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E-Health Web Application Framework and Platform Based on Cloud Technology

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Abstract: This papert deals with an E-health web application framework, cloud platform and responsive web design which aim to adjust the presentation on mobile devices. This work presents the whole development process of the self-care management web-app framework which provides instructive support for future other E-health field applications. The report consists of the following main parts: analysis, design and implementation, and evaluation. Literature review and internet search are the main methods for making an investigation of existing systems and related works. A prototype is developed by using .Net, CSS3, Javascript, and HTML5 technologies. The system test and evaluation are made to show the system's usability. The Interoperability of E-health model system allows people store large amount of information in different place. In many of the developed countries, healthcare has evolved to a point where patients can have many different providers– including primary care physicians, specialists, therapists, and even alternative medicine practitioners – to service their diverse medical needs. Telemedicine system is receiving great importance due to current changes in healthcare sectors all over the globe. The need for medical sectors to provide appropriate and precise remedy for various diseases is essentially increasing as they are facing new challenges every day. There comes a big problem that the information sharing increased the risk of medical misuse and data theft. The E-health record may include the patient personal information, like telephone number, age and so on, even more, the diabetes patients' glucose, exercise information which are private, sometimes, the patients just want to share their relative information to their physician. Data theft can invade to patients' medical records and stole patients records to do financial fraud. In order to forbidden this crime, how to keep the privacy and security becomes the key point in our work.

Keywords: Telemedicine, Data-Mining, Tools, Techniques, Medical-Data.

I. INTRODUCTION

With the rapid development of smartphones and mobile devices, it becomes very popular that people prefer to access information in this flexible way. So the requirement for a proper interface according to different devices become a hot topic and the goal will motivate the use of RWD(Responsive Web Design). It aims at crafting sites to provide an optimal viewing experience in easy reading and navigation with a minimum of resizing, panning, and scrolling across a wide range of devices such as desktop computer monitors to mobile phones. What's more, nowadays E-health has gradually aroused great attention all over the world. And the modern-day healthcare needs and delivery is complex, and the use of ICT has made some positive impact in attending to such needs that e-health applications require. The project is about the E-health web application framework and responsive web design based on the cloud platform. This idea comes from instructor Dr. Eric Chen's project proposal. Though there is some existing research in the above fields, there is less or almost no related work which combines these fields to provide a basic frame specifically focusing on e-health. The right

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information at right time saves lives, So an E-health web application framework and platform based on the cloud is a part of an information and communication technology-supported self-care system for diabetes. This project will closely collaborate with another group working on data collection and presentation application. The new related work in the above fields is worth being done from the view of reality and research. Telemedicine system is receiving great importance due to current changes in healthcare sectors all over the globe. The need for medical sectors to provide appropriate and precise remedy for various diseases is essentially increasing as they are facing new challenges every day. The Medical sectors aim at providing quality of service to the patients using telemedicine system, technology and informatics. However, a large set of heterogeneous medical data is being produced every day. Such as, new medications and treatments for every new disease discovered, which needs to be mined for useful information. Thus, in order to address this issue, the study implies on integrating data mining techniques into telemedicine system. In this paper, a brief information about the process of mining data, the tools and techniques which are available for data mining and knowledge discovery of the level of accuracy they may provide about various diseases is studied.

Now a day our healthcare sectors are facing wide range of challenges. The healthcare sectors in rural areas are less effective than those in cities. People face many difficulties in rural areas compared to those who reside in cities. May it be financial, transport, hospital infrastructures facilities, proper guidance about various illness, diseases and their medications and most importantly the non-availability of doctors all the time. This is where telemedicine comes into play. Telemedicine was originally developed by healthcare professionals to reach out to the people living in rural areas. However, within a short period of time it gained greater importance due to its potentiality of dealing with emergency period and also its ability to share medical facilities with larger set of population without any impediment [1].

Telemedicine is the application of telecommunication and computer technology to deliver healthcare from one location to another. In other words, telemedicine is the exchange of healthcare services over the distance using technology. According to WHO (1998), telemedicine is defined as “the delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for continuing education of healthcare providers, all in the interest of advancing the health of individual and their communities” [2].

“Telemedicine utilizes information and telecommunication technology to transfer medical information for diagnosis, therapy and education” (Shaikh et al., 2009). In general, technology has been linked to healthcare. It has grown stronger than ever in recent years, owing to the ease with which electronic gadgets may be put in most healthcare facilities. Mobile devices may access a variety of medical data, and health-related applications have been developed (Peral et al., 2018). “E-health is based on information technology and electronic communication, with the aim of revolutionizing the healthcare organizations and the way healthcare operations work. One of the major factors are responsible for influencing healthcare and its quality is the ability of the organization to provide accurate, previse and error free diagnosis of the disease” (Taha Khan et al., 2017).

Through components such as telemedicine, picture archiving and communication system (PACS), and healthcare information system, information and communication technology have made healthcare more accessible, engaging, and useful (Taha Khan et al., 2017). The PACS major component is responsible for image distribution and was designed for radiology services with the goal of electronically capturing medical pictures rather than utilizing film (de Macedo et al., 2008).

The information and technology process being used for activities concerning the process of the following.

1) Obtaining medical information from patients.
2) Providing physicians, patients, and other members of the medical community with the necessary medical information.
3) Patient monitoring in real time.
4) Using external systems to diagnose patients.

There are many types of services provided by telemedicine, they are as follows.

1) Telemonitoring - the monitoring of vital signs from a distance.
2) Teleradiology - compression and transmission of digital images, as well as decoding.
3) Telecardiology - providing patients with heart illness with access to medical services as well as instructing them on how to follow the proper therapy measures.
4) Telepathology - the practice of pathology from a distance, utilizing telecommunications technology to assist the transfer of image-rich pathology data between distant places for diagnostic, educational, and research purposes**.**
5) Teleophthalmology - uses digital medical equipment and telecommunications technology to provide eye treatment (GHEORGHE & PETRE, 2014).

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The following figure 1 shows the principal and various sub-systems used in telemedicine setup.

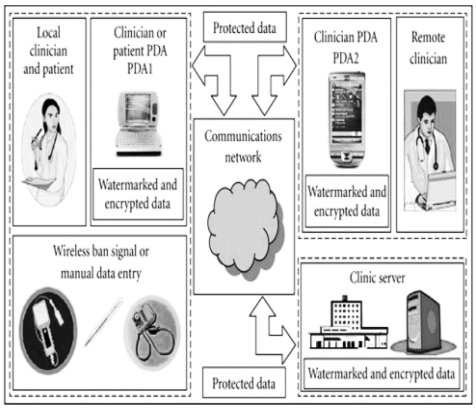

Fig. 1. Principal sub-systems used in telemedicine setup.

1. The Data mining System

Data mining is an interdisciplinary subject of statistics and computer science that allows us to extract information from big unstructured datasets using various intellectual methods and turns it into a comprehensible structure for subsequent applications. The process of uncovering patterns in huge datasets using approaches at the confluence of statistics, machine learning, and database systems is known as data mining. Knowledge finding from data is referred to as data mining. Data mining is the process of extracting relevant information from a large database or data warehouse (Rahman et al., 2020).

The process of data mining is as follows.

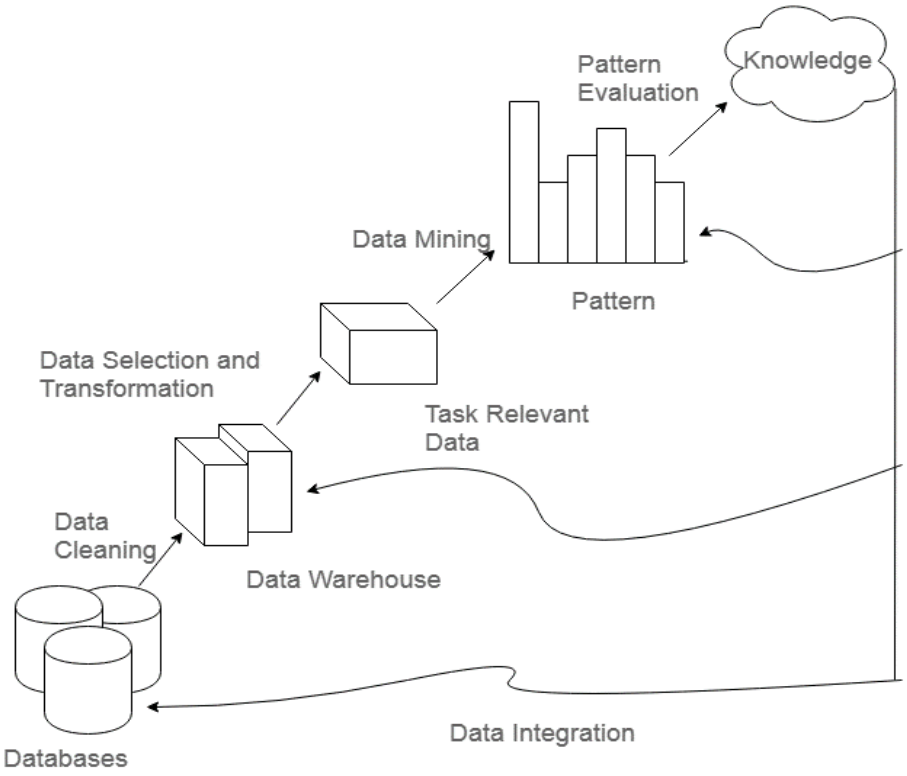

Fig.2. Process of Data Mining System

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1) **Data cleaning** – It is the process of removing unwanted, inconsistent, erroneous data or noise from the unstructured data.
2) **Data integration** – It is the process of merging or consolidating various information sources.
3) **Data selection** – It is the process of analyzing the datasets from the data pool in order to extract meaningful and relevant data.
4) **Data Transformation** – It is the process of transforming data from one from to another form which is useful and appropriate for mining by applying various operations like summarization or aggregation etc.
5) **Data mining** – It is the process of applying the intelligent methods and techniques in order to extract useful data patterns.
6) **Pattern Evaluation** – It is the process of evaluating the pattern of the data.
7) **Knowledge Presentation** – It is the process of representing the mined knowledge in visual form (Rani MCA MPhil & Professor, n.d.).

The figure 2 shows the process of data mining.

2. Data Mining Tools and Techniques

A range of data mining techniques, which are available with sophisticated algorithms, can be used to extract valuable knowledge from unstructured data. The next sections go over some of the techniques.

a. Classification

The given data instance must be categorized into one of the target classes that are already recognized or defined in this approach. One example is determining whether a consumer in a credit card transaction database should be classed as a trustworthy customer or a defaulter based on his different demographic and past purchase criteria (Singh Chaudhary Devi et al., 2015).

b. Association

Interesting hidden rules termed association rules in a big transactional data source are mined out using this technique. For example, the rule milk, butter->biscuit indicates that anytime milk and butter are purchased together, biscuit is also purchased, allowing these commodities to be sold together to enhance overall sales of each item (Singh Chaudhary Devi et al., 2015)

c. Clustering

The goal of grouping a given data set into homogenous clusters based on their similarities is the task of the clustering algorithm, which is the most important unsupervised learning tool. It is a critical way for rapidly recognizing unknown and valuable information from large amounts of heterogeneous health data in healthcare applications. The fundamental benefit of clustering is that while evaluating data, little or no information is required (Haraty et al., 2015)

d. Artificial neural network

Disease prediction is critical in telemedicine to protect patients from serious health problems. To address this type of medical care challenge, machine learning and artificial intelligence have already been developed. ANN has recently emerged as a significant tool for improving present medical techniques, including assisting in medical diagnostics. To provide answers to a problem, the ANN must be given primary knowledge in order to learn about the system through a series of trails regarding the system's hidden layers (Amato et al., 2013). ANN works similar to that of a human neural network would work.

e. Deep learning

Medical images are normally interpreted by a human specialist, which has limitations owing to subjectivity, image complexity, differing opinions among interpreters, and weariness. Many academics in the recent decade have proposed deep learning concepts using various algorithms, such as the convolution neural network (CNN), deep neural network, deep belief network, deep auto encoder, deep Boltzmann machine, and so on. Deep learning is giving intriguing solutions with good accuracy for medical imaging and is viewed as a vital method for future applications in the health sector, after the successful adoption of deep learning in other real-world applications (Razzak et al., n.d.).

f. Sequential pattern

SPM is a method for discovering all sequential patterns with a minimum support level set by the user. The number of data sequences that include the pattern is the pattern's support value. The SPM approach is frequently used to detect

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common patterns in datasets. Some methods have been proposed in the medical field. For example, the time-Annotated sequence method was used to evaluate the efficiency of extracorporeal photopheresis (ECP) from a liver transplant dataset. The routine tree approach was utilized to mine routine behaviour in a pervasive healthcare setting (Ou-Yang et al., 2018).

g. Prediction

The practice of predicting an outcome based on present data is known as prediction analysis. For example, current weather data will be used to determine if the day will be "sunny," "rainy," or "cloudy." Within this method, there are two steps to follow (Chakarverti et al., n.d.). They are:

1) Model construction
2) Model Usage

h. Decision trees

In classification and prediction, decision trees are frequently employed. It's a simple but effective technique of expressing knowledge. Decision trees generate models that are represented as a tree structure. The class of the samples is indicated by a leaf node. Sorting the instances along the tree from the root node to a leaf node is used to classify them (Anwer et al., 2008).

3. Integration of Data Mining Tools and Techniques into Telemedicine.

Telemedicine necessitates the integration of electronic medical records (EMRs) and electronic health records (EHRs) among the various stakeholders. Medical data is collected from various sources and fed into a data warehouse or cloud by various healthcare apps and electronic devices. It creates a comprehensive healthcare information system with a vast amount of data, such as a patient's demographic and medical history, as well as prescription, lab test results, radiological information, and treatments, among other things. Without a doubt, this data system is expanding all the time. The growing volume and heterogeneity of data necessitates data management and data methodologies in order to extract and explore important knowledge from the data. The data mining algorithm has been greatly enhanced over the previous two decades, and it has successfully interfered in a wide range of applications, from business intelligence to health informatics (Han et al., 2011).

Today, the healthcare business collects and stores a massive amount of data about patients, medical devices, hospital resources, diagnoses, and treatments, among other things. Data mining is a set of strategies for processing and analyzing data in order to find patterns that will allow healthcare professionals to make decisions based on the information gathered. All healthcare organizations require an expert study of their medical data, which is a time-consuming and costly project. The use of data mining in healthcare has a lot of potential.

The usage of patient information is particularly important to healthcare institutions. A crucial to the success of healthcare organizations is the ability to analyse data in databases to extract meaningful information for quality health care. Large volumes of data, such as patient information and data from laboratories, are stored in healthcare information systems, which are constantly growing. Data mining methods can be used to find useful patterns of information in this data, which can then be used for future research and report evaluation (Milovic & Milovic, 2012).The figure 3 shows the architecture framework of integrating data mining tools and techniques into telemedicine system.

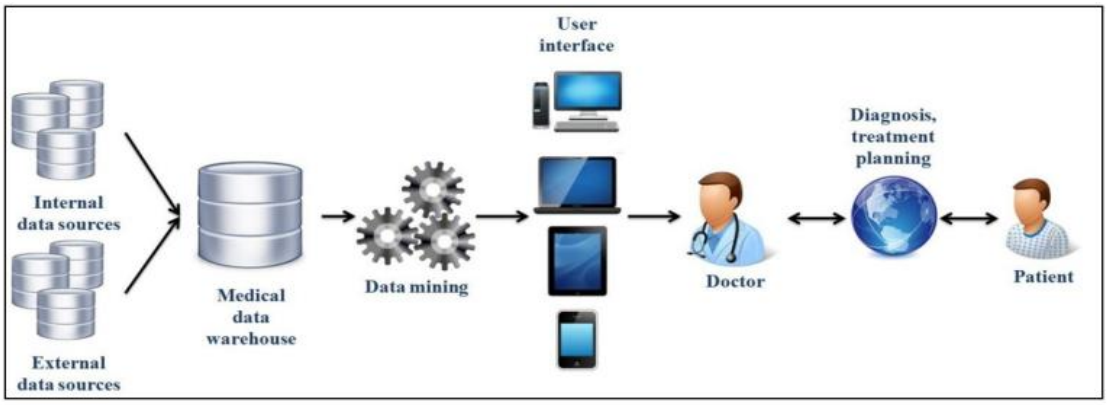

Fig.3. Architecture framework of telemedicine system integrates with data mining tools and techniques.

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Figure 4 depicts some of the most prevalent uses and their level of accuracy in various healthcare situations. Because of its flexibility, accessibility, portability, and reduced time, telemedicine's market growth in the healthcare area can be boosted. Because technology compresses time and distance, doctors and patients do not need to be in the same area at the same time; instead, they can converse in real time through an IT device application.

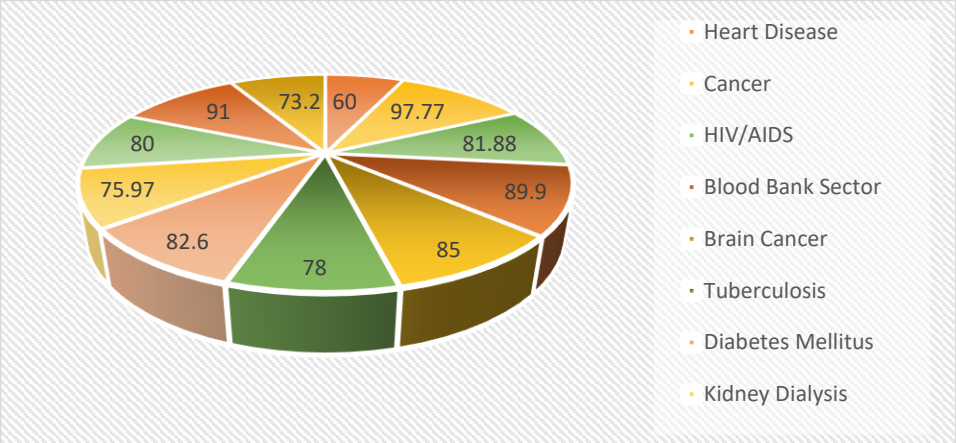

Fig. 4. Applications of Telemedicine with accuracy of their data mining techniques.

5. System Design

The healthcare industry is adopting ICT-based solutions to enhance its efficiency

and quality of services. These technologies can provide low-cost health services to improve the living quality of human beings. With advances in ICT, many healthcare applications are being developed that can provide services to support chronic diseases, early diagnosis, real-time monitoring, and medical emergencies through the Internet.

Moreover, the technologies of the Internet of Things (IoT) enable heterogeneous devices and applications to interwork together to support seamless and autonomous services. IoT devices are constrained devices with limited computation and communication abilities. These devices can be attached to any daily life object to collect desired data.

IoT-based solutions provide remote monitoring and sensing services through communications between entities and thus enabling efficient and comfortable services to end-users. Various IoT-based solutions have been successfully developed and deployed for various enterprise systems such as healthcare systems, factory management systems, smart homes, and logistics systems.

In the context of healthcare support, the concept of e-Health is a new approach to implementing a healthcare system that is based on electronic processes and internet communications. A healthcare system with e-Health elements includes users, devices, and servers. Users can be doctors, nurses, patients, and guardians who need to access the system with permission through devices such as mobile phones or specific e-Health devices.

Devices include various sensors attached to the patients for monitoring health status, retrieving health history, and sensing data. Sensing devices are connected to the internet to communicate with the server. In the e-Health system, devices should be portable and easy to operate. The server is the most important element of an e-Health system. It includes the service provider, health data, management t, and analysis functionalities for interacting with professionals and patients.

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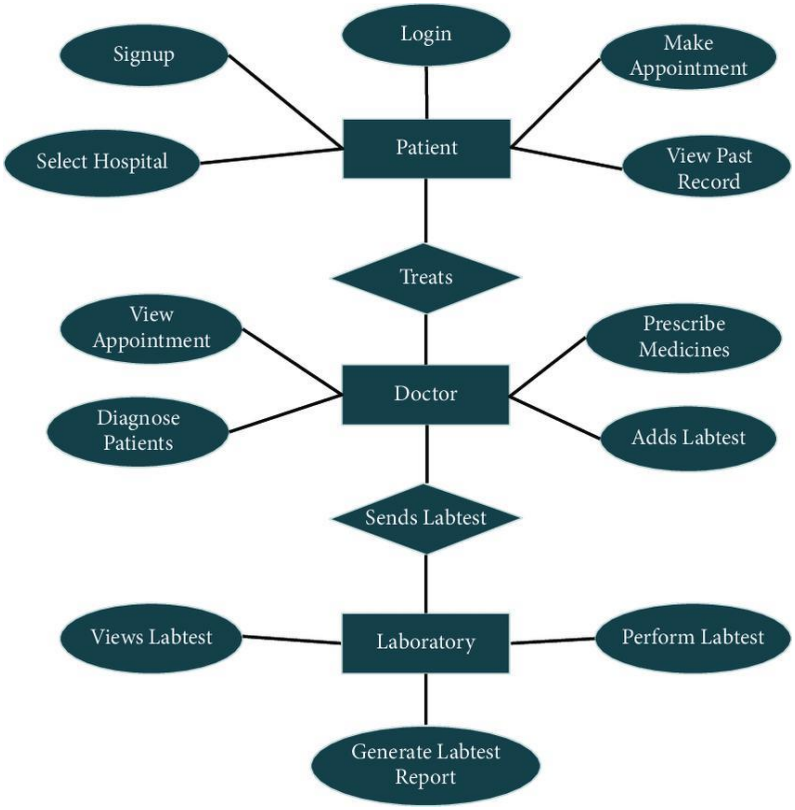

Fig 5. The entity-relationship diagram of electronic health record (EHR).

5.3 DATA FLOW DIAGRAM

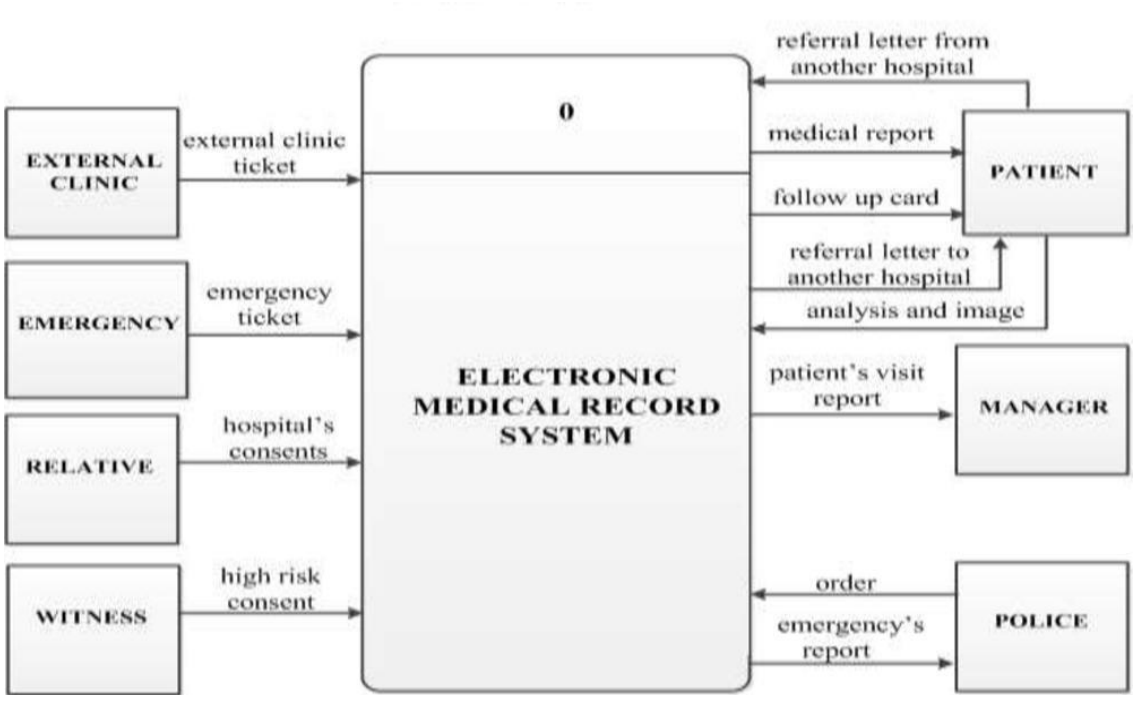

Fig 6. Data Flow diagram

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6. Implementation

6.1 Self-Care Management

Fig 7. Self-Care management page

The above figures are the home is page and tour page in the web app on PC. The home page mainly offers a simple introduction and an initial idea of diabetes and its harm. And the tour page mainly introduces the causing factors such as exercise, diet, glucose, etc, and how to protect the diabetes. Due to these two pages just making a role of presentation of some information, what needed to do is to make the front-end design more proper and beautiful. In order to make the page more diverse, the video and google Maps modules have been added to the page and all the work has been done in the front-end design.

6.2 Communication Platform

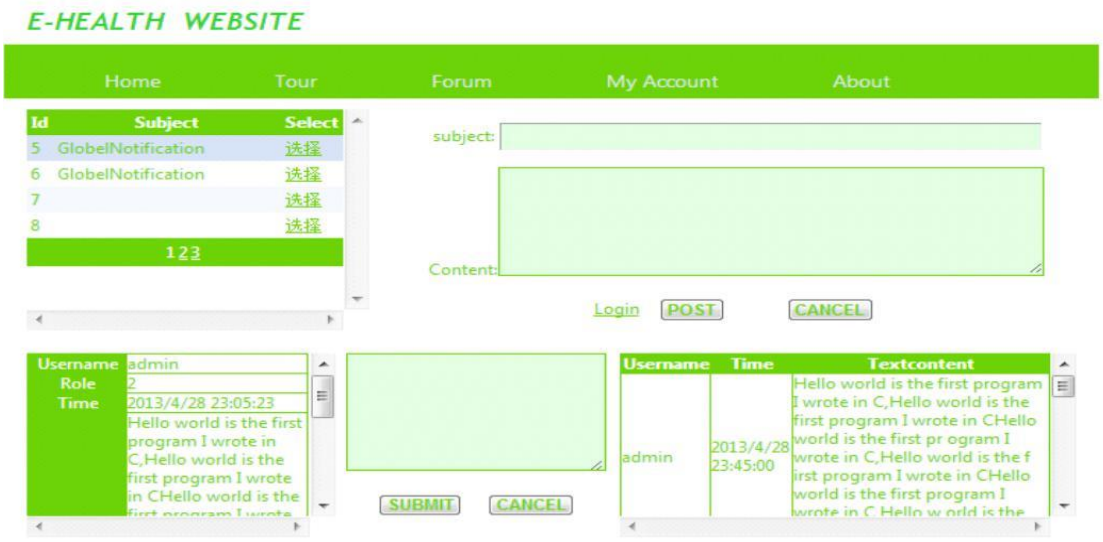

Fig 8. Forum page

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In the forum page offers a public communication platform for all the users to share the information and publish the topic they are concerned about. In order to fulfil the page, two basic modules, Grid-view and Detail view have been selected to use.

1. **Grid-view:** Grid-view tables are used for combining the corresponding data from the database and organize with some format to present the information that the users care about.

2. **Text-box:** It is the basic component of web applications. The user can put what they want to publish in the text box and the content can be stored into the corresponding table in the database through the back-end operation.

3. **Buttons:** Once fulfilling the text, the users can decide whether to send or cancel sending data to the server by clicking the Submit button and Cancel button. And some actions of the buttons will be done in the back-end programming.

4. **Detail-view:** Detail-view table is used for view the user's detail information rather than the grid-view.

6.3 Data Collecting And Presentation

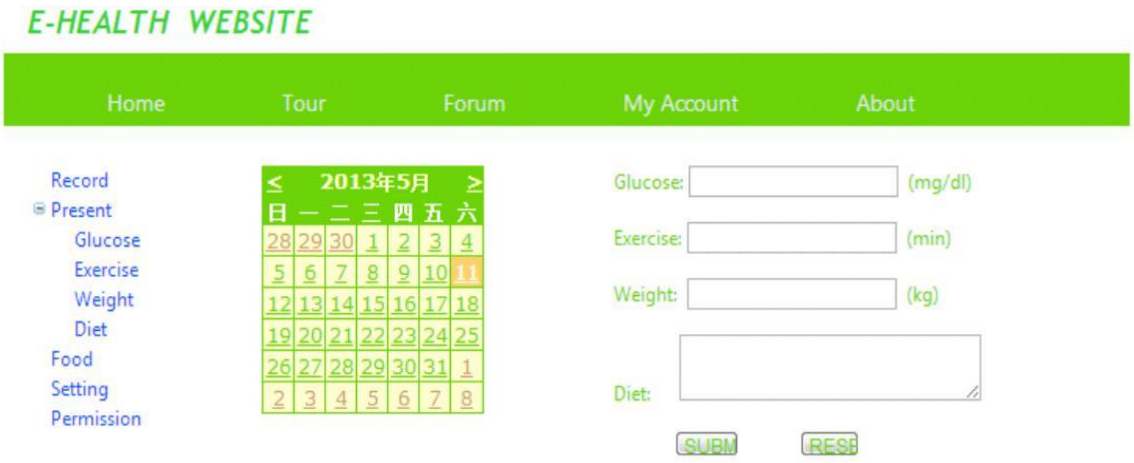

Fig 9. Record page

The above page present what information is needed to be recorded into the database for the user. What's more, through the Calendar module, each record of the user can be stored according to the date and now-time.

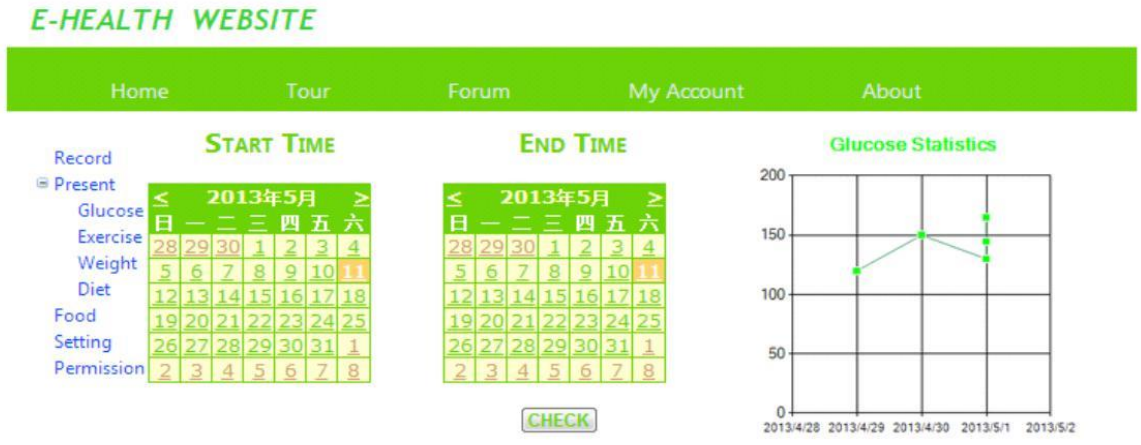

Fig 10. Glucose data presentation page

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The above figure illustrates the user's glucose data presentation. The user can view either the historical records or some specific records during some periods by selecting the date from the start calendar and end calendar. The other data presentation page is roughly the same as the glucose page.

Testing

Performance Testing

Page loading time is an important part of providing a responsive user experience, and extensive web research suggests that it correlates to how long users will stay on a website and how satisfied they are with the interaction. It also directly determine the search engine ranking of this website.

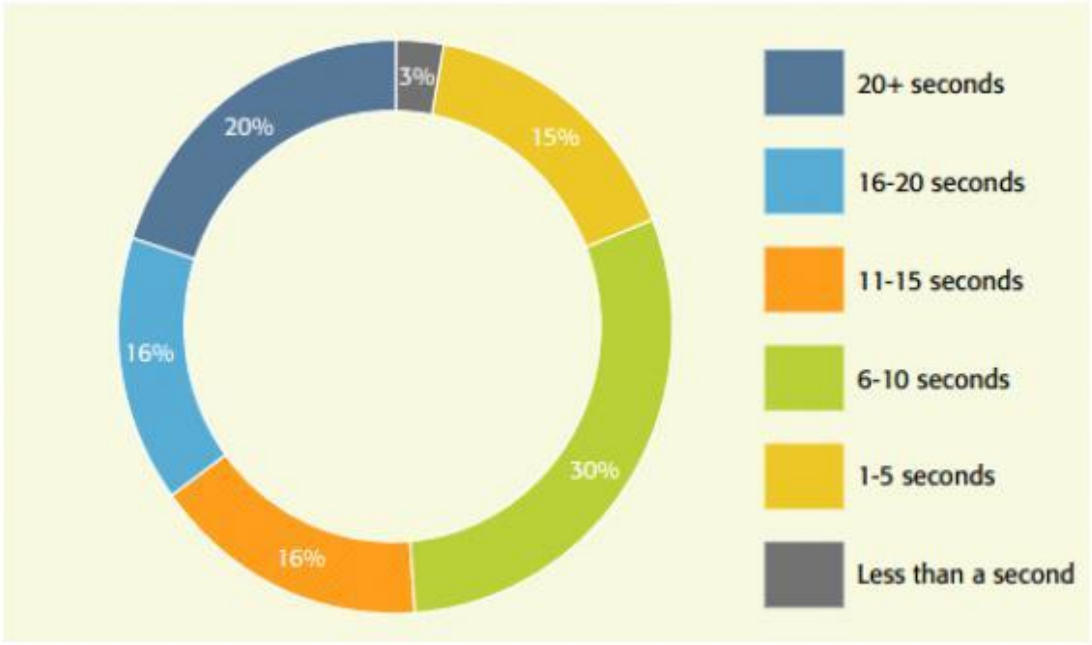

Fig 11. Correlating page load time and user patience. Most users will wait only 6 to 10 seconds for a site to load.

Figure 10 shows the time users are willing to spend waiting for a web page to load. According to surveys conducted by Akamai and Gomez.com, there exist 40 percent of users will abandon the website if page load time exceeds three seconds. And a one-second delay in page response can even reduce conversion by seven percent. The most serious event is that it would lead to economic losses, for example, an e-commerce site may make $100,000 per day, and a one-second delay would cause a $2.5 million loss in annual sales.

As page load speed is very important, we have to consider about how to improve the speed, the download speed of the network would be considered first, according to a study by PCWorld, the average download speed for 3G networks in the US is 2 Mbps, and 6.2 Mbps for 4G networks. A study by Ofcom found the average download speed for 3G in the UK to be 2.1 Mbps. Outside of North America and Europe, connection speeds are generally lower. Because 1 Mbps equals 122 KB/s (or 0.12 MB/s), this translates into the following:

244 KB/s on average for 3G users (0.24 MB/s)

756 KB/s on average for 4G users (0.76 MB/s).

However, download speed is not the bottleneck. The bottleneck is the network latency, when visiting a website, only 20% of the time it takes to display a Web page comes from downloading files. The rest of the time is spent processing HTTP requests and loading style sheets, script files, and images. So will a responsive web design will improve the speed of visiting the website? would it provide a better user experience and even recoup their economic losses? We separately test our two websites with responsive and no responsive technology, with the chrome browser. When testing the speed of these two websites, we use the page speed tool comes from google and www.webpagetest.org, these two tools are very useful and

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would generate the report of testing. With the help of these reports, we can directly recognize the advantage of responsive web design. The figure shown below gives a detailed report of using the same device to detect the website

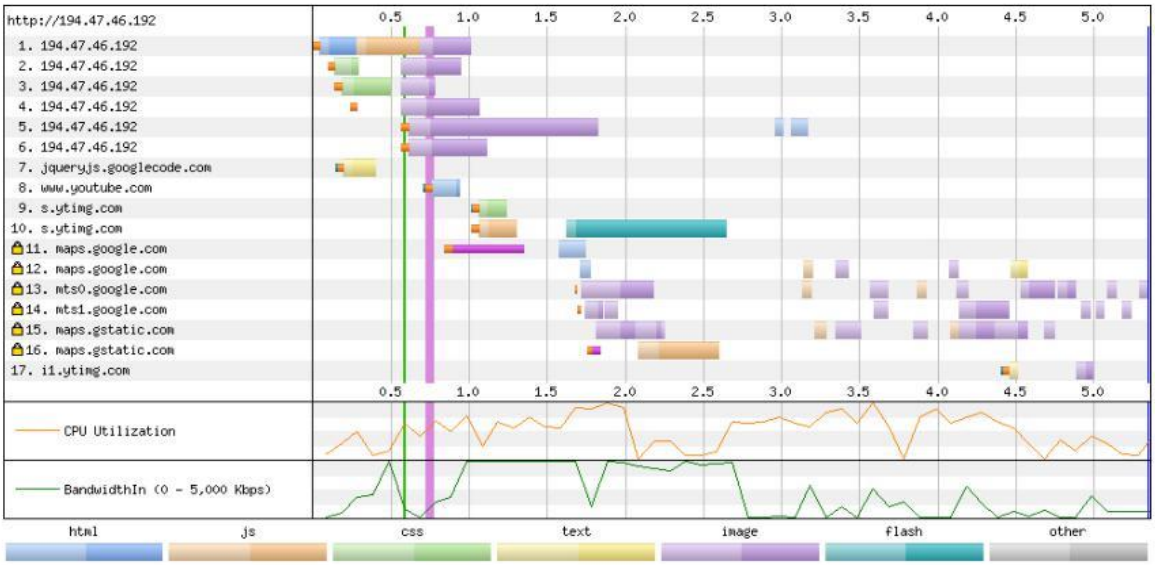

Fig 12. The connection view without using the responsive web design

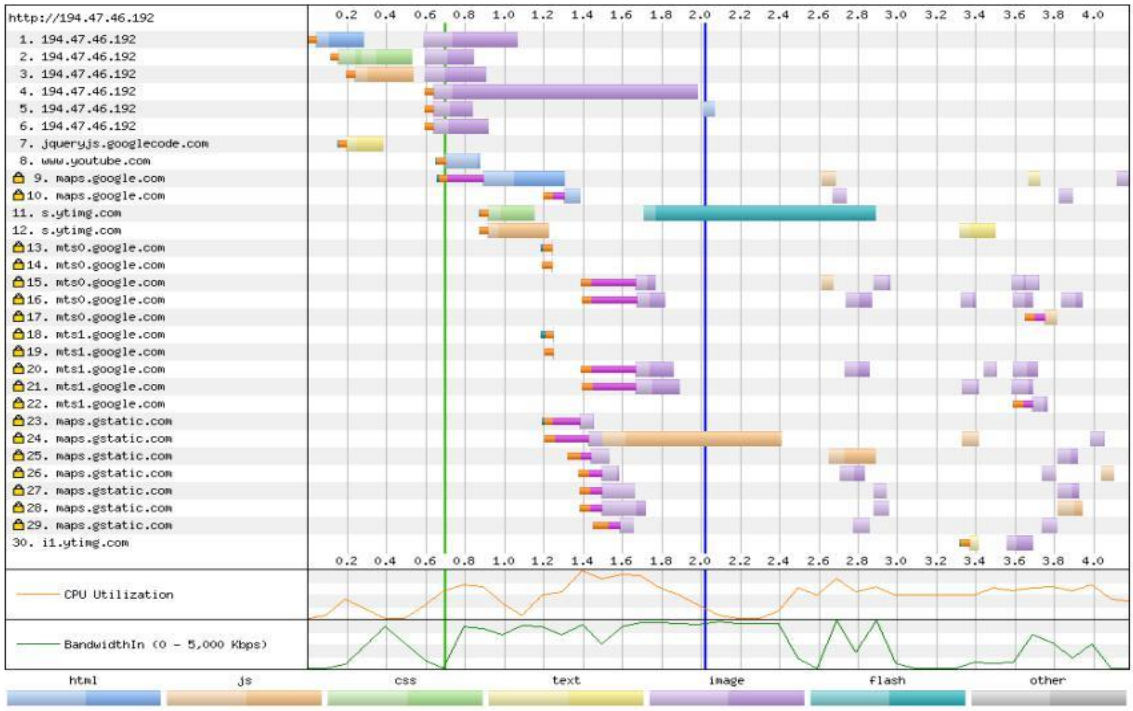

Fig 13. The connection view with using the responsive web design

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							Document Complete			Fully Loaded		
Load Time	First Byte	Start Render	Visually Complete	Speed Index	DOM Elements	Result (error code)	Time	Requests	Bytes In	Time	Requests	Bytes In
2.018s	0.100s	0.692s	6.200s	2348	1169	0	2.018s	34	1,228 KB	4.172s	70	1,449 KB

Fig 14. The figure show the detail speed of visiting the responsive web

						Document Complete			Fully Loaded		
Load Time	First Byte	Start Render	Visually Complete	Speed Index	Result (error code)	Time	Requests	Bytes In	Time	Requests	Bytes In
5.349s	0.101s	0.580s	6.600s	2722	99999	5.349s	68	1,490 KB	7.072s	68	1,568 KB

Fig 15. The figure show the detail speed of visiting the no responsive web

Result from the google page speed tool: The page default got an overall Page Speed Score of 88 (out of 100). (responsive page) The page default got an overall Page Speed Score of 83 (out of 100). (no responsive page) From the figure shown above, we can draw the conclusion that the user can get a faster and simpler experience with the responsive website since it is 2 times faster which is 2.018s while the non-responsive website gets a page load speed of 5.349s. Speed is a core feature in website creation, responsive web design not only meets the customer's requirement and also helps the web provider restore the loss.

II. CONCLUSION

Due to recent advancements in information and computer technology providing services via telemedicine has become an important element of the medical development process. In the realm of telemedicine, data mining is gaining popularity. It gives the healthcare organization a comprehensive tool to identify their demands. Data mining necessitates the creation of a system that integrates all of the components for reporting and tracking data created in telehealth business. Data mining can continue to uncover knowledge and provide feedback to telemedicine stakeholders once the system is ready, which can be one of the important components of a solid business plan. The incorporation of data mining technique into telemedicine system had advantages for both healthcare providers and patients.
Telemedicine system improves communication between them, and data mining tools integrated into the system support physician's decision-making process. Developing well-organized data mining tools for an application can reduce cost and control time in terms of human resources and capacity. Knowledge discovery from medical data is such a complex understanding that data found is noisy, irrelevant, and too large. In this case, data miners come close to medical data knowledge discovery and that's pretty exciting. Figure 4 shows the driving results that data mining techniques provide a more promising level of accuracy for all health application including 97.77% cancer and about 70% IVF treatment success rate estimates.

The main purpose of the report is to establish a general E-health web application framework including the cloud platform selection, security mechanisms defining, and the usage of the responsive web design technique. Through the systematic comparison, the MWAcloudplatformandASP.Net, HTML5, and CSS3 have been chosen as the main tools due to their good compatibility and operability. In addition, a general security guideline, common login structure, and RBAC access control structure have been given to protect personal information. Moreover, four main methods used to realize the responsive web design have been introduced in the report. And a responsive web framework has been designed to offer a basic referenced model for future specific applications. Finally, a prototype web application based on the general framework has been designed and implemented. Through testing, it proved that the responsive webpage loads faster than non-responsive web page.

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