EDUCATIONAL AND INFORMATIONAL E-HEALTH PORTAL

M. Verlič*, M. Lenič* and P. Kokol*

*Laboratory for System Design, University of Maribor, Maribor, Slovenia

{mateja.verlic, mitja.lenic, kokol}@uni-mb.si

Abstract: Improving the quality of life and promoting lifelong learning are the main objectives of educational and informational e-health portal. E-health portal acts as a common access point for general public, medical staff and researchers to obtain relevant information and services from the medicine and health-care area. It provides introductory, advanced, general and specific online courses on ICT used in medicine and health-care, statistics and tools for intelligent analysis of research data. It also includes services for exchange of expertise between researchers in medical domain. E-health portal is based on various technologies, including web services, e-learning course management system, machine learning techniques, knowledge management techniques and multi-agent systems.

Introduction

Today when using Internet is part of our daily routine, it is reasonable to ask "Why don't we take the state-of-art technology and apply it to health-related domain?" Some potential ways of applying modern technology are quite obvious. For instance, people search everyday for health-related information on the Internet. How to know which web site to trust? How to be sure that relying on the information provided is not risky? The best solution would be to have trustworthy information, services and software collected at one place and approved by medical organizations, Ministry of Health or acknowledged research institutions. The improvements of security mechanisms contributed to the popularity of online shopping, which could be used to order medicine online or to check whether specific medicine is available in the nearest pharmacy. Furthermore, knowledge management is a crucial part of any successful company. Hospitals can be considered as large and important companies – people's lives depend on them. To reduce costs and optimize specific tasks and procedures, it would be reasonable to introduce most successful knowledge management techniques to hospitals.

Even more important than recognizing the obvious is to identify what is really needed in hospitals: to improve existing hospital information systems, to unify them to some extent, to enforce the use of standards for patient records and for documentation (like HL7, DICOM), to disseminate research results and to develop a platform for exchange of expertise and experience gained from real-world situations. Some of the most important tasks are to educate medical staff and general public on how to use ICT and emphasize the importance of self engagement in the process of disease prevention.

Other source of motivation comes from EU initiatives concerning specific issues of e-health and e-learning (among all others), which are addressed under e-Europe action plan and are set as policy priorities. ICT as we know today provides a firm foundation for realization of EU initiatives. For instance, the quality of life heavily depends on the health-related information that people can get. One of objectives of EU Information Society sector is to help people maintain their health through being better informed. To be better informed is to be aware of all possible technologies and to know how to use them to obtain information. Skills needed for the exploitation of information sources can be obtained in various ways, for example through classical or e-learning courses. Obtaining skills can be a part of lifelong learning – learning anywhere, anytime at one's own pace. Our aim is to provide quality information for everyone from everywhere at anytime.

Materials and Methods

Main functions of informational and educational ehealth portal are to inform, to educate and to support the research in the area of medicine and health-care. Ehealth portal acts as a common access point for medical experts, hospital employees and any other person interested in health-related topics like healthy living style, illness prevention or useful information on health centers.

Architecture: E-health portal is accessible at two levels: (i) at the level available to general public, and (ii) at the level available to registered medical staff, experts and researchers. Two levels are necessary for many reasons: some medical documentation might be confidential and should not be available to general public (e.g. patient records, internal statistics); descriptions of medical procedures are meant to be read by experts only, because they have required knowledge to correctly interpret and apply them (in the worst case they could be carried out at home by non-qualified person and have fatal consequences); medical databases about patients are confidential and should not be available to everyone (they can contain sensitive data); average non-experts lack necessary specific knowledge to be able to participate in medical discussions.

Portal is divided into three main sections: (i) informational, (ii) educational and (iii) research section. Although it is based on typical web portal architecture,

each section includes many additional technologies originally not included in basic architecture.

Informational section offers different services: sending news and notifications about appointments by SMS, subscribing to e-mail news list or RSS feeds about new drugs available or any other novelties in medicine and health-care. It also provides payable services for requiring official second opinion from medical specialists, listed in portal's directory of specialists and online shop for general drugs available without prescriptions from registered vendors, which is in testing phase.

Educational section is based on Moodle [1], an open source course management system for online learning, which incorporates several knowledge management techniques. In this section several general and specific online courses are offered: introductory e-courses on ICT (public level), introductory and advanced e-courses on using statistics in medical research (restricted level), HOWTO's for tools available in research section (public and restricted level) and preparation of data to be analyzed (restricted level) etc.. This section is very important not only for public, but also for medical staff. For them is crucial to know how to efficiently use different technologies available at hospitals and other health institutions.

Important part of research section is a set of tools implementing machine learning techniques: a tool for intelligent analysis of medical data; an intelligent assistant[2] to be used by people with having diabetes, heart condition or being over-weight; and multi-agent system for solving patient scheduling problems [3]. Research section provides services for online cooperation and exchange of expertise between researchers. Anonymous users can participate in online surveys or fill online questionnaires, vote in polls – all designed and verified by qualified staff. Results can be used either to get feedback about the quality of information and services provided on the portal, or to gather data to be analyzed later.

Some of the technologies mentioned above will be described briefly just to get an overview of portal's structure.

Web portal: Web portals are present in almost every domain including sport, health, education and research. They are defined as web sites that provide a starting point, a gateway, or portal, to other resources on the Internet or an intranet [4]. Usually they are based on dynamic web pages (implemented in different programming languages like PHP, JSP and PERL) and databases, which can be centralized or distributed, flatfiles, relational databases or object-oriented databases.

Web Services: Portals can include web services, which nowadays typically refer to modular applications that can be invoked through the Internet. They are used primarily for businesses to communicate with each other and with clients. Computer applications that use web services usually communicate over HTTP protocol, using different standards including SOAP, WSDL and other UDDI open standards. Instead of roviding graphical user interface, web services share business logic, data and processes through a programmatic interface across a network [5, 6].

Short Message Service (SMS): One of the hottest trends in modern businesses is notifying customers by sending short text messages to their mobile phones. SMS is defined as a wireless messaging service that permits the transmission of a short text message from and/or to a digital wireless terminal.

Moodle – open source course management system: Moodle is is a software package for producing internetbased courses and web sites. Some of the most important Moodle features are: (i) it runs on any operating system that can run PHP programming language; (ii) it supports many types of databases; (iii) it is designed in modular way; (iv) it allows adding or removing functionalities at many levels; (v) it has relatively simple and efficient multi-language user interface; (vi) courses can be categorized and searched; (vii) it supports a range of authentication mechanisms, activities and other modules, that can be easily customized.

Knowledge Management Techniques: Malhotra [7] summarized several interpretations of knowledge management. In our case we adopted Chen's definition of knowledge management as a system and managerial approach to collecting, processing, and organizing enterprise-specific knowledge assets for business functions and decisions [8]. E-health portal incorporates some of the most popular KM implementation platforms like enterprise information portals (e-portals), document management systems, search engines, web-based training and e-mail[9].

Machine learning techniques: Tools for intelligent analysis of medical data implement several machine learning techniques (decision trees, neuron networks, Bayes nets, cellular automata etc.). The aim of intelligent analysis is to search for new information in medical datasets and to discover not so obvious relationships between attributes in datasets using multimethod approach [10, 11]. Multi-method approach combines different methods to classify data.

Multi-agent systems: A multi-agent system (MAS) is a collection of agents, which are defined as autonomous, problem-solving computational entities capable of effective operation in dynamic and open environments [12, 13]. MASs are based on the idea that a cooperative working environment comprising synergistic software components can cope with problems which are hard to solve using the traditional centralized approach to computation. Agent technologies are considered very suitable for managing the complexity of distributed systems. They represent more natural approach to solving problems in dynamic and open environments.

Although at least some (if not all) of the technologies described above have already been used in medicine and health-care domains [14-18], we wanted to integrate them all in one place – in public e-health portal available to medical experts and non-experts. Our goal

was to establish a firm ground for quality information and services that people can use with certain level of trust – they can be sure the health related information provided in the informational section is verified by medical experts/doctors.

Results and discussion

E-health portal is in a prototypic phase. Some of the services and tools are already implemented and included in proper sections. Table 1 summarizes information and services available at current development phase of e-health portal.

Information on illness prevention and healthy living style to be published in official release of e-health portal is being reviewed. Services for sending news via SMS and e-mail are already included in informational section. Course management system used in educational section had to be customized to meet the requirements for two levels of access. Introductory e-learning courses on ICT and statistics are available. In research section an online survey on breast-feeding has been conducted. The level of participation was satisfactory. The results of analysis will be published on the portal in the final phase.

Because the dynamic part of e-health portal is based on PHP programming language, but multi-method tool for intelligent analysis and intelligent assistant are implemented in Java, web interfaces will have to be developed to be able to use these tools online.

Obvious directions for future work include implementing, testing and publishing remaining services and tools. Our primary goal will be to convince general public, medical staff and researchers that using e-health portal would be beneficial for everybody. Only with their contributions to the content of e-health portal and their feedback on quality of information and services the idea of providing quality information for everyone from everywhere at anytime can be realized.

There are still open questions about security in open source systems, authorship of published research findings, means of protecting sensitive data in medical datasets and responsibility for published information that have to be considered seriously and discussed thoroughly. However, it is important to recognize the need for connecting e-health portal to existing hospital information systems to provide a transparent access to patient data and any other relevant medical information from everywhere it is needed.

Table 1: Information and services available at public and restricted level of e-health portal

Sections	Public level	Restricted level
informational	information on healthy living, illness prevention	test version of digital repository of drugs and their side-effects
	useful forms (e.g.: schedules for taking medicine, tables for tracking daily activities and nutrition)	directory of registered vendors of medical equipment
	information on patient's legal rights	information on standards in medicine and health-care
	information on health centers, hospitals and pharmacies: locations, phone numbers, working days, medical services,	
	service for requesting second opinion (testing phase)	
educational	e-courses on ICT	e-courses on statistics
		e-courses on preparing research data for analysis
research	online survey on breast-feeding	forums for registered users (medical experts, researchers, doctors) for exchange of expertise
	polls for getting feedback on quality of services in different hospitals	
	intelligent assistant	

Conclusions

Although e-health portal is still in a premature phase, setting up a foundation for quality information and services is a notable step toward realization of EU initiatives. Educating medical personnel plays a significant role in the process of providing an efficient and economical medical treatment, which is also one of the major priorities for hospital administration. It is not enough to have the technology available – people have to become aware of all the possibilities they have and get to know how to take the advantage of them.

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