

# Research Statement

Ali Zandifar, Ph.D. alizandusa@gmail.com, Novafora Inc., San Jose CA

## Research Background

My main research interests are computer vision, image, and video processing.

My Ph.D. research at the University of Maryland under the supervision of Dr. Ramani Duraiswami, Prof. Larry S. Davis and Prof. Rama Chellappa was dedicated to analysis of scenes containing non-rigid objects. I developed a novel method for 3D structure recovery for textured objects such as bent paper with printed text. I used differential geometric properties of non-rigid objects to formulate a closed-form set of equations that allow the recovery of the full geometric structure of the paper from a single image. I also proved that these partial differential equations can be reduced to the Hopf equation that arises in non-linear wave propagation, and deformations of the paper could be interpreted in terms of the characteristics of this equation.

After my graduation, I joined Epson R&D Lab in the Silicon Valley, where I worked on camera calibration and image registration in visual inspection systems, and on printed text watermarking. One of the main challenges was to use computer vision algorithm for visual inspection of printed circuit boards (PCB, detect defects and distortions in their industrial production process, and compensate for such distortions in a fully automatic and efficient method. I developed algorithms and software for all the stages in the system, including intelligent substrate scanning, automatic image quality enhancement, reference image generation, robust feature-based image registration, image stitching, error analysis and defect diagnosis.

Another project I was involved in during my term in Epson was the watermarking project. I introduced innovative embedding and extracting of invisible watermarking messages. At embedding stage, the document image before printing is watermarked. At extracting stage, the watermark message is extracted after printing and scanning the document. The challenge is the robust recovery due to the printing/scanning step. I developed algorithms and software at the embedding stage to find “acceptable” letters/strokes in the document suitable for embedding, how to “embed” a bit information, “add” markers and “encode” a message with error correction encoder schemes, “embed” many copies of the encoded watermark message throughout the image. Also, at the extracting stage I developed solutions to “segment” the extracted bit-string to many “almost” similar encoded watermarks using markers, “decode” each noisy encoded message, “recover” the final watermark message out of many noisy messages using partial string matching algorithms.

I filed 15 patents covering the new methods and algorithms I developed.

After Epson, I continued my industrial and applied research career at Novafora Inc. There, I was one of the first employees in the Video Genome project, dedicated to Internet-scale video analysis applications. I worked with the company co-founders and scientists Drs. Alex and Michael Bronstein and Prof. Ron Kimmel. I was responsible for developing algorithms for video indexing and search, interactive object segmentation, tracking, and annotation. I employed geometric approaches to computer vision in problems such as shot-detection using heat equation approaches and image segmentation using geodesic distance framework. I also worked on object tracking problem via classical intensity-based

method, mean-shift and covariance-based methods. For video and object similarity, video search and indexing, SIFT-like features methods were used. I filed 1 patent at Novafora.

## Future Direction

I am interested in continuing my work on hypervideo annotation, appearance-based object tracking, and object detection and similarity initiated at Novafora. My goal there is almost fully-automatic video annotation. I would like to explore the problems of metadata and annotation mapping between different video version, automatic extraction of objects and actions from movies, fast image and video search, invariant feature descriptors and compact video representation, and motion segmentation.

Another domain I am interested in is text retrieval and indexing analogy to video analysis. I would like to create "regular expressions" for videos, video source control and version management. The solution is reachable by integrating computer vision with differential geometric approaches, statistical image and signal processing, clustering and low-level vision algorithms with elegant engineering skills.

## References

1. **Ali Zandifar** and Anoop Bhattacharjya, "Fast imaging system calibration", EPSON R&D Inc., US Patent filed Ser. No 11/260,964
2. **Ali Zandifar** and Anoop Bhattacharjya, "Distortion correction of a captured image", EPSON R&D Inc., US Patent filed Ser. No. 11/679,664
3. **Ali Zandifar** and Anoop Bhattacharjya, "Distortion correction of a scanned image", EPSON R&D Inc., US Patent filed Ser. No. 11/679, 64
4. **Ali Zandifar** and Anoop Bhattacharjya, "Low-memory auto-focus/auto-exposure, EPSON R&D Inc., US Patent filed Ser. No. 11/ 778968
5. **Ali Zandifar**, "Characterization of a printed droplet", Epson R&D Inc., US Patent filed Ser. No. 11/85154
6. **Ali Zandifar**, Che-bin Liu and Jing Xiao, "Embedding data in images", Epson R&D Inc., US Patent filed in Nov. 2007
7. **Ali Zandifar**, Che-bin Liu and Jing Xiao, "Extracting data from images", EPSON R&D Inc., US Patent filed in Nov. 2007
8. **Ali Zandifar** and Che-bin Liu, "Identifying embedded data in an image", US Patent filed in Nov 2007
9. **Ali Zandifar** and Jing Xiao, "Identifying steganographic data in an image", US Patent filed in Nov 2007
10. **Ali Zandifar** and Jing Xiao, "Segmenting a string using similarity values", Epson R&D Inc., Us Patent filed in Nov 2007
11. **Ali Zandifar** and Jing Xiao, "String reconstruction using multiple strings", Epson R&D Inc., US Patent filed in Aug 2008
12. **Ali Zandifar**, High resolution inspection of large scale PCB substrates by vision-based feedback, Epson R&D Inc., US Patent filed in Aug 2008
13. **Ali Zandifar**, "Simulation of large PCB substrate dot-pattern bitmap by inkjet printing technology", Epson R&D Inc., US Patent filed in Aug 2008
14. **Ali Zandifar** and Jing Xiao, "High quality image capture, intelligent scanning and registration of large PCB substrates", Epson R&D Inc., US Patent filed in Aug 2008
15. **Ali Zandifar**, "Fault Detection of large PCB substrates by inkjet printing", Epson R&D Inc., US Patent filed in Aug 2008

16. **Ali Zandifar**, Guilles Devictor, Alex and Michael Bronstein, "Hypervideo annotation", Novafora Inc., US Patent pending.
17. **Ali Zandifar**, A. Chahine, R. Duraiswami and L. S. Davis, "Video-based Interface to Textual Information for the Visually Impaired", IEEE int. conf. at multimodal interfaces, 2002
18. **Ali Zandifar**, Ser-Nam Lim, N. Gumerov and R. Duraiswami, "Fast Evaluation of Thin Plate Spline (TPS) in Computer Vision", IEEE int. conf. of image processing, ICIP 2004
19. N. Gumerov, **Ali Zandifar**, R. Duraiswami and L. S. Davis, 'Structure of Applicable Surfaces from Single Views', ECCV 2004
20. **Ali Zandifar**, R. Duraiswami and L. S. Davis, "Video-based Framework for Analysis of Presentations/Posters" , Int. journal of document analysis and rectification (IJ DAR), Nov 2004.
21. N. Gumerov, **Ali Zandifar**, R. Duraiswami and L. S. Davis, "3D Structure Recovery and Unwarping Surfaces Applicable to Planes", Int. journal of computer vision (IJCV), Dec 2004
22. **Ali Zandifar**, "Unwarping scanned image of Japanese/English documents", Int. Conf. on Image analysis and processing (ICIAP) 2007
23. **Ali Zandifar**, "Ph.D. Thesis: Computer Vision for Scene Text Analysis", Aug 2004, University of Maryland, College Park, USA