MMU Institute for Biomedical Research into Human Movement and Health

Fully funded PhD studentship: Ultrasound analysis of neck muscle contraction: computer visual tracking and biomechanical modelling.

The Institute for Biomedical research into Human Movement and Health at Manchester Metropolitan University is a major research centre in issues concerning health, mobility and fitness. It is currently seeking a suitable qualified student to expand its research on automatic measurement and analysis of ultrasound images of skeletal muscles. The studentship will cover home/EU fees and a stipend (12,000 p.a.) and last for three years.

To apply, follow the link below and fill in the application form. Please note that this is a generic application form, and so you will need to list Ian Loram as the potential supervisor.

`http://www.red.mmu.ac.uk/?pageparent=4&page_id=99/#rihcs`

Supervisory Team

- Director of Studies: Ian Loram IRM, Motor control research line
- Supervisor: Nick Costen, Department of Computing and Mathematics
- Supervisor: Emma Tole IRM, Biomechanics Research Line

Abstract

Ultrasound provides a real time view of dynamic changes of muscle shape during human posture and movement. The offline analysis of ultrasound video images to model temporal changes in muscle activity is providing key insights into motor control physiology and is emerging as a new technology with clinical, scientific, gaming and training applications.

Surface EMG analysis is non invasive but can not record from deeper muscles. This is particularly the case for the neck muscles, which comprises of four layers, three of which are visible to ultrasound. Only the most superficial muscle layer can be recorded using EMG. The neck muscles are particularly important for postural control and are thought to be hierarchically important in relation to systemic muscle activity in posture and movement. Neck muscles have high importance in this respect. The ability to record neck muscle activity using ultrasound would demonstrate a major scientific and technological advance previously not achieved and would open the window to biofeedback approaches for regulating systemic muscle activity.

This project would build on existing methods developed in the IRM for studying the increments of muscle activity introduced during the progression from passive support to self supported posture and focal movements. This project would also build on existing methods developed within the IRM and Department of Computing and Mathematics for offline analysis of changes in muscle shape to model muscle contraction.

The work would focus on the relationship between passive changes in head position, active changes in neck muscle activity and changes in shape of the neck musculature as seen by ultrasound. The work will also focus on the relationship between biomechanical models of the neck musculature and changes in shape of the neck musculature as seen by ultrasound. With support from the supervisory team, this project will involve:

1. collection of data containing 3D kinematic information of the head, neck and torso, electromyographical recordings from the neck muscles, and ultrasound recordings from the neck musculature
2. developing and modifying existing computer vision algorithms and software in C++/MATLAB for offline analysis of changes in shape and texture of the ultrasound images,
3. developing and testing predictive models relating passive head movement and active contraction to changes in shape and texture

4. collection of MRI data providing spatial coordinates of the neck musculature
5. constructing 3D anatomical, biomechanical models of the neck musculature
6. developing and testing 3D anatomical, biomechanical models of the neck musculature describing changes in shape and texture of the ultrasound images.

The techniques to be used are at the forefront of research into real time computer vision and include appearance models of individual muscle activity, multiple combined models describing variation between muscles, and parallel programming on a Beowulf cluster.

Applicants should have, or would be expected to gain, a first or upper second-class degree or MSc in computing, electronics, engineering, or a related subject area. Experience of computer vision, C/C++ and MATLAB programming is desirable.

Additional Notes

This project would require substantial innovation and development in computer vision and would be of major significance for work carried out in the IRM.

Existing software in the IRM allows offline analysis of small changes in muscle length under postural conditions or large changes in passive muscle[1-3]. It is becoming clear that software previously developed in the Department of Computing and Mathematics for analysing moving faces[4-6] is suitable for studying changes in muscle shape under a greater variety of conditions. Collaborative development of this technology, will prove a major asset for attracting external funding.

This project would enable three major developments.

1. The extension of offline analysis to more complex muscle groups with differing architecture.
2. Specifically, the application of this technology to the bio-mechanically complex neck muscles which are of hierarchical importance in motor control.
3. The reduction and elimination of initial manual marking of video images.

This project is strategically important to a wider project intended to develop on-line real-time analysis of muscle contraction using algorithms embedded in electronic hardware. More information and information discussions can be had by speaking to Nick Costen, via n.costen@mmu.ac.uk.

References

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