Guest Editorial

Biomedical engineering

TANIA S DOUGLAS, ***BSc (Eng), MS, PhD***

Associate Professor and Director, MRC/UCT Medical Imaging Research Unit, Department of Human Biology, University of Cape Town

Tania Douglas is Associate Professor of Biomedical Engineering at the University of Cape Town. She holds degrees in electrical/electronic engineering (University of Cape Town) and biomedical engineering (Vanderbilt and Strathclyde universities), and completed a postdoctoral fellowship in image processing (Japan Broadcasting Corporation). She is the Director of the MRC/UCT Medical Imaging Research Unit. Her research interests include computer-assisted diagnosis of tuberculosis and fetal alcohol syndrome, and paediatric applications of digital X-ray imaging.

Correspondence to: *Tania Douglas (tania@ieee.org)*

The question 'What is biomedical engineering?' may elicit a host of answers, the most common of which would usually include mention of the interface between biomedicine and engineering and of the application of engineering principles towards understanding biological systems and improving health.

Medical devices are the most tangible results of the practice of biomedical engineering and may broadly be classified into three types:[1] diagnostic, therapeutic and assistive or rehabilitative. While there is evidence that assistive devices such as prostheses were used in ancient Egypt,[2] the roots of biomedical engineering may be traced to the more recent past. William Harvey lay the foundation for modern haemodynamics in 1616, with the suggestion that the heart propels blood around a closed system.[1] In 1808, Thomas Young proposed a theory for wave propagation in elastic tubes such as blood vessels. By 1900, principles of electrical engineering had been used to establish the electrical nature of nerve pulses in a stream of research known as electrophysiology, initiated in the 1780s by Luigi Galvani. Hermann von Helmholtz made contributions to both physics and physiology in the mid-late 19th century, measuring the speed of nerve impulses, inventing the ophthalmoscope, and publishing a classical work on acoustics and hearing.

Technological innovation and advances in and across the basic and applied sciences since the beginning of the 20th century stimulated rapid advances in medical science and the delivery of health care services, and contributed to the establishment of biomedical engineering as an academic discipline. The discovery of X-rays by Röntgen in 1895 was a landmark event in medicine, which 'essentially triggered the transformation of the hospital from a passive receptacle for the sick poor to an active curative institution for all members of society'.[3] The first X-ray imaging equipment was commercially available in 1896. By the 1930s, X-ray visualisation of nearly all organ systems was possible with the use of barium salts and a variety of radio-opaque materials.[3]

Discoveries and developments arising from the pursuit of military objectives during World War II led to many improvements in health care.[3] Imaging advances were made in diagnostic ultrasound, which was based on military sonar. Post-war advances were also made in medical electronics and nuclear medicine.

The 1970s are notable for the development of new medical imaging techniques. Physicist Alan Cormack's work in nuclear medicine at Groote Schuur Hospital prompted him to search for a way to estimate the densities of tissues undergoing X-ray treatment; he published a mathematical solution to the problem in 1963, laying the mathematical basis for the computer-assisted tomographic (CAT or CT) scanner.[4] The first clinical CAT scanner was presented by British engineer Godfrey Hounsfield in 1972. Advances in magnet technology accompanied by knowledge of nuclear magnetic resonance (NMR) led to the first NMR images in the 1970s and commercial availability of the magnetic resonance imaging (MRI) scanner in the early 1980s. Positron emission tomography (PET), which forms images from the positrons emitted by radioactive chemicals injected into or swallowed by a patient, became available commercially in 1977.[1] PET is a form of functional imaging, a category of methods allowing the visualisation of physiological processes, to which functional MRI has more recently been added.

In this issue we place the spotlight on biomedical engineering research activities surrounding medical imaging. The spotlight shifts between and across imaging modalities and applications to sample current medical imaging research in South Africa.

1. Nebeker F. Golden accomplishments in biomedical engineering. IEEE Engineering in Medicine and Biology Magazine 2002;21(3):17-47.
2. World Health Organization. Medical Devices: Managing the Mismatch. Geneva: WHO Press, 2010.
3. Bronzino JD, Smith VH, Wade ML. Evolution of American health-care technology – economic and ethical implications. IEEE Engineering in Medicine and Biology Magazine 1986;5(3):5-10.
4. Vaughan CL. Digital X-rays come of age. SAMJ 2006;96(7):610.