The 31st Conference of the Canadian Medical and Biological Engineering Society

Program • 2008 • Programme
Centre Mont-Royal, Montréal, Québec

CMBEC 31
June 11th-13th
Montréal, QC

CANADIAN MEDICAL AND BIOLOGICAL ENGINEERING SOCIETY
LA SOCIÉTÉ CANADIENNE DE GÉNIE BIOMÉDICAL INC.

Affiliated with the International Federation for Medical and Biological Engineering
Affiliée avec la Fédération internationale du génie médical et biologique

June, 2008

To All **CMBEC31** participants:

On behalf of the CMBES executive, I would like to welcome delegates to the 31st conference of the Canadian Medical and Biological Engineering Society.

The conference organizing committee has done an outstanding job of putting together an impressive program that I am confident everyone will find worthwhile. I would like to express my thanks to all members of the committee for their efforts. In addition, special thanks go to The Willow Group, in particular Pamela Wilson for all her work in support of the conference.

I would also like to thank all our exhibitors and sponsors, for their participation and generous support.

For the first time this year, we are offering simultaneous interpretation between French and English in all keynote addresses and sessions in the Clinical Engineering stream. We are hoping at this conference to develop closer ties with biomedical engineers and technologists in Quebec.

Bill Gentles, PhD., P.Eng., CCE,
President, CMBES

Le Maire de Montréal

Le mardi 20 mai 2008

Chère participante,
Cher participant,

Au nom des Montréalaises et des Montréalais, j'ai le plaisir d'accueillir la Société canadienne d'ingénierie médicale et biologique pour sa 31^{e} conférence annuelle.

Montréal est une ville de savoir ouverte sur le monde et nombreuses sont les entreprises et les institutions d'enseignement à y avoir pignon sur rue, notamment dans le domaine de la santé. Cette prédisposition avantageuse devient un atout majeur dans l'organisation et la tenue d'événements d'envergure.

Pendant les trois prochains jours, des centaines de spécialistes en ingénierie médicale et biologique se réuniront à Montréal afin de s'instruire, de diffuser les connaissances qu'ils ont acquises ainsi que d'entrer en contact avec les nouvelles percées effectuées dans le domaine.

Je suis convaincu que, malgré l'horaire rempli de la conférence, les participants sauront goûter aux charmes et aux attraits que Montréal leur propose.

Bonne conférence !

Gérald Tremblay

Hôtel de ville, 275, rue Notre-Dame Est, Montréal (Québec) H2Y 1C6 CANADA
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Montréal

Le Maire de Montréal

May 20, 2008

Dear participant,

On behalf of all Montrealers, I am pleased to welcome to Montréal the 31st annual conference of the Canadian Medical and Biological Engineering Society.

Montréal is a city of knowledge open to the world and is home to many businesses and learning institutions, particularly in the health sector. These favourable circumstances are key assets when organizing and hosting major events.

Hundreds of medical and biological engineering specialists will gather in Montréal in the next three days to learn, share information and get acquainted with the latest developments in the field.

Even with the conference's busy schedule, I am sure participants will have a chance to enjoy many of the charms and attractions Montréal has to offer.

Have a great conference!

Gérald Tremblay
Mayor of Montréal

Hôtel de ville, 275, rue Notre-Dame Est, Montréal (Québec) H2Y 1C6 CANADA
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We are pleased to offer Simultaneous Interpretation for both keynote addresses as well as for all sessions in the Clinical Engineering Stream – Sessions C1 – C10.

Il nous fait plaisir d'offrir la traduction simultanée lors des deux discours-programme ainsi que les sessions C1 à C10 du volet génie clinique

TUESDAY, JUNE 10, 2008 / MARDI LE 10 JUIN 2008

8:00 Registration and Continental Breakfast / Inscription et petit déjeuner continental

Continuing Education Program

9:00 **CE9 L'intégration des systèmes d'information**
Location: Mansfield 6

*Instructor***:** Martin Délage

- Introduction à HL7
- Connaître les concepts de base pour définir les interfaces lors de l'acquisition d'un syst;eme d'information
- Connaître les types d'interfaces et les méthodes de transmission de message
- Connaître les principaux messages HL7 des systèmes d'information médico-administratifs
- Comprendre le rôles et les avantages des engins d'interface
- Exemple de cas réels de définitions d'interface pour la mise en place d'un RIS/PACS

10:00 **Refreshment Break / Pause-rafraîchissements**

10:30 **CE9 L'intégration des systèmes d'information (Continued)**

14:00 **CE10 Systèmes de gestion des données médicales**
Location: Mansfield 6

*Instructor***: M**artin Délage

Les technologies émergentes en santé

- Survol des technologies émergentes en santé
- Présentation des technologies RFID, géopositionnement, la biométrie,
- virtualisation et technologie de stockage
- Exemple de cas concret au Québec

15:30 **Refreshment Break / Pause-rafraîchissements**

16:00 **CE10 Systèmes de gestion des données médicales (Continued)**

8:00 **Registration and Continental Breakfast / Inscription et petit déjeuner continental**

8:45 **Conference Opening and Welcoming Remarks**

- Bill Gentles, CMBES President and Conference Co-Chair
- Gnahoua Zoabli, Chief of Biomedical Engineering Department, Santa Cabrini Hospital, Montreal, QC and Conference Co-Chair

Séance d'ouverture et allocution de bienvenue

- Bill Gentles, président de la Société canadienne de génie biomédical et coprésident de la Conférence
- Gnahoua Zoabli, chef du Biomedical Engineering Department du Santa Cabrini Hospital, Montréal, Québec, et coprésident de la Conférence

Continuing Education Program

9:00 **CE1 Preparing for BMET Certification**
Location: Mansfield 7

Instructor: Rick Tidman

Biomedical Technicians and Technologists attending this course will review the information required for the successful completion of the BMET certification examination. The format of the exam will be discussed, as well as general study tips and techniques that will aid in preparation for the exam.

CE8 Communication sans fil dans les centres hospitaliers
Location: Mansfield 6

Instructor: Martin Miron

Communication & mobilité

- Présentation des concepts de communication, mobilité & multimédia
- Concept de convergence des réseaux sur la technologie IP
- Infrastructure technologiques permettant les communications et la mobilité
- Notion de qualité de service
- Problématiques vécues dans un monde hospital

10:00 **Refreshment Break / Pause-rafraîchissements**

10:30 **CE1 Preparing for BMET Certification (Continued)**

CE8 Communication sans fil dans les centres hospitaliers (Continued)

Keynote Address / Discours - programme

9:00 ***Location : International I & II***

Therapeutic and Diagnostic Technologies for Articular Cartilage
Technologies thérapeutiques et diagnostiques pour le cartilage articulaire

Michael D. Buschmann, PhD
NSERC Bio Syntech Industrial Research Chair in Hybrid Biomaterials for Innovative Regenerative Technologies
Canada Research Chair in Cartilage Tissue Engineering
Director Biomedical Science and Technology Research Group (FRSQ), Department of Chemical Engineering, Institute of Biomedical Engineering, École Polytechnique de Montréal

Chaire de recherche industrielle CRSNG-BioSyntech sur les biomatériaux hybrides pour les technologies régénératives novatrices
Chaire de recherche du Canada sur le génie tissulaire pour le cartilage
Directeur, Groupe de la recherche en science et technologie biomédicales (FRSQ), Département de génie chimique, Institut de génie biomédicale, École Polytechnique de Montréal

10:00 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

Academic Program

10:30 **A1 – Advancements in Biomedical Engineering**
Location: International I

Chair: D MacIssac

- **Development and performance of a novel closed-loop propofol system**
  S Charabati, B.Eng, P.A. Mathieu,PhD, TM Hemmerling, MD DEAA, MSc Institute of Biomedical Engineering, Université de Montréal, Dept. of Anesthesia, McGill University, Montreal

- **The 'Analgoscore': a novel score to monitor intraoperative pain and its use for remifentanil closed-loop application**
  TM Hemmerling MD DEAA,MSc, S Charabati, B.Eng, E Salhab, MSc, Pierre A. Mathieu, PhD Institute of Biomedical Engineering, Université de Montreal and McGill University, Montreal

- **Biomedical research ethics in developing countries: applying global guidelines to local contexts**
  Shauna Mullally

- **Complement is activated by coagulation and not by chitosan in human whole blood and plasma**
  Edward Baraghis[1], Catherine Marchand[2], Georges-Etienne Rivard[3], Caroline D. Hoemann[1]
  [1]Department of. Chemical Engineering, [2]Institute for Biomedical Engineering
  École Polytechnique, Montreal

Clinical Program

10:30

C1 – APIBQ Best Practices, CMBES Standards of Practice and Hospital Accreditation / Pratiques exemplaires de l'APIBQ, Normes de pratique de la Société canadienne de génie biomédical et agrément des services de santé.
Location: International II

Session Chair / Président de la séance:
Bill Gentles, CMBES President / président de la Société canadienne de génie biomédical

Panel Members:
Murat Firat, University Health Network
Madeleine Drew (formerly CCHSA) Representative
Fabienne Debiais APIBQ Representative

This session will compare the two Canadian documents that define best practices for Clinical Engineering Services in Canada. One of these is the *Clinical Engineering Standards of Practice for Canada* published by CMBES (Canadian Medical and Biological Engineering Society). The other is *Guide des bonnes pratiques biomédicales en établissement de santé*, published by the APIBQ (Association des physiciens et ingénieurs biomédicaux du Québec).

The objective of the session is to discuss the similarities and differences between the two documents, and begin a process of creating a single bilingual document that can apply to all of Canada. This will meet the requirements of the CCHSA (Canadian Council on Health Services Accreditation) who is considering the incorporation of a clinical engineering Best Practices/Standards of Practice document into their hospital accreditation standards.

Conférenciers :

Murat Firat, University Health Network

Madeleine Drew, Représentant du CCASS

Fabienne Debiais, représentante de l'APIBQ

Cette séance permettra de comparer les deux documents canadiens qui définissent les pratiques exemplaires pour les services de génie biomédical au Canada. L'un est l'ouvrage intitulé *Clinical Engineering Standards of Practice for Canada*, publié par la Société canadienne de génie biomédical. L'autre est le *Guide des bonnes pratiques biomédicales en établissement de santé*, publié par l'APIBQ (Association des physiciens et ingénieurs biomédicaux du Québec).

La séance a pour objectif de discuter des similarités et des différences entre les deux documents et d'amorcer un processus visant à établir un document bilingue unique qui puisse s'appliquer à l'ensemble du Canada. On répondra ainsi aux exigences du CCASS (Conseil canadien d'agrément des services de santé), qui envisage d'intégrer un document de pratiques exemplaires et de normes de pratique du génie biomédical à ses normes d'agrément des services de santé.

12:00 **Lunch in the Exhibit Hall / Déjeuner dans la salle d'exposition**

Poster Presentation

12:00 ***Location: Exhibit Hall***

- **Biomechanical Characterization of Biological Tissue by Coherent Imaging using Coupled Coherence-gated Photorefractive Holography and Speckle Shearography**
  Rémy Béland[2], Vanessa Rosso[1], Sylvain Lecler[1], Yvon Renotte[1], Serge Habraken[1], Yves Lion[1] and Paul Charette[2]
  [1]HOLOLAB, Département de Physique, Bât. B5a, Université de Liège, B-4000 Liège, Belgique
  [2]Département de génie électrique et de génie informatique, Université de Sherbrooke, Sherbrooke,

- **Multi-Modal Acoustic-photo-acoustic Imaging for Small Animal Imaging**
  M. Abran[1], Y. Ono[2], C.K. Jen[3], F. Lesage[1]
  [1]Ecole Polytechnique de Montréal, Département de génie électrique, C.P. 6079 succ. Centre-ville, Montréal, Québec, Canada
  [2]Carleton University, Department of system and computer engineering, 1125 Colonel By Drive Carleton University Ottawa, Ontario
  [3]Industrial Material Institute, National Research Council Canada,

- **Improved Adhesion and Growth of Vascular Smooth Muscle Cells in Cultures on Modified Polyethlene**
  Martin Parizek[1], Nikola Kasalkova[2], Lucie Bacakova[1], Katerina Kolarova[2], Vera Lisa[1], Vaclav Svorcik[2]. Institute of Physiology, ACAD. Sci. CR, Czech Republic. Institute of Chemical Technology, Technicka5.,

- **Heart Sound Segmentation Based on a Mel-Scaled Wavelet Transform**
  Karim Courtemanche[1], Véronique Millette[2] and Natalie Baddour[2]
  [1]McGill University [2]Department of Mechanical Engineering, University of Ottawa

- **Measuring Cellular Activity Using Surface Plasmon Resonance**
  Vincent Chabot[1], Charles M. Cuerrier[2], Michel Grandbois[2], Paul G. Charette[1]
  [1]Département de génie électrique et génie informatique, Faculté de génie, Université de Sherbrooke,[2]Département de Pharmacologie, Faculté de Médecine, Université de Sherbrooke

- **Contributions of the Ankle Stretch Reflex to Dynamic Postural Stability in Standing Humans**
  Siddharth Vedula

- **Ultra-Fast Wiener Filter Based Crystal Identification Algorithm Applied to the LABPET™ Phoswich Detectors**
  H. Camilia Yousefzadeh, Student Member, CMBEC, Nicolas Vscogliosi, Marc-André Tétrault, Catherin Michèle Pepin, Philippe Bérard, Mélanie Bergeron, Hicham Semmaoui, Roger Lecomte, and Réjean Fontaine

Continuing Education Program

14:00 **CE1 Preparing for BMET Certification**
Location: Mansfield 7

Instructor: Rick Tidman, CBETI, CET

CE6 Sécurité du réseau informatique de la santé
Location: Mansfield 6

Instructor: Denis Lebeuf
- Sécurité de l'information dans un contexte de soins de santé
- Évolution et tendances des attaques
- Sécurité proactive et systématique
- Gestion des risques
- Déploiement de réseaux sans-fil

15:30 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

16:00 **CE1 Preparing for BMET Certification (Continued)**

CE6 Sécurité du réseau informatique de la santé (Continued)

Academic Program

14:00 **A2 – Biomechanics I**

Location: International I

Chair: H deBruin

- **Residual Shoulder Motion Vector Projection**
  Yves Losier, Kevin Englehart, and Bernard Hudgins
  Institute of Biomedical Engineering, University of New Brunswick, Fredericton, Canada

- **Dynamics of Torque Responses to Visual Stimuli**
  Daniel Ludvig, Yong Zhao, Robert E. Kearney
  Department of Biomedical Engineering, McGill University

- **Human grip force response: An input-output approach**
  Alejandro Villaseñor-Herrer, Robert E. Kearney, Ph.D., Eng., Sophie J. De Serres, Ph.D. Ross Wagner, Ph.D

- **Design and Development of an Angular-Velocity Activated Hydraulic Knee Orthosis**
  Terris Yakimovich, Edward D Lemaire, Louis Goudreau and Jonathan Kofman
  Ottawa Hospital Rehabilitation Centre

- **Effect of Mobility Devices on Inertial Sensos Containing Magnometers**
  Cynthia L. Kendell, Edward D. Lemaire

Clinical Program

14:00 **C2 – Innovative Programs in Clinical Engineering / Programmes novateurs en génie biomédical**

Location: International II

Session Chair / Président de la séance:
Jeremy Dann, Regional Manager, Clinical Engineering, Nova Scotia Association of Health Organizations / gestionnaire régional, Génie biomédical, Nova Scotia Association of Health Organizations

The following presentations will describe an innovative program launched within their healthcare organization or nationally. The intent is to generate discussion on avenues for clinical engineering innovation and growth.

Les conférenciers ci-dessous décriront un programme novateur lancé à l'intérieur de leur organisation de soins de santé ou à l'échelle nationale. Le but est de stimuler la discussion sur les possibilités d'innovation et de croissance en génie biomédical.

- **Technology Assessment Officer / Prospectiviste**
  Ken George, PEng, IWK Health Center, Halifax

This presentation will summarize the current duties of a Technology Assessment Officer, review some successes over the years and project its future in light of current developments in the Health Centre.

Cette présentation résumera les tâches actuelles d'un prospectiviste, passera en revue certains succès connus au fil des ans et envisagera l'avenir de ce poste selon les faits actuels au Health Centre.

- **Clinical Engineering Rounds / Rondes de génie biomédical**
  Gordon McNamee, Brandon Regional Health Centre / Centre de santé régional de Brandon

Clinical Engineering rounds are to proactively seek out areas of concern with nursing and other clinical support staff, including: equipment or safety issues; customer satisfaction issues; and, special departmental concerns. Results of how user related and safety related problems have been reduced will be discussed.

Les de génie biomédical servent à s'informer de manière proactive auprès des infirmiers et infirmières et des autres membres du personnel de soutien clinicien, sur les sujets de préoccupation, y compris les préoccupations liées à l'équipement ou à la sécurité, à la satisfaction du client et à un département particulier. Il sera question des résultats obtenus en ce qui concerne l'atténuation des problèmes liés aux utilisateurs et à la sécurité.

- **Electromechanical Program / Programme électromécanique**
  Jeremy Dann, CBET, NSAHO Clinical Engineering

The Electromechanical Service was developed to bring clinical engineering discipline, processes, and client service commitment to support of a range of technology not previously considered within the traditional envelop of our field of expertise. An overview of the factors leading to the launch and its subsequent growth will be presented.

Le Electromechanical Service (Service électromécanique) a été conçu pour engager les responsables de la discipline, des processus et des services à la clientèle du génie biomédical à appuyer une gamme de technologies qui, traditionnellement, n'étaient pas considérées comme relevant de notre domaine d'expertise. On donnera un aperçu des facteurs qui ont mené au lancement du programme et à son évolution ultérieure.

- **Studying Preventive Maintenance Processes in Canada / Examen des processus d'entretien préventif au Canada**
  Mike Capuano CBET, Hamilton Health Sciences
  Martin Poulin, MEng, PEng., Royal Jubilee Hospital

From a preventive maintenance perspective, clinical engineering departments and services across Canada have never been studied to find out who is doing what, how, and to what degree. This presentation will discuss the results of the CMBES PM Subcommittee's nation-wide survey of clinical engineering service programs and literature search of all notable preventive maintenance systems that have been published.

Du point de vue de l'entretien préventif, on n'a jamais fait l'examen des départements et des services de génie biomédical partout au Canada afin de savoir qui fait quoi, comment et dans quelle mesure. Cette présentation traitera des résultats de l'enquête nationale du Sous-comité de l'entretien préventif de la Société canadienne de génie biomédical sur les programmes de services de génie biomédical et de son étude documentaire sur tous les systèmes d'entretien préventif notables ayant fait l'objet de publications.

15:30 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

Academic Program

16:00 **A3 – Cardiovascular Advances I**

Location: International I

Chair: R LeBlanc

- **Sliding window autocorrelation for the synchronous unsupervised segmentation of the phonocardiogram**
  Sankua Chao and Adrian D. C. Chan
  Department of Systems and Computer Engineering, Carleton University
  Ottawa, Ontario

- **Artery Stiffness Assessed by Pulse Counter Analysis**
  Gong Zhang, Simon Liao, Yong Liu, Shaohong Xu

- **Automated Pattern Classification for PCG Signal based on Adaptive Spectral k-means Clustering Algorithm**
  Abbas K. Abbas[1], Rasha Bassam[2], Rana M. Kasim[3]
  [1, 3] Biomedical Engineering Dept., RWTH Aachen Germany, [2] Aachen university of Applied Sciences, Germany

- **Structural design optimization of a pediatric stent**
  Zineb Idrissi, Département de génie biomedical, McGill, University

- **Pulse Wave Analysis for Cardiovascular Information Monitoring in Patients With Chronic Heart Failure: Effects of COQ10 Treatment**
  Gong Zhang, Xiaolin Kong ,Simon Liao, James Deng

16:00 **C3 – Recommendations for Electromagnetic Compatibility (EMC) and Wireless Technologies in Healthcare Wireless Technologies in Healthcare / Recommandations au sujet de la comptabilité électromagnétique (CEM) et des technologies sans fil en soins de santé**

Location: International II

Session Chair / Président de la séance

Bernard Segal, PhD, McGill University and Jewish General Hospital

Panel Members:

K.S. Tan, Health Canada, Ottawa, ON

D. McLain, Phillips Medical Systems, Andover, MA

Gnahoua Zoabli, PhD, Santa Cabrini Hospital, Montreal, QC

This session will overview the latest recommendations on EMC and Wireless Technologies in Healthcare that have emerged recently. This will include summaries of issues that were discussed at the Health Canada–Industry Canada July 2008 "Roundtable on EMC and Wireless Technologies in Healthcare", as well as issues that arose while drafting the second revision of AAMI's TIR 18. Academic, government, industry and hospital viewpoints will be presented, followed by audience questions to the panel.

Président de la séance :

Bernard Segal, Ph.D., Université McGill et Hôpital général juif

Conférenciers :

K.S. Tan, Santé Canada, Ottawa, Ontario
D. McLain, Phillips Medical Systems, Andover, Manitoba
Gnahoua Zoabli, Ph.D., Santa Cabrini Hospital, Montréal, Québec

Cette séance donnera un aperçu des dernières recommandations sur la CEM et les technologies sans fil en soins de santé, qui ont été faites récemment. Cela comprendra un résumé des questions qui ont été discutées à la « Table ronde sur la CEM et les technologies sans fils en soins de santé » de Santé Canada–Industrie Canada qui a eu lieu en juillet 2008 et de celles qui ont été soulevées à la rédaction de la deuxième révision du TIR 18 de l'AAMI. On présentera les points de vue du milieu universitaire, du gouvernement, de l'industrie et des hôpitaux et, ensuite, les membres du panel répondront aux questions de l'auditoire.

17:30 **Opening Reception in the Exhibit Hall/ Réception d'ouverture dans la salle d'exposition**

8: 00 **Registration and Continental Breakfast / Inscription et petit déjeuner continental**

Continuing Education Program

9:00 **CE2 Managing the Wireless Environment: Spectrum Analysis**
Location: Mansfield 7

Instructor: Dara McLain

Students will learn how to organize and coordinate a wireless management team, from wireless use policies to frequency management. Also covered are troubleshooting techniques and preventative maintenance efforts that will reduce the probability of wireless interference.

RF Surveillance**;** when and why RF Surveys are valuable, planning a survey, and implementation. Techniques for analyzing results. Lab exercises using spectrum analyzers and duplicated interference sources.

Class focuses on telemetry, and other wireless medical devices. Students will have the opportunity to ask questions and learn other wireless technologies of interest. Spectrum Analyzers will be provided by Anritsu Company for student use. Reference documents provided along with a student handbook.

CE11 Bonnes pratiques en génie biomedical
Location: Mansfield 6

Instructor: Guillaume Sulpice
- Introduction à la qualité et enjeux pour le GBM
- Le guide des bonnes pratiques de l'APIBQ
- Proposition d'une méthode d'implantation

10:00 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

10:30 **CE2 Managing the Wireless Environment: Spectrum Analysis (Continued)**

CE11 Bonnes pratiques en génie biomedical (Continued)

Keynote Address / Discours - programme

9:00 *Location : International I & II*

A nanorobotic approach for targeting tumours through the human microvasculature by using magnetotactic bacteria as computer-controlled MRI-trackable propulsion and steering systems.

Une approche nanorobotique pour le ciblage de tumeurs à travers la microvasculature humaine en utilisant des bactéries magnétotactique comme système de propulsion et de direction contrôlable par ordinateur tout en étant visible par l'IRM.

Sylvain Martel, B.Ing. (UQTR), M.Sc.A., Ph.D. (McGill)
Associate Professor, Département de génie informatique et génie logiciel
École Polytechnique de Montréal
Director, NanoRobotics Laboratory at EPM
Canada Research Chair (CRC) in Micro/Nanosystem Development, Fabrication and Validation

Professeur agrégé, Département de génie informatique et génie logiciel
École Polytechnique de Montréal
Directeur, Laboratoire de nanorobotique de l'EPM
Chaire de recherche du Canada en conception, en fabrication et en validation de micro et de nanosystèmes

10:00 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

Academic Program

10:30 **A4- NeuroMuscular Advances I**
Location: International I

Chair: K Englehart

- **Muscle Activation Patterns of the Forearm: High Density EMG Data of Normally Limbed and Transradial Amputee Subjects**
  Heather Daley, Usha Kuruganti, Kevin Englehart, and Levi Hargrove, University of New Brunswick

- **EmgSim: A comprehensive simulation toolbox for electromyography**
  Ning Jiang, Philip Parker, and Kevin Englehart
  Institute of Biomedical Engineering, University of New Brunswick

- **Decomposition of simulated ENG signals into velocity-specific components using a multi-contact nerve cuff electrode**
  Edward S. Rogers Sr. Department of Electrical and Computer Engineering, University of Toronto, Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto Rehabilitation Institute, Canada

- **Improved Phoneme-Based Myoelectric Speech Recognition**
  Quan Zhou

- **Multi-Scale Analysis of Myoelectric Signals: Assessment of Long-Range Dependencies and Fractal-Scaling-Break Assessment**
  Mehran Talebinejad [1,2], Adrian Chan [2], Ali Miri [1]
  [1]School of Information Technology and Engineering, University of Ottawa, CANADA
  [2]Department of Systems and Computer Engineering, Carleton University, CANADA

Clinical Program

10:30 **C4 - Réseau de la santé au Canada et au Québec - Canada and Quebec Healthcare network**
Location: International II

Session Chair / Président de la séance
Gnahoua Zoabli PhD, Santa Cabrini Hospital, Montreal, QC

Sécurité du réseau informatique médical au Québec (RTSS)
David Girard, CISSP, CWSP, CHFI, Coordonnateur de la sécurité, Centre de sécurité opérationnelle, Sogique-Bureau de Québec

Pour assurer la sécurité du transport de l'information médicale, le Québec s'est doté d'un Réseau de télécommunication du secteur socio-sanitaire (RTSS) reliant l'ensemble des établissements de santé. Ce réseau est isolé du reste du monde par une zone démilitarisée contrôlée par un service de téléaccès géré par la compagnie Sogique. Avec une simple ligne Internet jumelée aux mécanismes de sécurité de l'Interface sécuritaire du RTSS, ses utilisateurs peuvent accéder aux applications informatiques depuis leurs lieux de télétravail avec autant de facilité qu'à l'intérieur du RTSS. Un spécialiste en sécurité informatique de Sogique nous instruira sur la sécurité de ce réseau informatique médical québécois.

Sécurité du réseau informatique médical au Québec (RTSS)
David Girard, CISSP, CWSP, CHFI, Coordinator, Operational Security Centre, Sogique – Quebec Office

To ensure the secure transmission of medical information, Quebec's *Réseau de télécommunication du secteur socio-sanitaire* (RTSS) links all health care institutions in the province. The network is isolated from the rest of the world by a demilitarized zone, which is monitored by a remote access service and managed by the firm *Sogique*. Through a simple Internet connection coupled with RTSS interface security mechanisms, users can gain access to computer applications from their places of telework as easily as from within the RTSS. A *Sogique* IT security specialist will provide training on how to ensure the security of this medical IT network.

Canada Health Infoway / Inforoute Santé du Canada
Louise Beauchesne, Inforoute Santé du Canada

Canada Health Infoway (Infoway) is a federally-funded, independent, not-for-profit organization whose members are Canada's 14 federal, provincial and territorial Deputy Ministers of Health. Infoway is Canada's catalyst for collaborative change to accelerate the use of electronic health information systems and electronic health records (EHRs) across the Country.

Inforoute Santé du Canada (Inforoute) est une société indépendante à but non lucratif, financée par le gouvernement fédéral, dont les membres sont les 14 sous-ministres de la Santé aux niveaux fédéral, provincial et territorial. Au Canada, Inforoute agit comme catalyseur de la collaboration au changement en vue d'accélérer l'utilisation des systèmes électroniques d'information sur la santé et des dossiers de santé électroniques partout au pays.

12:00 **Lunch in the Exhibit Hall/ Déjeuner dans la salle d'exposition**

12:00 **APIBQ General Assembly/ Assemblée générale de l'APIBQ**
Location : International II

Continuing Education Program

14:00 **CE2 Managing the Wireless Environment: Spectrum Analysis**
Location: Mansfield 7

Instructor: Dara McLain

CE7 PACS/RIS
Location: Mansfield 6

Instructor: Slimane Rahmani
- Introduction au standard DICOM
- Quelques concepts IHE
- Systèmes PACS

15:30 **Refreshment Break / Pause-rafraîchissements**

16:00 **CE2 Managing the Wireless Environment: Spectrum Analysis (Continued)**

CE7 PACS/RIS (Continued)

Academic Program

14:00 **A5 – Biomechanics II**
International I

Chair: R Funnell

- **Current techniques for the evaluation of cross-sectional area in rat tail tendons generate significant errors**
  Gabriel Parent, Matthieu Cyr, Paule Cousineau-Pelletier, Frédérique Desbiens-Blais, Eve Langelier, PERSEUS, Department of mechanical engineering, Université de Sherbrooke, Sherbrooke, Canada

- **Finite element analysis of a fracture fixation plate: a parametric study**
  Kristina Haase

- **Sensitivity to the polarity of external loads in bone remodeling process**
  Mustafa Sasal, University of Ottawa, Faculty of Engineering, Gholamreza Rouhi, Mechanical Engineering Department, University of Ottawa, Ali Vahdati, Mechanical Engineering Department, University of Notre Dame

- **Algorithm for a thermodynamically based design of orthopaedic implants**
  Arnaud Divialle

- **A bioreactor design for the mechanobiological study of soft tissue damage and repair in conditions that provide the best approximation of actual use**
  **Huppé, N.; *Lessard, J.-L.; *Langelier, E.*
  ** PERSEUS, Department of mechanical engineering, Université de Sherbrooke,*

- **The Development of a PC based Instrument to Investigate Muscle Spindle Properties**
  Tsang, Ken; Hubert de Bruin, Associate Professor, McMaster University

Clinical Program

14:00 **C5 – Planning a Teaching Hospital: The role of the biomedical engineer / La planification d'un hôpital universitaire : le rôle de l'ingénieur biomédical**
International II

Session Chair / Président de la séance
Roger Jacob, P.Eng., M.A.Sc.; Associate Director, Medical Equipment and Technology Management, Agence de la santé et des services sociaux de Montréal / directeur associé, Gestion des immobilisations et des technologies médicales, Agence de la santé et des services sociaux de Montréal

Panel Members :
Marjan Yazdanpanah, M.A.Sc.; Technology Advisor, CHUM
Alain Lapointe, P.Eng., M.A.Sc., M.Sc.; Consultant, Direction de l'évaluation des technologies et des modes d'intervention en santé, CHUM

The planning of a MegaHospital presents a number of challenges for a clinical engineer. Some of the planning aspects that will be discussed during this session include:

- ✓ Development of a management plan;
- ✓ Risk management and how to control the spread of infectious diseases in special care units
- ✓ Strategic planning, training and development;
- ✓ Research latest medical technology and equipment available to address both short-term and long-term needs;
- ✓ Identify equipment needs;
- ✓ Collaborate with private sector infrastructure development.

The planning of a university hospital poses a number of challenges for a biomedical engineer, including, among other things, the master plan and the functional and technical plan (if he/she takes part in high-level planning). These challenges also include the problem of infection prevention involving the use of water and air in specialized care units.

After establishing the clinical care, teaching and research plans, the biomedical engineer must complete the medical technology functional framework to achieve the goals of the clinical plan. This involves preparing, among other things, a review of emerging and upcoming technologies, a comprehensive equipment plan and an equipment risk assessment, or collaborating to determine infrastructure requirements -- an important aspect of a project conducted in public-private partnership (PPP). These items will be discussed at the next session.

Conférenciers :

Marjan Yazdanpanah, M.Sc.A., conseillère en technologie, CHUM
Alain Lapointe, ing., D.Sc.A., M.Sc., conseiller, Direction de l'évaluation des technologies et des modes d'intervention en santé, CHUM

La planification d'un méga-hôpital présente de nombreux défis pour un ingénieur biomédical. Voici certains aspects de la planification dont il sera question au cours de cette séance :

- ✓ l'élaboration d'un plan directeur;
- ✓ la gestion des risques et la manière de prévenir la propagation de maladies infectieuses dans les unités de soins spéciaux;
- ✓ la planification stratégique, la formation et le perfectionnement;
- ✓ les recherches sur la technologie et l'équipement médicaux disponibles les plus récents afin de répondre aux besoins à court et à long terme;
- ✓ l'identification des besoins en matière d'équipement;
- ✓ la collaboration au développement de l'infrastructure réalisé par le secteur privé.

La planification d'un hôpital universitaire présente pour un ingénieur biomédical de nombreux défis, y compris, entre autres, le plan directeur et le plan fonctionnel et technique, s'il participe à la planification de haut niveau. S'ajoute à cela toute la problématique de la prévention des infections impliquant l'utilisation de l'eau et de l'air dans les unités de soins spécialisées.

À la suite de l'établissement du plan clinique des soins, de l'enseignement et de la recherche, l'ingénieur biomédical doit compléter le cadre fonctionnel des technologies médicales permettant l'atteinte des objectifs du plan clinique. Cela implique de réaliser, entre autres, le bilan des technologies en émergence et bientôt disponibles, la planification complète des équipement à acquérir, l'évaluation des risques liés à ces équipements ou encore, la collaboration à la définition des besoins en infrastructure, aspect important lors d'un projet réalisé en partenariat public-privé (PPP). Ces différents points seront ainsi discutés lors de cette séance.

15:30 **Refreshment Break in the Exhibit Hall/ Pause-rafraîchissements dans la sale d'exposition**

Academic Program

16:00 **A6 – Cardiovascular Advances II**
Location: International I

Chair: D Lovely

- **Smoothed particle hydrodynamics simulation of blood flow in the left ventricle in diastolic phase**
  Shahrokh Shahriari, Ibrahim Hassan, Lyes Kadem
  Concordia University, Montreal, Canada

- **Flow dynamics in the aORTIC arch after a VALVE replacement by a bileaflet mechanical valve**
  Zahra Keshavarz-Motamed, Lyes Kadem
  Concordia University, Montreal, Canada,

- **Effect of Bileaflet Mechanical Valve Malfunction on Blood Hemodynamics**
  Othman Smadi[1], Marianne Fenech[2], Ibrahim Hassan[1], Lyes Kadem[1]
  [1]Concordia University, Montreal, Canada; [2]. Ottawa University, Ottawa; Canada

- **Study of Tensile Cyclic Loading on Morphology of Endothelial Cell Line in Culture Medium: A Fractal and Topological Comparison**
  Samira Amini[1], Mohammad Tafazzoli-Shadpour[2], Nooshin Haghighipour[2], Mohamad Reza Hashemi Golpayegani[3], Mohammad Ali Shokrgozar[4]
  [1]Faculty of Mechanical Engineering, Ecole Polytechnique of Montreal, Montreal, Quebec, Canada
  [2]Faculty of Biomedical Engineering, Section of Biomechanics, Amirkabir University of Technology (Tehran Polytechnic), Tehran, Iran
  [3]Faculty of Biomedical Engineering, Section of Bioelectrics, Amirkabir University of Technology (Tehran Polytechnic), Tehran, Iran
  [4]National Cell Bank of Iran, Pasteur Institute, Tehran, Iran.

- **Hyperthermia via AC electromagnetic field and magnetic nanoparticles**
  Seyed Nasr Tabatabaei, Ecole Polytechnique Montreal Nanorobotics Lab

Clinical Program

16:00 **C6 – Biomedical Engineering and Information Systems / Génie biomédical et ressources informationnelles**

Location: International II

Session Chair/ Président de la séance :

Raymond Carrier, Project Manager, RUIS Quebec/ gestionnaire de projet, RUIS, Québec

Panel Members / Conférenciers :

Isabelle Jolicoeur, CHU Sainte-Justine, Montréal
Yves Amyot, Institut de Cardiologie de Montréal,
Martin Delage, Hôpital Maisonneuve-Rosemont, Montréal,
Éric Lefebvre, Cité de la santé, Laval

Cette session s'intéresse à la cohabitation du génie biomédical avec les ressources informationnelles.

La technologie biomédicale étant devenue de plus en plus informatisée, il y a davantage de recoupements de compétences entre les services de génie biomédical et d'informatique dans nos établissements de santé et des services sociaux.

Les animateurs de cette table ronde sont les rares personnes qui dirigent des services technologiques incluant le génie biomédical, la physique médicale, l'informatique et la téléphonie.

Quatre hôpitaux québécois sont invités à partager leur expérience d'intégration des ressources informationnelles et biomédicales.

This session deals with the cohabitation of biomedical engineering and information resources.

The increased computerization of biomedical technology has given rise to new areas of overlap between biomedical engineering and IT services in our health and social service institutions.

The hosts of this round table are the rare individuals who manage and oversee technology services, including biomedical engineering, medical physics, IT and telephony.

Four Quebec hospitals have been invited to share and discuss their experiences in integrating biomedical and information resources.

17:30 **Reception and Banquet / Réception et banquet – Le Bateau-mouche au vieux port de Montréal**

8 :00 **Registration and Continental Breakfast / Inscription et petit déjeuner continental**

Continuing Education Program

8:30 **CE3 Overview of Medical Device Regulations**
Location: Mansfield 7

Instructor: Rob Ngungu

- Overview of US FDA Regulations
- Key Comparisons – US / Canada regulations
- Device Regulatory Classifications & Approval Process
- Clinical / Regulatory Interface
- Device Good Manufacturing Practices
- Key / Hot Topics
  - CAPA
  - Process Validation
  - FDA Inspections / violations
  - DTC Advertising

CE4 Battery Technology for Medical Devices
Location: Mansfield 6

Instructor: Jerry Bruce

This technology-oriented workshop will cover advantages and limitations of the common rechargeable battery chemistries used in medical devices. Nickel Cadmium, Nickel Metal Hydride, Sealed Lead Acid, and Lithium-Ion, including the new high-power version Lithium varieties will be characterized. Since unreliable batteries are not an option in medical devices the workshop will also cover battery maintenance and management requirements. An overview of system design and management necessary for SM-Bus battery-medical device systems will be discussed as well.

10:00 Refreshment Break / Pause-rafraîchissements

10:30 **CE3 Overview of Medical Device Regulations (Continued)**

CE4 Battery Technology for Medical Devices (Continued)

Academic Program

8:30 **A7 - Neurological Advances**
Location: International I

Chair: B Gander

- **Event-related fMRI analysis by applying selection criteria to unsupervised clustering**
  Camille Gómez-Laberge and Andy Adler

- **Detecting Nonlinear Determinism of EEG Signals in Parkinson Disease**
  Amir H. Meghdadi, Reza Fazel-Rezai, Martin, McKeown

- **Structure and Function of the Compound Eye in Photinus carolinus (Lampyridae): Regional Variation and Visual Performance / Structure et fonction de l'œil à facettes chez Photinus carolinus (lampyridae): variations régionales et performances visuelles**
  Hassan A. Marshad, Andrew Moiseff

- **Evaluating the loudness exponent from auditory adaptation data**
  Lisa M. D'Alessandro[1,2], Kenneth H. Norwich[1,2] [1]Institute of Biomaterials & Biomedical Engineering, [2]Department of Physiology, University of Toronto

- **Human Endocannabinoid System Emulator**
  Paul Frenger

- **A multirate control scheme for a robotic eye/head system integrating visual and self-motion cues**
  Elias Abou Zeid, Henrietta L. Galiana,

Clinical Program

8:30 **C7 – Wireless Security / Sécurité du réseau sans fil**
Location : International II

Session Chair / Président de la séance :
Bernard Segal, PhD, McGill University; Jewish General Hospital / Université McGill, Hôpital général juif

Panel Members

David Girard, CISSP, CWSP, CHFI, Coordinator, Operational Security Centre, Sogique – Quebec Office
Denis Lebeuf, Officier de sécurité informatique au Centre Hospitalier de l'Université de Montréal.

Conférenciers :

David Girard, CISSP, CWSP, CHFI, Coordonnateur de la sécurité, Centre de sécurité opérationnelle, Sogique-Bureau de Québec
Denis Lebeuf, Officier de sécurité informatique auCentre Hospitalier de l'Université de Montréal.

The use of wireless communication tools is restricted or banned in hospitals. However, in light of recent major developments in wireless communications, and a growing interest in making this form of communication a standard tool in patient care units, it is important to discuss and review the security of such a network with regard to data confidentiality and user access.

L'utilisation des outils de communication sans fil est restreinte ou interdite dans les hôpitaux. Compte tenu de l'évolution technologique importante dans le domaine de la communication sans fil et de la volonté grandissante d'intégrer largement cette forme de communication aux unités de soins, il est important de se questionner sur la sécurité d'un tel réseau eu égard à la confidentialité des données transmises et l'accessibilité de l'information pour les usagers.

15:30 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la salle d'exposition**

Academic Program

10:30 **A8 – Neuromuscular Advances II**
Location: International I

Chair: A Chan

- **A computational model of nerve signal detection and recognition on innervating muscle contractions**
  Rui Zhou

- **Filtering strategies for robust myoelectric pattern classification**
  Levi Hargrove, MscE, PhD Candidate Erik Scheme, MscE, Peng, Kevin Englehart, PhD, Bernard Hudgins, PhD, University of New Brunswick

- **Spectrum-Based Fractal Analysis of Myoelectric Signals Using Piecewise Statistically Self-Affine Power-Laws**
  Mehran Talebinejad [1,2], Adrian Chan [2] and Ali Miri [1], [1]University of Ottawa, Ottawa, ON, Canada, [2]Carleton University, Ottawa, ON, Canada

- **Design and Testing of an Instrumentation System to Determine the Efficacy of Pain Reduction during Muscle Stimulation**
  Michael Willand

- **Reducing the Impedance of Passive Stainless Steel Surface Electrodes**
  Adam Wilson and Dennis F. Lovely1, BSc, PhD, PEng

- **Using Multiple Cameras to Realize Robust and Real-Time Facial Gesture Recognition for Children with Severe Spastic Quadriplegic Cerebral Palsy**
  Brian Leung, Institute of Biomaterials and Biomedical Engineering, University of Toronto
  Dr. Tom Chau, Institute of Biomaterials and Biomedical Engineering, University of Toronto

Clinical Program

10:30 **C8 – Noise Level in Hospitals / Niveau sonore dans le milieu hospitalier**

Location: International II

Session Chair / Président de la séance :
Ascher Berros, ing. Jr., Consultant en Génie Biomédical, HGJ-SMBD-Jewish General Hospital, Montréal

Panel Members
Richard Larocque, Audiologist, M.O.A., Institut national de santé publique du Québec; Lecturer, School of Speech Therapy and Audiology, Universtité de Montréal; Project Manager, ÉcoSon
André L'Espérance, Ph.D., M.Eng., P.Eng., Mechanical Engineering specializing in acoustics; President and founder, Soft dB (www.softdb.com) Quebec

Noise is an emerging concern in our healthcare setting. The objective of this session is to increase the awareness to this issue which has a direct impact on both patients and staff. A study was conducted at the Jewish General Hospital that was driven by our interest in improving the quality of patient care and to understand the noise situation and how to improve it. The different steps taken at the Jewish General Hospital to improve noise levels will be presented in this session based on the recommendations from this study on how to decrease the current noise level at this hospital.

Noise is an acoustic phenomenon or set of sounds producing an auditory sensation considered unpleasant or annoying. Today noise-related problems affect all our health care institutions without exception, and have only increased over the years. These auditory nuisances are detrimental to, among other things, patient recovery and the efficiency of hospital staff. During recent measures to control the problem of noise, the Jewish General Hospital has deployed a range of strategies to determine the causes, consequences and perception of this acoustic pollution to help minimize the harmful consequences associated with chronic exposure to hospital noise.

The aim of this session, presented by the people who conducted these studies, is to outline the different stages of the project conducted by Montreal's Jewish General Hospital (i.e. its implementation, analysis and conclusions). It will also describe how the Jewish General Hospital has followed up on recommendations and implemented strategies and structures to improve its acoustic environment in the short and long term.

Conférenciers :

Richard Larocque, audiologiste, M.O.A., Institut national de santé publique du Québec, chargé de cours, École d'orthophonie et d'audiologie de l'Universtité de Montréal, chargé de projet, ÉcoSon
André L'espérance, Ph.D., M.ing, ing, en Génie mécanique, spécialisation acoustique, président et fondateur de la compagnie Soft dB (www.softdb.com) Québec

Le bruit est une nouvelle préoccupation liée à notre contexte de soins de santé. Cette séance a pour objectif de sensibiliser les participants à cette préoccupation, qui a une incidence directe sur les patients et le personnel. Nous avons mené une étude à l'Hôpital général juif en vue d'améliorer la qualité des soins aux patients, et de mieux connaître la situation à l'égard du bruit et de trouver des façons de l'améliorer. Au cours de cette séance, on présentera les diverses mesures prises à l'Hôpital général juif afin de réduire les niveaux sonores, selon les recommandations de cette étude sur la façon de le faire.

Le bruit est un phénomène acoustique ou un ensemble de sons produisant une sensation auditive considérée comme désagréable ou gênante. Les problèmes liés au bruit touchent aujourd'hui l'ensemble de nos établissements de santé, sans exception, et ils ne font que croitre au fil des ans. Ces nuisances sonores se révèlent néfastes entre autre pour les rétablissements des patients et l'efficacité du personnel hospitalier. Lors de démarches récentes prises pour contrôler cette problématique de bruit, l'Hôpital Général Juif a déployé diverses stratégies visant d'abord à mieux comprendre les causes, les conséquences et la perception de cette pollution acoustique et ce afin de pouvoir amoindrir, dans un deuxième temps, les différentes conséquences néfastes attribuées à l'exposition chronique au bruit hospitalier.

Cette session, présentée par les responsables de ces études, aura pour but d'exposer aux participants les différentes étapes du projet initié par l'Hôpital Juif de Montréal, à savoir sa réalisation, son analyse et ses conclusions. Nous vous ferons également part du suivi des recommandations ainsi que des stratégies et des structures mis en place par l'Hôpital Général Juif pour améliorer l'environnement acoustique de l'établissement à court et long terme.

12:00 **Lunch in the Exhibit Hall/ Déjeuner dans la salle d'exposition**

12:00 **CMBES Annual General Meeting / Assemblée générale annuelle de la Société canadienne de génie biomédical**
Location : International II

Continuing Education Program

14:00 **CE5 Flat Screen Monitors for Medical Devices**

Location: Mansfield 7

Instructor: Francois Gauthier

From the advent of television broadcasting, CRT displays have been the default choice for monitoring video images in medical applications – from surgeries, to remote diagnostics. With the introduction of many new flat panel display technologies, medical personnel are now confronted with a crucial question – which display technology will replace CRT and which technology should they invest in next. This workshop will demystify display technologies such as LCD, CRT, OLED, SXRD, DILA and DLP/DMD and plasma panels. This workshop will inform attendees about the technology used in each display to better help them in their decision with selecting a display. It will also look at HD and how it is being implemented in medical applications.

15:30 **Refreshment Break / Pause-rafraîchissements**

16:00 **CE5 Flat Screen Monitors for Medical Devices (Continued)**

Academic Program

14:00 **A9 – Imaging**
Location: International I

Chair: R Fazel

- **Motion detection in fluoroscopic image and its application to catheter marker tracking**
  Simon Lessard[1] , Caroline Lau1, Daniel Roy, MD[2], Gilles Soulez, MD, MS[2] and Jacques A. de Guise, PhD[1]
  [1]Laboratoire de recherché en imagerie et orthopédie, École de technologie supérieure
  [1,2]Centre de recherché du centre hospitalier de l'université de Montréal
  CHUM pavillon Notre-Dame

- **Efficient Three-Dimensional Simulation of Ultrasound Imaging Using a Parallel k-Space Method**
  Mohammad I. Daoud and James C. Lacefield
  Department of Electrical & Computer Engineering and Robarts Research Institute
  University of Western Ontario, London, Ontario, Canada

- **Non-linear registration of serial histological images of the middle ear**
  Shruti Nambiar[1], W. Robert J. Funnell1, [2]
  [1]Department of BioMedical engineering, McGill University, Montréal
  [2]Department of Otolaryngology, McGill University, Montréal

- **The LabPET™, a Fully Digital, APD-based, Positron Emission Tomography Scanner Dedicated to Molecular Imaging**
  Réjean Fontaine, Jean-Baptiste Michaud, Jean-Daniel Leroux, Nicolas Viscogliosi, Joel Riendeau, Hicham Semmaoui, François Lemieux, Camille Yousefzadeh, Marc-André Tétrault, Philippe Bérard, Mélanie Bergeron, Catherine Pepin, Jules Cadorette, and Roger Lecomte

- **In vivo assessment of axonal disruption using diffusion magnetic resonance imaging**
  Julien COHEN-ADAD, Serge ROSSIGNOL, Habib BENALI, Richard D. HOGE

Clinical Program

14:00 **C9 – Reviewed Papers / C9 – Articles examinés**
Location: International II

Chair: Robert Prud'homme

- **Health Canada's new Guidance on Hospital Bed Safety: Patient Entrapment, Side Rail Latching Reliability, and Other Hazards**
  Denis G. Roy[1] Graham Ladner[2]
  [1]Product Safety Program, Health Canada and [2]Medical Devices Bureau

- **The Assessment of the Risk of Patient Entrapment in Hospital Beds Within the Vancouver Coastal Health Authority**
  Gord McConnel, and Charles Xiao, Biomedical Engineer.

- **Improving Safety and Efficiency within Air Ambulances in Ontario**
  Judith Seary and Vicki LeBlanc, Patricia Trbovich and Anthony Easty

- **Selection of IV technology with drug error reduction system**
  Jean Ngoie

- **Interconnection of 802.11B wireless physiologic monitors with a 802.11A/B/G wireless voip network at santa cabrini hospital's emergency care unit**
  Gnahoua Zoabli

15:30 **Refreshment Break in the Exhibit Hall / Pause-rafraîchissements dans la sale d'exposition**

Academic Program

16:00 **A10 – Medical and Assistance Devices**
Location: International I

Chair: P Mathieu

- **MONitorage IntraThoracique Optique de la Réparation Pulmonaire in vivo**
  Clément Fournier[1], Olivier Lesur[2], Frédéric Chagnon[2], Frédéric D'Aragon[2], Bruno Hogue[2], Daniel M Payet[2], Paul Charette[1]
  [1]Département de génie électrique et de génie informatique, Université de Sherbrooke,
  [2]Faculté de Médecine, Unité de Physiopathologie Respiratoire, Université de Sherbrooke,
- **Stove top thermal monitoring for assisted living at home**
  Ming Ye Yuan, James. R. Green, and Rafik Goubran
  Systems and Computer Engineering, Carleton University
- **Calibration of a simple, low cost, 3D laser light-sectioning scanner system for biomedical purposes**
  Beverly D. Bradley[1], Adrian D.C. Chan[2], John D. Hayes[3]
  [1]Ottawa Carleton Institute for Biomedical Engineering, Systems and Computer Engineering, Carleton University
  [2]Systems and Computer Engineering, Carleton University
  [3]Mechanical and Aerospace Engineering, Carleton University
- **Flexible Ultrasonic Transducers and Their Performance**
  M. Kobayashi, C.-K. Jen, Y. Ono, J.L. Shih and F. Lesage

Clinical Program

16:00 **C10 - Reviewed Papers / C10 – Articles examinés**
Location: International II

Chair: Robert Demers

- **Is reliability-centered maintenance a valid maintenance strategy?**
  Phill Thorburn and Rebecca Jucha
- **Clinical Engineering Electromechanical Program. Are your patients and staff safe without one?**
  Jeremy Dann

- **In-room HEPA Air Cleaners: Simple technology with complicated implications**
  Sonia Pinkney Tony Easty, Nancy Sikich

- **ISO quality systems & clinical engineering/standards of practice**
  Avril Sullivan

- **CMBES peer review of London Health Sciences Centre, October 2007**
  William Gentles

17:30 **Closing Remarks / Mot de la fin**

- Bill Gentles, CMBES President and Conference Co-Chair
- Gnahoua Zoabli, Chief of Biomedical Engineering Department, Santa Cabrini Hospital, Montreal, QC and Conference Co-Chair

Book of Abstracts

Academic Program

Wednesday, June 11th
10:30am – 12:00pm

Session A1 – Advancements in Biomedical Engineering

Development and performance of a novel closed-loop propofol system

S Charabati,[12] B.Eng, P. A. Mathieu,[1] PhD, TM Hemmerling[12] MD DEAA, MSc
Institute of Biomedical Engineering,[1] Université de Montréal, Dept. of Anesthesia, McGill University,Montreal, Canada[2]

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Objective: The purpose of this project is to asses the performance of a novel, expert-based adaptive closed-loop system for propofol administration using Bispectral Index (BIS) (fig. 1).

Methods: After IRB approval and written consent, 50 patients undergoing orthopedic or general surgery are randomly assigned to 2 groups of equal size. After manual propofol induction (1.5 mg/kg), closed loop control was used to maintain anesthesia at a target BIS of 45 (*Closed-loop group*); in the *Control group*, propofol was administered manually using a syringe pump by an experienced TIVA-anaesthesiologist in order to maintain a target of 45 as closely as possible. Data was recorded every 10 s. The performance of the system was defined as excellent, good, poor or inadequate, when the BIS was within 10%, between 10 and 20%, between 20 and 30% or above 30% of the target BIS, respectively. Data as mean ± SD. Comparison of the performance of the two systems was done by Wilcoxon signed-rank test, $P < 0.05$.

Results (preliminary results, N = 22, table): In the *Closed-loop group*, 11 patients (2 f, 9 m; age 50 ± 16 y; weight 80 ± 9 kg) underwent anesthesia of 178 ± 68 min and received propofol of 120 ± 35 µg/kg/min. During 48 %, 30% and 10% of the total anesthesia time, the system showed excellent, good and poor control, respectively. The time from the end of infusion to extubation was 9 ± 2 min. In the *Control* group, 11 patients (4 f, 7 m; age 65 ± 15 y; weight 70 ± 15 kg) underwent anesthesia of 115 ± 68 min and mean propofol of 105 ± 23 µg/kg/min. Excellent, good and poor control were noted during 26%, 32% and 15% of the time (fig. 2). Extubation was achieved after 11 ± 4 min from the end of infusion. Doses were changed 9 ± 5 times per h. In the *Closed-loop group*, excellent control of anesthesia occurred significantly more often (P=0.001) and inadequate control less often than in the *Control group* (P=0.01).

Discussion: The originality of the present system is that it is an expert-based system, which adapts itself to offset from target using pre-defined algorithms (fig. 3). In comparison to manual control, it seems to be able to maintain anesthesia closer to a given target.

Fig. 1

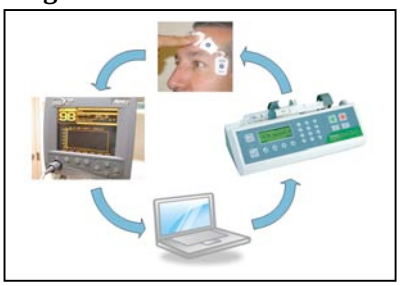


Table : Performance

	Closed-loop	Control Group	P value
Median BIS	43.8 ± 3.0	41.9 ± 7.8	0.656
Median performance error (MDPE) [%]	1.0 ± 6.4	-11 ± 17.4	0.042
Median absolute performance error (MDAPE) [%]	10.4 ± 2.2	18.8 ± 8.5	0.004
Wobble	9.6 ± 2.4	15.6 ± 10.4	0.054
Median pt-to-pt BIS variation	2.1 ± 0.9	1.7 ± 0.5	0.173

Fig. 2

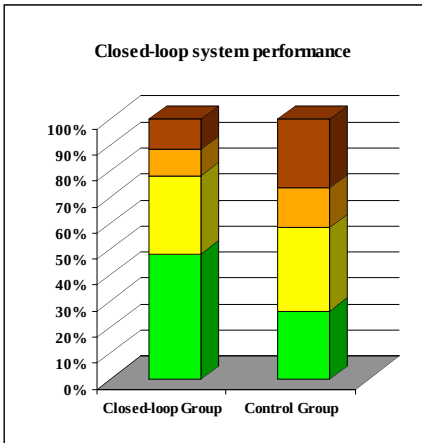
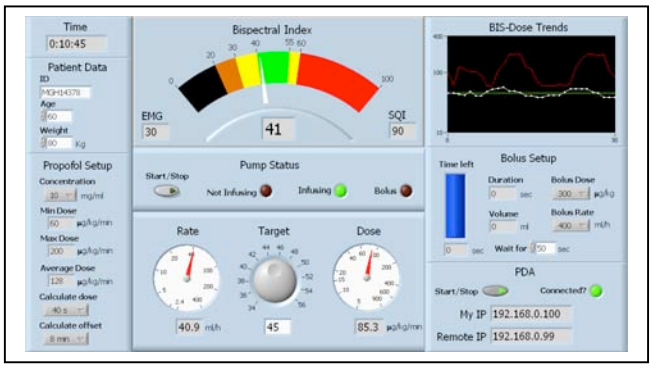


Fig. 3



The 'Analgoscore': a novel score to monitor intraoperative pain and its use for remifentanil closed-loop application

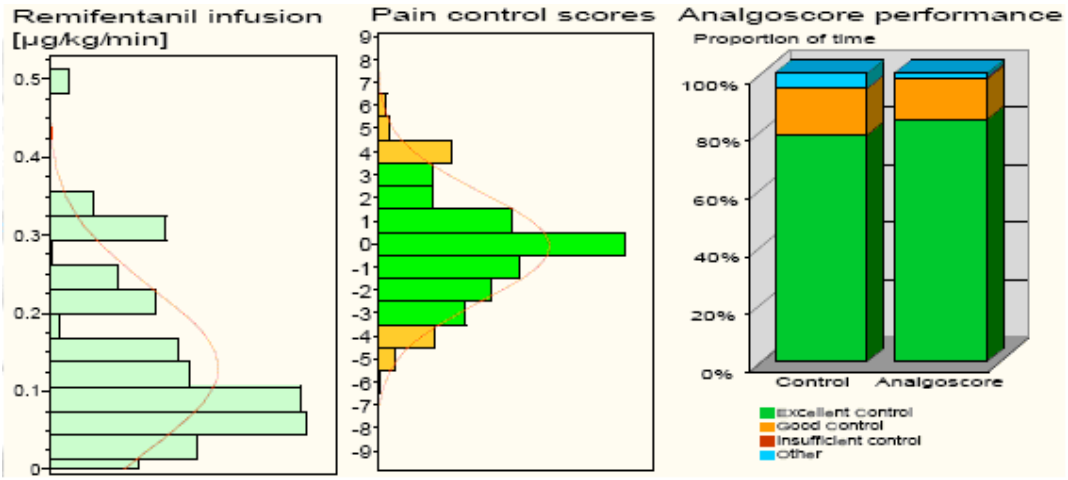
TM Hemmerling MD DEAA,MSc , S Charabati, B.Eng, E Salhab, MSc, Pierre A. Mathieu, PhD*
*Institute of Biomedical Engineering, Université de Montreal, *& McGill University, Montreal, Canada*

Purpose. Measuring pain during general anesthesia is difficult because communication with the patient is impossible. The focus of this project is the development of an objective score ('Analgoscore'®) of intraoperative pain based on mean arterial pressure (MAP) and heart rate (HR). The Analgoscore® was used for closed-loop application of remifentanil.

Methods. Based on fuzzy logic algorithms, the Analgoscore® ranges from -9 (too profound analgesia) to 9 (too little analgesia) in increments of 1, with -3 to + 3 representing excellent pain control, -3 to -6 and 3 to 6 good pain control, and -6 to -9 and 6 to 9 as insufficient pain control. According to the zone of pain, a remifentanil infusion was closed-loop-administered in 16 patients (ANALGOSCORE® group). In the CONTROL group (N=10), remifentanil was administered open-loop to maintain excellent pain control. The percentage of anesthetic time within the different control zones was recorded as well as the variability of MAP and HR. Data as means ± SD

Results (fig). In the ANALGOSCORE® group, 16 patients (5 f, 11 m; age 49 ± 21 y) underwent anesthesia of 108 ± 45 min, received remifentanil of 0.13 ± 0.08 µg/kg/min. During 84%, 14% and 0.5% of the total anesthesia time, the Analgoscore® showed excellent, good or insufficient pain control, respectively. Artifacts were recorded 1.5% of the time. The CONTROL group (4 f, 6 m; age 48 ± 17 y) underwent anesthesia of 110 ± 25 min and remifentanil of mean 0.17 (0.1) µg/kg/min was infused. Excellent control was obtained 79% of the time, whereas good and insufficient control yielded 15% and 1% respectively. Artifacts were recorded 5% of time.

Discussion. The Analgoscore® is a novel score of intraoperative pain. Remifentanil was successfully closed-loop-administered and excellent or good pain control achieved in more than 95% of the time. The controller performance was as good as the best manual performance.



Biomedical research ethics in developing countries: applying global guidelines to local contexts

Shauna Mullally

The rate of biomedical research performed in developing countries is on the rise, and serious questions regarding the ethicality of this research exist. Large scale public health surveys have become more common, facilitated by technological advancements in collecting and monitoring biological samples in harsh, resource-poor settings. Clinical trials have also become more common, and have been more controversial; many argue that they benefit from the less stringent ethical research guidelines found in developing countries. More than in public health surveys, clinical trial participation is rooted in vulnerabilities and therefore the exploitive potential of this research is greater. This paper examines the ethicality of both types of research within the framework of the World Medical Association's Declaration of Helsinki, which provides us with six guiding ethical principles: safety, informed consent, confidentiality, reporting, referral and service and the provision of care. Four case studies of clinical trials with varying degrees of ethical rigour are presented. These case studies expose the challenges of implementing global guidelines in a developing country context, and how this implementation can be used as justification for a lower standard of ethical rigour and care for participants. Two of the presented cases concern HIV research which requires further ethical sensitivity due to the stigmatized nature of the illness. Discussions and recommendations are presented, including the need for independent national ethics review boards in host countries that are culturally appropriate and scientifically competent. Biomedical research in developing countries should not be suppressed, but must be constrained to the equitable pursuit of ethical research regardless of host country or context.

Complement is activated by coagulation and not by chitosan in human whole blood and plasma

Edward Baraghis[1], Catherine Marchand[2], Georges-Etienne Rivard[3], Caroline D. Hoemann[1,2]
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École Polytechnique, Montreal

Chitosan is a biocompatible and adhesive polysaccharide scaffold composed of glucosamine and N-acetyl glucosamine. We previously showed that liquid chitosan buffered with glycerol phosphate (chitosan-GP) can be homogenously mixed into whole blood to form an in situ-solidifying clot implant that stimulates transient neutrophil chemotaxis during marrow-based regeneration of articular cartilage. Thrombin was recently shown to activate complement, a family of plasma proteases whose activation culminates in the cleavage of a C5 precursor to produce a potent neutrophil chemotactic factor, C5a. Solid chitosan particles were previously reported to activate complement in serum and plasma through the alternative pathway. We therefore tested the hypothesis that liquid chitosan-GP activates complement in human whole blood, plasma, and serum.

Complement and platelet activation was detected by Western blot analysis of soluble C5a and platelet factor 4 (PF4), respectively. C5a appeared in serum collected from coagulating whole blood and chitosan-GP/blood mixtures, concomitant with platelet activation and thrombin generation. Chitosan protected C5a from degradation that occurred during the first 30 minutes post-coagulation. Chitosan-GP mixed into plasma or serum failed to generate C5a, although C5 was found bound to the insoluble chitosan pellet as well as to zymosan. It is notable that others previously reported that chitosan activates complement solely on the basis of C5 or C3 depletion from serum or plasma. Our data indicate that complement is activated by coagulation and not by chitosan, although chitosan sustained C5a chemotactic peptide levels post-coagulation. Our data also suggest that blood cells contribute to complement generation during coagulation.

Wednesday, June 11th
12:00-14:00

Posters

Biomechanical characterization of biological tissue by coherent imaging using coupled coherence-gated photorefractive holography and speckle shearography

Rémy Béland[2], Vanessa Rosso[1], Sylvain Lecler[1], Yvon Renotte[1], Serge Habraken[1], Yves Lion[1] and Paul Charette[2]
[1]HOLOLAB, Département de Physique, Bât. B5a, Université de Liège, B-4000 Liège, Belgique
[2]Département de génie électrique et de génie informatique, Université de Sherbrooke, Sherbrooke,

Direct measurement of tomographic and strain information simultaneously in soft tissue is important to obtain a complete biomechanical characterization. This can be achieved by coupling two optical techniques: coherence-gated photorefractive holography for tomographic measurements and digital shearography for strain measurements. Whereas speckle interferometry techniques are normally used exclusively for surface material property measurements, the combination of the two techniques allows the direct measurement of strain in a plane inside the material. In addition, the photorefractive effect filters out the background optical noise arising from scattering inside of the biological medium, which significantly enhances image quality. In the presentation, we will describe the coupled optical imaging system and present characterisation results obtained with a synthetic phantom used to emulate a biological scattering medium at various levels of optical density.

Nano-spray ionization source isolation on proteomic mass specrometers for siloxane contaminant removal

Brian Carrillo, Pascal Pleynet, Daniel Boismenu, Robert E. Kearney
McGill University, Department of Biomedical Engineering; Genome Quebec

Proteomics mass spectrometer calibration experiments in our laboratory have shown the presence of an intermittently present low mass contaminant, later determined to be siloxane (a silicone polymer). Analysis of this contaminant revealed a cyclical temporal profile with a period of approximately 22 minutes. While contaminants are not necessarily problematic to proteomic experiments, particularly in the mass range of siloxane (355 m/z), this particular contaminant had the effect of suppressing peptides present at the same time. Further investigation led to the suspected source of the contaminant, the HVAC unit in the building [silicone is used to seal the ducting] which was also operating at a period of approximately 22 minutes. It is suspected that the siloxane contaminant ionizes either by contacting the high voltage ionization needle, or by stealing charges from the ionized sample [which would explain the decreased signal intensity].

This led to the design and construction of an enclosure to isolate the mass spectrometer's ionization source from the surrounding atmosphere. An airtight enclosure mounted against the inlet of the mass spectrometer effectively sealed off the front end of the instrument. A small port, away from the nano-spray (to avoid turbulence) was created to force a controlled leak. The port was connected to an activated carbon cartridge [used to remove organics from Gas for GC-MS applications] in order to sweep the incoming air from contaminants. This design had the effect of removing the siloxane from the air, without introducing turbulence or detrimentally impacting the intensity of the signal.

Multi-modal acoustic-photo-acoustic imaging for small animal imaging.

M. Abran[1], Y. Ono[2], C.K. Jen[3], F. Lesage[1]
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[2]Carleton University, Department of system and computer engineering, 1125 Colonel By Drive Carleton University Ottawa, Ontario Canada
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Photo-acoustic imaging (PAI) is sensitive to endogenous optical contrast present in tissues and, contrary to diffuse optical imaging, it reaches high resolution, functional imaging for in vivo studies at mid-range depths (3mm-10mm). This modality has been developed for different purposes but recent years have seen the modality gain interest with applications to small animal pre-clinical imaging. As a technique it is sensitive to endogenous optical contrast present in tissues and, contrary to diffuse optical imaging, it promises to bring high resolution imaging for in vivo studies at mid-range depths (3mm-10mm). Gain in resolution originates from the acoustic detection whereby it is limited by transducer frequency.

When using light in the visible to near-infrared region, the dominant chromophore in tissues is hemoglobin (oxy or deoxy) and PAI can be used to generate fine images of the vasculature in vivo as well as study the vascular response to stimuli. The presence of an ultrasound transducer suggests that one can also use the same system to perform acoustic imaging in parallel. The motivation for acoustic imaging is to add anatomical landmark to PAI imaging. In this work we show that it is possible to integrate a low voltage ultrasound pulser in the acquisition chain, in order to generate anatomical images at no cost in scanning time by interlacing laser and ultrasound pulses at rates reaching 10 KHz. We discuss potential applications to neuronal imaging and neuronavigation applied to small animal imaging.

Heart Sound Segmentation Based on a Mel-Scaled Wavelet Transform

Karim Courtemanche[1], Véronique Millette[2] and Natalie Baddour[2]
[1]McGill University
[2]Department of Mechanical Engineering, University of Ottawa

The identification and segmentation of heart beats in a phonocardiogram signal is of great interest, with applications ranging from diagnosis to use as a timing source. This paper proposes a new algorithm for the identification of the first and second (S1 and S2) heart sounds and for segmentation of the signal. The proposed algorithm is a novel combination of documented techniques, leading to improved segmentation accuracy. The Shannon Energy is first used to find sounds of interest. The algorithm subsequently uses the Mel-Scaled Wavelet Transform (MSWT) which is a modified Mel-Frequency Cepstral Coefficient (MFCC) algorithm with the Discrete Wavelet Transform (DWT) in order to reduce the impact of noise on the coefficients. These coefficients are used as a basis for distinguishing S1 from S2 and segmenting the signal accordingly. The algorithm is tested on real signals and is compared to a simpler Shannon Energy algorithm and to a traditional MFCC based algorithm. The new algorithm presents an improvement in accuracy especially when signals contain noise. It is therefore less susceptible to outside interference and could be used more accurately in a hospital setting.

Measuring cellular activity using surface plasmon resonance

Vincent Chabot[1], Charles M. Cuerrier[2], Michel Grandbois[2], Paul G. Charette[1]
[1]Département de génie électrique et génie informatique, Faculté de génie, Université de Sherbrooke, 2500 Boulevard Université Sherbrooke, Québec, J1K 2R1, Canada
[2]Département de Pharmacologie, Faculté de Médecine, Université de Sherbrooke, 3001 12e Avenue Nord, Sherbrooke, Québec, J1H 5N4, Canada

Ongoing research is abundant on biosensors for environmental and biomedical applications. A potential biosensor candidate is based on surface plasmon resonance, an optical detection method allowing real-time measurement of refractive index variations in the close vicinity of a thin metal layer. Since cellular activity is often associated with a change in cellular morphology, which in turn should lead to a variation of refractive index on the cell substrate, we propose a cellular biosensor based on surface plasmon resonance to evaluate cellular activity.

We monitored surface plasmon resonance signal originating from a surface coated with HEK-293 cells on a custom apparatus for a 30-minutes period after injection of various agents which are known to influence cellular activities and cause profound morphological changes. More specifically, we evaluated response to three types of stimulation: specific agonist with thrombin, endotoxin response with lipopolysaccharides (*Escherichia coli*) and apoptosis with sodium azide. Results were validated with phase contrast microscopy.

Thrombin injection led to a rapid decrease of the measured laser reflectance over 2 minutes followed by a plateau whereas lipopolysaccharides and sodium azide generated a continuous decrease of the measured reflectance. Phase contrast microscopy confirmed morphology changes over the measured period for all three agents.

In conclusion, the comparison with phase contrast microscopy confirms that surface plasmon resonance can identify cellular activity following activation by an agonist, an endotoxin agent or an apoptotic agent. We propose the combination of surface plasmon resonance with living cells as a biosensor to measure cellular activity induced by external agents.

Contributions of the ankle stretch reflex to dynamic postural stability in standing humans

Siddharth Vedula

Studies of quiet stance suggest that the peripheral stretch reflex at the triceps-surae muscle group is an important feedback mechanism in maintaining equilibrium, by contributing to the stiffness of the ankle joint complex. During the execution of voluntary movements, changes in the activity of ankle and thigh muscles precede the movement. These feedforward (predictive) anticipatory postural adjustments (APA's) are believed to stabilize the body against the upcoming postural disturbance. The objective of this novel

study was to quantify the triceps-surae stretch reflex during the APA phase of a voluntary unilateral arm raise, and hence better understand the interplay between these two postural control mechanisms.

Subjects stood on two hydraulically operated rotary pedals embedded with load cells and torque sensors for the measurement of the center of pressure (COP) and ankle torque respectively. In response to a visual cue, they raised their arm to hit a target switch at shoulder height and arm's length. To measure the sensitivity of the stretch reflex, the right pedal applied a short displacement randomly at different times during the APA and during the movement.

During the APA, the soleus muscle inhibited followed by an activation of the tibialis anterior muscle resulting in a backward shift in the COP and forward ankle torque. Electromyographic (EMG) and torque responses of triceps-surae reflex activity suggest that the stretch reflex is concurrently down-regulated. Since the sensitivity of the reflex pathway and APA control signals are centrally regulated, these results suggest that an integrated centralized active postural control mechanism exists.

Improved Adhesion and Growth of Vascular Smooth Muscle Cells in Cultures on Modified Polyethylene

Martin Parizek[1], Nikola Kasalkova[2], Lucie Bacakova[1], Katerina Kolarova[2], Vera Lisa[1], Vaclav Svorcik[2]
[1]Institute of Physiology, ACADB, SCI, CR, Videnska 1083, 142 20 Prague 4-KRC, Czech Republic. [2]Institute of Chemical Technology, Technicka 5, 166 28 Prague 6 – Dejvice

Synthetic polymers are widely used in medicine and various biotechnologies, such as construction of body implants, carriers for cells for transplantation or in vitro cultivation. The attractiveness of polymers for cell colonization can be affected by physical and chemical modification of the polymer surface. In this study, high density polyethylene (HDPE), often used as model material for the development of tissue replacements, was modified by Ar plasma discharge on Balzers SCD 050 device (exposure time 50 seconds, discharge power 1.7 W), and then grafted with various biomolecules, such as glycine (GLY), bovine serum albumin (BSA) or polyethylene glycol (PEG), and/or sputtered with carbon (C). Thus, we created the following material modifications: pristine HDPE, plasma-modified HDPE, HDPE+Gly, HDPE+C, HDPE+BSA, HDPE+PEG, HDPE+BSA+C and tissue culture polystyrene. The materials were seeded with rat aortic smooth muscle cells (SMC; passage 8-9, 17 000 calls/cm^2, medium DMEM with 10% of fetal bovine serum). On day 1 after seeding, the highest number of initially adhered cells was found on plasma-modified HDPE with PEG. On day 2, the cell number on all modified HDPE samples became significantly higher than that on non-modified HDPE. On day 5, the highest cell number was observed again on HDPE + PEG. On all modified samples, the cells were better spread and formed well-developed filament containing alpha-actin, a marker of SMC differentiation and contractility, although its concentration per mg of protein was unchanged.

ULTRA-Fast Wiener Filter based Crystal Identification Algorithm Applied to the LabPETTM Phoswich Detectors

H. Camilia Yousefzadeh, Student Member, CMBEC, Nicolas Viscogliosi, Marc-André Tétrault, Catherine Michele Pepin, Philippe Bérard, Mélanie Bergeron, Hicham Semmaoui, Roger Lecomte, and Réjean Fontaine

A Wiener filter based crystal identification (CI) algorithm achieving excellent discrimination accuracy (~98%) was recently proposed for identifying LYSO and LGSO crystals in phoswich detectors coupled to an Avalanche Photodiode. Such detectors are used in the LabPET^{TM}, an all-digital positron emission tomography (PET) scanner for small animal imaging recently developed in Sherbrooke. This algorithm was based on evaluating the scintillation decay constant and gain a_1 spectra. This input gain was not considered in the CI process even if it must be computed. We propose a 2-fold faster CI approach which also takes into consideration the input gain coefficient of each crystal. The new algorithm incorporates the DAQ chain model – in the Z domain – to each individual crystal model evaluated in a Wiener filter calibration process. The identification is performed by evaluating a single parameter – compared to two parameters in previous Wiener CI algorithm – characterizing the percentage of each crystal gain contribution in the event signal. The

phoswich arrangement for 511 keV photopeak. Although a calibration is required, initial implementation of the algorithm in a 400 MHz clocked FPGA can process up to 15 Mevents/sec.

Wednesday, June 11th
14:00pm – 15:30pm

Session A2 – Biomechanics I

Residual Shoulder Motion Vector Projection

Yves Losier, Kevin Englehart, and Bernard Hudgins
Institute of Biomedical Engineering, University of New Brunswick, Fredericton, Canada

Residual shoulder motion has been shown to be a useful input source for various prosthetic control strategies. In many cases, the controller must be tailored for each individual subject due to several factors such as the user's range of motion, the sensor type, positioning and output range. Ideally, it would be beneficial to have an initialization protocol by which these factors would be taken into consideration and their associated implementation complexity removed from the control scheme paradigm. Automatic tailoring of the system to the user would also speed up the setup time required within a clinical and/or system retraining setting.

We propose a mathematical framework to implement residual shoulder motion driven control using a short preliminary training protocol in an attempt to remove issues such as sensor alignment, range of motion, and possible non-orthogonal degrees of freedom. The algorithm associates the current real time residual limb position with a speed/amplitude for each class specified in the system and uses this calculated information to drive the prosthetic limb's actuators. This scheme has been formulated experimentally through the use of several pilot subjects. Several separate case studies were also investigated to illustrate the versatility of this approach when used with different input sensors.

Dynamics of Torque Responses to Visual Stimuli

Daniel Ludvig, Yong Zhao, Robert E. Kearney
Department of Biomedical Engineering, McGill University

Joint stiffness defines the dynamic relationship between the position of the joint and the torque acting about it. Joint stiffness plays a role in voluntary movements in all joints, but it is especially important in the ankle because it plays a large role in the maintenance of posture. Traditionally, joint stiffness has been considered to be composed of two components: intrinsic stiffness, which arises due to the viscoelastic properties of the joint, muscles, and connective tissue and the inertia of the limb; and reflex stiffness, which arises due to afferent feedback from the muscle in response to a stretch. This two component view of joint stiffness is appropriate when the voluntary torque produced by the person is not correlated with the joint position. However, given the task of maintaining the joint at a constant position, a person will produce voluntary torque which is correlated to the joint position; hence a voluntary component must be considered in joint stiffness. Identifying intrinsic and reflex stiffness is not trivial, because they appear and change together. Adding a third stiffness component makes identification even more complex. In this study we examined voluntary contribution to ankle stiffness, by using a paradigm in which subjects, through the use of visual feedback, controlled the position of a simulated load, without any actual movement of the ankle. We estimated voluntary stiffness non-parametrically, by calculating the impulse response function between the position of the simulated load and torque. Voluntary stiffness was estimated to be a linear dynamic element with a delay of approximately 200 ms and it accounted for 65% of the torque variance.

Human grip force response: An input-output approach

Alejandro Villaseñor-Herrer, Robert E. Kearney, Ph.D., Eng., Sophie J. De Serres, Ph.D. Ross Wagner, Ph.D.

The control of human grip force response plays an important role in interfacing the hand with the environment. It allows constant handling of a variety of objects between the pads, tips or sides of the fingers, even in the presence of unpredictable disturbances. Many precise manipulative tasks in the activities of daily living (e.g. eating) depend on the grip force response. The relative roles of reflex and voluntary responses have not been reported in a quantitative manner during a grip force task. Thus, quantification of the contributions of cutaneous reflex (e.g. supra-spinal) to the human grip force response is valuable.

This insight should contribute to future applications in the development of more objective evaluations of sensorimotor deficits resulting from acute or chronic conditions such as stroke and normal aging.
This paper will describe the experimental apparatus and analysis procedures developed to characterize the grip force response using system identification techniques (SID). The apparatus comprises a six degree-of-freedom (6 DOF) force transducer that the subjects grips with the tips of the thumb and the index finger. The transducer is attached to a servo-controlled motor that applies perturbations of load or position in the vertical direction. System identification methods characterize the dynamic relation between the vertical force (or position) and the resulting grip force. The relative contributions of passive, reflex and voluntary mechanisms are then determined from these models.

Design and Development of an Angular-Velocity Activated Hydraulic Knee Orthosis

Terris Yakimovich, Edward D Lemaire, Louis Goudreau and Jonathan Kofman
Ottawa Hospital Rehabilitation Centre

A hydraulic-based knee orthosis was designed to provide a unique level of support to individuals with quadriceps weakness. The orthotic knee joint allows free knee motion throughout the gait cycle, but will resist knee flexion if the knee flexes rapidly, such as during a stumble or knee collapse. This is the first orthotic knee joint design to incorporate an internal angular velocity triggering mechanism for stance control (i.e. flexion resistance at the appropriate time during weight-bearing). Other devices require external control/triggering systems, including foot pressure switches or are triggered by the orientation of the lower limb, which can be unreliable.

The orthotic knee joint design parameters called for a small, lightweight, strong, reliable joint, and presented a formidable design challenge. CAD and finite element analyses were used to model and develop the joint prototypes. Laboratory tests using different fluid flow rates through the valve achieved the sealing and activation-rate design criteria. During mechanical load testing of the initial prototype, the joint was not able to attain the internal pressure required to resist the knee flexion moments generated during a stumble. A reiteration of the joint's design resulted in a lower internal pressure required to resist the design-moments and had less potential for leaking hydraulic fluid. Future work includes testing the clinical effectiveness of the orthosis and technology transfer. A provisional patent has been filed.

Effect of Mobility Devices on Inertial Sensos Containing Magnometers

Cynthia L. Kendell, Edward D. Lemaire

Inertial sensors address issues surrounding lab based motion analysis systems. While lightweight, portable, and user friendly, commercially available orientation sensors that use a magnetometer may experience signal interference in the presence of ferromagnetic materials. The current study investigates the viability of using inertial sensors for motion analysis in an assistive devices rehabilitative setting. Two XSens MTx inertial sensors were connected to the XBus data collection unit. These two sensors were attached to a plastic frame such that the relative angle between sensors remained fixed. A series of assistive devices were then moved in and out of the proximity of the plastic frame (i.e., a knee-ankle-foot orthosis (stainless steel),

a walker (Evolution model), and a wheelchair (Quickie GTi model). Errors were calculated as the difference between the baseline and average peak relative angles. Errors ranged from less than 1 degree to 35.29 degrees, depending on the assistive device, the proximity of the sensor to the metal components of the device, and the number of sensors affected. Strategic sensor placement on some devices may minimize these errors to an acceptable level. Testing protocols should be implemented to verify sensor accuracy for these applications.

Wednesday, June 11th
16:00pm – 17:30pm

Session A3 – Cardiovascular Advances I

Sliding window autocorrelation for the synchronous unsupervised segmentation of the phonocardiogram

Sankua Chao and Adrian D. C. Chan
Department of Systems and Computer Engineering, Carleton University, Ottawa, Ontario

The phonocardiogram (PCG) is a bio-signal that represents sounds produced by the heart. The PCG can be used to detect and diagnose murmurs, which are usually associated with valve malfunctions within the heart. In order to accurately detect murmurs, the PCG must first be segmented to locate the boundaries between successive heartbeats. The Sliding Window Autocorrelation (SWA) is a proposed PCG segmentation algorithm, which is designed to perform unsupervised, synchronous segmentation of complex heart sounds. To preprocess the PCG prior to segmentation, a Heart Rate Estimator (HRE) is proposed which, in conjunction with *a priori* patient information, provides an estimate of the heartbeat period. The SWA generates a set of "similarity" correlations between windowed segments of the PCG, where peaks in a correlation indicate a high degree of similarity between the windowed segments. Each similarity correlation is generated by "sliding" a short "template" window (representing a single heartbeat) across a longer "search" window. By observing the template window offset at which peaks occur, the probable time difference between the template window and a highly similar segment in the search window can be determined. This time difference, along with knowledge of the actual position of the template window within the PCG, is used to calculate the probable position of the highly similar segment within the PCG. In this manner, the positions of highly similar segments and hence times at which heartbeats occur in the PCG are predicted. Further research will explore the use of wavelets to perform time-frequency analysis, in order to refine the PCG prior to segmentation.

Artery Stiffness Assessed by Pulse Counter Analysis

Gong Zhang, Simon Liao, Yong Liu, Shaohong Xu

Because pulse contour analysis might be used to assess artery stiffness, an index of stiffness (SI) derived by pulse counter analysis was examined. SI was obtained from subject height and from the time delay between direct and reflected waves in the pulse. Moreover, a pulse contour characteristic value K extracted from calculation of the pulse wave contour is introduced. K is also related to artery stiffness and can be used for artery stiffness assessment. 40 subjects were recruited for pulse wave analysis. By univariate analysis, SI and K are also highly correlated with ($r=0.632$, $P<0.0001$). It shows K also can be an accept parameter for artery stiffness assessment. The method for acquiring SI and K is simple, inexpensive, and rapid.

Automated Pattern Classification for PCG Signal based on Adaptive Spectral k-means Clustering Algorithm

Abbas K. Abbas[1], Rasha Bassam[2], Rana M. Kasim[3]

[1, 3] *Biomedical Engineering Dept., RWTH Aachen Germany,* [2] *Aachen university of Applied Sciences, Germany*

PCG Pattern classification, also known as auscultation pattern recognition, was one of the efficient computer-based methods applied to medical decision making. PCG Pattern recognition generally is interpreted in two ways. The most general definition includes recognition of patterns in any type of PCG dataset and is called uniform PCG pattern classification this discriminate peaks of heart sounds as excitation source for circulation hemodynamic, and other is called adaptive pattern clustering which magnify and observe the spectral characteristics associated with PCG waveform turbulences and differentiate them as clinical diagnostic indices. This work reports robust results with phonocardiogram PCG-signal pattern classification. Linear prediction analysis and basic agglomerative clustering techniques were applied to extract the spectral pattern from phonocardiogram signals, a relatively new technique. In this examination, 35 PCG samples are classified correctly, except for seven samples; and 24 PCG samples correctly, except for three samples. The characteristics for each class are well extracted and the results of spectral classifications are obviously robust. The efficiency of PCG spectral features classification has been confirmed experimentally to be integrated in automated auscultation computer aided diagnosis (AuCAD) systems. Discrimination of abnormal S1, S2 and S3 peaks was succeed with BAC-algorithm and k-mean based data clustering technique. The more specific interpretation algorithms are limited to finding patterns in PCG signals or other related biosignal activities. This work covers the new techniques applied in basis of pattern classification for mitral regurgitation PCG signals to investigate different hemodynamics turbulences and stochastic blood flow patterns associated with cardiac circulation.

Structural design optimization of a pediatric stent

Zineb Idrissi, McGill University

Problématique et objectif: Annuellement, 1% de nouveaux nés souffrent de maladies cardiovasculaires congénitales. Parmi celles-ci, nous retrouvons la sténose de l'artère pulmonaire qui est, en fait, un rétrécissement du vaisseau acheminant le sang oxygéné des poumons vers le ventricule droit. L'utilisation d'un stent adulte habituellement employé pour traiter les sténoses des artères coronaires soulève un problème d'importance majeure. En effet, le stent, n'ayant pas le potentiel de s'adapter à la croissance somatique de l'enfant, il nécessaire d'avoir recours à une chirurgie à cœur ouvert ultérieure pour enlever le stent lorsqu'il devient inadapté à la taille de l'artère.

Méthode: Une première génération de stents a pu être développée en suivant les différentes étapes couramment utilisées pour concevoir un nouveau design dans le domaine de l'ingénierie (Définition de la problématique, génération de concepts, etc.). A partir de là, la méthodologie suivie consiste à améliorer le design en ayant recours à des simulations numériques, à des tests mécaniques, et à des tests in vivo. Cela se fait de façon incrémentale dépendamment des résultats obtenus à l'étape précédente.

Résultats: Suivant la méthodologie décrite précédemment, il a été possible d'améliorer le design et diverses générations de stents ont pu êtres créées et améliorées. Selon les exigences des cardiologues et des contraintes mécaniques, la dernière génération de stent est en cours de fabrication et sera prête pour les tests mécaniques et, éventuellement, pour les tests in vivo.

Conclusion: La conception d'un stent pour la population pédiatrique pourrait constituer une importante percée dans le domaine de la cardiologie infantile permettant ainsi d'avoir recours à des procédures non invasives, évitant une chirurgie à cœur ouvert.

Pulse Wave Analysis for Cardiovascular Information Monitoring in Patients With Chronic Heart Failure: Effects of COQ10 Treatment

Gong Zhang, Xiaolin Kong ,Simon Liao, James Deng

For patients with chronic heart failure, the coenzyme Q10 can improve the symptom. This study is to using a pulse wave analysis system to evaluate the cardiac hemodynamics of patients with coenzyme Q10 treatment. A total of 10 people participated in the study. We found that treatment for 3 months with coenzyme Q10 resulted in a significant decrease in Systolic blood pressure at rest, and a significant increase in SI and CI. All these parameters remained unchanged in the placebo group.

Thursday, June 12
10:30am – 12:00pm

Session A4 - NeuroMuscular Advances I

Muscle Activation Patterns of the Forearm: High Density EMG Data of Normally Limbed and Transradial Amputee Subjects

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Myoelectric prosthetic devices have been accepted by upper limb amputees for many years. Advances in technology and improvement in design and comfort have contributed to growing user acceptance; however, there has been a limited amount of research using clinical populations to test advanced devices and control systems. Consequently, this study further investigates multifunction myoelectric control using upper limb amputee subjects.

A high density electromyography (HD-EMG) system has been used to investigate muscle activation patterns of both normally limbed and amputee subjects for multiple wrist and hand movements. Up to 64 channels of EMG were recorded from participants during multiple trials. MES amplitude estimates from each electrode were used to create topographical (energy) maps. These maps illustrate muscle activation patterns for each movement allowing for assessment of distinct and repeatable muscle activation patterns during different hand and wrist movements. These patterns are essential for pattern recognition based myelectric control.

Within-subject analyses were performed to determine the variance in EMG activity patterns across repetitions and between movements. Classification accuracies were also used to determine if distinguishable and repeatable muscle activation patterns are produced. Results show that distinct muscle activation patterns were produced for the amputee subjects but they were less distinguishable as those of the normally limbed subjects. Classification accuracies for a congenital and a traumatic amputee were 85.97% for six movement and 94.34% for seven movements respectfully. These preliminary results are favorable and additional data from further subject testing will be available.

EmgSim: A comprehensive simulation toolbox for electromyography

Ning Jiang, Philip Parker, Kevin Englehart
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This paper presents a comprehensive simulation toolbox for electromyography (EMG), EmgSim. It is a self-contained MATLAB toolbox with modular and flexible design, on which customized front end applications, such as graphic user interfaces, can be easily developed for studies in myoelectric control, conduction velocity estimation, EMG decomposition, and motor unit synchrony study.

The EmgSim toolbox consists of two main modules: innervation process module (IPM) and volume conductor module (VCM). The outputs of IPM, the innervation process of motor units, are the inputs of VCM. For IPM, several innervation process generation models in the literature have been implemented. Ranking by increasing complexity, these models are the random interval model, Yao's enhanced random interval model, the integral-to-threshold and fire model (ITF), and a Hodgkin-Huxley-like (HHL) model. Different models should be chosen depending on the applications at hand. For example, to simulate EMG under isotonic conditions, the random interval model is adequate; however to study dynamic EMG one must use either the ITF or the HHL model. The IPM module is the most significant feature of EmgSim, since it is the first toolbox that provides flexibility in the generation of the motor unit innervation process.

The second module, VCM, is a generator of tissue filter effects. Currently, a simple, but reasonably accurate volume conductor model is implemented, which is based on the model proposed by Dimitrov *et al.* This model is capable of generating tissue filters that correspond to parallel muscle fibers in an isotropic medium. The model is sufficient for many applications. For more advanced applications that require anisotropic medium, more complex models, such as those employing finite element analysis, can be easily implemented, thanks to the clearly defined interface of VCM.

The modular and flexible design of EmgSim makes it a useful tool for EMG simulation. It can also be used to simulate other similar electrophysiological signals, such as peripheral nerve signals.

Decomposition of simulated ENG signals into velocity-specific components using a multi-contact nerve cuff electrode

José Zariffa and Milos R. Popovic
Edward S. Rogers Sr. Department of Electrical and Computer Engineering, University of Toronto
Institute of Biomaterials and Biomedical Engineering, University of Toronto
Toronto Rehabilitation Institute, Canada

Identifying the conduction velocity of action potentials detected using a nerve cuff electrode has important applications to the control of neural prostheses, because it allows the activity of different pathways to be better discriminated. Multi-contact nerve cuff electrodes make it possible to track the action potential's progression through the cuff, and therefore obtain information about its velocity. We propose an algorithm that enables us not only to identify the velocities corresponding to multiple active pathways in the nerve, but also to decompose the nerve cuff signal into different waveforms, each corresponding to one of the identified velocities. The obtained waveforms can then be used to analyze the firing rates for individual velocity components. The algorithm relies on extracting physiologically plausible templates from the recorded signals themselves, such that the user does not need to provide any input other than the recordings. The proposed method is evaluated using simulated multi-contact nerve cuff recordings and its advantages and limitations are discussed.

Improved Phoneme-Based Myoelectric Speech Recognition

Quan Zhou, Ning Jiang, Englehart Kevin and Hudgins Bernie
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This paper introduces an adaptive phoneme-based multi-expert speech recognition system using the myoelectric signal (MES). Speech recognition using acoustic signals can be difficult in extremely noisy environments such as in the cockpit of a fighter jet. In noisy environments, the MES produced by the speaker's facial muscles can be used as another expert system to enhance recognition accuracy. In addition, the MES has also been used for speech recognition in voice prostheses. In previous work, acoustic and MES data were collected while the words "zero" through "nine" were spoken. The spoken words were classified at the phonemic level using a hidden Markov model (HMM) classifier. In the current study, an expanded set of words has been classified phonemically by an HMM classifier trained at the phoneme level using a subset of all the words. The system consists of preprocessing, feature extraction, dimensionality reduction, classification, and

post-processing. In the preprocessing stage, the raw MES signals are rotated by class-specific rotation matrices to spatially decorrelate the measured data prior to feature extraction. In the feature extraction stage, the root mean square (RMS) values and Mel-frequency Cepstral coefficients (MFCC) are extracted from the preprocessed data, followed by an uncorrelated linear discriminant analysis (ULDA) for dimensionality reduction. The resulting data are classified through an HMM classifier to obtain the phonemic log likelihoods, which are mapped to corresponding words using an artificial neural network. It is shown that these methods provide a recognition accuracy of around 89% when classifying an expanded lexicon containing the same phonemes as the ones used by the training set. As a result the new words are recognized from the phoneme structure without retraining the HMM classifier.

Multi-Scale Analysis of Myoelectric Signals: Assessment of Long-Range Dependencies and Fractal-Scaling-Break

Mehran Talebinejad [1,2] Adrian Chan [2], Ali Miri [1]
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[2]Department of Systems and Computer Engineering, Carleton University, CANADA

In this paper we propose a novel methodology for structure-function-based multi-fractal analysis of myoelectric signals. This methodology provides multi-scale information about the geometry of the myoelectric interference pattern. Specifically, it provides insight into the fractal characteristics of sampled myoelectric signals with assessment of long-range dependencies and fractal-scaling-break properties of this signal. Power spectrum and structure-function-based methods are also integrated in this work, presenting a unified framework for multi-scale analysis of myoelectric signals. Results of an experiment for comparison of myoelectric signals to strict mathematical fractional Brownian motion are provided. The novel methodology provides insight into the myoelectric signal's renewal process. The results also show a great potential for applications to clinical diagnosis and fatigue studies.

Thursday, June 12
14:00pm - 15:30pm

Session A5 – Biomechanics II

Current techniques for the evaluation of cross-sectional area in rat tail tendons generate significant errors

Gabriel Parent, Matthieu Cyr, Paule Cousineau-Pelletier, Frédérique Desbiens-Blais, Eve Langelier
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Rat tail tendons (RTTs) are commonly used tissues in biomechanical and mechanobiological studies. In order to accurately determine the stresses in these tissues, a precise evaluation of their cross-sectional area is required. Although many techniques have been developed for the evaluation of the cross-sectional area of soft tissues, optical techniques with low precision are still preferred for RTTs. In order to investigate the magnitude of the errors associated with these techniques, we performed a theoretical comparative analysis where five optical techniques were used to evaluate the cross-sectional area of five profiles: a circle, two ellipses and two RTT profiles obtained from scanning electron microscopy. We concluded from this analysis that currently used techniques may generate significant errors (up to 35% and 47% for the RTT profiles). Highly accurate results are obtained for convex profiles when using the reconstruction algorithm developed by Langelier *et al* (2004). Based on these results, we designed a new optic micrometer for use in conjunction with the profile reconstruction algorithm. With this new system, we evaluated the cross-sectional area of a 1.5mm hex key at six different sites along its length. The error on the measurement varied between -1.8 to +1.0%. Since tissue cross-sectional area is essential for the normalization of stress-strain curves, improvements of this measurement

could have a positive impact in biomechanical and mechanobiological studies using RTTs by decreasing inter-group variability and thus facilitating the discrimination between different experimental groups.

Finite element analysis of a fracture fixation plate: a parametric study

Haase, Kristina

In order to maintain an optimal structure of bone, i.e. a structure with minimum mass but maximum strength, a continuous process of bone remodelling occurs in response to changes in mechanical stimuli. Fracture fixation plates and screws are usually used to compress bone fractures. However, due to changes in the mechanical stimuli caused by differences in rigidity of implants and bones; excessive resorption will occur in the vicinity of implants, and so will result in implant loosening. In this study, finite element software was used to generate a simplified three-dimensional model of a transverse radius fracture affixed with a plate and screws. Several parameters were analyzed including plate thickness, angular bone coverage, and screw location. All parameters resulted in variant effects on the resultant stress in the regions of interest, namely the plate-bone contact region below the fracture site and the outer regions of plate coverage. Increased plate thickness resulted in decreased stress levels in the aforementioned regions. Increasing the bone surface coverage, as well as increasing the distance of the outer screw (which has the highest loading conditions) location from the fracture site resulted in an increase in stress levels. The above-mentioned results are in fairly good agreement with outcomes from previous studies. Knowing that both spongy and compact bone are anisotropic composite materials, investigations involving a fibre composite plate, instead of an isotropic plate, are in progress now with the hope of reducing stress shielding effects.

Sensitivity to the polarity of external loads in bone remodeling process

Mustafa Sasal [1], Gholamreza Rouhi [1], and Ali Vahdati[2]
[1]Department of Mechanical Engineering, University of Ottawa. [2]Aerospace and Mechanical Engineering Department, University of Notre Dame, USA

The bone remodeling process, a continuous bone resorption followd by bone formation, is viewed as a material response to functional demands that is governed by an intricate relationship between formation and resorption. Most of the models proposed for the bone remodelling are phenomenological in which different types of mechanical stimuli, e.g. strain, stress, and strain energy density, have been considered as a driving force.. Open questions such as “what is the exact mechanical stimulus to initiate bone remodelling?”; “what are the mechanosensors in bone and how they react to the external loads?”; and many others need to be addressed in order to be able to have a mechanistic model. In 2000, a semi-mechanistic model of bone remodelling was proposed by a well-known group in the field. In their theory strain energy density which is a scalar quantity was cosidered as a mechanical stimulus. In this research, the effect of polarity on the remodeling process will be investigated on a 2-D isotropic, square trabecular bone matrix using numerical techniques (FEA). The model is initialized with the same configuration of bone matrix for different cases of external loadings with different polarities but the same magnitude. This study shows that different external loading with the same magnitude but different polarities will result in different final patterns which will raise some question about the scientific merit of the model. Some explanation and interpretation about the aforementioned odd behaviour will be presented, in this work.

Algorithm for a thermodynamically based design of orthopaedic implants

Arnaud Divialle , Aurelian Vadean, Vaclav Klika, L’Hocine Yahia

The presented work is a new optimization framework to design orthopaedic prosthesis by taking into account the living environment of the implant. It reproduces the bone remodeling process and the

osseointegration of the bone surrounding the implant. The design of the implant is then performed using an efficient topology optimization. All this should allow designing prosthesis with extended lifespan and reduced revision rate. The internal bone remodeling model is based on the bio-thermodynamic theory. This approach merges the influences of both mechanical and chemical states. The model was set-up as a 5x5 differential system. From this system, the updated value of bone density is deduced. The osseointegration also comes from a thermodynamic model. It simulates the bone growth and deterioration into the implant. Mechanical and chemical states are coupled as stimuli. The growth/deterioration process is realized through the evolution of the stiffness of the contact element simulating the bone-implant interface. The final step is designing the implant. It is performed as a topology optimization where the material density distribution of the stem is modified to reach the convergence criteria. Those are the main defects of orthopaedic implants: micro-motions and stress-shielding. The global algorithm is implemented into Hyperworks© v8.0sr1, the finite element software from Altair Engineering, Troy Michighan, USA). Many tests have been performed to validate the model. The results were compared to analytic solutions, then onto a mechanical structure. To conclude, bones models have been simulated. Results show a strong correlation with experimental data.

A bioreactor design for the mechanobiological study of soft tissue damage and repair in conditions that provide the best approximation of actual use

Huppé, N, Lessard, J.-L.; Langelier, E.
PERSEUS, Department of mechanical engineering, Université de Sherbrooke, Sherbrooke

Our research program investigates the mechanobiological behavior of healthy and degenerated soft tissues under different loading and environmental conditions in vitro. Although existing bioreactors present interesting features, they suffer from important deficiencies with regards to mechanical testing and stimulation. We thus designed and validated a novel multi-specimen bioreactor which allows for independent characterization and long term stimulation of four specimens.

The bioreactor innovations integrate: 1) the application of complex force or position controlled stimuli; 2) the measurement of force exerted on each specimen; 3) the measurement of specimen elongation based on the relative displacement of the attachments as well as real-time photogrammetry at mid substance; 4) the independent containment, characterization and stimulation of four specimens; 5) specimen testing over a wide temperature range; and 6) maintenance of long term sterility.

The bioreactor achieves common characterization tests and a wide range of stimulation patterns. It provides a 0-140mm displacement range, a 0-30N force range over a 10Hz bandwidth to mimic real life loading. Its performances regarding feedback and characterization measurements are: 12.7µm and 50µm resolutions on the position recorded with the encoder and vision system respectively, and 45µN resolution on the force recordings. Finally, the bioreactor ensures proper animal tissue culture conditions and offers a wide temperature range from 15 to 45°C.

In conclusion, the new bioreactor is suitable for stimulation and characterization of soft tissues over long time periods. Mechanobiological studies such as slow tissue lesion processes are thus achievable.

The Development of a PC based Instrument to Investigate Muscle Spindle Properties

Tsang, Ken; Hubert de Bruin, Associate Professor, McMaster University

Although most muscle spindle investigations have used the cat model and invasive measurement techniques, several investigators have used microneurography to record from the Ia and II fibres in humans [1, 2]. In these studies the muscle spindle primary endings are stimulated using transverse vibration of the tendon at reflex sub-threshold amplitudes. Others [3] have used low level vibration and the H-reflex to determine reflex properties during both agonist and antagonist voluntary contractions. In the past we have developed a PC based instrument that uses Labview and a linear servomotor to study tendon reflex properties by recording H-reflexes

from single tendon taps or electrical stimuli to the afferent nerve [4]. In this paper we describe a further development of this system to provide precise sinusoidal vibrations of the tendon up to 80 Hz with amplitudes up to 2 mm. We can accommodate background EMG from low level agonist contractions, and still measure the H-reflex train by spike triggered averaging of the recorded signal. In contrast most researchers measure the mean absolute value of the mixed voluntary EMG and H-reflex signals [3], with a consequent loss of precise information about the reflex response. We are conducting a study of the properties of the reflex response of the flexor carpi radialis in humans to single taps and vibrations over a range of amplitudes, velocities and frequencies from 30 to 80 Hz. Our preliminary results show that spinal or H-reflex responses at higher vibration amplitudes are similar to the Ia responses recorded by others [1, 2] for very low sub reflex threshold amplitudes.

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Thursday, June 12
16:00 – 17:30

Session A6 – Cardiovascular Advances II

Smoothed particle hydrodynamics simulation of blood flow in the left ventricle in diastolic phase

Shahrokh, Shahriari; Ibrahim, Hassan, Concordia University, Lyes, Kadem, Concordia University

Introduction
Smoothed Particle Hydrodynamics (SPH) is a meshfree particle method (Lagrangian method), originally developed for modelling astrophysical phenomena, and later widely extended for applications to problems of continuum solid and fluid mechanics. SPH method consists of dividing the fluid into a set of discrete fluid elements (particles). These particles have a spatial distance, over which their properties are "smoothed" by a weighting function. This means that any physical quantity of any particle can be calculated by summing the relevant properties of all the particles which lie within its support domain. SPH method is very suitable for problems with complex deformable boundaries. These kinds of problems are usually encountered in the human body and more specifically in the cardiovascular system.

Methods
A 2D simplified model of the left ventricle (LV) was used to simulate the filling phase (diastolic phase) using SPH method. The mitral valve inlet velocity was simulated using an unsteady flat velocity profile with a maximal velocity of 0.6 m/s. The duration of the diastolic phase was 600 ms and the number of particles used for the simulations were 100 particles.

Results and Discussion
Our results show a close agreement with the experimental background knowledge about the nature of the blood flow in the left ventricle. The main vortex structure within the left ventricle during the diastolic phase was correctly modelled using SPH method. SPH should be a promising method for simulating the complex flow within the LV under realistic geometrical conditions obtained from magnetic resonance imaging.

Flow dynamics in the aORTIC arch after a VALVE replacement by a bileaflet mechanical valve

Lyes Kadem; Zahra, Keshavarz-Motamed, Concordia University

Introduction
The investigation 0f blood flow in the human aorta is important because of its potential application to the diagnosis and prevention of disease of the aorta. Many researchers have attempted to reveal the relationship between the flow in the aortic-arch and the apparition of disease such: aortic aneurysms or aortic dissection. These studies have been performed with a native valve in aortic position. However, disease of the aortic-arch and the aortic valve are usually coupled and should not be treated separately. In the present study, we simulated numerically the unsteady flow in the aortic-arch downstream of a native valve and after valve replacement by a bileaflet mechanical valve.

Methods
In this study, three-dimensional unsteady blood flow in a realistic model of the human aortic-arch (with its three major branches and an out-of-plane descending aorta) was simulated numerically. Both normal valve (flat inlet velocity profile) and mechanical bileaflet valve (central jet and two side jets as inlet condition) were modelled. The valves were in fully open position and the cardiac output was 5 l/min with a systolic duration of 300 ms. The flow was modelled as laminar past the normal valve and as fully turbulent past the bileaflet mechanical valve (transitional k-ω turbulent model).

Results and Discussion
Significant differences in the wall shear stress distribution and in secondary flows in the aortic-arch were observed between a normal valve and a mechanical bileaflet valve in aortic position. These differences could lead to a more important damage of the aortic-arch.

Effect of bileaflet mechanical valve malfunction on blood hemodynamics

Othman Smadi[1], Marianne Fenech[2], Ibrahim Hassan[1], Lyes Kadem[1]
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Introduction
Approximately 250,000 valve replacement operations occur annually around the world and more than two thirds of these operations use mechanical heart valves (MHV). However, a patient with a mechanical valve must take anticoagulant medication life long because of risks of thromboembolic complications and/or pannus formation associated with malfunction of the valve. The objective of the present study is to investigate using numerical simulations the pulsatile flow through a defected MHV in terms of velocity field, vortex shedding and wall shear stress (WSS) magnitude.

Methods
Five 2D models with realistic sinuses geometry were created. The lower leaflet was moved from fully opened position to fully closed position with three equally spaced intermediate angles. The bileaflet MHV modeled was based on a 25 mm St. Jude Medical Hemodynamic Plus valve. For each condition, the mean flow rate was 5 l/min for a heart rate of 70 bmp and an ejection time of 300 ms. Turbulence downstream of the defected valve was simulated using a transitional k-ω model.

Results and Discussion
Valve leaflet malfunction is a potential complication associated with mechanical heart valves. It results in a significant increase in the maximal velocity downstream of the valve (Fig.1) associated with high WSS and turbulent shear stresses. The complex flow configuration resulting from a defected valve could lead to blood component damage and to thrombus formation. It is, therefore, essential to detect as early as possible using a non-invasive technique (Doppler echocardiography or magnetic resonance imaging) such valve malfunction.

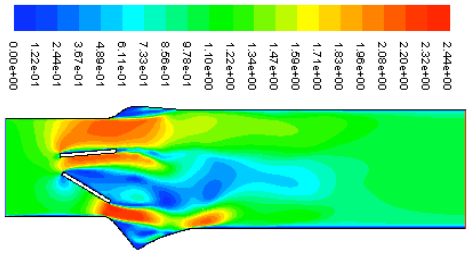

Figure 1: Velocity contour at the peak of the systolic phase with 50% malfunction in the lower leaflet.

Study of tensile cyclic loading on morphology of endothelial cell line in culture medium: a fractal and topological comparison

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[4]National Cell Bank of Iran, Pasteur Institute, Tehran, Iran.

Fractal analysis has been widely used in biological systems especially in cellular studies and the related patterns with morphological characteristics due to the complexities in their function and geometry. Endothelial layer which covers the innermost part of arteries is prone to blood pressure and flow and is a selective natural barrier to blood components. Endothelial damage might result in accumulation of blood components inside the arterial wall and consequently plaque formation. Morphological remodeling of endothelial cells induced by blood flow and pressure is considered as an adaptive response to mechanical stimuli. Since it has been widely accepted that biological shape is related to function, to determine the mechanism of response, change in the morphology of cultured endothelial cells caused by cyclic strain was examined. A digital image analysis method that has been adapted to evaluate fractal dimension based on two different methods and lacunarity of cellular profiles as a measure of morphological complexity was used. Application of cyclic tensile load to cultured endothelial cells resulted in systemic variation of fractal parameters. Fractal dimension and Lacunarity decreased with increased strain amplitude and cycle duration indicating organized and more uniform morphology of the cells after loading. Topological analyses were performed and results showed reduction in shape index and rise in orientation angle of endothelial cells after loading. Comparison of fractal and topological methods showed similar results with high degree of correlation. It is concluded that fractal analysis is a suitable index for evaluation of morphological changes of endothelial cells caused by mechanical loading.

Hyperthermia via AC electromagnetic field and magnetic nanoparticles

Seyed Nasr Tabatabaei

Hyperthermia has shown a promising future in fight against cancer and has drawn a lot of attention in the past recent years. Unlike healthy cells, cancer cells do not have sophisticated cooling system such as veins among them and thus once their temperature increase they die or become vulnerable and week towards the body immune system, drugs and even chemotherapy. In this study we tend to examine hyperthermia via Alternative Current (AC) electromagnetic field and magnetic nanoparticles to investigate its potential power to destroy tumors. Once magnetic nanoparticles are injected inside the body, they can be guided towards the tumor area by means of an external DC magnet, they are then influenced by yet another

external but AC electromagnetic filed and due mostly to hysteresis and relaxation (Neel and Brownian) mechanisms their temperature increases. This raise in temperature is then immediately dissipated to the surrounding target area and causes the cancer cells to also heat up. Many previous experiments are done in the frequency ranges higher than 375 kHz, whereas we are trying to perform hyperthermia in lower and less harmful frequency range of less than 150 kHz. In this investigation, we first tabulated temperature measurements based on previous studies and come about a complex formula. Then we obtained the optimum frequency and field necessary to examine temperature change in the available magnetic nanopartilces. Temperature changes were measured and tabulated and final results were carefully recorded.

Friday, June 13
8:30 -10:00

Session A 7 – Neurological Advances

Event-related fMRI analysis by applying selection criteria to unsupervised clustering

Camille Gómez-Laberge and Andy Adler

Functional images of brain activation are obtained indirectly using the blood-oxygen-level dependent (BOLD) contrast during the course of an experimental paradigm. The challenge lies in the fact that the neurovascular relationship between neural activation and the cerebral hemodynamic variables is not yet fully understood [1].

The application of unsupervised cluster analysis techniques may provide recourse to fMRI analysis by categorising voxels into distinct clusters without imposing models for the experimental paradigm nor for the hemodynamic response function. However, the subsequent task of inferring territories of potential neural activation from data-driven clusters must be systematically undertaken to prevent mis-interpretation [2].

This study develops selection criteria based on the temporal and spatial characteristics of the member voxels of each cluster. First, unsupervised fuzzy *c*-means cluster analysis [3] is used to analyse the images. Second, the criteria are applied to quantitatively rank and select clusters whose voxels are temporally correlated (possibly being delayed) to an event-related paradigm and whose voxels occupy contiguous regions of space in the brain.

The method is demonstrated using both simulated and experimental fMRI data involving a simple motor task paced by a visual stimulus. Receiver-operator characteristics are reported for the simulations, and results from the experimental data are compared to a multiple-comparison *t*-test model.

References:

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Detecting nonlinear determinism of EEG signals in Parkinson Disease

Amir H. Meghdadi, Reza Fazel-Rezai, Martin, McKeown

This paper presents a method for quantifying the level of determinism in EEG signals of patients with Parkinson disease (PD). The significance of this research is in early detection and measuring the severity of PD using the EEG. An index of determinism is proposed here based on smoothness analysis of reconstructed trajectory in embedding space calculated for principal components of the signal in each channel.

In this paper, the method is applied to EEG signals recorded from two groups of subjects (a control group of 10 normal subjects and a study group of 14 PD patients). EEG signals are recorded during a 25 minutes tracking task by using a joystick in response to visual stimuli. EEG signals are recorded for control subjects, PD subjects without medication and PD subjects under medication. The index of determinism is calculated and averaged for EEG segments of 20 seconds length and %50 overlap for all the channels. The results show that EEG signals of PD subjects (without medication) are slightly less deterministic than control subjects. However, determinism is increased for PD subjects when they are under medication.

Although there are reported studies in the literature (based on correlation dimension estimation using a spatial embedding method) that conclude lower dimension for EEG of PD subjects, it is also shown that during the execution/imagining of a complex motor task, dimensionality is higher for PD subjects compared to normal subjects. This is consistent with the results of this paper. Moreover, The topographic maps of the index of determinism are also calculated and plotted for different subjects. The results show that determinism is generally higher in central areas on the scalp.

Structure and Function of the Compound Eye in Photinus carolinus (Lampyridae): Regional Variation and Visual Performance / Structure et fonction de l'oeil à facettes chez Photinus carolinus (lampyridae): variations régionales et performances visuelles

Hassan A. Marshad, and Andrew Moiseff

Photinus carolinus fireflies (Lampyridae), nocturnal insects that rely on their visual systems for communication, were used as a model for the morphological and optical analysis of the insect eye. Our goal was to use a conventional optical microscope to study the facet structure on the hemispherical surface of the compound eye. We developed a mathematical model to describe the optical distortions that result when a curved surface is imaged on flat-field and applied our results to the development a technique to accurately measure the size and distribution of ommatidia facets of the compound eye in fireflies. An inexpensive miniature computerized stage goniometer was developed to facilitate acquisition of sequential overlapping images of the surface of each eye along longitudinal great-circle arcs. Imaging the eyes with seven great circle scans at increments of 26° rotation allowed us to maintain measurement errors at less than 1.5%. A polar contour plot provided a consistent display format to relate facet surface area with location on the eye. Our results indicated that male and female eyes were sexually dimorphic and exhibited regional variation.

The potential significance of these structural differences was investigated by modeling the optical properties of these structures. Measurements such as facet's size and number, eye radii, receptors widths, and local focal lengths were obtained from surface scans as well as thin histological sections.

This study illustrates the effectiveness of applying a rigorous bioengineering system for analyzing visual performance in the compound eyes which reflect their visual behavior and specialization.

Evaluating the loudness exponent from auditory adaptation data

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The loudness of a stimulus (L) is related to the intensity of that stimulus (φ) by Stevens' Power Law, $L = k\varphi^n$, where k is an arbitrary scaling constant and n is the parameter that characterizes loudness, for a given intensity. Given its importance in determining loudness, n has been measured extensively by psychophysicists usually by magnitude estimation (e.g., participants assign numbers to their sensation of loudness). We have devised a new method for obtaining n from experiments on auditory adaptation (tones sound less loud the longer a constant-intensity stimulus is applied). To measure adaptation, we used a binaural technique. We presented a 6-min continuous tone to a participant's *adapting ear*. At 1-min intervals, participants adjusted the intensity of the tone in the contralateral *control ear* until both tones sounded equally loud. We used the control ear, which was otherwise retained in silence, to measure adaptation in the adapting ear. As the steady stimulus in the adapting ear continues, the intensity that a participant selected to produce equal loudness between ears decreases. We created a model of loudness in the adapting ear, $L = L(\varphi, \varphi_a)$, where φ_a is the intensity of the final loudness match a participant made at t = 6 min. We expressed loudness in the control ear using Stevens' Law, $L = k\varphi^n$. Equating the functions for loudness in each ear, we obtained a relationship between n and decibels of adaptation.

Human Endocannabinoid System Emulator

Paul Frenger

Nerve impulses normally travel between neurons in the presynaptic to postsynaptic direction, via neurotransmitter release by the former and generation of action potentials in the latter. Following action potential initiation, ions pass through gated pores in the nerve cell membrane, causing various short-term and long-term changes to take place. The endocannabinoid system is uniquely involved in retrograde signaling by postsynaptic nerve cells, reducing the release of presynaptic neurotransmitter molecules and decreasing the excitation of the postsynaptic neuron. This action allows neurons to adjust their own responses to incoming data streams. Retrograde signaling is thought to be involved in long term potentiation, memory, and synaptic plasticity in the central nervous system. The author has previously developed computer emulators, some with hardware acceleration, for general human nervous system function, childhood growth and development, mental disorders, neurological diseases, hormonal responses, drug effects, the fear response and love / trust mechanisms. The author's emulator series is extended here to include simulated retrograde signaling via the endocannabinoid system. This is accomplished using both software and hardware techniques. This emulator operates at several levels: from membrane receptor binding to high-level behavioral effects.

A multirate control scheme for a robotic eye/head system integrating visual and self-motion cues

Elias Abou Zeid, Henrietta L. Galiana, Department of Biomedical Engineering, McGill University

In primates, the vestibulo-ocular reflex (VOR) is known to stabilize gaze during head perturbations. Also, the internal brain circuits controlling eye movements are found to operate with neural delays much smaller than visual processing pathways delays (~2ms vs 150 ms). Based on these biological findings, we present a unified multi-rate biomimetic gaze controller integrating VOR mechanisms (self-motion cues) with tracking (pursuit and saccade) for a robotic head with two cameras. The controller uses automatic parametric switching in shared premotor circuits to alternate between two movement types: smooth pursuit (slow phase) relying on visual feedback, and fast blind corrective jumps (fast phase) producing nystagmus. During the task of fixating/tracking a target (slow phase), a head-motion sensor (VOR) detects head

rotation direction and drives the cameras in the opposite direction so that the gaze in space remains on the visual target. A multi-rate control scheme is used to overcome inherent delays in the visual system limited to a 30Hz frame rate. Adding prediction and memory (PDI controller) in the visual feedback copes better with visual delays and allows slow tracking bandwidths near 2 Hz. The rest of the controller operates 600Hz: since the saccade circuit is effectively blind, the higher rate controller operation allows increasing saccade bandwidths without ringing to over 30 Hz. In this paper, we describe the controller model and we present simulations and experimental results to demonstrate its performance.

Friday, June 13,
10:30-12:00

Session A8 – Neuromuscular Advances II

A computational model of nerve signal detection and recognition on innervating muscle contractions

Rui Zhou

Technologies for acquiring muscle contraction information from surface myoelectric signals (MES) are mature and widely used, but the use of the signal is still confounded by some factors like muscle crosstalk, the inability to measure the contribution of deep muscles, and repeatability of the signal due to changes in electrode impedance and position. This study presents a computational model to investigate the efficacy of the signal generated by peripheral motor nerves, which also represents patterns of different contractions. In a peripheral nerve, nerve fibres are grouped in different functional fascicles to innervate particular target muscles, called somatotopic organization. Unlike muscle models, this computer based nerve model acquires signals from activated nerve fibres by implanted Utah slanted electrode arrays (USEA). This work considers the activity generated by four types of contractions: hand open/close and wrist flexion/extension, during which the median nerve (MN), radial nerve (RN), and ulnar nerve (UN) of the brachial plexus are activated, which in turn innervate six muscles in the upper limb. Since the degree of somatotopic clustering varies along the course of the nerve, the cross-section site is chosen to be 1/8 arm proximal to the level of medial and lateral epicondyle for MN and RN and the level of medial and lateral epicondyle for UN, where the selected fascicular groups can be dissected atraumatically. Results of this model establish a connection between the nerve signals to related muscle contractions, and are used for a subsequent pattern recognition analysis. This model suits high-level limb deficiency because the recording sites are all above or around elbow. Using this model, a comparison will be made between this nerve model and a classical surface muscle model in terms of pattern recognition accuracy.

Filtering strategies for robust myoelectric pattern classification

Levi Hargrove[2] Erik Scheme, MScE, PEng, Kevin Englehart, PhD, Bernard Hudgins, PhD
Dept. of Electrical & Computer Engineering / Institute of Biomedical Engineering, University of New Brunswick

Recent investigations into the use of real-time, pattern recognition based myoelectric control systems have shown excellent results under clinical supervision. Users are able to attain high classification accuracy and limb control when trained and tested within a given session. Long term, continuous use appears to be subject to deterioration in classification accuracy and usability due to factors including electrode displacement, electrode/skin interface impedance, and user variability. While clinical measures can be taken to minimize some of these effects, a robust classification system is imperative.

Myoelectric pattern classification relies on the repeatability of user modulated myoelectric signals generated during muscle contractions. Certain frequencies of the myoelectric signal spectrum are more susceptible to corruption from noise due to motion artifact and power line interference. Changes in these noise sources over time (such as varying electrode impedances) affect the detected patterns and degrade the system's ability to discriminate between classes. A filtering strategy for improved robustness to external noise is introduced. Recorded signals are digitally filtered to remove noise vulnerable frequencies while maintaining maximal discriminatory myoelectric information for classification. Using this filtering strategy, high classification accuracies can be retained in the presence of time varying noise sources; however, without filtering the system classification accuracy drops significantly yielding an unusable system.

Spectrum-based fractal analysis of myoelectric signals using piecewise statistically self-affine power-laws

Mehran Talebinejad [1,2] Adrian Chan [2] and Ali Miri [1]
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In this paper we present a novel set of statistically self-affine power-laws and an algorithm for parameter estimation of a piecewise power-law combination. The piecewise combination is applicable to irregular power spectral densities which do not follow the classic form of strict statistical self-affinity. The piecewise modeling also enables local analysis with variable magnification factors, which is very informative about the spectral distribution of the texture. Results of an experiment on simulated myoelectric signals are also presented. In this experiment, two conditions in which a single power law results in large errors are investigated. The results show that extension of the modeling to a piecewise combinational approach improves the accuracy and results in a better representation of the power spectrum. The results also show a great potential for applications of this approach to a wide variety of bio-signals with a multi-fractal behavior, which are very close to combinational mono-fractals in texture.

Design and Testing of an Instrumentation System to Determine the Efficacy of Pain Reduction during Muscle Stimulation

Michael Willand, Hubert de Bruin, Associate Professor, Department of Electrical and Computer Engineering, McMaster University

Functional Electrical Stimulation (FES) has been used for decades to restore muscle function following neural trauma. Another promising use has been to maintain or increase muscle strength following injury. Unfortunately in the latter case there is considerable stimulation pain for the sensory intact subject during effective levels of stimulation using surface electrodes. Recent research [1,2] has suggested using a constant long (up to 10 msec) low amplitude or ramped conditioning pulse just prior to the high amplitude stimulus pulse (100 – 200 μsec) will reduce the excitably of sensory nerve fibers. However, commercial muscle stimulators cannot be easily modified to provide such complex pulse patterns and flexible pulse train control. We have designed and implemented a novel very flexible LabVIEW based monophasic constant current muscle stimulator that provides pulse trains with long duration pre-pulses and high voltage stimulus pulses with selectable shapes, amplitudes, durations and frequencies. The stimulator hardware uses a standard voltage to current converter circuit with an efficient high voltage DC/DC converter which can present up to 100 ma pulses to surface electrodes. As well, the stimulator system includes an isolated EMG amplifier to record the evoked M-waves, which are used to estimate the fraction of muscle motor units being stimulated. The system is presently being tested in a study to determine the efficacy of the pain reduction stimulation strategy described above.

1. Poletto CJ, Van Doren CL. Elevating pain thresholds in humans using depolarizing prepulses. IEEE Trans Biomed Eng 2002;49:1221-4.
2. Hennings K, Arendt-Nielsen L, Andersen OK. Orderly activation of human motor neurons using electrical ramp prepulses. Clin Neurophys 2005;116:597-604.

Reducing the Impedance of Passive Stainless Steel Surface Electrodes

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Dept. of Electrical & Computer Engineering / Institute of Biomedical Engineering, University of New Brunswick

Surface electrodes are used in a variety of situations to access electrophysiological signals such as the electrocardiogram (ECG) from the human body. In a clinical setting, silver-silver chloride (Ag-AgCl) electrodes are used due to their stable half-cell potential and low impedance. These electrodes, which are chemically active, are used with a conductive paste which when coupled with good skin preparation provide a low-impedance sensor that is relatively free from motion artifact. However, such electrodes are often not suitable for long-term chronic use due to the effects of the paste drying and the possibility of skin irritation.

An area in which surface electrodes are employed chronically is that of powered upper limb prosthetics. In this situation, electrodes are mounted in the socket of the prosthesis to detect the electrical activity of remnant musculature, which in turn is used to control the prosthesis. Typically these electrodes are chemically inert, being made from such materials as stainless steel or gold. They are used dry, without paste or skin preparation, which make the prostheses more acceptable to the user.

Unfortunately, such electrodes, while suitable for chronic applications, do not have the same electrical properties of the Ag-AgCl types. The impedance of such electrodes tends to be much higher that that of similar sized Ag-AgCl types. This places increased demands on the electrode amplification system. In addition, socket fit is very critical to ensure minimal movement between the skin and the electrodes to reduce the chance of motion artifact from inadvertently operating the prosthesis.

This short paper describes a method of reducing the impedance of stainless steel electrodes for specific use in myoelectrically controlled prostheses. One of the benefits of the procedure is that it can be applied to existing electrodes and does not require any complicated chemical procedures.

Using Multiple Cameras to Realize Robust and Real-Time Facial Gesture Recognition for Children with Severe Spastic Quadriplegic Cerebral Palsy

Brian Leung, Dr. Tom Chau
Institute of Biomaterials and Biomedical Engineering,University of Toronto

We propose a new approach to realize an access modality by computer vision-based facial gesture recognition that accommodates the physiological conditions of children with severe spastic quadriplegic cerebral palsy (CP). Clinical observation suggests that these children can exploit one or more facial gestures (e.g. tongue protrusions) to reliably operate a facial gesture user interface with adequate proficiency. However, it is a difficult task for them to target a single camera for proper facial gesture recognition because of their involuntary and spastic head movements. The proposed algorithm uses independent input video data from three cameras (i.e. three independent viewpoints) to maximize the detection of intentional facial gestures in the presence of these spastic head movements. We use a case study approach to evaluate the proposed access method. Three elementary school children with severe spastic quadriplegic CP (GMFCS levels 4-5) will be testing the prototype once a week for four months. They will use the system to play a single-switch video game and complete learning exercises on the computer. Positive and negative predictivities will be used to quantify the proposed system's ability to discern between intentional and unintentional facial gestures.

Friday, June 13
14:00 – 15:30

Session A9 – Imaging

Motion detection in fluoroscopic image and its application to catheter marker tracking

Simon Lessard[1] , Caroline Lau[1], Daniel Roy, MD[2], Gilles Soulez, MD, MS[2] and Jacques A. de Guise, PhD[1]
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[1,2]Centre de recherche du centre hospitalier de l'université de Montréal CHUM pavillon Notre-Dame

The preferred treatment for cerebral aneurysms is currently endovascular intervention. The real-time navigation of tools is conducted with fluoroscopic image guidance. This imaging technology is composed of single or biplane panels mounted on C-arms with multiple orientations capability. In theory, simultaneous biplane image acquisitions allow for a 3D reconstruction of the object of interest, in this case, interventional devices (guide wires, catheters, coils). These devices must be precisely located and tracked in real-time in the two fluoroscopic images for 3D reconstruction. However, the X-ray output is adjusted to reduce radiation exposure which results in low contrast and low resolution images. Thus, tracking algorithms require numerous enhancement treatments which are time consuming. Many approaches on tools segmentation and tracking have been proposed in literature with highly successful results, but no author has yet achieved a real-time process. This constraining objective is of utmost importance for effective clinical implementation of 3D road-map guidance. A new solution is proposed to combine and restrict the tracking algorithms to motion detected areas in the fluoroscopic image sequences. Motion areas are located with simple and fast fluoroscopic subtraction and digitized using threshold based on the standard deviation. This technique is tested on catheter markers tracking from *in vivo* fluoroscopic images acquired during cerebral embolization of aneurysms. The effective tracking of multiple markers was benchmarked to 0.1 second. The motion areas restriction of algorithms can be implemented to other tools' tracking to eventually achieve a successful real-time 3D road-map guidance.

Efficient Three-Dimensional Simulation of Ultrasound Imaging Using a Parallel *k*-Space Method

Mohammad I. Daoud, James C. Lacefield Department of Electrical and Computer Engineering and Robarts Research Institute University of Western Ontario

Many ambitious applications have been identified for detailed simulations of ultrasound image formation. For example, simulations have the potential to suggest new insights into the physical interactions of ultrasound and tissue, enabling correlations to be identified between the morphological and functional information depicted in medical images and the underlying biological processes. However, computational complexity remains a major barrier to this research, because ultrasound imaging simulations require enormous computational resources and long running times. In this paper, a parallel three-dimensional (3-D) ultrasound simulator is presented based on a serial two-dimensional *k*-space method[1] to compute ultrasound propagation with feasible running times. The parallel simulator uses the message-passing paradigm to distribute the simulation grid between processors of a distributed-memory computing system. At each time step, the processors compute the fast Fourier transform (FFT) of the acoustic fields, apply the *k*-space spatial frequency domain propagation operators, and compute the inverse FFT of the fields. The simulator accuracy is evaluated by computing scattering of a 40 MHz Gaussian pulse by a sphere of diameter 0.24 mm, and comparing the results with matching analytical solution. The simulator achieved mean error values of 0.57%. Parallel computation improved the simulator efficiency; for example, the running times of 3-D benchmark simulations obtained using 32 processors are 28.2 ± 1.1 times faster than corresponding serial simulations. An example imaging simulation is performed to demonstrate the feasibility of 3-D imaging simulations. The simulated ultrasound B-mode images show realistic 3-D refraction artifacts.

[1]M. Tabei et al., J. Acoust. Soc. Am. 111:53-63, 2002.

Non-linear registration of serial histological images of the middle ear

Shruti Nambiar[1], W. Robert J. Funnell[1, 2]
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[2]Department of Otolaryngology, McGill University, Montréal

Hearing loss is the most common sensory impairment and often involves middle-ear disorders, but many questions about the acoustical and mechanical behaviour of the middle-ear remain unanswered. A comprehensive and reliable three-dimensional (3-D) finite-element model of the middle-ear can provide a better understanding of the mechanics of its many interrelated structures, and thus help address clinical issues related to both diagnosis and repair. Many 3-D middle-ear models have been based on microscopic X-ray computed tomography (microCT) or magnetic-resonance imaging (MRI), but histological images have higher resolution and better contrast than microCT and MRI. However, serious spatial misalignments and distortions are caused by the tissue decalcification, embedding, sectioning and mounting required for histological imaging. The usual approach to overcoming these problems is to use linear transformations to register the images with one another, but this cannot correct for all of the distortions. Non-linear registration techniques are also available. In this paper, we investigate the adaptation of a non-linear registration algorithm, originally developed for the creation of a brain atlas, for registration of middle-ear histological data. The parameters affecting the quality of the non-linear registration algorithm have been revised to suit the data. Preliminary results indicate that application of this algorithm to a set of consecutive histological slices corrects for most of the distortions, indicating an increased registration quality in comparison with the results obtained from manual linear registration.

The LabPET™, a Fully Digital, APD-based, Positron Emission Tomography Scanner Dedicated to Molecular Imaging

Réjean Fontaine[1], Jean-Baptiste Michaud[1], Jean-Daniel Leroux[1], Nicolas Viscogliosi[1], Joel Riendeau[1], Hicham Semmaoui[1], François Lemieux[1], Camille Yousefzadeh[1], Marc-André Tétrault[1], Philippe Bérard[2], Mélanie Bergeron[2], Catherine Pepin[2], Jules Cadorette[2], and Roger Lecomte[2]

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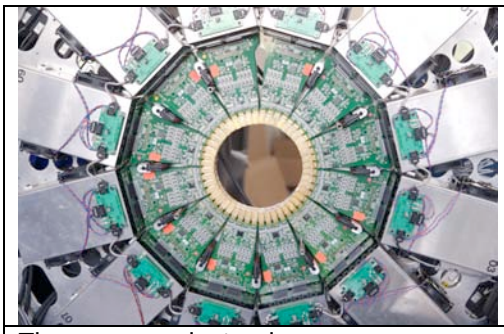
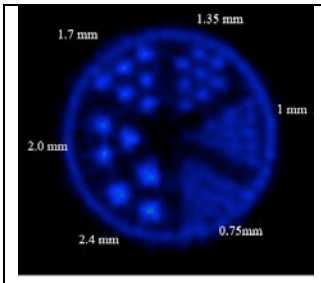
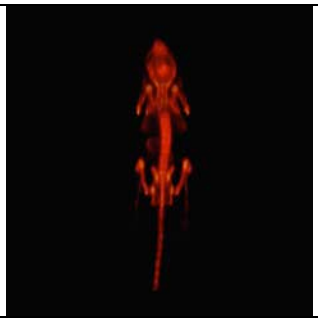
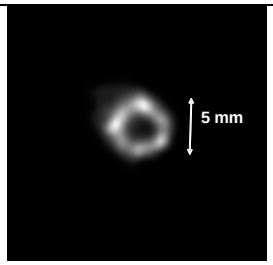
The LabPET™ is an avalanche photodiode (APD)-based Positron Emission Tomography scanner, designed at University of Sherbrooke, and aimed at imaging biochemical processes at molecular level on small animal imaging. Its particular architecture relies on early digitalization of signal issued from ~2 x 4 mm^2 ADP-based detector in a phoswich arrangement where two scintillating different crystals (LYSO and LGSO of 2 x 2 x ~12 mm^3) are joined on their long side and coupled an APD. A Field Programmable Gate array (FPGA) harvests samples for 64 free running off-the shelf Analog to digital converters (ADC) running at 45 MSPS and perform real time digital signal processing such as event timestamping with a resolution of ~ 5 ns, crystal identification with < 5% of error and energy measurement at crystal granularity. The scanner sports real time random estimation as well as a fully programmable digital coincidence engine. The scanner has fully of features (moving bead, triggers input-cardiac gating and respiratory gating, flat panel). The scanner achieves one of best spatial resolution (~ 1.3 mm) with a sensitivity of 1% for a 15 cm diameter and 4 cm axial length.

	
The scanner electronics	The scanner with the plastic cover

		
■ Derenzo Ultra-Micro Hot Spot phantom ■ 100 MLEM iterations ■ 18F ■ 2.8 cm diameter	■ 20.6 g mouse ■ 300 uCi injection (11 MBq) ■ 1 hour scan, 3 beds positions ■ 100 MLEM iterations	■ Gated mouse heart ■ 20 g mouse ■ ~435 uCi (16 MBq) at the beginning of acquisition ■ FDG ■ 30 minutes acquisition ■ 20 MLEM iterations

In vivo assessment of axonal disruption using diffusion magnetic resonance imaging

Julien COHEN-ADAD, Serge ROSSIGNOL, Habib BENALI, Richard D. HOGE Institute of Biomedical Engineering, Université de Montréal Groupe de Recherche sur le Système Nerveux Central, Faculty of Medicine, Université de Montréal Unité de Neuroimagerie Fonctionnelle, Université de Montréal INSERM U678, Université Pierre et Marie Curie (Paris VI), CHU Pitié-Salpêtrière

Following spinal cord injury (SCI), assessment of white matter integrity is crucial to evaluate the potential of motor rehabilitation. Derived from magnetic resonance imaging, diffusion tensor imaging (DTI) provides the ability to specifically observe white matter pathways. Although widely applied to the brain, DTI is challenging at the spinal level because of the small size of the cord, the presence of large physiological motions and magnetic field inhomogeneities. To circumvent these issues, we propose a clinically compatible methodology we validated on healthy and injured spinal cord of cats as well as in humans.
In vivo acquisitions were conducted on a 3T scanner using a standard spine coil. For the study, we selected healthy and spinal cord injured cats (N=6) and healthy humans (N=2). Diffusion-weighted scans were performed using high spatial (1.1 mm^3) and angular (55 directions) resolution to optimize the detection of various axonal tracts. Particular efforts were made to reduce distortions, notably by using parallel imaging technique. Following data acquisition, fractional anisotropy was measured at various levels of the cord, giving quantitative assessment of the cord's integrity.

The acquisition protocol yielded good quality images with few artefacts and no visible distortions. Fractional anisotropy was significantly reduced at the site of spinal cord lesions ($P<0.05$). Furthermore, high spatial

resolution enabled the identification of various anatomical tracts coursing through different quadrants of the cord. It is hoped that such studies, especially when performed longitudinally, will allow a better correlation between functional recovery and spinal cord integrity.

Support
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Friday, June 13
16:00-17:30

Session A10 – Medical and Assistance Devices

MONitorage IntraThoracique Optique de la Réparation Pulmonaire *in vivo*

Clément Fournier[1], Olivier Lesur[2], Frédéric Chagnon[2], Frédéric D'Aragon[2], Bruno Hogue[2], Daniel M Payet[2], Paul Charette[1]
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[2]Faculté de Médecine, Unité de Physiopathologie Respiratoire, Université de Sherbrooke,

Les outils cliniques permettant d'imager la réparation pulmonaire, dans le cas du Syndrome de Détresse Respiratoire Aigu (SDRA) par exemple, sont peu sensibles et peu spécifiques. La prise de biopsies tissulaire est possible mais présente néanmoins des risques de complications non négligeables. Un monitorage direct de la réparation pulmonaire par micro imagerie permettrait au clinicien de mettre en place un traitement adéquat, sans présenter les risques de biopsies chirurgicales. Le système d'imagerie de fluorescence confocale *in vivo* Optiscan Five 1 nous permet de travailler dans ce sens. L'imagerie se base sur un contraste systémique ou local avec un marqueur équipé d'un traceur émettant dans la gamme d'excitation/émission de la fluorescéine (FITC), et permettant en temps réel de visionner les espaces aériens distaux par application directe de la microsonde sur la plèvre viscérale pulmonaire. La résolution axiale de 7µm, ainsi que la résolution latérale de 0,7µm permet d'imager avec précision les espaces aériens distaux, la zone visualisée est de 475µm par 475µm. Les premiers résultats ont été obtenus à l'aide de trois marqueurs : l'agglutinine anti-Lectine (*Ricinus Communis*) –FITC (marquage épithélial membranaire), l'acridine orange (marquage cellulaire nucléaire endothélial ou épithélial) et le Dextran-FITC (marquage du plasma et visualisation des cellules circulantes par contraste négatif). Le travail actuel porte sur un comparatif de rats sains et de rats traités à la bléomycine –qui induit des lésions pulmonaires sévères-, afin d'étudier et d'imager le comportement des poumons face à une pathologie.

Stove top thermal monitoring for assisted living at home

Ming Ye Yuan, James. R. Green, and Rafik Goubran, Systems and Computer Engineering, Carleton University

The elderly segment of the population is growing worldwide and this trend will place an increasing strain on the health care system. Diverse technologies are being developed to facilitate 'aging in place' as an alternative to overburdened long-term care facilities. However, there remains a significant need for safety monitoring in the kitchen. Specifically, the stove is the number one cause of fire accidents in the residence. This danger is exacerbated due to the fact that many elderly users are faced with declining mental acuity due to age-related illnesses. At Carleton University, we are creating a stove top monitoring system based on thermal imaging to track stove top status and associated human activity in order to generate alerts as appropriate. This paper reports on our efforts to detect human activity on a stove top using an infrared camera. Monitoring of other events (pot presence, pot boiling dry, etc) and the subsequent alert generation

remain as future work, and will be presented in a separate paper.

Calibration of a simple, low cost, 3D laser light-sectioning scanner system for biomedical purposes

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[2]Systems and Computer Engineering, Carleton University
[3]Mechanical and Aerospace Engineering, Carleton University

For many years, three dimensional (3D) scanning systems for acquiring the external shape features of arbitrary objects have been widely used in industry for applications such as reverse engineering and part inspection. More recently, 3D scanning has been used in the biomedical field for applications such as orthodontic treatment planning, cranial deformation research, cartilage morphology studies, and anthropometric data collection. The potential exists to expand the biomedical uses of 3D models even further, by continuing to develop simpler, more cost effective systems. A simple, low cost, 3D scanning system is being developed for biomedical purposes which employs the laser light-sectioning technique. This technique involves measuring the position of an object's surface profile by capturing images of where the profile intersects a plane of laser light projected onto the object from different angles. Since the camera used to capture images is located at a fixed angle to the laser plane, an important part of this system is the calibration procedure required to eliminate the perspective distortion in the images. This paper presents an analysis of two different calibration techniques for finding a homogeneous transformation matrix, *T*, which maps points in the image plane of the camera to their corresponding points on a known calibration grid: a direct approach using projective geometry and a least squares approach involving the Direct Linear Transformation (DLT) algorithm. Both are evaluated in terms of their performance under noisy data conditions. Results of a proof of concept experiment employing the chosen calibration technique are also presented to demonstrate the validity of the approach. Directions for future work are also discussed.

Flexible Ultrasonic Transducers and Their Performance

M. Kobayashi1, C.-K. Jen[1], Y. Ono[2], J.L. Shih[3] and F. Lesage[4]
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[2] Department of Systems and Computer Eng., Carleton University, Ottawa, Ontario
[3] Department of Electrical and Computer Eng., McGill University, Montreal, Quebec,
[4] Département de Génie Électrique, Ecole Polytechnique de Montréal, Montréal, Québec,

Ultrasonic imaging technology is widely used to diagnose human health conditions noninvasively. One critical demand is to develop flexible ultrasonic transducers (FUTs) conformable to human body shapes and capable to perform real-time imaging with high resolution or other diagnostic functions convenient to patients and with cost-effectiveness. In this investigation, FUTs including array form fabricated by a sol-gel spray technique are presented. These FUTs consist of a 50μm thick polyimide membrane with a 1μm thick bottom electrode, a 30μm to 100μm thick piezoelectric lead-zirconate-titanate composite ceramic film and a several μm thick silver top electrode. The flexibility is realized owing to the porosity of piezoelectric film and the thinness of substrate and electrodes. The center operation frequency, fc, of these FUTs ranges from 2 to 30 MHz and with broad bandwidth and good signal to noise ratio. Due to the polyimide substrate a good impedance matching exists between such FUT and human tissues or water. FUTs having harmonic-imaging capability with fc and 2 fc being 10MHz and 20MHz, respectively, are also made. The FUT array can be conveniently configured by the top electrode design. Since such FUTs can be operated at 150°C, sterilization is feasible. Comparisons between FUTs and other commercial available UTs will be discussed.

Friday, June 13
14:00-15:30

C9 – Reviewed Papers

Health Canada's new guidance on hospital bed safety: Patient entrapment, side rail latching reliability and other hazards

Denis G. Roy[1], Graham Ladner[2]
[1]Product Safety Program, Health Canada and [2]Medical Devices Bureau

In an effort to reduce the number of life-threatening bed-related entrapment events, Health Canada has published a new guidance for assessing the entrapment risk posed by hospital bed systems. This guidance is aimed at health care providers as well as hospital bed manufacturers; it will help the former to better understand and measure the risks posed by bed systems present in their facilities and it will help the latter to produce safer beds.

The guidance identifies 7 zones where entrapment events are likely to occur and 3 key body parts at risk. The guidance also describes tools and test methods that health care facilities can use to measure beds in their institution to assess the entrapment risk posed by 4 of the 7 identified entrapment zones. The guidance is based on the published recommendations of the US FDA's Hospital Bed Safety Workgroup (HBSW), on which Health Canada played an active role.

The Assessment of the Risk of Patient Entrapment in Hospital Beds within the Vancouver Coastal Health Authority

Gord McConnell, Charles Xiao, Biomedical Engineer.

In late 2006, Health Canada issued a draft guidance document entitled, "Hospital Beds: Patient Entrapment Hazards, Side Rail Latching Reliability, and Other Hazards". The document describes the risk of patient entrapment in hospital beds and defines various zones on hospital beds where entrapment can occur. It also suggests that healthcare facilities determine the level of risk for entrapment and take steps to mitigate the risk. The Biomedical Engineering Department in the Vancouver Coastal Health Authority (VCHA) followed this suggestion and undertook a study to determine the risk within the health authority. VCHA is comprised of 94 facilities and has about 8000 hospital beds. In the study the various combinations of beds and mattresses were tested using a special purpose tool recommended in the Health Canada document. Several zones where entrapment can occur were examined and assessed using the criteria given in the guidance document as to whether the zone presented a risk or not. Each facility was visited and samples of the beds were tested. Overall, 73% of the beds in VCHA did not pass the criteria given in the guidance document. A number of ways to mitigate the risk of entrapment are being considered, such as bed replacement, mattress replacement, upgrades of beds using kits provided by the manufacturers, modifications of beds, redistribution of beds within the Health Authority, changes in practice, preventative maintenance, and staff education. The Biomedical Engineering Department is now working with the Risk Management Department to develop a cost-effective strategy.

Improving Safety and Efficiency within Air Ambulances in Ontario

Judith Seary, Vicki LeBlanc, Patricia Trbovich and Anthony Easty

The air ambulance is a pre-hospital environment where significant emergency medical care is provided. It is a remote patient care environment with limited equipment, confined space, constrained storage, and limited support (aside from telephone contact with base hospital physicians). Although this environment provides the highest level of care outside of a hospital, there is limited information available about the best arrangement of

instruments or the effects of air ambulance layout on patient care during air transportation. Understanding the current workflow, challenges, requirements, and other Human Factors issues of this patient care area is an important first step toward improving patient safety during air ambulance transport.
Pairs of paramedics from 3 flight paramedic bases in Ontario were shadowed, to gain an understanding of the work environment and perform a task analysis of the work done within the constraints of the air ambulance. Concurrently, semi-structured interviews with paramedics, education staff, engineering staff and base hospital physicians from the same flight paramedic bases were conducted to identify problems and unmet needs related to the physical layout. Data were grouped into themes of problems and concerns regarding the physical characteristics of the patient care compartment. These themes were used to identify areas that merited further attention and informed Human Factors recommendations to optimize the use of space. It is expected that these findings will lead to modifications to the current interior of air ambulances that will improve clinical efficiency and safety, as well as provide guidance for the design of future air ambulances.

The majority of healthcare research has focused on in-hospital rather than pre-hospital care settings. Significant care, however, is provided in the pre-hospital setting, often in challenging and time sensitive conditions. The air ambulance is an example of a pre-hospital environment. Specifically, the air ambulance is a remote patient care environment with limited equipment, confined space, constrained storage, and limited support (aside from telephone contact with base hospital physicians). Although this environment provides the highest level of care outside of a hospital, there is limited information available about the best arrangement of instruments within the constraints of an air ambulance or the effects of air ambulance layout on patient care during air transportation. Understanding the current workflow, challenges, and requirements associated with this patient care area is an important first step in working toward solutions to improve patient safety during air ambulance transport. To this end, the goal of the present study is to understand the effects of ambulance layout on paramedic workflow, as well as on paramedic and patient safety in this challenging and compact environment.

As part of a larger investigation, pairs of paramedics from 3 flight paramedic bases in Ontario, Canada were shadowed during 12 hour shifts, to gain an understanding of the work environment and perform a task analysis of the work done within the constraints of the air ambulance patient care environment. When possible, paramedics were asked to “think aloud” to explain their thoughts and the tasks they were performing. The observer asked clarifying questions to ensure that actions and thought processes were correctly interpreted, but was careful to be as unobtrusive to the workflow as possible. Concurrently, semi-structured interviews with paramedics, education staff, engineering staff and base hospital physicians from the same flight paramedic bases were conducted to identify problems and unmet needs related to the physical layout. An iterative approach to data collection was used, to allow for the exploration of relevant issues discovered in early interviews to be addressed in later interviews.

Data gathered through shadowing and interview sessions were grouped into themes of problems and concerns regarding the physical characteristics of the patient care compartment. These themes of problems were used to identify areas that merited further attention and informed recommendations to optimize the use of space in this challenging environment. It is expected that these findings will lead to modifications to the current interior of air ambulances that will improve clinical efficiency and safety, as well as provide guidance for the design of future air ambulances.

Selection of IV Therapy Technology with DERS

Jean Ngoie

The complexity of current Infusion Therapy technology, which incorporates Drug Error Reduction System (DERS) for tracking, monitoring, and control is becoming the standard for delivery of medication in IV therapy. Integration with hospital’s existing technology such as Admission Discharge Transfer (ADT) and Pharmacy Systems, along with Risk assessment and analysis on adverse events due to medication errors are expected from health care facilities. The acquisition of this technology requires a clear understanding of both clinical and technical needs of the facility. Also a better understanding of DERS as a system. Without adequate tools, guidance and advice, the process of selecting and implementing this technology can become very expensive and time consuming.

The choice of IV therapy requires close collaboration between healthcare professionals at all levels. Equally, clinicians and nursing staff as the end users, Pharmacy, Risk management, and other disciplines within the organization contribute to the discussion on the acquisition of this technology. Clinical or Biomedical Engineering has a greater role to play in this process. Therefore, there is a need for discussion, collaboration and sharing ideas on how different hospitals are implementing and supporting the technology

This paper discusses the acquisition of IV therapy technology in general, and the process of selection of smart infusion devices with Drug Error Reduction System in particular. It provides the reader with a matrix approach as one of the tools to facilitate the selection of the vendor based on technical specifications. The aim is to open up a discussion within the Clinical and Biomedical engineering community about this technology. Also to share our experience by highlighting some technical and clinical considerations that should be taken into account during the exercise of selecting the required technology for the healthcare facility. A matrix approach based on technical specification is used as a tool to help the project team to compare technologies offered by different vendors.

Interconnection of 802.11B wireless physiologic monitors with 802.11A/B/G wireless voip network at Santa Cabrini hospital's emergency care unit

Gnahoua Zoabli

Santa Cabrini Hospital (SCH) initiated the integration of VoIP wireless communication and patient monitoring systems in the Emergency rooms (ER). The new Bell-Nortel wireless network uses an IEEE 802.11a/b/g protocol while the GE mobile DASH 3000 monitoring system of the ER was initially an IEEE 802.11 one upgraded to IEEE 802.11b. A joint study conducted with the engineering teams of Bell, Nortel and GE Healthcare demonstrated the feasibility of this multivendor hardware (Symbol vs Nortel) and software (GE vs Bell) integration. During the first four months following the integration, issues regarding the secure cohabitation of both systems and electromagnetic interferences (EMI) with the medical equipment used in the ER were assessed. The functionality and clinical benefits of this integration have been demonstrated and the installation of wireless IP telephones in the other critical care departments of the hospital is being scheduled.

Friday, June 13
16:00 - 17:30

C10 – Reviewed Papers

Is Reliability-centred Maintenance a Valid Maintenance Strategy?

Phill Thorburn and Rebecca Jucha

Over the past 2 years, Biomedical Engineering Department (BME) at the Royal Adelaide Hospital (RAH) has been exploring the advantages of utilising principles and methodologies of reliability-centred maintenance (RCM) to improve the management of the hospital's medical assets.
RAH was founded in 1840 and is the major tertiary healthcare institution and trauma centre for the adult population of South Australia and surrounding regions.
Hospital Executive have supported BME and have endorsed a strategy to develop and implement a maintenance program based on RCM principles.
BME, with the assistance of clinical staff and representatives from manufacturers, has undertaken an RCM analysis of a number of medical devices to assess the benefits and issues surrounding the adoption of RCM as the tool for developing cost effective maintenance strategies.
While there are significant improvements to be gained in the performance of medical devices from the application of RCM, there are also a number of barriers, some considerable, to be overcome by any

biomedical or clinical engineering department wishing to implement RCM and avail their institutions of the benefits.

The BME Dept. has been working with the Aladon Network, Ontario, Canada, and Asset Partnership, Sydney, Australia, to adapt and develop RCM to the discipline of biomedical engineering while maintaining standards of patient safety.
This paper will:
1. outline the experience of the Royal Adelaide Hospital in implementing RCM
2. outline the benefits of RCM to the discipline of biomedical engineering and health
3. examine the barriers that impede the implementation of RCM in biomedical engineering
4. propose solutions to overcome the barriers and progress biomedical engineering.

Clinical Engineering Electromechanical Program. Are your patients and staff safe without one?

Jeremy Dann

An incident in 2003 resulted in the launch of a new Electromechanical Service by the Nova Scotia Association of Health Organizations Clinical Engineering Service. The Electromechanical service was developed, in its pilot stage, to bring clinical engineering discipline, processes, and client service commitment into play in support of a range of technology not previously considered within the traditional envelop of our field of expertise. The new service has been a dramatic success and has expanded rapidly since the conclusion of the pilot in 2004. The program's defined boundaries have been expanded between 2004 and 2007 to cover an increasing variety of technology. The author will provide an overview of the factors leading to the launch of the service, findings in the field, and its growth with suggestions for peers interested in broadening their services outside the normal bounds of Clinical Engineering.

In-room HEPA Air Cleaners: Simple technology with complicated implications

Sonia Pinkney, Tony Easty, Nancy Sikich

With the increasing complexity of healthcare technology, the planning and management requirements of more simple technologies are easily overlooked. In-room high-efficiency particulate air (HEPA) cleaners are a seemingly simple technology, which are used to quickly and inexpensively improve environmental controls to manage patients requiring airborne infectious precautions. However, this technology requires the cooperation of multiple stakeholders (e.g., Infection Control, Facilities Engineering, Biomedical Engineering, clinical areas) and has demanding support requirements. Insufficient planning, commissioning, and delegation of accountabilities, compromise its safe and effective use, potentially resulting in airborne infection isolation rooms not meeting standards.

The goal of this field study was to evaluate current practice related to in-room HEPA cleaners and provide recommendations regarding best practice. Phone interviews were conducted with sixteen Ontario hospitals to which six site visits were made to understand how the technology was being used and supported. Standards were researched and an Infection Control Expert Panel was convened to establish best practice.

There are over 500 in-room HEPA cleaners being used in over 100 Ontario healthcare organizations. However, there is a large variance in practice and a need for guidance targeted at the following issues:
1. There is insufficient knowledge regarding the risks and appropriate use of these units (e.g., precautions required by service personnel)
2. Best practice management processes were not always rigorously followed regarding the planning, use, and support of units (e.g., irregular preventive maintenance)

A sequential series of recommendations has been compiled to support facilities to appropriately plan, acquire, operate and support in-room HEPA cleaners.

ISO quality systems & Clinical engineering / standards of practice

Avril Sullivan

The project was an investigation of whether an ISO Quality Management System framework could be applied over a service guideline outlined in the Canadian Medical and Biological Society's (CMBES) Clinical Engineering Standards of Practice. The intention of the project was to make recommendations to enhance the existing Clinical Engineering Standard of Practice, and create a best practices approach to clinical engineering service delivery in Canadian hospitals. Based on the key findings of this research project, five recommendations will be put forward to the CMBES committee for revisions to the Clinical Engineering Standards of Practice.

CMBES PEER REVIEW OF LONDON HEALTH SCIENCES CENTRE, OCTOBER 2007

Bill Gentles[1], Mike Capuano[2], Mario Ramirez[3]
[1]BT Medical Technology Consulting, [2] Hamilton Health Sciences, [3] Hospital for Sick Children

CMBES offers a peer review process for its members. It uses a survey questionnaire based on the CMBES "Clinical Engineering Standards of Practice for Canada". The questionnaire format is similar to the Hospital Accreditation questionnaires, except that it is exclusively focused on Clinical Engineering Services. The most recent Peer Review survey was conducted at London Health Sciences Centre (LHSC), in October 2007. The surveyors were Mike Capuano, Bill Gentles and Mario Ramirez.

LHSC is an amalgamation of three formerly independent hospitals, University Hospital, St. Joseph's Hospital and Victoria Hospital. The Biomedical Engineering departments in these three hospitals have been amalgamated into a single department under one director. The incumbent director, Fernando Lebron, was about to retire, and requested a Peer Review to provide his successor with an outside perspective on the departments strengths and weaknesses.

The survey began with the department completing a pre-survey questionnaire. It was followed by a series of face to face meetings over two days, on October 17 and 18, 2007. There were over 25 meetings with various customers and stakeholders and department staff on the three sites. The survey ended with a wrap-up meeting with department staff, at which preliminary findings were discussed..

A final report was submitted to LHSC two weeks after the completion of the survey. It included 19 recommendations for improvement. A follow-up teleconference was held to discuss these recommendations. LHSC found this process to be a very positive experience, and they have scheduled a follow-up survey to take place in June 2009.

Our presentation will discuss the survey process in more detail, but will not disclose specific recommendations arising from this survey.

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