Chapter 12
Medical 3D Graphics With eXtensible 3D

Felix G. Hamza-Lup
https://orcid.org/0000-0002-8532-4228
Georgia Southern University, USA

Nicholas Polys
Virginia Tech, USA

Athanasios G. Malamos
Hellenic Mediterranean University, Greece

Nigel W. John
https://orcid.org/0000-0001-5153-182X
University of Chester, UK

ABSTRACT

As the healthcare enterprise is adopting novel imaging and health-assessment technologies, we are facing unprecedented requirements in information sharing, patient empowerment, and care coordination within the system. Medical experts not only within US, but around the world should be empowered through collaboration capabilities on 3D data to enable solutions for complex medical problems that will save lives. The fast-growing number of 3D medical 'images' and their derivative information must be shared across the healthcare enterprise among stakeholders with vastly different perspectives and different needs. The demand for 3D data visualization is driving the need for increased accessibility and sharing of 3D medical image presentations, including their annotations and their animations. As patients have to make decisions about their health, empowering them with the right tools to understand a medical procedure is essential both in the decision-making process and for knowledge sharing.

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INTRODUCTION

The 3D medical visualization field, both research and commercial, is heavily fragmented due to the lack of information sharing. As a result there is a tremendous amount of incompatibilities and duplicated efforts in fundamental methods like: volumetric rendering, registration and segmentation. The lack of cooperation capabilities also results in limited access to interpreted studies, due to multiple proprietary file formats, which restrict data sharing and collaboration. While the DICOM and HL7 ([Health Level 7], n.d.) standards are complex and capable for medical data interchange and structured reports, they do not represent the presentation state information required for interactive 3D graphics and haptic simulation. Further, proprietary file formats and software and hardware platforms are not easily accessible due to intellectual property, cost, and technical constraints.

The Blue Button Initiative ([Blue button Implementation Guide], n.d.) in the United States is a standard that facilitates patients' electronic access to their medical information, wherever it may be stored. In Europe, the United Kingdom's NHS Constitution also guarantees this right to patients. Additionally, as a multinational effort coordinated by EuroRec (European Institute for Health Records), by 2020 all European Union (EU) citizens should be able to access their online medical records anywhere in Europe. Accountable care organizations are appearing in increasing numbers, and require partnerships between healthcare organizations and providers; high levels of communication are necessary among these constituents to minimize waste, provide timely care, improve quality and reduce costs over the patient lifetime.

Enterprise scale' systems are characterized by their high availability and speed. Maintenance is a key concern as in many ways these systems determine the inertia of an organization; thus premium is placed on both their durability and extensibility. 'Web scale' systems include these requirements, but in addition they must address the challenges of distributed information, heterogeneous users, and non-linear network behavior. As the Web becomes the primary and common interface for numerous information services, we must consider the requirements, emergent properties, and access patterns for health data from laboratory to clinic.

Historically, the medical communities' IT systems have been insular, focused on providing information for their specific function, without concern for data integration or aggregation across the enterprise. Now the changes are fast as the medical enterprises realized that sharing of information within the organization significantly reduces costs and increases efficiency. Finally, in the shift of reimbursement of care from volume to value, medical enterprises are being compelled to share data among and between themselves. This has proven to be especially challenging as Electronic Health Record (EHR) systems, the main clinical data input mechanism for healthcare providers, have been slow to adopt interoperability to deliver integrated services to patients and caregivers, especially where the interoperability and security of the web and mobile devices are concerned.

Meanwhile, the web and entertainment industry has been adding more and more realism to their graphical models and rendering pipelines, including representations and computation for bones, skin and musculature, as well as physics and inverse kinematics, for their virtual characters. However, these representations are often proprietary or physiological simplifications. There are efforts underway to bring together the graphics and physiological models to deliver high-fidelity patient-specific, interactive 3D models to surgeons and trainees. In this paper we demonstrate several examples that are enabled by the interoperability of the Web3D/ISO/IEC Standard, Extensible 3D (X3D). We present the case that, given the requirements of electronic health records and care coordination, the two worlds of Web3D graphics