](image)

**Figure 5.** Analysis flow of the battlefield damage.

### 4. The Conclusion
The applicable target of the system is mainly some power supply equipment, the system’s remote diagnosis architecture is outgoing and useful, which combing the internet with the damage diagnosis technology, and it could process a remote equipment diagnosis and technical support. The exploit of the system adopt the combination of server’s ASP dynamic page design and the database, could realize the meeting hosting, chatting with characters, voice communication, scan the picture and file transformation (uploading and download). Hardware system could use in any army systematic, expanding and completing the database of the equipment maintain could realize the common use of all weapons, it could have a important actual significance for the ratio of complex equipment and battle in good condition.

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