MING-ZHER POH

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Education

MASSACHUSETTS INSTITUTE OF TECHNOLOGY/HARVARD MEDICAL SCHOOL, Cambridge, MA
Doctor of Philosophy in Electrical and Medical Engineering 9/2005 – 8/2011

- Division of Health Sciences and Technology (HST)
- Doctoral Dissertation Title: "Continuous Assessment of Epileptic Seizures With Wrist-worn Biosensors" (Advisor: Prof. Rosalind W. Picard)
- Cumulative GPA: 5.00/5.00

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Cambridge, MA
Master of Science in Electrical Engineering and Computer Science 9/2005 – 8/2007

- SM Thesis Title: "Investigating Transport of Charged Nanoparticles by Multiphoton Fluorescence Correlation Spectroscopy" (Advisor: Prof. Rakesh K. Jain)
- Cumulative GPA: 5.00/5.00

CORNELL UNIVERSITY, Ithaca, NY
Bachelor of Science in Electrical and Computer Engineering (with Honors) 9/2002 – 5/2005

- Graduated *Magna Cum Laude*
- Minor in Biomedical Engineering
- Cumulative GPA: 3.88/4.00

Honors and Awards

Rock Health Fellow 2012 • **Popular Science 2011 Invention Award** • Third Place in Center for Integration of Medicine and Innovative Technology (**CIMIT**) **Prize for Primary Healthcare** (Awarded $50,000, 2010) • Elected to **Sigma Xi** Scientific Research Society (Associate Member, 2007) • **HST Graduate Student Fellowship** (Harvard-MIT Division of Health Sciences & Technology, 2005) • **Learning Initiatives for Future Engineers (LIFE) Undergraduate Research Award** (Cornell University, 2005) • **Malaysian Government JPA Merit Scholarship** (Undergraduate Studies, 2001-2005) • Elected to **Tau Beta Pi** (National Engineering Honor Society, 2005) • Elected to **Eta Kappa Nu** (National Electrical and Computer Engineering Honor Society, 2003)

Experience

MIT MEDIA LABORATORY, Cambridge, MA
Research Affiliate 1/2012 – Present
• Continuing the research on epileptic seizure detection and characterization I started as my doctoral work by expanding the study to both children and adult populations.

CARDIIO INC., San Francisco, CA
Co-founder and CEO 1/2012 – Present
• Awarded seed grant of $20k and incubated by Rock Health, the nation's first digital health accelerator (3% acceptance rate).
• Led development of the Cardiio mobile app that transforms an iPhone/iPad into a contact-free heart rate monitor using the front camera. Launched in Apple's App Store and achieved **No. 1** spot in the Top Paid ranking for Health and Fitness, No. 32 in Overall Top Paid ranking within first week. Featured by BBC, Yahoo! News/ABC, The Doctor's (CBS), TechCrunch and more.
• Led the development of the first online website that allows people to measure their heart rate through the webcam.

AFFECTIVE COMPUTING GROUP, MIT MEDIA LABORATORY, Cambridge, MA
Postdoctoral Fellow 8/2011 – 1/2012
Graduate Research Assistant (Ph.D. Thesis Advisor: Professor Rosalind W. Picard) 3/2008 – 8/2011
• Developed a wrist-worn sensor for comfortable and long-term measurements of electrodermal activity (EDA) and actigraphy. Invention awarded US patent and resulted in spinoff company Affectiva, Inc.

• Studied the effect of epileptic seizures on EDA and heart rate variability (HRV) in pediatric patients with epilepsy (Recorded and analyzed over 4000 hours of EDA data from around 90 patients)
• Developed algorithms for epileptic seizure detection based on EDA and accelerometry using wrist-worn sensor with 94% sensitivity and less than 1 false alarm per day.
• Invented a novel technology for remote, contact-free measurements of physiological signals (e.g. heart rate and breathing rate) using a basic webcam with accuracy of ± 3 bpm compared to clinical gold standard. US patent-pending and technology commercialized through spinoff company Cardiio, Inc.
• Built a Medical Mirror that measures a user's heart rate in real-time using this technology.
• Designed heart rate sensing earphones to promote pervasive health monitoring while listening to music.
• Developed a tiny magnetic earring sensor for robust, ambulatory heart rate monitoring.

VETERANS AFFAIRS MEDICAL CENTER, West Roxbury, MA
Student Clerk 5-7/2009, 6-8/2011
Served as member of a ward team to become familiar with the clinical decision-making process and issues involved in patient care. Develop skills in patient interviewing, physical examination and communicating clinical information in both written and oral forms.

DEPARTMENT OF RADIATION ONCOLOGY, MASSACHUSETTS GENERAL HOSPITAL, Boston, MA
Research Fellow (SM Thesis Advisor: Professor Rakesh K. Jain) 1/2006 - 12/2007
Built and characterized a multiphoton fluorescence correlation spectroscopy (MPFCS) system to measure transport of nanoparticles in tumors. Investigated the effect of surface charge of quantum dots on diffusion in collagen and hyaluronan composite gels of human colon adenocarcinoma. Demonstrated that neutral nanoparticles diffuse faster than charged nanoparticles as a first step towards establishing design guidelines for effective drug delivery vectors.

CRAIGHEAD RESEARCH GROUP, CORNELL UNIVERSITY, Ithaca, NY
Undergraduate Research Assistant (Advisor: Professor Harold G. Craighead) 9/2004 - 5/2005
Developed a miniaturized on-chip immunoassay to study the induction of immune response in macrophages using micropatterned monolayers of bacterial lipopolysaccharides on silicon wafers. This model system is proposed as an on-chip simulation of immune processes as they occur in the lymphoid tissues, which can be used for drug testing and population screening.

BIOMEDICAL ENGINEERING DEPARTMENT, CORNELL UNIVERSITY, Ithaca, NY
Teaching Assistant 9/2004 – 5/2005
Assisted in the instruction of two undergraduate biomedical engineering courses – *Molecular Principles of Biomedical Engineering,* and *Information Exchange in Biomedical Engineering Systems*. Supervised the microfabrication labs which involved teaching students soft-lithography techniques to fabricate microfluidic devices such as micromixers.

CENTER FOR ENGINEERING IN MEDICINE, MASSACHUSETTS GENERAL HOSPITAL, Boston, MA
Summer Intern (Advisor: Professor Mehmet Toner) 6 - 7/2004
Designed a CD-like microfluidic device that separates peripheral blood mononuclear cells (PBMC) from whole blood based on centrifugation and elutriation. Fabricated a prototype using photolithography and soft-lithography methods and performed testing with human blood samples. Device automates the isolation process of PBMC which carry important information and provide insight on pathologic conditions.

NANOBIOTECHNOLOGY CENTER (NBTC), CORNELL UNIVERSITY, Ithaca, NY
Research Intern (Advisor: Dr. Andrea M.P. Turner) 5/2003 - 4/2004
Investigated the feasibility of using a polymer-based dry lift off technique to pattern multiple layers of biological materials. This technique would allow for precise placement of multiple biochemicals on device structures which is important for tissue engineering and the development of biosensors.

AGILENT TECHNOLOGIES, Penang, Malaysia
Summer Intern 6 - 7/2002
Designed several programs for test instruments and equipment using VEE Pro. Set up website and feedback system for handling customer requests.

Mentoring

Undergraduate Students
Nicholas Swenson (Biological Engineering, 2008-2010) • Andrew Goessling (Electrical Engineering and Computer Science, 2009) • Shubhi Goyal (Brain and Cognitive Sciences, 2009) • Mangwe Sabtala (Brain and Cognitive Sciences, 2009)

Skills

COURSEWORK
Pattern Recognition and Analysis • Sensors for Interactive Environments • Communication, Control and Signal Processing • Applied Probability • Biomedical Image and Signal Processing • Numerical Simulation • Digital System Design using Microcontrollers • Digital VLSI Design • Biomedical Instrumentation Design • MicroElectro Mechanical Systems (MEMS) • Nanofabrication • Microelectronics • Electromagnetic Fields & Waves • Computer Organization • Circuits • Signals & Systems

Human Function Anatomy • Human Pathology • Cardiovascular Pathophysiology • Renal Pathophysiology • Pulmonary Pathophysiology • Molecular Biology and Genetics in Modern Medicine • Fields, Forces and Flows in Biological Systems • Information Exchange in Biomedical Systems • Molecular Principles of Biomedical Engineering

PROGRAMMING
MATLAB • Python • C • Processing • Basic iOS/Objective C

EMBEDDED SYSTEMS DESIGN/PROTOTYPING
Microcontrollers (PIC, AVR) • Analog/digital electronics (Filters, wireless communication, A/D) • PCB board layout/design • Reflow soldering

MICROFABRICATION
Photolithography • Soft-lithography • Profilometry • Oxygen plasma etching • UV-ozone cleaning • Thin film deposition

MICROSCOPY
Multiphoton microscopy • Fluorescence correlation spectroscopy (FCS) • Confocal microscopy • Atomic force microscopy (AFM)

DESIGN
Adobe Illustrator • Adobe Photoshop • Dreamweaver

LANGUAGES
English • Chinese (Mandarin) • Malay

Publications

JOURNAL ARTICLES

M.Z. Poh, T. Loddenkemper, C. Reinsberger, N.C. Swenson, S. Goyal, J.R. Madsen and R.W. Picard, "Autonomic changes with seizures correlates with post-ictal EEG suppression," *Neurology*, vol. 78, no. 23, pp. 1868-76, 2012.

M.Z. Poh, T. Loddenkemper, C. Reinsberger, N.C. Swenson, S. Goyal, M. Sabtala, J.R. Madsen and R.W. Picard, "Convulsive seizure detection using a wrist-worn electrodermal activity and accelerometry biosensor," *Epilepsia,* vol. 53, no. 5, e93-e97, 2012.

M.Z. Poh, D. J. McDuff and R.W. Picard, "Advancements in non-contact, multiparameter physiological measurements using a webcam," *IEEE Trans Biomed Eng*, vol. 58, no. 1, pp. 7-11, 2011.

M.Z. Poh, K.H. Kim, A.D. Goessling, N.C. Swenson and R.W. Picard, "Cardiovascular monitoring using earphones and a mobile device," *IEEE Pervasive Computing,* vol. 11, no. 4, pp. 18-26, 2012.

M.Z. Poh, D. J. McDuff and R.W. Picard, "Non-contact, automated cardiac pulse measurements using video imaging and blind source separation," *Optics Express*, vol. 18, no. 10, pp. 10762-10774, 2010.

M.Z. Poh, N.C. Swenson and R.W. Picard, "Motion tolerant magnetic earring sensor and wireless earpiece for wearable photoplethysmography," *IEEE Trans Inf Technol Biomed*, vol. 14, no. 3, pp. 786-794, 2010. [Selected as the cover article]

M.Z. Poh, N.C. Swenson and R.W. Picard, "A wearable sensor for unobtrusive, long-term assessment of electrodermal activity," *IEEE Trans Biomed Eng*, vol. 57, no. 5, pp. 1243-1252, 2010.

T. Stylianopoulos, **M.Z. Poh**, N. Insin, M.G. Bawendi, D. Fukumura, L.L. Munn and R.K. Jain, "Diffusion of particles in the extracellular matrix: The effect of repulsive electrostatic interactions," *Biophys J*, vol. 99, no. 5, pp. 1342-1349, 2010.

R. Fletcher, K. Dobson, M.S. Goodwin, H. Eydgahi, O. Wilder-Smith, D. Fernholz, Y. Kuboyama, E. Hedman, **M.Z. Poh** and R.W. Picard, "iCalm: Wearable sensor and network architecture for wirelessly communicating and logging autonomic activity," *IEEE Trans Inf Technol Biomed*, vol. 14, no. 2, pp. 215-223, 2010.

CONFERENCE PROCEEDINGS

M.Z. Poh, T. Loddenkemper, N.C. Swenson, S. Goyal, J.R. Madsen and R.W. Picard, "Continuous monitoring of electrodermal activity during epileptic seizures using a wearable sensor," *Proc. 32nd Int. Conf. IEEE Engineering in Medicine and Biology Society*, pp. 4415-418, 2010.

R. Fletcher, **M.Z. Poh**, H. Eydgahi, "Wearable sensors: Opportunities and challenges for low-cost health care," *Proc. 32nd Int. Conf. IEEE Engineering in Medicine and Biology Society*, pp. 1763-1766, 2010.

E. Hedman, O. Wilder-Smith, M.S. Goodwin, **M.Z. Poh**, R. Fletcher, and R.W. Picard, "iCalm: Measuring electrodermal activity in almost any setting," *Proc. 3rd Int. Conf. Affective Computing and Intelligent Interaction*, Amsterdam, pp.1-2, 2009.

M.Z. Poh, K.H. Kim, A.D. Goessling, N.C. Swenson and R.W. Picard, "Heartphones: Sensor earphones and mobile application for non-obtrusive health monitoring," *Proc. 13th IEEE Int. Symp. Wearable Computers (ISWC),* Linz, Austria, pp. 153-154, 2009.

CONFERENCE ABSTRACTS

M.Z. Poh, T. Loddenkemper, C. Reinsberger, N.C. Swenson, S. Goyal, J.R. Madsen and R.W. Picard, "Intensity of autonomic disturbance following tonic-clonic seizures is correlated with post-ictal generalized EEG suppression," *Annual Meeting of the American Epilepsy Society*, Baltimore, MD, Dec 2-6, 2011.

M.Z. Poh, T. Loddenkemper, C. Reinsberger, N.C. Swenson, S. Goyal, J.R. Madsen and R.W. Picard, "Sympathetic changes associated with epileptic seizures," *Annual Meeting of the American Epilepsy Society*, San Antonio, TX, Dec 3-7, 2010.

M.Z. Poh, T. Loddenkemper, N.C. Swenson, M.C. Sabtala, J.R. Madsen and R.W. Picard, "Characterization of long-term continuous electrodermal activity lateralization in pediatric epilepsy patients," *Epilepsia*, Vol 50 (Suppl. 11), pp. 11-12, 2009.

M.Z. Poh, N.C. Swenson and R.W. Picard, "Comfortable sensor wristband for ambulatory assessment of electrodermal activity," *1st Biennial Conference of the Society for Ambulatory Assessment*, Greifswald, Germany. June 25-28, 2009.

E. Hedman, M. Eckhardt, **M.Z. Poh**, M.S. Goodwin, L.J. Miller, B. Brett-Green, S.A. Schoen, D.M. Nielsen and R.W. Picard, "Heart rate variability and electrodermal activity in children with atypical sensory processing: Exploratory pattern analysis," *in the Extended Abstract of the International Meeting for Autism Research (IMFAR) 2009*, Chicago, Illinois, USA, May 7-9, 2009.

PATENTS

R.W. Picard, C.J. Williams, R.R. Fletcher, H. Eydgahi, **M.Z. Poh**, O.O. Wilder-Smith, K.H. Kim, K Dobson, C.H. Lee, “Washable Wearable Biosensor,” U.S. Patent No. 8,140,143, issued March 20, 2012.

M.Z. Poh and R. W. Picard, “Methods and Apparatus for Assessment of Atypical Brain Activity,” U.S. Patent Application No. 61/486,896, Publication No. 2012/0296175 (published Nov 22, 2012).

M.Z. Poh, D.J. McDuff and R.W. Picard, "Method and System for Measurement of Physiological Parameters," U.S. Patent Application No. 13/048,965, Publication No. 2011/0251493 (published Oct 13, 2011).

M.Z. Poh, R. W. Picard and K.H. Kim, "Sensor Earphone System for Cardiovascular Assessment, Feedback and Communication," U.S. Patent Application No. 61/164,677, Unpublished (filing date Mar 30, 2009).

THESIS

M.Z. Poh, "Continuous Assessment of Epileptic Seizures With Wrist-worn Biosensors," *PhD Thesis, Harvard-MIT Division of Health Sciences and Technology, Massachusetts Institute of Technology*. September 2011.

M.Z. Poh, "Investigating Transport of Charged Nanoparticles by Multiphoton Fluorescence Correlation Spectroscopy (MPFCS)," *SM Thesis, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology*. September 2007.

Media and Press

- TechCrunch (January 2, 2013), "The Ultimate Guide To The 50+ Hottest Health And Fitness Apps, Gadgets And Startups Of 2012".
- **Huffington Post** (December 27, 2012), "Best Fitness Apps of 2012".
- The Next Web (August 19, 2012), "5 Personal Data Tracking Innovations To Watch".
- **BBC Channel 4** (December 17, 2012), Cardiio App Featured on "Stephan Fry: Gadget Man".
- **CBS The Doctors TV Show** (November 8, 2012), "Must-Know Gadgets, Gizmos and Health Trends".
- **ABC News** (Oct 11, 2012), "A Camera That Measures Your Pulse From Afar".
- Fast Company (August 10, 2012), "Heart-Monitor iPhone App Works By Scanning The Blood In Your Face".
- Mashable (August 10, 2012), "App Turns Your iPhone's Camera Into a Heartrate Monitor".
- Fast Company (August 10, 2012), "To Find Your Heart Rate, Stare At This App".
- **PC Magazine** (August 9, 2012), "Cardiio App Offers Touch-Free Heart and Health Monitoring".
- TechCrunch (August 9, 2012), "Using The iPhone's Front-Facing Camera, Cardiio Measures Your Heartrate".
- GigaOm (August 9, 2012), "Cardiio Uses iPhone Camera Sensor To Get Your Heart Rate On The Go".

- CBS SmartPlanet (May 10, 2012), "Wristband Sensors to Prevent Fatal Epileptic Seizures".
- **Popular Science** (May 9, 2012), "Wristband Sensors Can Detect, and Possibly Predict, Life-Threatening Seizures".
- New Scientist (May 9, 2012), "Sweat-Sensing Bracelet Could Detect Fatal Seizures".
- **Huffington Post** (April 27, 2012), "Wristband Could Predict Severe Epileptic Seizures".
- MIT News (April 27, 2012), "Gauging Seizures' Severity". [Featured on MIT homepage]

- **Wired UK** (November 12, 2012), "Medic On The Wall: How Ming-Zher Poh's Mirror Displays Your Pulse".
- **Wall Street Journal** (September 25, 2012), "Mirrors That Double As Computers".
- **CNN** (Jun 10, 2011), "Medical Mirror Monitors Vital Signs". [Featured in "The Big I (idea, innovation, intelligence"]
- **Popular Science** (May 26, 2011), "**2011 Invention Awards**: A Mirror That Monitors Vital Signs".
- MIT Technology Review (Feb 2011), "Mirror, Mirror on the Wall … System could monitor vital signs without contact".
- **New York Times** (Jan 1, 2011), "Computers That See You and Keep Watch Over You". [**Front page** article]
- **New York Times Magazine** (Dec 19, 2010), "Taking Your Pulse By Webcam". [Featured in **10th Annual Year in Ideas**]
- EarthSky (Dec 16, 2010), "Monitor Your Heart Rate at Home via Webcam".
- **Forbes** (Dec 3, 2010), "Written All Over Your Face".

- **BBC News** (Oct 19, 2010), “The Place Where Crazy Inventors Create Your Future”.
- **ABC** (Oct 15, 2010), “New System Could Measure Pulse, Respiration and Blood Pressure With a Webcam”.
- Boston Globe (Oct 11, 2010), “Measuring Vital Signs At a Glance”.
- The Harvard Crimson (Oct 7, 2010), “Webcams May Now Record Vital Signs”.
- Engadget (Oct 7, 2010), “MIT Medical Lab Mirror Tells Your Pulse With a Webcam”.
- **Discovery Channel**, Canada (Oct 5, 2010), Featured on the “Daily Planet” show
- EE Times (Oct 5, 2010), “Webcam Takes Vital Signs Noninvasively”.
- The Engineer (Oct 5, 2010), “MIT Develops Low-Cost Cameras For Measuring Heart Rate”.
- **CNET News** (Oct 5, 2010), “Mirror, Mirror, Show Me My Vital Signs”.
- **Popular Science** (Oct 4, 2010), “Common Webcams Could Be Used Continuously To Monitor Your Vital Signs”.
- Medgadget (Oct 5, 2010), “MIT Student Uses Webcam to Measure Heart Rate From a Distance”.
- MIT News (Oct 4, 2010), “Your Vital Signs, On Camera”. [Featured on MIT homepage]

Invited Talks/Oral Presentations

“Cardiio,” Digital Health Summer Summit - Tomorrow’s Rockstars: Rock Health Startup Demo, June 15, 2012.

“Cardiocam: Technology for Non-Contact Multi-Parameter Physiologic Measurements,” 33rd Int. Conf. IEEE Engineering in Medicine and Biology Society, Sept 1, 2011.

"Continuous monitoring of electrodermal activity during epileptic seizures using a wearable Sensor," 32nd Int. Conf. IEEE Engineering in Medicine and Biology Society, Sept 3, 2010.

"Innovative Technologies for Monitoring Physiology and Promoting Health," Center for Integration of Medicine & Innovative Technology (CIMIT) Forum: Human Behavior Models for New Media Health, June 8, 2010.

Exhibition

ACM **SIGGRAPH** Emerging Technologies, *A Medical Mirror for Non-contact Health Monitoring,* Vancouver, Canada, August 7-11, 2011

Leadership/Volunteer Work

Managed a team of US and UK university students and organized/taught charitable English camps in Jinan, China for ten weeks (Summer 2007) • Organized and taught a short English camp in Shenzhen, China (Winter 2007) • Volunteered on a house building project with Habitat for Humanity) • President of the Biomedical Engineering Society (BMES), Cornell University (2004 – 2005) • Executive Officer of the Institute of Electrical and Electronics Engineers (IEEE), Cornell University (2002-2003)