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Computer Vision Platforms

Insight Toolkit

The Insight Toolkit (ITK) is a software development solution for medical image processing, segmentation, and registration. ITK is a library of segmentation and registration imaging algorithms tailored for medical investigations. The toolkit supports a variety of imaging data formats.

3D Slicer

3D Slicer is a medical image computing and visualization application. 3D Slicer works with optical imaging, MRI, CT, and ultrasound data. We have applied 3D Slicer to a range of research and commercial applications.

Pulse Physiology Engine

The Pulse Physiology Engine has an explorer with models for anaphylaxis and multi-trauma. The engine also contains physiological systems and a common data model.

interactive Medical Simulation Toolkit

The interactive Medical Simulation Toolkit (iMSTK) provides developers with software for making virtual simulators for medical procedures, including biopsies, resectioning, radiosurgery, and laparoscopy.

Super Awesome Medical Computing Tagline for this introduction section

We are an interdisciplinary team of computer scientists, software engineers, and imaging experts who provide collaborative research, development, and technology integration services for research centers, universities and companies working in the medical and biomedical business sectors.

We have a long history leading and contributing to open source platforms such as the Insight Toolkit (ITK) or 3D Slicer, that serve as the foundation of many medical visualization and data processing applications. We work with our commercial customers to streamline their internal software and processes, by investigating new algorithms or methodologies that upgrade existing commercial offerings or develop new products. Alone or as part of partnerships, we generate results for research publications, generate prototypes for raising venture capital, conduct first-in-human trials or pursue regulatory approval such as FDA.

Computational Physiological Modeling

Our open source Pulse Physiology Suite includes a well-validated and documented computational physiology engine for real time simulations of the body's response to trauma, disease, and treatment and the Pulse Physiology Explorer is an extendable user interface for quick exploration and experimentation with the Pulse Physiology Engine.

Ultrasound Systems

We are integrating artificial intelligence and deep learning technologies with custom ultrasound and augmented reality hardware to advance the use of ultrasound in a variety of applications. These applications include preclinical and clinical research, pre-hospital patient triage, bedside patient monitoring, and precision needle guidance. Our integrations are enabling less-experienced operators to complete the applications with confidence, in less time, and with expert-level outcomes. They have been transitioned into several consulting projects and pending commercial products.

Medical Imaging Areas of Focus

3D Slicer-based Applications

We help solve challenges by creating custom plugins, SDKs, applications, and software packages using 3D Slicer. Our 3D Slicer packages and modules have been used in a variety of medical and basic scientific applications such as dentistry, radiation oncology, surgical planning, and drug development. These custom applications can be deployed as local software, or they can be deployed on remote servers using Docker or on tablets. To support reproducible workflows, they can also be integrated with our Girder data management solution or with Jupyter notebooks. 3D Slicer is free, open source software that is available across different platforms. Its permissive license makes it even more flexible for the creation of custom commercial software.

Medical Visualization

Kitware is a leader in scientific visualization, including medical data visualization. Kitware began with the open-source release of the Visualization Toolkit (VTK) in 1996, and that toolkit has become the leading visualization tool in multiple scientific domains, including medical imaging. VTK is capable of generating visualizations of exascale data using supercomputers, heterogeneous data (e.g., genomic as well as image data) using cloud resources, and composite geometric and volume rendered data on desktops; and then VTK can stream any or all of those visualizations to mobile devices, surgical microscopes, and augmented reality / virtual reality systems. Our philosophy is to innovate, promote, and support "pervasive visualization" whereby the data that you need to make a decision is presented to you in an intuitive format, when and where you need it, within your own workflows. Examples of our implementation of pervasive visualizations include the ITK-JupyterWidgets for visualizing data within the Jupyter Lab Python research environment, 3D Slicer for biomedical research data visualization, ParaView Glance for in-browser visualization of a wide variety of scientific data, and ParaView Server for visualization of high-fidelity biomedical simulations of blood flow and/or respiratory air motion.

Image Guided Intervention and Surgical Planning

We develop image-guided intervention and surgical planning applications that replace traditional surgery and invasive procedures with minimally invasive techniques that incorporate medical imaging to guide the intervention. Patients prefer these procedures to open surgeries because they are typically less traumatic to the body and result in faster recovery times. Technological advancements in medical imaging, registration algorithms, visualization technologies, and tracking systems are driving forces behind increased adoption of these procedures by physicians. Software is an integral part of these image-guided intervention systems. Whether it is for interfacing with a tracking device to collect position information from surgical instruments, integrating intra-operative and pre-operative images, or generating a 3D visualization to provide visual feedback to the clinician, software has a critical role. The software platforms we are developing at Kitware is playing a major role in increasing the pace of research and discovery in image-guided intervention systems by promoting collaborations between clinicians, biomedical engineers, and software developers across the globe.

Virtual Simulation in Health Care

Our experience with developing medical skill and procedural trainers includes developing the underlying real-time technologies such as fast numerical solvers, haptic rendering algorithms, advanced rendering for 2D and virtual reality displays, collision processing and custom hardware interfacing. These technologies are embedded in our Interactive Medical Simulation Toolkit (iMSTK) which is a C++ based open-source toolkit that aids rapid prototyping of interactive multi-modal surgical simulations. iMSTK features a highly modular and easy to use framework with a comprehensive ecosystem of tools and algorithms required to develop end-to-end medical planners and trainers. Besides access to the technologies that are exclusive to iMSTK, applications can benefit greatly from its interfacing with Kitware's another open-source software tools such as VTK, 3D Slicer and Pulse. Such synergistic use of disparate software has broadened the range of medical applications that are possible and has already helped Kitware successfully build virtual trainers for laparoscopic camera navigation, kidney biopsy and osteotomy procedures.

Medical Image Analysis

Our expertise in the development of custom image analysis algorithms spans brain morphology assessment associated with mental disorders, tumor volume estimation for clinical trials, vessel modeling for stroke and tumor microenvironment research, multiparametric MRI prostate cancer assessment, deep learning for interpreting histology images, and a number of other applications. Building on our role in the creation and maintenance of libraries such as the Insight Toolkit (ITK) and applications such as 3D Slicer, we lead and partner on basic research grants, small business grants, and development contracts for the National Institutes of Health and the Department of Defense. These encompass nearly every aspect of medical image segmentation, registration, quantification, and computer-aided diagnosis. In addition to working on grants and contracts, we can extend ITK and 3D Slicer with new algorithms to speed the deployment of pre-clinical and clinical products, as well as to collaborate on research investigations.

Cross-platform Interactive Applications

We work on a variety of cross- and multi-platform applications from desktop, to server, to mobile, to cloud, to web. The focus of these applications includes distributed 2D and 3D ultrasound, augmented reality, manual and semi-automatic segmentation and registration, quality control workflows, and surgical robotics. At their core, these applications are built on our technologies and expertise in image processing, segmentation, registration, and surgical guidance. We work directly with customers to design workflows, user experiences, and custom interfaces from the ground up. Our development, testing, and documentation practices are aligned with FDA requirements and HIPAA technical safeguards for software products.

Digital Pathology

We are building a suite of open source web-based informatics tools that manage, visualize, and analyze massive and growing collections of data in digital pathology. The key solutions in the making include Digital Slide Archive (DSA), HistomicsTK, and Large-image. DSA is a web-based platform for the aggregation, management, and dissemination of large collections of whole-slide histopathology images, along with associated clinical and genomic metadata. HistomicsTK serves as both a web-based analytics platform and a standalone Python toolkit. It contains computer vision and machine learning algorithms for the quantitative analysis of whole-slide histopathology images and associated data. Large-image supports the web-based visualization and annotation of large multi-resolution whole-slide histopathology images. It also includes a Python API for reading/writing these images in a tiled fashion.

Dental and Craniomaxillofacial Image Analysis

Our projects and research aim to quantitatively explore how age, disease or treatment affect structures in the craniomaxillofacial (CMF) complex. This improved knowledge can help diagnose disease early, plan and measure treatment, and monitor the progression of certain conditions. In particular, we are experts in morphometry analysis, a technique that can be used to quantitatively plan CMF surgery or measure remodeling in the bony structures of the skull. Our dental image analysis methods, for example, can quantify bone quality or tooth integrity. We also develop CMF-specific surgical trainers to improve procedural knowledge and surgical proficiency without sacrificing patient safety.