

## Zoran Duric

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### Research Interests

Computer Vision, Video Image Processing, Human-Computer Interaction, Study and Simulation of Human Movement, Information Hiding.

### Education

- *Ph.D.* in Computer Science, University of Maryland, College Park, July 1995  
Thesis: Geometrical Methods in Visual Motion Analysis Advisor: Dr. Azriel Rosenfeld
- *M.S.* in Electrical Engineering – Control Systems and Electronics, University of Sarajevo, Bosnia and Herzegovina, July 1986
- *B.S.* in Electrical Engineering – Control Systems and Electronics, University of Sarajevo, Bosnia and Herzegovina, July 1982

### Work Experience

- **Associate Professor** August 2003 - present  
Computer Science Department, George Mason University.
- **Associate Chair for Graduate Studies** June 2006 - May 2008  
Computer Science Department, George Mason University.
- **Assistant Professor** September 1997 - August 2003  
Computer Science Department, George Mason University.
- **Visiting Assistant Professor** September 1996 - August 1997  
Computer Science Department, George Mason University.
- **Assistant Research Scientist** October 1995 - August 1997  
Joint position at Machine Learning and Inference Laboratory, George Mason University and Center for Automation Research, University of Maryland.
- **Graduate Research Assistant** June 1990 - October 1995  
Computer Vision Laboratory - University of Maryland, College Park.
- **Graduate Teaching Assistant** September 1989 - June 1990  
Department of Computer Science - University of Maryland, College Park.
- **Researcher** August 1982 - August 1989  
Energoinvest - Institute for Control and Computer Science - Division for Vision and Robotics, Sarajevo, Bosnia and Herzegovina.

• **Instructor/Teaching Assistant**

September 1982 - August 1989

Department of Electrical Engineering - University of Sarajevo, Bosnia and Herzegovina.

## Publications

### Journals

H. Wechsler, Z. Duric, F. Li, and V. Cherkassky. "Motion Estimation Using Statistical Learning Theory". *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 26:466–478, 2004.

Z. Duric and A. Rosenfeld. "Shooting a Smooth Video with a Shaky Camera". *Machine Vision and Applications*, 13:303–313, 2003.

Z. Duric, W. Gray, R. Heishman, F. Li, A. Rosenfeld, M. Schoelles, C. Schunn, and H. Wechsler. "Integrating Perceptual and Cognitive Modeling for Adaptive and Intelligent Human-Computer Interaction". *Proceedings of the IEEE*, 90:1272–1289, 2002.

S. Sirohey, A. Rosenfeld, and Z. Duric. "A Method of Detecting and Tracking Irises and Eyelids in Video". *Pattern Recognition*, 35:1389–1401, 2002.

Z. Duric, R. Goldenberg, E. Rivlin, and A. Rosenfeld. "Estimating Relative Vehicle Motions in Traffic Scenes". *Pattern Recognition*, 35:1339–1353, 2002.

P. Cucka, Z. Duric, E. Rivlin, and A. Rosenfeld. "Qualitative Description of Camera Motion and Scene Depth from Histograms of Normal Flow". *Proceedings of the Indian National Science Academy, PINSA, A*, 67(2):145–156, 2001.

S.J. McKenna, S. Jabri, Z. Duric, A. Rosenfeld, and H. Wechsler. "Tracking Groups of People". *Computer Vision and Image Understanding*. 80:42–56, 2000.

Z. Duric, A. Rosenfeld, and J. Duncan. "The Applicability of Green's Theorem to Computation of Rate of Approach". *International Journal of Computer Vision*. 31(1):83–98, 1999.

Z. Duric, E. Rivlin, and A. Rosenfeld. "Understanding Object Motion". *Image and Vision Computing*, 16:785–797, 1998.

Z. Duric and A. Rosenfeld. "Image Sequence Stabilization in Real Time", *Real-Time Imaging*, 2:271–284, 1996.

Z. Duric, J. Fayman, and E. Rivlin. "Function from Motion". *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 18:579–591, 1996.

Z. Duric, A. Rosenfeld, and L. S. Davis. "Egomotion Analysis Based on the Frenet-Serret Motion Model". *International Journal of Computer Vision*, 15:105–122, 1995.

Y. Aloimonos and Z. Duric. "Estimating the Heading Direction Using Normal Flow". *International Journal of Computer Vision*, 13:33–56, 1994.

## Patents

N. Johnson, Z. Duric, and S. Jajodia. *Fingerprinting and Recognition of Data.* US 7,127,106. Oct. 24, 2006.

## Books and Book Chapters

Z. Duric, M. Jacobs, and S. Jajodia. "Information Hiding: Steganography and Steganalysis.", In *Handbook of Statistics*, Vol. 24, Elsevier B.V., 2005.

N. Johnson, Z. Duric, and S. Jajodia. *Information Hiding: Steganography and Watermarking — Attacks and Countermeasures.*, Kluwer Academic Publishers, Boston, 2000.

R.S. Michalski, A. Rosenfeld, Z. Duric, M. Maloof, Q. Zhang. "Applications of Machine Learning in Computer Vision", in *Machine Learning, Data Mining and Knowledge Discovery: Methods and Applications*, R.S. Michalski, I. Bratko, and M. Kubat Eds., John Wiley, 1998.

B. Perunicic and Z. Duric. "An efficient algorithm for embedding graphs in the projective plane". In Y. Alavi et al., editor, *Graph Theory and Its Applications to Algorithms and Computer Science.*, John Wiley, 1985.

## Refereed Conferences and Workshops

C. Narber, I. Avramovic, N. Vishnoi, Z. Duric, and N.L. Gerber. "Application of Haptic Technology to Fine Motor Learning in College Students", In *Proc. 71st Annual Assembly of the American Academy of Physical Medicine and Rehabilitation*, Seattle, Nov. 4–7, 2010.

C. Narber and Z. Duric. "Analysis of Collision Detection Algorithms in Haptic Environments", In *Proc. IEEE International Symposium on Haptic Audio Visual Environments and Games, HAVE 2010*, Phoenix, Arizona, Oct. 15–16, 2010.

D. Fleck and Z. Duric. "Using Local Affine Invariants to Improve Image Matching", In *Proc. ICPR 2010*, pp. 1844–1847, Istanbul, Turkey, 2010.

N. Vishnoi, W.E. Lawson, N.L. Gerber, and Z. Duric, Identifying Phases of Gait Using Image-Flow, In *Proc. JEGM*, Miami, May 12–15, 2010.

N. Vishnoi, C. Narber, N.L. Gerber, and Z. Duric. Methodology for Simulating Upper Extremity Functional Activities using Haptic Interfaces, In *Proc. JEGM*, Miami, May 12–15, 2010.

W.E. Lawson, N. Vishnoi, N.L. Gerber, and Z. Duric. Markerless Identification of Dissimilarities in Gait Sequences, In *Proc. JEGM*, Miami, May 12–15, 2010.

N. Vishnoi, C. Narber, Z. Duric, and N.L. Gerber. Guiding Hand: A Teaching Tool for Handwriting, A *Demo presentation at ICMI-MLMI*, pp. 221–222. Cambridge, Massachusetts, Nov. 2–6, 2009.

D. Fleck and Z. Duric. "An Evaluation of Affine Invariant-Based Classification for Image Matching", In *Proc. ISVC, LNCS 5876*, pp. 417–429, Springer, Las Vegas, Nov. 30 – Dec. 2, 2009.

D. Fleck and Z. Duric. "Affine Invariant-Based Classification of Inliers and Outliers for Image Matching", In *Proc. ICIAR, LNCS 5267*, pp. 268–277, Springer, Halifax, Canada, July 6–8, 2009.

W.E. Lawson and Z. Duric. "Analyzing Human Gait using Patterns of Translation and Rotation", In *Proc. ICIAR, LNCS 5267*, pp. 408–417, Springer, Halifax, Canada, July 6–8, 2009.

Y. Kim, Z. Duric, N.L. Gerber, A.R. Palsbo, S.E. Palsbo. "Poster: Teaching Letter Writing using a Programmable Haptic Device Interface for Children with Handwriting Difficulties" (best poster award), In *Proc. IEEE Symposium on 3D User Interfaces 2009* (in conjunction with IEEE Virtual Reality 2009), March 14–15, Lafayette, Louisiana.

W.E. Lawson, Z. Duric, and H. Wechsler. "Gait Analysis Using Independent Components of Image Motion", In *Proc. IEEE Int. Conf. on Automatic Face and Gesture Recognition*, Amsterdam, Netherlands, Sep. 2008.

D. Barbara, C. Domeniconi, Z. Duric, M. Filippone, R. Mansfield, and W.E. Lawson. "Detecting Suspicious Behavior in Surveillance Images", In *Proc. of the First Int. Workshop on Video Mining* (in conj. with the IEEE Int. Conference on Data Mining), Pisa, Italy, Dec. 2008.

Y. Kim, Z. Duric, and D. Richards. "Improved lower bounds on embedding distortion in information hiding", In *Proc. of SPIE Security, Forensics, Steganography, and Watermarking of Multimedia Contents*, Vol. 6819, February 2008.

R. Heishman, Z. Duric, and H. Wechsler. "Understanding Cognitive and Affective States Using Eyelid Movements", In *Proc. IEEE Conf. on Biometrics: Theory, Applications and Systems*, Washington, D.C., Sep. 2007.

R. Heishman and Z. Duric. "Using Eye Blinks as a Tool for Augmented Cognition", In *Proc. 12th Int. Conf. on Human-Computer Interaction*, Vol. 4565, pp. 84–93, Beijing, China, July 2007.

Z. Duric, W.E. Lawson, and D. Richards. "Streaming Clustering Algorithms for Foreground Detection in Color Videos", In *Proc. VISAPP*, Barcelona, Spain, Mar. 2007.

R. Heishman and Z. Duric, "Using Image Flow to Detect Eye Blinks in Color Video", In *Proc. of the IEEE Workshop on Applications of Computer Vision*, pp. 52–57, Austin, Texas, Feb. 2007.

Y. Kim, Z. Duric, and D. Richards. Towards Lower Bound on Embedding Distortion in Information Hiding, In *Proc. Int. Workshop on Digital Watermarking*, Jeju Island, Korea, 2006.

Y. Kim, Z. Duric, and D. Richards. Modified Matrix Encoding Technique for Minimal Distortion Steganography, In *Proc. Information Hiding*, Washington, 2006.

W. Lawson and Z. Duric, "Using Deficits of Convexity to Recognize Hand Gestures from Silhouettes", In *Proc. VISAPP*, Setubal, Portugal, 2006.

Y. Kim, Z. Duric, and D. Richards, "Limited Distortion in LSB Steganography", In *Proc. of SPIE Electronic Imaging*, Vol. 6072, January 2006.

R. Heishman, W. Powers, and Z. Duric, "Techniques for tracking and analyzing eye region biometrics in HCI Scenarios", In Proc. of the 19th British HCI Group Annual Conf., Vol. 2, pp. 229–231, Edinburgh, 2005.

W. Lawson, D. Harmony, and Z. Duric. Designing and Implementing a Gesture Mouse., In *Proc. HCI International 2005*. Las Vegas.

Z. Duric, D. Richards, and Y. Kim. "Minimizing the Statistical Impact of LSB Steganography". In *Proc. ICIAR 2005*, Springer, LNCS 3656, pp. 1175–1183, Toronto, Canada.

R. Heishman, Z. Duric, and H. Wechsler. Using Eye Region Biometrics to Reveal Affective and Cognitive States. In *Proc. Workshop on Face Processing in Video, CVPR 2004*. Washington.

Z. Duric, F. Li, H. Wechsler, and V. Cherkassky. "Controlling Model Complexity in Flow Estimation", In *Proc. Int. Conf. on Computer Vision*, Nice, France, 2003.

J. Kosecka, L. Zhou, P. Barber, and Z. Duric. "Qualitative Image Based Localization in Indoors Environments", In *Proc. Computer Vision and Pattern Recognition*, Vol. II, pp. 3–8, Madison, Wisconsin, 2003.

Z. Duric, F. Li, Y. Sun. and H. Wechsler. "Using Normal Flow for Detection and Tracking of Limbs in Color Images". In *Proc. International Conference on Pattern Recognition*, Quebec City, Canada, August 2002.

Z. Duric, H. Wechsler, and J. Yven. "Adaptive and Smart Interface for VCR Remote Control Using Hand Gestures". In *Proc. International Conference on Pattern Recognition*, Quebec City, Canada, August 2002.

H. Wechsler, Z. Duric, F. Li, and V. Cherkassky. "Motion Prediction Using VC-Generalization Bounds". In *Proc. International Conference on Pattern Recognition*, Quebec City, Canada, August 2002.

H. Wechsler, Z. Duric, and F. Li. "Hierarchical Interpretation of Human Activities Using Competitive Learning". In *Proc. International Conference on Pattern Recognition*, Quebec City, Canada, August 2002.

Z. Duric, F. Li, and H. Wechsler. "Recognition of Arm Movements". In *Proc. Automatic Face and Gesture Recognition*, Washington, DC, May 2002.

Z. Duric, E. Rivlin, and A. Rosenfeld. "Qualitative Description of Camera Motion from Histograms of Normal Flow", In *Proc. 15th International Conference on Pattern Recognition*, Barcelona, Spain, Vol. 3, pp. 198–202, September 2000.

S. Jabri, Z. Duric, H. Wechsler, and A. Rosenfeld. "Detection and Location of People in Video Images Using Adaptive Fusion of Color and Edge Information". In *Proc. 15th International Conference on Pattern Recognition*, Barcelona, Spain, Vol. 4, pp. 627–630, September 2000.

S.J. McKenna, S. Jabri, Z. Duric, and H. Wechsler. "Tracking Interacting People". In *Proc. Automatic Face and Gesture*, pp. 348–353, Grenoble, France, March 2000.

N. Johnson, Z. Duric, and S. Jajodia. "On Fingerprinting Images for Recognition". In *Fifth International Workshop on Multimedia Information Systems (MIS'99)*, October 1999.

N. Johnson, Z. Duric, and S. Jajodia. “Recovery of Watermarks from Distorted Images”. In *Proc. Information Hiding*, Lecture Notes in Computer Science 1768, Andreas Pfitzmann (Ed.), Springer, pages 318–332, 1999.

Z. Duric, E. Rivlin, and A. Rosenfeld. “Understanding Motions of Tools and Vehicles”. In *Proc. International Conference on Computer Vision*, January 1998.

Q. Zhang, Z. Duric, and R.S. Michalski. “Detecting Targets in SAR Images: A Machine Learning Approach”, In *Proc. Asian Conference on Computer Vision*, January 1998.

Z. Duric, J. Fayman, and E. Rivlin. “Recognizing Functionality”. In *Proc. International Symposium on Computer Vision*, November 1995, pp. 247–252.

Z. Duric, A. Rosenfeld, and L. S. Davis. “Egomotion analysis based on the Frenet-Serret motion model”. In *Proc. International Conference on Computer Vision*, June 1993, pp. 703-712.

Y. Aloimonos and Z. Duric. “Active egomotion estimation: A qualitative approach”. In *Proc. European Conference on Computer Vision*, 1992, pp. 497–510.

B. Perunicic, N. Rajnpreht, and Z. Duric. “A real time topology update”. In *Proc. 8th Power System Computation Conference*, Finland, 1984.

## Other Publications

1. R. Heishman, Z. Duric, and H. Wechsler. “PUPILS — Enabling a Dialogue Between the Machine and the Brain”. In *Proc. 30th Applied Imagery Pattern Recognition Workshop*. pp. 87–93, Washington, DC, October 2001.
2. M. Mason and Z. Duric. “Using Histograms to Detect and Track Objects in Color Video”. In *Proc. 30th Applied Imagery Pattern Recognition Workshop*. pp. 154–159, Washington, DC, October 2001.
3. Z. Duric, E. Rivlin, and A. Rosenfeld. “Qualitative Description of Camera Motion from Histograms of Normal Flow”. In *Proc. DARPA Image Understanding Workshop*, November 1998, pp. 979–986.
4. Z. Duric, E. Rivlin, and A. Rosenfeld. “Understanding Object Motion”. In *Proc. DARPA Image Understanding Workshop*, May 1997.
5. Z. Duric, E. Rivlin, and A. Rosenfeld. “Learning an Object’s Function by Observing the Object in Action”. In *Proc. DARPA Image Understanding Workshop*, February 1996.
6. M. Maloof, Z. Duric, R. S. Michalski, and A. Rosenfeld. “Recognizing Blasting Caps in X-Ray Images”. In *Proc. DARPA Image Understanding Workshop*, February 1996.
7. R. S. Michalski, A. Rosenfeld, Y. Aloimonos, Z. Duric, M. Maloof, Q. Zhang. “Progress on Vision through Learning: A Collaborative Effort of George Mason University and University of Maryland”. In *Proc. DARPA Image Understanding Workshop*, February 1996.
8. Z. Duric, A. Rosenfeld, and J. Duncan. “The Applicability of Green’s Theorem to Computation of Rate of Approach”. In *Proc. DARPA Image Understanding Workshop*, November 1994, pp. 1209–1217.

9. J. Aloimonos, Z. Duric, C. Fermuller, H. Liuqing, E. Rivlin, and R. Sharma. "Behavioral visual motion analysis". In *Proc. DARPA Image Understanding Workshop*, January 1992, pp. 521–541.

### Refereed Yugoslav Conferences (In Serbo-Croatian)

1. Z. Duric, H. Cipovic, and S. Milovanovic. "Methods of edge detection in digital pictures - an analysis of applicability to robot vision systems". In *Proc. of JUROB*, Opatija, Croatia, 1989.
2. Z. Duric and H. Cipovic. "A decision tree for industrial parts classification". In *Proc. of ETAN*, Sarajevo, Bosnia and Herzegovina, 1988.
3. H. Cipovic, Z. Duric, and D. Lenger. "EKVI - visual sensor for advanced robots". In *Proc. of Yugoslav - Russian Symposium on Applied Robotics*, Novi Sad, Yugoslavia, 1988.
4. H. Cipovic, Z. Duric, D. Lenger, O. Lenger, B. Bogdanic, D. Puljic, and S. Milovanovic. "EKVI - Energoinvest vision controller". In *Proc. of JUROB*, Opatija, Croatia, 1988.
5. Z. Duric and H. Cipovic. "Determination of position and orientation of flat objects". In *Proc. of Yugoslav Symposium on Applied Robotics*, Bled, Slovenia, 1987.
6. Z. Duric. "Sorting of flat elongated objects". In *Proc. of Yugoslav Symposium on Applied Robotics*, V. Banja, Yugoslavia, 1985.
7. H. Cipovic, Z. Duric, Z. Kajmakovic, and D. Lenger. "A vision controlled robot system for sorting of complex curved parts". In *Proc. of JUROB*, Rijeka, Croatia, 1985.
8. Z. Duric and B. Perunicic. "An algorithm to recognize a planar graph in a binary flat scene". In *Proc. of PPPR*, S. Toplice, Croatia, 1983.
9. B. Perunicic and Z. Duric. "An algorithm for topological analysis of a binary flat scene". In *Proc. of ETAN*, Struga, FYRM/Yugoslavia, 1983.
10. Z. Duric and Z. Cvetanovic. "An algorithm for recognition of planar objects". In *Proc. of Yugoslav Symposium on Applied Robotics*, V. Banja, Yugoslavia, 1983.
11. A. Nikolic, D. Milivojevic, Z. Duric, and Z. Kajmakovic. "Realization of structure for sorting and assembling tasks with robot and video sensor". In *Proc. of NUMA and Robots*, Beograd, Yugoslavia, 1983.
12. Z. Duric. "Some applications of graphs in the designing of gas networks". In *Proc. of ETAN*, Mostar, Bosnia and Herzegovina, 1981.
13. I. Demirdzic, Z. Duric, P. Kaludjercic, M. Peric, and N. Stosic. "Computer analysis and design of gas networks". In *Proc. of Symposium on Informatics*, Sarajevo, Bosnia and Herzegovina, 1981.
14. B. Perunicic and Z. Duric. "A computer algorithm for automated drawing of planar graphs". In *Proc. of ETAN*, Pristina, Yugoslavia, 1980.
15. B. Perunicic and Z. Duric. "Drawing of graphs containing vertices of degree one". In *Proc. of Symposium on Informatics*, Sarajevo, Bosnia and Herzegovina, 1980.

## Student Supervision

### Doctoral Students

- Neil Johnson (IT, co-advised with Sushil Jajodia), graduated in September 2000, thesis: *Information Hiding: Steganography, Attacks, and Countermeasures*.
- Ricci Heishman (IT), graduated in July 2007, thesis: *Deducing Fatigue and Cognitive Engagement from Eye Blinks*.
- Youn-Hee Kim (CS, co-advised with Dana Richards), graduated in September 2008, thesis: *Towards Lower Bounds on Embedding Distortion in Information Hiding*.
- Wallace Lawson (CS, co-advised with Lynn Gerber), graduated in July 2010, thesis: *Using Image Flow to Analyze Human Gait*.
- Dan Fleck, graduated in October 2010, thesis: *Using Affine Image Matching to Build and Maintain 3D Models*.
- Nalini Vishnoi (CS, co-advised with Lynn Gerber), advanced to candidacy in May 2010, thesis: *Analysis and Recognition of Human Functional Movements*.
- David Bagheri, tracking of human movements
- Kenneth Daffron, study and simulation of human movement
- Cody Narber, study and simulation of human movement
- Michael O'Malley, recognition of human movement
- Gene Shuman, study and simulation of human movement

### Masters Students

- Sumer Jabri, graduated Dec. 1999
- Diego Vasquez, graduated May 2001
- Philip Barber, graduated May 2002
- Yan Sun, graduated October 2002
- David Harmony, graduated May 2003
- Wallace Lawson, graduated May 2004
- Michael Sullivan, graduated January 2009
- Matthew Revelle, graduated May 2009

## Professional Activities

- Associate Editor of Pattern Recognition Journal (since 2002)
- Editorial Board of Pattern Recognition Journal (since 2006)
- Program Committees: CVPR 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011; ICCV 2005, 2007, 2009; V4HCI 2005; ICIAR 2006, 2007, 2008, 2009, 2010; ECCV 2006, 2008, IEEE Southeast Conference 2007, VISAPP 2007, 2008, 2009; AVSS 2009, 2010; ACCV 2009, 2010
- Member NSF panels 2004, 2005, 2008
- Professional Societies: IEEE Computer Society since 1990, elected to Senior Member in 2002, IEEE Senior member review panel on June 18, 2005