

ECG database management system design

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6th semester biomedical

january 2022

ABSTRACT

Databases of electrocardiograms (ECGs) are used in medical research, pharmaceutical research, medical education, and health care. due to increasing needs in research, education, and health care Creating and maintaining ECG databases has been a challenge. It has evolved into a complicated issue.

This paper discusses the a fresh design strategy and a new application model ECG Management System (EMS). The EMS isn't just for storing and managing data. Not only to collect ECG data, but also to automate the ECG workflow. to make the editing and checking of ECGs easier to acquire and compare the serial ECG recordings save auditing data and generate a serial ECG report changes, and, above all, to communicate with Hospital information systems, for example, are examples of other systems. A **relational database manages** the patient demographic and clinical data, as well as ECGs. The system allows authorised users to access ECG data, ECG recordings, and ECG graphs. In data format, measurements and ECG interpretation eXtensible Markup Language is a markup language that allows you to express yourself in a variety of ways (**XML**), and to collect clinical cases for educational and research purposes queries written in a minimal structured **query language** In conclusion, the electronic EMS is a powerful and versatile system. a simple tool for research, education, and outreach Finally, to improve patient care.

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INTRODUCTION

ECG databases and **database management systems** are required for medical research, medical education, and patient care . Over the last few decades, many research institutions, healthcare organisations, and manufacturers have devised and constructed database management systems, but only a small percentage of them have been successful . The biggest challenge arises from the rapid advancement of technology. Current "state-of-the-art" technology is frequently obsolete within a few years, if not months. In an era of rapid clinical and information technology advancement, designing such a sophisticated ECG database management system has become increasingly difficult. The development and upkeep of a website consumes a significant amount of resources. Significant efforts have been made to the ECG management system as part of Philips Medical Systems' historical commitment to the medical community. The purpose of this study is to describe Philips ECG Management System's new design techniques, with a focus on its flexibility and openness in data access.

TECHNICAL METHODS AND MATERIALS

Materials

Open source software was used to create the application. It is cost economical and flexible to design applications using open source software. MySQL is a database management system. It's a multi-user, multi-threaded SQL (Structured QueryLanguage) database server with a lot of power. The MySQL database server is built on a clever software architecture that prioritises speed and flexibility . MySQL's key advantages are its speed, robustness, and flexibility in storing huge things like ECGs. MySQL is

also the database server of choice because it is gratis and its web interface is simple to create. As a web server, Apache is utilised. It's a feature-rich, fast, and stable open source web server. It's built to work on multitasking operating systems and can handle many requests at once. PHP is a scripting language that is widely used. PHP is an open source scripting language that is frequently used. Because PHP supports a wide range of databases and offers capabilities that link the Web and database environments, it is well-suited for web database applications.

Methods

Our web database's implementation can be represented as a three-tiered architectural model. The database tier of the application is made up of MySQL, a database management system. The middle tier is built on top of the database tier and contains the majority of the application functionality, which is handled using PHP: Hypertext Preprocessor (PHP). The Apache web server is used to support tier-to-tier communication. On top of it, there's the client tier, which consists of standard web browser software that interacts with the application.

ECG DATABASE MANAGEMENT SYSTEM (EMS)

The system was implemented using a **three-tier architectural** approach, which has been an industry standard for decades and has been employed in numerous studies. With a web-based front-end interface, the database was built on **MySQL** and ran on Windows. The ECG data were maintained with a **MySQL database management system (DBMS)**.

The built-in file-directory system in Windows was used to store temporal data and ECG waveform data. For system implementation, open source software was chosen because of its low maintenance costs, reliability, and efficiency. **Apache, PHP, and MySQL** served as the system's backbone, all of which were freeware but performed admirably. The MySQL DBMS and a file-directory system formed the system's foundation (first-tier). To accommodate the MySQL database and PHP scripts, the file-directory structure was changed. The second tier, which was built with Apache and PHP, was built on top of the first. This was the primary component of the system. To make communication between the subsystems easier, Apache was employed as the web server. PHP was the preprocessor for web application logic interpretation.

Commands for each sub-system were interpreted and processed by PHP and then provided to the Apache server for web representation. Finally, web browsers served as the Internet's third tier for end-users (clients).

1. First tier

The MySQL DBMS and a file-directory system formed the system's foundation (first-tier). To accommodate the MySQL database and PHP scripts, the file-directory structure was changed.

2. Second tier

The majority of the application logic is handled by the second tier. It primarily serves as a link between the other two layers. An Apache web server, the PHP Zend engine (scripting engine), and PHP scripts make up the system. The data from the user is collected by the second tier (a request is made to the web server, which is then passed to the Zend engine (scripting engine) via the Zend engine's web server interface). A data query is constructed and submitted to the database based on the information provided by the user (An appropriate PHP script is retrieved from the disc which is then compiled and run by the Zend engine). Finally, the results are prepared and provided to the user through the Internet for viewing. (The output of the web server interface is returned to the web server, which then sends it on to the user.)

3. Third tier

Finally, web browsers served as the Internet's third tier for end-users (clients). web browsers are very thin clients, using web browser as thin clients offer the advantage of easy deployment, and makes our application platform independent .

DATABASE SCHEMA

ECG database system is a **relational database management system** RDBMS.EMS database composed of normalized tables containing digital ECG waveform , patients demographics , measurement and ECG interpretation. The majority of ECG data is available through individual columns in relational tables. For information retrieval, this approach allows for the use of simple to complicated SQL queries. The responsibilities of RDBMS is :

- Make effective data storage
- Provide data integrity constraints
- Provide concurrent multi-user access
- Ensure permitted and secure data access
- Recover the database in the event of a crash

DATAFORMAT EXCHANGE

The raw ECG data was saved in ASCII format in EMS. Several open-source ECG formats, such as XML (FDA-XML or ecgML), SVG, and PNG, were utilised to communicate ECG data in order to suit the needs of clinical physicians and academic researchers.

Four open sources ECG related formats were generated by this system including FDA XML, ecgML, SVG and PNG.

Rendering ECG with XML

Since November 2001, the Food and Drug Administration (FDA) has advocated an XML-based format for annotated ECG waveform data. Using the HL7 Version 3 standard, an FDA XML format was created. ecgML is an alternative XML format for ECG that was created by Wang et al and has a simpler structure. The system stores ECGs in an industry-standard XML format. The most major move done by Philips Medical System is the availability of the XML data format schema to consumers. This new strategy allows users to have the most access to the data stored while also promoting system compatibility.

Rendering ECG with SVG

Some graphic formats for viewing and transmitting ECG waveform data were utilised to represent it on the web. The most prevalent formats are SVG and PNG, which have been endorsed by the World Wide Web Consortium (W3C). PNG was chosen as the master image output format and SVG was chosen as the scalable vector image output format for this investigation. The W3C website and the internet have extensive documentation and support for these two formats.

The system also generated a PNG file online. PNG is supported by almost all web browsers, including Netscape and Internet Explorer. Authorized end-users can review the ECG records saved in the database using the PNG format from anywhere in the world.

The results of the signal analysis can be included in the XML-related ECG files because FDA XML and ecgML both permit annotation of an ECG waveform. The study ECG management system's functionality is improved by integrating these analytic modules with other components.

SYSTEM COMMUNICATION

TCP/IP over LAN and WAN, as well as transmission control protocol/point-to-point protocol (TCP/PPP) over modem and dialup connections, are supported for communication with electrocardiographs for delivery of ECGs to the Philips EMS for storage and

subsequent evaluation. Unicode encoded XML and HL7 message exchange are used to allow bidirectional interactions between the EMS and the hospital information system (HIS). ECG orders are typically imported from the HIS Data Order Entry system, ECG order fulfilment is exported to the HIS billing system, and validated ECG readings are exported to the enterprise clinical information system.