

**TECHNICAL
EXPERTISE**

More than 11 years of experience in multi-dimensional image/signal processing, pattern recognition, segmentation, quantification and tracking in real-time applications including: 2D, 3D, and 4D medical image analysis (Ultrasound, X-ray, CT and MR), image fusion and visualization for guiding interventional procedures, video surveillance, etc. Key-contributor on numerous industrial as well as US government funded projects (Samsung-Medison, GE Healthcare, NIH, NASA, NSF, NIJ, DoD, etc). Multiple patent filings in the area of automated medical image analysis, quantification, as well as disease staging. Background in human-anatomy specifically related to Liver, Musculoskeletal and Cardiac applications. **Over 5 years experience with leading the setup of clinical collaborations for long term research and product development. Engineering management experience with globally situated teams. Six-Sigma Green Belt Certified.**

EDUCATION

Ph.D., Electrical Engineering, October 2007
Thesis Title: "Video Inpainting And Scene Analysis"
Advisor: Prof. Guillermo Sapiro
University of Minnesota, Minneapolis, MN

M.S., Electrical Engineering (*Minor in Mathematics*), April 2004
Thesis Title: "Techniques For Automatic Image Inpainting"
Advisor: Prof. Guillermo Sapiro
University of Minnesota, Minneapolis, MN

B.E., Instrumentation and Control Engineering, August 2001
First Class with Distinction (summa cum laude)
Final Project: "Auscultation Assistant"
Advisor: Prof. Agashe and Prof. Mudhalwadkar
Govt. College of Engineering, University of Pune (GCOEP), Pune, India

COMPUTER SKILLS

- Programming: strong C++OOP background
- Data analysis tools: Python (iPython, numpy, scipy, matplotlib, scikit-learn), MATLAB
- C++Libraries: opencv, vxl, ITK
- GUI tools: Qt, pyqt, pyqtgraph

**RESEARCH AND
EXPERIENCE**

Sr. Chief Engineer, **Samsung Research Institute**
Healthcare and Medical Equipment Division.
Bangalore, India 560037 **June 2015 – Present**
Overview: Senior Engineering Manager - responsible for technical leadership of Ultrasound R & D team towards development 4D Ultrasound applications for automated clinical quantification of anatomical structures. Responsible for developing a R & D road map for Samsung-Medison's premium line of Ultrasound scanners in a specific clinical application space.

**RESEARCH AND
EXPERIENCE**

Lead Scientist, **GE - Global Research**
Biomedical Image Analysis Lab.
1 Research Circle, Niskayuna, NY 12065 **Nov 2007 – May 2015**

- Overview: Senior member of a multidisciplinary team and responsible for leading image analysis efforts for identification, extraction and quantification of clinically relevant features from medical imagery; inventing and implementing algorithms; developing intuitive visualization approaches to present quantified information to user.
- Key Work: **Multi-modality (ultrasound and fluoroscopy) fusion for interventional procedures (slated for NPI in 2016)**, real-time segmentation and tracking of anatomical features, automated detection of anatomical structures. Led the development of algorithms for automated assessment of rheumatoid arthritis from 3D ultrasound images

of finger-joints. Developed automated algorithms for real-time detection and tracking of blood vessels as well as embedded catheters in 4D ultrasound images for enabling interventional procedure guidance (**led the transition to product**). Key personnel in securing the funding for and leading engineering efforts on MR-Ultrasound fusion for automated assessment of intracranial pressure in astronauts (funded by NASA).

- Built research collaborations with radiologists at Mass. General Hospital MA, Mayo Clinic MN and Univ. Rochester NY.

Research Assistant - Image and Video Processing,

Image Processing Laboratory

200 Union St SE, Minneapolis, MN 55455

University of Minnesota

June 2002 – Oct 2007

- Developed an automatic background subtraction and foreground detection algorithm that uses “layers” to model the scene. Algorithm runs at 10fps on a 166 x 120 color video. Implemented using the Intel OpenCV® Library in C++.
- Developed an algorithm to separate individual foreground objects in a crowd. The ultimate goal of this work being separation, detection and tracking in multiple views.
- Developed a novel and fast technique for automatic object removal and occlusion filling-in for video. A priority based inpainting rule, with an automatic stopping criterion, is used to complete the occluded moving foreground. This algorithm was implemented using the Intel OpenCV® Library in C++.
- Developed a fast and simple automatic technique to decompose a given image into “structure + texture”. A gradient projection scheme is utilized for automatic iterative computation of the key parameter (which governs the decomposition) to minimize the energy functional proposed by L. Vese and S. Osher. Implemented in C++ as well as MATLAB.
- Developed a fast and automatic algorithm for color image inpainting by applying the concepts of “Projection Onto Convex Sets” and Wavelets. The algorithm usually converges in less than 25 iterations. Implemented in MATLAB.

Research Intern - CT Colon Segmentation

6580 Via del Oro, San Jose, CA 95119

Echopixel Technologies Inc.

June 2007 – August 2007

- Research possible methodologies and algorithms for segmenting colon lumen from series of DICOM images. Writing and defining algorithms for colon segmentation based on ITK and VTK toolkits. Implement colon segmentation algorithm. Defining testing protocols for said algorithms. Proposing methodology for extracting or generating surface mesh from a segmented colon DICOM stack.

Supervisor: Sergio A. Valencia (President)

Research Intern - Video Analysis,

Automatic Control Solutions Lab.

3600 Technology Dr., Minneapolis, MN 55418

Honeywell

May 2006 – August 2006

- Refinement of existing foreground detection algorithm for surveillance applications.
- Design of a robust algorithm for “example based query” type of people detection in multiple cameras, under varying pose and scale.

Supervisor: Dr. Vassilios Morellas (Principal Scientist)

Research Intern - Video Analysis,

Automatic Control Solutions Lab.

3600 Technology Dr., Minneapolis, MN 55418

Honeywell

June 2005 – August 2005

- Developed a fast algorithm for automatic segmentation of color images into homogeneous regions or layers. This algorithm was implemented in C++ using the Intel OpenCV library.
Supervisor: Dr. Vassilios Morellas (Principal Scientist)
- Researched possible techniques for video compression using the MPEG4 standard.
Supervisor: Dr. Saad Bedros (Principal Scientist)

Research Assistant - Heart Sound Analysis,
Biomechanical Engineering Laboratory
200 Union St SE, Minneapolis, MN 55455

University of Minnesota

June 2003 – October 2003

(In Collaboration With 3M Corp.)

- Developed an automatic technique to segment Heart Sounds into four parts - S1, systolic period, S2 and the diastolic period. Implemented in MATLAB.
Supervisor: Dr. Marie Guion

Teaching Assistant,
Dept. Of Electrical Eng.
200 Union St SE, Minneapolis, MN 55455

University of Minnesota

September 2001 – December 2003

Assisted the instructor in preparing material, web-tutorials, and conducting experiments for various under-graduate laboratory courses: Fundamentals of Electrical and Electronics Engineering, Senior Design Project.

PATENTS

> 10 Patents filed (> 5 as *Lead Inventor*).

Below is a sample of patents available on Google patent search:

K. A. Patwardhan, S. Gupta, Y. Yu, A. Dentinger, D. Mills, “Method and System for Automatic Segmentation and Temporal Tracking of Blood Vessels”

K. A. Patwardhan, N. Krahnstoever, T. Yu, “Method and System for Object Tracking Using Appearance Model”

A. Dentinger, **K. A. Patwardhan**, R. Hoctor “Method and System for Non-Invasive Monitoring of Patient Parameters”

N. Krahnstoever, T. Yu, **K. A. Patwardhan**, “System and Method for Monitoring an Entity Within an Area”

N. Krahnstoever, T. Yu, S. Lim, **K. A. Patwardhan**, “System, Method and Program Product for Camera-Based Discovery of Social Networks”

JOURNAL PUBLICATIONS

K. Cao, D. Mills, R. G. Thiele, **K. A. Patwardhan**, “Towards Automated Assessment of Rheumatoid Arthritis with Volumetric Ultrasound”, *accepted for publication in IEEE Trans. Biomedical Engg.*

K. A. Patwardhan, G. Sapiro, and V. Morellas, “A Pixel Layering Framework For Robust Foreground Detection In Video” *IEEE Transactions on Pattern Analysis and Machine Intelligence*, Volume 30, Issue 4, April 2008, pp:746-751 *Impact Factor : 3.58*

K. A. Patwardhan, G. Sapiro, and M. Bertalmio, “Video Inpainting Under Constrained Camera Motion,” *IEEE Transactions on Image Processing*, Volume 16, Issue 2, Feb. 2007, pp:545 - 553, *Impact Factor : 2.46*

CONFERENCE PUBLICATIONS

K. Cao, B. Bednarz, L. S. Smith, T. K. F. Foo, **K. A. Patwardhan**, “Respiration induced fiducial motion tracking in ultrasound using an extended SFA approach”, *accepted for oral presentation at SPIE Medical Imaging 2015: Ultrasonic Imaging and Tomography.*

K. Cao, D. Mills, **K. A. Patwardhan**, “Automated Catheter Detection in Volumetric Ultrasound”, *accepted for oral presentation at IEEE ISBI, San Fransisco USA, April 2013*

D. Mills, K. Cao, R. G. Thiele, **K. A. Patwardhan**, “Volumetric Ultrasound and Computer-Assisted Analysis At The Point-of-Care: A Musculoskeletal Exemplar”, **invited talk** *IEEE Engineering in Medicine and Biology Conference*, San Diego USA, August 28-31 2012.

K. A. Patwardhan, “Automated symmetry based feature detection in Ultrasound”, *Proceedings, IEEE Engineering in Medicine and Biology Conference* 2012.

K. A. Patwardhan, Y. Yu, S. Gupta, A. Dentinger, D. Mills, “Fast 4D vessel segmentation and tracking in Ultrasound”, *Proceedings, IEEE Intl. Conference on Image Processing* 2012.

K. A. Patwardhan, K. Cao, D. Mills, R. G. Thiele, “Automated bone and joint-region segmentation in volumetric ultrasound”, *IEEE Intl. Symposium on Biomedical Imaging (ISBI)*, Barcelona Spain, May 2-5 2012.

R. G. Thiele, **K. A. Patwardhan**, K. Cao, D. Mills, “Feasibility of Volumetric Ultrasound and Automated Analysis for Rheumatic Disease”, *Arthritis and Rheumatism* 2011; Vol 63; no.10

N. Krahnstoever, P. Tu, T. Yu, **K. A. Patwardhan**, D. Hamilton, B. Yu, C. Greco, G. Doretto, “Intelligent video for protecting crowded sports venues” (2009) 6th IEEE International Conference on Advanced Video and Signal Based Surveillance, AVSS 2009, art. no. 5279520, pp. 116-121.

N. Krahnstoever, T. Yu, **K. A. Patwardhan**, D. Gao, “Multi-camera person tracking in crowded environments” (2009) Proceedings of the 12th IEEE International Workshop on Performance Evaluation of Tracking and Surveillance, PETS-Winter 2009, art. no. 5399731.

N. Krahnstoever, T. Yu, S. Lim, **K. A. Patwardhan** and P. Tu, “Collaborative real-time control of active cameras in large scale surveillance systems”, ECCV Workshop On Multi-camera and Multi-modal Sensor Fusion Algorithms and Applications 2008, ($\approx < 25\%$ acceptance rate, CiteSeer impact factor rankings in the top 7%)

D. Rother, **K. A. Patwardhan**, I. Aganj and G. Sapiro, “3D Priors For Scene Learning From A Single View”, S3D Workshop, IEEE Conference on Computer Vision and Pattern Recognition, ($\approx < 25\%$ acceptance rate one of top 3 Computer Vision Conferences)

D. Rother, **K. A. Patwardhan** and G. Sapiro, “What Can Casual Walkers Tell Us About A 3D Scene?”, Intl. Conference on Computer Vision, ($\approx 23\%$ acceptance rate)

K. A. Patwardhan, G. Sapiro, and V. Morellas, “A Graph-based Foreground Representation and its Application in Example Based People Matching in Video,” *IEEE Intl. Conference on Image Processing* Sep. 2007 ($\approx < 45\%$ acceptance rate)

K. A. Patwardhan, G. Sapiro, and M. Bertalmio, “Video Inpainting Of Occluding And Occluded Objects,” *Proceedings of IEEE Intl. Conference on Image Processing*, Genova, Italy, Sept. 2005, Vol. 2, pp:69-72 ($\approx < 45\%$ acceptance rate)

K. A. Patwardhan, and G. Sapiro, “Automatic Image Decomposition,” *Proceedings, IEEE Intl. Conference on Image Processing*, Singapore, Sept. 2004, Vol. 1, pp:645-648 ($\approx < 45\%$ acceptance rate)

K. A. Patwardhan, and G. Sapiro, “Projection Based Image And Video Inpainting,” *Proceedings, IEEE Intl. Conference on Image Processing*, Barcelona, Spain, Sept. 2003, Vol. 1, pp:857-860 ($\approx < 45\%$ acceptance rate)

BOOK CHAPTERS G. Brooksby, G. Doretto, D. Hamilton, N. Krahnstoeber, J. Laffen, X. Liu, **K. A. Patwardhan**, T. , Y. Tong, J. Tu, P. Tu, F. Wheeler, C. Wynnyk, Y. Yao, and T. Yu, Chapter - “Video Analytics for Force Protection” In Book Titled - “Distributed Video Sensor Networks” (Springer, 2009). Editors - B. Bhanu, C. V. Ravishankar, A. K. Roy-Chowdhury, D. Terzopoulos, and H. Aghajan

N. Krahnstoeber, T. Yu, S. Lim, **K. A. Patwardhan** and P. Tu, Chapter - “Collaborative Control of Active Cameras in Large-Scale Surveillance” in Book Titled - “Multi-Camera Networks: Concepts and Applications” (ELSEVIER). Editors - H. Aghajan and A. Cavallaro

AWARDS AND HONORS

- **Article highlighting research on *Video-Inpainting* published in *Scientific American* in October 2006.**
- Best Undergraduate Final Year Project Award.
- Ranked 4th among > 100000 high-school science majors in state of Maharashtra, India.

PROFESSIONAL ACTIVITIES

- Member of *IEEE*
- Reviewer for esteemed journals and peer-reviewed conferences like *IEEE Transactions on Image Processing*, *IEEE Signal Processing Letters*, *ACM-SIGGRAPH*, *Journal of Visual Communication and Image Representation Registration*, *IEEE Transactions on Circuits and Systems for Video Technology*, *ACM SIGGRAPH*, *Pacific Graphics*, *IEEE ICIP*, *IEEE ICME*, etc.
- Member of technical program committee for IEEE ICME 2008.

INVITED TALKS

- Sony Research, San Jose, CA, August 2007
- Image Processing group, HP Research, Palo Alto, CA, August 2007
- Intelligent Systems Research Center at Kodak Research Laboratories, Rochester, NY, May 2007
- Minerva Research Group, Georgia Tech, April 2007

REFERENCES

Available upon request.