

Study on Remote Aided Diagnosis System of Mental Health Base on Expert Knowledge Base

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Abstract—By the developing and maturing of remote communications technology, computer network technology and multimedia technology, internet applications has passed into a new phase. With the fast developing of the world economy, morbidity rate of morbidity rate in every country shows an upward tendency year by year. According to the curiative features of mental disease, application principles of expert system and the idea of object oriented programming, the paper expatiates the design proposal of remote aided diagnosis system base on the Browser-Server three-layer architecture. This system takes Internet as platform, puts forth the expendable knowledge base structure of mental illness professional field that is suitable for this system, by the object oriented analytic technique. And this structure can be mapped the relational database to set up relevant expert knowledge database. Which breaks the geographical limitation of mental health test, has good extensibility and usability, and will give a lot of assistance to the diagnosis of mental health.

Index Terms—expert knowledge database, remote communications technology, computer network technology, Aided Diagnosis System

I. INTRODUCTION

Nowadays, There's a high incidence of mental diseases in every country all around the world, and according to statistics, mental diseases occupies eight of the ten diseases that deprive of strength or ability the most presently. And 70 percent of the depression patients cant not get effective treatment for various reasons. The suicide rate grows rapidly in the recent decades. According to the World Health Organization, there was a 60 percent increase of suicide rate in the past fifty years. The number of suiciders increased the fastest, and a great part of the suiciders died of depression. Mind-cure and medication are the main two treatments of mental diseases, and those diagnoses are still in a traditional experience-stage, and mainly depend on various clinical diagnostic indices and experimental results. Lack of diagnostic experience will undoubtedly affect the diagnostic results. General speaking, it will take a professional doctor several years to practice to

accumulate certain experience. The research tasks of expert system knowledge dam in artificial intelligence are to explain and rearrange the expert knowledge of professional field, and set up man-machine system inferred and developed from these knowledges. It provides related knowledges to express the technology, inferring control-mechanism and problem solving strategy. Meanwhile, the developing of professional artificial intelligence Expert System often needs professional artificial intelligence development language and tool, e.g.PROLOG and LISP, and the system weak in is very complicated openness and flexibility which will effect its comprehensive application a lot. How to set up a intelligent network application system that takes general-purpose system as running platform, more open and flexible in architecture, and easier to infer and reason, is the direction deserving of study [1]. In recent years, by the development and maturation of remote communication technology, computer network technology and multimedia technology, these network database technology, middleware technology, COM technology and computing paradigm base on Internet and its Browser and Server provide some basic information to develop the investigation.

II. PRESENTING OF PLAN AND DESIGN

The design objective of remote aided diagnosis sstem of mental health base on expert knowledge base is to make the best of existing network technology, computer technology and modern information technology to set up a geniusnet based on the professional knowledge of Psychological Medicine, which can realize computer-assisted instruction while mental health diagnosing and explain the relevanl knowledge. The consumers can remote access the system to get a new aids of mental health diagnosing that is more convenient, economical and practical. The main features are intelligence, remoteability, usability and extendibility.

A. Logic and Structured Design of the System

The system develops the intelligence of the inferring aided diagnosis under the help of some information of the AL expert System Field, and the logical structure design

bases on the fundamental structure of expert system and meets functional requirement, to set up the logical structure design model, showed as Fig.1.

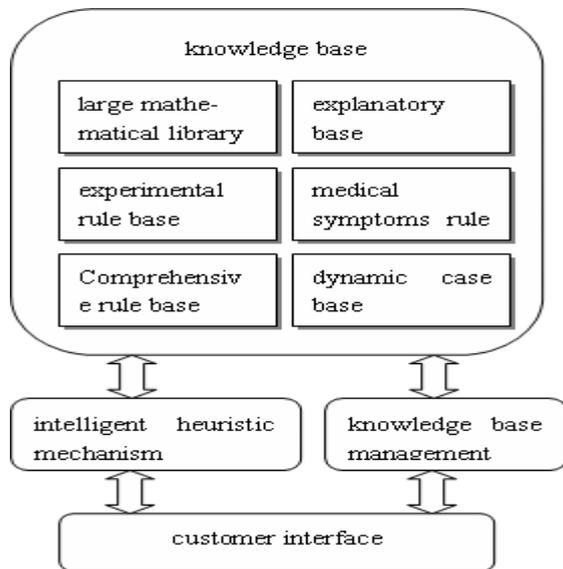


Figure 1. Logical structure of the system

The model mainly contains the following four parts: knowledge base, intelligent heuristic mechanism, knowledge base management abbr: KBM, and customer interface abbr: UI.

- Knowledge Base

The professional field knowledge and its creating dynamic information mentioned in the system is kept in different types of knowledge base, such as large mathematical library, explanatory base, experimental rule base, medical symptoms rule base, comprehensive rule base and dynamic case base.

- Intelligent Heuristic Mechanism

It is used to realize the computer-aided diagnosis , equals to inference mechanism.

- Knowledge Base Management ,abbr. KBM

It is used to manage and service for the Knowledge Base.

- Customer Interface abbr. UI

It provides the customer with a convenient system user interface.

B. System Architecture Design

In order to manage the functional modules better, and based on the Logical Structure, a Browser/Server-typed three-layer architecture is set up by Component Object Model technology, showed as Fig .2.

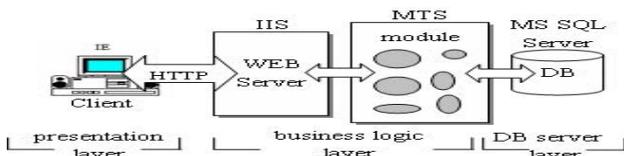


Figure 2. Architecture frame of the system and the UAP

Essentially speaking, the system is to use the remote data information dynamically, and do some related logic reasoning. That's to say, it is a service system that provided by the Internet and for the dynamic use of medical data information. So the relative ideal model to analyse the system architecture is that the client ask the public server for a service, then the server chooses a proper services application program automatically and feedback the results of execution to the client. Traditional Client-Server system has many limitations, such as non-telescopic, hard-to-manage, hard-to-upgrade, hard to cross the platform, and poor performance, and so on. While combining with COM component technology and based on Browser-Server, the three-tier architecture the weakness of the traditional system. It adds WEB server, a new layer to the traditional Client-Server architecture to realize a the three-tier architecture which includes presentation layer, business logic middle layer and db server layer.

On presentation layer, the Client Browser downloads HTML pages from the WEB server to make the interface between the AP and consumers. And the client components in the page can exchange message with other client components or server components.

On the business logic middle layer, the server-side components are packaged up as middle layer to run on the WEB. It separates the presentation logic from business logic and application logic to provide data calculating and accessing, and so on.

On db server layer, all space that components can access form this layer, such as database system, mail servers and groupware Server, and so on. Unlike the traditional two-layer Client-Server structure, these services do not face to the customer service client directly, but be carried out by the server components and feedback the results of execution to the client.

In this architecture, there is only formal logic of AP in the client that is browser. That figures out the disadvantage of maintaining, updating and platform-crossing of Client-Server model. The middle layer is to reflect and maintain the business logic, such as to send the information of presentation layer to db server layer, manage the complex data, and nalysis and monitor the spontaneous processes. Middle layer does not undertake the missions of presentation layer and data layer, but to link and coordinate the two. Therefore, the middle layer can circulate in different computer from the WEB Browser , and manage several requests from the WEB Browser user simultaneity.

This architecture is suit for the design needs of remote aided diagnosis system of mental health base on export knowledge base, and realize the changing of remote information from static publishing to dynamic using. Meanwhile, the architecture raises the application efficiency of the data base on WEB, component method and componentize software realize the layering and layer-componenting of business logic, application logic and presentation logic. The system constructed on Internet and based on the three-layer logic system adopts the code-reusing technology to make the best use of service-

independent software so as to enhance the efficiency of software development. That will advance the maintainability, extendibility and flexibility of the software developed.

C. Systematic Function Module Design

By design objective, the schematic diagram of basic systematic function module is showed as the following Fig .3.

Mental-illness-diagnosing module: It leads the user to make a whole diagnosis step by step, that is from symptoms observing, history taking, basic experimental checking to diagnoses giving, which shows the whole processes of diagnosing.

Knowledge-explaining module: It includes classification explaining, medical principles explaining and question answering. The module also gives some experimental explanations and instructions of the professional knowledge of related fields, such as to expound terminology, clinical significance and interrelation, and so on. And that will give the user a lot of guidances and trainings.

Knowledge management module: It includes the compiling of knowledge base and rule bank. This module mainly maintains and manages the domain knowledge and rules to set an interface for knowledge updating and consummating.

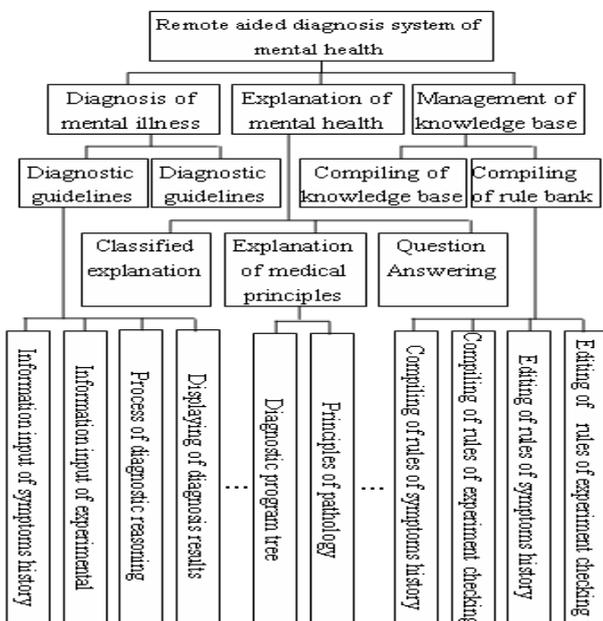


Figure 3. The schematic diagram of basic systematic function module

III. DEVELOPMENT ENVIRONMENT-CHOOSING OF THE SYSTEM

The system is a new three-layer architecture by the model technology of COM component object which is based on Browser-Server model. How to is choose the appropriate technology and tools to use and develop it is

crucial to advance the running performance and developing efficiency of the system.

The development of WEB's dynamic applications has its own characteristics. It runs the program of server and promises the customer to exchange with the server and access the back-end database and build HTML page dynamically. This development involves a large number of number of software tools, is much more delicate than that of the traditional Client-Server softwares. In dynamic WEB-development technology, the ASP technology of Microsoft and the component-object-matching dynamic WEB development method are more convenient and practical. So the system chooses the Visual InterDev of Microsoft to be the integrated development environment of the dynamic WEB-application development of ASP. The system's WEB thematic framework is developed under Visual InterDev.

Visual InterDev is the dominant tools developed cooperating with ASP, and can run the mixed programming of VBScript, Javascript and HTML. It can integrate with many components developed by third-party tools, such as VJ++, VB and VC++, and so on, and the application programs developed has good compatibility. Furthermore, the system integrates the functions of accessing the related database and browsing pages, and so on, so that the development of application programs can be finished under the same environment, and do not need to switch back and forth from different tools, which is of great convenience.

Moreover, to be the third-party tools, Visual J++ develops the reusable servers and client component objects for ASP. Visual J++ is the visual integrated development environment Java-programmed under Visual Studio by Microsoft. It promises the developers on Windows platform either to write the Java code by the Pure Java mode of Sun Company, or to write the more practical and efficient Java WEB application programs by taking the best use of Windows platform. And Microsoft also promises the cross call between Java and COM components, that is either to write COM components by the advantage of Java language, or to improve programming efficiency by adding the resources of Windows platform into Java application. The custom components used in the system is developed by VJ++, such as information input component of Client, like BSH inputctrl and zhenzhi nputctrl, and inference control components of Server, like reasonctrl.

IV. PRESENTING OF PLAN AND DESIGN

According to the structure of the logical component of the system in Fig.1, the system logically consists of four parts: knowledge base, knowledge base management, intelligent thought-provoking mechanisms and user interface. Knowledge base is actually a back-end database, storing the dynamic use of specialistic knowledge data. The knowledge needed in the field of the inference and the explanation, and the dynamic information produced in facts, rules and the dynamic operation process are stored here (ie, integrated database). Meanwhile, the back-end

database provides a basic database management for the maintenance and management of such information.

Smart stimulating mechanism of the system is a logic to accomplish some of the specific business, such as the diagnostic process guidance. It implements part of the core functionality of the system. It needs to access and manipulate the knowledge base (ie, back-end database) frequently. So it should be put server-side to achieve it. One part runs on the server as the server-side script, while the other parts which are more complex are compiled into COM components by using VJ ++, and they work as server-side plug-in type objects. In other words, it functions as the connection between middle-tier application services and Web network servers.

User interface is actually the one for the user and the system to interact with. This system runs the ASP page through the browser. When ASP technology is used and integrated scripting language and HTML for Web programming are combined with some custom ActiveX components, a dynamic interactive remote user interface will come into existence.

Knowledge Base Management is responsible for the maintenance and management of datas in Knowledge Base. And it actually maintains and manages a back-end database, namely, completing some functions of Web database system. The system uses integrated ASP powerful Web database access features and server-side scripting to achieve its functionality.

The following are the description of the various parts of the specific implementation technology.

A. Establishment and Management of the Knowledge Base

Knowledge is an important component of this component in realizing the remote diagnosis of mental health. After the exchange of experts in the field, the following are my analysis on the uses of the domain knowledge in this system:

From knowledge-level point of view, the goal of the system-level knowledge is divided into descriptive knowledge (Kd) and process knowledge (Kp). Descriptive knowledge provides factual and conceptual knowledge in the field, specifically knowledge in the field of psychological medicine and concepts, such as: mental illness, laboratory examination, medical history or the concept note of the symptoms. Procedural knowledge is knowledge of reasoning, specifically the knowledge of guiding the rules and heuristic of medical diagnostic procedure in Medicine.

From the knowledge representation point of view, the structural system of knowledge includes concepts, facts and rules, namely, $K = C + F + R$. (K: items; C: concept; F :facts; R :rules.). As the concept is usually included in the facts, actually knowledge base contains facts and rules.

The rule is in the form of the following description:
 <Rule>: : = (<Rule numbers> ,
 <Premise 1>|<Premise 2>|.....
 <Conclusion> , <Credibility CF>)

In the description, the premise and conclusion are facts. Therefore, from the logical point of view of knowledge, there are only two kinds of predicating rules and facts in systemic knowledge base. However, from the data point of view of the relational model of data, two kinds of relationships exist in the base, and they can create two kinds of tables, rules tables and fact tables.

All the information needed and produced dynamically in the process of system running, including intermediate results and diagnostic records, are all stored in the comprehensive database (database server), for example, the target model structure of a patient.

Through the analysis of the characteristics of domain knowledge and application of object-oriented data modeling methods, the database tables and structures in knowledge base are established [2]. there are three main types of data tables in Knowledge base, as shown in Table 1.

TABLE I. TABLE CLASSIFICATION, FUNCTION AND COMPOSITION OF EXPERT KNOWLEDGE BASE

Classification	Function	Correlation table
Fact table	The concept, professional object and descriptive knowledge that mentioned and stored in the system, equal to the domain knowledge and explanatory knowledge base in the logical structure of the system.	Tables of diseases, disease-owned series, symptom, drug form, past history, family history, drug history, experiment checklist and experimental checking function parameter list, and so on.
Rules table	The rules and heuristic knowledge stored in the system to instruct the diagnosis, equals to the experimental rule base and medical symptoms rule base in the logical structure of the system.	Tables of medical symptoms rule, screening experimental rules, precondition, function parameters of experimental checking rules, confirmed experimental examination rules, focus rules and conditions for medical symptoms, and so on.
Dynamic Table	The data information needed and dynamically generated during operation and stored in the system, such as intermediate results, diagnosis conclusion, and so on.	Tables of alternative conclusion, provisional medical symptoms rules, scheduled model parameters, conditions for medical symptoms and parameter status of model checking function, and so on.

By the usability, readability and expandability, which are needed while setting the knowledge base, the system chooses SQL Server to be the db server., which is the high-performance relational database management system produced by Microsoft.

B. Data Access Implementation Technology of Expert Knowledge Base

The accession and management to the knowledge base in the system are realized by the OLE DB and ADO technologies of Microsoft.

ADO technology synthesizes the advantages of Remote Data Objects, abbr. RDO, and Data Access Objects, abbr. DAO. The object hierarchy of ADO is showed as Fig. 4.

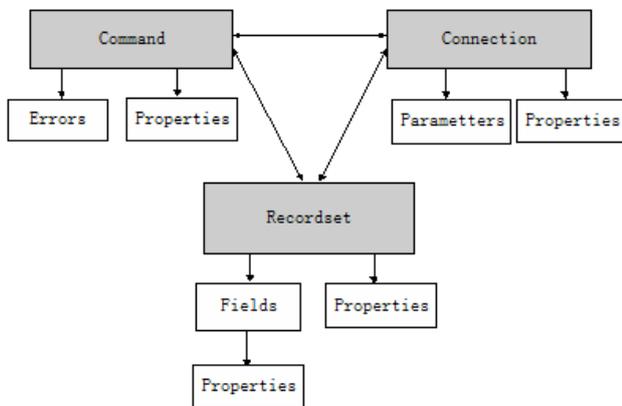


Figure 4. The object hierarchy of ADO

ADO is supported by many programming languages and development environments, both of Visual J++ and Active Server Pages used in the system support it. And ADO can be used in VBScript, so it is suitable for the integration of WEB or database server-side very much. To realize the application of WEB, the system uses the VBScript of Active Server Pages to support ADO [3].

For example, the linking of Diseases Table and displaying its contents by browser can be realized by the asp files including the following statement.

```

<HTML>
<TITLE></TITLE>
</HEAD>
<LANGUAGE="VBS">
<!--#include file="adovbs.inc"-->
<CENTER>
<H1><fontsize=4>Introduction of mental
illness</H1></font><br><br>
<!--Setting ADO objects -->
<%set myConnection=CreateObject(
"ADODB.Connection")
myConnection.Open "DSN=iatrixa;UID=sa"
SQLQuery = "select * from Diseases Table"
Set RSTitleList= myConnection.Execute(SQLQuery)%>
<!--to link Data Table -->
<TABLE align=center COLSPAN=8
CELLPADDING=5 BORDER=0 WIDTH=200>
<!-- BEGIN column header row -->
<TR>
<TD VALIGN=TOP BGCOLOR="#800000">
<FONT STYLE="ARIAL NARROW"
COLOR="#ffffff" SIZE=1>
Title ID</FONT>
</TD>
<TD ALIGN=CENTER BGCOLOR="#800000">
<FONT STYLE="ARIAL NARROW"
COLOR="#ffffff" SIZE=1>
Title</FONT>
</TD>
</TR>
  
```

```

<!--To display content-->
<% do while not RSTitleList.EOF %>
<TR>
<TD BGCOLOR ="f7efde" align=center><font style
="arial narrow" size=1>
<%=RSTitleList("title_id")%></font>
</TD>
<TD BGCOLOR ="f7efde" align=center><font style
="arial narrow" size=1>
<%=RSTitleList("title") %> </font>
</TD>
</TR>
<% RSTitleList.MoveNext%>
<% loop %>
<!-- Next Row -->
</TABLE>
</center>
</BODY>
</HTML>
  
```

C. The implementation process of the intelligent systemic stimulating mechanism

The intelligent stimulating mechanism of the system is a specific business logic to accomplish. Namely, it is used to complete the process of a remote diagnosis, through the use of psychological knowledge base stored in the medical domain knowledge, heuristic knowledge and dynamics of factual information, combined with a certain degree of reasoning control strategies.

With the help of the heuristic knowledge, the System combines data-driven and goal-driven to realize the intelligent diagnosis inspired by the mechanism. Here are two types of knowledge in the rules of the system. One is the solution-based rules. In the diagnosis process can provide direct guidance of heuristic knowledge rules, generally the experience of the psychological knowledge of medical experts. It can direct the diagnosis or draw conclusions prompt the diagnostic information needed for the next step, under the guidance of the existing dynamical factual information (patient history, symptoms, laboratory test results information). The other one is the testing rules. In these rules, the necessary diagnostic conditions for a certain kind of conclusion are given, and if the existing information is able to meet these conditions, the conclusions are drawn. The former is used in data-driven strategy, while the latter is used in goal-driven strategy. Intelligent instructive mechanisms in Fig.5 are put forward with the combination of both strategies [4]. From the figure, we can see that in the diagnosis process, patients have a predetermined model, which contains a number of items to store and describe the properties of the existing dynamic factual information. the solution-based rules are actually the use of rules-based data-driven strategy coupled with enlightening information. It makes full use of the link between the information of predetermined models and the professional knowledge of the system. or directly gives conclusions or rule-based model of the scheduled expansion of the items contained in the attributes to obtain the diagnostic information necessary to promote the efficient and accurate diagnostic

process. When the system model information is not intended to provide adequate solution-based rules, we can combine goal-driven strategies, and make use of empirical rules of the knowledge to identify the conditions diagnosed in whole or in part to meet the intended model of existing information and diseases of the highest degree of confidence as a test target. If an exact match is given, the conclusions will be drawn. If it is partially matched, we should extend the items of a predetermined model to provide diagnostic information on the direction of the heuristic. After the extension of a predetermined model, we should start from the application of the solution-based rules, and repeat the process of the combining data-driven and goal-driven, and then constantly deepen the end and to complete the diagnostic process [5].

Initialize System			
Conclusion candidate set (H) Empty			
Model T for patients and the establishment of scheduled			
Enter the value of property items			
Been filled and property inspection marks			
Search for properties in line with the focus of the rules according to the rules of entry			
The establishment of answer-type rule sets J			
J is empty or not			
YES		NO	
The establishment of test-based conclusions set Y		If J has conclusions or not	
Information matching between Y and J		YES	NO
YES	NO	Con	Extensi
clusion	Extensio	clusion	on of
filling H	n of property	filling H	property
	items in T		items in T
until no blanks in T			
If H is blank			
YES		NO	
Output diagnoses		The system can not draw diagnostic conclusions	

Figure 5. the map of the process of Intelligent inspired mechanism

In the running process of the system, this part needs to access the knowledge base frequently (ie, back-end database) and complete the corresponding logical control. Considering the servering efficiency of the system, it is realized on the server-side. Some runs on the server as scripted server pages, and other complicated hardware are used as plug-in object of the server written as COM components by VJ++.

Here the paper takes reasonctrl, the user-defined functional components of the intelligent heuristic

mechanism for example, to analyse the development processes of VJ++ components.

- To set up ADL File

When Java develops the COM components, the first step is to provide the definitions and interfaces for COM –Creatable Classes by Interface Description Language, abbr. IDL.

The interfaces can only use the COM-Classes that can be mapped to Java, and OLE is a good choice to be compatible types and dual interface automatically. A dual interface component promises to be called both by vtable and IDispatch. And that promises the server objects written by Java to be accessed by other programs in different languages completely.

To set up ADL Files for reasonctrl similar to the following form,

```
#include <MtxAttr.h>
#include <JavaAttr.h>
[
    uuid(24BCB100-C7DE-11D4-9423-00E04C67FDDB),
        version(1.0),
]
library reasonctrlLib
{
    importlib("stdole2.tlb");
    [ object,
        uuid(24BCB101-C7DE-11D4-9423-00E04C67FDDB),
        dual,
        pointer_default(unique)
    ]
    interface Ireasonctrl: IDispatch
    {
        import"oidl.idl";
        HRESULT reason([out] BSTR* pbstrResult );
        .....
    };
    [
        uuid(24BCB102-C7DE-11D4-9423-00E04C67FDDB),
        JAVACLASS("reasonctrl.reasonctrl"),
        PROGID("reasonctrl.reasonctrl"),
    ]
    coclass Creasonctrl
    {
        [default] interface Ireasonctrl;
        .....
    };
};
```

- To set up type-library file

That is to compile the IDL files into specific type-library files. IDL Compiler of Microsoft can compile the reasonctrl.idl files into reasonctrl.tlb ones., and then check and see if the contents of type -library meet the requirements or not by OLE Object Viewer.

- To set up the shell-type of Java

The next thing to do is to set up the shell-type of Java for, and type-conversing tools can do this job, such as Creasonctrl.class and Ireasonctrl.class. Creasonctrl is the shell-type of COM and by which, the reasonctrl samples of COM are set up. Ireasonctrl is the interface shell type

of COM, it maps the procedure call of its methods to that of reasonctrl.reasonctrl.

- To realize Java type

It makes the realization of components' createable type defined by IDL files. The name of this type should be in accordance with the one designated by JAVACLASS items of IDL files, and must realize the interface for all createable classes.

- To compile and set up COM DLL

It use Visual J++ compiler to compile and produce Java-type files, and produce COM DLL by adding type-library and COM shell type [6].

Compiled by server-side components, intelligent inspired mechanism can run on the server-side in the form of component object to improve the efficiency and provide better maintainability and flexibility.

D. User Interface

The User Interface is, in fact, the interacting interface between user and system. For example, the gain of patient information needed, diagnostic tips of the system, the output of conclusions, the introduction of medical knowledge and the management of knowledge base, and so on. The system realizes the dynamic remote interaction between the user and system by ASP pages, takes the Visual InterDev of Microsoft as ASP development environment, and writes scripts with VBScript.

As for the components objects used by ASP, the objects embedded in the page of client-side are marked by extended HTML<OBJECT> and </OBJECT>.

E.g. <OBJECT classid="clsid:B6F6AA46-B009-11D4-9423-00E04C67FDDDB" data=data:application/xoleobject id=BSHinputctrl1 style="LEFT: 0px; TOP: 0px" > </OBJECT> to embed a user defined BSHinputctrl component object , and BSHinputctrl inputs the information of mental illness history:

```
set
cmd=Server.CreateObject("ADODB.Command") to set
up a ADO Command data object, cmd of server-side.
```

```
set
reason=Server.CreateObject("reasonctrl.reasonctrl") to
set up a reasonctrl component object, reason, defined by
server-side.
```

Statement examples of hybrid programming embedded by the ASP Scripts, VBScript, HTML and its objects are shown as the following:

```
<% @ Language=VBScript %>
<!--#include file="db.fun" -->
<% shiyanid=Session("attritemname")
set cmd=Server.CreateObject("ADODB.Command")
set rsshyname=GetMdbRecordset( "Experiment
Checklist" )
rsshyname.MoveFirst
While Not rsshyname.EOF
if rsshyname("ID")=shiyanid then
shiyanname=rsshyname("shyanname")
explain=rsshyname("explain")
rsshyname.MoveLast
else
```

```
rsshyname.MoveNext
end if
Wend %>
<HTML><HEAD></HEAD>
<BODY background=images/zhenduanzhinan.gif> for
further diagnosis, it needs
<%=shiyanname%>
use<%=shymethod%><P><%=shiyanname%> clinical
significance: <br>
<%=explain%></P><br><p><FONT color=darkcyan
face=Lishu size=5> to input the patients
<%=shiyanname%> conclusion information
</FONT></p>
<% Response.Write "</BODY></HTML>"
Response.End
%>
```

V. CONCLUSION

Study of this system uses the related design technology of artificial intelligence in expert system, is based on the principles and techniques of expert system's knowledge acquisition, knowledge representation, knowledge base building, reasoning and strategies, etc. It sets up domain knowledge base structure that can be easily mapped to relational databases by analysing the characteristics of mental illness professional field. It also puts forward the method that can express logical relationship between the facts in the relational database. By the characteristics of the knowledge-classification on knowledge base system, it adopts the intelligent heuristic mechanism that combines the reasoning strategy both of data-driven and goal-driven, and take the best use of the existing heuristic knowledge and information to raise the intelligence and accuracy of the process of aided-diagnosis. The study on remote aided diagnosis system of mental health base on expert knowledge base, can provide the reference model that integrates the Browser-Servethree-tier architecture and COM technology, to develop the similar intelligent WEB application systems based on domain professional knowledge.

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