CHAPTER 2

BACKGROUND WORK

2.1 INTRODUCTION

This thesis proposes a Web based model of healthcare service by using modern communication technologies namely the Internet, through which medical care is delivered to each individual at any time and at any place. The basic idea is to facilitate healthcare needs at a much better qualitative level and at lower costs. Hence, to make our efforts pragmatic and highly productive, a review of past studies was done. This helped the definition of the scope, concepts, working definitions, technology and formulation of model used in our research. Hence, a brief review of literature related to the subject of the research, is presented in this chapter.

2.2 LITERATURE REVIEW

The health of a population is a direct index of development of a Nation. It affects the productivity, the potential of children and allocation of resources within a family, community and nation [S. Satyamurty et al. (1997)]. Easy access to better health services results in poverty reduction and increased productivity. Investment in health is a prerequisite to economic and social progress.
Many researchers have proved that telemedicine services have the potential to improve both the quality of and access to health care regardless of geography [Andrés Martínez et al. (2004 and 2005), Amrita Pal et al. (2005), K.Ganapathy, (2002)].

In the work proposed by I.Sachpazidis (2002), C.Kunze et al. (2002), P.Bauer et al. (2000) and Nicholas et al. (2006), monitoring is done for patients within a hospital or from home. Voskarides et al. (2003) have implemented a method to acquire the X-ray image from orthopedics department and to upload to the server of the Internet provider through ADSL (Asymmetrical digital subscriber line).

Graham T. McMahon et al. (2005) have described a Web-based care management system for patients with poorly controlled diabetes. It has the ability to post professionally vetted material on secure Websites, 24 hr accessibility, and availability to individuals in their homes without regard to the distance from their sites of healthcare. Patients with poorly controlled diabetes who adopt such a system and regularly exchange information with their healthcare providers are likely to derive important clinical benefits. With the increasing Web connectivity and the worldwide deployment of Internet connections, this infrastructure can support many current and emerging healthcare applications.
Kevin D. Blanchet (2008) has proposed a project to evaluate the feasibility, acceptability, effectiveness, and cost-effectiveness of telemedicine as it relates to diabetes home care monitoring.

Central to the project is the technology—a home Telemedicine unit (HTU) developed by American telecare with the following four functions:

- Synchronous videoconferencing over standard telephone lines,
- Electronic transmission of finger stick glucose and blood pressure readings,
- Secure Web-based messaging and clinical data review, and
- Access to Web-based educational materials.

Santamore, W.P et al. (2007) have proposed a telemedicine system to decrease cardiovascular disease risk in an underserved population using the Internet. Patients send/receive data to/from their care provider via the Internet. The system optimizes function and minimizes cost.

Bellazzi R et al.(2002) present a design, development and evaluation of telemedicine system for insulin dependent diabetes patients management. The system relies on the integration of two modules, a Patient Unit (PU) and a Medical Unit (MU). It is able to communicate over the Internet and the Public Switched telephone Network.
Stefania Montani et al. (2002) present a successful application of Artificial Intelligence (AI) methodologies in the context of a telemedicine service for diabetes patients management. The system architecture is distributed and composed by a Patient Unit and by a Medical Unit, connected through a telecommunication link. Several AI methods have been exploited to implement the functionality. The database relies on an explicit representation of the domain ontology.

Temporal abstractions and other intelligent data analysis techniques are used to analyze the patient’s monitoring data; the Case Based Reasoning (CBR) methodology is applied to perform the Knowledge Management task. Finally, CBR is integrated with Rule Based Reasoning to provide physicians with a multi-modal reasoning decision support tool.

Bellazzi, R et al. (2001) describe multi-access services for the management of diabetes mellitus. The Key features of the system include the merging of telemedicine with knowledge management.

Sweta Sneha and Upkar Varshney (2007) propose an architectural framework for pervasive monitoring of cardiac patients using intelligent agents. An intelligent agent is a software entity that has reasoning, planning and learning capability along with the capability to communicate to other agents in order to accomplish a certain goal specified by the user. Upkar Varshney (2006) shows how infrastructure-oriented WLAN’s can be used to support patient monitoring in hospitals.
Bengisu Tulu and Samir Chatterjee (2007) present an Internet based telemedicine: An Empirical investigation of objective and subjective video quality. Khalid Mohamed Alajel et al. (2005) have proposed an Internet based ECG tele monitoring system which has been developed as an instance of the general client server architecture.

The aim of this research is to provide easy accessibility to diabetes diagnosis to the patients through an intelligent medical kiosk based expert system.

A new design and implementation of the expert Telemedicine system proposed by Rudi and Branko G. Celler (2006) for diabetes management, is capable of storing clinical data in diabetes management, such as blood glucose measurements, insulin injection doses, hypoglycemic events, dietary intake and exercise activities. These stored records eventually will allow the doctors to monitor their patients remotely. Furthermore, the system will give recommendations to the patients about insulin dose adjustments.

Shihab A. Hameed et al. (2008) focus on developing electronic patients medical records system that will help make patient monitoring more effective using open source tools. Reddy. S et al. (1997) have proposed an Internet-based telemedicine system to support real-time consultations among health care providers via a computer network, provide secure access to multi-media patient records and discharge summaries, facilitate authentication/digital sign-off, multi-media mail-based referrals, and network-based dictation/transcription.
Ralph Grove (2000) discusses the value of Internet as a medium for expert systems development and he has explained the advantages and disadvantages of the of Web based expert system development. Narongrit Waraporn (2007) has explained a methodology of defining the confidence levels for computer-aided medical diagnosis according to the patient-doctor physical interaction. The extension of this AI methodology in the medical field via Internet will provide support to the physicians and improve the health of world population.

Several papers have successfully has explained the benefits and challenges of using Web based expert systems. Tsumoto (2003) has proposed a Web based medical decision support system to enable home doctors to take rapid action. Hongmei Yana et al.(2002) presented an Internet-based knowledge acquisition and management method to construct large-scale distributed medical expert systems. They have demonstrated that a medical Knowledge management system can be built upon a three-tier distributed client/server architecture. The knowledge in the system is stored/managed in three knowledge bases. The maturity of the medical know-how controls the knowledge flow through these knowledge bases.

Wan Hussain et al.(2002) have explained the potential of artificial intelligence techniques particularly for Web-based medical applications. Dai Sheng Hui et al. (2008) have proposed a design of the intelligent real-time hypertensive diagnosis expert system based on Web. They have described a medical network based on state of the art medical kiosk
that addresses the problems of providing preventive and diagnostic health care.

Bursuk E et al. (1999) have described a medical expert system for diagnosis in the domain of cardiological diseases. This medical expert system is developed by using a public domain rule based expert system (RES).

Mu-Jung Huang and Mu-Yen (2006) Chen have proposed an integrated design of an intelligent Web-based Chinese Medical Diagnostic System (CMDS) – Systematic development for digestive health for intelligent disease diagnosis. CMDS uses Web interface and expert system technology to act as human expertise and can diagnose a number of digestive system diseases.

Mara Nikolaidou and Dimosthenis Anagnostopoulos (2003) have presented an Exploring Web-Based Information System Design: A Discrete-Stage Methodology and the Corresponding Mode using object oriented modeling with UML as a visual tool for graphical representation of model components.

The second part of the research is related to the design and architecture of real-time Web centric telehealth expect system. Stamper, R et al. (1992) have proposed a software engineering approach to the design of a medical expert system. R. Klar and Zaiss A Lung (1990) have proposed a design and application of a medical expert system for pulmonary medicine used for automatic interpretations of lung function.
data which are measured on-line and directly computed. Ismail Saritas et al. (2003) have proposed a design of a fuzzy expert system for diagnosis of prostate cancer. Edward I-i Shortliffe and Larvrence M. Pagan (1982) discuss about the expert systems research in modeling the medical decision making process.

Many proposals have been made based on object-oriented design approach in expert system development. Yao Tsung Lin et al. (2003) have designed new object-oriented rule base management system on the concept of learning and thinking behaviors of humans. It provides high maintainability and reusability through the object-oriented concept. Branson et al. (2001) have proposed an object-oriented rule-based expert system framework mechanism.

The framework includes a condition manager object that keeps track of what conditions are true at any time and a rules compiler that processes the rules so they can be used by the condition manager. The conditions are a set of object classes that are organized into an inheritance hierarchy for use by the condition manager. A detector determines when to set conditions as true. When a condition state is changed, the condition manager realizes that one or more rules might indicate a particular action might now be appropriate. Therefore, the condition manager checks the rules against the conditions each time a condition changes.

Marina Kro and David L. Reich (1999) have designed an object-oriented model of a health care management information system. A set of three models has been developed: (1) the object model describes the
hierarchical structure of objects in a system—their identity, relationships, attributes, and operations; (2) the dynamic model represents the sequence of operations in time as a collection of state diagrams for object classes in the system; and (3) functional diagram represents the transformation of data within a system by means of data flow diagrams. Within these models, they have defined major object classes of health care participants and their subclasses, associations, attributes and operators, states, and behavioral scenarios. They have also defined the major processes and sub processes. The top-down design approach allows use, reuse, and cloning of standard components.

Somlak Wannarumon et al. (2007) have developed a collaborative design system based on object-oriented modeling of Web assisted product development. Xie Hongchao et al. (2001) have proposed a Web based tribology design repository system using the object oriented design. Miguel Aluen and Hector Arrechedera (1999) have developed a Web-based object-oriented multimedia medical system. This medical application is focused on the development, diffusion and use of the technology in response to specific domain needs of medical experts in the area of tropical diseases. Jacob Anhøj (2003) proposed a generic design of Web-based clinical databases using object oriented modeling. Tsang, C.H.K and Bloor. C (1994) have proposed a medical expert system using object-oriented frame work and describe about static object components, presentation components and inference components.

Several papers have successfully explained the benefits and challenges of using Web-based expert system. Y. Duan et al. (2005)
have discussed the benefits and challenges of Web-based expert systems and address the issues associated with the design, development, and use of the Web-based Expert system from the standpoint of the benefits and challenges of developing and using them. The original theory and concepts in conventional expert systems were reviewed and a knowledge engineering framework for developing them was revisited. The study considered three Web-based ES: for e-business strategy development, for fish disease diagnosis, and to promote intelligent interviews.

The benefits and challenges in developing and using expert system are discussed by comparing them with traditional standalone systems from development and application perspectives. Parr, A (1993) has described the design problems encountered in the development of a medical expert system for diagnosis of cardiac defects.

Nilmini Wickramasinghe et.al(2008) have explained the healthcare Intelligence Continuum: key model for enabling Knowledge management initiatives and realizing the full potential of systems management technologies in healthcare delivery. A vital technique in KM is data mining that enables critical knowledge to be gained from the analysis of large amounts of data and information.

Nilmini Wickramasinghe et.al(2008) describes a knowledge-based adaptive mapping to realization methodology to traverse successfully from idea to realization rapidly and without compromising rigor so that success ensues. It is discussed in connection with trying to implement superior ICT-enabled approaches to facilitate superior Chronic Disease Management.
R.K. Bali et.al(2007) prescribes to examine the efficacy of the Knowledge Management (KM) paradigm for a web-based Patient Administration System (PAS) for Cardiovascular Disease (CVD) management. The role of contemporary Information and Communication Technologies (ICTs) for the management of electrocardiographic information and how this can act as a foundation for a KM-based system is discussed. Moreover, the proffered CVD KM system, coupled with the tools, technologies and techniques of the Intelligence Continuum (IC) is presented as a suitable model to enable critical information to be captured and accessed in a timely fashion by clinical decision makers, thereby ensuring the highest level of quality care in CVD treatment.

J. Puentes et. Al(2007) have explained Among the multiple technology evolutions that could be identified as significant trends we have selected four – wireless broadband, non-invasive sensors, emerging multimedia standards, and open source software – which are likely to have an impact on the current telemedicine progression, at the functional and economic levels.

Nilmini Wickramasinghe et.al(2008) have explained about the healthcare industry is facing increasing pressures to embrace new technologies that support greater patient access to, and higher quality of (but at the same time offer cost-effective), healthcare delivery. This pressure has spawned a plethora of initiatives to embrace the possibilities and potentials of technologies to develop and then diffuse new devices, new pharmaceutical products and support minimal invasive surgical
techniques that will facilitate superior healthcare delivery. Pursuing such initiatives from idea generation to commercialization and adoption, however, also necessitates new alliances between academe and industry to ensure rigorous research followed by rapid diffusion to support the realization of these initiatives so that the patient becomes the ultimate beneficiary. The Accelerated Mapping-to-Realization (AMR) methodology is used as an appropriate knowledge-based methodology to ensure academic rigor and validation and also facilitate rapid diffusion and commercialization of m-health initiatives.

2.3 ORGANIZATION OF THE THESIS

The objectives stated above have been carried out and organized for presentation into seven chapters. Chapter 1 explains the motivation and goals along with an introduction to telemedicine. It covers the facts and socioeconomic issues related to diabetes, the conventional methods of patient monitoring in diabetology and the proposed telemedicine system for high risk cardiac patients.

In Chapter 2, a brief literature survey pertaining to the work done in the thesis has been presented. The benefits and challenges of using Web based expert system have been discussed. Proposals based on object oriented design approach in expert system development related to design and architecture of real-time Web centric telehealth expert system have been studied.

Chapter 3 gives an introduction to Diabetes and its classification, signs and symptoms, genetics, diagnosis screening and prevention,
treatment and management, cure and prognosis and its associated complications

Chapter 4 gives an overview of expert system and object-oriented design concepts. It also discusses the various developmental tools used in this research for object-oriented design and implementation of Web centric telemedicine system.

Chapter 5 presents a developmental process of real time Web-centric intelligent health care diagnosis system to support the diabetes diagnosis and particularly focuses on the development process of its corresponding Web applications.

Chapter 6 presents a design and architecture of real time Web centric telehealth diabetes diagnosis expert system. This chapter also describes the implementation of architecture including a hospital network, telehealth kiosk (patient) and Web server. The chapter concludes with the results obtained and conclusions.

In Chapter 7 an overall scope of the Web based telehealth care intelligent diagnostic system using UML notations with a high level model allowing for accurate estimation is developed. The Use Case Driven nature of modeling with UML ensures that all levels of model trace back to elements of the original functional requirements.

The chapter ends with implementation and results obtained. A certain amount of work has been done to develop an automatic Web
based diagnostic telemedicine system for diabetes patients, which is very critical as a preventive and diagnostic measure. Also, the technology used will be cost effective so that it will be affordable by the individual user when compared to existing available systems. In Chapter 8, the conclusions and scope for future work are discussed.