Developing a Three-Tier Web Data Management Application for Higher Education Admission Environment

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Abstract: *The work presents a framework for a web-based database management application that concerns announcing the yearly Iraqi ministerial college admissions. The framework is based on three-tier architecture: the client, the server, and the Database Management System (DBMS) which are combined in a web application. The Three-Tiers are designed to comprise four layers: Presentation, Business Logic, Data Access Logic, and Database layers. The Presentation Layer is responsible for providing portable presentation logic and results transformation. The Business Logic Layer deals with the client requests and redirects them to the data access logic layer. The Data Access Logic layer provides access to the database by executing a set of pre-defined SQL queries. The fourth layer is the Database Layer which consists of SQL-Server 2008. The work provides a three-tier architecture technology for the construction of a Web Data Management System, which aims to solve data management and publication, website resources construction, as well as editing and browsing online issues. Besides, the system can be used effectively and conveniently. Security has been embedded into the system by applying appropriate security development patterns.*

The technical environment used for system development provides flexibility and interoperability on variety of operating platforms.

Keywords: *Three-tier Architecture, DBMS, Web Content Management, Client/Server, Integrated Platform*

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1. Introduction

The three-tier architecture pattern provides a means of structuring and decomposing applications into three tiers or layers, where each tier provides a different level of responsibility. One tier deals with the presentation part of the system (user and system interfaces), another handles the business logic, being the core of the system, and the last tier is representing the data storage [3].

Enterprise applications are typically implemented as three-tier architectures that consist of clients in the front tier, servers that perform the application business logic processing in the middle tier, and databases that store the application data in the back-end tier [9].

World Wide Web has brought a lot of challenges, such as infinite contents, resource diversity, maintenance and update of contents. Web based database (WBDB) is one of the answers to these challenges. Currently the most commonly used WBDB architecture is three-tier architecture [1].

Typical three-tier systems have some nice properties: clients are thin, application states are stored in database, and the middle servers are stateless. This makes three-tier systems well scalable and manageable [2].

Many complex issues have to be considered when designing an N-Tier client/server system. This includes tools used to build the front end (client interface), middleware (software layer that enables information communications between the client and server), and hardware that would be best for the clients and the servers. Topics ranging from software engineering to distributed computing technologies must be considered [7].

The Three-Tier Architecture pattern and its variants have been around for a while and there are several researches introducing systems based on this architecture.

He Liduo and Chen Yan [4] provide a J2EE-based three-tier architecture technology for the construction of Web Content Management System, which aims to improve the effectiveness of development, management, and maintenance in web applications.

Leite et al. [5] present a software tool based on a three tier-architecture known as Migratool. It aims to easy the geospatial data migration among both distributed and heterogeneous data sources.

Te-Kai Liu et al. [8] investigate a model based approach for performance engineering of three-tier enterprise Java applications. A layer queuing model is proposed comprising the layers of client applications, session beans and entity beans as business logic, and

Enterprise Information Systems (EIS) representing the data layer.

Rykowski, and Wieczerzyck [6] propose a new architecture for web servers. This architecture is of three-tier type, and it is composed of a query language interpreter as the interface to the server, a specialized object-oriented database of resources as an engine, equipped additionally with semi-transaction and user managers, and an XML wrapper as a gateway to data repositories.

This paper proposes an application for a three-tier web-based management system that can serve for announcing the Iraqi ministerial college admissions. The main research objective of this paper is to develop a system that does not depend on a platform and has the characteristics of high flexibility, expansibility and reusability.

The rest of this paper is organized as follows. Section 2 discusses proposed system architecture. Section 3 presents system design concepts. Section 4 discusses additional system activities. Section 5 focuses on implementation issues. Finally, section 6 concludes this paper.

2. System Architecture

The proposed system supports a web site that provides a database related services based on three-tier architecture. However, the proposed system has been designed to comprise four main layers:

- Presentation Layer: This is a front-end component, which is responsible for providing portable presentation logic. The Presentation Layer physically lies in the client machine. Since the client is freed of application layer tasks, this eliminates the need for a powerful client technology (thin client). The presentation logic layer consists of standard ASP.NET web forms, ASP (Active Server Pages), documents, and Windows Forms. This layer transforms the results/output of the business logic layer into a form usable and readable by the client. The client can retrieve the services proposed by his (her) Internet browser on the local machine, and get the data through the Internet.
- Business Logic Layer: The business layer functions between the presentation layer and data access logic layer sending the client's data requests to the database layer through the data access layer after converting the request(s) to an SQL Query. This layer is located physically on the server that hosts the web service.
- Data Access Logic Layer: Provides access to the database by executing a set of SQL statements or stored procedures. This is where the developer will write generic methods to interface with his (her) data. For example, writing a method for creating and opening SQL connection object, creating SQL command object for executing a stored procedure, etc. The data access logic layer contains no business rules or data manipulation/transformation logic. It is merely a reusable interface to the database.
- Database Layer: It is made up of a DBMS component namely the SQL Server that provides the mechanism to store and retrieve data and grant the permissions to each user as it is planned by the system administrator.

The Three-Tier system basically works as illustrated in figure 1.

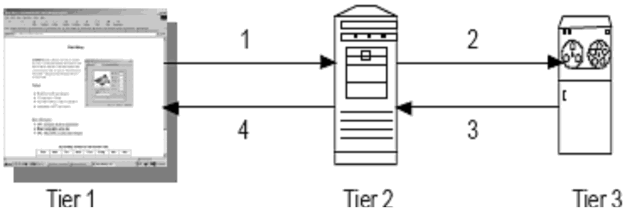


Figure 1. Three-Tier Application Interaction.

- The client application (Internet browser) receives input from the users and sends a request to the server tier.
- The server application receives and processes the request, passing it to the database tier (SQL server).
- The database retrieves data and sends the data to the server application.
- The server application receives the data, executes the SQL-query and passes the result to the client application.

In this work, a modified three-tier application interaction model has been applied. The proposed system uses the server as a bridge between the client and the SQL-Server, and the web server mainly redirects the log-in requests to the SQL-Server. Thereafter, the user interacts with the SQL-Server directly as an authorized user of the SQL-Server itself. However, the clients' requests are translated by the server through the "Business Logic Layer" to SQL-requests and transferred to the "Data Access Logic Layer". Then, these requests are relayed to the SQL-Server. The SQL-queries are executed in the database engine and then the resulted data are sent back to the web server where the job of the web server is just data translation. The benefit of this architecture is that it allows flexible management of a cluster of computers for better performance.

3. The proposed System Design

Building the proposed system has been granted through a multi-stage process.

3.1. Connecting To The DBMS

The connection to the DBMS (SQL server 2008) is done by using the Microsoft visual studio 2008, and managed by the. NET Framework which is integrated in Visual Studio libraries. The SQL server contains the system database that consists of 21 tables. 20 tables comprise university admission results for the 20 territories of Iraq (14 governorates, and 6 territories of Baghdad), and one table for the authorized administrators. The connection is established using a simple but efficient process that at first connects the visual studio to the SQL server and then explores the database that is integrated into the SQL server. When connected, the visual studio makes a full benefit of the SQL-Server and the database employed. That is it has the full control of the server contents, such as adding a new database or managing databases. This would deploy the tables into the application created by the visual studio.

3.2. Creating The Application Pages

Each table in the selected database has been used in creating an asp.net page in the web application by importing the database contents to the web page and also importing all the possible operations that could be done on the database. So the client can browse the table in his (her) own browser with all the controls and operations such as (add, delete, edit, view). However, this is done with permission limitations according to the user level permissions for each user.

The pages are mainly created by the C# 3.5 language which is fully compatible with the ASP.NET application and the Visual Studio .Net. A separate page is created for each operation with an additional confirmation page for the data alteration (add, edit, delete).

3.3. Creating The Search Operation

The search operation is the most functional and usable process in this work. It simply allows the client to search within the requested table to find a single or multi entries in the table. This function is executed by opening a direct connection to the system database, and execution an SQL command. The system introduces three types of searches: “exact phrase”, “all words”, and “any word”. Each of these searches has a different scenario and a related set of results. Figure (2) illustrates the proposed search activity.

3.4. Publishing The Service

The final project is compiled and published on the local Internet Information Server IIS (Microsoft’s web server that runs on the Windows platforms) using the visual studio and tested by the IIS locally. The importance of the publishing process comes from the fact that the web application cannot be tested as a whole without being published first.

3.5. Securing The Proposed System

The security is a major concern in the web development area, especially regarding the public nature of the communication media: the Internet in our case. That is the information sent or received is very vulnerable, according to the existence of attackers and malware applications.

The suggested system involves the use of three levels of security. The first level is the authorization step. The administrator has a username-password combination saved as a table in the system database. This sensitive data is protected by the embedded SQL server security measures.

Second level involves the deployment of the Secure Sockets Layer (SSL), which is specifically used to secure communication between clients and web server keeping user's data in secure transmission via Internet. It realizes the security functions of data confidentiality, data integrity and endpoint authentication.

Finally, the research designs and implements a data integrity checking system based on Message-Digest Algorithm 5 (MD5). This aims to solve the susceptible problem about user’s password safety guard. After disposing SSL in a web server, the random data provided by the server’s script is encrypted and user’s password is saved in the system with MD5. In this way the susceptible information transferred between the server and browser and saved in the database is ensured to be in a confidential format.

4. Proposed System Activities

The proposed system offers all facilities of a “stand alone” DBMS.

4.1. User Level Management

The proposed system offers three main user levels. The system administrator has the full privilege of database system management. He can modify, add or delete any table entry and can manage the user levels supported by the proposed system. The second user level is called “Table Administrator” where this user can manage just one table as an administrator related to one territory or governorate. The third user level is the “anonymous” user, where this user can only view the tables of the proposed system.

The proposed system gets the user level from the SQL-Server itself, where customized user levels are created by the system administrator through the “employees” table. This table is a multi column table with one column specifying the user level. This column has pre-defined values that refer to the user levels assigned for each table. The system supports one administrator for

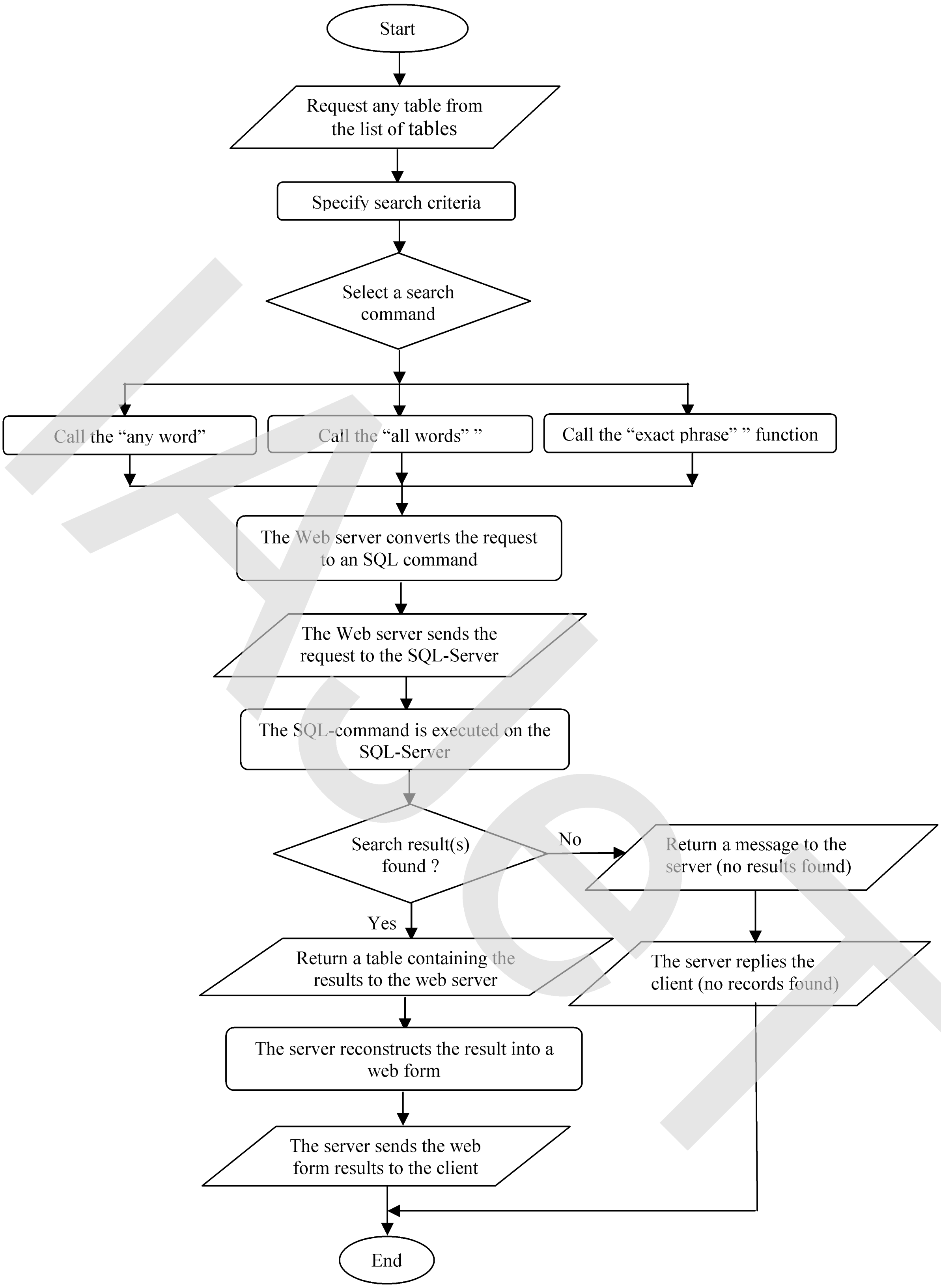

Start
Request any table from the list of tables
Specify search criteria
Select a search command
Call the "any word"
Call the "all words" "
Call the "exact phrase" " function
The Web server converts the request to an SQL command
The Web server sends the request to the SQL-Server
The SQL-command is executed on the SQL-Server
Search result(s) found ?
No
Return a message to the server (no results found)
Yes
Return a table containing the results to the web server
The server replies the client (no records found)
The server reconstructs the result into a web form
The server sends the web form results to the client
End

Figure 2. Search Activity Sequence.

each table and a system administrator that is registered in the same table, and encrypted in the web server.The system introduces user levels from (1, 20) corresponding to the 20 territories of Iraq. As an example the "الكرخ الاولى" table has one administrator; which has the "1" user level. So when this user logs into the system it invokes the created class which it will in turn call the user level value from the "administrator table" and converts it to the pre-defined user level. This will grant the designated user a full control of the related table management. The system administrator has a full control of all the tables including the "administrators table".

4.2. Addition Process

Both of the system administrator and a table administrator can invoke an “add” new entry process for his (her) assigned table(s). When the client invokes an “add” new entry process, the system checks the authorization and validity of data type entered by the client. Consequently, the system confirms the client and the related table is updated accordingly. The edit process resembles the add process, but as the name suggests, the edit process is to modify an existence entry while the add process is to add a new entry.

4.3. Delete Process

Delete decision differs slightly from the other processes where no need to invoke a separate delete page, however a confirmation page is required. The system supports a single or multiple deletes as the client requests.

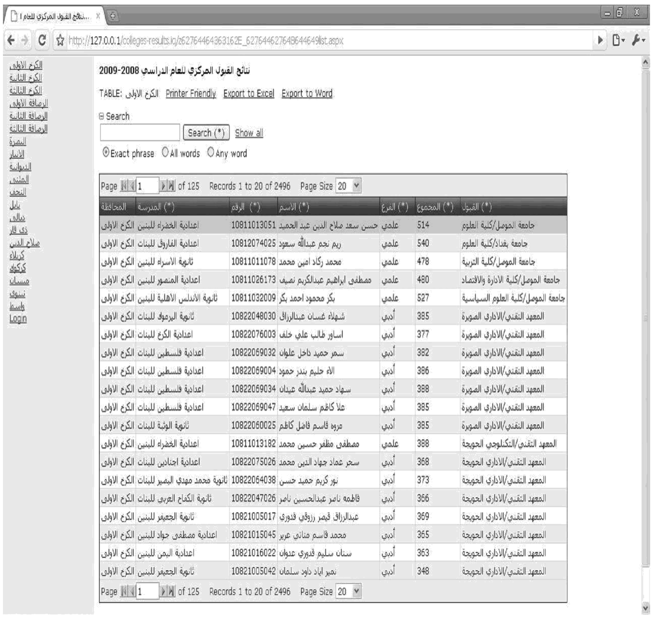
4.4. Proposed System Additional Facilities

Several additional facilities have been augmented and integrated within the proposed system to introduce a full-fledged web-based database management system:

- The proposed system is occupied with a log file to track the activity of the system administrator.
- The proposed system is occupied with a full online registration option.
- The proposed system supports session timeout. This feature allows to 'time out' administrators if they do not interact with the web page for a certain number of minutes. This acts as a security feature to allow the designated web-based application to logoff privileged users if they do not interact with the server periodically. A timer on the page and a status bar displays the time remaining before timing out.
- A java script code is supplied for the system GUI enhancement issues. This gives the application a dynamic visual experience with a “mouse over” event applied allowing the row to appear in a different color whenever the mouse passes over that area.
- Auto-Suggest in the fields (search, add, edit, and update) is enabled.

5. Implementation

A connection to the SQL-Server is done using the Visual Studio.Net and the database imported. The proposed system interacts with each table and form individually. Each table is called individually to create a separate page for each activity such as view, add, delete, edit. Each page simply interacts with a single table by opening a connection to the SQL-Server and then to the selected integrated database and therefore to the specific table in the database. The home page for the proposed system contains links to all tables of the selected database. Figure 3 shows a snapshot of one of the table’s entries.



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http://127.0.0.1/colleges-results.iq/z627644643631 62E_627644627648644649list.aspx

الكرخ الاولى
الكرخ الثانية
الكرخ الثالثة
الرصافة الاولى
الرصافة الثانية
الرصافة الثالثة
البصرة
الانبار
الديوانية
المثنى
النجف
بابل
ديالى
ذي قار
صلاح الدين
كربلاء
كركوك
ميسان
نينوى
واسط
Login

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TABLE: الكرخ الاولى Printer Friendly Export to Excel Export to Word

⊟ Search

Search (*) Show all

● Exact phrase ○ All words ○ Any word

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المحافظة	المدرسة (*)	الرقم (*)	الاسم (*)	الفرع (*)	المجموع (*)	القبول (*)
الكرخ الاولى	اعدادية الخضراء للبنين	10811013051	حسن سعد صلاح الدين عبد الحميد	علمي	514	جامعة الموصل/كلية العلوم
الكرخ الاولى	اعدادية الفاروق للبنات	10812074025	ريم نجم عبدالله سعود	علمي	540	جامعة بغداد/كلية العلوم
الكرخ الاولى	ثانوية الاسراء للبنين	10811011078	محمد ركاد امين محمد	علمي	478	جامعة الموصل/كلية التربية
الكرخ الاولى	اعدادية المنصور للبنين	10811026173	مصطفى ابراهيم عبدالكريم نصيف	علمي	480	جامعة الموصل/كلية الادارة والاقتصاد
الكرخ الاولى	ثانوية الاندلس الاهلية للبنين	10811032009	بكر محمود احمد بكر	علمي	527	جامعة الموصل/كلية العلوم السياسية
الكرخ الاولى	ثانوية اليرموك للبنات	10822048030	شهلاء غسان عبدالرزاق	أدبي	385	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية الكرخ للبنات	10822076003	اساور طالب علي خلف	أدبي	377	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية فلسطين للبنات	10822069032	سمر حميد داخل علوان	أدبي	382	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية فلسطين للبنات	10822069004	الاء حليم بندر حمود	أدبي	386	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية فلسطين للبنات	10822069034	سهاد حميد عبدالله عيدان	أدبي	388	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية فلسطين للبنات	10822069047	علا كاظم سلمان سعيد	أدبي	385	المعهد التقني/الاداري الصويرة
الكرخ الاولى	ثانوية الوثبة للبنات	10822060025	مروه قاسم فاضل كاظم	أدبي	385	المعهد التقني/الاداري الصويرة
الكرخ الاولى	اعدادية الخضراء للبنين	10811013182	مصطفى مظفر حسين محمد	علمي	388	المعهد التقني/التكنلوجي الحويجة
الكرخ الاولى	اعدادية اجنادين للبنات	10822075026	سحر عماد جهاد الدين محمد	أدبي	368	المعهد التقني/الاداري الحويجة
الكرخ الاولى	ثانوية محمد مهدي البصير للبنات	10822064038	نور كريم حميد حسن	أدبي	373	المعهد التقني/الاداري الحويجة
الكرخ الاولى	ثانوية الكفاح العربي للبنات	10822047026	فاطمه ناصر عبدالحسين ناصر	أدبي	366	المعهد التقني/الاداري الحويجة
الكرخ الاولى	ثانوية الجعيفر للبنين	10821005017	عبدالرزاق قيصر رزوقي قدوري	أدبي	369	المعهد التقني/الاداري الحويجة
الكرخ الاولى	اعدادية مصطفى جواد للبنين	10821015045	محمد قاسم مناتي عرير	أدبي	365	المعهد التقني/الاداري الحويجة
الكرخ الاولى	اعدادية اليمن للبنين	10821016022	سنان سليم قدوري عدوان	أدبي	363	المعهد التقني/الاداري الحويجة
الكرخ الاولى	ثانوية الجعيفر للبنين	10821005042	نمير اياد داود سلمان	أدبي	348	المعهد التقني/الاداري الحويجة

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Figure 3. A Snapshot of a Table Entry.

The first (20) entries in the table of (الاولى الكرخ) are shown in the client display. The operations allowed are related to the user level granted by the system. The GUI applied is a friendly and easy to use web interface but with database related functions. So the user will experience a special database engine using his (her) normal Internet explorer without the need to special software like a database viewer.

6. Conclusions

The present work developed a web-based solution based on three-tier architecture that deals with DBMS for publishing the ministerial college admissions in Iraq. The aim of the solution is to reduce the design complexity, facilitate architecting information system applications, and provide an efficient way for management and data retrieval.
The main conclusions drawn are:

- The solution is based on a modular design, which enhances scalability and maintainability. For example, it is easier to modify or replace the database-tier without affecting the other tiers.
- The proposed system acts as an online web based data administration which facilitates data retrieval, editing and online entry of information.
- The proposed system demands a limited data transition between the client and the web server, which eliminate the need for a high speed channels, or a wide bandwidth connection on the client side to use the offered services
- Adequate security policies have been enforced within the Business Logic layer and Database layer without hindering the system administrators.

- Transparency is granted. The user accesses the system without being aware of the interactions being carried between system modules.
- This system can get a benefit from the Internet cashing services provided by the main search engines to reduce the retrieval time.
- The proposed system could support access by mobile devices because it does not demand extra software, hardware or browsing requirements, but it requires a functional third party browser.

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