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DESIGN AND IMPLEMENTATION OF A WEB-BASED HOSPITAL MANAGEMENT SYSTEM

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ABSTRACT
Hospital Management System (HMS) is a simple and a user-friendly web application where Patient Information record is stored. Traditionally, the process of storing the records of all the patients was done manually, which is a tedious and time-consuming task. With the utilization of technology for digitization, this procedure becomes easier. It provides an opportunity for integrating all the data regarding the patients, doctors, staff, hospital administrative information etc. into one unified software driven platform that opens the potential of providing a holistic approach to patient care. This core idea is to store patient details in a database, retrieve the same when required and to present the right type of information that is required for different actors, with the access levels / roles that are determined by a username and password. For example, only an "administrator" can add data into the database. The scope for development of an HMS is very wide. It is designed to manage all the departments of the hospital such as the medical, financial, administrative and the corresponding processing of services. However, for the purpose of this project, the focus would be on building the core functionality of a web application interface to add, edit and present basic patient information.

Keywords: *Web-Application, Hospital Management System (HMS), automation, Relational Database Management System (RDBMS).*

1. INTRODUCTION
Health or Medical Informatics is the "scientific field that deals with biomedical information, data, and knowledge - their storage, retrieval, and optimal use for problem solving and decision making. It covers almost all areas of basic and applied fields in medical science using modern information technologies notably in the areas of computing and communication (medical computer science)" [Stanford Medical Informatics].
As a continuously evolving nation, India has seen immense growth in the health sector in the field of research as well as development of numerous large and small-scale facilities. A few decades ago, before the concept of digitization of documents was not common, it was difficult to keep proper records of the daily activities of hospitals, patient information and how funds are being allocated and used. This led to a waste of resources, time and manpower. However, the basic working of most of the hospitals in India is still paper based as compared to hospitals in foreign countries where computers are used in assisting the hospital personnel's in their work. Recently, large hospitals like APOLLO in various countries of the world, AIIMS in Delhi, ESCORTS in Chennai, have implemented the concept of automation and management in their Hospitals.
Hospital Management Systems (HMS) are in high demand to handle the increasing population's needs. HMS facilitates access to information and automation of complex task promptly and aids the practicing doctors and hospital service and support staff with timely service and precision which allows staff to spend more time caring for patients and accessing the previous records quickly. The envisioned HMS, when built with all modules, could meet the common requirements of the medium and large size hospitals across the globe. The purpose of the project is to computerize the Front Office Management of Hospital to develop software which is user friendly, simple, fast, and cost – effective.

2. LITERATURE SURVEY
The literature search has brought forth a brief historical overview of hospital information systems and its development over the years. Even though the government has taken steps to promote and established a basic

healthcare facility in the villages, there are concerns abound about serious lack of specialized health care facilities. This is overcome with the help of a Web-Based HMS which includes strategic support systems as well as documentation systems. [2]

2.1. Current Management System:

Currently, most hospitals face several challenges with Hospital Management because some of them are still using manual techniques, and the ones that use the computerized methods also face the challenge of adjusting to it. Some problems include:

- High cost of software.
- Deployment and enhancement of software.
- Problem in migrating from manual processes, because both staff and patients are used to the manual processes and so are not able to cope with the system.
- Many patients who visit government hospitals make the process of migration from manual to automatic difficult. They have difficulty in understanding the function of automatic processes and often do not have the patience to wait for registration and data entry.

2.2. Hospital Management System:

Hospital management system is a computerized system designed and programmed to deal with day to day operations taking place. The program can look after inpatients, outpatients, records, database treatments, status illness, billings in the pharmacy and labs. It also maintains hospital information such as ward id, doctors in charge and department administering. The purpose of the project is to computerize the Front Office Management of Hospital to develop software which is user friendly, simple, fast, and cost – effective. It deals with the collection of patient's information, diagnosis details, etc. Traditionally, it was done manually. The project outlines all the process followed to come up with the software that is from analysis to testing the system.

Considering the above-mentioned points, there is a distinct need for the creating a user friendly and reliable computerized hospital management system. HMS helps in monitoring the hospital's daily transactions, as well as maintaining the records of patients along with their test reports and prescriptions. It also helps in addressing other crucial requirements of the hospital.

The quality of healthcare and patient safety is the motto of almost all primary and secondary health care providers. Over the years, a variety of models and schemes for hospital interventions and development have been used. HMS provides the benefits of streamlined operations, better administration and control, controlling the cost and therefore improving the profits. The HMS provides the following services:

- Patient management
- Services management
- Appointment scheduling
- Store management
- Pharmacy management
- Admission management
- Account management [3]

A **Web application** (Web app) is an application program that is stored on a remote server and delivered over the Internet through a browser interface. It implements a client-server environment where multiple computers

share information such as entering information into a database. The "client" is the application used to enter the information, and the 'server' is the application used to store the information. Web-based project management system can surprisingly increase performance, productivity and efficiency within an organization. Since web-based applications can be accessed through any web browser, no desktop installation or updates are required.

Database is a collection of related data and data is a collection of facts and figures that can be processed to produce information. A Database Management System (DBMS) stores data in such a way that it becomes easier to retrieve, manipulate, and produce information.

Over the past several years, there's been a big push for web applications to be developed for functions that do not normally need a server to store the information. Your word processor, for example, stores documents on your computer, and doesn't need a server. Web applications can provide the same functionality and gain the benefit of working across multiple platforms. For example, a web application can act as a word processor, storing information in the cloud and allowing you to 'download' the document onto your personal hard drive. [7]

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3. PROPOSED WEB BASED HOSPITAL MANAGEMENT SYSTEM (HMS)

As explained above, the main objective of this project is to design a **simple** and efficient web-based system for patient information management part of an HMS, which will make it easier to follow up a patient's medical record from any system that is linked to the hospital computer network with basic modules as explained in the scope of the project. This helps to minimize irregularities in hospital record managements like:

- ❏ Loss of the patient entry form
- ❏ Lack of maintenance of appointment with doctors

This will contribute to the improvement of medical services provided to the citizens. This digitization process is capable of not only solving these problems but many more which can be encountered. This system helps to replace the method of single point of entry and retrieval that typically exists in a non-web-based system, thus speeding up the processing, storing and retrieval of information, which will greatly aid the medical personnel in performing their roles.

The focus of this paper will be to document the design of a web-based Hospital Management System that will provide the basic services as shown below:

- ❏ Creating and updating patient records
- ❏ Creating and updating doctor records
- ❏ Creating appointments

The application is intended to be a web-based system that can be executed on any client computer which has access via the world wide web to the back-end database server. It is envisaged that for each patient, a patient record will be created in the database to be able to be retrieved by other actors (for example like administrators, doctors, lab technicians, pharmacists, etc.) to assist them in completing their tasks. The objective of the system is to incorporate patient services and administrative control such that both the patient and the administrator can view the page. [11]

3.1. ARCHITECTURE OF A WEB-BASED HOSPITAL MANAGEMENT SYSTEM:

A Web-Application is implemented using a client-server environment where multiple computers share information such as entering information into a database. The "client" is the application used to enter the information, and the 'server' is the application used to store the information.

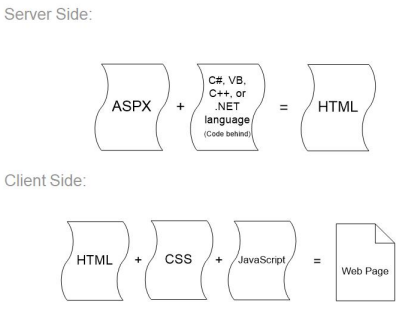

Fig.1 Page Composition part

The design of a DBMS depends on its architecture. It can be centralized or decentralized or hierarchical. The architecture of a DBMS can be either single tier or multi-tier. There are multiple types of DBMS architecture. One of the most commonly used is the **3-tier architecture.** This type of architecture separates its tiers from each other

based on the complexity of the users and how they use the data present in the database. It is the most widely used architecture to design a DBMS.

- **Database (Data) Tier** − At this tier, the database resides along with its query processing languages. We also have the relations that define the data and their constraints at this level.
- **Application (Middle) Tier** − At this tier reside the application server and the programs that access the database. For a user, this application tier presents an abstracted view of the database. End-users are unaware of any existence of the database beyond the application. At the other end, the database tier is not aware of any other user beyond the application tier. Hence, the application layer sits in the middle and acts as a mediator between the end-user and the database.
- **User (Presentation) Tier** − End-users operate on this tier and they know nothing about any existence of the database beyond this layer. At this layer, multiple views of the database can be provided by the application. All views are generated by applications that reside in the application tier.

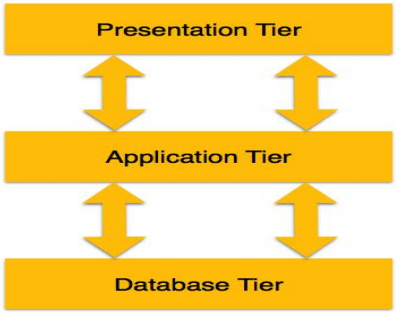

Fig 2. General framework of a web-application

The technology stack used in this project is **Microsoft SQL Server** with IIS at the back end and **Visual Studio (ASP.NET framework with C#)** in the front end. In simpler terms,

- **Database (Data) Tier** − Microsoft SQL Server
- **Application (Middle) Tier** − Visual Studio (ASP.NET framework along with C#)
- **User (Presentation) Tier** − Web browser.

3.2. DATABASE TIER DESIGN:

- **Database aspect** of the project was is designed using an RDBMS (Relational Database Management System). An RDBMS is an excellent tool for organizing large amount of data and defining the relationship between the datasets in a consistent and understandable way. An RDBMS provides a structure which is flexible enough to accommodate almost any kind of data. Relationships between the tables were defined by creating special columns (keys), which contain the same set of values in each table. The tables can be joined in different combinations to extract the needed data.
- This is implemented in the HMS by Microsoft SQL Server. The SQL Server Management Studio is an administration tool for managing the data where we can create tables, linkages between them etc.

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- In an RDBMS, multiple users can access a file at the same time. They can view and modify files according to the permissions which are controlled by the software.
- In order to implement the Web-based hospital management system, having the basic modules, we create three tables. The first one for Hospital employees where the employee can either be an administrator or a doctor, a table which stores the patient information and lastly, a table which connects both of the aforementioned tables together, thus creating a link between them is the table for patient visits.
- The tables tblHospitalEmployees and tblPatients both have a primary key. However, the table tblPatientVisits has a foreign key because of which this table can access fields of other tables respectively, effectively creating a link between them.
- With the help of this, the patient can make an appointment from the complete list of doctors which can be accessed

- from the table tblHospitalEmployees. These tables are created and maintained with the help of Microsoft SQL Server.

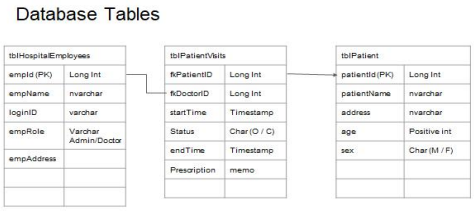

Fig.3 Database Tables in SQL

3.3. APPLICATION TIER DESIGN:

- The application server and the programs that access the database are present. In a nutshell, this tier presents an abstracted view of the database. End-users are unaware of any existence of the database beyond the application. The application layer is a mediator between the end-user and the database.
- In this tier, the Graphical user Interface is designed using C# along with ASP.NET framework. The software is designed to have several menus and pages in C# scripting, this tend to create the unique interaction between the patients and system to support them into achieving their task.
- With the design of this tier, when the user enters or modifies the data from the end-user point, the data in the database tier is entered or modified too.
- This can be achieved by creating a basic design of how the Presentation tier is going to look as shown in the figure below. The figure describes the User Interface Design, i.e. how the application tier is going to look. It allows the user to access a page according to his/her 'role' (doctor, admin or patient). When the user enters their respective details, it gets stored into a database which is implemented in the Application Tier.
- It consists of the Home/Login Page where the user enters their ID and password. After entering the information, the user can access any page depending on his/her role as an admin, doctor, patient or for managing reports.
- Depending on the option the user selects, their respective modules can be accessed by them which is further explained in the Presentation tier.

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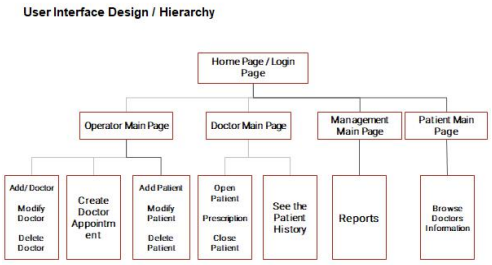

Fig.4 User Interface Design Hierarchy

3.4. PRESENTATION TIER DESIGN:

- As discussed above, end-users operate on this tier and they know nothing about any existence of the database beyond this layer. At this layer, multiple views of the database can be provided by the application. All views are generated by applications that reside in the application tier.
- This is implemented in the form of a Web-Browser. The user enters the required data onto the interface which is created in the Application tier.
- The background details are not shown to the user as he/she are not concerned with it where the data goes when it is entered or how the browser is designed. Rather, it focuses on the where the user is entering the data by arranging it with the help of a user interface.
- With the design of the user interface, the expected screens for different modules are shown below.

Fig.5 Expected Screens-Home Page

- In the above page, the user enters his/her ID and password in order to access the HMS. After the user enters the details, he/she is given a choice to go further depending on his/her role as shown in the figure below.

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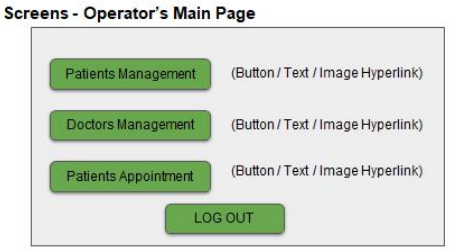
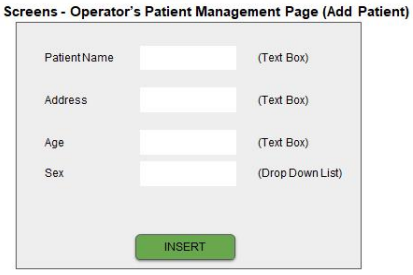


Fig.6 Expected Screens-Operator Main Page

- PATIENT MANAGEMENT PAGE:

This page allows the user to create a new patient record, and/or modify and delete the existing patient records.

- By clicking the required button from the page shown above, the screen for adding modifying patient data is shown below.
- The modules shown above are for the patient user. Another module for the doctors can be designed in a similar fashion as illustrated below.



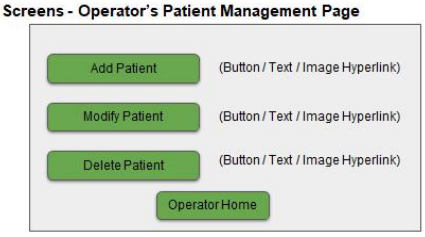


Fig.7a,7b Expected Screens-Patient Management Page

- DOCTORS MANAGEMENT PAGE**:** This page allows the user to create a new doctor record, and/or modify and delete the existing patient records.

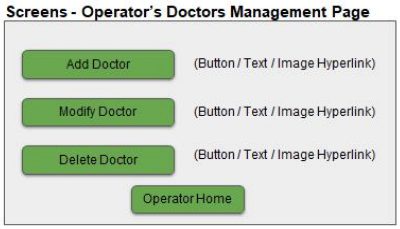


Fig.8 Expected Screens-Doctors Management Page

- PATIENT APPOINTMENT PAGE:

  This page allows the user to create an appointment by selecting the doctor and the patient name and designating the meeting time.

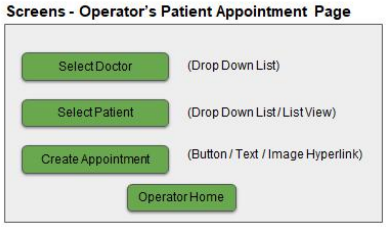


Fig.9 Expected Screens-Patient Appointment Management Page

4. RESULTS AND DISCUSSIONS

By implementing the above points, the code for the HMS is written in Visual Studio using C# and is executed. The result is a web-browser which can be accessed by multiple clients/users.
The advantage of a Web-Application is that if the user has access to the address of the web page, it can be accessed and modified by multiple users simultaneously without having to worry about how and where the data is being stored. The output is according to the modules explained in the application tier and is illustrated as shown below.

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Fig.10 Output Screens-Login Page

Fig.11 Output Screens-Main Page (After Login)

The above images show us the output just as the user opens the browser. The first image shows the login page where the user enters his/her ID and password. After entering the details, he/she is directed to a new page which allows the user to choose a role i.e. an admin, doctor or a patient. The patients as well as the doctors have an option to create and modify their information. Also patients' appointments can also be managed.

Fig.12 Output Screens-Patient Management Page

When the button for managing patients information is clicked, the page shown above is opened, depending upon the option to create a new patient record modifies an existing record or delete a patient record. The same pattern is followed for the doctors' page as demonstrated below.

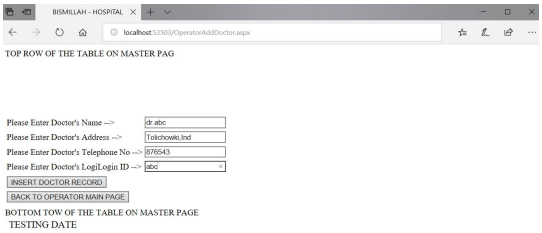

Fig.13 Output Screens-Doctors Management Page

5. CONCLUSION

The paper "Design and Implementation of a Web Based Hospital Management System (HMS)" is for computerizing the daily works carried out in a hospital. The software takes care of all the requirements of an average hospital and is capable of providing easy and effective storage of information related to patients that come up to the hospital.

Hospital Management System not only provides an opportunity to the hospital to enhance their patient care, but also can increase the profitability of the organization. Hospital administrators would be able to significantly improve the operational control and thus streamline operations. This would improve the response time to the demands of patient care because it automates the process of collecting, collating and retrieving patient information.

The system integrates technology advantages of Visual Studio 2013 and C#.NET (C-sharp .Net) development environment along with ASP.NET framework to design and develop a web based hospital management system. As explained before, the proposed Web based HMS is by no means perfect. There is a lot of scope for improvement of the project. The main goal was to understand the concepts of designing a web application and implementing it using simple modules.

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