



Case Study:

Winning the “Prostate MR Image Segmentation 2012” (PROMISE12) Grand Challenge

Imorphics delivered the best overall performance in an open demonstration of MR image segmentation of the prostate.

◀ At left: segmentation of the prostate from MR images can be particularly challenging due to low contrast boundaries and random noise.

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.

“This challenge demonstrated that our technology is robust enough to deal with the wide range of anatomical appearances from differing image modalities or sequences that are produced by real clinical applications”

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 tackled an anatomical structure that we had no previous experience with. Prostate MR images can present some particular image analysis problems due to low-contrast boundaries and a high level of random and structured noise; however, we developed an automated segmentation solution in less than two months. In spite of the short development timeframe, we had considerable success:

- Our delivered software performed fully automated segmentation “out of the box” with no additional manual correction.
- Our average distance error ranked first out of 11 groups with an excellent 1.95 ± 0.36 mm for the whole (base and apex) prostate surface.
- In overlap scores, we again ranked first with an average DICE coefficient for the whole prostate of 0.89 ± 0.03 .

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 collection of images used for this Challenge was deliberately chosen to represent the large heterogeneity in clinical data that is typically found in surgical planning. In MR images, the pixel/voxel intensities and therefore appearance characteristics of the prostate can greatly differ between acquisition

protocols, field strengths and scanners. Hence, image data was gathered from 4 different sites with both 1.5T and 3T machines from two different manufacturers. In addition, although in-plane resolution was <1mm, the through-plane resolution was relatively low at 2-4mm. Our statistical model-based approach is designed to cope with exactly these kinds of 3D analysis problems.

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.

Importantly, our latest technical developments mean that we can now segment surfaces of organs such as the prostate with average distance errors of around 0.1mm.

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 for

“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”

Alan Brett Phd, Head Of Business Development

orthopaedic image-guided surgery, image guided neurosurgery and population shape analysis for implant design.