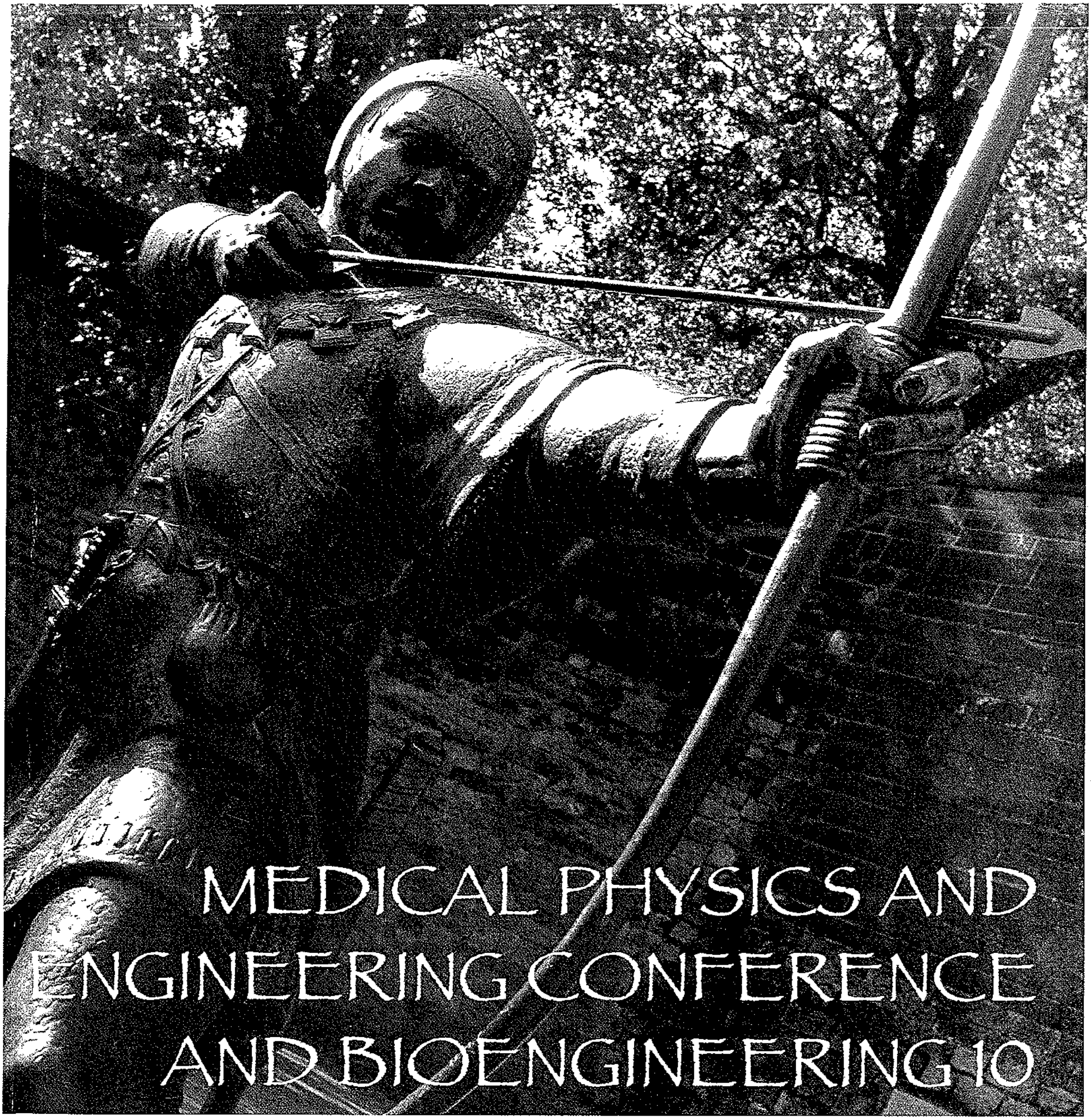

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sometimes the beat is detected before the R point compared with the FECG detections and other detections are completed after this mentioned point were the measurement of the intervals present in consequence a lack of reliability.

To correct this time shift present for both transforms, more work can be developed adopting a probabilistic approach to the analysis of the extracted temporal data from the Doppler envelope. Probabilistic techniques have been used widely in the analysis of complex temporal data [3].

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Wednesday 15th September 2010, 10.00 – 11.00

Biomechanical measurement in clinical practice I

Shoulder Function - Some Insights from Biomechanical Modelling and Measurement

Johnson G, Newcastle University

The shoulder, commonly referred to as a single joint, is a complex of three bones (humerus, scapula and clavicle) which articulate relative to the sternum. It is this unique mechanism which gives the arm the large range of motion required for its varied functional demands. Understanding of the biomechanics of shoulder function requires measurements of the movements of all three bones together with models for the prediction of muscle and joint forces.
Following the selection of a range of representative tasks, optical and palpation techniques have been used to study the three dimensional kinematics of the shoulder complex both in normal subjects and patients have glenohumeral joint replacements. This has led to new insights into the possible mechanisms for control of scapula motion.

A biomechanical model was then developed to understand joint function and a more detailed study was performed to understand the rationale for using reverse anatomy joint replacements in patients with rotator cuff damage. It was shown that this approach, while overcoming some of the problems of cuff tear, may also lead to impingement leading to a need for optimised designs. The influence of some of the key design variables will then be discussed.

Exploring wrist motor control in stroke patients, using a target tracking task

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[2]ISVR, University of Southampton,

Background and purpose
Motor impairments following an upper motor lesion such as stroke include weakness, loss of motor control, and fatigability, as well as characteristics associated with increased levels of involuntary activity: spasticity, increased tendon reflexes, clonus, associated reactions, spasms, and coactivation during movement. Subsequent to the initial insult, limb movement may be impaired by mechanical changes, including shortening and increased stiffness of muscles and soft tissue around joints leading to contracture. These combined impairments may affect the individual's ability to move effectively and perform functional tasks. Improved understanding of patients' specific impairment may aid in optimizing individualized therapeutic interventions, and in assessing progress in rehabilitation. The current work presents an experimental rig that aims to measure patients' ability to track a target by moving their wrist, and some first results on assessing tracking performance and co-activation of flexor and extensor muscles.

Methods
The rig is mounted on the armrest of a chair, as shown in Fig. 1. The tracking target is made up of a set of 80 LEDs, mounted in an arc at 2o intervals. Wrist angle and flexor and extensor EMG signals are recorded, and maximum voluntary contraction and stiffness can be measured via a strain-gauge mounted in the lever arm. The signals are all acquired simultaneously to a computer (using the Matlab signal acquisition toolbox, and a sampling rate of 2000 Hz), which also controls the target. For the current work, the target was moved in random steps over a range of ±40o around the midpoint of subject's active range of movement. An adjustable slip-clutch is used to set resistance to movement as a fixed percentage of subjects' maximum voluntary contraction.
In-house software was developed to extract parameters from the recorded signals. These include measures of accuracy in tracking (mean absolute error; standard deviation of wrist excursion; length of path of the wrist movement), as well as indexes of co-activation in the EMGs, calculated during wrist extension.
In addition, patients performed a 'Wolf motor function test', to evaluate their ability to carry out functional movements with their impaired upper limb.

For the current paper, data was acquired from six hemiplegic patients and six age and sex-matched healthy controls.

Fig. 1. The wrist-rig, showing the arc of target LEDs, as well as the lever arm in which the hand is held.

Results

The patients performance in tracking was significantly worse than that of the healthy controls in mean-absolute error and standard deviation ($p<0.05$), and for path length ($p<0.01$), with patients less able to move smoothly between target positions.

There was strong correlation between the Wolf motor function test, and mean absolute error in tracking ($r=-0.93$, $p=0.008$). Most patients showed little evidence of co-activation (beyond the level observed in normal healthy controls), but two subjects did, and these also displayed the worst performance in the tracking task.

Discussion and Conclusions

The current system allows the measurement of wrist function in well defined target-tracking tasks. While the task is not 'functional', the high correlation with the Wolf motor function test is very encouraging, suggesting the validity of these measurements. Results so far confirm the large inter-individual differences in movement strategy in health and with impairment. For example, co-activation was, surprisingly, observed in one healthy control, and only in two (the worst performing) patients. These individual differences indicate the dangers of analysis based on averages across cohorts. Measurements also provided indications of those patients where specific therapies such as botulinum toxin may or may not be effective. Ongoing and future work includes measurements of stretch response, passive stiffness and the timing of muscle activation, as well as the evaluation of a larger sample of patients and healthy control subjects, in order to pinpoint subjects' impairment more precisely.

Wednesday 15th September 2010, 11.30 – 12.30

Current issues in positron emission tomography II

Iterative image reconstruction: theory and practice

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Teaching aims

Filtered back projection used to be the standard reconstruction technique for SPECT and PET but increasingly iterative reconstruction is being used in its place in the clinical setting. The improved image quality and flexibility in adapting iterative algorithms to suit system geometry and corrections for physical effects (attenuation, scatter, randoms, resolution, motion) make iterative reconstruction an appealing alternative. The basic principles of iterative reconstruction will be reviewed with some emphasis on potential limitations. The focus will be on maximum likelihood reconstruction and its commonly used accelerated form based on use of ordered subsets (OSEM) [1]. Recent commercial options include the ability to include a resolution model and time-of-flight information. There is also increasing interest in incorporating information from anatomical modalities to further enhance image quality, which would take advantage of data from dual modality systems. Although able to produce very impressive images these algorithms require further development as they can introduce potential errors which makes quantification difficult.

References

[1] Hudson HM and Larkin RS. Accelerated image reconstruction using ordered subsets of projection data. IEEE Transactions on Medical Imaging, 1994: 13: 601-609.

PET Instrumentation: The future

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The historical development of positron emission tomography (PET) is marked by numerous significant technological accomplishments driven by an unprecedented collaboration between multi-disciplinary groups of investigators with backgrounds in medical sciences, physics, chemistry, mathematics, bioengineering, and computer science. During the last two decades, functional and metabolic imaging using PET has advanced elegantly and steadily gained importance in the clinical and research arenas. Significant progress has been made by scanner manufacturers and academic research groups in the design of dedicated high-resolution PET units; however, emerging clinical and research applications of molecular imaging promise even greater levels of accuracy and precision and therefore impose more constraints with respect to the intrinsic performance of the PET scanner and its quantitative capabilities.