

# Eric C. Larson

Curriculum Vitae

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## RESEARCH VISION

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I am interested in the interdisciplinary nature of signal processing techniques and have published in the fields of image processing, medical devices, psycho-visual psychology, human-computer interaction, and ubiquitous computing. Most recently, I have positioned myself in a unique role, supporting healthcare and sustainability applications via the integration of signal processing and ubiquitous sensing. My dissertation focuses on signal processing that supports sustainability research using a technique known as Infrastructure Mediated Sensing (IMS). IMS infers activity in a space or residence by sensing at a single point along a home's infrastructure. For example, using a single pressure sensor on a home's plumbing system to monitor water activity throughout the entire home. This information is conveyed back to the homeowner and can be used to reduce wasteful practices. My dissertation covers the gamut of topics for IMS in water monitoring: low-power sensing, real-time embedded analysis, unsupervised calibration in the cloud, and efficient scaling of IMS technology. Outside of my dissertation I have become increasingly interested in sensing markers of health and wellness using commonplace sensors. Mobile healthcare is particularly interesting to me, as it has become an explosive topic in the last decade. For example, I have worked on projects in mobile-phone-based spirometry and cough detection, and I am currently working on trials for FDA approval of these devices. I am working to support many healthcare initiatives by creating applications that use sensors already embedded in the mobile phone to manage and diagnose many types of ailments. Samplings of my research projects appear in the color-coded map below.

### GasSense *Pervasive 2010*

Using a single sensor to analyze gas usage down to the individual appliance (*i.e.*, fireplace, stove, *etc.*).

### FlowSensing *Advised Thesis 2010*

Using encapsulated regression to estimate hot/ cold water flow via a pressure sensor.

### Feedback Displays *CHI 2012*

Surveying methods of displaying water usage and themes around what information is actionable.

### HydroSense

*UbiComp 2009*

Single point pressure sensing solution for identifying water use down to the fixture level (*i.e.*, specific faucets, toilets, showers).

### HydroSense: Longitudinal Study

*Pervasive 2011*

A five week study using HydroSense in real world conditions. Most comprehensive hot- and cold-water dataset ever created.

### Dante Vision

*ESPA 2012*

Using thermal/depth cameras to infer gestures and identify multiple users.

## Health

### SpiroSmart *UbiComp 2012*

Using a mobile phone microphone to infer lung function measures.

### CoughSense

*UbiComp 2011*

Using a mobile phone microphone to infer cough rate. Speech is disguised to preserve privacy.

### MAD

*JEI 2010*

Predicting the perceived annoyance of compression/photographic artifacts in images.

### HeatWave *CHI 2011*

Using a thermal camera to detect touches on projected interfaces.

## Image Processing

### Facial Animation Optimization

*WCCI 2008*

Optimizing facial animation parameters in video using multi-objective optimization.

## EDUCATION

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- Present **PhD Candidate in Electrical Engineering**, Post Qualifying Examination, University of Washington, Seattle  
Area: Digital Signal Processing; Advisor: Dr. Shwetak Patel, Co-Advisor: Dr. Les Atlas  
Thesis Topic: *Infrastructure Mediated Sensing without Tears: Semi-Supervised, Multi-objective Training of Conditional Random Fields* (Expected Completion April 2013)
- 2008 **Master of Science in Electrical Engineering**, Oklahoma State University, Stillwater  
Area: Image Processing and Digital Signal Processing, Advisor: Dr. Damon Chandler  
MS Thesis: *Predictive Image Quality: The Most Apparent Distortion*
- 2006 **Bachelor of Science in Electrical Engineering**, Oklahoma State University, Stillwater  
Area: Communications, Signals, and Controls  
GPA: 3.92/4.00, summa cum laude

## HONORS AND AWARDS

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|------|---|
| 2012 | UW College of Engineering Student Research Innovator                                |
| 2012 | UbiComp 2012 Best Paper Award Nomination ( <i>First Author</i> )                    |
| 2012 | Madrona Prize for Research Excellence and Commercial Appeal, UW CSE Affiliates 2012 |
| 2012 | CHI 2012 Best Paper Award Nomination ( <i>Supporting Author</i> )                   |
| 2012 | Intel Science and Technology Fellowship   |
| 2011 | CHI 2011 Best Paper Award Nomination ( <i>First Author</i> )                        |
| 2010 | Yang Research Award Finalist  |
| 2010 | Chair's Award for Outstanding Teaching Assistant                                    |
| 2010 | Madrona Prize for Research Excellence and Commercial Appeal, UW CSE Affiliates 2010 |
| 2009 | UbiComp 2009 Best Paper Award Nomination ( <i>Supporting Author</i> )               |
| 2009 | Nominated for Outstanding UW Research Assistant Award                               |
| 2009 | Nominated for Outstanding UW Teaching Assistant Award, Fall and Winter Quarters     |
| 2008 | OSU Distinguished Regents Scholarship   |
| 2006 | President of Eta Kappa Nu Omega Chapter   |
| 2004 | Inducted into Eta Kappa Nu, Electrical Engineering Honor Society                    |
| 2004 | Dowty Carlson Scholarship Recipient   |
| 2002 | Naeter Scholarship Recipient  |

## TEACHING

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|--------------------|---|
| 2010 <i>Spring</i> | <b>Teaching Assistant CSS457, Multimedia and Signal Computing</b><br>UW Bothell, Course Reorganization  |
| 2009 <i>Winter</i> | <b>Teaching Assistant EE518, Graduate Level Digital Signal Processing</b><br>UW Seattle, Lecturer for Recitation, Professional Master's Program |
| 2009 <i>Autumn</i> | <b>Teaching Assistant EE233, Circuit Analysis II</b><br>UW Seattle, Lab Manager, Lecturer for Recitation  |
| 2006-2007          | <b>Teaching Assistant ECEN 3714, Network Analysis</b><br>OSU, Stillwater, Lab Manager, Lecturer for Recitation                                  |
| 2005-2006          | <b>Teaching Assistant ECEN 3021, Experimental Methods II</b><br>OSU, Stillwater, Lab Manager, Lecturer for Recitation                           |

## EMPLOYMENT

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|--------------------|---|
| 2012-present       | <b>Intel Science and Technology Center, Seattle WA</b><br>Research Assistant                                |
| 2009-present       | <b>University of Washington, Electrical Engineering, Seattle, WA</b><br>Research Assistant                  |
| 2010 <i>Summer</i> | <b>Intel Research, Seattle, WA</b><br>Research Intern with Dr. Beverly Harrison                             |
| 2007-2008          | <b>Oklahoma State University, Stillwater, OK</b><br>Research Assistant with Dr. Damon Chandler              |
| 2006 <i>Summer</i> | <b>Garmin International, Olathe, Kansas</b><br>Design Engineer Intern for Consumer Electronics              |
| 2005 <i>Summer</i> | <b>Oklahoma State University, Stillwater, OK</b><br>Research for Undergraduates (REU) with Dr. Keith Teague |

## REFEREED JOURNAL PUBLICATIONS

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- 2011** [J.04] **E. C. Larson**, J. Froehlich, T. Campbell, C. Haggerty, L. Atlas, J. Fogarty, and S. N. Patel, (2011). "Disaggregated Water Usage Sensing from a Single, Non-Intrusive Sensor: an Extended Analysis of HydroSense using Staged Experiments." *The Pervasive and Mobile Computing Journal (PMC)*. 8(1):82-102.
- [J.03] J. Froehlich, **E.C. Larson**, S. Gupta, G. Cohn, M. Reynolds, S.N. Patel (2011). "Disaggregated End-Use Energy Sensing for the Smart Grid" *IEEE Pervasive Computing, Special Issue on Smart Energy Systems*. 10(1):28-39.
- 2010** [J.02] **E. C. Larson** and D. M. Chandler (2010). "The Role of Strategy in Image Quality: The Most Apparent Distortion," *Journal of Electronic Imaging*, 19(1), 011006, January-March 2010. **Featured on Cover**
- [J.01] **E. C. Larson** and G. Yen (2010). "Facial Feature Tracking via Evolutionary Multi-objective Optimization," *International Journal of Applied Evolutionary Computation (IJAEC)*, 1(1):57-71, 2010.

## REFEREED CONFERENCE PUBLICATIONS<sup>1</sup>

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- 2012** [C.16] **E.C. Larson**, M. Goel, G. Boriello, S. Heltshe, M. Rosenfeld, and S.N. Patel (2012). "SpiroSmart: Using a Microphone to Measure Lung Function on a Mobile Phone." *Proceedings of the 14th International Conference on Ubiquitous Computing (UbiComp 2012)*, Pittsburgh, USA, Sep 5-8, 2012.  
**Nominated for Best Paper**  
Acceptance Rate: 19% (58/301)
- [C.15] J. Froehlich, L. Findlater, M. Ostergren, S. Ramanathan, J. Peterson, I. Wragg, **E.C. Larson**, F. Fu, M. Bai, S.N. Patel, J. Landay (2012). "The Design and Evaluation of Prototype Eco-Feedback Displays for Fixture-Level Water Usage Data." *Proceedings of the 2012 ACM Annual Conference on Human Factors in Computing Systems (CHI 2012)*, 2367-2376, Austin, TX May 2012.  
**Best Paper Honorable Mention**  
Acceptance Rate: 23% (363/1577)
- [C.14] T. Phan, **E.C. Larson**, S. Sohoni, and D. Chandler (2012). "Performance-Analysis-Based Acceleration of Image Quality Assessment." *IEEE Southwest Symposium on Image Analysis and Interpretation (SSIAI 2012)*, 81-84, April 2012.
- [C.13] E. Saba, **E. C. Larson**, and S. N. Patel (2012). "DANTE Vision: In-Air and Touch Gesture Sensing for Natural Surface Interaction with Combined Depth and Thermal Cameras." *First Annual Conference on Emerging Signal Processing Applications (ESPA 2012)*, 167-170, January 2012.  
Acceptance Rate: 38% (52/137)
- 2011** [C.12] **E. C. Larson** T. Lee, S. Liu, M. Rosenfeld, and S. N. Patel (2011). "Accurate and Privacy Preserving Cough Sensing from a Low Cost Microphone." *Proceedings of the 13th International Conference on Ubiquitous Computing (UbiComp 2011)*, 375-384, Beijing, China, September 2011.  
Acceptance Rate 16.6% (50/302)

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<sup>1</sup> My research is often interdisciplinary, attracting readers with various backgrounds. It is worth noting that unlike in many academic fields, premiere conferences (such as CHI and UbiComp) are highly selective venues intended for archival papers only. These conferences exceed many IEEE journals in their selectivity, visibility, and impact. For a study of the impact of ACM conference proceedings, see [Conference Paper Selectivity and Impact](#) by Jilin Chen and Joseph Konstan.

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- 2011** [C.11] **E.C. Larson**, J. Froehlich, E. Saba, T. Campbell, L. Atlas, J. Fogarty, S.N. Patel (2011). "A Longitudinal Study of Pressure Sensing to Infer Real-World Water Usage Events in the Home." Proceedings of the Ninth International Conference on Pervasive Computing (Pervasive 2011). 50-69, San Francisco, CA, June 12-15, 2011.  
Acceptance Rate: 23.6% (22/93)
- [C.10] **E.C. Larson**, G. Cohn, S. Gupta, X. Ren, B. Harrison, D. Fox, S.N. Patel (2011) "HeatWave: Thermal Imaging for Surface user Interaction." Proceedings of the 2011 ACM Annual Conference on Human Factors in Computing Systems (CHI 2011), 2565-2574, Vancouver, Canada, May 7 - 12, 2011.  
**Best Paper Honorable Mention**  
Acceptance Rate: 25%
- 2010** [C.09] T. Campbell, **E.C. Larson**, G. Cohn, J. Froehlich, R. Alcaide and S.N. Patel (2010). "WATTR: A Method for Self-Powered Wireless Sensing of Water Activity in the Home." In Proceedings of the 12th ACM International Conference on Ubiquitous Computing (UbiComp 2010). 169-172, Copenhagen, Denmark, September 2010.  
Acceptance Rate: 19% (39/202)
- [C.08] G. Cohn, S. Gupta, J. Froehlich, **E. C. Larson**, and S. Patel (2010). "GasSense: Appliance-Level, Single-Point Sensing of Gas Activity in the Home" Proceedings of the Eighth International Conference on Pervasive Computing (Pervasive 2010), 265-282, Helsinki, Finland, May 17-20.  
Acceptance Rate: 17%
- 2009** [C.07] J. Froehlich, **E. C. Larson**, C. Haggerty, T. Campbell, S. Patel, and J. Fogarty (2009). "HydroSense: Infrastructure-Mediated Single-Point Sensing of Whole Water Home Activity In Proceedings of the 11th ACM International Conference on Ubiquitous Computing (UbiComp 2009), Orlando, FL, September 2009. **Nominated for Best Paper**  
Acceptance Rate: 12.4%
- [C.06] **E. C. Larson** and D. M. Chandler (2009). "The Most Apparent Distortion: A Dual Strategy for Full Reference Image Quality," Proc. SPIE Image Quality and System Performance, 7242, January 2009.
- 2008** [C.05] **E. C. Larson** and D. Chandler (2008). "Unveiling relationships between regions of interest and image fidelity metrics." Visual Communications and Image Processing 2008 (VCIP 2008), 6822, 2008,
- [C.04] **E. C. Larson** and G. Yen (2008). "Facial feature tracking in dynamic bandwidth environments: a genetic approach," IEEE World Congress on Computational Intelligence (CEC 2008), 2819-2826, June 2008.
- [C.03] V. Kadiyala, S. Pinneli, **E. C. Larson**, and D. M. Chandler (2008). "Quantifying the Perceived Interest of Objects in Images: Effects of Size, Location, Blur, and Contrast," Proc. Human Vision and Electronic Imaging 2008 (HVEI 2008), San Jose, CA, January 2008.
- [C.02] **E. C. Larson**, C. Vu, and D. Chandler (2008). "Can Visual Fixation Patterns Improve Image Fidelity Assessment?," Proc. of the International Conference on Image Processing (ICIP 2008), 2572-2575, 2008.
- 2007** [C.01] **E. C. Larson** and D. Chandler (2007). "Explaining Crypsis and Information Content in the Mammalian Visual Pathway using Statistical Measures of Animal Camouflage," OSA Fall Vision Meeting 2007, January 2007.

## SELECTED TALKS

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- 2012** [V.11] **Sensing for Sustainability: Disaggregated Sensing of Electricity, Water, and Gas**, *Berkeley, CA*  
Invited Talk, i4Energy CITRIS Fall Seminar, 2012
- [V.10] **SpiroSmart: Measuring Lung Function from a Mobile Phone**, *Pittsburg, PA*  
International Conference on Ubiquitous Computing 2012
- [V.9] **Indirect Water End-Use Sensing: Consumption, Disaggregation, and Feedback**, *Berkeley, CA*  
Invited Talk, 2012 ACEEE Hot Water Forum
- [V.8] **OpenCV for Ubiquitous Computing**, *Seattle, WA*  
Invited Lecture, CSE599 - Ubiquitous Computing
- 2011** [V.7] **Accurate and Privacy Preserving Cough Sensing**, *Beijing, China*  
International Conference on Ubiquitous Computing 2011
- [V.6] **A longitudinal Study of Pressure in the Home**, *San Francisco, CA*  
International Conference on Pervasive Computing 2011
- [V.5] **Where Ubiquitous Computing Meets Signal Processing**, *Atlanta, GA*  
Invited Talk, Georgia Institute of Technology
- [V.4] **HeatWave: Thermal Imaging for Surface Interaction**, *Vancouver, Canada*  
International Conference on Human-Computer Interaction 2010
- 2010** [V.3] **Disaggregated Water Sensing from a Single Sensor**, *Berkeley, CA*  
Invited Talk, 2010 ACEEE Hot Water Forum,
- [V.2] **Machine Learning Toolkits**, *Seattle, WA*  
Invited Lecture, CSE599 - Ubiquitous Computing, November
- 2009** [V.1] **The Most Apparent Distortion: A Dual Strategy for Image Quality**, *San Francisco, CA*  
SPIE Image Quality and System Performance, January

## PATENTS

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- 2012** S. Patel, **E.C. Larson**, T. Lee, S. Liu, Cough Detecting Methods and Devices for Detecting Coughs. US Patent Pending.
- T. Campbell, **E. C. Larson**, G. Cohn, R. Alcaide, J. Froehlich, S. Patel, Systems and Methods for Energy Harvesting in a Contained Fluid Circuit. US Patent Pending.
- 2009** S. Patel, J. Fogarty, J. Froehlich, **E. C. Larson**, Sensing Events Affecting Liquid Flow in a Liquid Distribution System. US Patent Pending.