1999 American Association of Neurological Surgeons Annual Meeting

New Orleans, Louisiana, April 24-29, 1999

TITLE: Creation of Anatomically Accurate Computer-Aided Design (CAD) Solid Models from Medical Images

AUTHORS: John E. Stewart, MS, R. Scott Graham, MD (Richmond, VA), Jamshid A. Samareh, PhD (Hampton, VA), Eric J. Oberlander (Richmond, VA), William C. Broaddus, MD, PhD (Richmond, VA)

ABSTRACT:

INTRODUCTION: Most surgical instrumentation and implants used in the world today are designed with sophisticated Computer-Aided Design (CAD) / Computer-Aided Manufacturing (CAM) software. This software automates the mechanical development of a product from its conceptual design through manufacturing. CAD software also provides a means of manipulating solid models prior to Finite Element Modeling (FEM). Few surgical products are designed in conjunction with accurate CAD models of human anatomy because of the difficulty with which these models are created. We have developed a novel technique that creates anatomically accurate, patient specific CAD solids from medical images in a matter of minutes.

METHODS: Three-dimensional (3-D) triangulated models are created from any standard CT or MR study. These models are simplified and converted into quadrilaterals through a simple geometric operation. Each quadrilateral is then converted into a Non-Uniform Rational B-Spline (NURB) surface automatically. 3-D solid models are output in a format appropriate for CAD and FEM software.

RESULTS: 3-D triangulated models were created for all 7 cervical vertebrae using 150 CT scans obtained from the Visible Human Project. Each vertebrae required approximately 30 minutes to isolate from surrounding structures and less than 1 minute to be converted into a CAD solid. These solid models were input directly into FEM and CAD software packages. Boolean operations such as additions and subtractions of cervical vertebrae and surgical screw solids were easily performed in each system.

CONCLUSION: We have developed a technique to quickly and accurately model the human anatomy as a CAD solid. This new technique has the potential to significantly and positively influence the way in which surgical instruments and implants are designed in the future.

KEYWORDS: Computer-Aided Design, Solid Modeling, Simulation, Finite Element Modeling