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Telemedicine Application for Distant Management of Oro-maxilo-facial Tumors

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Abstract – TeleOralTum software is intended to collect on one server specific data from departments that work on the facial cancer diagnosis. Classical medical services imply the existence of a direct link between medical staff in different departments and the patient. Telemedicine is an old concept, which arise debates for more then 30 years. The application that we developed proves the need for a diagnose and management system that will allow a rapid gathering of data, a rapid elaboration of the diagnose, but also elaboration of reports and estimates that are so much needed in this field of medical research. The application works on a three layer distributed architecture, thus taking advantage of a high security for the patient data, easiness in splitting the work among software development teams, and also the easiness in which other medical departments can be added to the application. The user administration section is used to divide the accessibility domain for different types of client users. The architecture of TeleOralTum is an innovative one and has at its origin open-software tools.

Keywords: telemedicine, medical management, Hibernet, telediagnosis.

I. INTRODUCTION

Telemedicine is intended to raise the standards of the actual medical act, by using electronic content management and state of the art telecommunication techniques. Classical medical services are limited by a certain geographical area, area defined by where the medical specialist work, and also by the pour capabilities of structuring data. The medicine applications are a modern and viable alternative in the development of the medical science. Among the benefits of telemedicine we can see the access of rural area patients to state of the art medical solutions that can be found only in urban areas. The telemedicine applications are divided in clinical related applications, and non clinical related applications. Among the last ones we can find the medical educational applications, and the information management applications that use digital telecommunications. The clinical applications deal with diagnosing and treating patients using teleconference systems, telediagnosis systems, or telemonitoring systems of patients.

By looking at the specifications for implementation of the TeleOralTum application we can classify it as a non clinical tele-oncologycal application, which serves at the study of oro-maxilo-facial cancer.

The application wants to implement an electronic management system for the oro-maxilo-facial tumors cases, which with the help of telemedicine will allow the collaboration between different medical centers involved in the treatment of this kind of disease. Telemedicine is at the boundary between medical science and state of the art technology, and appeared with the purpose of enhancing the existing medical services (Figure 1).

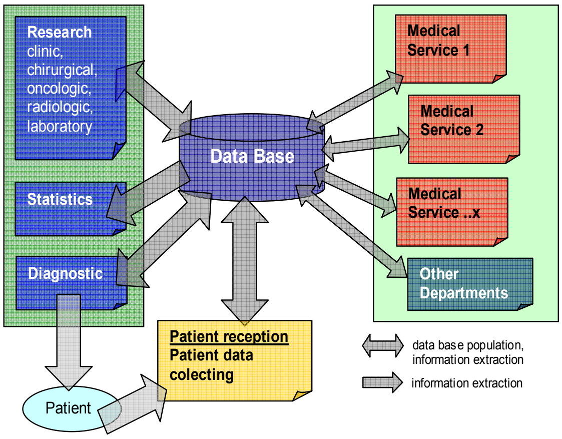

Figure 1 The architecutre of the telemedicine/telediagnosis application

The TeleOralTum is a telemedicine project developed by the Center of Multimedia Technologies and Distance Education (CTMED) from the Technical University of Cluj-Napoca, in collaboration with the Medicine and Pharmacology University from Cluj-Napoca. The project aims to develop a web application using the Microsoft .Net technology and the database server Microsoft SQL Server. The application brings to the user an attractive, intuitive

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and easy to use graphical interface. We also decided to implement this application in such a way that it will be easy to develop it in the future. When designing the software architecture we took into consideration that in the future other medical departments, which have interest in the results from this field of research, will be integrated. TeleOralTum can be very easily adapted, the software intervention in this direction are very small and they are not resource consuming. The application is portable on multiple database servers, even without the recompiling the source files.

This project main objective is to develop a database containing the cases of patients with oral cancer. The implementation of the application that will generate and manage this database has the following objectives:

- an improved management of information gathered from different medical departments involved in the diagnosis and monitoring of oral cancer,
- the elaboration of an exact epidemiologic report,
- the evaluation of risk factors that may cause tumors,
- standardization of the diagnosis, cure criteria, and patient monitoring,
- monitoring in time of medical cases.

II. APLICATION ACHITECTURE

The TeleOralTum architecture is distributed on three layers (Figure 2), in order to take advantage of the distributions capabilities. The three layer architecture is composed of:

- the web layer,
- the application layer,
- the data layer.

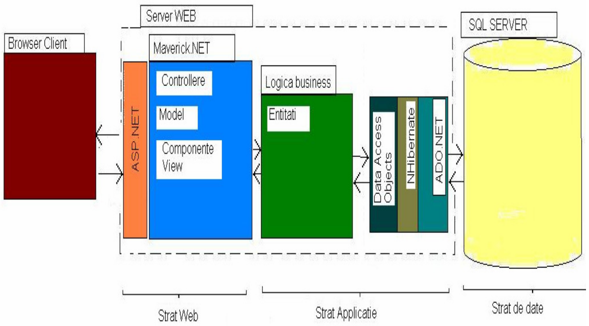


Figure 2 The architecture of the TeleOralTum application

The web layer is responsible for taking the client requests and sending them to the application layer. When the application layer finishes serving the request, the web layer composes the answer that will be sent back to the client, and displayed. The application layer is responsible for the logics of the application. The data layer contains the database server and the database. The three layer architecture increases the reusability of the software components for similar applications, as well as in the case when we need to move the application on a different database, or in the case when the web layer is replaced by a different web layer or by a windows interface. The security of a three layer application is increase because one is able to implement three points that check the authenticity of the client: at the web gate, at the application gate, and at the database entry.

The Web Layer

Microsoft ASP.NET offers for the web layer an architecture model based on treatment of events triggered by the user. The server keeps in a HTTP variable the state of all the HTTP parameters from every page, and in the moment when an entity from the web browser is modified, the server knows what event was triggered, and will treat that event in a special routine. This approach is based on the command of the desktop graphical interfaces. ASP .NET doesn’t offer the implementation of the MVC frame (Model-View-Controller). The Model-View-Controller (MVC) frame consists in the division of the application in function blocks: the Model, the View Components, and the Controller. What we have chosen is an open source project, called Maverick.NET, which is a replica of the MVC framework called Maverick, developed in Java technology. Maverick .NET is minimal and extensive MVC framework which offers the following functionalities:

- the routing of requests and answers taking into account a configuration map written in XML,
- the construction of View controls based on the ASPX or XSLT page transforms, or based on the type of the model defined for a certain request,
- the possibility of globalizing (of internationalization) of the application,
- the easy extension of the framework.

The Application Layer

The application layer consists of Business Logic objects, Data Access Objects and Entity objects. This layer is designed of the ADO.NET library, a set of utilitarian classes for the management of data base connections using .NET. On top of the ADO.NET we placed the Nhibernate [NHibernate] framework, a persistence layer that makes the connection between the object world of the business entities used by the business logic, and the rational world of the tables used in the database. We didn’t use ADO.NET, because our application works directly with the Nhibernate framework, and thus is independent of the database server. So we didn’t use the Microsoft layers that regard the connection and management of databases, because as themselves stated in the article [Microsoft1] don’t correspond to the needs of business application. From the ADO.NET technology, Nhibernate uses the pooling connection technology [Gamma], which manages the data base

connections. The Nhibernate technology is a predecessor of the successful Hibernate technology, that was developed in Java and that wined the race of the relational-object mapping frameworks. We can read about the Persistence Layer in the [Mark]. The idea of the Persistence Layer framework consists in the existence of a special sub-layer of the application which offers an interface for the business entities.
On the tables from the data base we mapped the business entities using XML configuring files. The link between the relational and object world is not made in a programmatic fashion because the XML files can be modified without the need of recompiling the application.

The advantages of this technology are: the independence from the database server that we use for the application; the integration of the ADO.NET technology, which lets us take advantage of the pooling technology; the use of the business object entities to manage data from the data base. The disadvantages of using this technology consist in the increased code and memory redundancy, due to the fact that the server has to maintain the map of the business entity objects, and because the translation of the HQL (Hibernate Query Language) queries in data base specific queries increases the time of task completion.

Nether the less we must remember that C# and ASP.NET are technologies that offer a much smaller execution time then Java technology.

Data Base Layer

This is the most sensitive layer of the application because it contains the data itself. This layer consists of a Microsoft SQL Server 2000 data base server, which will host the data for our application.

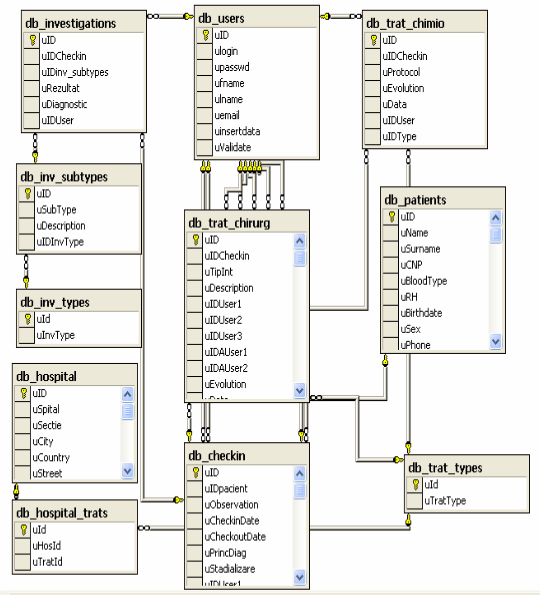
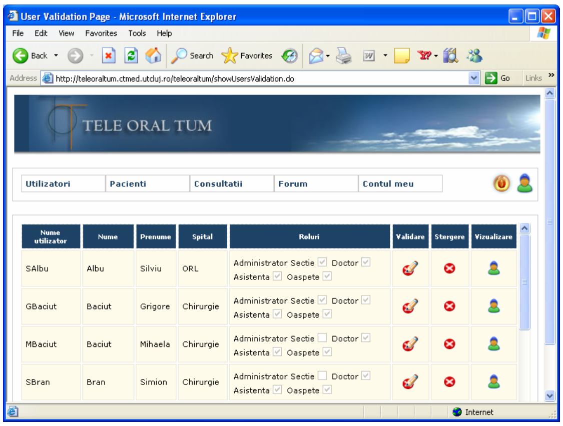


Figure 3 The data base table diagrams

Because we use a persistence layer for the management of the date in the data base, we don't need to use stored procedures, all the management queries used to manipulate the data from the data base being written in HQL (Hibernate Query Language), language that is independent of the data base platform. We choose the Microsoft data base server because is a very stable, reliable tool, which proved its efficiency in other applications that we developed.

III. APPLICATION DESCRIPTION

The application defined five different roles: *the general administrator, the department administrator, the medic, the nurse* and *the guest.*


User Validation Page - Microsoft Internet Explorer

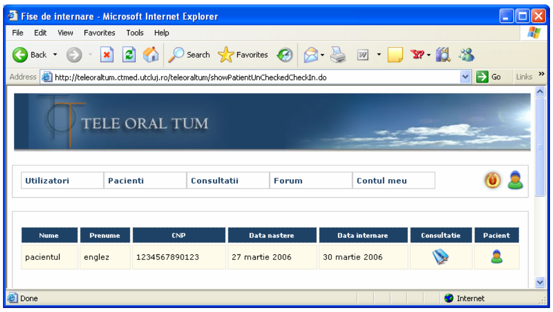
Address http://teleoraltum.ctmed.utcluj.ro/teleoraltum/showUsersValidation.do

TELE ORAL TUM

Nume utilizator	Nume	Prenume	Spital	Roluri	Validare	Stergere	Vizualizare
SAlbu	Albu	Silviu	ORL	Administrator Sectie ☑ Doctor ☑ Asistenta ☑ Oaspete ☑			
GBaciut	Baciut	Grigore	Chirurgie	Administrator Sectie ☑ Doctor ☑ Asistenta ☑ Oaspete ☑			
MBaciut	Baciut	Mihaela	Chirurgie	Administrator Sectie ☐ Doctor ☑ Asistenta ☑ Oaspete ☑			
SBran	Bran	Simion	Chirurgie	Administrator Sectie ☐ Doctor ☑ Asistenta ☑ Oaspete ☑			

Figure 4 The user management (administration) page

Every user that joins the application has to choose a role. If the user subscribes as a guest, he will be automatically validated, and so he will be able to enter in the forum to read the existent debates. For every other role the user request for subscription must be validated according to the algorithm presented in each role description. At the same time, in order to increase the flexibility of the environment, each user is able to create its own user profile. By simply validating the roles of a user, that person can be simultaneously a department administrator, a medic, a nurse or a combination of the above.
The general administrator is able make modifications in the user accounts and in their profiles. He's also able to delete patient's files after following a two step confirmation procedure.


Fise de internare - Microsoft Internet Explorer

Address http://teleoraltum.ctmed.utcluj.ro/teleoraltum/showPatientUnCheckedCheckIn.do

TELE ORAL TUM

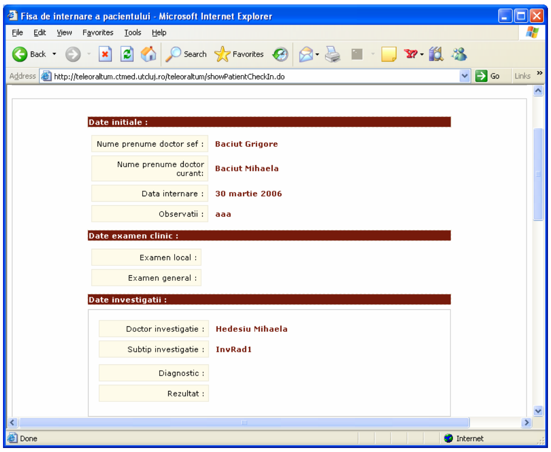
Nume	Prenume	CNP	Data nastere	Data internare	Consultatie	Pacient
pacientul	englez	1234567890123	27 martie 2006	30 martie 2006		

Figure 5 The medical appointment management page

If we need to visualize the personal user data we have to press the visualize button. The administrator is not able to see the user passwords, even if he looks for them in the data base, because they are encrypted with the MD5 algorithm. Besides the capability to validate and modify the roles of users in his validation domain, the administrator can’t change their personal data. The visualization button let the administrator user know the exact identity of the user that he wants to validate or delete. In a similar manner works the validation of medics and nurses by the department administrator, or the validation of nurses by the medics.

The department administrator manages the patients and the lower rank users (medics and nurses) from his department, but is not able to affect the users form parallel departments.

The nurse is supposed to insert the patient’s information in the database. Practically she creates a hospitalization file for each of the patients. Here the file will be completed with the patient personal data and hospitalization observations. The application offers to the nurse an array of reports that shows the list of patients with an open hospitalization file or with investigation files from her department.


Fisa de internare a pacientului - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Address
http://teleoraltum.ctmed.utcluj.ro/teleoraltum/showPatientCheckIn.do
Go
Links
Done
Internet

Date initiale :

Nume prenume doctor sef : Baciut Grigore

Nume prenume doctor curant: Baciut Mihaela

Data internare : 30 martie 2006

Observatii : aaa

Date examen clinic :

Examen local :

Examen general :

Date investigatii :

Doctor investigatie : Hedesiu Mihaela

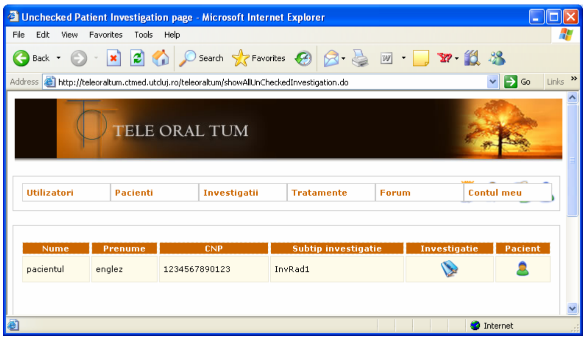
Subtip investigatie : InvRad1

Diagnostic :

Rezultat :

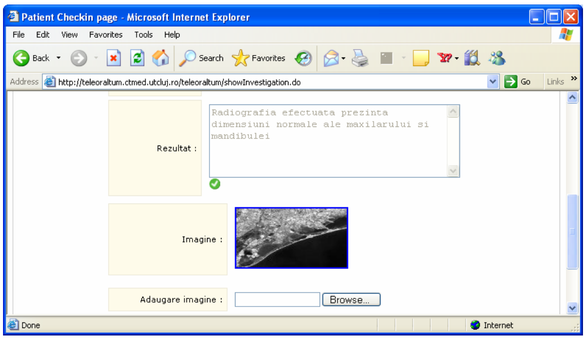
Figure 6 The page that shows hospitalization file

The medic can visualize the hospitalization files (Figure 6) of his patients. At the same time, the medic can open an investigation or treatment file at other departments then his own. The files contain textual information about the diagnostic, treatment, investigation, as well as visual information as images files, video files, DICOM files etc., which will allow the currant medic to give an accurate diagnostic. The investigation and treatment files can be seen by the department administrators, nurses of that department (Figure 7), but can be modified only by the medic that received the patient (Figure 8).


Unchecked Patient Investigation page - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Address
http://teleoraltum.ctmed.utcluj.ro/teleoraltum/showAllUnCheckedInvestigation.do
Go
Links
TELE ORAL TUM
Utilizatori
Pacienti
Investigatii
Tratamente
Forum
Contul meu
Internet

Nume	Prenume	CNP	Subtip investigatie	Investigatie	Pacient
pacientul	englez	1234567890123	InvRad1		

Figure 7 The page that show the investigation and treatment files


Patient Checkin page - Microsoft Internet Explorer
File
Edit
View
Favorites
Tools
Help
Back
Search
Favorites
Address
http://teleoraltum.ctmed.utcluj.ro/teleoraltum/showInvestigation.do
Go
Links
Browse...
Done
Internet

Rezultat : Radiografia efectuata prezinta dimensiuni normale ale maxilarului si mandibulei

Imagine :

Adaugare imagine :

Figure 8 The page that allows to edit the investigation and treatment file

Taking into account the need of communication between the users of this system, that is intended to be also a tool used in oro-maxilo-facial cancer research, the application contains also a forum module for each medical department, which gives the users the ability to open new debate themes.

IV. CONCLUSIONS

From the technology point of view the application has a degree of novelty in the field of telemedicine applications. The novelty consists in the combined use of .NET C# with the Nhibernate framework and the dynamical connection to the database using the HQL language.

TeleOralTum is in the finalization status, all that needs to be added is a series of reports that are necessary for medical departments. The reports will extract from the data base information of the current patients as well as information stored in the archive, offering the medic the ability to evaluate rapidly the degree of wellness of the patient by comparing the diagnostic and visual information from the data base.

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