References

[1] S. Abe, T. Tanamura, and H. Kasahara, "Scene Retrieval Method for Video Database Applications using Temporal Condition Changes," *Proceedings of the International Workshop on Industrial Applications of Machine Intelligence and Vision,* Tokyo, IEEE Computer Society Press, pp. 355-359, 1989.

[2] D.A. Adjeroh and K.C. Nwosu, "Multimedia database management – Requirements and Issues," *IEEE Multimedia,* pp. 24-33, July-September, 1997.

[3] P. Aigrain, H-J. Zhang, and D. Petkovic, "Content-Based Representation and Retrieval of Visual Media: A State-of-the-Art Review," *Multimedia Tools and Applications,* vol. 3, pp. 179-202, 1996.

[4] J. Akkerhuis, A. Marks, J. Rosenberg, and M.S. Sherman, "Processable Multimedia Document Interchange Using ODA," *Proc. EUUG Autuman Conf.,* pp. 167-177, Sept. 1989.

[5] A.A. Alatan, E. Tuncel, and L. Onural, "A Rule-Based Method for Object Segmentation in Video Sequences," *Proc. Int'l Conf. Image Processing,* vol. 2, pp. 522-525, Oct. 1997.

[6] S. Al-Hawamdeh, B.C. Ooi, R. Price, T.H. Tng, Y.H. Ang, and L. Hui, "Nearest Neighbour Searching in a Picture Archive System," *Proceedings* of *the International Conference on Multimedia Information Swstems,* pp. 17-29, Singapore, McGraw Hill Book Co., 1991.

[7] W. Al-Khatib, Y.F. Day, A. Ghafoor, and P.B. Berra, "Semantic Modeling and Knowledge Representation in Multimedia

Databases," *IEEE Trans. on Knowledge and Data Engineering,* vol. 11, no. 1, pp. 64-80, January/February 1999.

[8] Y.Y. Al-Salqan and C.K. Chang, "Temporal Relations and Synchronization Agents," *IEEE Multimedia,* pp. 30-39, Summer 1996.

[9] J. Allen. *Natural Language Understanding,* The Benjamin/Cummings Publishing Company, Inc., 1995.

[10] J. Allen, "Maintaining Knowledge About Temporal Intervals," *Comm. ACM,* vol. 26, no. 11, pp. 832-843, 1983.

[11] T.L. Anderson, "Modeling Time at the Conceptual Level," *Improving Database Usability and Responsiveness,* P. Scheuermann, Ed., New York: Academic, pp. 273-297, 1982.

[12] D.P. Anderson, R. Govindan, and G. Homsy, "Design and Implementation of a Continuous Media 1/0 Server," *Proceedings* of *the Conference on Multimedia Issues in Networking and Operating Systems,* 1990.

[13] F. Arman, R. Depommer, A. Hsu, and M.Y. Chiu, "Content-Based Browsing of Video Sequences," *ACM Multimedia,* pp. 97-103, Aug. 1994.

[14] J. Ashford and P. Wilett. *Text Retrieval and Document Databases,* Chartwell-Bratt, Broomley, 1988.

[15] A.F. Ates, M. Bilgic, S. Saito, and B. Sarikaya, "Using Timed CSP for Specification Verification and Simulation of Multimedia Synchronization," *IEEE J. Selected Areas in Comm.,* vol. 14, no. 1, pp. 126-137, Jan. 1996.

[16] M. Atkinson, F. Bancilhon, D. DeWitt, K. Dittrich, D. Maier, and S. Zdonik, "The Object-Oriented Database System Manifesto," *Proc. First Int'l Conf. Deductive and Object-Oriented Databases,* pp. 40-57, 1989.

[17] J.R. Bach, S. Paul, and R. Jain, "A Visual Information Management System for the Interactive Retrieval of Faces," *IEEE Trans. Knowledge and Data Engineering,* vol. 5, no. 4, pp. 619-628, 1993.

[18] C. Batini, T. Catarci, M. Costabile, and S. Levialdi, "Visual Query Systems: A Taxonomy," *Proceedings of the 2nd Working Conference on Visual Database Systems,* Budapest, International Federation for Information Processing, IFIP Working Group 2.6, pp. 159-173, 1991.

[19] R. Bayer and E. McCreight, "Organization and Maintenance of Large Ordered Indices," *Proc.* 1970 *ACM-SIGFIDENT Workshop on Data Description and Access,* Houston, Texas, pp. 107-141, Nov. 1970.

[20] P. Berra, C. Chen, A. Ghafoor, T. Little, and S. Shin, "Architecture for Distributed Multimedia Database Systems," *Comput. Commun.,* 13, pp. 217-231, 1990.

[21] E. Bertino and E. Ferrari, "Temporal Synchronization Models for Multimedia Data," *IEEE Trans. on Knowledge and Data Engineering,* vol 10, no. 4, pp. 612-631, July/August 1998.

[22] E. Bertino, E. Ferrari, and M. Stolf, "A System for the Specification and Generation of Multimedia Presentations," *Proc. Third Int'l Workshop Multimedia Information Systems,* pp. 83-91, Sept. 1997.

[23] A.D. Bimbo, P. Pala, and S. Santini, "Image Retrieval by Elastic Matching of Shapes and Image Patterns," *Proc. IEEE Int'l Conf. Multimedia Computing and Systems,* pp. 215-218, June 1996.

[24] A.D. Bimbo, E. Vicario, and D. Zingoni, "Symbolic Description and Visual Querying of Image Sequences Using Spatio-Temporal Logic," *IEEE Trans. on Software Engineering,* vol 7, no. 4, pp. 609-621, August 1995.

[25] E. Binaghi, I. Gagliardi, and R. Schetini, "Indexing and Fuzzy Logic-Based Retrieval of Color Images," *Proceedings* of *the 2nd Working Conference on Visual Database Systems,* Budapest, International Federation for Information Processing, IFIP Working Group 2.6, pp. 84-97, 1991.

[26] E. Blair, D. Hutchinson, and D. Shepherd, "Distributed Systems Support for Heterogeneous Multimedia Environments," *Proceedings of the Conference on Multimedia Issues in Networking and Operating Systems,* 1990.

[27] G. Blakowski, J. Huebel, and U. Langrehr, "Tools for Specifying and Executing Synchronized Multimedia Presentations," *Proc. 2nd Int'l Workshop on Network and Operating System Support for Digital Audio and Video,* pp. 271-279, 1991.

[28] G. Bordogna, I. Gagliardi, D. Merelli, P. Mussio, M. Padula, and M. Protti, "Iconic Queries to Pictorial Data," *Proceedings* of *the*

1989 IEEE Workshop on Visual Languages, Rome, pp. 38-42, 1989.

[29] C.A. Bouman and B. Liu, "Multiple Resolution Segmentation of Textured Images," *IEEE Trans. Pattern Analysis and Machine Intelligence,* vol. 13, no. 2, pp. 99-113, February 1991.

[30] M. Buchanan and P. Zellweger, "Automatically Generating Consistent Schedules for Multimedia Documents," *ACM Multimedia Systems Journal,* 1(2), Springer-Verlag, pp. 55-67, 1993.

[31] M. Buchanan and P. Zellweger, "Specifying Temporal Behavior in Hypermedia Documents," *Proc. ACM Conf. Hypertext,* pp. 262-271, 1992.

[32] R.H. Campbell and A.N. Habermann, "The Specification of Process Synchronization by Path Expressions," G. Goos and J. Hartmanis, eds., *Operating Systems,* Lecture Notes in Computer Science 16, pp. 89-102, Springer-Verlag, 1974.

[33] K.S. Candan, B. Prabhakaran, and V.S. Subrahmanian, "CHIMP: A Framework for Supporting Distributed Multimedia Document Authoring and Presentation,'' *Proc. ACM Multimedia Conf.,* pp. 320-340, Nov. 1996.

[34] T. Catarci, "On the Expressive Power of Graphical Query Languages,') *Proceedings* of *the 2nd Working Conference on Visual Database Systems,* Budapest, International Federation for Information Processing, IFIP Working Group 2.6, pp. 404-414, 1991.

[35] A. Celentano, M.G. Fugini, and S. Pozzi, "Knowledge-Based Retrieval of Office Documents," *Proc. 13th Int'l Conf. Research and Development in Information Retrieval,* pp. 241-254, Sept. 1990.

[36] S.F. Chang, W. Chen, H.J. Meng, H. Sundaram, and D. Zhong, "VideoQ: An Automated Content Based Video Search System Using Visual Cues," *Proc. ACM Multimedia,* pp. 313-324, 1997.

[37] H.J. Chang, T.Y. Hou, S.K. Chang, "The Management and Application of Teleaction Objects," *ACM Multimedia Systems Journal,* vol. 3, pp. 228-237, November 1995.

[38] N.S. Chang and K.S. Fu, "Query-by-Pictorial Example," *IEEE Trunsactions on Software Engineering,* 14, pp. 681-688, 1988.

[39] S.K. Chang, C.W. Yan, D.C. Dimitroff, and T. Arndt, "An Intelligent Image database System," *IEEE Trans. on Software Engineering,* vol 14, no. 5, pp. 681-688, May 1988.

[40] S.K. Chang, "Iconic Indexing By 2D String," *IEEE Trans. Pattern Analysis and Machine Intelligence,* vol. 6, no. 4, pp. 413-428, 1984.

[41] R. Chellappa, C.L. Wilson, and S. Sirohey, "Human and Machine Recognition of Faces: A Survey," *Proc. IEEE,* vol. 83, no. 5, pp. 705-741, May 1995.

[42] C.Y. Roger Chen, D.S. Meliksetian, Martin C-S, Chang, L. J. Liu, "Design of a Multimedia Object-Oriented DBMS," *ACM Multimedia Systems Journal,* Vol. 3, pp. 217-227, November 1995.

[43] S-C. Chen and R. L. Kashyap, "Temporal and Spatial Semantic Models for Multimedia Presentations," in *1997 International Symposium on Multimedia Information Processing,* Dec. 11-13, 1997, pp. 441-446.

[44] S-C. Chen and R. L. Kashyap, "A Spatio-Temporal Semantic Model for Multimedia Presentations and Multimedia Database Systems," *IEEE Trans. on Knowledge and Data Engineering,* accepted for publication.

[45] S-C. Chen, S. Sista, M-L. Shyu, and R.L. Kashyap, "Augmented Transition Networks as Video Browsing Models for Multimedia Databases and Multimedia Information Systems," *the 11th IEEE International Conference on Tools with Artificial Intelligence (ICTAI'99),* pp. 175-182, 1999.

[46] J.Y. Chen, C. Taskiran, E.J. Delp, and C.A. Bouman, "ViBE: A New Paradigm for Video Database Browsing and Search," *Proc. IEEE Workshop Content-Based Access* of *Image and Video Libraries,* pp. 96-100, 1998.

[47] M.G. Christel and D.J. Martin, "Information Visualization Within a Digital Video Library," *J. Intelligent Info. Systems,* 11(3), pp. 235-257, 1998.

[48] M.G. Christel and A.M. Olligschlaeger, "Interactive Maps for a Digital Video Library," *IEEE Int'l Conf. on Multimedia Computing and Systems,* 1999.

[49] C. Colombo, A.D. Bimbo, and I. Genovesi, "Interactive Image Retrieval by Color Distributions," *IEEE Multimedia Systems,* pp. 255-258, 1998.

[50] D. Comer, "The Ubiquitous B-tree," *Computing Surveys,* 11:2, pp. 121-138, June 1979.

[51] J.E. Coolahan Jr. and N. Roussopoulos, "Timing Requirements for Time-Driven Systems Using Augmented Petri Nets," *IEEE Trans. Software Engineering,* vol. SE-9, pp. 603-616, Sept. 1983.

[52] J.M. Corridoni, A.D. Bimbo, S. De Magistris, and E. Vicario, "A Visual Language for Color-Based Painting Retrieval," *Proc. Int'l Symp. Visual Languages,* pp. 68-75, 1996.

[53] G. Costagliola, M. Tucci, and S.K. Chang, "Representing and Retrieving Symbolic Pictures by Spatial Relations," *Visual Database Systems,* vol. II, E. Knuth and L.M. Wegner, eds., Elsevier, pp. 55-65, 1991.

[54] J. D. Courtney, "Automatic Video Indexing via Object Motion Analysis," *Pattern Recognition,* vol. 30, no. 4, pp. 607-625, 1997.

[55] J. Cove and B. Walsh, "Online Text Retrieval vis Browsing," *Information Processing and Management,* 24(1), 1988.

[56] I.F. Cruz and W.T. Lucas, "A Visual Approach to Multimedia Querying and Presentation," *Proc. ACM Multimedia,* pp. 109-120, 1997.

[57] J. Davies, D.M. Jackson, J.N. Reed, G.M. Reed, A.W. Roscoe, and S.A. Schneider, "Timed CSP: Theory and Practice," J.W. De Bakker, C. Huizing, W.P. De Roever, and G. Rosenberg, eds., *Real-Time: Theory and Practice,* Lecture Notes in Computer Science 600, pp. 640-675. Springer-Verlag, 1991.

[58] Y.F. Day, S. Dagtas, M. Iino, A. Khokhar, and A. Ghafoor, "Object-Oriented Conceptual Modeling of Video Data," *IEEE 11th International Conference on Data Engineering,* Taipei, Taiwan, pp. 401-408, 1995.

[59] Y.F. Day, S. Dagtas, M. Iino, A. Khokhar, and A. Ghafoor, "Spatio-Temporal Modeling of Video Data for On-line Object-Oriented Query Processing," *Proc. Int'l Conf. Multimedia Computing and Systems,* pp. 98-105, May 1995.

[60] M.J. Egenhofer, "Query Processing in Spatial-Query-Sketch," *J. Visual Languages and Computing,* vol. 8, no. 4, pp. 403-424, 1997.

[61] R. Erfle, "Specification of Temporal Constraints in Multimedia Documents Using HyTime," *Electronic Publishing,* vol. *6,* no. 4, pp. 397-411, 1993.

[62] M.L. Escobar-Molano and S. Ghandeharizadeh, "A Framework for Conceptualizing Structured Video," *Proc. First Int'l Workshop Multimedia Information Systems,* pp. 95-110, Sept. 1995.

[63] B. Falchuk and K. Karmouch, "A multimedia news delivery system over an ATM network," in *International conference Multimedia Computing and Systems,* 1995, pp. 56-63.

[64] A.M. Ferman, B. Gunsel and A.M. Tekalp, "Object Based Indexing of MPEG–4 Compressed Video," *Proc. SPIE: VCIP,* pp 953-963, vol. 3024, San Jose, USA, February 1997.

[65] M. Flickner, H. Sawhney, W. Niblack, J. Ashley, Q. Huang, B. Dom, M. Gorkani, J. Hafner, D. Lee, D. Petkovic, D. Steele, P. Yanker, "Query by Image and Video Content: The QBIC System," *IEEE Computer,* vol. 28, no. 9, pp. 23-31, September 1995.

[66] J. Foote, J. Boreczky, A. Girgensohn, and L. Wilcox, "An Intelligent Media Browser using Automatic Multimodal Analysis," *ACM Multimedia,* 1998.

[67] K. Fujikawa, S. Shimojo, T. Matsuura, S. Nishio, and H. Miyahara, "Multimedia Presentation System 'Harmony' with Temporal and Active Media," *Proc. Usenix Conf.,* 1991.

[68] A. Ghafoor and P. Bruce Berra, "Multimedia Database Systems," Lecture Notes in Computer Science, (Advanced Database Systems, Eds. B. Bhargava and N. Adams), vol. 759, pp. 397-411, Springer-Verlag Publisher, 1993.

[69] A. Ghafoor, "Multimedia Database Management Systems," *ACM Computing Survey,* vol. 27, no. 4, pp. 593-598, December 1995.

[70] A. Ghafoor, "Special Issue on Multimedia Database Systems," guest editor, *ACM Multimedia Systems,* vol. 3, pp. 179-181, November 1995.

[71] A. Ghafoor and Y.F. Day, "Object-Oriented Modeling and Querying of Multimedia Data," *Proc. First Int'l Workshop Multimedia Information Systems,* pp. 111-119, Sept. 1995.

[72] S. Gibbs, "Composite Multimedia and Active Objects," *Proc. Int'l Conf. Object-Oriented Programming: Systems, Languages, and Applications,* Oct. 1991.

[73] S. Gibbs, C. Breiteneder, and D. Tsichritzis, "Audio/Video Databases: An Object-Oriented Approach," *Proc. Ninth Int'l Conf. Data Eng.,* pp. 381-390, 1993.

[74] S. Gibbs, C. Breiteneder, and D. Tsichritzis, "Data Modeling of Time-Based Media," *Proc, ACM SIGMOD Int'l Conf. Management of Data,* pp. 91-102, 1994.

[75] F. Golshani and N. Dimitrova, "Retrieval and Delivery of Information in Multimedia Database Systems," *Information and Software Technology,* vol. 36, no. 4, pp. 235-242, May 1994.

[76] *Y.* Gong, H. Zhang, H.C. Chuan, and M. Sakauchi, "An Image Database System with Content Capturing and Fast Image Indexing Abilities," *Proc. Int'*1 *Conf. Multimedia Computing and Systems,* pp. 121-130, May 1994.

[77] W.I. Grosky and R. Mehrotra, "Index-Based Object Recognition in Pictorial Data Management," *Computer Vision Graph Image Processing,* 52, pp. 416-436, 1990.

[78] V.N. Gudivada and G.S. Jung, "An Algorithm for Content-Based Retrieval in Multimedia Databases," *Proc. Int'l Conf. Multimedia Computing and Systems,* pp. 193-200, 1996.

[79] A. Gupta, T. Weymouth, and R. Jain, "Semantic Queries with Pictures: the VIMSYS Model," *Proc. 17th Int'l Conf. Very Large Databases,* pp. 69-79, Barcelona, September 1991.

[80] A. Guttman, "R-tree: A Dynamic Index Structure for Spatial Search," *in Proc. ACM SIGMOD,* pp. 47-57, June 1984.

[81] V. Haarslev and M. Wessel, "Querying GIS With Animated Spatial Sketches," *Proc. Int'l Symp. Visual Languages,* pp. 201-208, Sept. 1997.

[82] T. Hamano, "A Similarity Retrieval Method for Image Databases using Simple Graphics," *The 1988 IEEE Workshop on Languages for Automation: Symbiotic and Intelligent Robots,* IEEE Computer Society Press, pp. 149-154, College Park, MD, 1988.

[83] C.L. Hamblin, "Instants and Intervals," *Proc. 1st Conf. Int'l Society for the Study of Time,* J.T. Fraser et al., Eds., New York: Springer-Verlag, pp. 324-331, 1972.

[84] D. Harman, "Relevance Feedback Revisited," *Proceedings of the 15th ACM SIGIR,* pp. 1-10, Copenhagen, ACM Press, New York, 1992.

[85] S.A. Hawamdeh, B.C. Ooi, R. Price, T.H. Tng, Y.H. Ang, and L. Hui, "Nearest Neighbour Searching in a Picture Archive System," *Proc. Int'l Conf. Multimedia Information Systems,* pp. 17-33, 1991.

[86] T. Helbig and O. Schreyer, "Protocol for browsing in Continuous Data for Cooperative Multi-Server and Multi-Client Applications," in T. Plagemann and V. Goebel, eds., *IDMS,* Springer LNCS, 1998.

[87] R.G. Herrtwich and L. Delgrossi, "ODA-Based Data Modeling in Multimedia Systems," Technical Report TR 90-043, Int'l Computer Science Inst., Berkeley, CA., 1990.

[88] N. Hirzalla, B. Falchuk, and A. Karmouch, "A Temporal Model for Interactive Multimedia Scenarios," *IEEE Multimedia,* pp. 24-31, Fall 1995.

[89] S. Hollfelder, A. Everts, and U. Thiel, "Concept-Based Browsing in Video Libraries," *Proceedings of the IEEE Forum on Research and Technology Advances in Digital Libraries,* 1998.

[90] S. Hollfelder, A. Everts, and U. Thiel, "Designing for Semantic Access: A Video Browsing System," *IEEE Int'l Conf. on Multimedia Computing and Systems,* 1999.

[91] M.A. Holliday and M.K. Vernon, "A Generalized Timed Petri Net Model for Performance Analysis," *Proc. Int'l Conf. Time Petri Nets,* pp. 181-190, 1985.

[92] P. Hoepner, "Synchronizing the Presentation of Multimedia Objects – ODA Extensions," *Proc. First Eurographics Workshop: Multimedia Systems, Interaction, and Applications,* pp. 87-100, Apr. 1991.

[93] B.K.P. Horn and B.G. Schunck, "Determining Optical Flow," *Artificial Intelligence,* vol. 17, pp. 185-203, 1981.

[94] C.C. Hsu, W.W. Chu, and R.K. Taira, "A Knowledge-Based Approach for Retrieving Images by Content," *IEEE Trans. Knowledge and Data Engineering,* vol. 8, no. 4, pp. 522-532, 1993.

[95] M. Iino, Y.F. Day, and A. Ghafoor, "An Object-Oriented Model for Spatio-Temporal Synchronization of Multimedia Information," *Proc. Int'l Conf. Multimedia Computing and Systems,* pp. 110-119, May 1994.

[96] H. Ishikawa, K. Kubota, Y. Noguchi, K. Kato, M. Ono, N. Yoshizawa, and A. Kanaya, "A Document Warehouse: A Multimedia Database Approach,'' in R.R. Wagner, editor, *DEXA,* 1998.

[97] S.S. Iyengar and RL Kashyap, "Guest Editor's Introduction: Image Databases," *IEEE Transactions on Software Engineering,* 14, pp. 608-610, 1988.

[98] A.K. Jain, Y. Zhong, and S. Lakshmanan, "Object Matching Using Deformable Templates," *IEEE Trans. Pattern Analysis and Machine Intelligence,* vol. 18, no. 3, pp. 267-278, Mar. 1996.

[99] H. Jiang and A.K. Elmagarmid, "WVTDB – A Semantic Content-Based Video Database System on the World Wide Web," *IEEE Transactions on Knowledge and Data Engineering,* vol. 10, no. 6, pp. 947-966, November/December 1998.

[100] J.M. Jolion, P. Meer, and S. Bataouche, "Robust Clustering with Applications in Computer Vision," *IEEE Transactions on Pattern Analysis and Machine Intelligence,* vol. 13, no. 8, pp. 791-802, August 1991.

[101] T. Joseph and A.F. Cardenas, "PICQUERY: A High-Level Query Language for Pictorial Database Management," *IEEE Transactions on Software Engineering,* 14, pp. 630-638, 1988.

[102] A. Karmouch and J. Emery, "A Playback Schedule Model for Multimedia Documents," *IEEE Multimedia,* vol. 3, pp. 50-61, 1996.

[103] R. Kasturi and R. Jain, "Dynamic Vision," R. Kasturi and R. Jain, eds., *Computer Vision,* pp. 469-480, IEEE CS Press, 1991.

[104] T. Kato, T. Kurita, H. Shimogaki, T. Mizutori, and K. Fujimura, "A Cognitive Approach to Visual Interaction," *Proceedings of the International Conference on Multimedia Information Systems,* pp. 109-120, Singapore, McGraw Hill Book Co., 1991.

[105] R. Kimberley. *Text Retrieval – A Directory of Software,* 3rd edition, Gower Publishing Company, 1990.

[106] W. Klas, E.J. Neuhold, and M. Schrefl, "Visual Databases Need Data Models for Multimedia Data," In T. Kunii (ed) *Visual Database Systems,* pp. 433-462, North Holland, New York, 1989.

[107] S.C. Kleene, "Representation of Events in Nerve Nets and Finite Automata, Automata Studies," *Princeton University Press,* Princeton, N.J., pp. 3-41, 1956.

[108] A. Klinger and A. Pizano, "Visual Structure and Databases," *Visual Database Systems,* T.L. Kunii, ed., pp. 3-25, 1989.

[109] A. Komlodi and L. Slaughter, "Visual Video Browsing Interfaces Using Key Frames," *Proceedings of the CHI 98 Summary Conference on CHI 98 Summary: Human Factors in Computing Systems,* pp. 337-338, 1998.

[110] F. Kubala, R. Schwartz, R. Stone, and R. Weischedel, "Named Entity Extraction from Speech," *Proc. DARPA Workshop on Broadcast News Understanding Systems,* Feb. 1998.

[111] T.L. Kunii, Y. Shinagawa, R.M. Paul, M.F. Khan, and A.A. Khokhar, "Issues in Storage and Retrieval of Multimedia Data," *ACM Multimedia Systems,* vol. 3, pp. 298-304, November 1995.

[112] S. Lakshmanan and H. Derin, "Simultaneous parameter estimation and segmentation of Gibbs random fields using simulated annealing," *IEEE Trans. Pattern Analysis and Machine Intelligence,* vol. 11, no. 8, pp. 799-813, 1989.

[113] M.K. Leong, S. Sam, and A.D. Narasimhalu, "Towards a Visual Language for an Object-Oriented Multimedia Database," *International Federation for Information Processing (IFIP) TC-2 Working Conference on Visual Databases,* pp. 465-496, 1989.

[114] L. Li, A. Karmouch, and N.D. Georganas, "Multimedia Teleorchestra with Independent Sources: Part 2 – Synchronization Algorithms," *ACM/Springer Multimedia Systems,* vol. l, no. 4, pp. 154-165, 1994.

[115] E.B.W. Lieutenant and J.R. Driscoll, "Incorporating A Semantic Analysis into A Document Retrieval Strategy," *Proc. A CM/SIGIR Conf. Research and Development Information Retrieval,* pp. 270-279, Oct. 1991.

[116] J.H. Lim, H.H. Teh, H.C. Lui, and P.Z. Wang, "Stochastic Topology with Elastic Matching for Off-Line Handwritten Character Recognition," *Pattern Recognition Letters,* vol. 17, no. 2, pp. 149-154, Feb. 1996.

[117] C.C. Lin, J.X., S.K. Chang, "Transformation and Exchange of Multimedia Objects in Distributed Multimedia Systems," *ACM Multimedia Systems Journal,* vol. 4, pp. 12-29, February 1996.

[118] T.D.C. Little and A. Ghafoor, "Synchronization and Storage Models for Multimedia Objects," *IEEE J. Selected Areas in Commun.,* vol. 9, pp. 413-427, Apr. 1990.

[119] T.D.C. Little and A. Ghafoor, "Scheduling of Bandwidth-Constrained Multimedia Traffic," *Computer Commun.,* vol. 15, pp. 381-387, July/Aug. 1992.

[120] T.D.C. Little and A. Ghafoor, "Interval-Based Conceptual Models for Time-Dependent Multimedia Data," *IEEE Trans. On Knowledge and Data Engineering,* vol. 5, no 4, pp. 551-563, Aug. 1993.

[121] T.D.C. Little, G. Ahanger, R.J. Folz, J.F. Gibbon, F.W. Reeve, D.H. Schelleng, and D. Venkatesh, "A Digital On-Demand Video Service Supporting Content-Based Queries," *Proc. ACM Multimedia,* pp. 427-436, 1993.

[122] T.D.C. Little, G. Ahanger, H-J. Chen, R.J. Folz, J.F. Gibbon, A. Krishnamurthy, P. Lumbda, M. Ramanathan, and D. Venkatesh, "Selection and Dissemination of Digital Video via the Virtual Video Browser," *Multimedia Tools and Applications,* 1(2), 1995.

[123] Z.Q. Liu and J.P. Sun, "Structured Image Retrieval," *J. Visual Languages and Computing,* vol. 8, no. 3, pp. 333-357, 1997.

[124] Y. Masunaga, "Design Issues of OMEGA – An Object-Oriented Multimedia Database Management System," *J. Information Processing,* vol. 14, pp. 60-74, 1991.

[125] C. Meghini, F. Rabitti, and C. Thanos, "Conceptual Modeling of Multimedia Documents," *IEEE Computer,* 24, pp. 23-30, 1991.

[126] J. Meng, Y. Juan, and S.F. Chang, "Scene Change Detection in a MPEG Compressed Video Sequence," *Proc. SPIE,* vol. 2,419, pp. 14-25, 1995.

[127] J. Meng and S.F. Chang, "CVEPS: A Compressed Video Editing and Parsing System," *Proceedings of MM'96,* pp. 43, ACM Press, 1996.

[128] T. Meyer, W. Effelsberg, and R. Steinmetz, "A Taxonomy on Multimedia Synchronization," *Proc. Fourth Int'l Workshop on Future Trends in Distributed Computing Systems,* 1993.

[129] B. Meyer, "Pictorial Deduction in Spatial Information Systems," *Proc. Int'l Symp. Visual Languages,* pp. 23-30, 1994.

[130] M. Mills, J. Cohen, and Y.Y. Wong, "A Magnifier Tool for Video Data," *Proc. ACM Computer Human Interface (CHI),* pp. 93-98, May, 1992,

[131] S. Miyamoto, "Two Approaches for Information Retrieval Through Fuzzy Associations," *IEEE Transactions on Systems, Man and Cybernetics,* 19, pp. 123-130, 1989.

[132] J. Motiwalla, A.D. Narasimhalu, and S. Christodoulakis, *Proceedings of the International Conference on Multimedia Information Systems,* Singapore, McGraw Hill Book Co., 1991.

[133] *Multimedia Office Filing – The MULTOS Approach,* C. Thanos, ed., North-Holland, 1990.

[134] A. Nagasaka and Y . Tanaka, "Automatic Video Indexing and Full Video Search for Object Appearances," *Proc. Second Working Conf. Visual Database Systems,* pp. 119-133, IFIP WG 2.6, Oct. 1991.

[135] A.D. Narasimhalu, "Multimedia Databases," *Multimedia Systems,* 4: 226-249, 1996.

[136] A.D. Narasimhalu, "A Framework for the Integration of Expert Systems with Multimedia Technologies," *Expert Syst Appl,* 7: 3, pp. 427-439, 1994.

[137] S.R. Newcomb, N.A. Kipp, and V.T. Newcomb, "HyTime – Hypermedia/Time-Based Document Structuring Language," *Comm. ACM,* vol. 34, no. 11, pp. 67-83, Nov. 1991.

[138] *Office Document Architecture (ODA): An Interchange Format,* no. 8613, ISO, 1986.

[139] A. Ono, M. Amano, M. Hakaridani, T. Satou, and M. Sakauchi, "A Flexible Content-Based Image Retrieval System with Combined Scene Description Keyword," *Proc. Int'l Conf. Multimedia Computing and Systems,* pp. 201-208, 1996.

[140] E. Oomoto, and K. Tanaka, "OVID: Design and Implementation of a Video Object Database System," *IEEE Trans. on Knowledge and Data Engineering,* vol. 5, no. 4, pp. 629-643, August 1993.

[141] M.T. Özsu, D. Duane, G. El-Medani, C. Vittal, "An object-oriented multimedia database system for a news-on-demand application," *ACM Multimedia Systems Journal,* vol. 3, pp. 182-203, November 1995.

[142] J.L. Peterson, "Petri nets," *ACM Comput. Surveys,* vol. 9, pp. 223-252, Sept. 1977.

[143] A. Poggio, J. Garcia Luna Aceves, E. J. Craighill, D. Worthington, and J. Hight, "CCWS: A Computer-Based Multimedia Information System," *Computer,* vol. 18, no. 10, pp. 92-103, Oct. 1985.

[144] D. Ponceleon, S. Srinivasan, A. Amir, D. Petkovic, and D. Diklic, "Key to Effective Video Retrieval: Effective Cataloging and Browsing," *Proceedings of the 6th ACM Int'l Conf. on Multimedia,* pp. 99-107, 1998.

[145] R. Price, M.K. Leong, N. Karta, and A.D. Narasimhalu, "Experiences in the Implementation of a Multimedia DBMS," *ISS Working Paper WP 89-12-0,* Institute of Systems Science, National University of Singapore, Singapore, 1989.

[146] R. Rabitti and P. Stanchev, "GRIMDBMS: A GRaphical IMage Database Management System," In T. Kunii (ed) *Visual Database Systems,* pp. 415-430, North Holland, New York, 1989.

[147] S. Ravela, R. Manmatha, and E.M. Riseman, "Image Retrieval Using Scale-Space Matching," *Proc. Fourth European Conf. Computer Vision,* pp. 273-282, 1996.

[148] R.R. Razouk and C.V. Phelps, "Performance Analysis Using Timed Petri Nets," *Proc. 1984 Int'l Conf. Parallel Processing,* pp. 126-129, 1984.

[149] N. Reddy, "Improving Latency in Interactive Video Server," *SPIE MMCN,* 1997.

[150] C. J. van Rijsbergen. *Information Retrieval,* Butterworths, London, 1979.

[151] N. Roussopoulos, C. Faloutsos, and T. Sellis, "An Efficient Pictorial Database System for PSQL," *IEEE Transactions on Software Engineering,* 14, pp. 639-650, 1988.

[152] T. Sakai, M. Nagao, and S. Fujibayashi, "Line Extraction and Pattern Detection in a Photograph," *Pattern Recognition,* vol. 1, no. 3, pp. 233-248, Mar. 1969.

[153] G. Salton and M.J. McGill. *Introduction to Modern Information Retrieval,* McGraw-Hill, New York, 1983.

[154] M. Schneider and T. Trepied, "Extensions for the Graphical Query Language CANDID," *Proceedings of the 2nd Working Conference on Visual Database Systems,* Budapest, International Federation for Information Processing, IFIP Working Group 2.6, pp. 189-203, 1991.

[155] S. Sista and R.L. Kashyap, "Bayesian Estimation for Multiscale Image Segmentation," *IEEE International Conference on Acoustics, Speech, and Signal Processing,* March 1999.

[156] S. Sista and R.L. Kashyap, "Unsupervised Video Segmentation and Object Tracking," in *ICIP'99,* Japan, 1999.

[157] S. Sista. *Image And Video Segmentation Using Unsupervised Classification in a Bayesian Set up.* Ph.D. Thesis, Purdue University, May 1999.

[158] A.P. Sistla, C. Yu, and R. Haddad, "Reasoning About Spatial Relationships in Picture Retrieval Systems," *Proc. Int'l Conf. Very Large Database,* pp. 570-581, Sept. 1994.

[159] A.P. Sistla, C. Yu, C. Liu, and K. Liu, "Similarity Based Retrieval of Pictures Using Indices on Spatial Relationships," *Proc. Int'l Conf. Very Large Database,* pp. 619-629, Sept. 1995.

[160] S.W. Smoliar and H.J. Zhang, "Content-based video indexing and retrieval," *IEEE Multimedia,* pp. 62-72, Summer, 1994.

[161] S. Srinivasan, D. Ponceleon, A. Amir, and D. Petkovic, "What is in the Video Anyway? In Search of Better Browsing," *IEEE Int'l Conference on Multimedia Computing and Systems,* pp. 388-393, 1999.

[162] R. Steinmetz, "Synchronization Properties in Multimedia Systems," *IEEE* J. *Selected Areas in Commun.,* vol. 8, no. 3, pp. 401-412, 1990.

[163] R. Steinmetz and T. Meyer, "Multimedia Synchronization Techniques: Experiences Based on Different Systems Structures,'' *Proc. Fourth IEEE Computer Society Int'l Workshop Multimedia Comm.,* pp, 306-314, 1992.

[164] S.Y.W. Su, S.J. Hyun, and H.-H.M. Chen, "Temporal Association Algebra: A Mathematical Foundation for Processing Object-Oriented Temporal Databases," *IEEE Trans. on Knowledge and Data Engineering,* Vol. 10, No. 3, pp. 389-408, May/June 1998.

[165] M. Tanaka and T. Ichikawa, "A Visual User Interface for Map Information Retrieval Based on Semantic Significance," *IEEE Transactions on Software Engineering,* 14, pp. 666-670, 1988.

[166] *Y.* Theodoridis, M. Vazirgiannis, and T. Sellis, "Spatio-Temporal Indexing for Large Multimedia Applications," *Proc. Int'l Conf. Multimedia Computing and Systems,* pp. 441-448, 1996.

[167] H. Thimm and W. Klas, "d-Sets for Optimized Relative Adaptive Playout Management in Distributed Multimedia Database Systems," *IEEE 12th International Conference on Data Engineering,* New Orleans, Louisiana, pp. 584-592, 1996.

[168] D. Toman, "Point vs. Interval-Based Query Languages for Temporal Databases," *Proc. Fifth ACM SIGACT/MOD/ART Symp. Principles of Database Systems,* pp. 58-67, 1996.

[169] K. Tsuda, K. Yamamoto, M. Hirakawa, and T. Ichikawa, "MORE: An Object-Oriented Data Model with A Facility for Changing Object Structures,'' *IEEE Transactions on Knowledge and Data Engineering,* vol. 3, no. 4, pp. 444-460, 1991.

[170] A. Tversky, "Features of Similarity," *Psychol Rev.,* 84, pp. 327-354, 1977.

[171] H. Wactlar, M. Christel, Y. Gong, and A. Hauptmann, "Lessons Learned from Building a Terabyte Digital Video Library," *IEEE Computer,* vol. 32, no. 2, 1999.

[172] T. Wahl and K. Rothermel, "Representing Time in Multimedia Systems," *Proc. Int'l Conf. on Multimedia Computing and Systems,* CS Press, Los Alamitos, Calif., pp. 538-543, 1994.

[173] R. Weiss, A. Duda, and D.K. Gifford, "Composition and Search with a Video Algebra," *IEEE Multimedia,* vol. 2, no. 1, pp. 12-25, Spring1995.

[174] R. Weiss, A. Duda, and D.K. Gifford, "Content-Based Access to Algebraic Video," *Proc. IEEE Int'l Conf. Multimedia Computing and Systems,* pp. 140-151, May 1994.

[175] K.H. Weiss, "Formal Specification and Continuous Media," *Proc. First Int'l Workshop Network and Operating System Support for Digital Audio and Video,* pp. 123-127, Nov. 1990.

[176] D. Woelk, W. Kim, and W. Luther, "An Object-Oriented Approach to Multimedia Databases," *Proc. ACM SIGMOD Int'l Conf. Management ofData,* pp. 311-325, May 1986.

[177] D. Woelk and W. Kim, "Multimedia Information Management in an Object-Oriented Database System," *Proceedings of the 13th VLDB Conference,* pp. 319-329, Brighton, 1987.

[178] W. Woods, "Transition Network Grammars for Natural Language Analysis," *Comm. ACM,* 13, pp. 591-602, October 1970.

[179] X. Wu and T. Ichikawa, "KDA: A Knowledge-Based Database Assistant with A Query Guiding Facility," *IEEE Trans. Knowledge and Data Engineering,* vol. 4, no. 5, pp. 443-453, 1994.

[180] H. Wynne, T.S. Chua, and H.K. Pung, "An Integrated Color-Spatial Approach to Content-Based Image Retrieval," *Proc. ACM Multimedia,* pp. 305-313, 1995.

[181] B-L. Yeo and M.M. Yeung, "Retrieving and Visualization Video," *Comm. of the ACM,* Vol. *40,* No. 12, December 1997, pp. 43-52.

[182] M.M. Yeung, B-L. Yeo, W. Wolf, and B. Liu, "Video Browsing Using Clustering and Scene Transitions on Compressed Sequences," *Proc. IS and T/SPIE Multimedia Computing and Networking,* 1995.

[183] A. Yoshitaka and T. Ichikawa, "A Survey on Content-Based Retrieval for Multimedia Databases," *IEEE Transactions on Knowledge and Data Engineering,* vol. 11, no. 1, pp. 81-93, January/February 1999.

[184] A. Yoshitaka, T. Ishii, M. Hirakawa, and T. Ichikawa, "Content-Based Retrieval of Video Data by the Grammar of the Film," *Proc. Int'l Symp. Visual Languages,* pp. 314-321, Sept. 1997.

[185] A. Yoshitaka, Y. Hosoda, M. Yoshimitsu, M. Hirakawa, and T. Ichikawa, "VIOLONE: Video Retrieval By Motion Examples," J. *Visual Languages and Computing,* vol. 7, no. 4, pp. 423-443, 1996.

[186] A. Yoshitaka, S. Kishida, M. Hirakawa, and T. Ichikawa, "Knowledge-Assisted Content-Based Retrieval for Multimedia Databases," *IEEE Multimedia,* vol. 1, no. 4, pp. 12-21, 1994.

[187] C. Yu, W. Sun, D. Bitton, Q. Yang, R. Bruno, and J. Tullis, "Efficient Placement of Audio on Optical Disks for Real-Time Applications," *Commun ACM,* 32, pp. 862-871, 1989.

[188] L.A. Zadeh, "The Role of Fuzzy Logic in the Management of Uncertainty in Expert Systems," *Fuzzy Sets Sys.,* 11, pp. 199-227, 1983.

[189] H.J. Zhang, A. Kankanhalli, and S.W. Smoliar, "Automatic Partitioning of Full-Motion Video," *Multimedia Systems,* vol. 1, no. 1, pp. 10-28, 1993.

[190] H.J. Zhang, *C.Y.* Low, Y. Gong, and S.W. Smoliar, "Video Parsing Using Compressed Data," *Proc. SPIE,* vol. 2,182, pp. 142-149, 1994.

[191] M.M. Zloof, "QBE/OBE: A Language for Office and Business Automation," *Computer,* vol. 14, no. 5, pp. 13-22, 1981.

[192] W.M. Zuberek, "Performance Evaluation Using Extended Timed Petri Nets," *Proc. Int'l Conf. Timed Petri Nets,* pp. 272-278, 1985.

[193] A.K. Elmagarmid, H. Jiang, et al. *Video Database System: Issues, Products, and Applications,* Kluwer, 1997.

Index

About the Authors

Dr. Shu-Ching Chen received his Ph.D. from the School of Electrical and Computer Engineering from Purdue University, West Lafayette, Indiana, USA in 1998. He also received his Computer Science, Electrical Engineering, and Civil Engineering Master degrees from Purdue University, West Lafayette, IN. He has been an Assistant Professor in the School of Computer Science, Florida International University (FIU) since August, 1999. Before joining FIU, he worked as a R&D software engineer at Micro Data Base Systems (MDBS), Inc., IN, USA. His main research interests include distributed multimedia database systems and information systems, information retrieval, object-oriented database systems, data warehousing, data mining, and distributed computing environments for intelligent transportation systems (ITS). He is the program co-chair of the 2nd International Conference on Information Reuse and Integration (IRI-2000). He is a member of the IEEE Computer Society, ACM, and ITE.

Dr. R. L. Kashyap received his Ph.D. in 1966 from Harvard University, Cambridge, Mass. He joined the staff of Purdue University in 1966, where he is currently a Professor of Electrical and Computer Engineering and the Associate Director of the National Science Foundation supported Engineering Research Center Intelligent Manufacturing Systems at Purdue. He is currently working on research projects supported by the Office of Naval Research, Army Research Office. NSF, and several companies like Cummins Engines. He has directed more than 40 Ph.D. dissertations at Purdue. He has authored one book and more than 300 publications, including 120 archival journal papers in areas such as pattern recognition, random field models, intelligent data bases, and intelligent manufacturing systems. He is a Fellow of the IEEE.

Dr. Arif Ghafoor received his BS degree in electrical engineering from the University of Engineering and Technology, Lahore, Pakistan, in 1976; and the MS, Mphil, and PhD degrees from Columbia University in 1977, 1980, and 1984, respectively. In the Spring of 1991, he joined the faculty of the School of Electrical Engineering at Purdue University, where he is now a full professor. Prior to joining Purdue University, he was on the faculty of Syracuse University from 1984 to 1991. His research interests include design and analysis of parallel and distributed systems, and multimedia information systems. He has published in excess of 100 technical papers in these areas. Currently, he is directing a research laboratory in distributed multimedia systems at Purdue University. His research in these areas has been funded by DARPA, NSF, NYNEX, AT&T, Intel, IBM, Fuji Electric Corporation, and GE. He has served on the program committees of various IEEE and ACM conferences. He is a fellow of the IEEE.