VIRTUAL REALITY OF CARDIAC ANATOMY FOR DEVICE DESIGN PURPOSES

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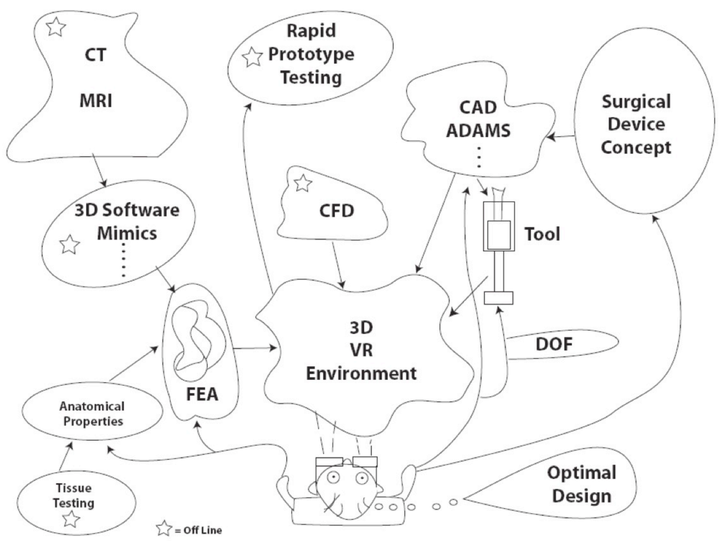


Early Schematic of Proposed Virtual Design Environment for Medical Device Designers

Introduction

The current **medical device design** process has the potential to be significantly improved through the introduction of transformative computational tools and processes. An integrated approach to cyber-design, experimentation, and interactive visualization will enable designers to gain new knowledge of optimal device configurations and deployment strategies, design more robust devices, and reduce time to market.

There exists an urgent need for improved design methodologies and tools that will provide designers meaningful and accurate **feedback earlier** in the design process; to enable designers to more broadly explore the space of potential **design alternatives**; and to expand the boundaries of complex designs that are possible given today's computer assisted design tools.

This project will ultimately provide new tools developed from a synergy of expertise in medical device design from both academic and industry perspectives, computational fluid dynamics, high performance computing, perceptually accurate computer visualization, and effective computer interfaces for virtual design. These tools will facilitate **accelerated development cycles** and **more robust modeling environments**.

Background – Current Work

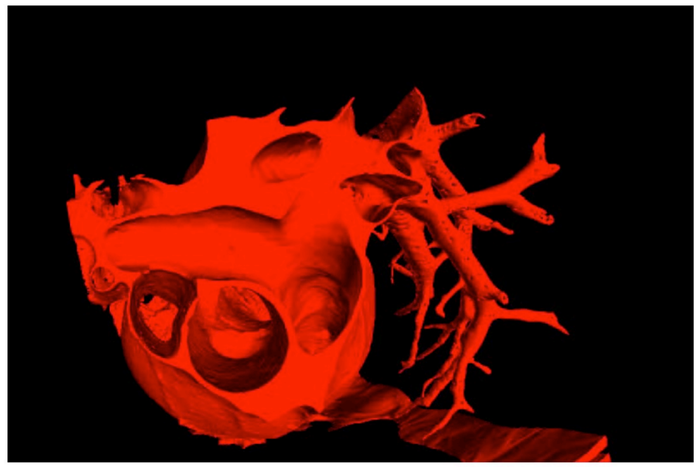
Medical device researchers seek to better understand the complexities of cardiac anatomy, visualize how surrounding structures affect device function and deployment, and **ultimately design more effective devices**. Virtual representation combines visual graphics, virtual reality applications, finite element analysis based on the architecture of a 3D model created from Magnetic Resonance Imagining (MRI) or Computer Tomography (CT) scans. The virtual model is experienced in a virtual reality environment to enhance understanding of the complexities and difficulties of new medical device development.

Methods

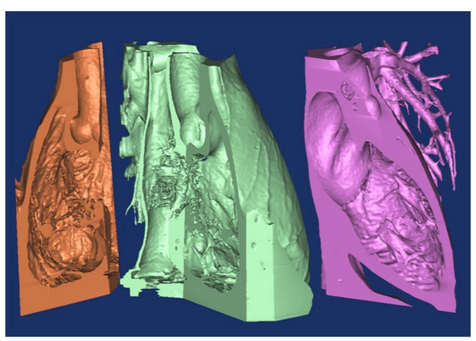
CT scans of the heart were obtained from a live subject. The initial CT data had artifacts or areas with poor contrast. The MIMICS® software was used to segment the images, clear artifacts, and make a 3D model of the heart from the subject CT scans. The model was imported into CAD and visualized using VR applications. The 3D environment allows complex models and structures to be **visualized** in an **immersive and interactive environment** to better understand the constraints that environment can place on medical device development.

Results

The team was able to successfully create 3D cardiac models from CT data using MIMICS® software. The 3D models were exported to both a CAD environment and a virtual reality environment. Inside of the virtual environment, the user was able to navigate and create a "fly-through" of the heart.



Figures: 3D representations of live subject CT data
Provided in collaboration with St. Jude™ Medical



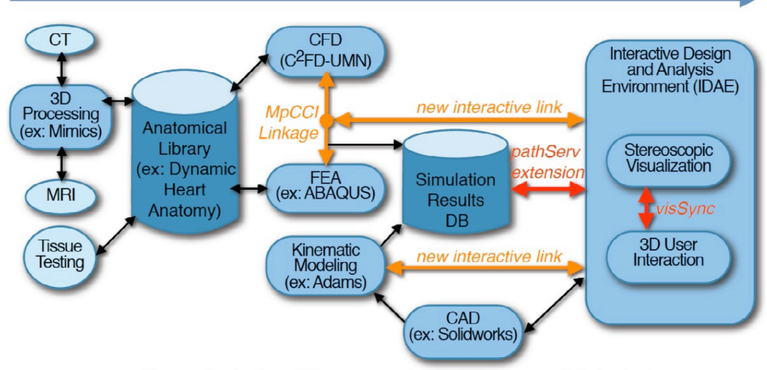


Figure: Illustration of the proposed pipeline from raw data to design

Future Work

Moving forward, the team will focus individual expertise to advance this virtual design environment system. In collaboration with Boston Scientific, Medtronic and St. Jude Medical the team will integrate advances in simulation, visualization, and interactive techniques in a new Interactive Design and Analysis Environment (IDAE).

1. **Continue to build library of MRI-reconstructed dynamic cardiac anatomy**
2. **Characterization of cardiac tissue properties**
3. **Build 3D models (CAD) and mechanical simulations (ADAMS) of medical devices, with a focus on valves and delivery methods**
4. **Develop new CFD methods that account for dynamic deformation of the vasculature**
5. **Design and run perceptual studies aimed at improving ability to accurately visualize complex spatial data in the virtual design environment**
6. **Develop new human-computer interaction techniques using 3D force-feedback technology to allow designer to edit and refine design within the 3D visualization environment in real-time.**
7. **Integrate all components into an interactive design environment where testing is done via computer simulation, results are interpreted using perceptually accurate visualization, and design refinements are made within the environment using new 3D input techniques**

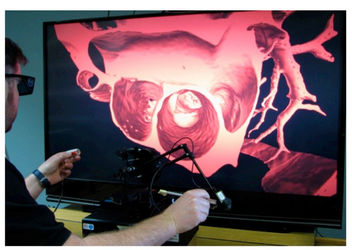


Figure: Future Virtual Environment for Medical Device Design

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