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COGNITIVE REHAB SOLUTIONS

A COMPUTER-ASSISTED COGNITIVE TRAINING PROGRAM

A Project

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Computer Science

---

by

Avani Rajnikant Patel

June 2003

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Approved by:

[redacted]

Kerstin Voigt, Ph.D. Chair, Computer Science — Date 04/16/03

[redacted]

Ernesto Gomez, Ph.D.

[redacted]

Richard Botting, Ph.D.

ABSTRACT

Attention disturbances represent the largest portion of neuropsychological deficits following a brain injury. An estimated 73% of neuro-rehab centers across the nation utilize Computer Assisted Cognitive Retraining (CACR) to treat attention and other cognitive impairments. Effectiveness of CACR has led to the development of various types of cognitive software. However, limitations of these applications have surfaced and point to their lack of test parameter control and their inability to generate reports with graphical output.

Cognitive Rehab Solutions (CRS) is a direct answer to these problems. CRS is a functionally comprehensive software package designed for neuropsychologists to deliver restorative cognitive therapy. Its key features include an attention test that can be tailored to an individual patient's need, ability to store and maintain patient records and the capability to generate graphical & tabular reports. CRS precisely addresses the concerns of its users and can prove to be an effective adjunct to a comprehensive cognitive rehabilitation program.

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CHAPTER ONE

INTRODUCTION

Purpose

Cognitive Rehab Solutions (CRS) is a software tool for neuropsychologists that can deliver restorative cognitive training in the areas of attention and memory. Motivating factor for the development of this application include the lack of report generating capabilities in the products currently available on the market. Inability to modify test parameters is another limitation noticed by the users of cognitive rehab software. The purpose of this project is to offer a functionally comprehensive application with an underlying design that easily lends itself to incorporate additional tests.

Research conducted in the discipline, as well as my own experience as a physical therapist working with neurologically impaired individuals, warrants the need for such an application.

Scope

Cognitive Rehab Solutions is the software tool designed to address the concerns listed above. The primary users of such an application are neuropsychologists who

administer cognitive training to patients during the course of their rehabilitation (see Appendix A for Use Case).

CRS is equipped with a database that allows you to create and maintain patient medical information as well as their test results. There is also a feature that performs report generation to present test data in a tabular format with graphical representation. Test data can be examined either on an individual basis using patient's MRN or on a group by basis such as grouping data by a single diagnosis or grouping data by a single test. Security in protecting sensitive medical data from exposure is handled by requiring the user to be registered. Registration gives the user an account with a username and password. Users are required to login successfully in order to administer a test as well as to view and save results.

Currently CRS contains an attention test called the Scroll Target Test. There is a clinical model of attention that proposes five sub-categories of attention [1].

> They include focused attention, sustained attention, selective attention, alternating attention, and divided attention. Focused attention refers to the ability of an individual to focus one's gaze on an object. Sustained attention pertains to an individual's ability to maintain the focus on the object. Selective attention is the ability to sustain attention in the presence of distracters. Alternating

attention refers to an individual's ability to change mental-set, as signaled by some type of cue [1].

The ability to simultaneously process two pieces of information at once is referred to as divided attention [1]. The Scroll Target Test addresses four of these types of attention and they include: focused, sustained, alternating and divided. Although this test is developed to primarily challenge attention, many aspects of the test also exercise memorization as well as spatial orientation and color differentiation skills.

The test offers seven different parameters that can be adjusted by the administrator. The setting of these parameters can determine the difficulty of the test presented. The options to modify parameters allow the tester to tailor the problem set to the needs of the patient and serve as a tool in monitoring progress.

Significance

The importance of this application lies in its graphical reporting capability, in the value of the cognitive test it includes and its system design. The most desirable feature of this test is the graphical analysis of progress to facilitate the evaluation of a patient's performance. The Scroll Target Test is clinically

significatnt since it is hierarchically constructed, meaning it allows basic skill to be constantly exercised while more complex skills are incorporated. Repetition is another key feature of this test. Similar types of problems are presented to the patient repeatedly until the test finishes. Studies have shown that "repetition sensitizes cortical responses and expedites the establishment of new neural organization [1]." Lastly, the design of CRS is such that it can incorporate new tests as they are designed. There is a potential for CRS to become the sole tool in the neuropsychologist's office to provide computer-assisted cognitive rehab.

Abbreviations

CVA	Cerebro Vascular Accident
TBI	Traumatic Brain Injury
CACR	Computer-Assisted Cognitive Rehab
CRS	Cognitive Rehab Solutions
MRN	Medical Record Number

CHAPTER TWO

LITERATURE REVIEW

History

Speculation regarding the possibility of enhancing cognitive performance of persons with brain impairment by systematic training gained attention in literature more than four decades ago, soon after which, many rehabilitation centers started programs emphasizing retraining of impaired thinking, memory and information processing [3]. Prior to the 1970's it was common practice to use recreational games (cards, board games and puzzles) in recreational programs, however with the introduction of video games and personal computers, clinicians began to use microcomputers as means of providing cognitive rehabilitation [3].

Software used in Computer-Assisted Cognitive Retraining (CACR) fall into three categories; video games, educational software (math and vocabulary problems), and specially written CACR software [3].

Attention Disorders

Attention disturbances represent the largest part of neuropsychological performance deficits after an acquired

brain damage. They can be found in 80 % of the patients after a stroke (apoplexy), a brain injury, diffuse organic brain impairments (e.g. caused by chronic alcohol abuse or intoxication), as well as with other diseases of the central nervous system [2].

Research Studies

General consensus of studies investigating the effectiveness of CACR is that it can be successful in remediating certain cognitive deficits provided that it is an adjunct to a comprehensive neuropsycological rehabilitation program. In one study [4], the efficacy of a computer-assisted attention retraining program was assessed with patients from moderate to severe TBI. Training lasted nine weeks with two 2-hr sessions per week for both the experimental and control group. At the end of the trial, the experimental group improved significantly in comparison with the control group on measures of attention.

Studies conducted in the area of computer aided cognitive retraining, both acute and several years post injury demonstrate effectiveness of the treatment. One study examined the effectiveness of attention and memory tests on patients two to ten years post trauma and found

results of post tests significantly better than pre-tests with the effects of training still present 24 to 29 weeks following the last training session [5].

In yet another study examining the efficacy of CACR in persons with traumatic brain injury (TBI), they found significant post-treatment gains on the neuropsychological test scores for experimental groups compared to control groups [6].

In comparison with other cognitive impairments, attention deficits show the most pronounced improvements with computer-assisted cognitive retraining [7]. Relationship between attention and functional outcomes has been investigated and found that there is a significant association between attentional functioning and both physical and social outcome measures [8]. This study also found that poorer attentional performance was associated with a more negative impact of stroke on daily functioning.

CHAPTER THREE

REQUIREMENTS

System Requirements

The system requirements outline the functional needs of the user. The system should be able to allow the following:

- Login with password.
- Change password once logged in.
- Create a patient account with pertinent medical information.
- Modify information for an existing patient account.
- Delete patient account.
- View test description.
- Adjust test parameters.
- Administer Test.
- View test results.
- Request comprehensive test results with graphical output.
- Save and print results.
- Allow guest to take test.
- Log out.
- Exit application.

Hardware Requirements

Hardware requirements outline the processor speed and memory that must be available on the computer on which the user runs this application. They are as follows:

- CPU: Minimum - 600 MHz, Suggested - 800 MHz
- Memory: Minimum - 128 MB, Suggested - 256 MB
- Disk space requirements: 200 MB (Framework & CRS)

Software Requirements

Software requirements outline the applications, runtime components and operating system that must be available on the computer on which the user runs this application. They are as follows:

- Microsoft .NET framework
- Microsoft Data Access Components (MDAC), version 2.6
- Crystal Reports runtime components, version 8.5
- Windows OS, 98 or later

The .NET framework can be made available to the user by installing an executable file on their computer. For both Microsoft data access components and Crystal Reports runtime components any version later than the one listed will be acceptable.

CHAPTER FOUR

USER'S GUIDE

Cognitive Rehab Solutions

Cognitive Rehab Solution (CRS) is a computer program that is designed to aid in the rehabilitation of neurological disorders leading to attention and memory deficits. Currently CRS offers one attention test, called the Scroll Target Test.

CRS is equipped with a database that allows you to create and maintain patient medical information as well as their test results. There is also a feature that performs report generation to present test data in a tabular format with graphical representation. Test data can be examined either on an individual basis using patient's MRN or on a group by basis such as grouping data by a single diagnosis or grouping data by a single test. Security in protecting sensitive medical data from exposure is handled by requiring the user to be registered. Registration gives the user an account with a username and password. Logging in is required for administering a test as well as for viewing and saving test results.

Logging In

Upon starting the application, you will be prompted with a log in screen (see Figure 1). If you attempt to login without an account or an invalid username and password combination, a login failed screen is displayed with option to re-attempt login.

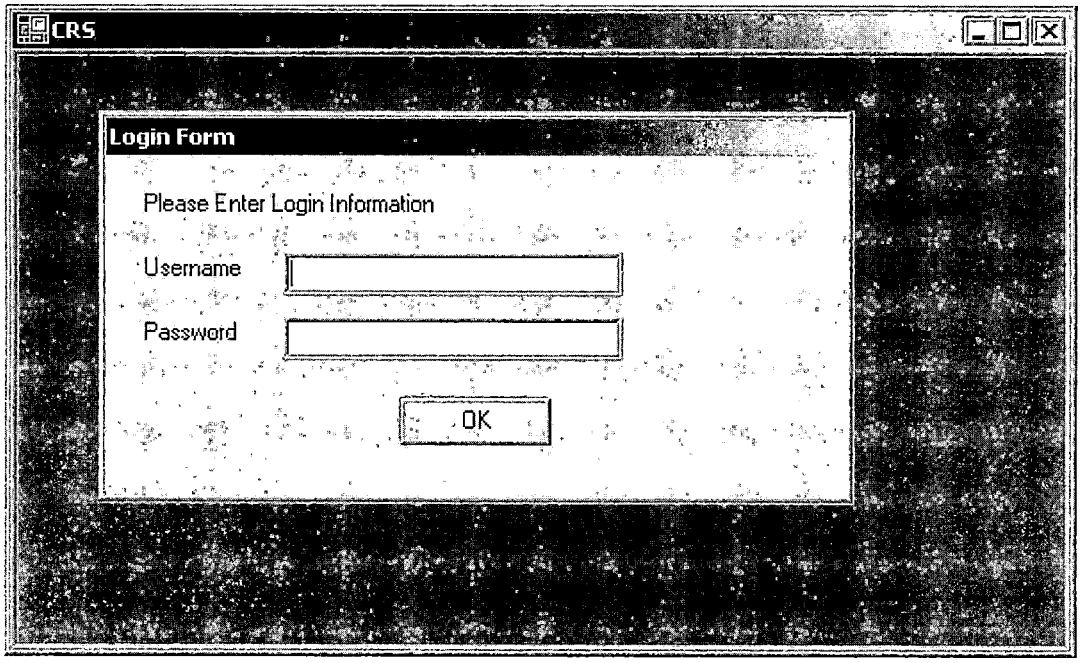


Figure 1. Login Window

Main Menu

Once you have successfully logged in, the main menu bar is displayed across the top of the CRS screen (see Figure 2). The user can proceed to do perform several different tasks from here. Pressing the ALT key underlines

a letter in each menu option, which can then be pressed and used as a keyboard shortcut to select that choice. The following section walks you though each of the menu choices.

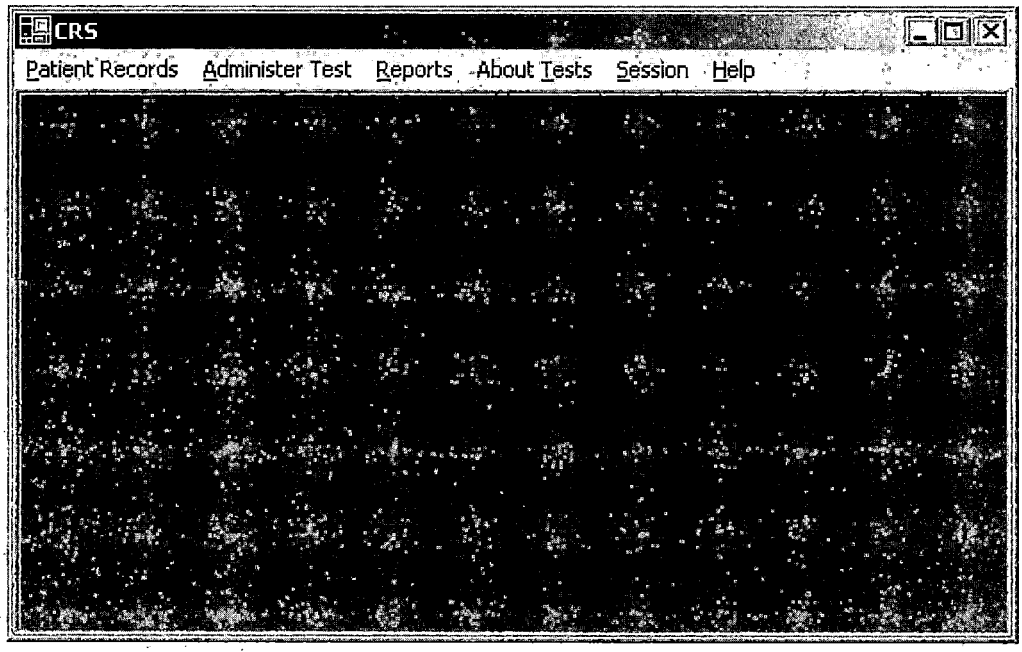


Figure 2. Main Menu

Patient Records

Patient Records option on the menu can be selected by clicking on that option or by keyboard shortcut 'Alt p'. This menu option allows you to create a new patient record as well as edit or delete an existing patient record (see Figure 3).

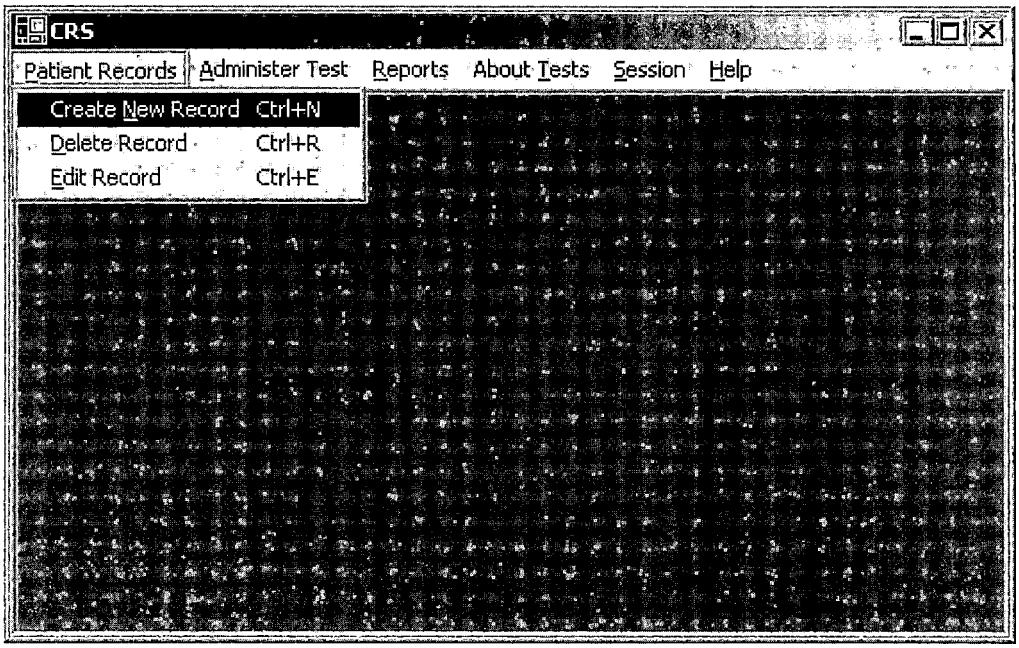


Figure 3. Patient Record Menu Option

Create New Record

In order to create a patient record all seven fields must be filled out in the correct format (see Figure 4). Diagnosis and Neuropsychologist fields have dropdown lists, which offer choice, however it is not necessary to select from them. If a value in the field was entered incorrectly, a dialog box will pop up and request that you format your entries correctly. For example, the MRN cannot include any alphabetic characters and names cannot include any numeric characters. The format for the date is shown below the label. Keyboard shortcut for this menu selection is 'Ctrl N' or 'Alt pn'.

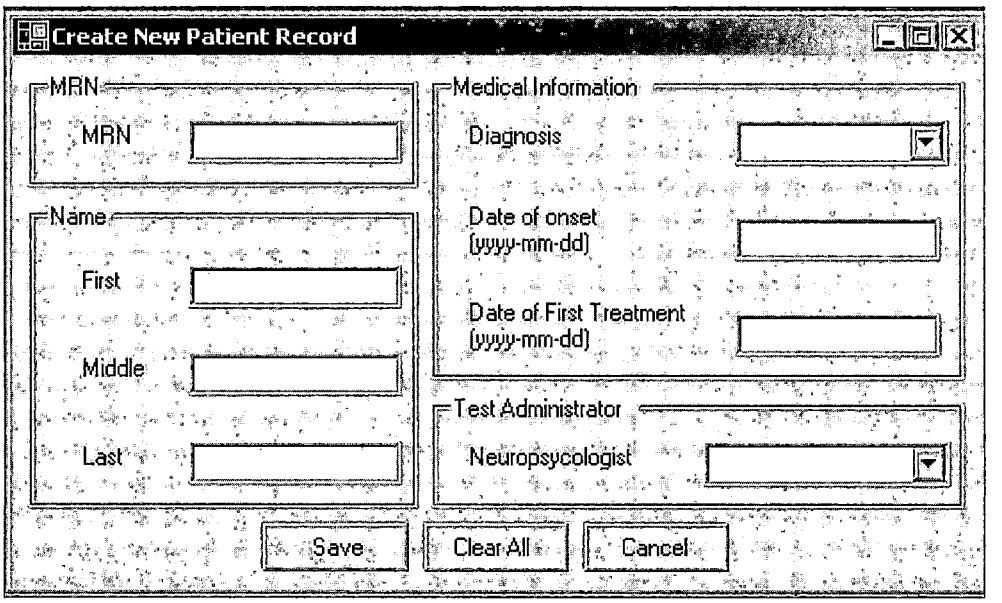


Figure 4. Create New Record

Delete Record

Deleting patient record involves choosing an MRN from the drop down list (see Figure 5). Pressing the OK button will remove all of the records associated with that MRN from the database. Again a confirmation window will appear after pressing OK to let you know that the patient record has been deleted. The keyboard shortcut to this menu selection is 'Ctrl r' or 'Alt pd'.

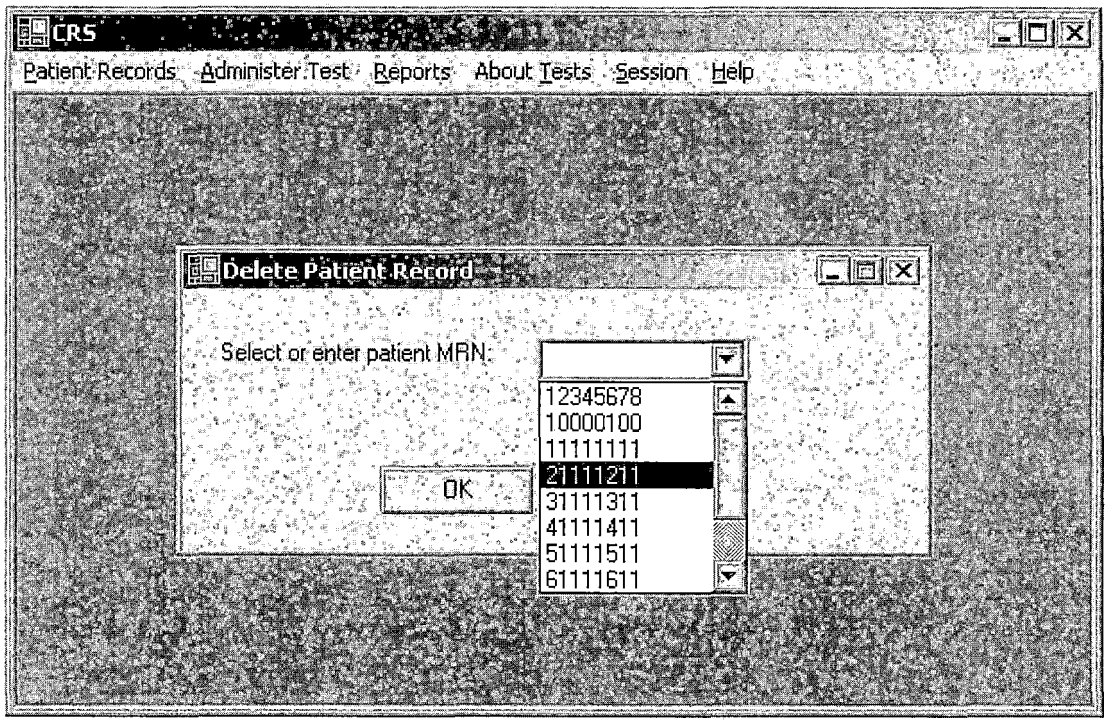


Figure 5. Delete Record

Edit Record

In order to edit an existing patient record, you must first select an MRN from the drop down list options (see Figure 6). This brings up the respective medical information. You will then need to press the edit button, which will allow you to modify the stored information. The "Clear All" button erases all the fields. After alterations have been made, hit the OK button and a confirmation window will pop up letting you know that the patient record has been updated. Keyboard shortcut for this menu option is 'Ctrl e' or 'Alt pe'.

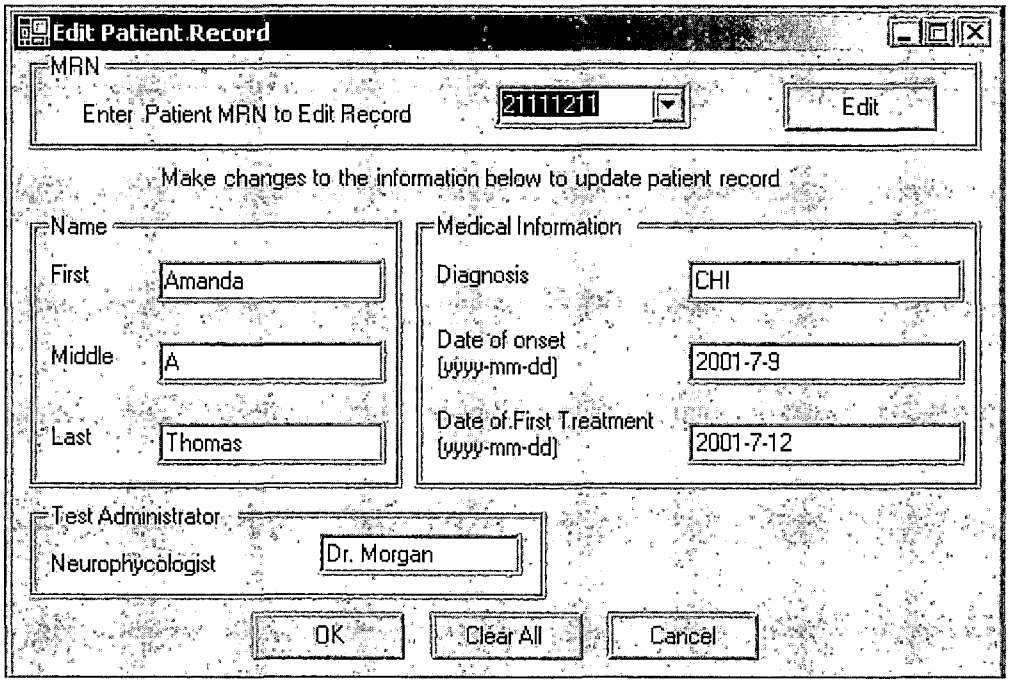


Figure 6. Edit Record

About Tests

The About Tests option form the main menu will bring up a window with a brief description of the test (see Figure 7, 8). There is also an option to take a sample test. The keyboard shortcut to this menu option is Alt t. Should you opt to take the sample test, the test description window is dismissed and the Scroll Target Test Parameter Form is displayed. Notice that the MRN select field is disabled since is a demonstration and not actual test. After setting the parameters or pressing the Set Default Button to use default parameter settings, hit the

OK button and this will bring up the test form. Now you are ready to start the test. Once you have completed the test, a Test Results Window is displayed. Note that the Save button is disabled, again this simply because it is a demo.

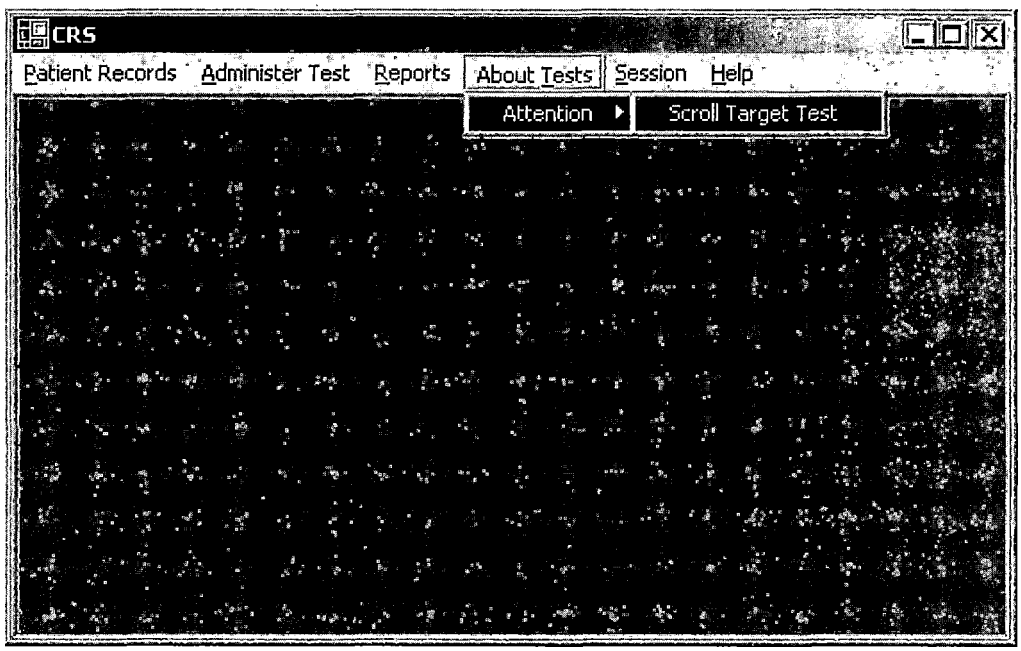


Figure 7. About Tests Menu Option

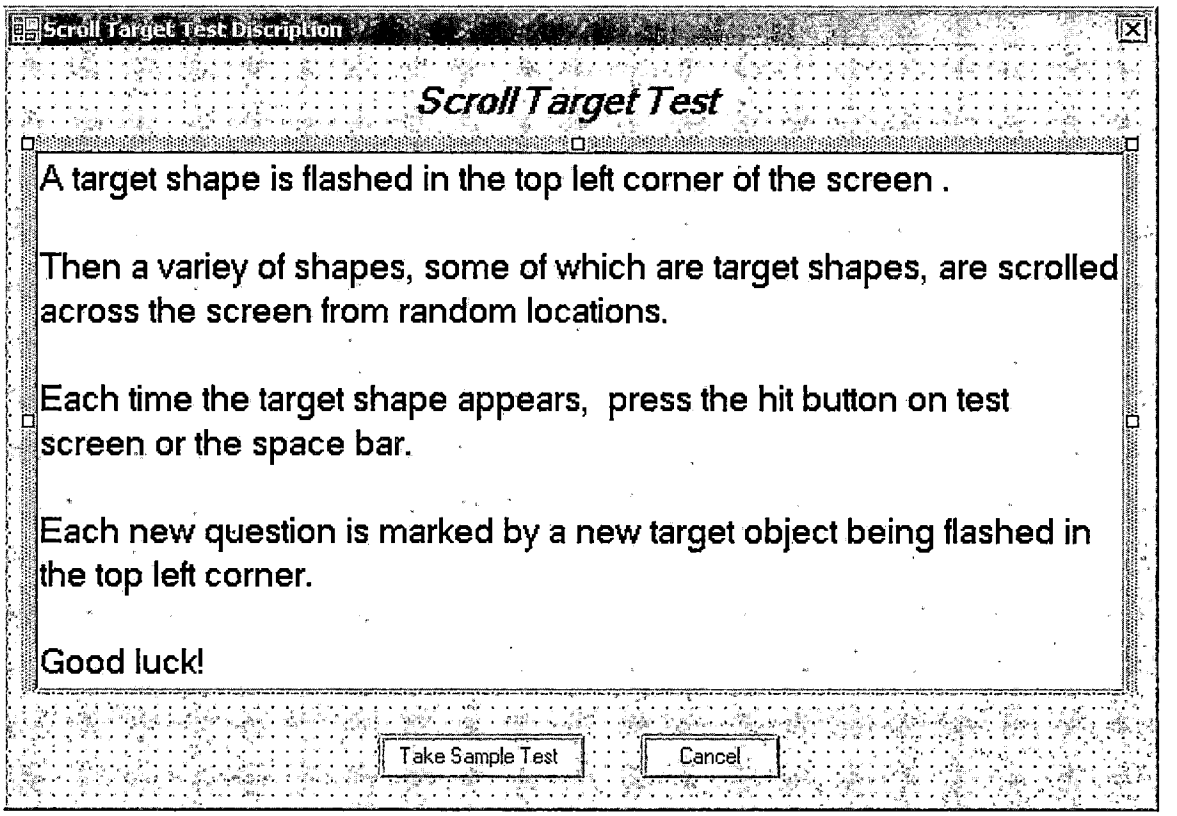


Figure 8. About Scroll Target Test

Scroll Target Test

The Scroll Target Test is developed to primarily challenge attention although many aspects of the test also require memorization as well as spatial orientation and color differentiation.

A problem in the test is presented as follows. First a target object is flashed, after which a selection of six shapes are scrolled across the screen from different directions. A random number from the selection will match

(as determined by predefined criteria) the target object. The objective of the test taker (also referred to as a patient) is to identify the matching object amongst the selection by pressing the space bar or the hit button on the screen. Once the hit button is pressed, the identified object will disappear from the screen regardless of correctness of choice and the next object will begin scrolling. Once the six choices have appeared a new problem is presented with a new target object.

The test offers seven different parameters to be adjusted by the administrator. The setting of these parameters can determine the difficulty of the test presented. The options to modify parameters allow the tester to tailor the problem set to the needs of the patient and serve as a tool in monitoring progress. The Color and the Rotation Discrimination settings are used determine the correctness of the match between a scrolling object and the target object. On the parameter form (see Figure 9), there is an option to choose pre-set default parameters. Detail description of all the parameters along with its default value is presented below.

- Questions: Minimum 1 Maximum 20

  Questions represent the number of problems that will be presented during the session. The number of questions handled can be used to gauge the endurance or tolerance of the individual taking the test. Default value of this parameter is 5.

- Speed: Minimum 1 Maximum 5

  Represents the rate at which the object is scrolled across the screen. Speed setting can reflect the recognition or reaction time frame required by the patient. Default value of this parameter is 3.

- Level: Minimum 1 Maximum 2

  Level 1: This is the easier of the two levels. The reason for this is that the valid objects are either identical to the target object or resemble the target object as closely as possible. This makes it relatively easy to spot the correct match.

  Also in this level, the incorrect options very drastically from the target shape and therefore

it is easy to notice that they are the incorrect choices.

Level 2: This is the more difficult setting for the following reasons: First the Valid options are not necessarily a close match to the target. Furthermore, the invalid objects share certain similar qualities with the target object but are not the right choice because of the other characteristics.

This feature affects the involvedness of the problem since the question can be of a simple nature (Level 1) or more complex (Level 2). It allows the administrator to extract the depth of the attention deficit. Default value of this parameter is Level 1.

- Visual Distraction: ON/OFF setting

  ON: Implies that the background of the test area will display images/patterns that will change periodically to provide a visual distraction to the scrolled object.

  OFF: Implies that the background of the test area will remain blank (white) leaving the

scrolled object to be the only image in the region.

This feature examines ability to respond to demands of dual tasks, one to focus on the object and second to disregard the distraction images.

Default setting for this parameter is OFF.

- Color Discrimination: ON/OFF setting

  ON: Implies that both shape and color need to match in order to secure a valid match between the target and the scrolled object.

  OFF: Implies that matching only the shape of the target object with that of the scrolled object makes a valid match. Color is not taken into consideration when deciding a match.

  This feature takes into account the ability of the patient to discriminate colors and can also be considered to demand dual attention tasking, meaning paying attention to both color and shape.

  Default setting for this parameter is OFF.

- Rotational Discrimination: ON/OFF setting

  ON: Indicates that rotation is a factor when

determining a valid match between target and the current scrolling object.

OFF: Indicates that rotation is not taken into account when determining a match between a scroll and a target object. Only the shape if the color feature is off, determines a valid match. And both shape and color if the color feature is on, but not rotation, determines a match.

This feature demands dual or multiple attention tasks since concentration needs to be paid to both shape and rotation or all shape, rotation and color respectively depending on the combination of the color and rotation setting.

Default setting for this parameter is OFF.

- Visual Discrimination: ON/OFF setting

ON: This feature allows objects that are similar in shape to be introduced to the collection of prospective target and scrolled objects. As a result the patient can be potentially required to discern not only between shape, color, rotation but also likeness.

OFF: Indicates the "like-objects" will not appear at all in the problem sets. The OFF feature in visual discrimination is unlike the off feature in color and rotation setting in that, selecting a "like" object will never be considered valid when the feature is off since the "like-objects" will not be presented in this situation.

This feature introduces a larger memory component to the task. Default setting for this parameter is OFF.

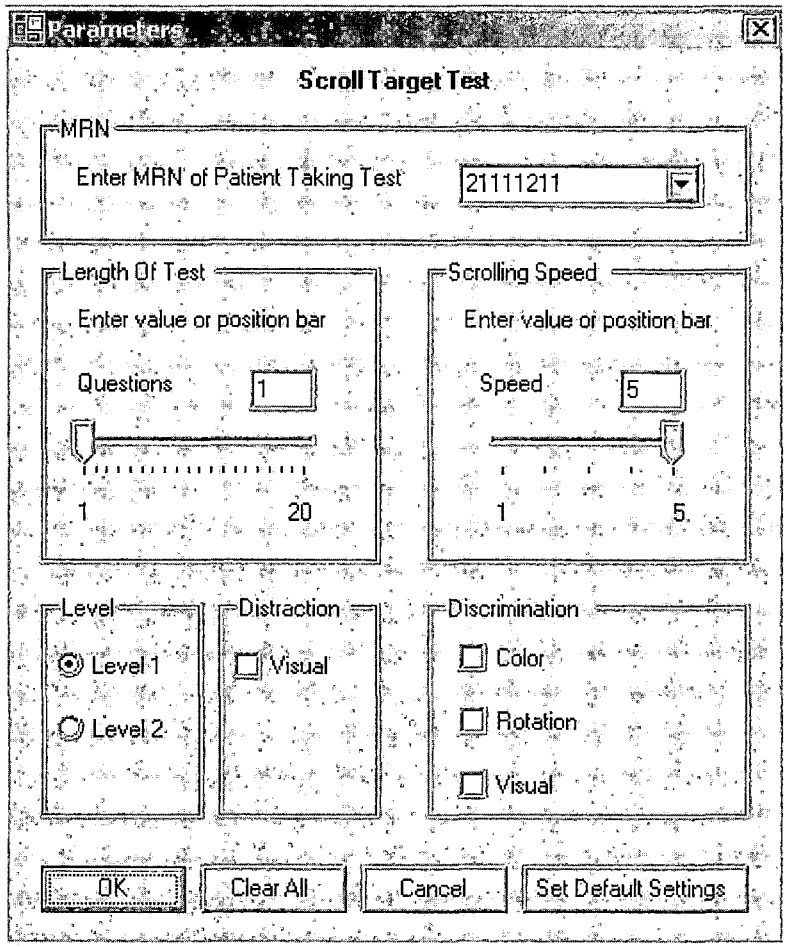


Figure 9. Parameter Form

Administer Test

From this menu option you can select the test to administer (see Figure 10). The tests are listed under their category. For example, the Scroll Target Test is listed under Attention, since it is geared towards improving this cognitive function. The keyboard shortcut to this menu option is 'Alt a'. And the keyboard shortcut to administer the Scroll Target Test is 'Ctrl s'. The first

screen that pops up when you select to administer the test is its parameter form.

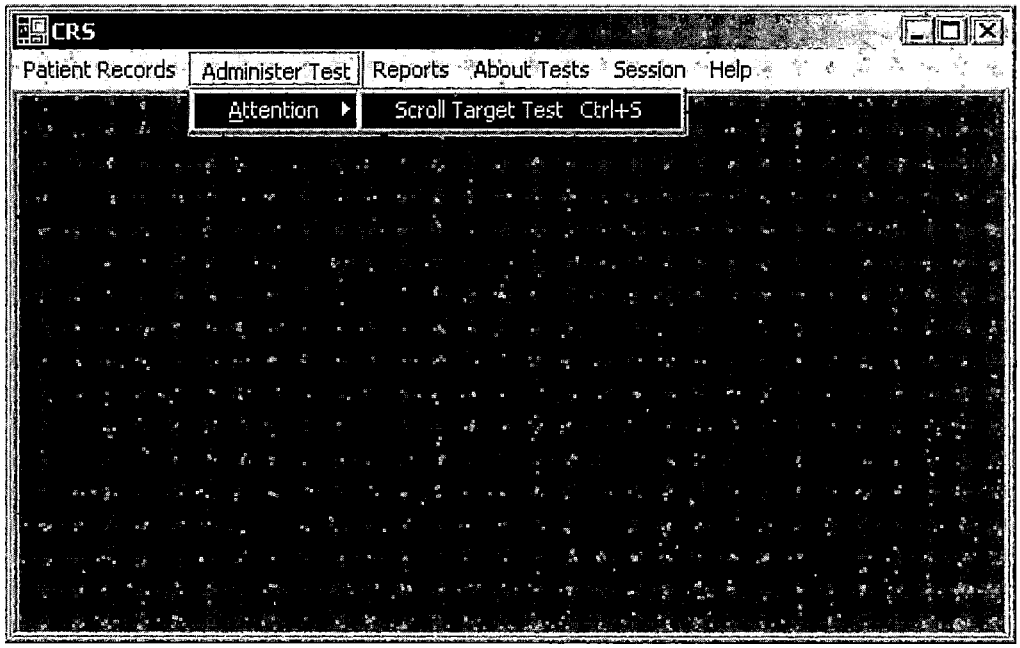


Figure 10. Administer Test Menu Option

Once the parameters are set, the test screen (see Figure 11), which consists of an information section and a test section, appears. The information panel includes an area where the target object is flashed, the directions on what to match and the control button to start the game.

When the start button is pressed, the information panel includes two additional controls, the pause and the hit buttons and the start button disappears. A target object flashes at the top left corner in the designated

area on the information panel and objects began to scroll in the test area. Supervision during the test guarantees that the pause button is not abused.

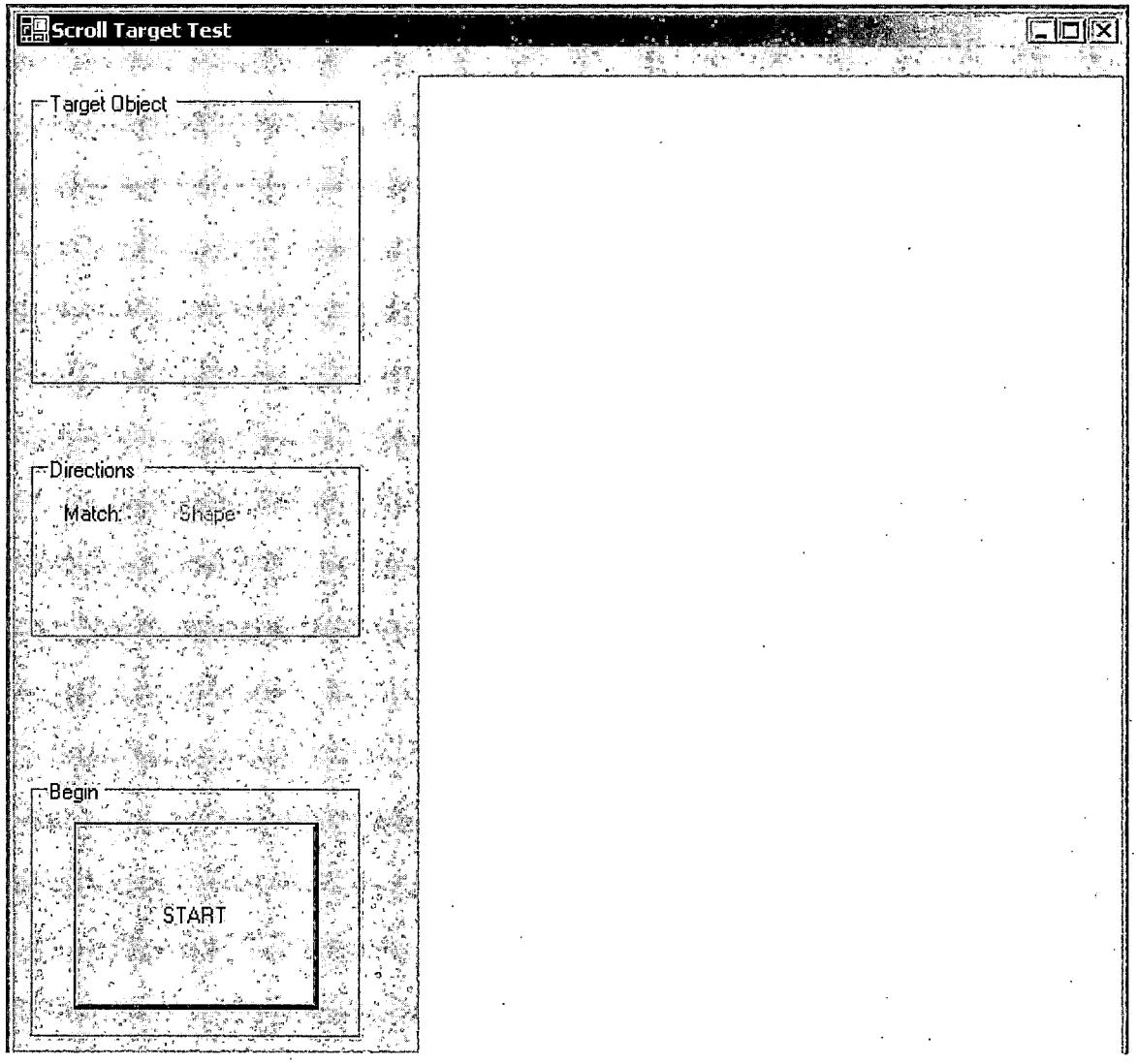


Figure 11. Test Form

On completion of the test, a result screen is displayed (see Figure 12). It consists of the values of

the parameters, test performance in percentage as well as a breakdown of the score which includes, the number of hits (hit button pressed and the match was correct), misses (hit button pressed, but the match was incorrect) and ignores (failed to press the hit button when a valid match was scrolled). The overall score or performance is computed by dividing the hit by the sum of hit, miss and ignore. On the results form, there is also an area on the bottom to add written comments pertaining to the test session. The tester can opt to save or cancel the test results.

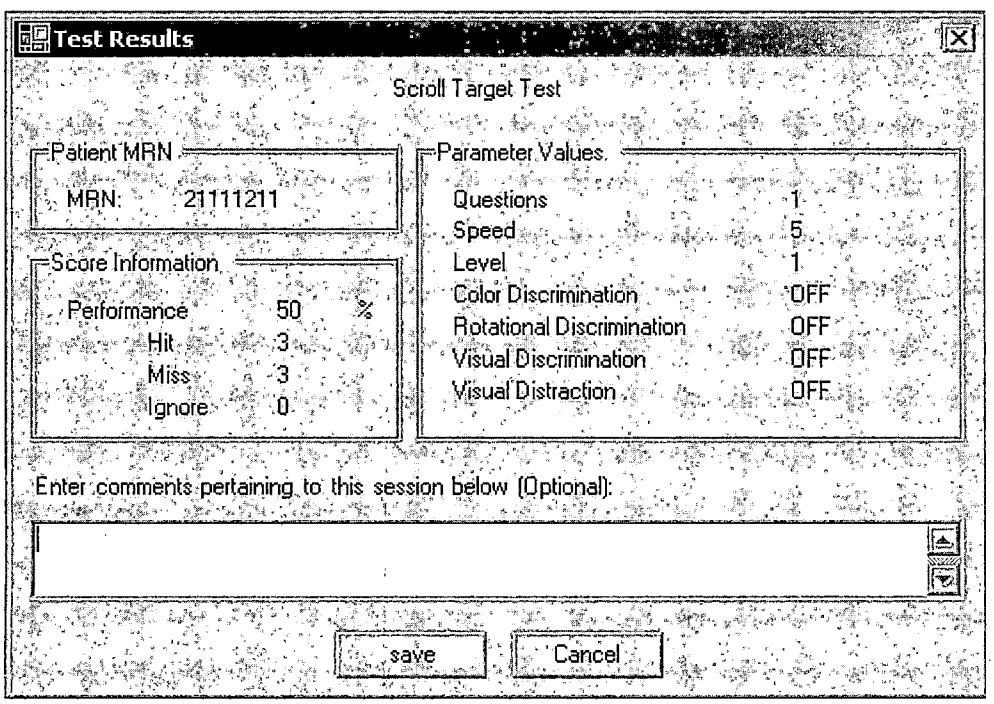


Figure 12. Results Form

Once the results form is dismissed, the parameter form will be still available should the tester wish to re-administer the test. Changes in the parameters can be made should they be desired before starting the next test. It is important to note that the test does not at any point automatically adjust test parameters depending on the patient's performance. Fine-tuning the parameters is left as manual process. According to a consultation with a neuropsychologist in the field, patients tend to make steady progress when they are allowed to practice their skills at a given level for a certain period of time before being advanced to the next level.

Reports

This menu option allows for viewing and/or printing test results (see Figure 13). The keyboard shortcut for this menu option is 'Alt r'. There are three types of reports that you can request.

Report By MRN

The first type is an individual patient report (see Figure 14). The keyboard shortcut to this menu selection is 'Alt rm' or 'Ctrl m'. Report by MRN shows results of tests pertaining to a single individual. You are asked to

choose a MRN form the drop down list. There is also a field for you to select the test you want results for. Since there is only one test offered currently, the Scroll Target Test is selected by default.

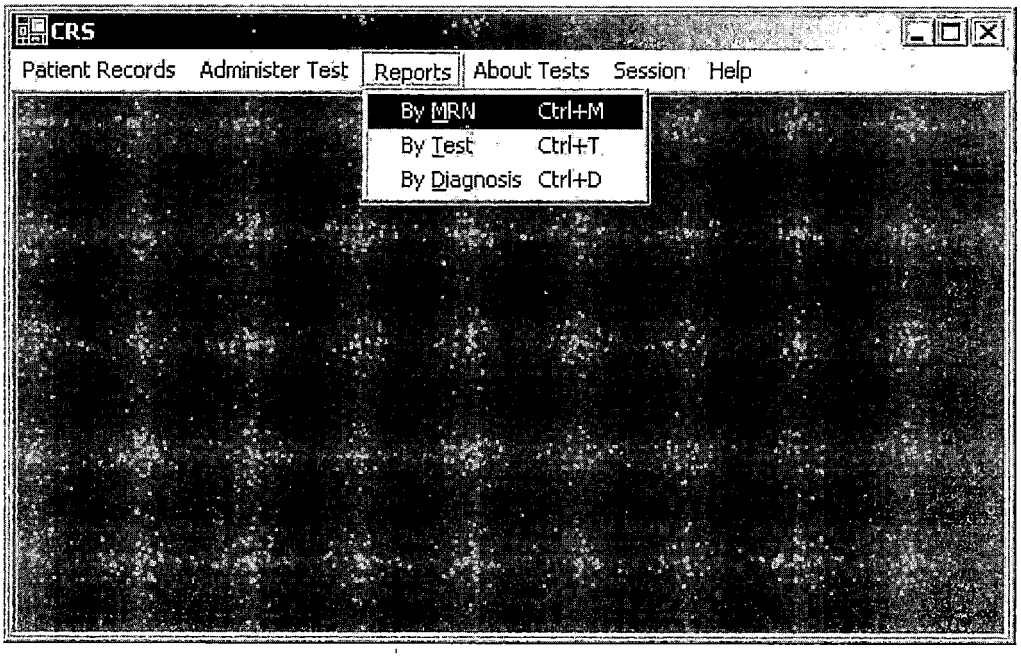


Figure 13. Reports Menu Option

The next choice you need to make is the type of the report. You can choose to receive a detailed report which means that the breakdown of the scores, along with the parameter settings are listed for each test session or the summarized version, in which only the score with its breakdown is listed for each test taken. The detailed report will also include two charts, one for the parameter

setting and one for the score. On the charts, test results are shown for each day, so if a patient took the same test more than once in a day, then the mode of the results is depicted on the graph for that day in the parameter value, and the average of the results is depicted on the graph for that day in the score breakdown value. In the summarized version, only one chart is included, it portrays the score for the dates the test was taken. If more than one test was taken in a given day than the avg. of all the scores is graphed.

In the Report by Medical Record Number form, you are also asked to enter a range of dates you want the test results to cover. The 'Clear All' button in the date range section erases all selections for the dates.

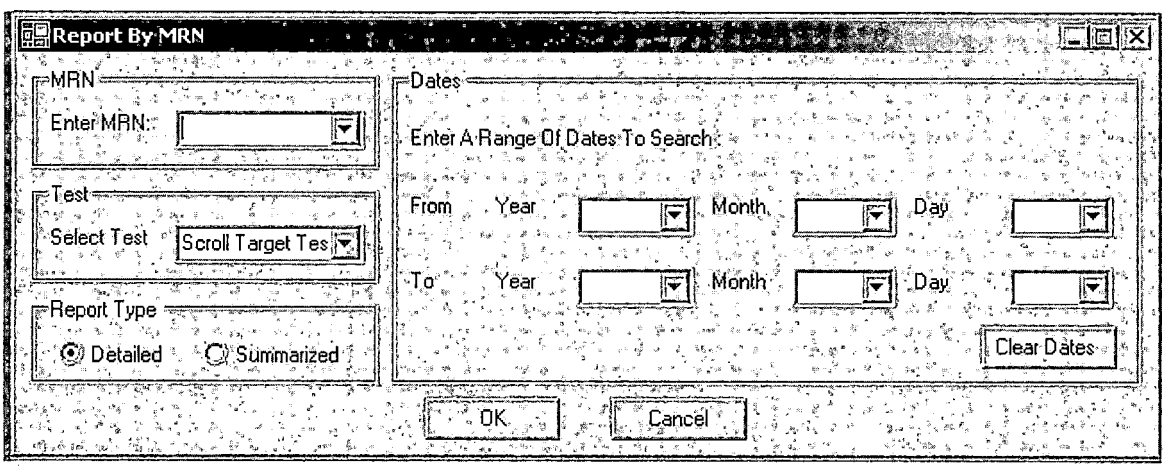


Figure 14. Report By Medical Record Number

Report By Test

The second type of report that you can request is one by test (see Figure 15). In the report by test form, the Scroll Target Test is chosen by default. There is a drop down list for the diagnosis if you wish to select one or you can choose all. The next option is for the type of the report. The detailed report includes Test name, MRN, Diagnosis, date and score for each day the test was taken along with an overall average score for each MRN. If more than one test was taken on a day then the average of the scores is given. Date of the first test is listed in a separate column for ease in reading the start date. The summarized version of the Report by Test includes only the overall average score for each MRN along with the start date and the diagnosis. There is a chart included in the detailed report that plots the overall average score for each of the MRNs. The summarized report does not include a graphical output. The keyboard shortcut for this form is 'Alt rt' or 'Ctrl t'.

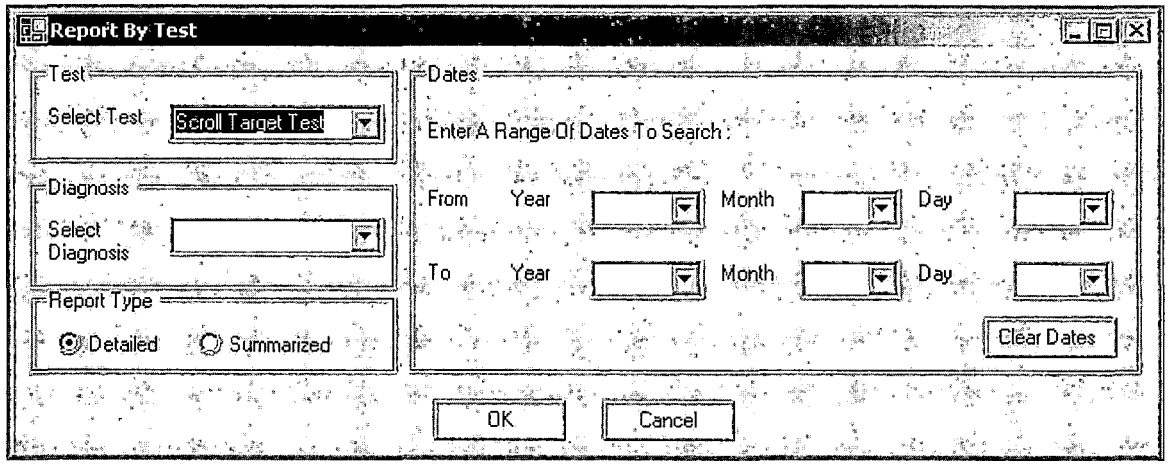


Figure 15. Report By Test

Report By Diagnosis

The third type of report that you can request is the Report by Diagnosis (see Figure 16). This form asks you to select a diagnosis and test from a drop down list.

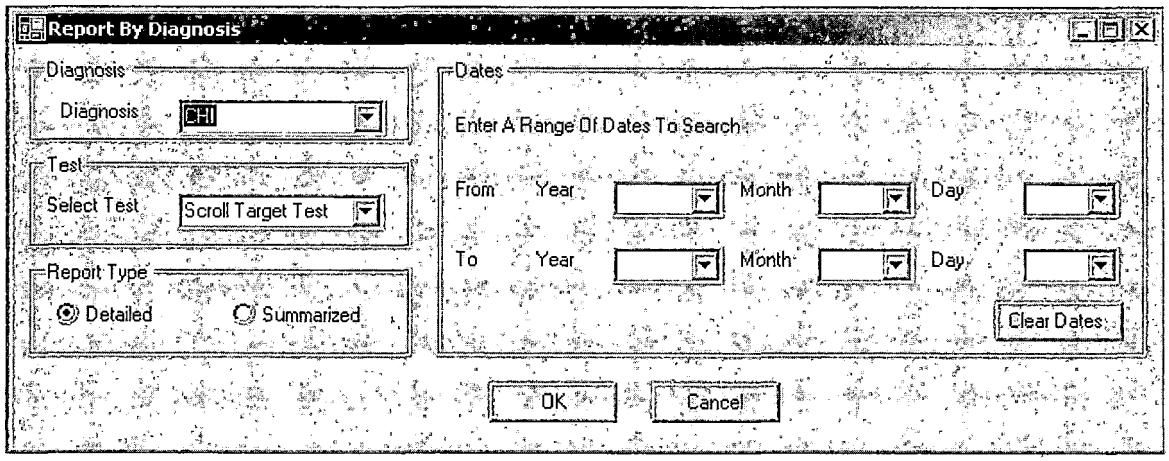


Figure 16. Report By Diagnosis

As with the previous two report forms, this form allows you to select between detailed and summarized

report. The detailed reports contain the following data: Diagnosis, Test name, MRN, test dates and average scores for those days, an average score for each MRN and a group average score for each diagnosis. The summarized version includes Diagnosis, Test name, MRN, an average score for each MRN, the start date for each MRN as well as a group average for each diagnosis. Both the summarized and detailed version of the report contain one graph the shows the group average plotted against the respective diagnosis. The keyboard shortcut to bring up this form is 'Alt rd' or 'Ctrl d'.

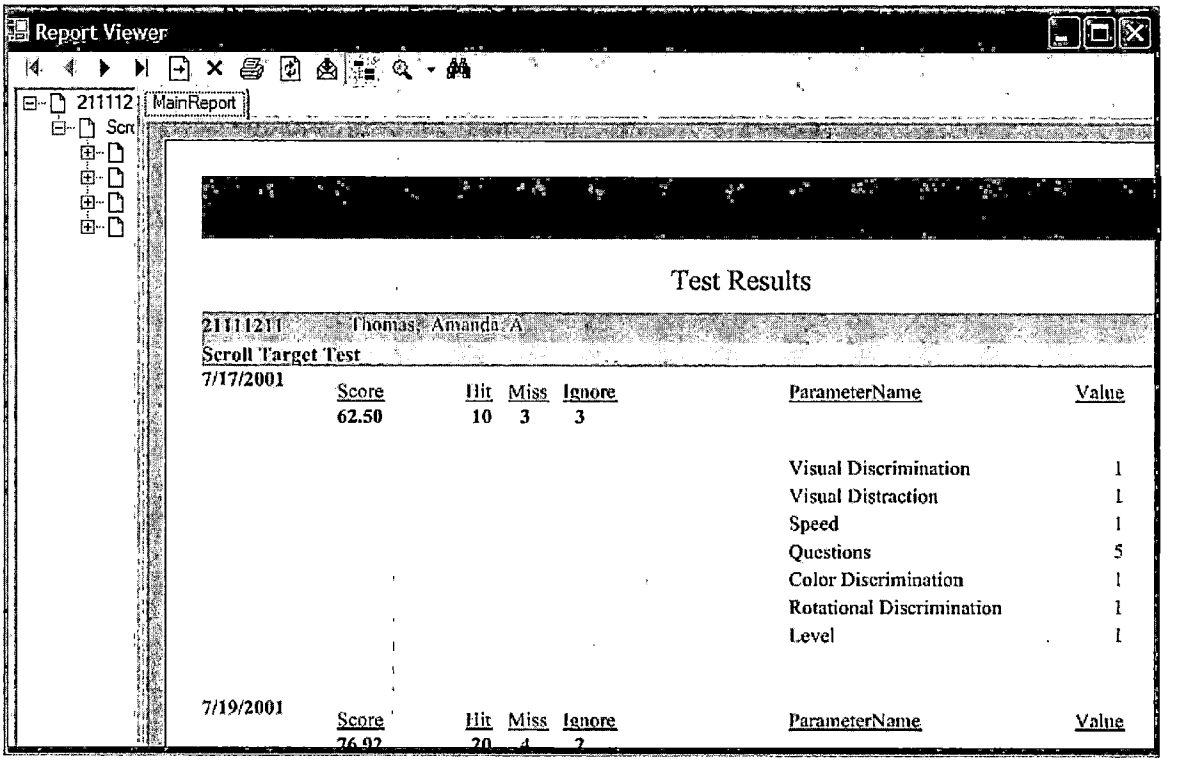


Figure 17. Report Viewer Form

Once you hit the 'OK' button on any of the report forms, the requested reports will be generated and shown in a Report Viewer Window (see Figure 17). There is a menu bar across the top of the Widow that allows you to navigate through the pages of the report, print the report, or export, which means save the report at a new location. On the left hand side of the report viewer there is label with a plus sign next to it. Pressing the plus sign expands the label and you can see detailed information pertaining to the label. Each expansion may lead to more plus signs

leading to a hierarchical tree view of the report to be revealed. This serves as an outline of the report.

Session

The Sessions menu option will let you log out from the current session, exit the CRS application or change the password for the current user (see Figure 18). Logging out simply terminates the current users session and displays the login window on the screen. Exiting the application shuts down CRS completely. If you request to change login in information, you are asked to supply the username, old password you wish to change and the new password you want. If the information supplied is correct a confirmation window will pop up to let you know that the login information has been updated. The keyboard short cuts to the Sessions menu, log out option and exit option are 'Alt s', 'Alt so' and 'Alt se' or 'Ctrl x' respectively.

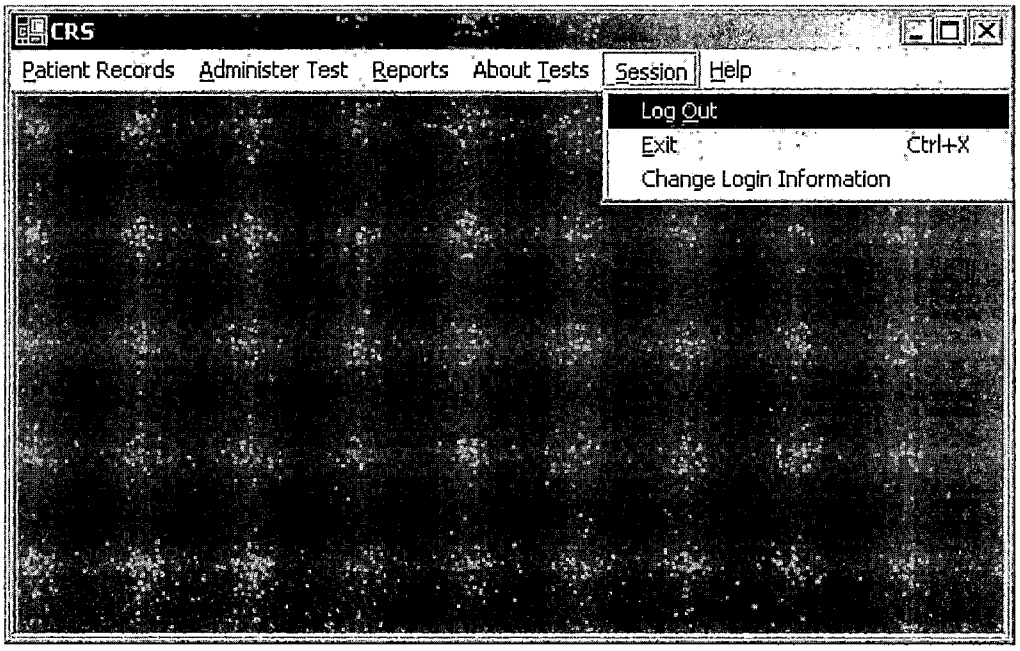


Figure 18. Session Menu Option

Help

From the help menu (see Figure 19) you can choose the 'About CRS' option (see Figure 20) which simply lists the version number and the products available with this current version of CRS. The other option under this menu is the User's guide. Selecting that choice will let you view this document! The keyboard shortcut to the Help menu is 'Alt h'.

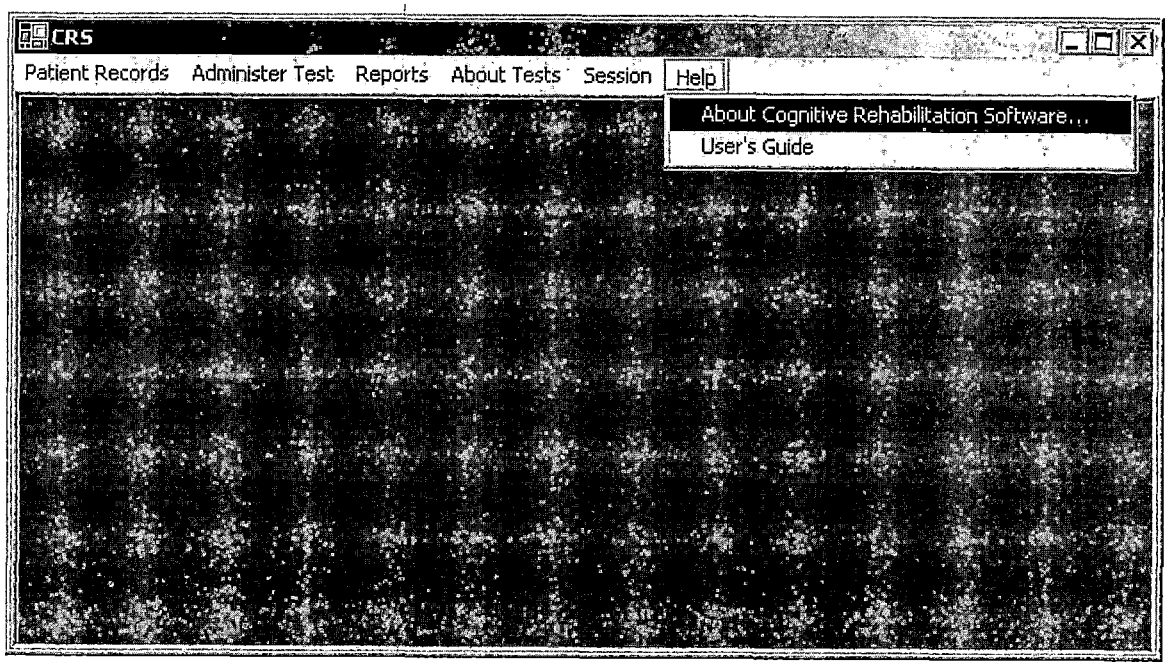


Figure 19. Help Menu Option

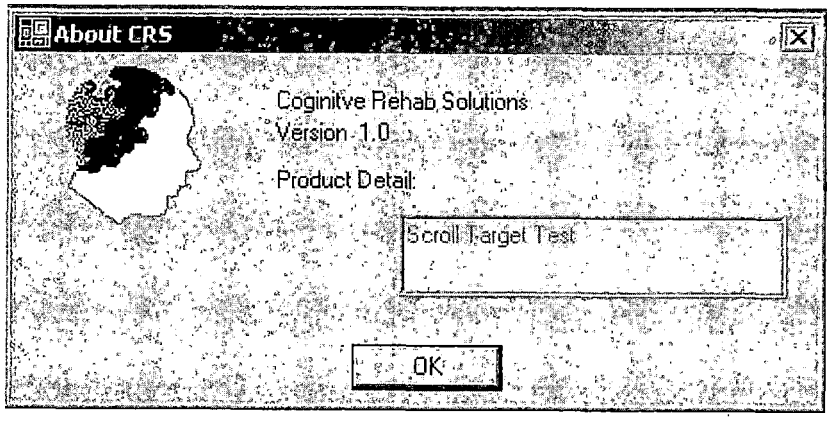


Figure 20. About Cognitive Rehab Software

CHAPTER FIVE

FUTURE ENHANCEMENTS

There are several directions that future work on CRS can pursue. The application was designed to host additional cognitive tests and therefore it is the most apparent direction to take. However, the future of CRS can be concentrated on a variety of other areas such as enhancement of the current cognitive test, development of additional user features, improvement of performance challenges and web enablement of CRS.

The current test can be modified to incorporate additional parameters and add more levels of difficulty. For example, auditory distraction can be added to test divided attention in an alternate manner.

Data mining feature can be added to the application to analyze trends and anomalies in information collected. This will give the neuropsychologist and additional tool to measure patient performance and conduct research.

Performance for a standalone application can be improved by incorporating slightly more efficient two-dimensional motion capabilities. This can be applicable in

the current attention test for the scrolling of objects and for the visual distraction feature.

In order to make CRS available on line, one approach is to implement it as a website. Another route and perhaps a more feasible solution would comprise of a thin client communicating to the server via HTTP and XML web services.

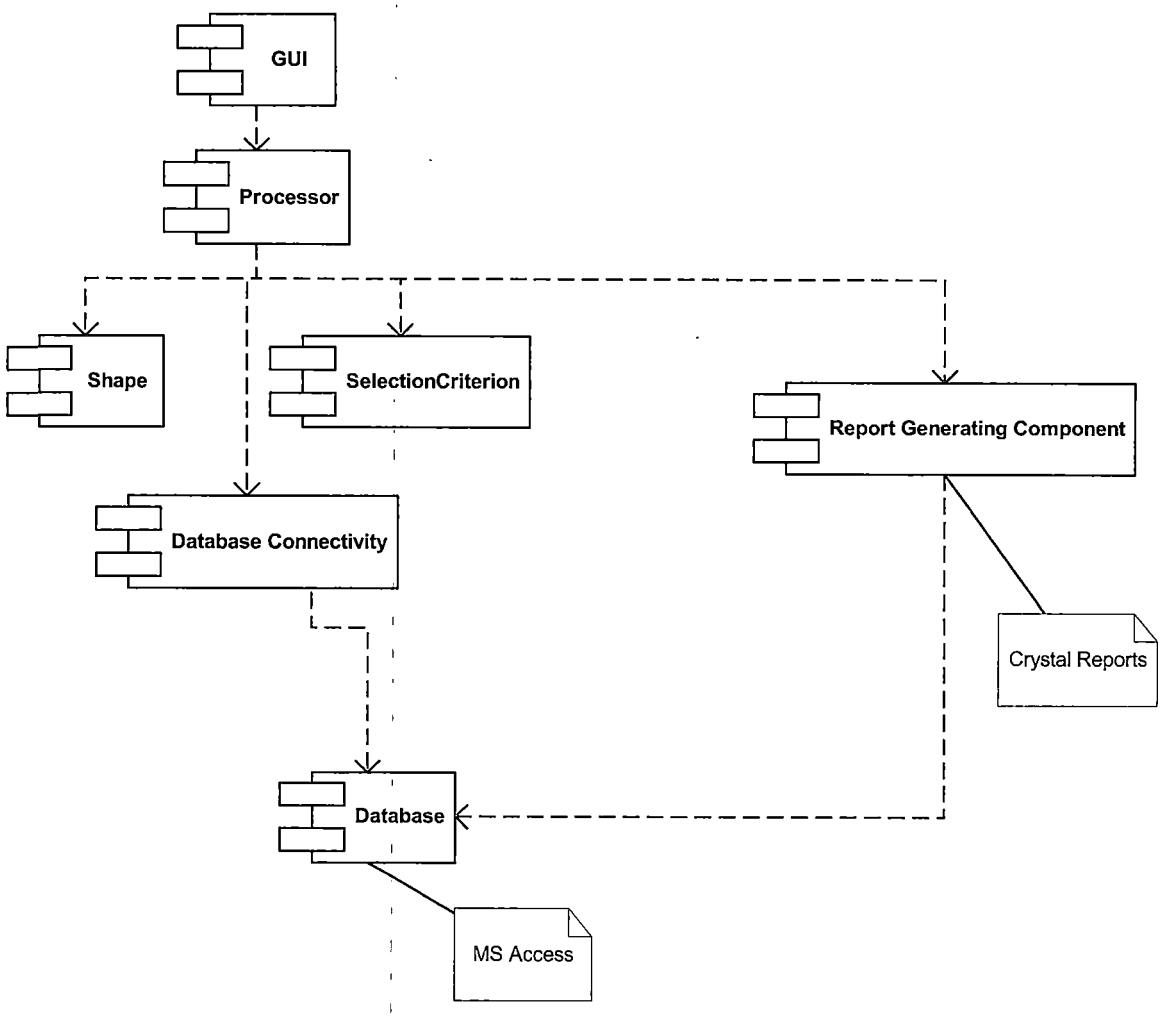
These are some of the options available in order to augment the functionality of CRS. Anyone of the listed approaches would be considered a beneficial improvement. Feedback from the user will most likely be the governing factor in deciding the direction taken.

APPENDIX A

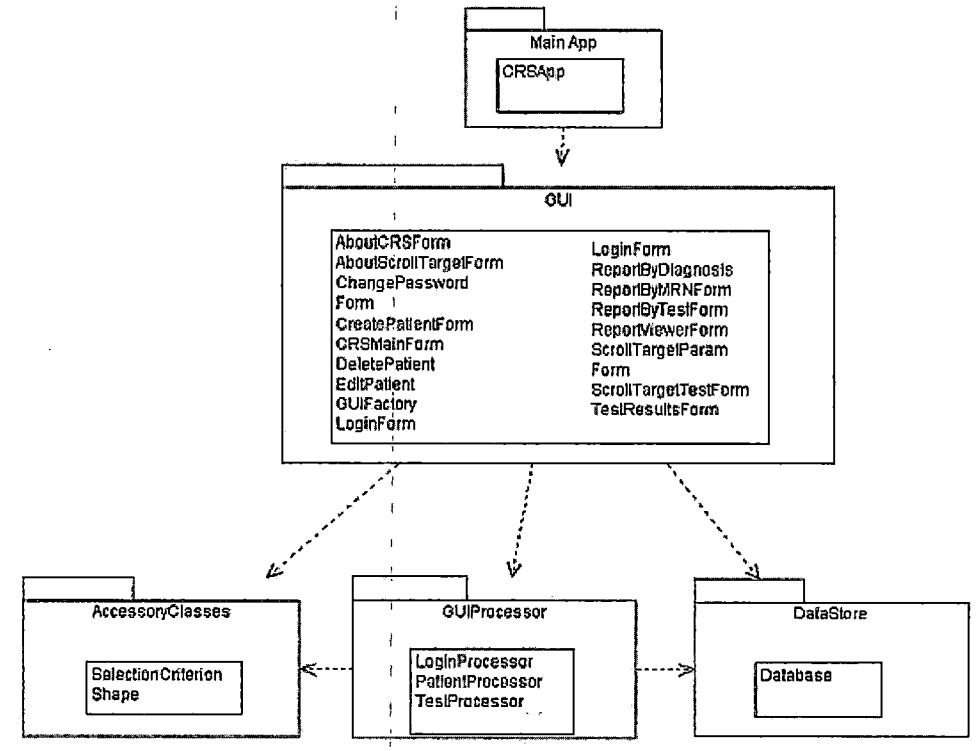
SYSTEM DESIGN

Use Case Diagram

Component Diagram

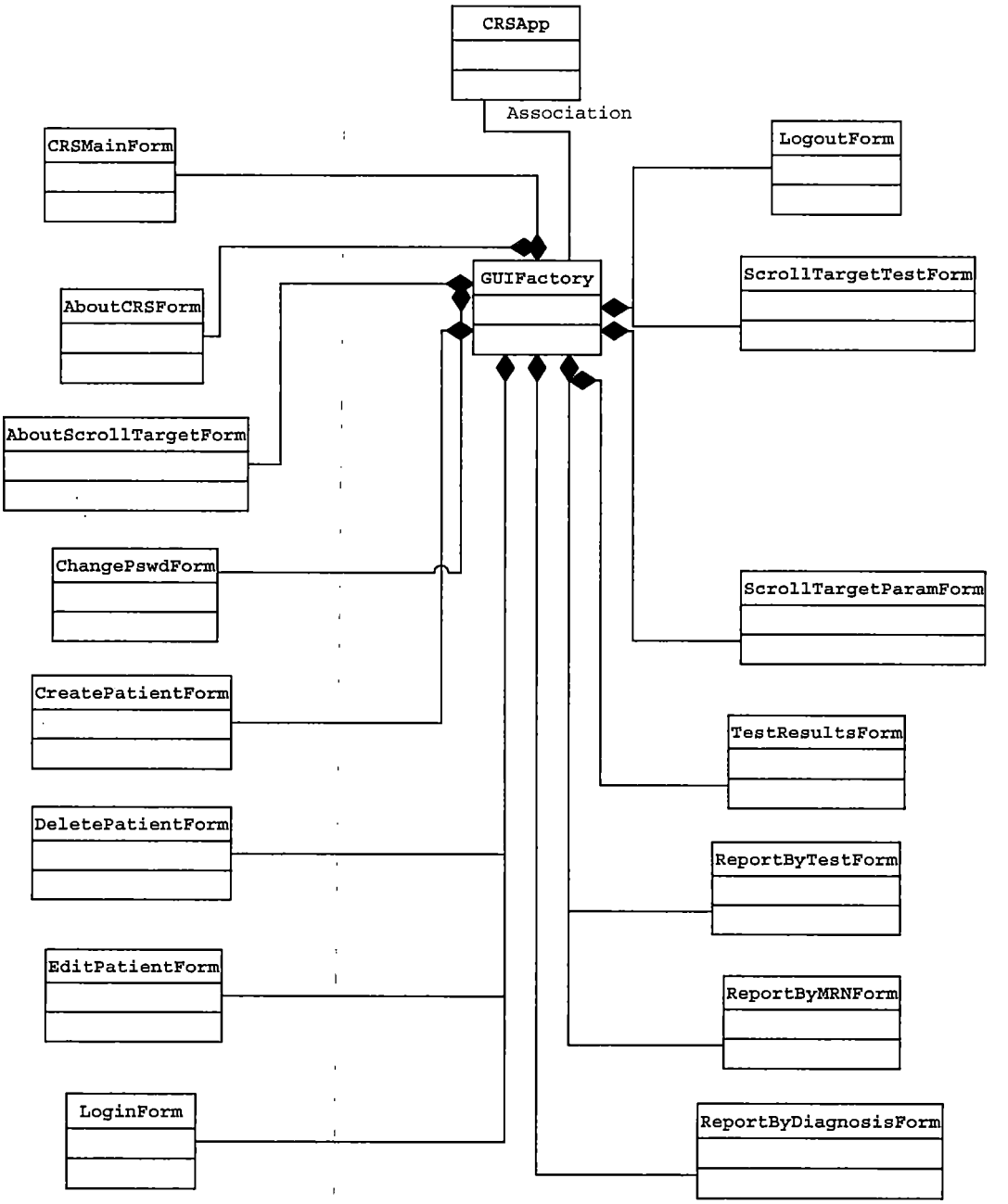


Package Diagram

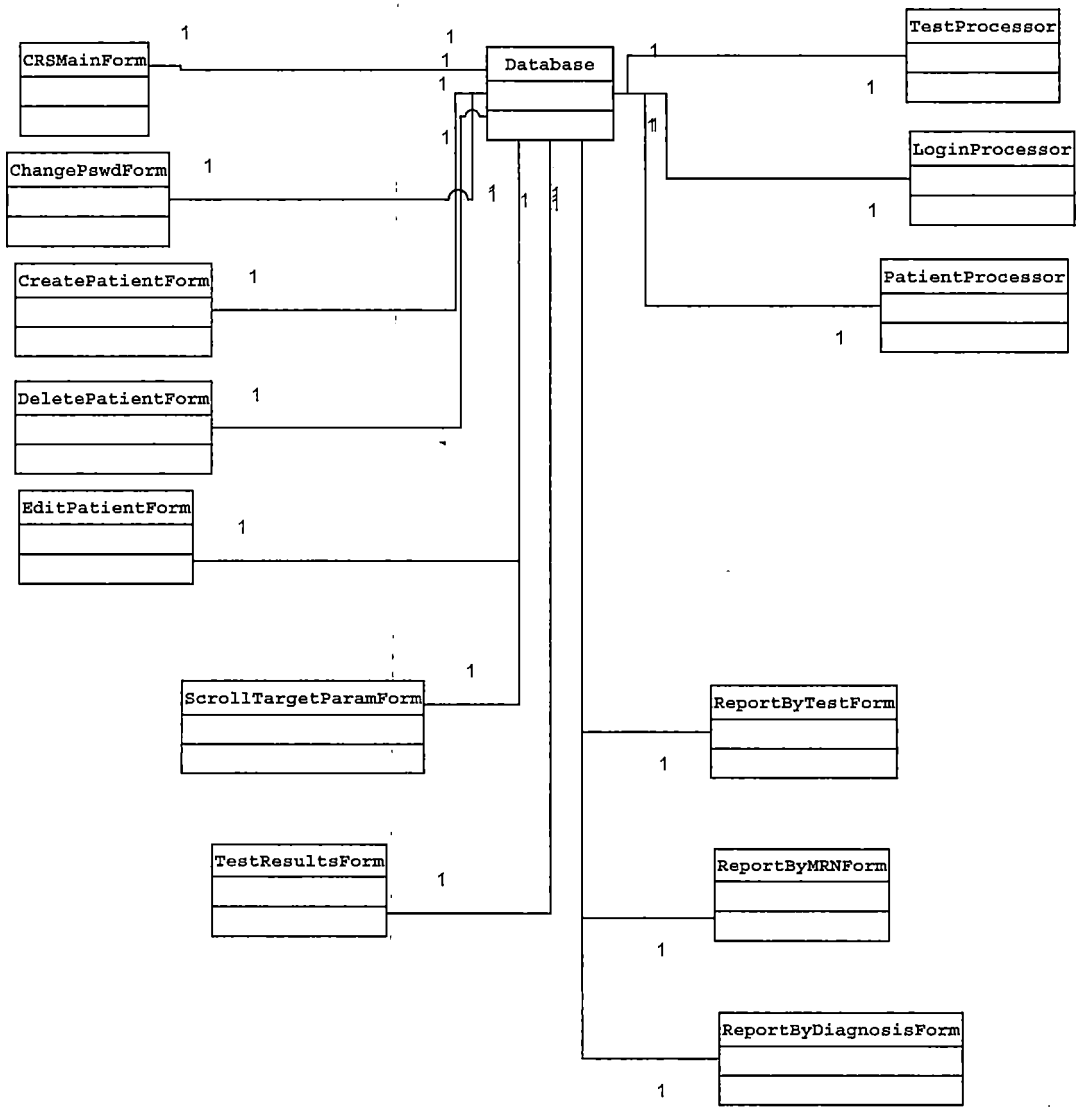


Note: Packages contain classes listed within them.

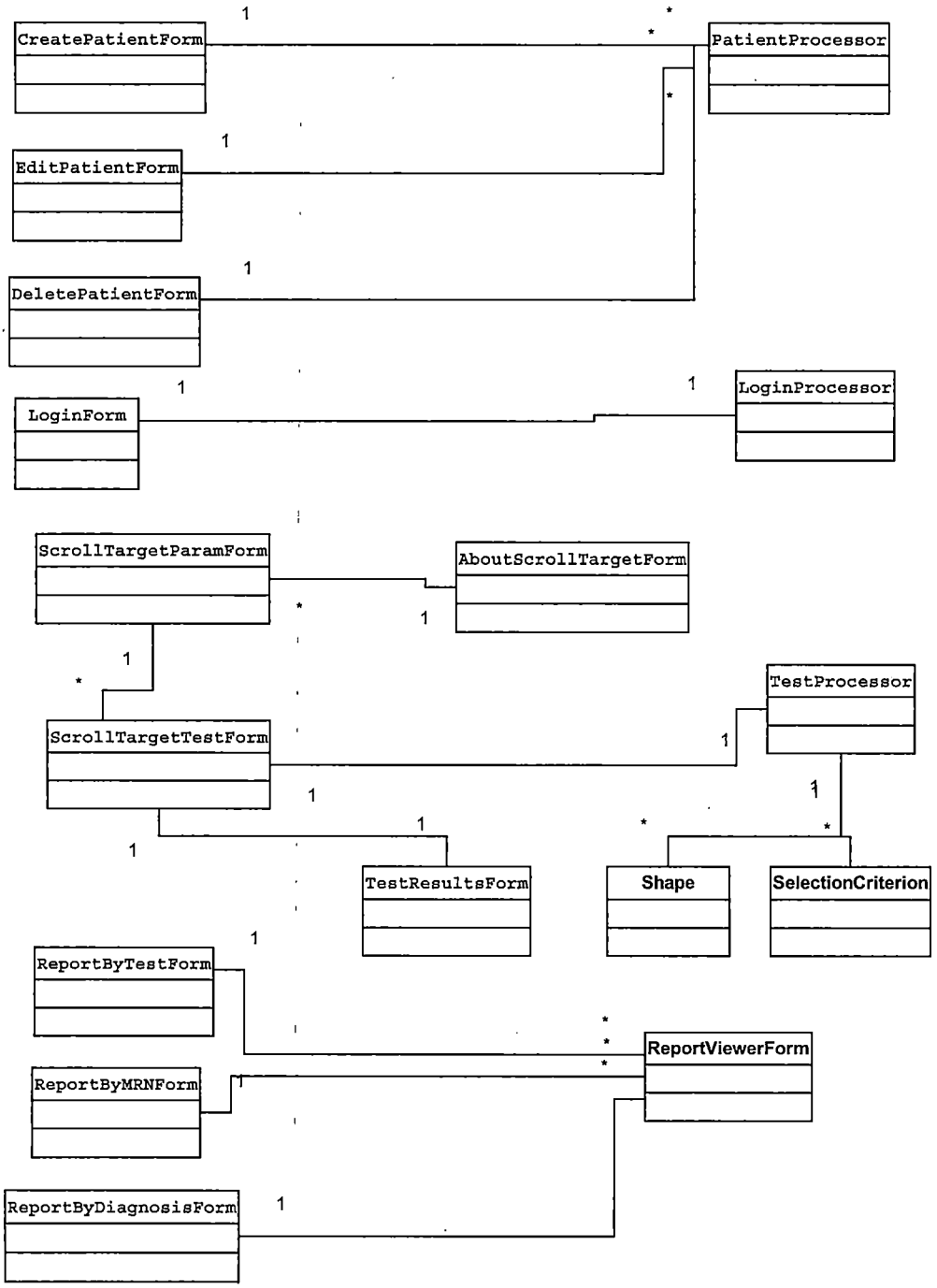
Class Diagram I



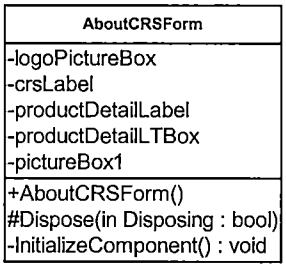
Class Diagram II



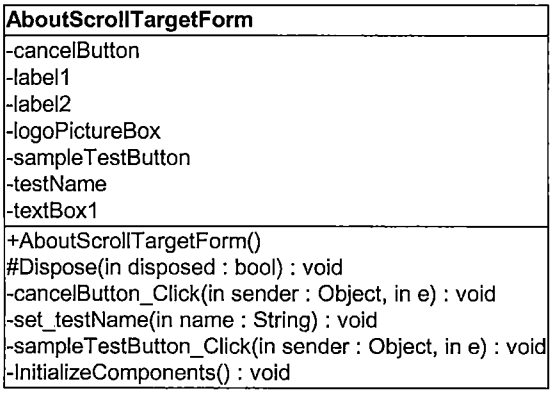
Class Diagram III



AboutCRSForm Class Diagram



AboutScrollTargetTestForm Class Diagram



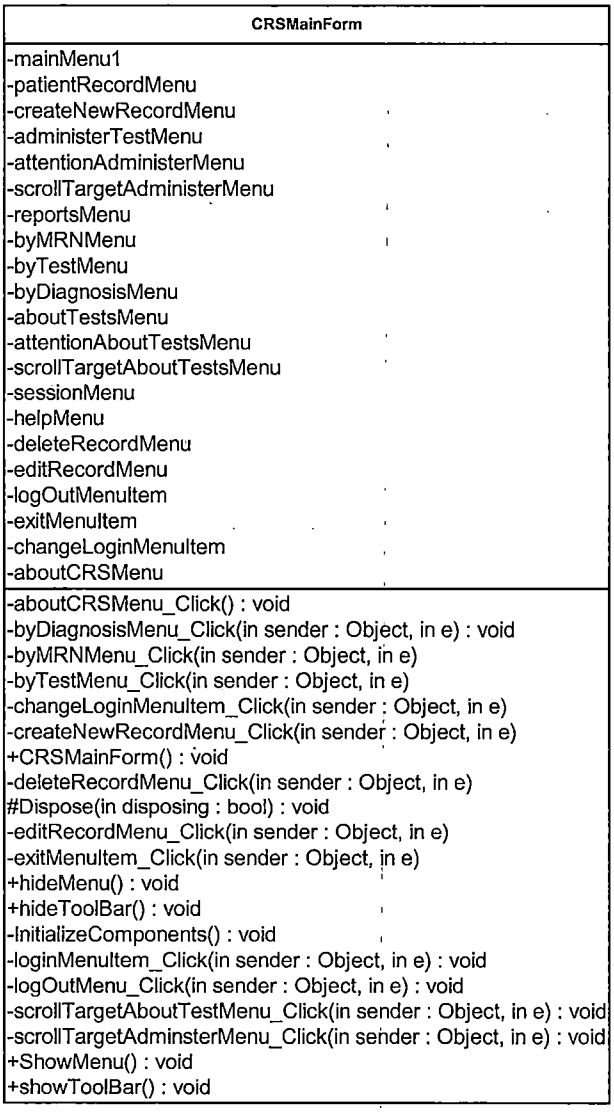
ChangePswdForm Class Diagram

ChangePswdForm
-m_usernameTbox : System.Windows.Forms -m_oldPswdTbox : System.Windows.Forms -m_newPswdTbox : System.Windows.Forms -m_cancelButton : System.Windows.Forms -m_userNameLabel : System.Windows.Forms -m_oldPswdLabel : System.Windows.Forms -m_newPswdLabel : System.Windows.Forms -m_okButton : System.Windows.Forms -m_db : Database -m_dataReader : System.Data
+ChangePswdForm() +Dispose(in : bool) +InitializeComponent() +m_cancelButton_Click(in : EventArgs, in) +m_okButton_Click(in : Object, in : EventArgs)

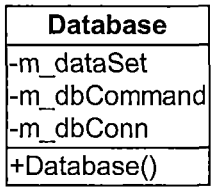
CreatePatientForm Class Diargam

CreatePatientForm
-clearButton : System.Windows.Forms -cancelButton : System.Windows.Forms -saveButton : System.Windows.Forms -mrnTbox : System.Windows.Forms -firstNameTbox : System.Windows.Forms -middleNameTbox : System.Windows.Forms -lastNameTbox : System.Windows.Forms -onsetDateTbox : System.Windows.Forms -mrnGbox : System.Windows.Forms -nameGbox : System.Windows.Forms -txStartTbox -ptProc : PatientProcessor -medicalGbox : System.Windows.Forms -testAdminGbox : System.Windows.Forms -neuropsycLabel : System.Windows.Forms -mrnLabel : System.Windows.Forms -fNameLabel : System.Windows.Forms -lNameLabel : System.Windows.Forms -diagnosisLabel : System.Windows.Forms -onsetDtLabel : System.Windows.Forms -txStartDtLabel : System.Windows.Forms -mNameLabel : System.Windows.Forms -m_db : Database -diagnosisCbox : System.Windows.Forms -neuroPsycCbox -m_dataReader : System.Data
-cancelButton_Click(in : Object, in : EventArgs) : void -clearAll() : void -clearButton_Click(in : Object, in : EventArgs) : void +CreatePatientForm() #Dispose(in : bool) -InitializeComponents() -saeButton_Click(in : Object, in : EventArgs)

CRSMainForm Class Diagram



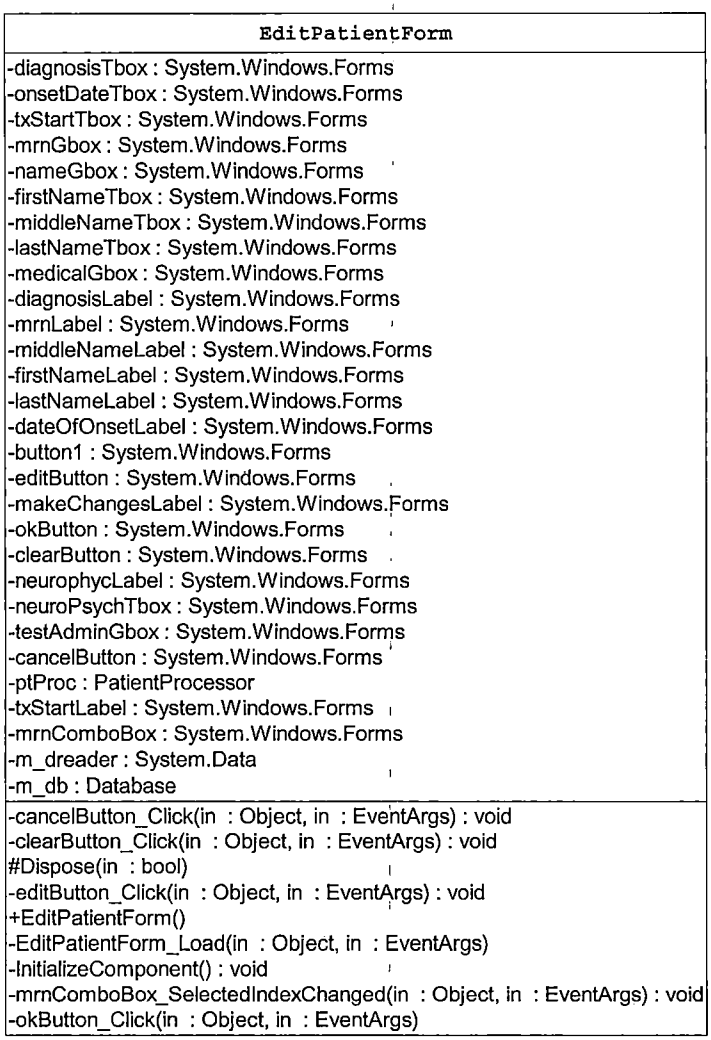
Database Class Diagram



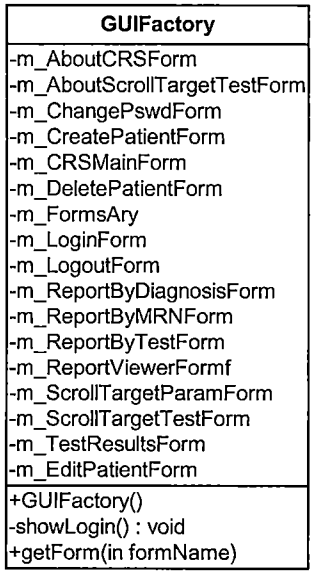
DeletePatientForm Class Diagram

DeletePatientForm
-enterMRNLabel : System.Windows.Forms -okButton : System.Windows.Forms -cancelButton : System.Windows.Forms -ptProc : PatientProcessor -mrnSelectComboBox : System.Windows.Forms -m_db : Database -m_dreader : System.Data
-cancelButton_Click(in : Object, in : EventArgs) : void +DeletePatientForm() -DeletePatientForm_Load(in : Object, in : EventArgs) : void #Dispose(in : bool) : void +InitializeComponent() : void -okButton_Click(in : Object, in : EventArgs)

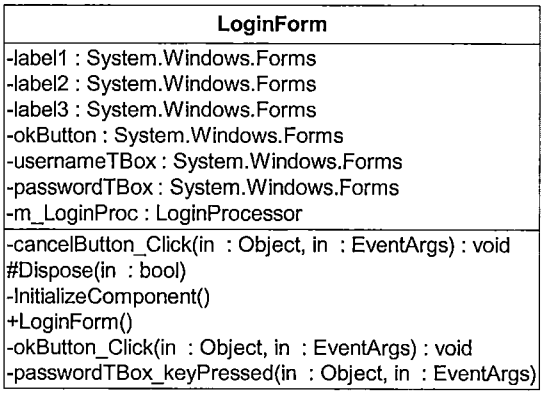
EditPatientForm Class Diagram



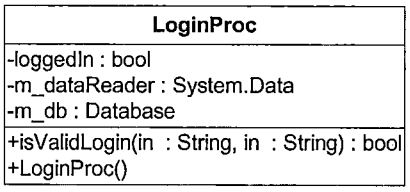
GUIFactory Class Diagram



LoginForm Class Diagram



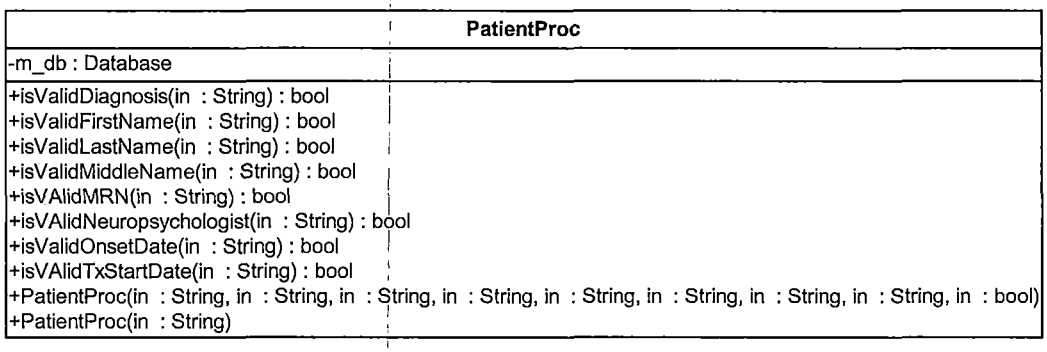
LoginProc Class Diagram



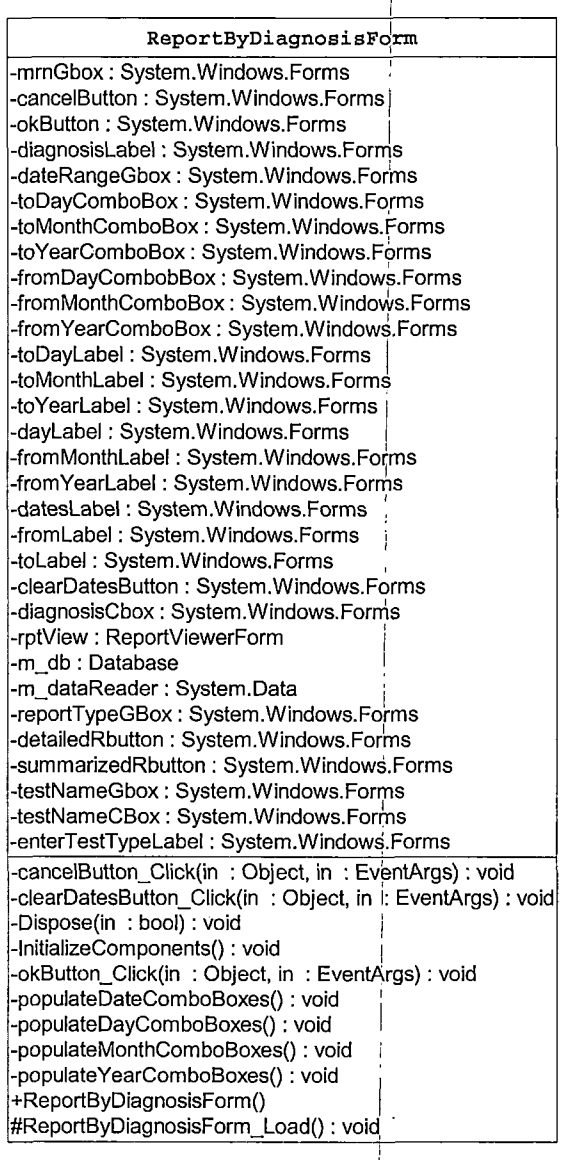
LogoutForm Class Diagram

LogoutForm
-logoutLabel : System.Windows.Forms -yesButton : System.Windows.Forms -noButton : System.Windows.Forms
#Dispose() : void -InitializeComponent() : void +LogoutForm() -noButton_Click(in : Object, in : EventArgs) : void

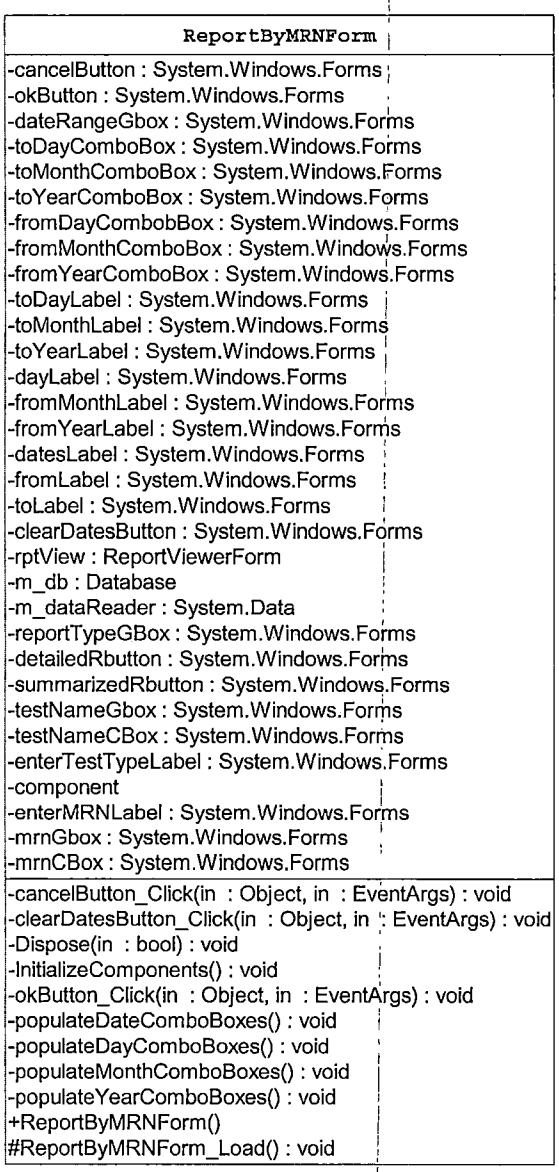
PatientProc Class Diagram



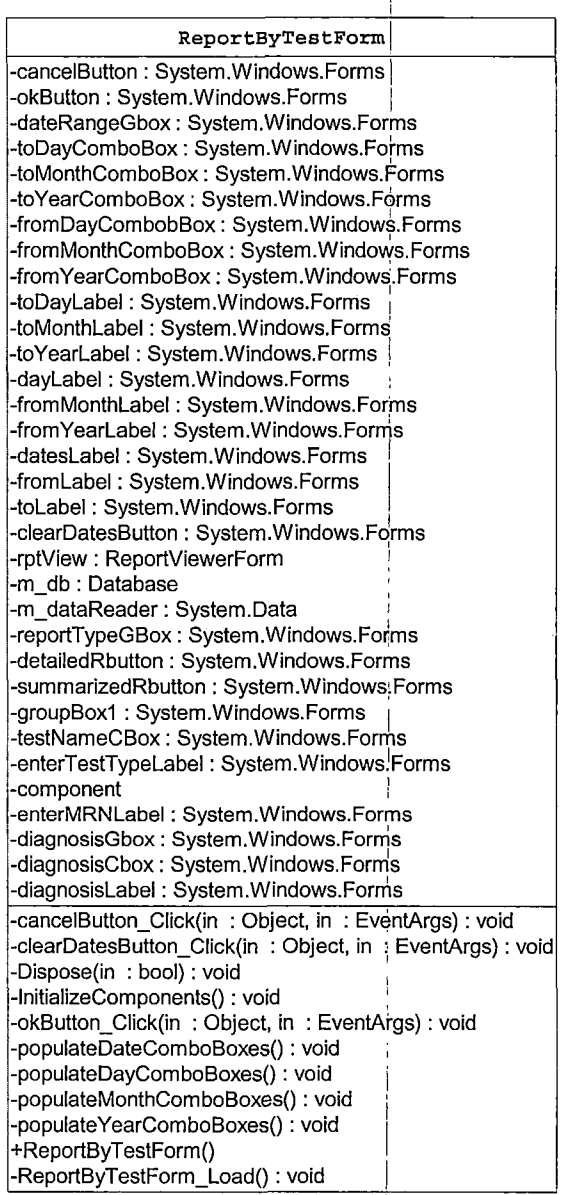
ReportByDiagnosisForm Class Diagram



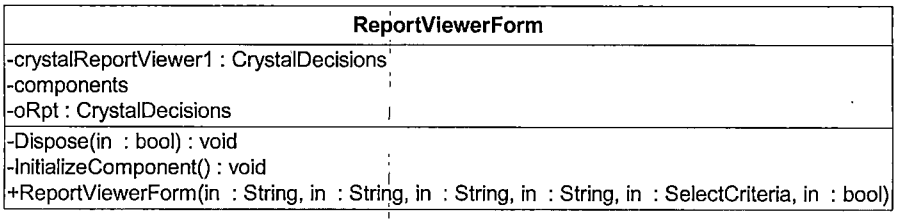
ReportByMRNForm Class Diagram



ReportByTestForm Class Diagram



ReportViewerForm Class Diagram



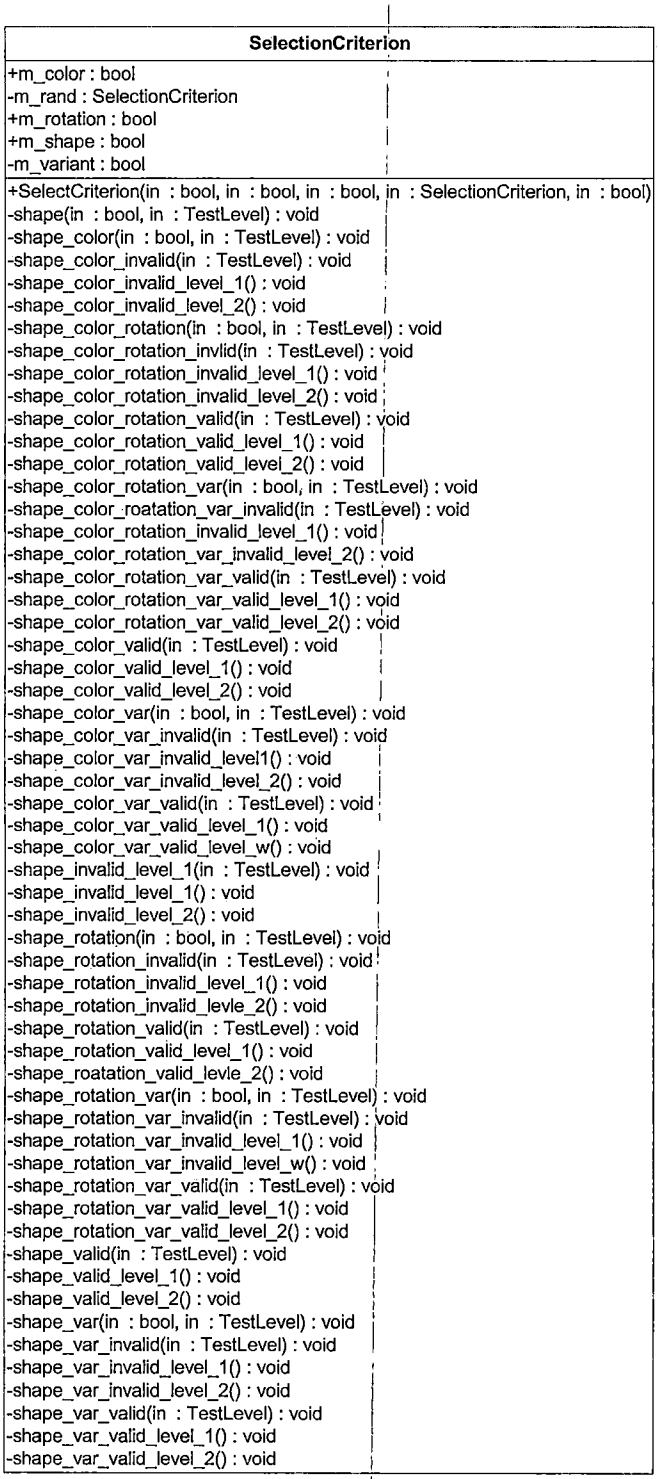
ScrollTargetParameterForm Class Description

ScrollTargetParameterForm
-cancelButton : System.Windows.Forms -clearButton : System.Windows.Forms -colorCbox : System.Windows.Forms -components -discriminationGbox : System.Windows.Forms -durationGbox : System.Windows.Forms -enterQuestLabel : System.Windows.Forms -enterSpeedLabel : System.Windows.Forms -guest : bool -lenthGbox : System.Windows.Forms -level1Rbutton : System.Windows.Forms -level2Rbutton : System.Windows.Forms -levelGbox : System.Windows.Forms -mark10Label : System.Windows.Forms -mark1QuestLabel : System.Windows.Forms -mark1speedLabel : System.Windows.Forms -mark50Label : System.Windows.Forms -m_dataReader : System.Data -m_db : Database -mrnGbox : System.Windows.Forms -mrnLabel : System.Windows.Forms -mrnSelectCbox : System.Windows.Forms -numOfQuestionLabel : System.Windows.Forms -okButton : System.Windows.Forms -questionsBar : System.Windows.Forms -questionsValueTbox : System.Windows.Forms -rotationCbox : System.Windows.Forms -setDefaultButton : System.Windows.Forms -speedBar : System.Windows.Forms -speedGbox : System.Windows.Forms -speedLabel : System.Windows.Forms -speedValueTbox : System.Windows.Forms -testNameLabel : System.Windows.Forms -visualDiscrimCbox : System.Windows.Forms -visualDistractCbox : System.Windows.Forms
-cancelButton_Click(in : Object, in : EventArgs) : void -clearButton_Click(in : Object, in : EventArgs) : void -createDefaultButton_Click(in : Object, in : EventArgs) : void #Dispose(in : bool) : void -InitializeComponent() : void -questionsBar_Scroll(in : Object, in : EventArgs) : void -questionsValueTbox_LeaveFocus(in : Object, in : EventArgs) : void +ScrollTargetParamForm() -ScrollTargetParamForm_Load(in : Object, in : EventArgs) : void -setButto_Click(in : Object, in : EventArgs) : void -set_defaults() : void +set_guest(in : bool) : void +set_testName(in : String) : void -speedBar_Scroll(in : Object, in : EventArgs) : void -speedValueTbox_LeaveFocus(in : Object, in : EventArgs) : void

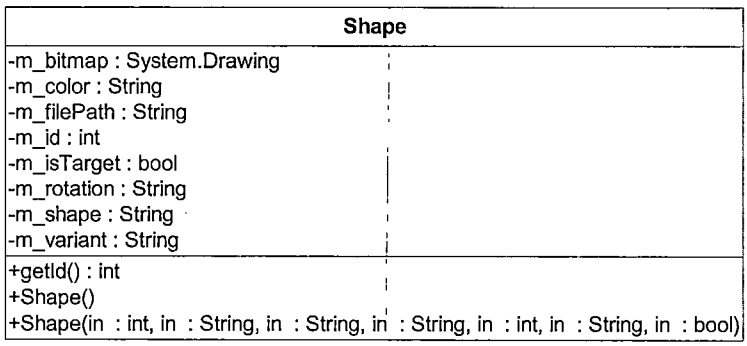
ScorllTargetTestForm Class Diagram

	System.Windows.Forms
-m_TestProc : TestProcessor -scrollTimer : System.Windows.Forms -testInfoPanel : System.Windows.Forms -targetPictureBox : System.Windows.Forms -startButton : System.Windows.Forms -hitTArgetButton : System.Windows.Forms -matchShapeLabel : System.Windows.Forms -hitButton : System.Windows.Forms -matchLabel2 : System.Windows.Forms -matchLabel1 : System.Windows.Forms -targetObjectGbox : System.Windows.Forms -directionsGbox : System.Windows.Forms -controlGbox : System.Windows.Forms -testPanel : System.Windows.Forms -backImageTimer : System.Windows.Forms -targetFlashTimer : System.Windows.Forms -backImage : System.Collections -distractionImages : System.Collections -backGroundImage : System.Drawing -blankImage : System.Drawing -blankDistractionImage : System.Drawing -pauseGbox : System.Windows.Forms -pauseButton : System.Windows.Forms -backImageEnum : System.Collections -distractionImageENum : System.Collections -m_bg_counter : int	
-backImageTimer_Tick(in : Object, in : EventArgs) : void #Dispose(in : bool) : void -flash_target() : void -hitButton_Click(in : Object, in : EventArgs) : void -InitializeComponent() : void -pauseButton_Click(in : Object, in : EventArgs) : void -scroll_object(in : int, in : int) : void +scrollTargetTestForm() -scrollTimer_Tick(in : Object, in : EventArgs) : void -setBackImages() : void -setDistractionImages() : void -setSpeed(in : int) : void +setTestParameters(in : String, in : String, in : int, in : int, in : TestLevel, in : bool, in : bool, in : bool, in : bool) : void -show_results() : void -spaceBar_KeyPress(in : Object, in : EventArgs) : void -startButton_Click(in : Object, in : EventArgs) : void -targetFlashTimer_Tick(in : Object, in : EventArgs) : void -togglePause() : void	

SelectionCriterion Class Diagram



Shape Class Diagram



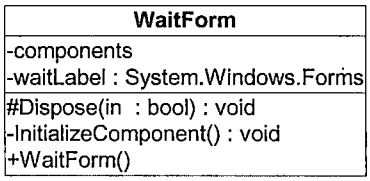
TestProc Class Discription

TestProc
+m_testName : String +m_mrn : String +m_question : int +m_questions_orig : int +m_speed : int +m_level : TestLevel +m_color : bool +m_rotation : bool +m_variance : bool +m_visualDistraction : bool +m_hit : int +m_hitTotal : int +m_mis : int +m_missToatal : int +m_ignore : int +m_ignoreTotal : int +m_avgScore : double +m_xCoord : int +m_yCoord : int +m_xDistance : int +m_yDistance : int +m_screenSize : int -m_choiceLength : int -m_numOfMaxValidChoices : int -m_validAnswers : int -m_index : int -m_valid_choices -m_final_choices -m_invalid_choices -m_targetObject -m_currentObject -m_targetShape -m_currentShape -m_choiceEnum -m_selectCrit -m_db : Database -m_datareader : System.Data
+calc_results() : void -compareObjects() : void +get_current_object() : void +get_target_object() : void +next_problem() : void +processHit() : void -set_choices() : void -set_final_choices(in : int, in : int) : void -set_first_scroll_object() : void -set_invalid_choices() : void -set_inalid_select_query() : void +set_next_scroll_object() : void +set_scroll_info() : void -set_target_obj() : void -set_valid_choices() : void -set_valid_select_query() : void +TestProc(in : String, in : String, in : int, in : int, in : TestLevel, in : bool, in : bool, in : bool, in : bool)

TestResultsForm Class Diagram

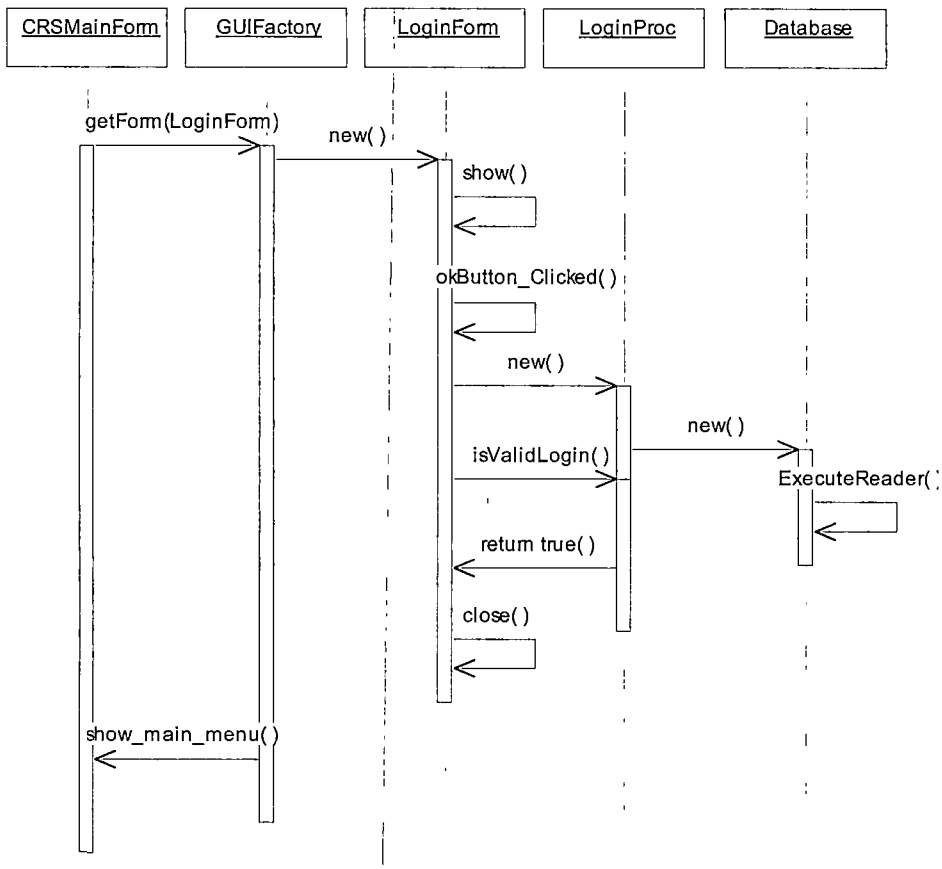
TestResultsForm
-avgScoreValLabel : System.Windows.Forms -cancelButton : System.Windows.Forms -colorLabel : System.Windows.Forms -colorValLabel : System.Windows.Forms -commentsLabel : System.Windows.Forms -commentsTbox : System.Windows.Forms -hitLabel : System.Windows.Forms -hitValLabel : System.Windows.Forms -ignoreLabel : System.Windows.Forms -ignoreValLavel : System.Windows.Forms -levelLabel : System.Windows.Forms -levelValLavel : System.Windows.Forms -m_dataReader : System.Data -m_db : Database -missLabel : System.Windows.Forms -missValLabel : System.Windows.Forms -mrnLable : System.Windows.Forms -mrnValueLabel : System.Windows.Forms -parameterGbox : System.Windows.Forms -percentLabel : System.Windows.Forms -questionLabel : System.Windows.Forms -quesValLabel : System.Windows.Forms -rotationLable : System.Windows.Forms -rotationValLabel : System.Windows.Forms -saveButton : System.Windows.Forms -scoreGbox : System.Windows.Forms -speedLabel : System.Windows.Forms -speedValLabel : System.Windows.Forms -testNameLabel : System.Windows.Forms -visualDiscrimLabel : System.Windows.Forms -visualDiscrimValLabel : System.Windows.Forms -visualDistracLabel : System.Windows.Forms -visualDistracValLabel : System.Windows.Forms
-clearButton_Click(in : Object, in : EventArgs) : void #Dispose(in : bool) : void -InitializeComonent() : void -saveButton_Click(in : Object, in : EventArgs) : void -set_level(in : TestLevel) : void +set_members(in : String, in : String, in : TestLevel, in : double, in : int, in : int, in : int, in : bool, in : bool) : void +TestResultsForm() -TestResultsForm_Load(in : Object, in : EventArgs) : void

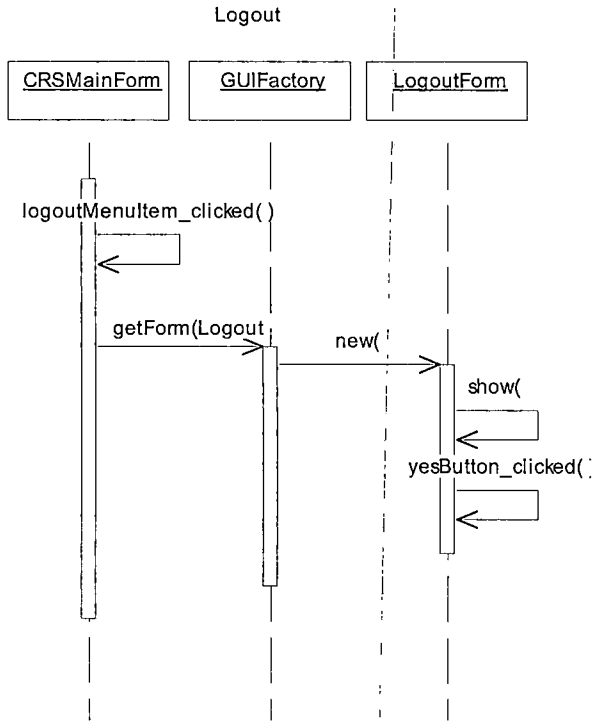
WaitForm Class Diagram

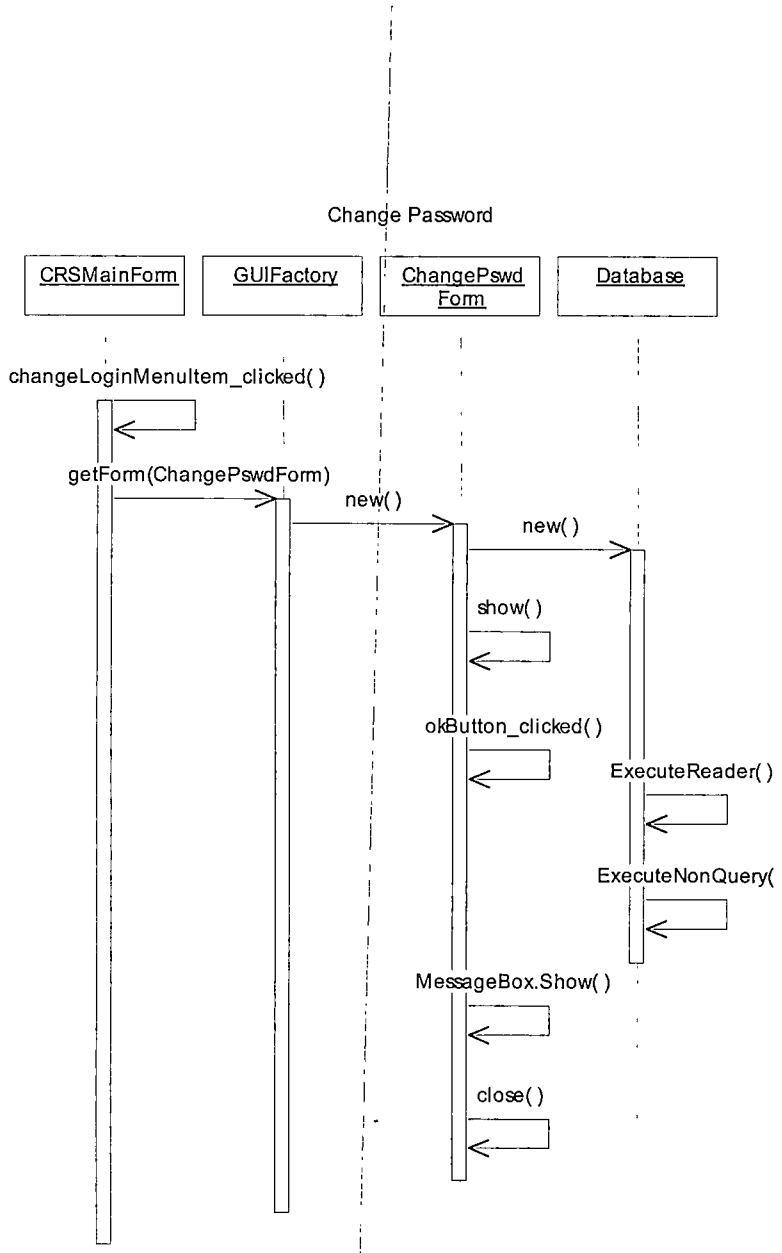


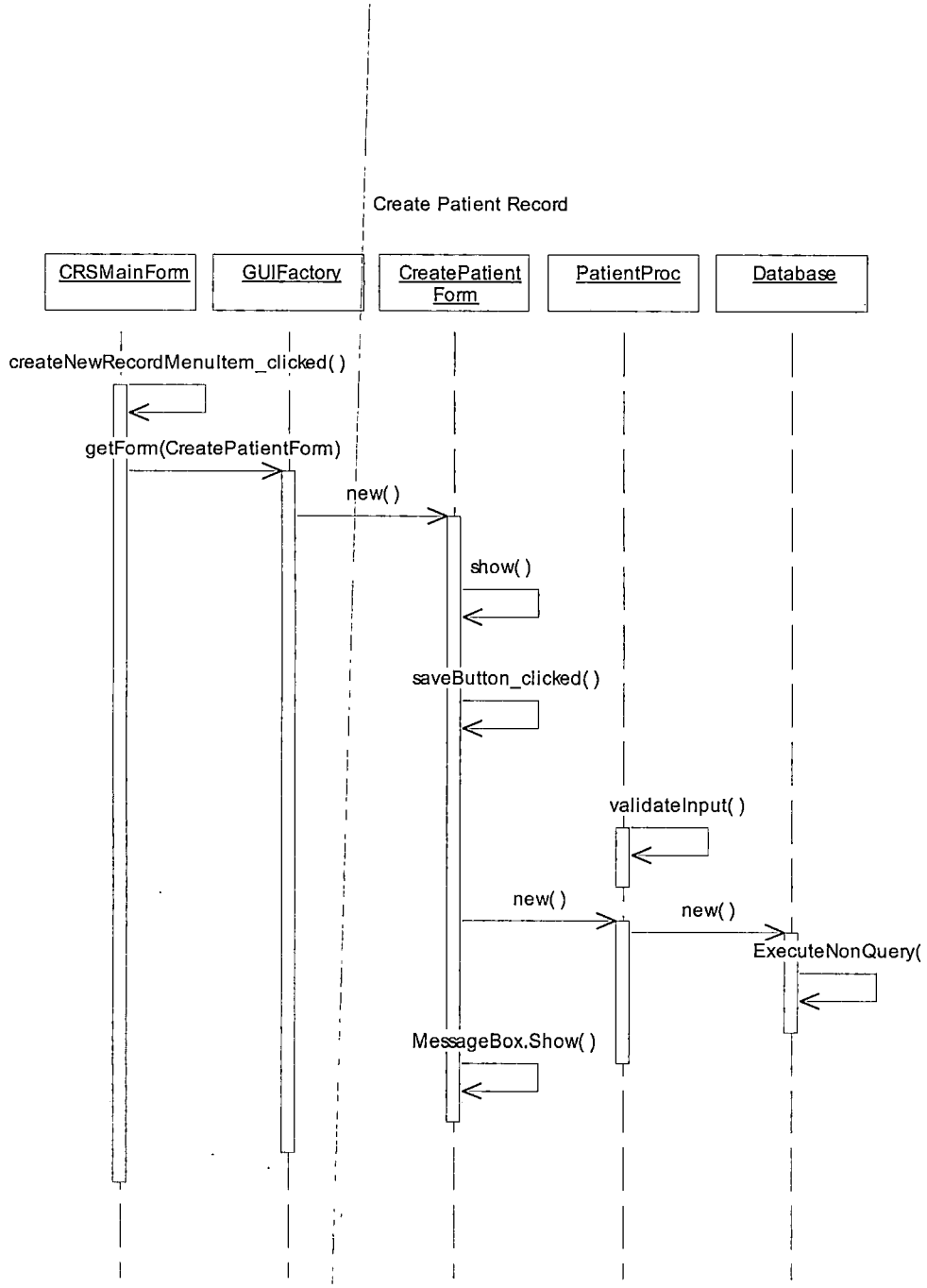
Sequence Diagrams

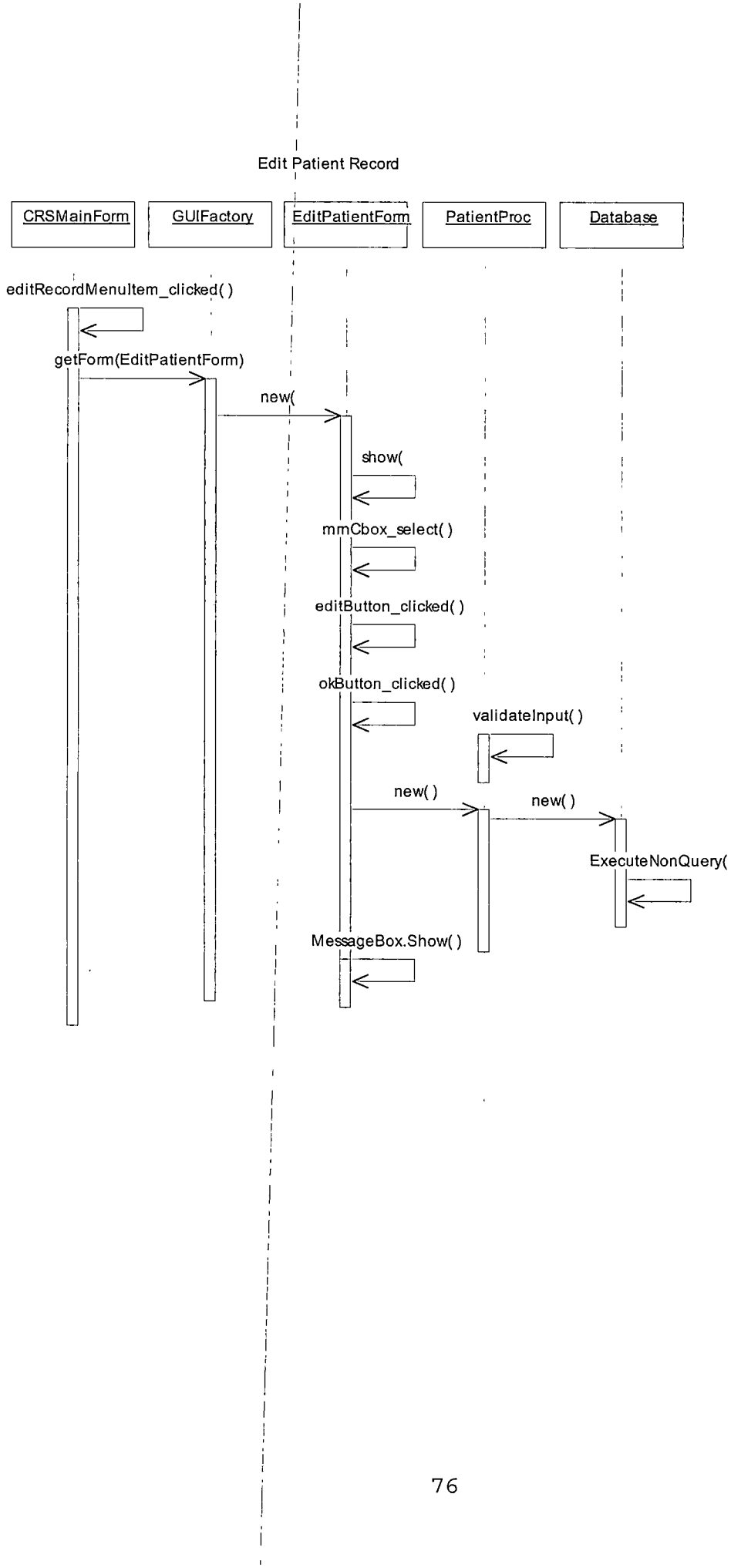
Successful Login

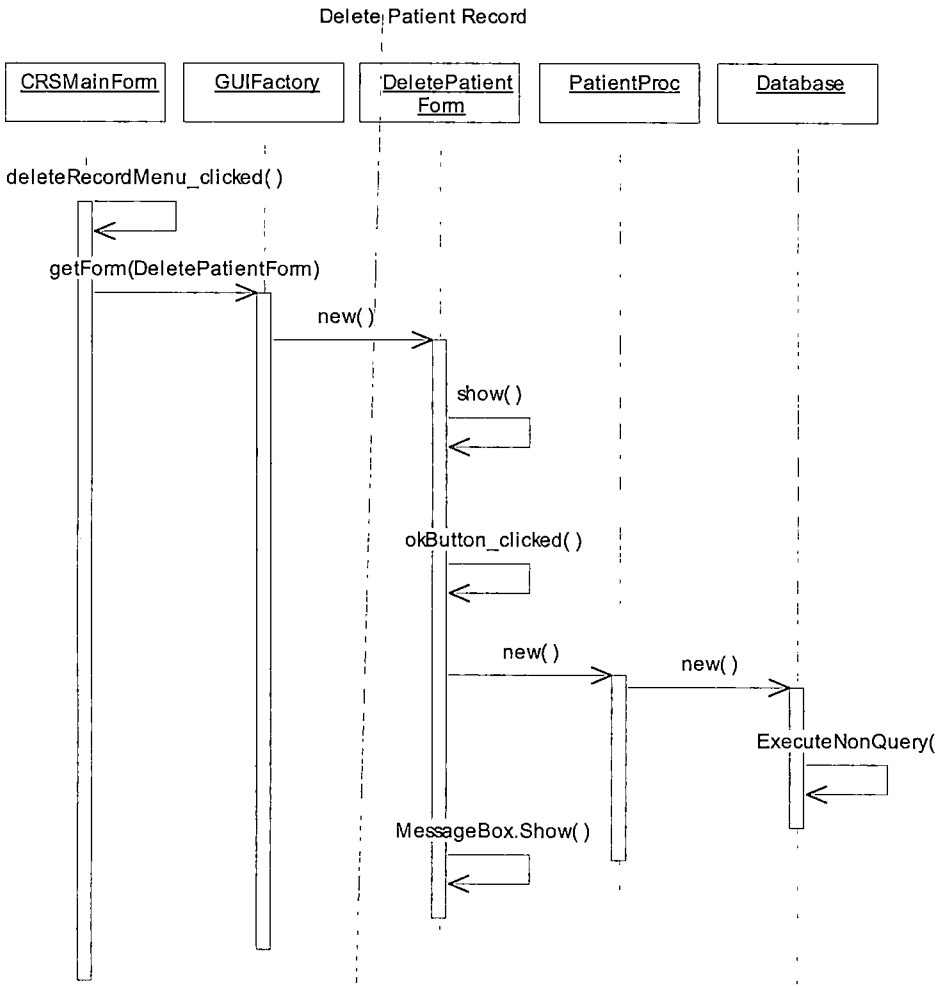


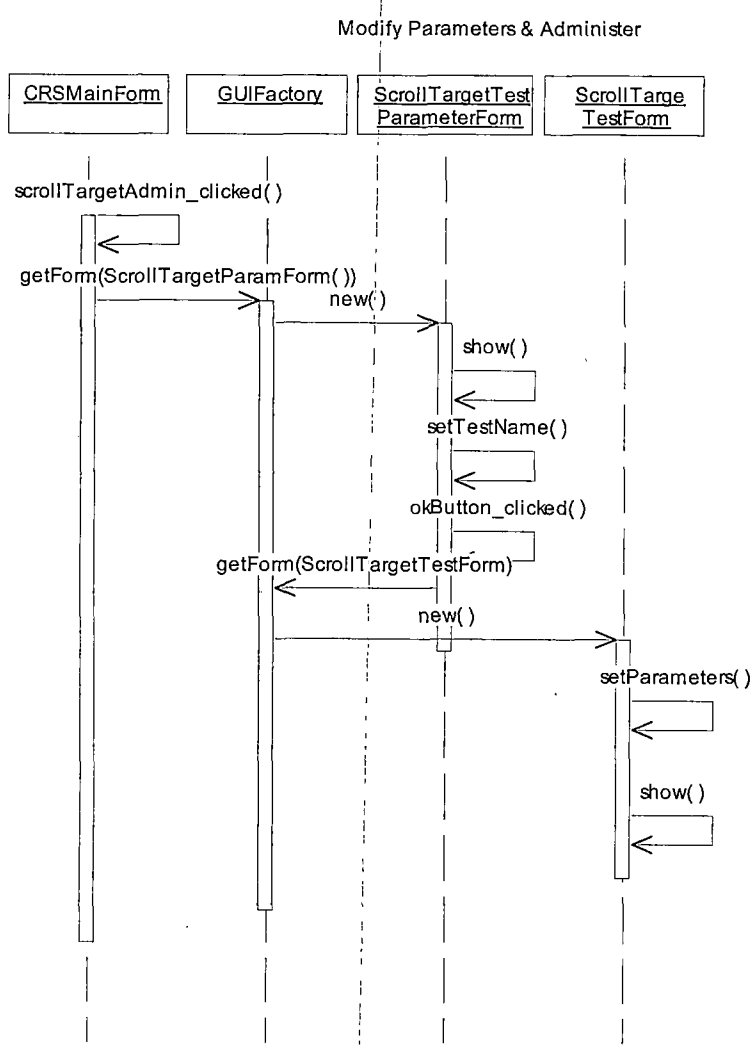

Logout
CRSMainForm
GUIFactory
LogoutForm
logoutMenuItem_clicked( )
getForm(Logout
new(
show(
yesButton_clicked(

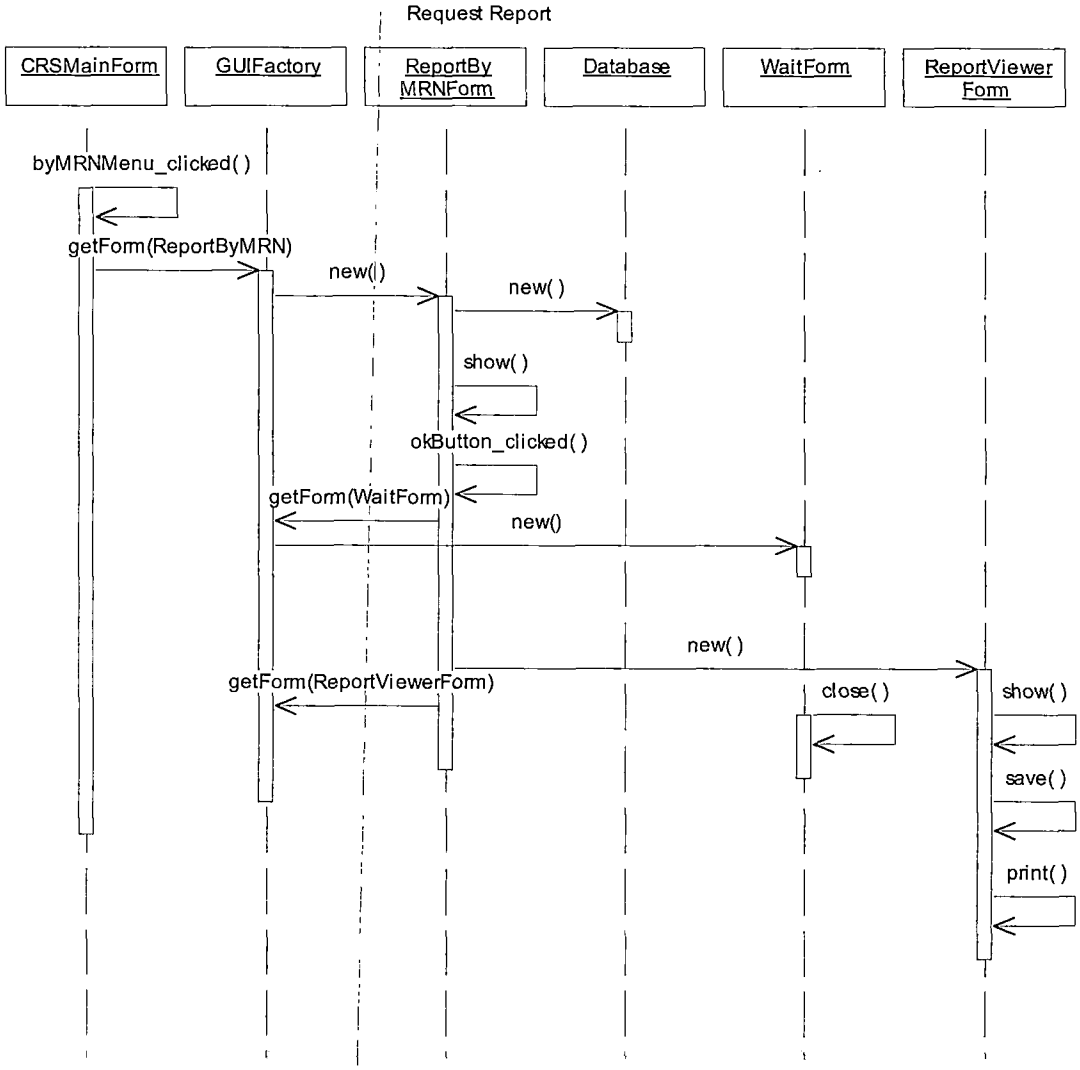

Change Password
CRSMainForm
GUIFactory
ChangePswd Form
Database
changeLoginMenuItem_clicked( )
getForm(ChangePswdForm)
new( )
new( )
show( )
okButton_clicked( )
ExecuteReader( )
ExecuteNonQuery(
MessageBox.Show( )
close( )


Create Patient Record
CRSMainForm
GUIFactory
CreatePatient Form
PatientProc
Database
createNewRecordMenuItem_clicked( )
getForm(CreatePatientForm)
new( )
show( )
saveButton_clicked( )
validateInput( )
new( )
new( )
ExecuteNonQuery(
MessageBox.Show( )

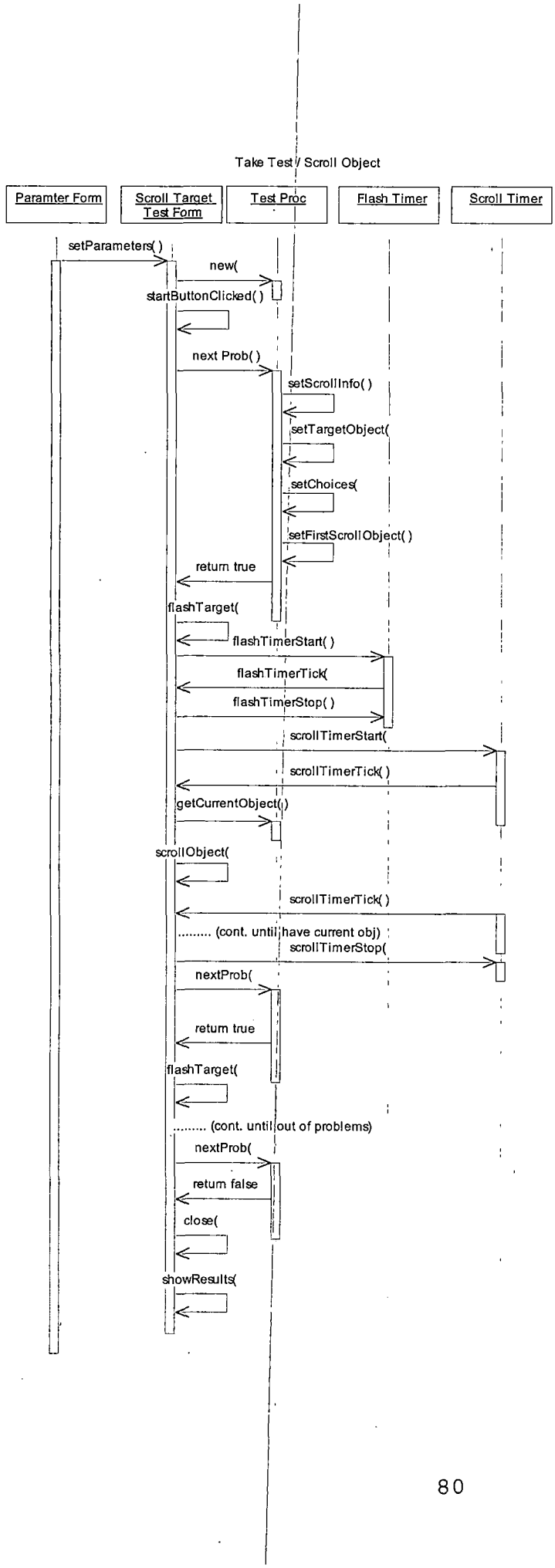

Edit Patient Record
CRSMainForm
GUIFactory
EditPatientForm
PatientProc
Database
editRecordMenuItem_clicked( )
getForm(EditPatientForm)
new(
show(
mmCbox_select( )
editButton_clicked( )
okButton_clicked( )
validateInput( )
new( )
new( )
ExecuteNonQuery(
MessageBox.Show( )

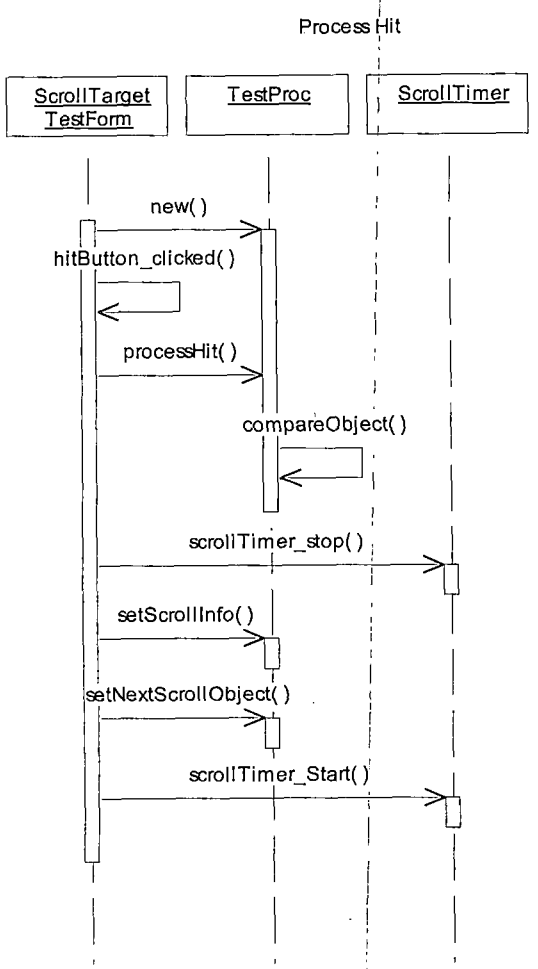

Delete Patient Record
CRSMainForm
GUIFactory
DeletePatient Form
PatientProc
Database
deleteRecordMenu_clicked( )
getForm(DeletePatientForm)
new( )
show( )
okButton_clicked( )
new( )
new( )
ExecuteNonQuery(
MessageBox.Show( )


Modify Parameters & Administer
CRSMainForm
GUIFactory
ScrollTargetTest ParameterForm
ScrollTarge TestForm
scrollTargetAdmin_clicked( )
getForm(ScrollTargetParamForm( ))
new( )
show( )
setTestName( )
okButton_clicked( )
getForm(ScrollTargetTestForm)
new( )
setParameters( )
show( )



Note: Similar interaction diagram for all types of report request.


Take Test / Scroll Object
Paramter Form
Scroll Target Test Form
Test Proc
Flash Timer
Scroll Timer
setParameters( )
new(
startButtonClicked( )
next Prob( )
setScrollInfo( )
setTargetObject(
setChoices(
setFirstScrollObject( )
return true
flashTarget(
flashTimerStart( )
flashTimerTick(
flashTimerStop( )
scrollTimerStart(
scrollTimerTick( )
getCurrentObject( )
scrollObject(
scrollTimerTick( )
..... (cont. until have current obj)
scrollTimerStop(
nextProb(
return true
flashTarget(
..... (cont. until out of problems)
nextProb(
return false
close(
showResults(


Process Hit
ScrollTarget
TestForm
TestProc
ScrollTimer
new( )
hitButton_clicked( )
processHit( )
compareObject( )
scrollTimer_stop( )
setScrollInfo( )
setNextScrollObject( )
scrollTimer_Start( )

Database Schema

Patient

First Name	Last Name	Middle Name	MRN	Diagnosis	Injury Date	Treatment StartDate	Neuro-psychologist

Test

TestName	Category	Description

Parameter

TestName	ParameterName	High	Low

PatientTestInfo

ID	MRN	TestName	DateOfTest	Score

Score

ID	Score	Hit	Miss	Ignore	Detail

ParameterSetting

ID	ParameterName	Value

ImageDescription

ID	Shape	Variant	Color	Rotation	FilePath

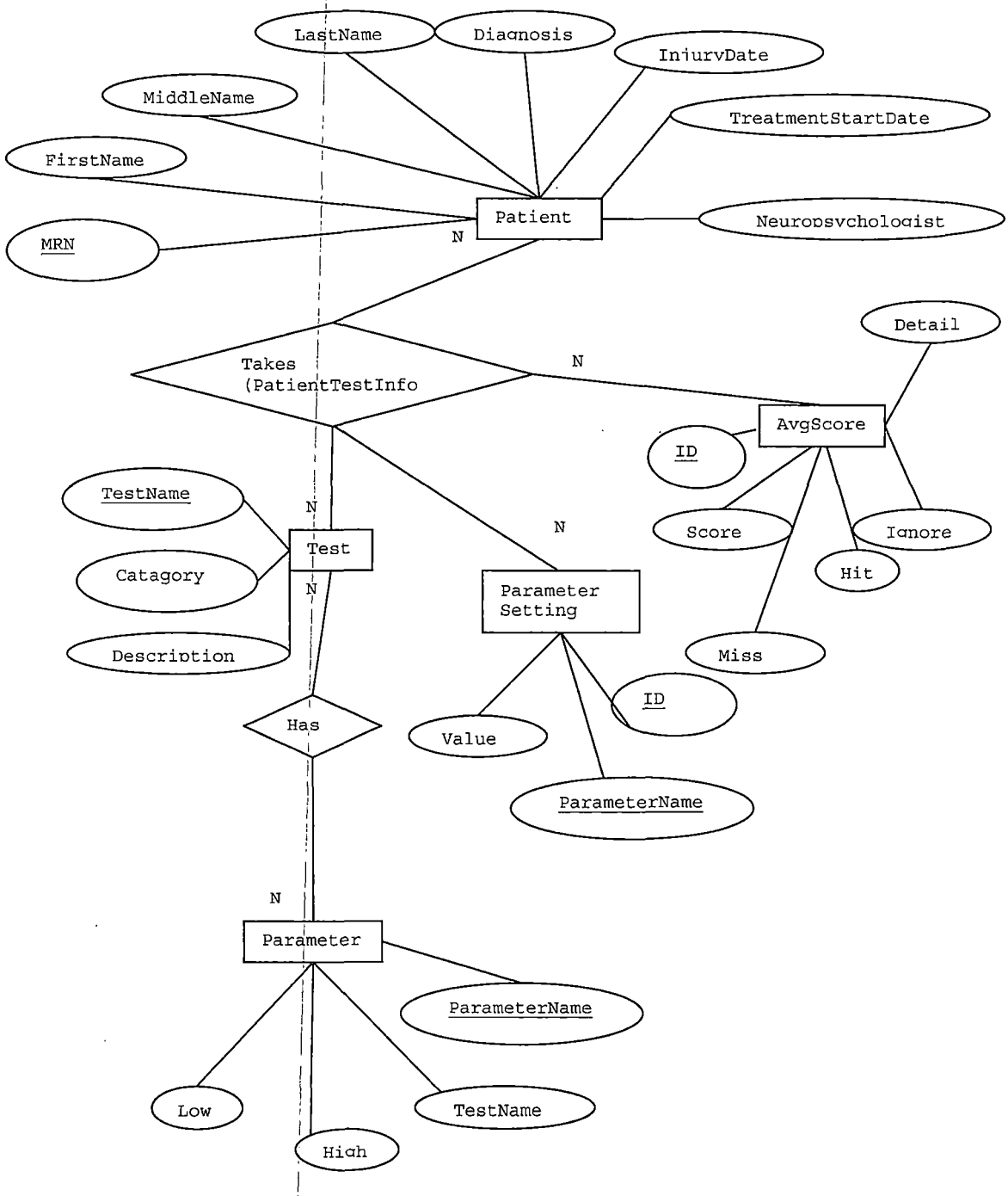
Users

UserName	Pswd

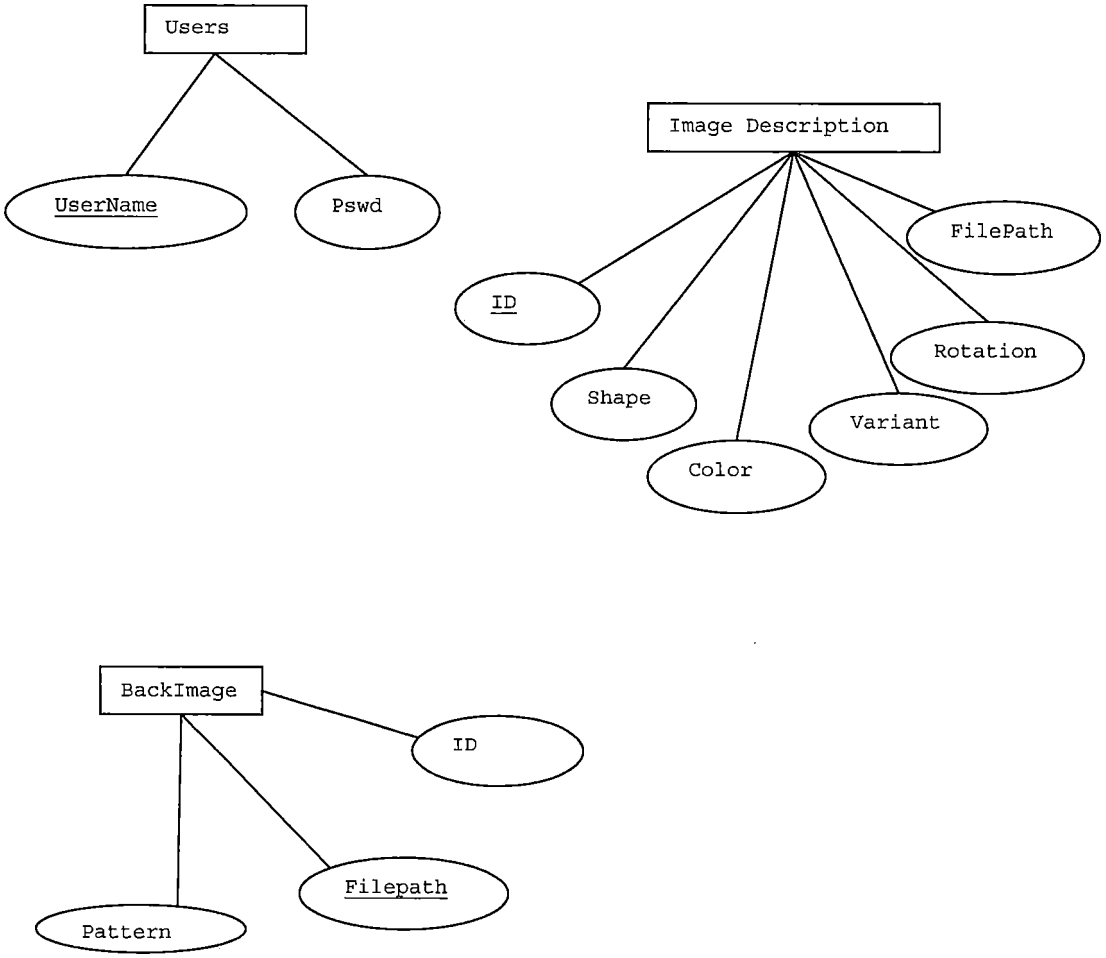
BackImages

ID	FilePath	Pattern

ER Diagram I

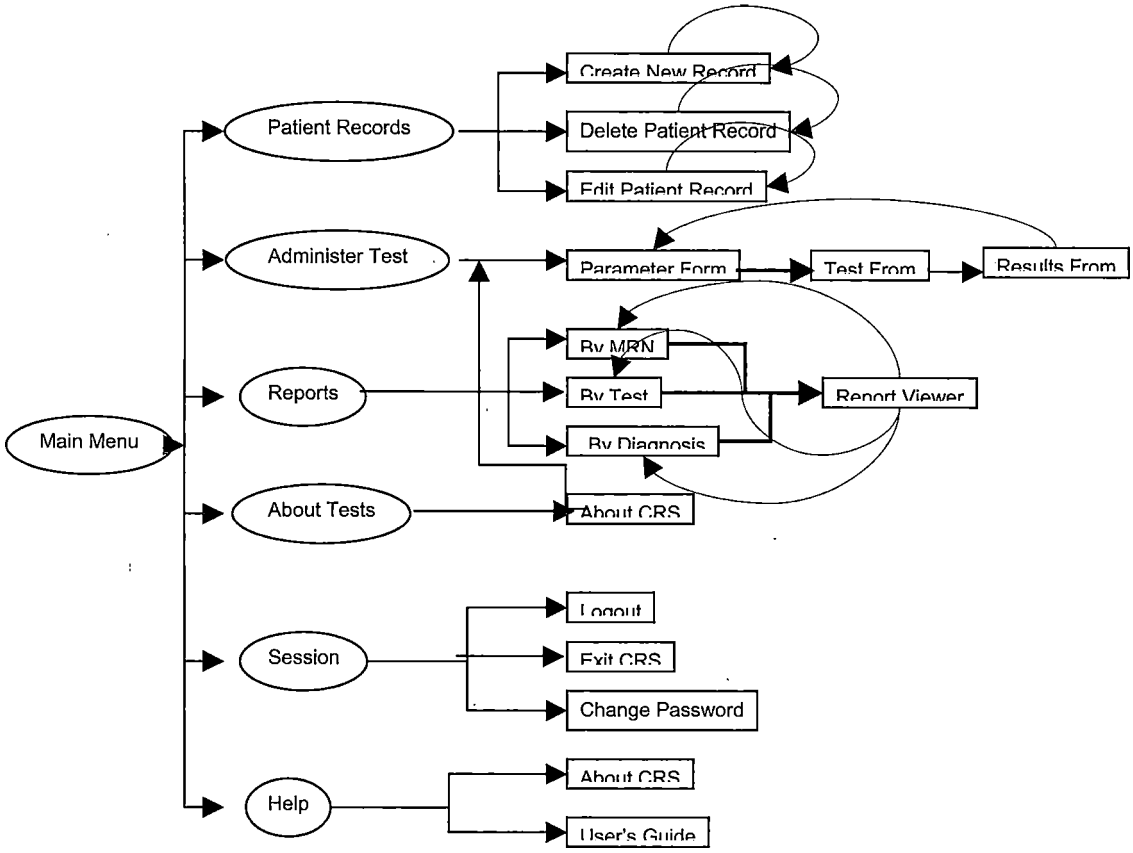

LastName
Diagnosis
InjuryDate
MiddleName
TreatmentStartDate
FirstName
Patient
Neuropsychologist
MRN
N
Takes
(PatientTestInfo
N
Detail
AvgScore
ID
TestName
N
N
Test
Score
Ignore
Catagory
N
Parameter
Setting
Hit
Description
Miss
ID
Has
Value
ParameterName
N
Parameter
ParameterName
Low
TestName
High

ER Diagram II



APPENDIX B

GRAPHICAL USER INTERFACE DIAGRAM


Main Menu
Patient Records
Create New Record
Delete Patient Record
Edit Patient Record
Administer Test
Parameter Form
Test From
Results From
Reports
By MRN
By Test
By Diagnosis
Report Viewer
About Tests
About CRS
Session
Logout
Exit CRS
Change Password
Help
About CRS
User's Guide

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