Mathematics in Medical Imaging

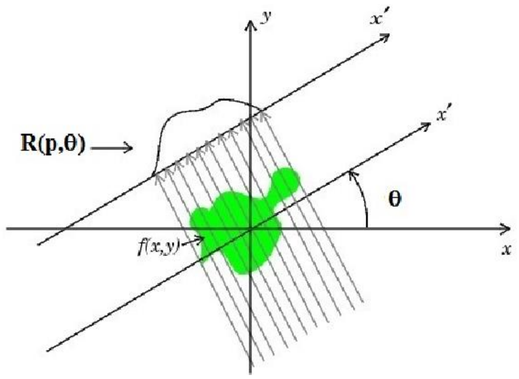
Yi Hu
MSc Big Data

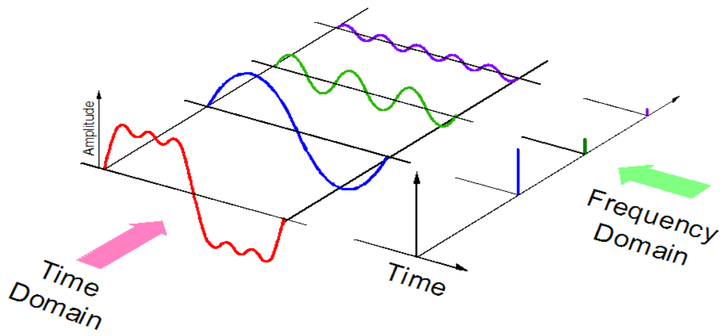
UNIVERSITY of STIRLING

Introduction to Medical Imaging

Medical imaging refers to a collection of techniques and processes of obtaining internal tissue images in a non-invasive manner of the human body or a part of the human body for medical or medical research. Obtaining the desired images usually requires solving inverse problems.

In 1895, Wilhelm Conrad Rontgen discovered X-rays and opened the development of medical imaging. Medical imaging uses technologies such as: X-rays, ultrasonic, gamma ray, magnetic resonance, optical imaging, etc. It not only expands the scope of the human body, improves the level of diagnosis, but also can be used to treat certain diseases. This is another reason why the discipline has been greatly expanded and became an important pillar for a variety of branches of medical science.





The Fourier and Radon Transforms

The Fourier transform is key to a variety of imaging technologies. It provides a tool to process the received signal (waves).

$$F(\omega) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} f(x)e^{i\omega x}dx.$$

The Radon transform, based on the Fourier transform, lies at the core of CT (computed tomography) scanning. Due to the special diagnostic value of CT, it is widely used in clinical practice. With the development of technology and computer science, CT technologies have also developed rapidly. Nowadays CT scanning plays an important role in the examination of diseases in the central nervous system, head and neck, heart and large blood vessels, abdomen, chest and other parts of the human body.

$$Rf = \int_L f(\boldsymbol{x})|d\boldsymbol{x}|$$

Combining Imaging Technologies with Deep/Machine learning

1 Medical image segmentation/target detection: Using the advantages of Deep Learning classification to segment medical images. At present, using Random Forest and CNN, the segmentation of various tissues can exceed the accuracy of manual segmentation by experts.

2 Computer-aided diagnosis: computer-aided diagnosis based on machine learning, extracting diagnostic-related features from images or other clinical data. Combined with prior clinical knowledge, this can provide very accurate diagnosis an predictions. To some extent, it could help the doctors with their work.

3 Image reconstruction: avoid ionizing radiation; reduce imaging costs; make up for the shortcomings of various interpolation schemes.

4 Motion capture / joint reconstruction, such as Kinect: It reconstructs the joint nodes from human depth image and infrared image color image.

For further information contact: Yi Hu
yih00041@students.stir.ac.uk