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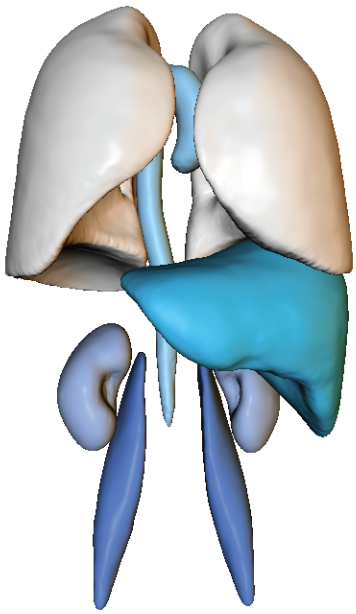

Case Study:

Winning the VISCERAL 2014 Grand Challenge

Imorphics delivers the best aggregate performance in an open series of segmentation tasks on abdominal CT images

At left: segmentation of the lungs, liver, kidneys, aorta and psoas muscles. These organs show considerable variation in shape and relative position.

About Imorphics

Based in Manchester, UK, Imorphics provides technology for the automatic identification of organs and tissues from 3D medical images, to sub-millimeter accuracy. Global medical device and pharmaceutical companies rapidly innovate using our technology to understand and analyze CT, MRI and ultrasound images.

To find out more, please visit our website at www.imorphics.com.

"We had done no previous work on images of these tissues when we started but with less than two months of development, we were beating the best in the field".

Mike Bowes Phd, CEO

The Challenge and How We Performed

In order to provide an independent determination of algorithm performance in medical image detection, registration and segmentation, the prestigious Medical Image Computing and Computer Assisted Intervention Society (MICCAI) conference series runs an annual competition.

Each year, the "Grand Challenge" allows entrants from both academia and industry to test their methods in a fair and direct comparison with the state-of-the-art on previously unseen medical images.

The testing is done live and concurrently during the conference or else online using pre-delivered software applications in order to give a fair representation of clinical performance.

For this challenge, we deliberately chose not to segment bones, since this was familiar territory, but instead focussed on a set of challenging organs shapes that we not tackled before. In spite of this, we had considerable success.

- Our software performed fully-automated segmentation of the liver, lungs, psoas muscles, kidneys and the aorta with no additional manual correction.
- In DICE overlap scores, we ranked top for the aorta, left and right psoas major muscles, and kidney (wide-beam and thoracic images).
- Our average distance error was an excellent 0.36mm on standard CT images and 0.40mm on contrast-enhanced CT images.

Addressing the Problem

To address the problems of speed, accuracy and precision in automated 3D medical image segmentation, many image analysis algorithms have been developed over the years to automate the task. However, these algorithms are usually not robust to anatomical shape variability and they struggle when organ boundaries are noisy or indistinct due to low contrast between regions in the image.

They therefore require considerable manual correction. To make these algorithms work better, they are usually highly customized to the individual anatomical structure of interest and a specific imaging modality, representing man-years of research and development for each task.

In contrast to custom segmentation solutions, the use of statistical shape models has proved to be one of the most successful approaches to medical image segmentation. The underlying idea is to use a set of examples that represent the variability of an object's shape and appearance to train a deformable 3D model.

Since its inception, Imorphics has developed several revolutionary patent-protected methods to radically improve the performance of 3D statistical models.

Imorphics Technology

Our technology now represents a trainable platform for the segmentation and analysis of virtually any anatomical structure or tissue in a 3D medical image.

Using this machine learning technology, we have now demonstrated fully-automated identification and segmentation of bones, cartilage and other musculoskeletal tissues, sub-cortical brain tissues, prostate, liver, and other abdominal organs, skulls and sinuses with sub-voxel or sub-millimeter accuracy.

The VISCERAL competition we undertook was particularly challenging and included segmentation of organ and tissues that have a great deal of shape and appearance variation. Importantly, we had done no previous work on any of the organs and tissues represented in the CT images when we started this Grand Challenge. With less than two months of development, we had produced a solution that performed better than those representing man-years of effort.

Conclusion

Imorphics have won all four of the MICCAI Grand Challenge competitions that they have entered. These were for the segmentation of knee bone and cartilage in 2010 (SKI10), of the prostate in 2012 (PROMISE12), abdominal organs in 2014 (VISCERAL) and the Head & Neck radiotherapy challenge in 2015. These successful competition entries have all been against leading commercial and academic groups.

We continue to provide world-class 3D image understanding services to contract research organizations and pharmaceutical sponsors of clinical trials; and revolutionary fully-automatic software applications for segmenting and analyzing 3D images with sub-millimeter accuracy to manufacturers of medical devices.

As a Contract Research Organization (CRO), we have provided services to all the major imaging core lab CROs and also direct to several of the largest pharmaceutical companies.

In the medical devices market, we have delivered solutions to some of the world's leading device manufacturers for orthopaedic image-guided surgery, image guided neurosurgery and population shape analysis for implant design.

> "Our success in these Grand Challenges continues to provide an independent validation of the efficiency of our technology in solving real-world medical imaging problems".
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> Alan Brett Phd, Head Of Business Development