Research Forum. Biomedical Engineering Research

1. Medical engineers usually apply engineering principles to medical problems and Professor Morgan, Brian Lithgow and I all do research in this area.
2. My projects all involve the application of technology to a medical problem and usually involve medical collaborators. Examples of this are: -
    a. The development of a Virtual Reality based simulator for training surgeons to do endoscopic surgery.
        i. Professor David Healy, who is head of the Monash University Department of O&G, and a clinical reference group that consists of ten endoscopic surgeons from Southern Health.
        ii. Zorana Mayooran, Cory Seligman, and two new engineering post grads.
    b. The development of a portable monitoring system for monitoring the physiology of spinal injured patients during activity. This project is being undertaken at the Royal Talbot Rehab Centre.
        i. Dr.Andrew Nunn, who heads up the spinal cord injury reahb team at the Royal Talbot.
        ii. a new Monash Engineering Post Grad, some undergraduate students from Monash, Swinburne and Latrobe.
    c. The development of a closed loop upper limb prosthetic control system.
        i. Bill Contoyannis, Post Graduate students Matthew Sanakiewtz and Elias Track.

3. Upper Limb Prosthetic Control.
    a. A number of very sophisticated upper limb prosthetics systems have been designed and commercialised but these prosthetic limbs are not as successful as lower limb prosthetics.
    b. The main reason is that there is little if any effective feedback.
    c. These systems usually receive their input from the EMG signal from the remaining part of the amputated limb.
    d. The patient wearing the limb can use visual feedback but if they are not looking at the prosthetic hand they don't know if it is open, or closed, or opening or closing.
    e. Cable driven prosthetic hands although they are very less technically complex, are much more successful in clinical practice.
    f. The reason for this is that the patient does get some feedback and does know if the hand is open, closed, opening or closing.
    g. In a project suggested by Bill Contoyannis we want to use
        i. the advantages of this cable driven approach
        ii. and those of telerobotics

        to develop a prosthetic hand control system that has both position and force feedback.

h. We intend to use the shoulder as a control position input, together with force feedback from the prosthetic hand to let the shoulder know what the hand is grasping.

i. The key to this approach is getting the position signal from the shoulder which is getting its instruction to move from the motor cortex, and applying the force feedback signal directly to the shoulder which again will send the perceived force signal to the same part of the motor cortex that initiated the shoulder signal.

j. Even without force feedback the motor cortex will know if the prosthetic hand is open, closed, opening or closing, where as EMG driven hands may not.

k. As you can see this is an engineering control project that involves the design and construction of

    i. a subsystem for capturing shoulder movement,

    ii. a subsystem for measuring the grasp forces in the prosthetic hand,

    iii. a feedback control system

    The other element of the control system is the human subject wearing the system, which consists of a number of man machine interfaces, and the motor control system.

l. The project involves some modelling, building the mechanical components, building a microcontroler interface, determining control parameters, and addressing some fundamental questions relating to the shoulder as a control input.

m. In relation to the shoulder we need to know

   i. how well it can control something,

   ii. Its range of movement and

   iii. the smallest movement it can control,

   iv. its frequency response,

   v. and its sensitivity and range of perceived force.

Thank you for your attention.

Brian Lithgow leads the Auditory Neurosignal Processing Group which is conducting research in the following areas.

1. In conjunction with industry and Lulea University an ARC supported project :-

a) Tinnitus modeling and Suppression

b) Vestibular Organ Diagnostics for Meniere's Disease and seasickness.

c) Localisation of Superior Olivary Pathologies using Wavelet analysis of Auditory Brainstem Response.

2. In conjunction with the Alfred Hospital Neurosurgery and Psychiatric medicine departments and Lulea University

(1) The development of a Parkinsons Disease diagnostic based on Vestibular measures.

(2) The development of a Depression diagnostic based on vestibular measures.

3. Other studies include:-

i) Speaker Separation and identification of voiced/unvoiced components including intonation. Detection of Micro-calcifications in Mammograms

ii) Effects of LF EMF on Cerebral Heamodynamics

iii) Cochlear Implant Signal Processing

iv) Precise measurement of anaesthetic gas uptake.