

Tissaphern “Tissa” Mirfakhrai

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EDUCATION

Ph.D. in Electrical and Computer Engineering

Dec 2009

University of British Columbia (UBC), Vancouver BC

Thesis: Carbon Nanotube Yarn Actuators

M.A.Sc. in Engineering

Aug 2002

Simon Fraser University (SFU), Burnaby, BC

Thesis: Force-Reflecting Teleoperation Over the Internet: Theory and Experiment

TECHNICAL SKILLS

- **Electrochemistry/chemistry**: cyclic voltammetry (CV), impedance spectroscopy, rotating disc electrode (RDE); electrodeposition of polymers; synthesis and electrochemistry of carbon nanotubes, graphene oxide, and metal oxides/hydroxide-graphene compounds; electrocatalysis; physical and inorganic synthetic chemistry; vacuum furnace design and assembly; high temperature annealing; advanced electrochemical software (e.g. CorrWare & CorrView)
- **Mechanical and electromechanical**: fracture mechanics; thermomechanical reliability of multilayer structures; viscoelastic properties of polymers; nanoindentation; design and use of electromechanical instruments, e.g. dynamic mechanical analyzers; Instron tensile/compression tester; robotics; microcontrollers; force sensors/strain gauges
- **Material characterization**: X-ray photoelectron spectroscopy (XPS); scanning electron microscopy (SEM); nano-mechanical measurements using atomic force microscopy (AFM); profilometry; BET surface area measurement; focused ion beam (FIB); Raman spectroscopy; X-ray diffraction (XRD); transmission electron microscopy (TEM)
- **Thin Film processing and characterization**: chemical vapor deposition (CVD, PECVD), CNT and Si nanowire growth; spin coating; Langmuir-Blodgett (LB); atomic layer deposition (ALD); ellipsometry; SIMS
- **Thermal**: thermo-gravimetric analysis (TGA); differential scanning calorimetry (DSC)
- **Optical**: optical microscopy; UV-vis; laser interferometry; Fourier transform infrared (FTIR) spectroscopy
- **Computational**: computational chemistry e.g. Gaussian 03; COMSOL (finite elements analysis); highly experienced with MATLAB and LabView; C/C++ programming
- Project management methods; failure analysis; root cause analysis; reliability theory
- **Courses**: Fracture Mechanics; Polymer Science & Engineering; Mechanical Properties of Materials; Interfacial electrochemistry, Applied Electrochemistry; Semiconductor Device Physics; Electronic Materials and Devices; Quantum Mechanics; Materials Chemistry; Computational Molecular Chemistry, Elasticity

RESEARCH EXPERIENCE

Stanford University, Stanford, CA

Materials Science Postdoctoral Scholar, (Feb 2011-Dec 2012, Supervisor: Prof. R. Dauskardt), Department of Chemistry (Jan 2010-Feb 2011, Supervisor: Prof. H. Dai). Funded partly by Postdoctoral Fellowship from Natural Sciences and Engineering Research Council of Canada

- Developed novel high performance graphene/metal compounds for pseudocapacitors, batteries and catalysis
 - Created ultra-high capacity pseudo-capacitors and cathode materials for Li ion batteries based on graphene-metal compounds
 - Developed low-cost, high performance metal-graphene catalysts for oxygen reduction (ORR)
 - Devised a low energy method to dope graphene with boron and nitrogen
 - Made high-surface-area 3D self-assembled porous graphene electrodes for double-layer capacitors
 - Built vacuum furnace for CVD/high temperature annealing

- Led a team of 4 graduate students in analyzing the failure modes and thermomechanical reliability of photovoltaic (PV) materials:
 - Discovered the long-term and in-situ effects of UV light, humidity, and temperature on the interfacial adhesion and debonding in the polymer-inorganic barrier multilayers used for PV/electronics, and dye-sensitized solar cell electrodes
 - Studied fracture and mechanical properties of flexible transparent barrier and encapsulation multilayer films for PV/electronics

University of British Columbia, Vancouver BC

Research Assistant, Molecular Mechatronics laboratory, Department of Electrical and Computer Engineering (Sep 2003-Dec 2009, Advisor: Prof. J. D. Madden)

- Characterized and developed applications for ionically charged CNT fibers and conducting polymer films as flexible electromechanical actuators
 - Invented a new type of ionic artificial muscle with mechanical load 800 x higher than natural muscle
 - Discovered novel mechanism of charge-induced strains in CNT yarns and conducting polymers
 - Characterized kinetics and mass transport in porous electrodes
 - Designed and built the potentiostats and electro-mechanical characterization instruments
 - Performed ab initio / FEA / molecular dynamics simulations of CNTs and polymer systems

Alan G. MacDiarmid Nanotech Institute, Richardson TX

Visiting Scientist (Aug 2007-Oct 2007, Supervisor: Prof. R. H. Baughman)

- Characterized the mechanical, electrochemical, and thermal properties of shape memory alloys and carbon nanotube materials for artificial muscles applications as an invited member of a research team; CVD growth and properties of forests of vertically aligned CNTs; electrochemical and viscoelastic properties of CNT yarns

SFU, Experimental Robotics Laboratory, Vancouver BC

Research Associate (Sep 2002- May 2003),

Research Assistant (Sep 1999-Sep 2002) Supervisor: Prof. S. Payandeh

- Pioneered force-feedback robotic teleoperation over the Internet:
 - Built a force-feedback teleoperation system to control a robot remotely through the Internet while providing the operator with haptic feedback of the forces applied to robot
 - Invented a novel stochastic controller that used a mathematical model to predict and compensate for the destabilizing variable time delays of the Internet
 - Designed and implemented a Multi-User Teleoperated Camera Holder device: users interact online to position a camera, monitoring an area for security, medical or entertainment purposes

Intern

Summer 2000

International Submarine Engineers (ISE), Port Coquitlam, BC

- Developed a controller for electromechanical manipulators and motors with applications in robotics and teleoperation. Work included writing device drivers on real-time OS using C/C++.

TEACHING AND SUPERVISION EXPERIENCE

Co-instructor, (Electronic Materials, UBC EECE 352

Fall 2006 and Fall 2007

Taught a class of >80 students on properties and applications of dielectric and magnetic materials. Described as “a confident, motivated, and knowledgeable instructor” in student evaluations

Acting supervisor

2003-2008

Supervised 23 UBC undergraduate students from Electrical Engineering, Mechatronics and Engineering Physics. These included summer internships sponsored by NSERC (USRA), senior year, and group projects (list of students and projects available)

Teaching Assistant, UBC

2004-2007

Electronic Materials (tutorials and office hours, developed homework questions/solutions, marked exams); Linear Circuit Analysis (tutorials/lab instructor); Signals and Systems (lab instructor).

Teaching Assistant, SFU

2001-2002

Electronic System Design; Digital and Computer Design Lab; Introduction to Computer Design; reputed as a very effective and helpful instructor

HONORS AND AWARDS

Postdoctoral: Natural Sciences and Engineering Research Council of Canada Postdoctoral Fellowship (NSERC PDF), for \$80,000 over 2 years (2010-11).

Student: Eileen Purkiss Memorial Award (2001); BC Advanced Systems Institute communication award (2001); Pacific Metals Graduate Scholarship (2001); SFU Center for System Sciences best poster (2001); SFU Dean of Graduate Studies Scholarship (2000); Ranked 2 in Iranian nationwide university entrance exam among 1 million participants (1993)

COMMUNITY INVOLVEMENT

• Reviewed papers for:

IOP journals: Nanotechnology; Journal of Physics D; Journal of Micromechanics and Microengineering; Materials Science and Technology

Elsevier journals: Physics Letters A; International Journal of Solids and Structures

Other journals: Journal of the Electrochemical Society (ECS); IEEE/ASME Transactions on Mechatronics (IEEE); Applied Physics A (Springer); Journal of Nanoscience and Nanotechnology (ASP); Journal of Intelligent Material Systems and Structures (SAGE);

Conferences: IEEE Engineering in Medicine and Biology Conference (EMBC 2011); 1st Microsystems and Nanoelectronics Research Conference (MNRC 2008)

• Conference session chair for: SPIE Smart Materials and Structures/NDE (2008, 2009, 2011)

COLLABORATIONS

- Dr. Mark Roehrig, 3M Corporate Research Process Laboratory, St. Paul, MN: thermomechanical reliability of ultra-high barrier films for solar cells and organic electronics
- Dr. Matthew Chisholm, Oak Ridge National Laboratory, Oak Ridge, TN, microscopy of doped graphene compounds for energy storage
- Prof. Ray H. Baughman; Alan G. MacDiarmid Nanotech Institute, Richardson, TX, characterization and applications of carbon nanotube yarns and sheets
- Prof. Geoffrey M. Spinks, Intelligent Polymers Research Institute, Wollongong, NSW, Australia: torsional actuation of carbon nanotube yarns
- Prof. Alireza Nojeh; UBC, Underlying quantum physics of nanotube actuators
- Prof. Joseph Yan; UBC, Artificial muscles for a wing-flapping biomimetic flying insect robot
- Prof. William Megill; University of Bath, UK: Artificial muscles for a biomimetic swimming fish robot

INTERESTS AND ACTIVITIES

- Classical music (composition, piano playing Royal Conservatory of Music Grade 10)
- Executive member and artistic director of the UBC Electrical Engineering Graduate Student Association (2004-8);
- Co-chair of the SFU Engineering Graduate Student Association (EGSA), 2001-2
- Languages: English, French, Arabic and Farsi; Sports: Swimming, Squash and Volleyball

REFEREED JOURNAL PUBLICATIONS

- J17. Mirfakhrai, T.;** Dauskardt, R. H.; Thermomechanical Reliability of Multilayer Transparent Protective Barrier Films; *in preparation*
- J16. Mirfakhrai, T.;** Chisholm, M. F.; Wang, H.; Pennycook, S. J.; Duscher, G.; and Dai, H. (2012) Atomic and Electronic Structures of Boron and Nitrogen Dopants in Graphene, under review for *ACS Nano*
- J15. Mirfakhrai, T.;** Oh, J. Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D.; Ultrahigh Load Actuation of Carbon Nanotube Yarns in Ionic Liquids, *in preparation*
- J14. Foroughi, J.;** Spinks, G. M.; Wallace, G. G.; Oh, J.; Kozlov, M. E.; Fang, S., **Mirfakhrai, T.;** Madden, J. D. W.; Shin, M. K.; Kim, S. J.; and Baughman, R. H. (2011) Torsional carbon nanotube artificial muscles; *Science*, **334**, 494-497
- J13. Wang, H.;** Liang, Y. **Mirfakhrai, T.;** Chen, Z.; Sanchez-Casalongue, H. G.; and Dai, H. (2011) Advanced Asymmetrical Supercapacitors Based on Graphene Hybrid Materials, *Nano Research*, **4** (8), 729–736 (Cited 22 times)
- J12. Mirfakhrai, T.;** Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. (2011) Mechano-electrical Force Sensors Using Twisted Yarns of Carbon Nanotubes, *IEEE/ASME Transactions on Mechatronics* **16** (1), 90-97
- J11. Shoa, T.;** Madden, J. D. W. **Mirfakhrai, T.;** Alici, G.; Spinks, G. M. and Wallace, G. G. (2010) Electromechanical coupling in polypyrrole sensors and actuators, *Sensors and Actuators A-Physical*, **161** (1-2), 127–133
- J10. Mirfakhrai, T.;** Shoa, T.; Madden, J. D. W. (2010) Electro-stiffening in Polypyrrole films: Dependence of Young's modulus on oxidation state, load and frequency, *Synthetic Metals* **160**, 1280–1286 (Equally-contributing first author)
- J9. Mirfakhrai, T.;** Krishna-Prasad, R.; Nojeh, A. and Madden, J. D. W. (2010) Bond Order Effects in Electromechanical Actuation of Armchair Single-Walled Carbon Nanotubes, *Journal of Chemical Physics* **132** (7), 074703. Also selected for *IOP/APS Vir. J. Nan. Sci. & Tech.* **21** (9) Carbon Nanotubes, C60, and Related Studies
- J8. Hui, J. K.-H.;** Yu, Z.; **Mirfakhrai, T.;** and MacLachlan, M. J. (2009) Supramolecular Assembly of Carbohydrate-Functionalized Salphen Metal Complexes, *Chemistry-A European Journal* **15**, 13456 - 65 (Cited 15 times)
- J7. Mirfakhrai, T.;** Oh, J. Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. (2009), Carbon Nanotube Yarn Actuators: An Electrochemical Impedance Model, *Journal of the Electrochemical Society*, **156** (6) K97-K103. Also selected for *IOP/APS Vir. J. Nan. Sci. & Tech.* **19** (16) Carbon Nanotubes, C60, and Related Studies
- J6. Mirfakhrai, T.;** Oh, J.; Kozlov, M.; Fok, E. C. W.; Zhang, M.; Fang, S., Baughman, R. H. and Madden, J. D. (2008) Carbon Nanotube Yarns as High Load Actuators and Sensors, *Advances in Science and Technology* **61**, pp. 65-74
- J5. Shoa, T.;** Madden, J. D.; **Mirfakhrai, T.;** and Fok, C.-W. E. (2008) Conducting Polymer Actuators: Rate Limits, *Advances in Science and Technology* **61**, pp. 26-33
- J4. Mirfakhrai, T.;** Krishna-Prasad, R.; Nojeh, A. and Madden, J. D. W. (2008) Electromechanical actuation of single-walled carbon nanotubes: an ab initio simulation study, *Nanotechnology* **19** 315706
- J3. Mirfakhrai, T.;** Madden J.D. and Baughman, R. H. (2007) Polymer Artificial Muscles, *Materials Today*, Vol. 10 No. 4, pp. 30-38, May 2007. (Cited 147 times)
- J2. Mirfakhrai, T.;** Oh, J.; Kozlov, M.; Fok, E. C. W.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. (2007) Electrochemical actuation of carbon nanotube yarns, invited paper, *Smart Materials and Structures*, Vol. 16, No. 2, pp. S243-9, April 2007 (Cited 36 times)
- J1. Mirfakhrai, T. and Payandeh, S. (2005) On Using Delay Predictors for Teleoperation Over the Internet, *Robotica*, Vol. 23, Issue 06, November 2005, pp. 809-813**

REFEREED CONFERENCE PUBLICATIONS

- C9. Mirfakhrai, T.;** Novoa, F.; and Dauskardt, R.H. (2012) Debonding and Environmental Degradation in Transparent Barrier Films and Protective Coatings, *2012 MRS Spring Meeting*
- C8. Chisholm, M. F.;** Restrepo, O. D.; Windl, W.; Duscher, G; **Mirfakhrai, T. and Dai, H. (2012) Atomic Bonding Configurations of Boron and Nitrogen Dopants in Graphene, 2012 MRS Spring Meeting**
- C7. Mirfakhrai, T.;** Shoa, T. Fekri, T. and Madden, J. D. W. (2010) , A Model for Mechanical Force Sensing in Conducting Polymers, *ECS Transactions - Vancouver, Canada" Volume 28, "Sensors, Actuators, and Microsystems (General) - 217th ECS Meeting"*, pp. 59-71, Vancouver, Canada meeting, May 2010.
- C6. Mirfakhrai, T.;** Shoa, T.; Fekri, N. and Madden, J. D. (2009) Electrically-activated catheter using polypyrrole actuators: cycling effects, *Proc. of SPIE Smart Structures / NDE 2009*

- C5. Mirfakhrai, T.;** Oh, J. Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. W. (2008), Carbon Nanotube Yarn Actuators: An Electrochemical Impedance Model, *ECS Transactions - Phoenix, AZ" Volume 13, "Electron Transfer and Applications of Fullerene and Nanostructured Materials"*, Phoenix, AZ meeting, September, 2008.
- C4. Mirfakhrai, T.;** Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. (2008) Carbon nanotube yarns: actuators, sensors and current carriers, *Proc. of SPIE Smart Structures / NDE 2008*, pp. 6927081-8
- C3. Mirfakhrai, T.;** Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. W. (2007) Capacitive charging and background processes in carbon nanotube yarn actuators, *Proc. of SPIE Smart Structures / NDE 2007* [6524-54]
- C2. Mirfakhrai, T.** and Payandeh, S. (2002) A Delay Prediction Approach for Teleoperation Over the Internet, Proc. of 2002 *IEEE International Conference on Robotics and Automation (IEEE ICRA 2002)* (Cited 43 times)
- C1. Mirfakhrai, T.** and Payandeh, S. (2001) A Model for Time-Delays for Teleoperation Over the Internet, Proc. of 2001 *IEEE International Symposium on Computational Intelligence in Robotics and Automation (IEEE CIRA 2001)* (Cited 17 times)

BOOK CHAPTERS

Mirfakhrai, T. and Madden, J. D. W. (2010) Individual carbon nanotubes as electro-mechanical actuators: Simulations and initial experiments; in "Nanoelectronics: Nanowires, Molecular Electronics, and Nanodevices"; Krzysztof Iniewski, Ed.; McGraw-Hill, New York City

INVITED TALKS

- L5.** "Nanostructured Materials for Artificial Muscles and Energy Storage", 4D-Labs, Simon Fraser University, Burnaby, BC, Canada, July 2010
- L4.** "Artificial Muscles Using Carbon Nanotube Yarns", Massachusetts Institute of Technology, Cambridge, MA, September 2009
- L3.** "Nanotubes Charging Forward: Electrochemical actuation in carbon nanotube yarns", German Aerospace Center (DLR) Institute of Composite Structures and Adaptive Systems, Braunschweig, Germany, June 2008
- L2.** "Electrochemically-induced actuation in yarns of carbon nanotubes", Institut Catala de Nanotecnologia, Barcelona, Spain, June 2008
- L1.** "Carbon nanotube yarns: Actuators, sensors, and current carriers", Alan G. MacDiarmid NanoTech Institute, University of Texas at Dallas, Richardson, TX, USA, September 2007

CONFERENCE PRESENTATIONS AND POSTERS

- P22. Mirfakhrai, T.;** Dauskardt, R. H. (2012) Structural and Environmental Effects in Multilayer Ultra-high Barriers for Solar Cells, poster presentation; Center for Advanced Materials for Photovoltaics Annual Meeting 2012, Stanford, CA
- P21.** Cai, C; Isaacson, L., **Mirfakhrai, T.;** Dauskardt, R. H. (2012) UV Degradation of Multilayer Barrier Film Structures for Solar Cells, poster presentation; Center for Advanced Materials for Photovoltaics Annual Meeting 2012, Stanford, CA
- P20. Mirfakhrai, T.;** Novoa, F.; Dauskardt, R. H. (2011) Environmental Effects in Transparent Multilayer Ultra-high Barrier Films for PV and OLEDs, *Printed Electronics USA 2011*, Santa Clara, CA
- P19. Mirfakhrai, T.;** Novoa, F.; Dauskardt, R. H. (2011) Debonding and Environmental Degradation in Transparent Barrier and Encapsulant Layers for Photovoltaics and Display Technologies, poster presentation, *Printed Electronics USA 2011*, Santa Clara, CA
- P18. Mirfakhrai, T.;** Novoa, F.; Dauskardt, R. H. (2011) Environmental Effects in Solar Cells EVA Encapsulant Layers, poster presentation, *ICMR Workshop on Emerging Materials for Thin Film Solar Cells* Santa Barbara, CA
- P17. Mirfakhrai T.;** Shoa, T.; Madden, J. D. W. (2011) Conducting polymers, carbon nanotubes, and other low voltage ion-based actuators as mechanical energy harvesters, *SPIE Smart Structures / NDE 2011*
- P16.** Foroughi, J.; **Mirfakhrai, T.;** Baughman, R. H. ; Fang, S; Kozlov, M.; Madden, J. D. W.; Spinks, G. M.; Wallace, G. G. (2010) CNT yarn as a microscale rotational actuator, *SPIE Smart Structures/ NDE 2010*
- P15. Mirfakhrai, T.;** Madden, J. D. W.; Foroughi, J.; Spinks, G. M.; Baughman, R. H. ; Wallace, G. G. (2010) Nanotube Yarns as High Stress Actuators and Sensors, *SPIE Smart Structures / NDE 2010*
- P14. Mirfakhrai, T.;** Oh, J.; Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H; Krishna-Prasad, R.; Nojeh, A. and Madden, J. D. W. (2009) Artificial Muscles for Actuation and Energy Harvesting Using Carbon Nanotube Yarns, *TechTextil 2009*, Las Vegas, NV

- P13. Mirfakhrai, T.**; Oh, J.; Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. W. (2009) Actuation and Sensing in Twisted Yarns of Carbon Nanotubes, poster presentation, ACES: Electromaterials Symposium 2009, “Nanostructured Electromaterials”, Wollongong, NSW, Australia
- P12. Madden, J. D. W.; Mirfakhrai, T.**; Fok, E. C. W.; MacLachlan, M. J.; Roy, X.; Wolf, M. O.; Bremner, G.; Takshi, A.; Beatty, J. T.; Baughman, R. H.; Kozlov, M. E.; Oh, J.; Zhang, M. and Fang, S. (2009) Nanostructured Electrodes for Energy Storage, Harvesting and Actuation, ACES: Electromaterials Symposium 2009, “Nanostructured Electromaterials”, Wollongong, NSW, Australia
- P11. Baughman, R. H.**; Fang, S.; Zhang, M.; Zakhidov, A. A.; Kozlov, M.; Aliev, A. E.; Atkinson, K. R.; **Mirfakhrai, T.**; Madden, J. D. W.; Galvan-Garcia, P. and Romero, M. I. (2008) Fabrication and Multifunctional Applications of CNT Yarns and Self-woven Transparent Sheets, *3rd International conference of Smart Materials, Structures and Systems (CIMTEC 2008)*, Sicily, Italy June 2008
- P10.** Oh, J.; Kozlov, M.; **Mirfakhrai, T.**; Seker, V.; Zhang, M.; Fang, S.; Capps, R.; Kozlov, M.; Ebron, V. H.; Madden, J. D.; Ferraris, J.; and Baughman, R. (2007) Electro-Mechanical Actuation of Carbon Nanotube Yarns, Sheets and Composites, NanoTx conference, Dallas, TX
- P9. Mirfakhrai, T.**; Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. W. (2007) Capacitive Charging and Background Processes in Carbon Nanotube Yarn Actuators, *ECS Young Author Symposium*, June 2007, Vancouver BC.
- P8. Kozlov, M.**; Oh, J.; **Mirfakhrai, T.**; Ebron, V. H.; Yang, Z.; Seyer, D. J.; Xie, H.; Razal, J.; Hall, L. J.; Zhang, M.; Fang, S.; Ferraris, J. P.; MacDiarmid, A. G.; Madden, J. D. W. and Baughman, R. H. (2007) From electrical to fuel-powered artificial muscles, *Proc. of SPIE Smart Structures / NDE 2007* [6524-14]
- P7.** Hall, L. J.; Coluci, V. R.; Galvao, D. S.; Zhang, M.; Kozlov, M.; Zakhidov, A. A.; Shah, S. R.; Raj, R.; Dalton, A. B.; Madden, J. D. W.; **Mirfakhrai, T.**; Spinks, G. M.; Wallace, G. G.; Barisci, J. N.; Dantas, S. O.; Munoz, E. and **Baughman, R. H.** (2006) Strain Amplification for Artificial Muscles and Sensors Using Giant Poisson Ratios and Giant Linear Compressibilities, *MRS Fall meeting 2006*.
- P6. Mirfakhrai, T.**; Kozlov, M.; Zhang, M.; Fang, S.; Baughman, R. H. and Madden, J. D. W. (2006) On electromechanical actuation of CNT yarns, poster presentation *SPIE Smart Structures / NDE 2006*
- P5. Kozlov, M.**; Zhang, M.; Fang, S.; **Mirfakhrai, T.**; Madden, J. D.; and Baughman, R. H. (2005) Electro-Mechanical Actuation of Carbon nanotube Yarns and Sheets, *Materials Research Society Fall Meeting*
- P4. Yeung, H. T.**; **Mirfakhrai, T.**; Wieringa, P.; Madden, J. D. and Yan, J, (2004) Dielectric Elastomer Actuating a Flapping Wing, poster presentation, *IRIS-Precarn meeting*, 2004, Ottawa ON
- P3. Mirfakhrai, T.** and Payandeh, S. (2003) ‘Multi-User Teleoperated Camera Holder’ poster presentation, *ASI exchange 2003*, Vancouver BC
- P2. Mirfakhrai, T.** and Payandeh, S. (2001) ‘On Force Reflecting Teleoperation Over the Internet’, poster presentation, *IRIS-Precarn meeting 2001*, Ottawa ON
- P1. Mirfakhrai, T.** and Payandeh, S. (2001) ‘Force Reflecting Teleoperation Over the Internet’, poster presentation, *ASI exchange 2001*, Vancouver BC (winner of ASI best poster award)

REFERENCES

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