Proceedings of the 24th International Symposium on Computer-Based Medical Systems – CBMS 2011

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I. INTRODUCTION

The 24th International Symposium on Computer-Based Medical Systems, CBMS 2011, took place at the University of the West of England, Bristol, UK, on 27th to 30th June 2011. As a special feature, instead of the traditional (since 2005) special track on “healthgrids”, i.e. grid computing for biomedicine and healthcare, latterly encompassing cloud computing also, the conference HealthGrid 2011 collocated with CBMS to the benefit of both. This was the culmination of a hope that those of us working at UWE had entertained since 2008. The invitation to CBMS was first made in Jyväskylä in 2008, became a formal proposal in Albuquerque in 2009 and was confirmed in Perth in 2010. As for HealthGrid, it seemed an opportunity not to be missed to collocate with CBMS in Bristol, only the second time the conference has been awarded to a British city (after Oxford in 2005).

The quality of the program speaks for itself. All contributions were subjected to rigorous scrutiny by two reviewers and at least one member of the Program Committee, i.e. a Conference, Program or Track Chair. The acceptance rate of just over 35% for full papers allowed the Program Committee to highlight work that is truly at the leading edge of developments in healthcare and biomedical informatics. In addition, the conference encompassed a range of new work through a number of exciting posters. These are also included in these proceedings but are not discussed further in this introduction.

II. MAIN CONFERENCE TRACKS

About two fifths of submissions to the conference were made to the general conference track. The Program Committee developed the tracks below in response to the general themes represented among these submissions.

A. Streams, Signals and Visualization

Cloud computing, which has made as much impact on the conference as it seems to be making in real healthcare organizations, is well suited to streaming data and signal analysis problems. There is an interesting contrast of papers addressing the challenges of remote monitoring of acute critical care patients in remote locations and of context-aware analysis of the condition of vulnerable individuals with chronic conditions. Two other papers tackle issues of gaze analysis, one in the case of nystagmus (which has enormous implications, e.g. for drivers) and the other offering a generic research tool for work in this area. A further paper offers an effective autofocus algorithm for imaging of immuno-fluorescence in biological specimens.

B. Guidelines / Organization / Communication and Interfaces in Healthcare

A set of interesting ‘mainstream’ applications have been presented through these subheadings. An algorithm to support manual binding of terms in archetype-oriented EHRs is compared against human performance. Another paper reports on process re-engineering of chemotherapy in an Italian framework heavily reliant on ICT support. A major problem in public health research is the difficulty of simulating public policy; a vital contribution here comes in the form of a novel semantic web-like framework to support policy simulation. Another contribution describes the application of a generic tool developed in an engineering context to the organization of a pediatric intensive care unit. Two contributions from Ireland expound, first an extension of the NASA ‘task load index’ framework in the assessment of user interfaces and second an analysis of record keeping requirements and practice in multi-disciplinary teams.

III. SPECIAL TRACKS

The conference was delivered through a number of tracks that arose naturally through the submission process as well as through a number of Special Tracks with their own ST Program Committee and review process.
A. Knowledge Discovery and Decision Systems in Biomedicine

The vast volumes of data generated by biomedical devices or that are available to be retrieved from medical archives motivates the development of tools that can handle, analyze and make use of the resulting information with appropriate computer support. On one hand, data mining has become a popular and effective way of discovering new knowledge from large and complex data sets, and particularly, medical data sets. Advances in data mining research and technology have made it possible to address many interesting problems in medical diagnostics and healthcare. On the other hand, computer-based systems supporting medical decision-making have received a great deal of attention in research. These systems may be used towards different objectives, from pre-selection of cases to be examined, through serving as a second reader to working as a tool for training and education of specialized medical personnel. However, the development of versatile systems applicable to different working scenarios remains a major issue. They call both for the careful design of data processing methods as well as the determination and definition of decision rules. Moreover, the need to ensure that such systems work safely and effectively inevitably leads to the definition of mandatory performance evaluation criteria.

Papers in this track include a quantitative evaluation of Parkinson's disease, an attempt at automation of decision support, and a classifier for ECG beats using mobile phones. Another contribution considers the information content of newborn sleep cycles as an indicator of the infant brain's maturity. A further paper considers imaging support in the interpretation of colors in indirect immunofluorescence.

B. Technology Enhanced Learning in Medical Education

This long-standing Special Track has sought to capture the impact of advances in ICT on medical education. It captures the momentum of an international trend to involve computers and the Internet in medical curricula and in continuing life-long medical learning. The fundamental challenge for medical education is how to enable clinicians and scientists to encompass the enormous expansion in medical and biomedical knowledge. Novel educational approaches build on traditional concepts of adult education and rely on situational or constructive learning. They accommodate elements derived from the traditions of active, self-directed, student-centred and experiential educational programs to lead learners to develop robust conceptual models that can eventually facilitate the transition towards expert, highly specialized knowledge, without losing sight of the “big picture”. The goal of information technology is thus to provide some added value in the development of individual strategies to deal effectively with the sheer volume and complexity of medical knowledge.

It is appropriate that the program in this track leads with a paper that co-opts persuasive technologies in the service of linking sources of medical knowledge. In a similar spirit another paper accepts the potential of semantic wikis in sharing medical knowledge, but acknowledges and goes on to consider the problems their open nature presents in this particular case. An interesting contribution from Cardiff explores the problem of “information without understanding” and considers ways in which education theory can complement design principles in the development of an effective information system for non-communicable diseases. The final paper in the track presents a training system to support the education of radiologists in assessing bone age, i.e. the degree of skeletal maturity, of children suffering from endocrinological and growth conditions.

C. Intelligent Patient Management / Supporting Collaboration in Healthcare

Over the past three decades, there have been large demographic changes in most industrialized countries, with improvements in standards of living and in healthcare leading to a pronounced increase in longevity. Not surprisingly, this has led to rising expectations in terms of both quality and access to healthcare, with the needs of an increasingly elderly population competing with the cost of cutting edge advances in medicine and the promise to translate scientific breakthroughs “from the lab bench to the bedside”. Governments and health authorities thus have both a moral and an economic interest in using intelligent technologies to support the goals of public health and health equity.

One paper in this track explores the use of the “model view controller” design pattern in a system to support long term resource planning in a London health planning region. Another contribution from Glasgow considers the development of patient pathways through process mapping, illustrating the method in detail through a case study of pre-operative assessment.

The extent of interaction and mobility exhibited by healthcare staff in their work is well known. This may involve coupled, synchronous or asynchronous communication and activity, often shared and conducted among a distributed team. Moreover, the fundamental importance of providing harmonised hospital, social care and community services has also become an identified goal in health and social care. As well as providing novel approaches to support traditional methods of communication, a range of technologies offer the potential for individuals and groups to reconfigure their collaboration practices in new and useful ways.

Three Scandinavian papers illuminate the scope of this point of view. The first, from Sweden, explores the use of X-ray imaging during surgery, where spatiotemporal information from a motion tracking system complements the X-ray images. A contribution from Norway uses ethnographic methods to analyze a nurse calling system, both in supporting their decision-making and in disrupting their work through unwarranted interruptions. The use of laser pointer in meetings to discuss X-ray and other images is examined in another Swedish paper, leading to recommendations concerning the design of a specialized pointing device, realized in fact through haptic rendering.

D. Biomedical Image Processing and Informatics

Academic research and industrial developments in medical imaging and all its stages and methods – acquisition, PACS, image processing, segmentation and registration, content-based image retrieval – and the development of systems and tools,
have played a critical role in advancing clinical medicine and biomedical research. The call for papers in 2011 singled out a special interest in analysis of digital or digitized chest X-ray images for automated screening, diagnostics, and informatics applications. Contributions to the track exhibit the wide scope of the subject.

Two papers from a team at Fraunhofer IGD present, first, an elaboration of a graph matching algorithm that can overcome some of the problems with missing or poorly defined images of hepatic vasculature, remaining robust in the face of gaps in the image, and second, its application to the visual separation and discrimination of hepatic veins with potential clinical application in surgery planning. A team from Brazil exploited the “Cloud Bank” concept to improve segmentation of MR images of the hippocampus. A paper from the National Library of Medicine in the US explores a set of algorithms for the detection of vertebral boundaries with a view to recognizing occurrence of one particular condition, anterior osteophyte, which is symptomatic of spinal osteoarthritis. A second paper from the same source exploits Kohonen-like Self-Organizing Maps to use “bags of keypoints” as a search index in a medical image database. An Italian team report on a Kinect-based interface for the manipulation of images by means of gestures alone, making it suitable for operating theatre use. Finally a team from the US reports, first, on an interoperable middleware that supports the straightforward creation of task- and data-parallel stream programs that can exploit grid-like infrastructures; this has been shown to improve processing rates by an appreciable factor. Second, they report on advances in the use of reflection in colonoscopy.

E. Medical Robotics

There is an enormous difference between the robots of science fiction and the robotic applications that have been realized to date, but in the medical field the potential of robotics appears limitless. Research and development is under way in both the academic and industrial sectors to create ever more adaptable and subtle devices: rehabilitation robots that steady or support the patient’s movement; service robots for the elderly and physically challenged, supplementing the patient’s strength and providing exercise at the same time; sensitive haptics that can palpate remotely and tools complementing the surgeon’s skill in minimally invasive procedures; through to tele-operated devices for field first aid. The Special Track on Robotics provided a number of illuminating examples of work in this highly interdisciplinary area. The work presented here brings together the disciplines of mechanical engineering, medicine, electrical engineering, nursing, physiotherapy, computer science and informatics, neuroscience, physiology, artificial intelligence and psychology.

The breadth of work is indeed considerable. Two contrasting papers from different teams in Bristol report, on one hand, on a masticatory simulator with six degrees of freedom to test materials for restorative dental treatments, and on the other, an active orthotic ankle foot device with two degrees of freedom for post-stroke rehabilitation. Another rehabilitation-oriented application aims to support arm movement with seven degrees of freedom and minimal cognitive stress through the use of tongue control and gaze recognition. A further paper looks at problems arising typically in internal medicine, when the benefit of palpation is not available, and demonstrates a prototypical elastography-based palpation application. The final paper deals with multimodal registration of surfaces for intra-operative visualization, exploiting time-of-flight camera techniques during an operation with preoperative imaging, even when these are from different modalities.

F. Assistive Technologies

As the area of computer-based assistive technologies grows, it provides the potential for making assistive technology adaptable and customizable to suit individuals’ needs and enable the development of more robust, usable and flexible solutions. The technology should reflect not only end-users’ changing physiological and contextual needs, but also draw on broader psychological, social and ethical issues, to remain relevant and valued. In order to do this effectively, it is important to employ methods that are able to give the design team a more considered and holistic view of all the stakeholders’ perspectives and the related context they are designing for. Concern with ethics and privacy is prominent in monitoring situations, where the “patient” may well be suffering from memory loss, lapses in attention and general confusion.

A case in point is recognition of activities through sensor signals; in the absence of duration information, this may be misleading, but there is no fixed duration for any given task common to all individuals. A team from the University of Ulster has used statistical methods to “discretize” activity intervals and so improve activity prediction. A contribution from Trinity College, Dublin, considers a novel context-aware model-based architecture for a way-finding application to support people with cognitive impairment. Finally, an analysis of requirements for a telehealth (rather than telecare) system for the elderly is reported from New Zealand; here the emphasis is on supporting autonomous decision making relating to health by the elderly user rather than focusing on doctors’ decisions.

G. Ontologies, Terminologies and Language Processing / Computational Proteomics & Genomics

Biomedical Ontologies provide a crucial framework for handling and coping with an exponential growth in the volume of biological data, generated by high-output technologies and fuelled by advances in biotechnology. However, these Ontologies have developed in a largely uncoordinated way, often reflecting mere relations of ‘association’ between concepts, and primarily serving the purposes of information extraction from on-line biomedical literature and databases. In recent years, a great deal has been learned about the criteria which must be satisfied if an ontology is to allow true information integration and automatic reasoning across data with information derived from different sources.

A paper from Heilbronn in Germany aims to enhance search for relevant or personalized health information through
semantic networks generated from publicly available sources; these in turn can be used to inform “health recommender systems” to be coupled with personal EHRs. A team from Manchester analyzed the evolution of the National Cancer Institute’s Thesaurus through its 88 available OWL versions spanning 2003 to 2010. Through the analysis of two consecutive “diffs” they were able to examine purely syntactic changes and changes in entailments. Their findings have implications for developers planning to use an evolving ontology as part of their system. A paper from Wollongong takes as its starting point the mismatch between specific domain experts’ language and the more restricted terminology of the NCI Thesaurus. It introduces the “Cancerology” ontology as one that is more amenable to the understanding of natural language texts relating to specific cancers. Finally, a paper from the THESEUS project in Germany reports on the use of a variety of sources of guidance in the ontology matching problem; these include corpus linguistic rules, context information and expert user feedback.

Genomics, the study of the genome, and proteomics, the biochemical investigation of the proteins expressed in an organism or a cell, have given rise to a multitude of interesting computational problems. In the paper presented in this track, the authors consider ways that currently available services and data can be effectively integrated to infer new knowledge. The size of such datasets makes integration and search highly intensive computationally, making it worthwhile to seek ways to optimize the search for appropriate combinations to be extracted.

ACKNOWLEDGEMENTS

We owe the success of this conference in no small measure to the dedication and hard work of numerous reviewers as well as those more closely identified with the conferences. It would not be appropriate to single out individuals here, but my Conference, Programme and Special Track Chairs deserve special mention. The list of all reviewers has been included in the proceedings. Collectively, we owe them a debt of gratitude for their thoroughness and professionalism.

It is also a pleasant duty to express our appreciation to the Faculty of the Environment and Technology at UWE, to Snap Surveys (www.snapsurveys.com) and to the Bristol Branch of the British Computer Society for sponsorship of CBMS. Through HealthGrid, the conference also received support from the European Grid Infrastructure project (http://www.egi.eu/). The IEEE, this year in the form of the Engineering in Medicine and Biology Society (EMB), the ACM and IFIP have once again provided technical sponsorship of CBMS.

As the local host and joint Conference Chair, I owe a particular debt to my student and colleague Mark Olive who served with exceptional energy as the Local Organizing Committee Chair and continued to make a thoughtful editorial contribution as we prepared these proceedings for publication.