

Zoran Duric

Computer Science Department
George Mason University — MS 4A5
Engineering Building, Room 4443
4400 University Drive
Fairfax, VA 22030-4444

Phone: (703) 993-1717
Fax: (703) 993-1710
EMail: zduric@cs.gmu.edu
URL: www.cs.gmu.edu/~zduric

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

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 conjunction 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. ICAR 2005*.
- 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, defense expected in Fall 2009, thesis: *Automated Gait Analysis*.
- Dan Fleck, defense expected in 2010, thesis: *Updating and Maintaining 3D Worlds*.
- 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
- Nalini Vishnoi, recognition 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; ICCV 2005, 2007, 2009; V4HCI 2005; ICIAR 2006, 2007, 2008, 2009; ECCV 2006, 2008, IEEE Southeast Conference 2007, VISAPP 2007, 2008, 2009, AVSS 2009, ACCV 2009
- 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