Medical Imaging Informatics and Medical Informatics: Opportunities and Constraints

Findings from the IMIA Yearbook of Medical Informatics 2002

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Summary
Objectives: The Yearbook of Medical Informatics is published annually by the International Medical Informatics Association (IMIA) and contains a selection of recent excellent papers on medical informatics research (http://www.yearbook.uni-hd.de). The 2002 Yearbook of Medical Informatics took as its theme the topic of Medical Imaging Informatics.
In this paper, we will summarize the contributions of medical informatics researchers to the development of medical imaging informatics, discuss challenges and opportunities of imaging informatics, and present the lessons learned from the IMIA Yearbook 2002.
Results and Conclusions: Medical informatics researchers have contributed to the development of medical imaging methods and systems since the inception of this field approximately 40 years ago. The Yearbook presents selected papers and reviews on this important topic.
In addition, as usual, the Yearbook 2002 also contains a variety of papers and reviews on other subjects relevant to medical informatics, such as Bioinformatics, Computer-supported education, Health and clinical management, Health information systems, Knowledge processing and decision support, Patient records, and Signal processing.

Keywords
Medical informatics, International Medical Informatics Association, Medical imaging informatics, Yearbook

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Introduction

The Significance of Medical Imaging Informatics

The 2002 Yearbook of Medical Informatics takes as its theme the topic of Medical Imaging Informatics. The visual nature of so much critical information in the practice, research, and education of medicine and health care would suggest that computer-based imaging and its related fields of graphics and visualization should be central to the practice of medical informatics. Yet, historically, this has not usually been the case. The need for technological sub-specialization on the part of imaging researchers and the frequently opposite tendency towards generality of information systems studied and developed by informatics researchers may have contributed to an increasing separation between the fields in the period from the 1970's to the 1990's.

A trend towards re-convergence, however, began in the early 1990's as important new image database, mapping, registration, and segmentation issues arose in the context of neuroimaging with the Human Brain Project (1, 2), and multimodal, whole body imaging with the Visible Human Project (3, 4). There was early recognition of the need for computer-based knowledge representations, not only of anatomy at the tissue level, but also at the multiple underlying biological levels (cellular, molecular, atomic) leading to the definition of structural informatics (5), and the development of a Foundational Model of Anatomy (6). Meanwhile, knowledge representations for integrating multimodal image interpretations (7), methods for modeling elastically deformable anatomical objects (8), integrated segmentation and visualization systems (9), knowledge-based methods (10), and model-driven systems for surgery and education (11) have been gradually helping renew connections between imaging and mainstream informatics work. Encouraging further productive collaborations between researchers in imaging and informatics was one of our motivations in the choice of Medical Imaging Informatics as the theme for the 2002 Yearbook.

Imaging Informatics and Medical/Health Care Informatics

The Opportunities and Constraints of Interdisciplinarity

Medical informatics researchers have contributed to the development of medical imaging methods and systems since the inception of this field approximately 40 years ago. Starting in the mid-1970's rapid progress in computer-based imaging research and practice came from the increasingly specialized, highly mathematical, biophysical, and engineering models of different imaging modalities (CT, MRI, digital angiography, ultrasound, nuclear

medicine imaging, etc.). Various specialties such as radiology, cardiology, and nuclear medicine distinguished themselves by concentrating their efforts on the technologies most effective for their own diagnostic and therapeutic goals. Hospital or enterprise-wide storage and retrieval of large numbers of patient image studies led to the development of PACS systems, but, technological, organizational, and economic constraints tended to divorce them from novel imaging research, and they frequently became just another part of the IT infrastructure for hospitals and clinics. Meanwhile, professional societies and conferences devoted exclusively to biomedical imaging and its subdisciplines proliferated. The number of researchers in the mainstream of medical informatics who remained professionally active in medical imaging began to shrink, and this trend continued until recently.

The combination of more advanced and user-friendly medical image data bases, coupled with improved 2D and 3D reconstruction, visualization and navigation algorithms, is making medical imaging results more accessible to physicians at the point of care. Starting in the early 1990's the Visible Human Project produced a widely available reference set of multimodal images of the whole body. Its wide dissemination has led to much anatomically-detailed education software, but more importantly, it has raised important informatics issues of knowledge representation, modeling, and information retrieval for dealing with large-scale repositories of such multimodal digital image sets. The Human Brain Project initiated at around the same time led to a very large number of projects in brain data mapping, registration and segmentation, all of which made clear the new informatics, biometrics, and computational imaging challenges inherent in integrating massive visual datasets of subject-specific data which needed to be abstracted and summarized into atlases and retrievable maps of the brain. Possibly as result, there has been a re-awakened interest of medical informatics researchers in imaging problems, and the development of what can be identified as a medical imaging informatics subspecialty (13). This is centered around the problems of image data representation and abstraction, where ontologies for describing the underlying medical knowledge needed to interpret images are now being developed in computationally explicit form (14). This will not only assist in standardization and interoperability, but will be crucial in making image data more usable for data mining, decision support, and visual modeling and simulation.

Fundamental issues in imaging that are well-known to medical informatics researchers include: standards for image information exchange, communication protocols, underlying computer data and knowledge representations, coding, nomenclature and vocabulary for including imaging information in the electronic medical record, relation to computerized guidelines for health care, information compression, efficient indexing of image databases, security and confidentiality of imaging records, etc.

There are also many informatics challenges that require deeper scientific, technical, and medical expertise as imaging information becomes more integrated and pervasive to the practice of medicine. These include:

- the development of better human-computer interaction models for health care that rely not only on the increasing power of graphics and visualization but also on good psychophysical and cognitive science studies, given the multiresolution nature of many medical imaging studies, and how this affects perception and interpretation of data;
- developing better techniques for automatic segmentation and registration of medical images in 3D as well as 2D;
- data abstraction, summarization, and graphical (iconic) representation involved in atlas construction;
- representation of biological variability across repositories of bioimaging data to interpret imaging data across populations, and the linking of phenotype to genotype data;
- improving ways of integrating results from automatic image segmentation with expertly derived manual segmentations and annotations – and methods for evaluating the outcomes;
- developing annotation languages for extracting key patient findings found within the massive quantity and great level of detail inherent in medical imaging data;
- creating underlying computer-based representations of knowledge (ontologies, atlases, etc.) to help formalize such communication, while also preserving the flexibility needed for capturing novelty and enabling discovery;
- embedding advanced imaging systems in more general health care delivery software and evaluating their results within health care environments with effective feedback for learning how to modify and update the imaging methods in different clinical contexts.

As researchers in medical imaging informatics begin to address these and other topics, we hope that the 2002 IMIA Yearbook's theme will stimulate greater interaction among imaging and informatics researchers in the development of working systems for the practice of health care, and the improvement of education.

The IMIA Yearbook of Medical Informatics 2002

The IMIA Yearbook of Medical Informatics (14) has been published annually since 1992, by the International Medical Informatics Association (IMIA). It contains a selection of recent, excellent and original research papers in the area of medical informatics. It includes papers selected from the literature for the period from April 2000 to March 2001. The selection criteria include topic significance, representativeness and coverage of research in a given subfield, subject to appropriately high levels of quality in presentation and results.

Traditionally, the selected papers are structured according to main sections: Bioinformatics, Computer-supported Education, Health and Clinical Management, Health Information Systems, Knowledge Processing and Decision Support, Patient Records, and Signal Processing. In addition, papers such as reviews covering medical

Table 1 Table of contents of IMIA Yearbook of Medical Informatics 2002 (this table can also be found in the Internet under http://www.yearbook.uni-hd.de).

Preface	Ayache N, From Digital Anatomy to Virtual Scapels and Image Guided Therapy.
Editorial	Kulikowski C, Haux R. Medical Imaging Informatics.
Review Section	Kaplan B, Shaw NT. People, Organizational and Social Issues: Evaluation as an exemplar. Klein G. Standardization of health informatics – results and challenges. Ackerman MJ. Visible Human Project: From Data to Knowledge. Nowinski, W. Model-enhanced neuroimaging: clinical, research, and educational applications. Brinkley JF, Rosse C. Imaging Informatics and the Human Brain Project: the Role of Structure.
Research and Education Section	Altman RB. Biomedical Computation at Stanford University: A Larger Umbrella for the Future. Reprinted from MD Computing 2000 Nov-Dec;17(6):35-7. Fieschi M, Fieschi D, Gouvernet J, Joubert M, Soula G. Education and Research in Health Informatics at the Faculty of Medicine of Marseille, Laboratory for Education and Research in Medical Information Processing (LERTIM). Kozmann G. Education in medical informatics on the basis of the information technology curriculum at the Veszprém University. Li Y-C. The Evolving Biomedical Informatics Program in Taipei Medical University. McPhee W. Education Downunder (Centre of Medical Informatics, Monash University). Shortliffe E. Medical Informatics Training and Research at Columbia University.
Challenges in Medical Informatics	Lun KC. Inaugurational address. Haux R, Knaup P, Bauer AW, Herzog W, Reinhardt E, Überla K, van Eimeren W, Wahlster W. Information processing in healthcare at the start of the third Millennium: potential and limitations. Methods Inf Med. 2001 May;40(2):156-62. Musen M, van Bemmel JH. Challenges for Medical Informatics as an Academic Discipline: Workshop Report.
Special Section: Medical Imaging Informatics	Audette MA, Ferrie FP, Peters TM. An algorithmic overview of surface registration techniques for medical imaging. Med Image Anal 2000;4(3):201-17. Kockro RA, Serra L, Tseng-Tsai Y, Chan C, Yih-Yian S, Gim-Guan C, Lee E, Hoe LY, Hern N, Nowinski WL. Planning and simulation of neurosurgery in a virtual reality environment. Neurosurgery 2000;46(1):118-35; discussion 135-7. Lohmann G, von Cramon DY. Automatic labelling of the human cortical surface using sulcal basins. Med Image Anal 2000;4(3):179-88. Mueller K, Yagel R. Rapid 3-D cone-beam reconstruction with the simultaneous algebraic reconstruction technique (SART) using 2-D texture mapping hardware. IEEE Trans Med Imaging 2000;19(12):1227-37. Wang J, Naghdy G. Three novel lossless image compression schemes for medical image archiving and telemedicine. Telemed J 2000;6(2):251-60.
Section 1: Health and Clinical Management	Chu S. Information Retrieval and Health/Clinical Management. Synopsis. Lovis C, Baud RH. Fast exact string pattern-matching algorithms adapted to the characteristics of the medical language. J Am Med Inform Assoc 2000;7(4):378-91. Pratt W, Fagan L. The usefulness of dynamically categorizing search results. J Am Med Inform Assoc 2000;7(6):605-17. Schleyer TK, Forrest JL. Methods for the design and administration of web-based surveys. J Am Med Inform Assoc 2000;7(4):416-25. Schulz S, Hahn U. Morpheme-based, cross-lingual indexing for medical document retrieval. Int J Med Inf 2000 Sep;58-59:87-99.
Section 2:	Kimura M. What can we currently expect from patient records? Synopsis. Brossette SE, Sprague AP, Jones WT, Moser SA. A data mining system for infection control

Table 1 Continued

Patients' Records	surveillance. Methods Inf Med 2000;39(4-5):303-10. Brown PJ, Sönksen P. Evaluation of the quality of information retrieval of clinical findings from a computerized patient database using a semantic terminological model. J Am Med Inform Assoc 2000;7(4):392-403. Drury M, Yudkin P, Harcourt J, Fitzpatrick R, Jones L, Alcock C, Minton M. Patients with cancer holding their own records: a randomised controlled trial. Br J Gen Pract 2000;50(451):105-10. Goorman E, Berg M. Modelling nursing activities: electronic patient records and their discontents. Nurs Inq 2000;7(1):3-9. Nadkarni P, Chen R, Brandt C. UMLS Concept Indexing for Production Databases: A Feasibility Study. J Am Med Inform Assoc 2000;8(1):80-91. Nilsson G, Petersson H, Åhlfeldt H, Strender LE. Evaluation of three Swedish ICD-10 primary care versions: reliability and ease of use in diagnostic coding. Methods Inf Med 2000;39(4-5):325-31.
Section 3: Health Information Systems	Isaacs S. Some Evaluations of Informatics Applications in Health Care. Synopsis. Coiera E. When conversation is better than computation. J Am Med Inform Assoc 2000 May-Jun;7(3):277-86. Gray JE, Safran C, Davis RB, Pompilio-Weitzner G, Stewart JE, Zaccagnini L, Pursley D. Baby CareLink: using the internet and telemedicine to improve care for high-risk infants. Pediatrics 2000 Dec;106(6):1318-24. Mair F, Whitten P. Systematic review of studies of patient satisfaction with telemedicine. BMJ 2000 Jun 3;320(7248):1517-20. Marcelo A, Fontelo P, Farolan M, Cualing H. Effect of image compression on telepathology. A randomized clinical trial. Arch Pathol Lab Med 2000 Nov;124(11):1653-6. Nahm R, Poston I. Measurement of the effects of an integrated, point-of-care computer system on quality of nursing documentation and patient satisfaction. Comput Nurs 2000 Sep-Oct;18(5):220-9.
Section 4: Signal Processing	Laguna P. Signal processing. Synopsis. Gonzalez Andino SL, Grave de Peralta Menendez R, Menendez R, Thut G, Spinelli L, Blanke O, Michel CM, Seeck M, Landis T. Measuring the Complexity of Time Series: An Application to Neurophysiological Signals. Hum Brain Mapp 2000 Sep;11(1):46-57. Janušauskas A, Marozas V, Engdahl B, Hoffman HJ, Svensson O, Sørnmo L. Otoacoustic emissions and improved pass/fail separation using wavelet analysis and time windowing. Med Biol Eng Comput 2001 Jan;39(1):134-9. Le Van Quyen M, Martinerie J, Navarro V, Boon P, D'Have M, Adam C, Renault B, Varela F, Baulac M. Anticipation of epileptic seizures from standard EEG recordings. Lancet 2001 Jan 20;357(9251):183-8. Zhukov L, Weinstein D, Johnson C. Independent Component Analysis for EEG Source Localization - An Algorithm that Reduces the Complexity of Localizing Multiple Neural Sources. IEEE Eng Med Biol Mag. 2000 May-Jun;19(3):87-96. Zigel Y, Cohen A, Katz A. The weighted diagnostic distortion (WDD) measure for ECG signal compression. IEEE Trans Biomed Eng. 2000 Nov;47(11):1422-30.
Section 5: Knowledge Processing and Decision Support	Cooper G. Knowledge Processing and Decision Support. Synopsis. Durieux P, Nizard R, Ravaud P, Mounier N, Lepage E. A clinical decision support system for prevention of venous thromboembolism: effect on physician behavior. JAMA 2000 Jun 7;283(21):2816-21. Sanders GD, Nease RF Jr, Owens DK. Design and pilot evaluation of a system to develop computer-based site-specific practice guidelines from decision models. Med Decis Making 2000 Apr-Jun;20(2):145-59. Schwarzer G, Vach W, Schumacher M. On the misuses of artificial neural networks for prognostic and diagnostic classification in oncology. Stat Med 2000 Feb 29;19(4):541-61. van Wijk MA, van der Lei J, Mosseveld M, Bohnen AM, van Bemmel JH. Assessment of decision support for blood test ordering in primary care. A randomized trial. Ann Intern Med 2001 Feb 20;134(4):274-81.

Table 1 Continued

Section 6: Computer-supported Education	Dørup J. Educational technology as a scientific discipline. Synopsis. Bell DS, Fonarow GC, Hays RD, Mangione CM. Self-study from web-based and printed guideline materials. A randomized, controlled trial among resident physicians. Ann Intern Med 2000 Jun 20;132(12):938-46. Berridge E, Roudsari A, Taylor S, Carey S. Computer-aided learning for the education of patients and family practice professionals in the personal care of diabetes. Comput Methods Programs Biomed 2000 Jul;62(3):191-204. Popescu VG, Burdea GC, Bouzit M, Hentz VR. A virtual-reality-based telerehabilitation system with force feedback. IEEE Trans Inf Technol Biomed 2000 Mar;4(1):45-51. Shegog R, Bartholomew LK, Parcel GS, Sockrider MM, Masse L, Abramson SL. Impact of a computer-assisted education program on factors related to asthma self-management behavior. J Am Med Inform Assoc 2001 Jan-Feb;8(1):49-61.
Section 7: Bioinformatics	Hofestädt R. Bioinformatics. Synopsis. Berman HM, Westbrook J, Feng Z, Gilliland G, Bhat TN, Weissig H, Shindyalov IN, Bourne PE. The Protein Data Bank. Nucleic Acids Res 2000 Jan 1;28(1):235-42. Kolaskar AS, Naik PS. Online identification of viruses. J Microbiol Immunol Infect 2000 Jun;33(2):69-78. Miller PL. Opportunities at the intersection of bioinformatics and health informatics: a case study. J Am Med Inform Assoc 2000 Sep-Oct;7(5):431-8. Paton NW, Khan SA, Hayes A, Moussouni F, Brass A, Eilbeck K, Goble CA, Hubbard SJ, Oliver SG. Conceptual modelling of genomic information. Bioinformatics 2000 Jun;16(6):548-57. Rzhetsky A, Koike T, Kalachikov S, Gomez SM, Krauthammer M, Kaplan SH, Kra P, Russo JJ, Friedman C. A knowledge model for analysis and simulation of regulatory networks. Bioinformatics 2000 Dec;16(12):1120-8.

imaging informatics as well as other topics, synopsis by guest editors, and papers presenting international research and education programs, are included. In the following, we will give a short outline of the content. The detailed table of contents of the IMIA Yearbook 2002 can be found in Table 1.

Preface

This year's preface to the Yearbook »From Digital Anatomy to Virtual Scapels and Image Guided Therapy« has been prepared by Nicholas Ayache, Research Director for the Epidaure Project, Medical Imaging and Robotics of INRIA (The French National Institute for Research in Computer Science and Control), Sophia Antipolis, France.

Reviews

As is customary, the 2002 Yearbook includes a number of original review articles, which focus primarily on this year's theme. An article by Michael Ackerman on »Visible Human Project: From Data to Knowledge« updates the status of this seminal project for the field. »Imaging Informatics and the Human Brain Project: The Role of Structure« by Jim Brinkley and Cornelius Rosse, provides a comprehensive review of how imaging informatics approaches were essential for the Human Brain Project and the development of structural informatics, and have led to the development of a computer-based foundational model of anatomical structure. Wieslaw Nowinski gives a systematic review of the application of different modeling methods for enhancing neuroimaging results. Two papers address other important topics to medical informatics: Bonnie Kaplan and Nicola T. Shaw use evaluation processes to review how people, organizations, and social issues impact medical informatics concerns; and Gunnar Klein reviews advances in standards-setting activities in the field.

Education and Research in Medical Informatics

The Yearbook provides an opportunity for highlighting an international selection of current education, training, and research programs in Medical Informatics. This year Russ B. Altman describes the program in Biomedical Computation at Stanford University which increasingly introduces biomolecular as well as clinical applications

of informatics. Marius Fieschi, D. Fieschi, J. Gouvernet, M. Joubert, and G. Soula provide an overview of Research and Development in Health Informatics at the Faculty of Medicine of Marseille, while György Kozman of Veszprem University describes how education in medical informatics is based on an information technology curriculum at his university. Yu-Chuan Li presents the Evolving Biomedical Informatics Program at Taipei Medical University, and Wendy McPhee writes about Education Downunder from the Centre of Medical Informatics at Monash University. Finally Edward H. Shortliffe describes the changes in the program in Bio-Medical Informatics at Columbia University, where he has recently assumed the chairmanship.

Challenges in Medical Informatics

In this section, three papers can be found dealing with the future of Medical Informatics. Incoming IMIA President KC Lun (Singapore) describes important future tasks of IMIA. Mark Musen (Stanford) reports on the outcomes of an IMIA satellite conference on this topic. Finally, the result of a panel discussion on the future impact of information and communication technology on health care, addressed by clinicians, researchers and industrial representatives, is presented.

Selected Papers and Synopses

This year, overall 37 original papers, obtained from 27 international journals, were selected to be included in the Yearbook. After the selection had been completed, guest editors were asked to write Synopses reviewing the papers in the different sections.

The section on Health and Clinical Management, which contains 4 papers dealing with search and retrieval techniques, intelligent information presentation, and information retrieval and delivery on the Internet, was edited by Steven Chu of the University of Auckland. He concluded that a challenge is to further improve these technologies and to build them into integrated software applications to support automated knowledge retrieval.

The section on Patient Records was edited by Michio Kimura of Hamamatsu University. It contains 6 papers on data mining, information retrieval by semantic terminological models, concepts indexing by UMLS, diagnostic coding, and patient holding their own records. The guest editor remarked that medical informatics professionals can prepare healthcare information systems which help to manage data in an intelligent and standardized way, and which provide a good working environment for future users.

Sedick Isaacs of Groote Schuur Hospital Observatory edited the section on Health Information Systems which contains 5 papers on human communication, using the internet to improve patient care, patient satisfaction with telemedicine, effects of compression in telepathology, and measurement of the quality of nursing documentation. The guest editor points to the necessity to prove the cost-effectiveness and acceptability of new information technology in health care.

Signal Processing, with 5 papers, was edited by Pablo Laguna of Zaragoza University. The papers deal with three types of biomedical signals: Electrocardiogram, otoacoustic emissions, and electroencephalogram. The guest editor concluded that signal processing is a very useful technique in many biomedical applications, especially as it offers low cost and non-invasive techniques compared to more elaborate techniques such as imaging.

The section on Knowledge Processing and Decision Support, containing 4 papers, was edited by Greg Cooper of the University of Pittsburgh. The papers discuss methodological issues in developing and evaluating predictive clinical models, novel methods for converting decision models into guidelines, and evaluation of guidelines integrated into the physicians' workflow. In the opinion of the guest editor, finding a bridge between the development of diagnostic, predictive, and therapeutic models and the presentation of such models to clinical users will remain an important issue for medical informatics research.

Computer-supported education, with 4 papers, was edited by guest editor Jens Dørup of Aarhus University. The papers deal with web-based clinical guidelines, the design and programming of a computer-aided educational system, a virtual-reality based telerehabilitation system, and a patient education program. The guest editor discussed success criteria for educational software and expressed his hope that more top-quality medical educational software is made available via the Internet.

The section on Bioinformatics was edited by Ralf Hofestädt of the University of Bielefeld. The 5 selected papers present the current situation of the electronic infrastructure of molecular biology. They deal with the Protein Data Bank, an information system to identify viruses, data modeling for genomic data, analysis of gene controlled metabolic networks, and the future of bioinformatics in the field of health informatics. The guest editor discussed benefits and barriers of bioinformatics and concluded with prospects for the near future.

Information on IMIA

The Yearbook contains detailed information about IMIA, its Member Societies, Working Groups, and Special Interest Groups. Preparation of the general pages describing IMIA activities received considerable assistance from Steve Huesing, the Executive Director. The section on IMIA Working Groups and Special Interest Groups was greatly aided by contributions from Nancy Lorenzi.

For the first time in this Yearbook, a more detailed report on the activities of IMIA regions is included with the help of Regional Editors: Arie Hasman (for EFMI), Sedick Isaacs (for Helina), Jochen Moehr and Charles Safran (for the North American IMIA Member Societies), and Chun Por Wong (for APAMI).

The IMIA representatives from the individual countries provided the material for their own national societies.

Outlook

The next IMIA Yearbook, 2003, will appear in March, 2003. The theme of the 2003 Year-

book will be on the Informatics Foundations of the Quality of Healthcare. With the increasing automation of health care systems, the more widespread introduction of electronic patient records, and the application of evidence-based medicine guidelines for care, as well as the world-wide concerns for controlling costs in health care systems, there has been growing research on the impact of informatics systems on the quality of health care, and its implications for patients and health care practitioners.

The 2003 Yearbook will continue its coverage of all topics in medical informatics, including the one newly added this year, that of bioinformatics, which, due to its long-term implications for the development of molecular medicine and its methodological connections to medical informatics, will now become a permanent section of the Yearbook.

Up-to-date information about the current and future issues of the IMIA Yearbook is available at http://www.yearbook.uni-hd.de.

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Reviewer of the IMIA Yearbook 2002 were: A. Abu-Hanna, The Netherlands; H. Åhlfeldt, Sweden; R. Beuscart, France; A. Bolz, Germany; T. Bürkle, Germany; J.J. Cimino, USA; H. Dickhaus, Germany; J. Dørup, Denmark; M. Egmont-Petersen, The Netherlands; U. Engelmann, Germany; K.-H. Englmeier, Germany; G. Eysenbach, Germany; M. Fischer, Germany; D. Gamberger, Croatia; G. Gell, Austria; W.T.F. Goossen, The Netherlands; A.M. Grant, Canada; J. Grimson, Ireland; L. Hanmer, South Africa; E. Hovenga, Australia; H.K. Huang, USA; R. Jané Campos, Spain; M. Kaus, Germany; G. Kozmann, Hungary; T. Lehmann, Germany; N. Maglaveras, Greece; V. Maojo, Spain; F. Martin Sánchez, Spain; W. McPhee, Australia; A. Merzweiler, Germany; J. Möhr, Canada; P. Molholt, USA; P.W. Moorman, The Netherlands; J. Murphy, United Kingdom; C. Nøhr, Denmark; N. Oliveri, Argentina/USA; C. Quantin, France; C. Safran, USA; G. Schiff, USA; B. Seroussi, France; Y. Shahar, Israel; M. Stefanelli, Italy; I.M. Symonds, New Zealand; M. van Gils, Finland; R. Walton, United Kingdom; A. Winter, Germany; W. Wolf, Germany; T. Yoo, Korea; J. Zvárová, Czech Republic.

References

1. Toga AW. Three Dimensional Neuroimaging. New York: Raven Press; 1990.
2. Koslow SH, Huerta MF, editors. Neuroinformatics: an overview of the Human Brain Project. Mahwah, New Jersey: Lawrence Erlbaum; 1997.
3. National Library of Medicine (U.S.) Board of Regents. Electronic imaging: National Institutes of Health. NIH Publication 1990: 90-2197.
4. National Library of Medicine (U.S.). Proceedings of the Third Visible Human Project Conference. In: Banvard RA, editor. October 5-6, 2000, Bethesda, MD: US Department of Health and Human Services, Public Health Service, National Institutes of Health; 2000.
5. Brinkley JF. Structural informatics and its applications in medicine and biology. Acad Med 1991; 66 (10): 589-91.
6. Rosse C, Mejino JL, Modayur BR, Jakobovits RM, Hinshaw KP, Brinkley JF. Motivation and organizational principles for anatomical knowledge representation: the Digital Anatomist symbolic knowledge base. J Am Med Inform Assoc 1998; 5 (1): 17-40.
7. Höhne KH, Pflesser B, Riemer M, Schiemann T, Schubert R, Tiede U. A new representation of knowledge concerning human anatomy and function. Nat Med 1995; 1 (6): 506-10.
8. Gee JC, Reivich M, Bajcsy R. Elastically deforming 3D atlas to match anatomical brain images. J Comput Assist Tomogr 1993; 17 (2): 225-36.
9. Robb RA, Hanson DP, The ANALYZE software system for visualization and analysis in surgery simulation. In: Lavalle S, Taylor R, Burdea G. Mosges R, editors. Computer Integrated Surgery. Cambridge, MA: MIT Press; 1995. p. 175-90.
10. Gong L, Kulikowski CA. Composition of image analysis processes through object-centered hierarchical planning. IEEE Trans Pattern Analysis and Machine Intelligence 1995: 997-1009.
11. Kikinis R, Shenton ME, Iosifescu DV, McCarley RW, Saiviroonporn P, Hokama HH, et al. A digital brain atlas for surgical planning, model-driven segmentation, and teaching. IEEE Trans Visualization and Computer Graphics 1996; 2 (3): 232-41.
12. Kulikowski CA. Medical imaging informatics: challenges of definition and integration. J Am Med Inform Assoc 1997; 4 (3): 252-3.
13. Mejino JLV, Noy NF, Mussen MA, Brinkley JF, Rosse C. Representation of structural relationships in the foundational model of anatomy. In: Proc. AMIA Fall Symp, Washington DC, 2001. p. 973.
14. Haux R, Kulikowski C, editors. IMIA Yearbook of Medical Informatics 2002: Medical Imaging Informatics. Stuttgart: Schattauer, 2002. www.yearbook.uni-hd.de.

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