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<http://research.google.com/pubs/author20740.html>

- BACKGROUND** I am interested in developing practical computer vision and machine learning inspired solutions for important real-world problems.
My research has provided key technology components to several highly visible products such as YouTube, Google StreetView, Google Docs and Google Books. It has also contributed to several areas of computer vision and robotics such as optical character recognition, scene text detection, image mosaicking, color image processing, 3D shape reconstruction, and performance metrics for evaluating computer vision algorithms.
- Area keywords:** Computer Vision, Mobile robotics, Optical character recognition, Machine learning, 2D image processing, 3D range data processing, Algorithm evaluation metrics
- EDUCATION**
- Carnegie Mellon University** Pittsburgh, PA
Ph.D in Robotics, School of Computer Science (GPA 4.0/4.0) **2002–2008**
Thesis: Statistical approaches to multi-scale point cloud processing
Advisor: Prof. Martial Hebert
- Carnegie Mellon University** Pittsburgh, PA
M.S. in Robotics, School of Computer Science (GPA 4.0/4.0) **2000–2002**
Thesis: Globally consistent mosaicking for autonomous visual navigation
Advisor: Prof. Alonzo Kelly
- Indian Institute of Technology** Kharagpur, India
B.Tech.(Hons.) in Electronics and Elec. Commn. (GPA 9.32/10.0) **1996–2000**
Thesis: Evaluation of a multi-camera stereo system for generating dense disparity maps
- RESEARCH EXPERIENCE**
- Google Inc.** Mountain View, CA
Senior Software Engg. (OCR team) **April 2008 – present**
Engg. Intern (Research, OCR) **May–July 2007, July–October 2005**
- ◊ Developed solutions to several problems in optical character recognition that are currently used in the Google Books processing pipeline. These include algorithms for language identification, script and page orientation estimation, and recognition of books in medieval language variants.
 - ◊ Developed a low-latency distributed service for OCR processing currently used by several projects including Google Goggles and Google Docs.
 - ◊ Conceived and implemented a new algorithm for text detection in unconstrained images that achieved performance competitive with or surpassing that of benchmarked commercial systems in diverse image categories, and used by several projects including Google StreetView and Google Video.
 - ◊ Developed new metrics for evaluating text detection algorithms.

RESEARCH
EXPERIENCE
(contd.)

Robotics Institute, Carnegie Mellon University
Research Assistant

Pittsburgh, PA
Aug '02–April '07

Low-level vision in 2D images:

- ◇ Developed algorithm to extract scale-invariant keypoints from color images while being invariant to changes in scene illuminant.
- ◇ Developed new metrics for quantitative evaluation of image segmentation algorithms.
- ◇ Formulated extensions of traditional scale-invariant keypoint detectors to process vector-valued quantities such as optical flow and histograms.

Environment understanding from images and 3D laser data:

- ◇ Demonstrated automatic generation of simplified semantic maps of large urban environments for object-referenced navigation and display.
- ◇ Developed new statistical tools for multi-scale geometric reconstruction from sparse and noisy 3D data with the goal of extending the perceptual horizon of laser scanners.
- ◇ Implemented fast algorithms to perform online terrain classification in unstructured outdoor environments for mobile robot navigation.
- ◇ Demonstrated new robust statistical methods for detection of multiple coherent planar structures (such as faces of buildings) in data with high clutter.
- ◇ Also developed solutions to several ancillary problems, including new techniques for fast and accurate laser-to-camera calibration.

National Robotics Engineering Consortium
Research Assistant

Pittsburgh, PA
Aug '00–July '02

Building large image mosaics for robot localization:

- ◇ Developed a general optimization framework for building mosaics of large-scale cyclic environments at low computational cost.
- ◇ Demonstrated use of image mosaics for visual odometry to automate guided vehicles in complex factory environments.

Texas Instruments (R&D)
Engg. Intern

Bangalore, India
May–July 1999

- ◇ Conceived and implemented an efficient technique for VOIP packet encryption (patent pending).
- ◇ Designed and implemented a VOIP communication framework with g.723 voice codec running on a TMS320 processor.

Indian Institute of Technology
Undergraduate Researcher

Kharagpur, India
1999–2000

- ◇ Simulated a multi-camera vision system and studied its utility in generating dense disparity maps.

PUBLICATIONS

Journals and Magazines (refereed)

- [1] “Scale Selection for Geometric Fitting in Noisy Point Clouds”, R. Unnikrishnan, M. Hebert, *Intl. Journal of Computational Geometry and its Applications (IJCGA)*, 20(5), October 2010
- [2] “Towards Objective Evaluation of Image Segmentation Algorithms”, R. Unnikrishnan, C. Pantofaru, M. Hebert, *IEEE Trans. Pattern Analysis and Machine Intelligence (PAMI)*, 29(6), June 2007
- [3] “An Infrastructure-Free Automated Guided Vehicle Based on Computer Vision”, A. Kelly, B. Nagy, D. Stager, R. Unnikrishnan, *IEEE Robotics and Automation Magazine*, 14(3), pp. 24–34, Sept. 2007

Conferences (refereed)

- [4] “Combined Script and Page Orientation Estimation using the Tesseract OCR Engine”, R. Unnikrishnan, R. Smith, *Proc. Intl. Conf. on Document Analysis and Recognition (ICDAR), Workshop on Multi-lingual OCR*, 2009
- [5] “Multi-scale interest regions from unorganized point clouds”, R. Unnikrishnan, M. Hebert, *Proc. IEEE Conf. on Computer Vision and Pattern Recognition (CVPR), Workshop on Search in 3D*, 2008
- [6] “Denoising Manifolds and Non-manifolds from Point Clouds”, R. Unnikrishnan, M. Hebert, *Proc. British Machine Vision Conference (BMVC)*, 2007
- [7] “Vegetation Detection for Driving in Complex Environments”, D. Bradley, R. Unnikrishnan, J. Bagnell, *Proc. IEEE Intl. Conf. on Robotics and Automation (ICRA)*, 2007
- [8] “Extracting Scale and Illuminant Invariant Regions Through Color”, R. Unnikrishnan, M. Hebert, *Proc. British Machine Vision Conference (BMVC)*, Vol. 2, pp. 499–508, 2006
- [9] “Scale Selection for the Analysis of Point-Sampled Curves”, R. Unnikrishnan, J.-F. Lalonde, N. Vandapel, M. Hebert, *Proc. Third Intl. Symposium on 3D Processing, Visualization and Transmission (3DPVT)*, June 2006
- [10] “A Measure for Objective Evaluation of Image Segmentation Algorithms”, R. Unnikrishnan, C. Pantofaru, M. Hebert, *Proc. IEEE Intl. Conf. on Computer Vision and Pattern Recognition (CVPR), Workshop on Empirical Evaluation Methods in Computer Vision*, June 2005
- [11] “Scale Selection for Classification of Point-sampled 3D Surfaces”, J.-F. Lalonde, R. Unnikrishnan, N. Vandapel, M. Hebert, *Proc. IEEE Intl. Conf. on 3D Digital Imaging and Modeling (3DIM)*, June 2005
- [12] “Measures of Similarity”, R. Unnikrishnan, M. Hebert, *Seventh IEEE Workshop on Applications of Computer Vision (WACV)*, pp. 394-400, January, 2005
- [13] “Robust Extraction of Multiple Structures from Non-Uniformly Sampled Data”, R. Unnikrishnan, M. Hebert, *Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Vol. 2, pp. 1322–1329, 2003
- [14] “Toward Generating Labeled Maps from Color and Range Data for Robot Navigation”, C. Pantofaru, R. Unnikrishnan, M. Hebert, *Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Vol. 2, pp. 1314–1321, 2003
- [15] “Efficient Construction of Globally Consistent Ladar Maps using Pose Network Topology and Nonlinear Programming”, A. Kelly, R. Unnikrishnan, *Proc. 11th Intl. Symposium of Robotics Research (ISRR)*, 2003
- [16] “A Constrained Optimization Approach to Globally Consistent Mapping”, R. Unnikrishnan, A. Kelly, *Proc. IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)*, Vol. 1, pp. 564–569, Oct 2002
- [17] “Mosaicking Large Cyclic Environments for Visual Navigation in Autonomous Vehicles”, R. Unnikrishnan, A. Kelly, *Proc. IEEE Intl. Conf. on Robotics and Automation (ICRA)*, Vol. 4, pp. 4299–4306, May 2002

PUBLICATIONS (contd.)	Theses & Technical reports [18] “Statistical Approaches to Multi-Scale Point Cloud Processing”, R. Unnikrishnan, <i>Ph.D thesis, Tech. report CMU-RI-TR-08-15, Robotics Institute, Carnegie Mellon University</i> , May. 2008 [19] “Fast Extrinsic Calibration of a Laser Rangefinder to a Camera”, R. Unnikrishnan, M. Hebert, <i>Tech. report CMU-RI-TR-05-09, Robotics Institute, Carnegie Mellon University</i> , July 2005. Associated with the public domain <i>Laser-Camera Calibration Toolbox (LCCT)</i> [20] “Globally Consistent Mosaicking for Autonomous Visual Navigation”, R. Unnikrishnan, <i>Master’s thesis, Tech. report CMU-RI-TR-02-22, Robotics Institute, Carnegie Mellon University</i> , Sept. 2002
PATENTS	R. Smith and R. Unnikrishnan, “Identifying script and orientation of text in an image”, Patent application filed March 24, 2010.
OPEN-SOURCE CONTRIBUTIONS	The Laser-Camera Calibration Toolbox (LCCT) : A tool for robust and portable external calibration of a camera to a laser rangefinder, with an easy-to-use Matlab®-based graphical interface.
PROFESSIONAL SERVICES	Regular reviewer of journal and conference publications in computer vision, robotics and machine learning, including the Intl. Journal of Computer Vision (IJCV), IEEE Trans. on Pattern Analysis and Machine Intelligence (PAMI), Journal of Computer Vision and Image Understanding (CVIU), IEEE Intl. Conf. on Computer Vision and Pattern Recognition (CVPR), IEEE Intl. Conf. on Computer Vision (ICCV), Intl. Conf. on Machine Learning (ICML), Intl. Symposium on 3D Processing, Visualization and Transmission (3DPVT), IEEE Intl. Conf. on Robotics and Automation (ICRA), IEEE/RSJ Intl. Conf. on Intelligent Robots and Systems (IROS)
AWARDS & SCHOLARSHIPS	◇ Graduate Fellowship from the School of Computer Science, Carnegie Mellon, since August 2000. ◇ Placed among top 3% of candidates in the 1996 Senior Mathematics Olympiad organized by the Central Board of Secondary Education (CBSE), India. ◇ Air-India Scholastic Award and the Chairman Award in 1994, for placing 1 st among candidates from five Gulf countries in the Secondary School AISSE examination.
TECHNICAL SKILLS	Programming Languages: C/C++, Matlab, Visual Basic Operating Systems: Linux/Unix, Windows Applications: OpenGL, GLUT, Mathematica, Visual Studio, Unix networking
REFERENCES	Available upon request