MEDnet: A model for applying supercomputing technologies to medical biostereometrics

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ABSTRACT

MEDnet, a project sponsored by the National Center for Supercomputing Applications and the University of Illinois, is an advanced computational science and health care telecommunications project. State-of-the-art computational tools and advanced technologies, accessible through MEDnet, can optimize biostereometric data collection, data transfer and the reconstruction of various metrics and images. This national network could also serve as a clearinghouse for biostereometric data, as well as survey hardware and software suitable for academia, industry and health care providers.

1. INTRODUCTION

The National Center for Supercomputing Applications (NCSA) initiated a project in July 1988 designed to explore the application of advanced computation to medical imaging and medical informatics in both research and clinical settings. This culminates several years of interest on the University of Illinois campus and provides a locus for integrating efforts from different departments as well as the larger community. The project, entitled MEDnet, is being implemented in collaboration with a variety of university units as well as community and regional health care facilities plus individual physicians and researchers on a national basis.

MEDnet's mission is to provide state-of-the-art computational technology and methodology for solving clinical problems common in regional and community-based medical care systems.

MEDnet is committed to multidisciplinary communication and cooperation. It will serve as the hub of interaction among medicine, advanced computational methodologies and technologies and all other arts and sciences in the common mission of solving real-life clinical problems.

Mission goals include:

1. Establishing with NCSA and the University of Illinois a world-class center supporting research and development of advanced computational technologies and methodologies for clinical problem solving.

2. Providing an environment where medical multidimensional signal and image processing, using advanced display techniques, can be prototyped and refined.

3. Serving as a local, regional and national clearinghouse where strategies on the management of the vast amounts of medical images and information produced by today's clinical services can be shared and implemented.

4. Facilitating the development and evolution of clinical decision support tools.

5. Enhancing medical record, data base and image archiving and transfer at local, regional, state and national levels.

MEDnet's initial sponsors include the Champaign County Medical Society and a variety of units at one or both of the Urbana-Champaign (UIUC) or Chicago (UIC) campuses of the University of Illinois:

- National Center for Supercomputing Applications (UIUC)
- McKinley Health Center (UIUC)
- College of Veterinary Medicine (UIUC)
- College of Medicine (UIC/UIUC)
- Electronic Visualization Laboratory (UIC)
- Large Scale Computing Center (UIC)

2. GENESIS AND EVOLUTION

The MEDnet concept was an idea which germinated in the minds of a number of local physicians and other health care professionals, university faculty and administrators, community and corporate leaders, and the Director and staff of NCSA. In 1988, a series of discussions among these individuals, including a formalization of earlier experiments conducted between NCSA and Dr. Paul Lauterbur's magnetic resonance imaging group, resulted in the formation of MEDnet.

MEDnet will evolve through three growth phases:

PHASE I, the current stage, involves the recruitment of regional charter member institutions and industrial partners as well as the selection of representative pilot projects. The initial focus will be on projects utilizing both NCSA-developed technology and software as well as commercially available products. Demonstration projects being investigated include clinical decision support, electronic office environment, and image display and analysis.

During PHASE II, NCSA will move its research offices and equipment facility for the MEDnet project into the Beckman Institute for Advanced Science and Technology. Those health care units which become Clinical Partner sites will be networked to NCSA. Powerful network resources such as the NCSA CRAY 2 supercomputer, three-dimensional display devices, and massive databases stored on laser disk jukeboxes will be available to selected projects in MEDnet. Each Clinical Partner site will identify and support at least one programmer who will coordinate research and program development for the Partner within MEDnet guidelines. Each Partner's team will develop and field joint projects with MEDnet. They will also generate solutions to specific in-house problems.

During this phase, the desktop workstations will become ubiquitous windows into a national medical computational infrastructure that will tie together imaging devices, medical records systems, local, state and national databases, as well as individual health care professionals. MEDnet will cooperate with participants who wish to port the unified software base to several operating system environments.

By PHASE III, MEDnet will be a self-sustaining national resource for clinical information sciences and medical imaging, including clinical data storage/retrieval/transmission, visualization, biostereometrics, and decision support for clinical medicine. A MEDnet Advisory Board of national leaders in medical technology and computer science will be assembled to provide direction and to set priorities.

Phase III will continue the work begun in the Phase II projects coupling leading edge devices such as CRAY 2 supercomputers, Pixar imaging computers, AT&T PIXEL machines, and terabit laser disk jukeboxes to an individual port of entry such as the Macintosh II. The clinical informatics thrust will be refined in terms of the quality of programs available as well as expanded in scope. Partners will be eligible for participation on a National Advisory Board setting goals to include a significant reduction in national morbidity and mortality rates and other critical issues of health care delivery in the United States.

3. ORGANIZATIONAL STRUCTURE

MEDnet has three basic divisions: academic, clinical, and industrial/vendor. The Academic Division, which currently consists of the University of Illinois' College of Medicine, the University of Illinois at Urbana-Champaign's McKinley Health Center and College of Veterinary Medicine, and the University of Illinois at Chicago's Electronic

Visualization Laboratory and Large Scale Computing Center, will be enlarged to include additional local and remote units. The Clinical Division is presently being organized with the goal of inclusion of all interested local regional health care facilities. The Industrial Division will include corporate partners who are involved with the application of advanced computing to medical projects. In addition, proposals will be generated to external granting agencies to help expand MEDnet projects.

4. PROJECT SUPPORT CENTERS

Three main project support centers will be defined and organized:

* The Clinical Services Support Center will promote access to medical, scientific, and medicolegal databases from local, state, and national sources. Data base and imaging archiving, transfer, and management including advanced telecommunications strategies will be established. Expert systems including those with artificial intelligence capabilities are being acquired and will be available for demonstration purposes.

* The Imaging Resource Center will promote and develop pilot projects in image processing, visualization, and biostereometrics. This can complement the community's imaging equipment and will explore novel methods of analyzing clinical data.

* The Research Consulting Center will assist partners in project design and grant proposal preparation.

5. DISCUSSION

Biostereometrics is a maturing scientific methodology and mode of conceptualization which focuses upon mathematical descriptions of body geometry in both the healthy patients and those who are ill. The driving force among biostereometricians appears to be a sincere desire to understand form and function at all levels, from the subcellular to the whole organism. Biostereometrics has evolved from relatively crude observational techniques employing linear measurements to utilization of the most sophisticated automated sensors, advanced software and hardware and, most recently, quantitative 3-D displays.

MEDnet is a fledgling academic project which aspires to serve as a model of interdisciplinary research, cooperation and communication. The basic goal is to enhance the quality of health care delivery via basic and applied research using advanced computational technologies and methodologies. It has evolved over the last two to three years from an idea in the minds of a few academic, medical, industrial and community people into a core of key individuals who represent several thousand professional, technical, administrative, and scientific populations.

The Biostereometric Movement teaches that scientists and physicians must strive for a holistic approach to problem-solving even though their areas of expertise become increasingly esoteric and fragmented: X-Ray became Radiology which has evolved into Imaging Centers with increasing subsets comprised of Ultrasound, Thermography, Nuclear Magnetic Resonance Spectroscopy, Radionuclide Imagery, Positron Emission Tomography, and now Electron-Spin Resonance Imaging.

MEDnet can access an advanced technology base housed within NCSA, the Beckman Institute for Advanced Science and Technology, the Colleges of Human and Veterinary Medicine, the Large Scale Computing Center and Electronic Visualization Laboratory, other academic departments and laboratories, as well a range of health care institutions from community primary care to tertiary facilities. Age-specific populations could also be be surveyed including neonatal, infant, preschool, school-age, college, university, middle-age and geriatric. Special groups could include highly trained athletes as well as those diagnosed with sports injuries including those of the cervical spine.

6. CONCLUSION

In summary, the MEDnet project may benefit from reviewing the impressive history of development and evolution in the field of Biostereometrics. The rapid growth of classification strategies from simplistic stereometric procedures to the more recent advancements in robotic vision and artificial intelligence previews the progression of a

discipline. MEDnet could have an accelerated development by virtue of its juxtaposition with cutting edge resources at the University of Illinois, NCSA, and other academic, clinical and industrial affiliates.

MEDnet's challenge is to serve in a position that emphasizes commonalities, collaboration and communication among academic, industrial, and service partners. The emphasis that biostereometricians have placed on such in the past is a prime example of how efforts in diverse areas can be coalesced, thus promoting synergism and more rapid scientific and medical progress.

MEDnet has a unique position and opportunity to bring national recognition to selected projects. The prospect of serving as a locus for coordination and communication is taken seriously and with some trepidation. MEDnet personnel look forward to working with biostereometric projects which have basic or applied medical applications. The resources that MEDnet can bring to bear on accepted projects can be considerable. Combining the proven Biostereometric approaches with Supercomputing resources and personnel available through MEDnet will greatly leverage results in both areas. We look forward to a challenging interaction between MEDnet and Biostereometrics, in which both areas can advance together at a pace not possible separately. The possibility of our combined efforts resulting in significant basic and computational scientific advancements is exciting. The challenge of actually impacting on human morbidity and mortality is paramount and of international import.