INTRODUCTION OF AN INTERNATIONAL HEALTH CARD IN HEALTHCARE INFORMATION SYSTEMS

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Abstract— The "International Health Card" is a portable USB based smart health card to carry the entire medical records of a person. It can act as a medical passport while the person travels from one place to other. International Health Card has been designed to store and update patient medical records including personal profile, insurance details, family medical history, emergency details, immunization history, allergy history, full medical treatment history, and diagnosis details. An application with graphical user interface has been developed to store and manage the entire medical records of the patient on the card and in a server to avoid loss of data due to the damage of the card. Adequate privacy and security of the data is ensured by providing patient credentials and credentials are encrypted in the SQLite database to provide an adequate protection.

Keywords— Adobe Flash, SAP Crystal reports, SQLite, USB-Smart Card, Visual Studio.NET.

I. INTRODUCTION

Managing health information using information technology is an important part of the changing health-care system. A health-care information management system is defined as software consisting of a collection of procedures and programs with the requirements for entering, storing, retrieving, updating and manipulating data having adequate capacity to maintain the integrity, security and confidentiality with fulfilling management, legal and accounting requirements[1]. Proper implementation of information technology makes it easy for health-care providers to store, share and access the health information. With an increase in access to larger computers and new advances in information technology resulted the development of more efficient data management system. However, all these development are within the network of a particular hospital or within the network of a limited number of hospitals. The patient cannot utilize their medical data outside the network as patient wishes.

The invention of smart card concept in 1970s and the development of the internet in the 1980s envisaged new fields of health care information management system using smart health card. A smart health card is a credit –card like storage media that carry information about a patient in a magnetic strip or by embedded integrated circuits[5]. The principal benefits of this system are improved quality of health care and reduced cost. These cards can overcome certain shortcoming in the communication of clinical information and thereby improve the quality of health care services.

This research has been conducted to develop a patient-centric ‘International Health Card (IHC)’, which can act as a ‘Medical Passport’ to provide a secure carrier of entire medical records of the patient.

The limitations of currently available health cards are identified and alternative technologies to enhance the efficiency of the card without compromising the other benefits are developed. The system help us to reduce health care fraud and support new processes for portable medical records with secure access to emergency medical information.

Major Objectives of the Health Card Project

- Develop a portable smart health card - "International health card" to carry the entire medical records of a patient with adequate privacy and security.
- Develop a "patient-centric" health information system instead of a "hospital-centric" system.
- Develop a graphical viewer with the help of skeleton image for easy navigation through the treatment history of the patient.
- An encryption method will be applied on patient credentials to ensure adequate privacy and security of the smart health card.
- Store the entire medical data of the patient on the card and in an authorized local database to avoid loss of data due to the damage of smart health card.
- Develop adequate technology to store and access huge files like operations videos and CT scan, MRI scans, and X-ray in the smart card.
- Store and update patient medical records including patient personal profile, insurance details, emergency contacts, current and past treatment details, and diagnosis details.
- Emergency access to the critical medical data and biometric access to the medical data while the patient is unconscious mode as provided.
- Develop a software tool in smart health card application to execute the backup of the entire patient health database as required.
II. EXPERIMENTAL DETAILS

2.1 Currently available Health Card System

Accurate and complete medical information is essential for both patient and doctors for a quick and efficient treatment. Personal health records like smart health cards are very important in the health care sector, its value depends on the medical information it can provide, and the easiness of access the data. However, Presently available health cards such as LAN based/standalone health card[2], the Internet-based health card[4], and Near Field Communication (NFC)[3] based health cards doesn’t meet basic requirements of health care needs.

LAN-based smart health card holds basic patient information in the card and the detailed health information in the central database on the local area network. The system provides adequate privacy and security to the data; however, mobility of patient data cannot be satisfied in this system. In the web-based health card mobility of data can be assured due to the data are stored on a web server. However, the malicious software in the internet and hacking of website jeopardize the privacy and security of the system. NFC-enabled health card satisfies the mobility of the data and the storage capacity of the card can be increased by storing the data in a secure field other than the NFC tag. However, the wireless environments are highly unpredictable and interception attacks and relay attacks can jeopardize the privacy and security of the health card. None of the above discussed systems satisfies the requirement of smart health card to carry the entire medical record of a patient with adequate security and privacy. Those systems cannot be used by the patient especially as a medical passport while traveling from one place to other.

The research concluded that a USB based health card overcomes the storage deficiency of ordinary smart card by adopting ‘flash memory’ technology instead of EEPROM memory. The flash memory of USB-based health card is adequate to store the medical data of the patient. This system also satisfies the mobility of the data[7]. The privacy and the security of the data and the limitation of database due to the use of MS Access as the database are the major drawbacks of the system. Other deficiencies like privacy and security and the limitation of database can be overcome by the latest technological advances. Table 1 shows the classification of smart health card based on their architecture.

Table 1: Classification of smart health cards

<table>
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<tr>
<th>Architecture</th>
<th>Storage Device</th>
<th>Device/Storage requirement</th>
<th>Mode of data access</th>
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<tbody>
<tr>
<td>Local/Standalone</td>
<td>USB, smart card, NFC card, PC, CD and LAN</td>
<td>Software designated for interface and computing devices.</td>
<td>Portable computing devices and card reader.</td>
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<tr>
<td>Hybrid</td>
<td>Local devices and remote server</td>
<td>Local interface software and computing devices.</td>
<td>With or without the internet connection via portable computing devices.</td>
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2.2 Proposed Health Card System

International Heath Card (IHC) application provides a portable USB-based smart card to carry the complete health records of a person. The project requirements are captured from interviews and surveys conducted with medical professionals and public. The aim of this health card application is to provide user-friendly and easy access to navigate through the health records. It helps medical professionals to understand the patient medical condition without going through emergency tests. Medications and diagnostics tests details are easily accessible in the card, which helps the doctor to provide proper treatment on time. The card also acts as ‘traveller medical passport’ when the person travels from one place to another. The IHC app, health card database and USB-Smart card are the major components of International health card and it is illustrated in Fig.1.

![Functional architecture of health card.](image-url)
The main architecture of International health card is comprised of four components such as Computer with USB port, USB-based smart card, portable desktop application and portable database. The USB-based smart card acts as a hardware interface with a computer and health card application. The application resides in the client which is stored in the USB-based smart card provides access to the application whereas data server stored on the same smart card help us to store patient health data.

The Visual Studio.NET is used for building GUI layouts of Health Card application because of prominent features such as security, multi-language integration, and application compatibility, platform-independent and easy of deployment [8]. Adobe flash has been used for creating graphical treatment viewer and database as SQLite because of outstanding features such as high storage capacity, security and free cost[6]. Moreover, the reports are developed by SAP Crystal reports. The major features of IHC is illustrated in Fig.2.

The potential users involved in health card project are classified as Patient, Doctor, Pharmacist and Hospital staff. To understand the workflow of the IHC app, a Use Case Diagram is created showing the relation between potential users and functionalities identified in the requirement analysis. An application algorithm has been created and provided in Fig.5.

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**Fig.2. Major features of health card**

<table>
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<tr>
<th>Treatment history</th>
<th>Medical diagnosis reports</th>
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<tr>
<td>Graphical treatment viewer</td>
<td>Female Health history</td>
</tr>
<tr>
<td>Insurance data</td>
<td>Allergy history</td>
</tr>
<tr>
<td>Family Health history</td>
<td>Patient profile</td>
</tr>
<tr>
<td>Immunization/Vaccination</td>
<td>Data backup and mobility</td>
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</table>

**Fig.3. Application map of health card**

**Fig.4. Use Case diagram of health card**
2.3 Architecture of International Health Card

The system architecture of IHC application is based on a two-tier architecture consists of presentation layer, data access layer and a database, which are combined together to form a two-tier architecture in health card. The presentation layer and data access layer contain reusable functions and methods to achieve the functionality of application.

**Presentation Layer**

The layer contains GUI interfaces designed in Visual Studio.Net environment. The GUI interface uses windows forms, tools and controls to achieve the GUI functionalities. The required number of classes are created and coded in VB.Net language to achieve GUI functionality.

**Data Access Layer**

The layer directly interacts with database and manages storage and retrieval of data. It contain classes to perform database function such as open connection, close connection, create untyped datasets to perform data updating and retrieval. The untyped datasets provide better performance. The data access
layer uses System.Data.SQLite namespace to perform database operations.

- Database
  The SQLite database is used as a database to store data. It directly interacts with data access layer to perform data updation and data retrieval.

2.4 Technical Specification of health card
The most suitable and recommended technological tools Visual Studio .NET 2010 or higher version, Adobe Macromedia Flash, SQLite, ADO.NET provider of SQLite, and SAP Crystal report has been used for the development of IHC application. The startup screen of International health card is illustrated in Fig.6.

![Fig.6. Startup screen of IHC app](image)

DB Browser for SQLite is the design tool used for creating database. This tool provides support for creating tables, views, constraints and indexes and help to perform database operations. The tables of database are categorized as master tables and transaction tables. The contents of medical reports files (image, video.pdf, doc etc.) are stored in the BLOB column in SQLite database. The snapshot of IHC database is illustrated in Fig.7.

![Fig.7. Snapshot of health card database](image)

### III. RESULTS AND DISCUSSION
The International Health card application is developed in a very user-friendly manner. The performance of health card has been analysed against the basic requirement of a health card to make sure that the it can perform satisfactory manner. It also acts as a medical passport while the patient travels from one place to other. The performance of International Health Card against the basic features are provided in **Table II**.

<table>
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<th>Feature</th>
<th>IHC Performance</th>
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<tr>
<td>The database adopted for IHC is SQLite and the storage capacity of this database is 128FD. The flash memory feature of USB based smart card and provides adequate storage space.</td>
<td></td>
</tr>
<tr>
<td>The security of the data is provided by user credential and the user credential encrypted to enhance the security.</td>
<td></td>
</tr>
<tr>
<td>Data is easily accessible through the USB port in the computer. The user friendly application makes the navigation through the data a tiring job.</td>
<td></td>
</tr>
<tr>
<td>The international health card is portable credit card type card. It is easily carried in a pocket.</td>
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The medical record of a patient consists of lot of medical files in different formats. To store all these files in database as well as to view the files in user computer require adequate data conversion algorithm. To accommodate these functionalities in health card, certain data conversion programs has been created and implemented in health card application. The SQLite has been adopted to store patient data due to its high storage capacity and portability of the system. The biometric access to health card data is required for patients who are in unconscious stage or in critical stage. A biometric algorithm has been developed to store fingerprint image act as the password to access the data for the critically ill patient. The access of the health card is strictly controlled by user login credentials. To ensure the security of credentials on health card, a data encryption algorithm has been created which helps to encrypt login credentials of application. In addition, the same password is decrypted using decryption algorithm for validating access. The access screen of health card is illustrated in Fig.8.

![Fig.8. Login screen of International health card.](image)
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Graphical view of patient treatment history enables even computer illiterate people to navigate through the treatment details. The entire body of human skeleton is designed and enclosed in a grid by using Adobe flash. The corresponding treatment details belongs to the selected human body part will be displayed on the screen. The graphical viewer screenshots are illustrated in Fig. 9(a) and 9(b).

CONCLUSIONS

"International Health Card" has been developed, which can provide a secure carrier of entire medical records of a patient. USB based smart card has been adopted as hardware for managing medical records. In addition, a set of additional features like graphical view of treatment data using skeleton image, biometric algorithm, E-Immunization card, International health card web browser etc, has been successfully developed and implemented.

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