Curriculum Vitae

PERSONAL DETAILS

Name: Manoj K. Arora

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Department of Civil Engineering
Indian Institute of Technology (IIT) Roorkee
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ACADEMICS

Education

- Ph. D. (Remote Sensing), University of Wales Swansea (now Swansea University), UK, 1996
- M.E. (Survey & Photogrammetry), University of Roorkee (now I I T Roorkee), India, 1986
- B.E. (Civil), Punjab Engineering College (now PEC University), Chandigarh, India, 1984

Training

- One week training course on Bernese' GPS Software in University of Bern, Switzerland, (15.2.99 to 21.2.99)

EMPLOYMENT

- Professor, Department of Civil Engineering, I I T Roorkee, India, (19.12.07 to date)
- Associate Professor, Department of Civil Engg., I I T Roorkee, India, (03.02.04 to 18.12.07)
- Visiting fellow, Department of Electrical Engineering and Computer Sciences, Syracuse University, NY, USA (15.05.04 to 15.07.04)
- Visiting Research Scholar, Department of Electrical Engineering and Computer Sciences, Syracuse University, NY, USA (15.01.02 to 15.07.03)
- Assistant Professor, Department of Civil Engineering, I I T Roorkee, India, (25.03.97 to 02.02.04)
- Lecturer, Department of Civil Engineering, I I T Roorkee, India, (13.10.88 to 24.03.97)
- Lecturer, Regional Engineering College, Kurukshetra, India, (18.08.88 to 12.10.88)
- Senior Research Fellow, Department of Civil Engineering, I I T Roorkee, India (26.08.86 to 12.08.88)

AWARDS & FELLOWSHIPS

- Outstanding Teacher Award, IIT Roorkee (2010)
- Outstanding Teacher Award, IIT Roorkee (2006)
- Star Performer in Teaching and Research, IIT Roorkee, (2005-06)
- Star Performer in Teaching and Research, IIT Roorkee, (2004-05)
- Star Performer in Teaching and Research, IIT Roorkee, (2003-04)
- Visiting fellowship, Syracuse University, USA (2004)
- Post Doctoral Research Fellowship in a NASA project at Syracuse University, USA (2002-2003)
- Young Teacher Career Award from All India Council of Technical Education (AICTE), India (1998)

- Commonwealth Scholarship for PhD in U.K. (1993)
- Research fellowship in Engineering and Technology from University Grants Commission (UGC), India (1986)

AREAS OF INTERESTS

Core areas: Remote Sensing and GIS, Surveying, GPS applications
Allied areas: Advances in Digital Image Classification, Soft Computing, Land Cover Mapping, SAR Interferometry, Hazard and Risk Studies.

SKILLS

Familiarity with C, C++ and FORTRAN, Competency in Erdas Imagine, Arc-GIS and other image processing and GIS software.

TEACHING EXPEREINCE

Total teaching experience till date: ~ 24 Years

Subjects taught at undergraduate level

- Geomatics Engineering (covering Photogrammetry, Remote Sensing, GIS & GPS)
- Engineering Surveys
- Principles of Surveying and Photogrammetry
- Surveying and Photogrammetric Mapping Techniques
- Project Surveys and Photogrammetry
- Computer Programming and its applications (FORTRAN and C)
- Computer Systems and Programming (C++)

Subjects taught at graduate level

- Survey Measurements and Adjustment Procedures
- Basic Remote Sensing
- Remote Sensing for Land Use Mapping and Urban Planning
- Digital Image Processing
- Remote Sensing for Civil Engineering
- Programming Languages and Computer Graphics (C language)
- Advanced Programming and Computer Graphics (C and C++)

Short Term Courses Organised

- Training for Engineers on Modern Surveying Equipment, IRCON, Delhi (May 1999).
- A Teaching Capsule for Remote Sensing and GIS, QIP, I I T Roorkee, India (July, 2000).
- GIS Training for Army Personnel, BEG and Center, Roorkee Roorkee, India (Feb. 2007).
- Remote sensing and GIS training for scientists and engineers, Uttarakhand Space Application Centre, Dehradun (May 2008)

CONSULTANCY EXPERIENCE

Consultancy Projects in India and abroad: 20

i. Field Survey Work for Bridge Alignment at river Ganges in DeoPrayag
ii. Reconnaissance Surveys for a Rail Route Alignment from Jammu to Poonch.
iii. Design of Drainage and Sewage in Moradabad City (Topographical surveys of a part of Moradabad City).
iv. Bridge Survey Work at Yamuna river.
v. Soil Erosion Estimation using GIS.
vi. Levelling of Feeder Channel connecting Upper Ganga Canal and Eastern Yamuna Canal.
vii. Topographical Survey of Pendaras Village, Koteshwar.
viii. Contour Survey of a Landslide area near Haridwar.
ix. Profile Leveling along proposed Sewer Line, BHEL, Haridwar
x. Development of Index to Monitor Debris Cover on Himalayan Glaciers using LISS II and LISS IV Data
xi. Software for Advanced Classifiers for Multispectral Remote Sensing Images, Defence Electronics Application Laboratory, DRDO, Dehradun
xii. Provision of GCP using GPS Survey in Delhi area.
xiii. GIS Training for Army Personnel
xiv. Remote Sensing and GIS Training for Scientists and Academicians
xv. Safeland: Living with Landslide Risk in Europe: Assessment, Effects of Global Change and Risk Management Strategies, International Center of GeoHazards, Norwegian Geotechnical Institute, Oslo, Norway
xvi. Development of an Operational Algorithm for Snow Water Equivalent, Snow and Avalanche Study Establishment (SASE)
xvii. Development of Algorithms for Anomaly Detection and Sub-pixel Classification from Hyperspectral Remote Sensing Data, Defence Electronics Application Laboratory, DRDO, Dehradun
xviii. Development of Algorithms for Feature Reduction and Per-pixel Classification from Hyperspectral Remote Sensing Data, Defence Electronics Application Laboratory, DRDO, Dehradun
xix. Groundwater Table Checking along Madhya Ganges Canal, World Bank Project, UP Irrigation Department.
xx. Alignment checking of Rishikesh to Karnprayag railway line (ongoing)

RESEARCH EXPERIENCE

Total research experience till date: ~26 Years

ME Thesis Topic ***Error analysis in survey and photogrammetric projects***

PhD Thesis Topic ***An Evaluation of Factors Affecting the Accuracy of Digital Multi-spectral Land Cover Classifications***

Publications

i) Articles ***180 (169 papers + 11 chapters)***

Research Papers Published **166**

In press/Accepted	**03**
Under Revision/Submitted/Preparation	**07**
Chapters in Books	
Published	**11**

ii) Books

Distance Education Learning Books	**2**
Edited Book	**1**
Text Book	**1**

iii) Invited Lectures **31**

Ph. D Theses Supervision **14 (Completed)**
7 (In progress)

M. Tech./ M. S. Theses Supervised **50 (Completed)**
2 (In progress)

Sponsored Research Projects: **12**

i. Environmental Impact Assessment of River Valley Project using Remote Sensing Technique, University Grants Commission (UGC), India, Rs. 500K **(Completed) (Co-PI) (1997-2000)**
ii. Fuzzy Approaches for Classification of Land Use/Land Cover Mixtures in a GIS Environment, All India Council of Technical Education (AICTE), India**,** Rs. 300K, **Young Teacher Career Award (Completed) (PI) (1998-2001)**
iii. Neural Network Techniques for Land Cover Classification, Department of Science and Technology (DST), India, Rs. 160K, **Young Scientist Project (Completed) (PI) (1999-2001)**
iv. Integrated National Program on Terrain Dependent Accuracy Assessment of DEM of SRTM, Department of Science and Technology, India, Rs. 140K **(Completed) (Co-PI) (2001)**
v. Soil Moisture Estimation using Microwave Remote Sensing Data, AICTE, India, Rs. 1250K **(Co-PI) (2000 - 2004) Completed**
vi. Study of Shallow Earthquakes in Indian Region using Differential SAR Interferometry, AICTE , Rs. 1000K **(Co-PI) (2002 - 2004) Completed**
vii. SAR Interferometry for Mapping Land Subsidence due to Mining in Jharia Coalfields, DST, Rs. 350K **(Co-PI) (2002 - 2004) Completed**
viii. Application of DIF-SAR to Investigate Critical Deformation in Garhwal Kumaon Himalaya Related to Earthquakes and Landslides, DST, Rs. 1500K **(Co-PI) (2005 - 2007) Completed**
ix. Sub-pixel Snow Cover Mapping from Remote Sensing Data, SASE, DRDO, Rs. 918K **(PI) (2006 - 2008) Completed**
x. Landslide Risk Assessment using Advanced Pattern Recognition Techniques, DST, Rs. 1146K **(PI) (2007-2011) Completed**
xi. Department of Science and Technology (DST), Delhi -International Center of Geohazards (ICG), Oslo (Indo-Norwegian Institutional Co-operation Project on Geohazards in the Himalayas. **(PI) (2011-) (Data and Travel Costs)**
xii. Application of Differential SAR Interferometry in Landslide Investigation, DST, Rs. 4467K, (**PI) (2012-)**

Membership of Professional Societies

i. Member, American Society of Photogrammetry and Remote Sensing (ASPRS) (2002-2010)
ii. Member, IEEE Geoscience and Remote Sensing Society (2002)
iii. Student Member, UK Remote Sensing Society (1993-1996)
iv. Life Member, Indian Society of Remote Sensing
v. Life Member, Indian Society of Construction Materials and Structures

Key Conferences attended

- American Society of Photogrammetry and Remote Sensing (ASPRS) Annual Convention and Exposition, Charlotte, NC, USA, Feb.27 - March 2, 1995
- 21st Annual Conference of the Remote Sensing Society, Southampton, UK, Sept. 11-14, 1995
- International Workshop on Soft Computing in Remote Sensing Data Analysis, Dec. 4-5, 1995, Milan, Italy.
- Remote Sensing Society One Day Student Meeting, April 4, 1996, Salford, UK.
- National Conference on Global Positioning System, Feb. 21-23, 1997, IIT Kanpur, India.
- Seminar on Recent Advances in Differential SAR Interferrometry and Applications, Jan. 18 – 22, 1999, IIT Bombay, Mumbai, India.
- Workshop on Problems and Methods in RS-based Land Use / Land Cover Mapping in Mountainous Terrain, Aug. 7-10, 2000, Wildlife Institute of India, Dehradun, India.
- International Conference on Mathematical Modelling, Jan. 29-31, 2001, University of Roorkee, Roorkee, India.
- International Conference on Remote Sensing and GIS/GPS, 2-5 Feb., 2001, Hyderabad, India.
- International Geoscience and Remote Sensing Symposium (IGARSS 02), June 24 – June 28, 2002, Toronto, Canada.
- 2nd Annual New York State Remote Sensing Symposium, April 17, 2003, Rochester, NY, USA.
- 1st India International Conference on Artificial Intelligence, Dec. 18-20, 2003, Hyderabad, India.
- American Society of Photogrammetry and Remote Sensing (ASPRS) Annual Convention and Exposition, Denver, CO, USA, May 23 – May 28, 2004.
- South Asian Countries Himalayan Science Workshop, Dehradun, India, June 27-28, 2006
- International Workshop on Snow, Ice, Glacier and Avalanches, IIT Bombay, Mumbai, India, Jan, 7-9, 2008
- National Snow Science Workshop, SASE, DRDO, Chandigarh, India, Jan. 11-12, 2008
- Cryoshphere & Hazards Workshop for the Hindu Kush, Himalaya & Tibetan Plateau, 3-6 April, 2008, Kathmandu, Nepal
- Indo-Norwegian workshop on Geohazards, Anna University, Chennai, Feb. 9-10, 2010
- India-Norway Institutional Cooperation Project Workshop on Tsunami Modeling and Landslides, Aug. 13 – 16, 2010, Oslo, Norway.
- Indo-Norwegian workshop on Geohazards, Anna University, New Delhi, Feb. 7, 2011
- International Conference on Rock Mechanics, INDOROCK, Oct. 13-15, 2011, IIT Roorkee, Roorkee.
- National Seminar on “Geospatial Solutions for Resource Conservation and Management”, 18-20 January, 2012, Bangalore
- International Conference of Geospatial Techniques and Application (Geomatrix’ 12), Indian Institute of Technology Bombay, 26 - 29 February, 2012
- All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, March 2-3, 2012, Dehradun.

- Mini Symposium on Soft Computing in Civil Engineering, 10th World Congress on Computational Mechanics, July 8 – 13, 2012, Sao Paulo, Brazil.

Other Pertinent Information

i) Member, Advisory board of Journal of Conservation and Society, India
ii) Reviewer of following journals:

1. IEEE Transactions on Geoscience and Remote Sensing
2. IEEE Geoscience and Remote Sensing Letters
3. International Journal of Image Fusion
4. Remote Sensing of Environment
5. International Journal of Remote Sensing
6. Photogrammetric Engineering and Remote Sensing
7. Landscape Ecology (UK)
8. Optical Engineering
9. Computers and Geosciences
10. Environmental Engineering Science
11. Journal of Applied Remote Sensing
12. Journal of Indian Society of Remote Sensing
13. Current Science
14. Hydrology Journal of Indian Association of Hydrologists

iii) Associate Editor, Proceedings of 1st Indian International Conference on Artificial Intelligence
iv) Session Chair, Advanced Image Processing Algorithms for Remote Sensing Data, 1st Indian International Conference on Artificial Intelligence, Dec. 18-20, 2003, Hyderabad, India.
v) Session Chair, National Seminar on "Geospatial Solutions for Resource Conservation and Management", 18-20 January, 2012, Bangalore
vi) Session Chair, Hyperspectral Imaging, International Conference of Geospatial Techniques and Application (Geomatrix' 12), Indian Institute of Technology Bombay, 26 - 29 February, 2012, Mumbai
vii) Session Chair, All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, March 2-3, 2012, Dehradun.
viii) Session Chair, Mini Symposium on Soft Computing in Civil Engineering, 10th World Congress on Computational Mechanics, July 8 – 13, 2012, Sao Paulo, Brazil.

Administrative Experience

- Dean Academic Studies (Jan. 2013 – continuing)
- Professor in-Charge, Training and Placement (Jan. 2012 – Jan. 2013)
- Associate Dean (Academics) (Jan 2010 – Jan. 2012)
- Chairman GATE 2010, JAM 2010 (June 2009 – May 2010)
- Coordinating Chairman GATE 2009, JAM 2009 (June 2008 – May 2009)
- Vice Chairman GATE 2007, 2008, JAM 2007, 2008, (June 2006 – May 2008)
- Coordinator, Geomatics Engineering Group, Civil Engineering Department (July 2010 – June 2012)

- Honorary Secretary, IIT Roorkee Alumni Association (April 2007- March 2009)
- Officer-in-charge, Guest House, IIT Roorkee (Aug. 2005 – May 2006)
- Coordinator, Geomatics Engineering Section, Civil Engineering Department (May 2004 – April 2006)
- Wardenship of student's hostels (twice)
- Member, Center of Excellence Disaster Mitigation and Management, IIT Roorkee.
- Member, various departmental and institute administration committees (from time to time).
- Staff Advisor, Squash sports activity (1996-2007).

LIST OF PUBLICATIONS

Books

1. Varshney, P. K. and Arora, M. K. (Eds.), 2004, Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data, Springer Verlag Heidelberg, Germany.
2. Arora, M. K. and Badjatia, R. C, 2011. Introduction to Geomatics Engineering, Nem Chand & Bros., Roorkee, India.
3. Badjatia, R. C., and Arora, M. K., 2011, Remote Sensing and its Applications, Block II, Distance Learning Teaching course material, Indira Gandhi National Open University (IGNOU), New Delhi, India. (In Print)
4. Badjatia, R. C., and Arora, M. K., 2011, Surveying and its Applications, Block I, Distance Learning Teaching course material, Indira Gandhi National Open University (IGNOU), New Delhi, India (In Print)

Chapters in Books

1. Foody, G. M., and Arora, M. K., 1995, Fuzzy thematic mapping: incorporating mixed pixels in the training, allocation and testing stages of a supervised image classification, *In Soft Computing in Remote Sensing Data Analysis*, Edited by E. Binaghi, P. A. Alessandro and A. Rampini, World Scientific, Singapore, pp. 43-52.
2. Arora, M. K., 1997, Application of log linear modelling in digital image classification, In *Mathematics and its Applications in Engineering and Industry*, Edited by B. Singh, K. Murari, U.S. Gupta, G. Prasad and Sukavanam, Narosa Publishing House, UK, 237-246.
3. Arora, M. K., 2003, Role of Remote Sensing in Disaster Risk Management. In *Disaster Risk Reduction in South Asia*, (Eds) M. Ariyabandu and P. Sahni, Prentice-Hall (India), New Delhi, 84-100.
4. Rao, R. and Arora, M. K., 2004, Overview of Image Processing, In *Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data*, (Eds.) P. K. Varshney and M. K. Arora, Springer Verlag Heidelberg, Germany pp. 51-85.
5. Watanachaturaporn, P. and M. K. Arora, 2004, Support Vector Machines for Classification of Multi and Hyperspectral Data, , In *Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data*, (Eds.) P. K. Varshney and M. K. Arora, Springer Verlag Heidelberg, Germany pp. 238-255.
6. Kasetkasem, K. Arora, M. K. and Varshney, P. K., 2004, An MRF model based Approach for Sub-pixel Mapping from Hyperspectral Data, In *Advanced Image Processing Techniques for Remotely Sensed Hyperspectral Data*, (Eds.) P. K. Varshney and M. K. Arora, Springer Verlag Heidelberg, Germany pp. 257-277.

7. Shalan, M. A., Arora, M. K. and J. Algy, 2004, Crisp and Fuzzy Image Classification Accuracy Measures, In *Geodynamics*, (Eds) P. A. Atkinson, G. M. Foody, CRC Press, Boca Raton, FL, USA, pp. 11-23.
8. Arora, M. K., 2006, Modern Surveying Equipment, In *Advanced Survey*, Indira Gandhi National Open University, New Delhi, pp. 93-112.
9. Chen, H. M., Arora, M. K. and Varshney, P. K., 2006, A comparative assessment of similarity measures for registration of multi-temporal images, *In Analysis of Multi-temporal Remote Sensing Images*, Edited by P. Smits and L. Bruzzone, World Scientific, Singapore, pp. 43-52.3-11.
10. Arora, M. K., Shukla, A. and Gupta, R. P., 2010, Digital information extraction techniques for snow cover mapping from remote sensing data, *Encyclopedia of Snow, Ice and Glacier*, Springer, pp. 213-231.
11. M K Arora, A. K. Saha, Gupta, P. and R P Gupta, 2012, J-LaSIRF: Java-based Landslide Safe Intelligent Route Finder for mountainous terrain in GIS environment, Editors: B. Pradhan and M. Buchroithner, *GI Technology for Terrigenous Mass Movements*, Springer Verlag, Berlin, pp. 349-368

Research Papers in International Journals

1. Arora, M. and Garg, P. K., 1993, Expert systems in remote sensing- the way forward, *Asian-Pacific Remote Sensing Journal*, 5, 67-70.

2. Foody, G. M., and Arora, M. K., 1996, Incorporating Mixed Pixels in the Training, Allocation and Testing Stages of Supervised Classifications, *Pattern Recognition letters*, 17, 1389-1398.

3. Arora, M. K., and Foody, G. M., 1997, Log-linear Modelling for the Evaluation of Variables Affecting the Accuracy of Probabilistic, Fuzzy and Neural Network Classifications, *International Journal of Remote Sensing*, 18(4), 785-798.

4. Foody, G. M., and Arora, M. K., 1997, An Evaluation of Some Factors Affecting the Accuracy of Classification by an Artificial Neural Network, *International Journal of Remote Sensing*, 18(4), 799-810.

5. Arora, M. K., and Ghosh, S. K., 1998, A comparative evaluation of accuracy measures for the classification of remotely sensed data, *Asian Pacific Remote Sensing and GIS Journal*, 10(2), 1-9.

6. Arora, M. K., Narsimham, G., and Mohanty, B., 1998, Neural network approach for the classification of remotely sensed data, *Asian Pacific Remote Sensing and GIS Journal, 10 (2*), 11–18.

7. Arora, M. K., Tiwari, K. C., and Mohanty, B., 2000, Effect of Neural Network Variables on Image Classification, *Asian Pacific Remote Sensing and GIS Journal*, Vol. 13, 1 – 11.

8. Arora, M. K., and Mathur, S., 2001, Multi-source image classification using neural network in a rugged terrain, *Geo Carto International*, 16 (3), 37 – 44.

9. Saha, A. K., Gupta, R. P., and Arora, M. K., 2002, GIS- Based Landslide Hazard Zonation in a part of the Himalayas, *International Journal of Remote Sensing*, 23(2), 357-369.

10. Arora, M. K. and Agarwal, K., 2002, A program for sampling design for image classification accuracy assessment, *Photogrammetry Journal of Finland*, 18(1), 33-43.

11. Shalan, M. A., Arora, M. K., and Ghosh, S. K., 2003, An evaluation of fuzzy classifications from IRS 1C LISS III data, *International Journal of Remote Sensing*, 23(15), 3179 - 3186.

12. Chen, H., Varshney, P. K. and Arora, M. K., 2003, Mutual information based image registration of remote sensing data, *International Journal of Remote Sensing*, 24(18), 3701-3706.

13. Chen, H., Varshney, P. K. and Arora, M. K., 2003, Automated registration of multi-temporal remote sensing images using mutual information, *IEEE Transactions on Geoscience and Remote Sensing*, 41 (11), 2445-2454.

14. Chen, Hua-mei, Arora, Manoj K. and Varshney, Pramod K., 2003, Mutual information based image registration for remote sensing data, *Electrical Engineering and Computer Science*. Paper 127, Syracuse University, USA, (http://surface.syr.edu/eecs/127).

15. Shah, C. A, Arora, M. K., and Varshney, P. K., 2004, Unsupervised Classification of Hyperspectral Data: An ICA Mixture Model based Approach, *International Journal of Remote Sensing*, 25(2), 481-487

16. Arora, M. K, Gupta, A.S.D., Gupta, R. P., 2004, An artificial neural network approach for landslide hazard zonation in Bhaghirathi (Ganga) valley, Himalayas, *International Journal of Remote Sensing*, 25(3), 559-572.

17. Hyder, S. S., Said, S., Kothyari, U. C., and Arora, M. K., 2004, Soil moisture estimation using ERS-2 SAR data in Solani river catchment *Journal of International Association of Hydrological Sciences (IAHS)*, 49(2), 323–334.

18. Saha, A.K., R P Gupta , I Sarkar, M K Arora and E Csaplovics, 2005, A Statistical approach for GIS-based Landslide Hazard Zonation: A case study in the Himalayas, *Landslides*, 2, 61-69.

19. Sharma, M. L. and Arora, M. K., 2005, Prediction of seismicity cycles in the Himalayas using artificial neural network, *Acta Geophysica Polonica* 53(3), 299-309

20. Kasetkasem, T., Arora, M. K., and Varshney, P. K., 2005, MRF based approach for super resolution mapping, *Remote Sensing of Environment*, 96, 302-314.

21. Min Xu, P. Watanachaturaporn, P. K. Varshney and M. K. Arora, 2005, Decision Tree Regression for Soft Classification of Remote Sensing Data, *Remote Sensing of Environment*, 97, 322-336.

22. Ibrahim, M. A., Arora, M. K., and Ghosh, S. K., 2005, Estimating and Accommodating uncertainties through soft classification of remote sensing data, *International Journal of Remote Sensing*, 26, 2995-3007.

23. Saha, A.K., M. K. Arora, R P Gupta , M. L. Virdi, and E Csaplovics, 2005, GIS-Based Route Planning in Landslide Prone Areas, *International Journal of Geographic Information Science*, 19(10), 1149-1175.

24. Saha, A. K., Arora, M. K., Csaplovics E., and Gupta, R. P., 2005, Land cover classification using IRS 1C LISS and topographic data in a rugged terrain in Himalayas, *Geo Carto International*, 20(2), 33-40

25. Kanungo, D. P., Gupta, R. P., Arora, M. K., Sarkar, S., 2006, A comparative study of conventional, ANN Black Box, Fuzzy and combined neural and fuzzy Weighting Procedures for landslide susceptibility zonation in Darjeeling Himalayas, *Engineering Geology*, 85, 347-366.

26. Cheng, Qi, Varshney, P. K. and Arora, M. K., 2006, Logistic Regression for Feature Selection and Soft Classification of Remote Sensing Data, *IEEE Transactions on Geosciences and Remote Sensing Letters*, 3, 491-494

27. Singh, S., Parkash, B., Rao, M. S., Arora, M. K. and Bhosle, B, 2006, Geomorphology, Pedology and Sedimentology of the Deoha/Ganga- Ghaghara Interfluve, Upper Gangetic Plains (Himalayan Foreland Basin)- Extensional Tectonic Implications, *CATENA*, 67, 183-203.

28. Stehman, S. V., Arora, M. K., Kasetkasem, T. and Varshney, P. K., 2007, Estimation of Fuzzy Error Matrix Based Accuracy Measures for Soft Classification and their Variances under Stratified Random Sampling, *Photogrammetric Engineering and Remote Sensing*, 73, 165-174.

29. Sunderasan, A., Varshney, P. K. and Arora, M. K., 2007, Robustness of Change Detection Algorithms in the Presence of Registration Errors, *Photogrammetric Engineering and Remote Sensing*, 73, 375-384.

30. Shah, C. A, Arora, M. K., and Varshney, P. K, 2007. ICA Mixture Model Algorithm for Unsupervised Classification of Remote Sensing Imagery, *International Journal of Remote Sensing*, 28, 1711 – 1731.

31. Watanachaturaporn, P., P. K. Varshney and M. K. Arora, 2007, Multisource classification using support vector machines: an empirical comparison with decision tree and neural network classifiers, *Photogrammetric Engineering and Remote Sensing*, 74, 239-246.

32. Chauhan, H. J., M. K. Arora, A. Agarwal, 2007, A Comparison of Area Estimation Techniques for Remotely Sensed Derived Crisp Classification, *Journal of Applied Remote Sensing*, (Published online).

33. Tiwari, K. C., Singh, D. and Arora, M. K., 2008, Development of a Model for Detection and Estimation of Depth of Shallow Buried Non-Metallic Landmine at Microwave X-Band Frequency, *Progress In Electromagnetics Research, PIER*, 79, 225–250.

34. Said S., Kothyari, U. C., Arora, M. K., 2008, Soil Moisture Estimation from ERS-2 SAR Data over Bare and Vegetated Areas Using Neural Network: A Case Study, *ASCE Journal of Hydrologic Engineering*, 13, 461-475.

35. Kanungo, D. P., Arora, M. K., Gupta, R. P. and Sarkar, S., 2008, Comparative evaluation of GIS-based landslide susceptibility maps, *International Journal of Applied Earth Observation and Geoinformation*, 10, 330-341.

36. Kanungo, D. P., Arora, M. K., Gupta, R. P. and Sarkar, S., 2008, Landslide Risk Assessment Using Concepts of Danger Pixels and Fuzzy Set Theory in Darjeeling Himalayas, *Landslides*, 5, 407-416.

37. Kanungo, D. P., Arora, M. K., Gupta, R. P., Sarkar, S., 2009, A Fuzzy Set Based Approach for Integration of Thematic Maps for Landslide Susceptibility Zonation, *GeoRisk*, 3, 30-41

38. Shukla, A., Gupta, R. P., and Arora, M. K., 2009, Estimation of debris cover and its temporal variation using optical satellite sensor data: a case study in Chenab basin, Himalaya, *Journal of Glaciology*, 55, 444-452.

39. Kanungo, D. P., M. K. Arora, S. Sarkar and R. P. Gupta, 2009, Landslide susceptibility zonation mapping – A review, *Journal of South Asia Disaster Studies*, 2, 81-105

40. Shukla, A., Gupta, R. P., and Arora, M. K., 2010, Delineation of debris-covered glacier boundaries using optical and thermal remote sensing data, *Remote Sensing Letters*, 1, 11-17.

41. Shukla, A., M. K. Arora and R. P. Gupta, 2010, Synergistic approach for mapping debris-covered glaciers using optical-thermal remote sensing data with inputs from geomorphometric parameters, *Remote Sensing of Environment*, 114, 1378-1387.

42. Chauhan, S., Arora, M. K., and Gupta, N. K., 2010, Landslide Susceptibility Zonation through ratings derived from Artificial Neural Network, *International Journal of Applied Earth Observation and Geo Information*, 12, 340-350.

43. Pareek, N., Sharma, M. L., and Arora, M. K., 2010, Impact of seismic factors on Landslide Hazard Zonation: A case study in part of Indian Himalayas, *Landslides*, 7, 191-201.

44. Chauhan, S., Sharma, M and Arora, M. K., 2010, Landslide Susceptibility Zonation of Chamoli region, Garhwal Himalayas, using Logistic Regression Model, *Landslides*, 7(4), 411-423.

45. Maithani, S., Arora, M. K. and Jain, R. K., 2010, Urban Growth Zonation in Dehradun City using Artificial Neural Network, *Geo Carto International*, 25, 663-681.

46. Kasetkasem T., M.K. Arora, P.K. Varshney and V. Areekul, 2011, Improving Sub-pixel Classification by Incorporating Prior Information in Linear Mixture Models, *IEEE Transactions on Geoscience and Remote Sensing*, 49, 1001-1013.

47. Tiwari, K. C., Arora, M. K., and Singh, D., 2011, An Assessment of Independent Component Analysis for Detection of Military Targets from Hyperspectral Images, *International Journal of Applied Earth Observation and Geo Information*, 13, 730-740.

48. Varshney, A., Arora, M. K. and Ghosh, J. K., 2012, Median Change Vector Analysis Algorithm For Land Use Land Cover Change Detection From Remote Sensing Data, 2011 *Remote Sensing Letters*, 605-614.

49. Bhattacharya, A., Sharma, M. L., and Arora, M. K., 2012, Usefulness of SAR Interferometry for DEM Generation and subsidence estimation in Jharia Coalfield area, *Geo Carto International*, 27, 57-77.

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88. Sharma ML, Bhattacharya A, Arora MK., 2012, Convergence rate estimation of Indian plate using advanced remote sensing technique. *International conference of Geospatial Technique and Application (Geomatrix' 12)* Indian Institute of Technology Bombay on 26th-29th February, 2012, (Presented)

89. Srivastava, M., Arora, M. K., and Balasubramanyan, R., 2012, An Evaluation Technique to Assess Quality Of Segmentation from Remote Sensing Data, *International conference of Geospatial Technique and Application (Geomatrix' 12)* Indian Institute of Technology Bombay on 26th-29th February, 2012, (Presented)

90. Gusain H. S., Mishra V. D. and Arora, M. K, 2012, Estimation of Net Shortwave Radiation Flux of Western Himalayan Snowcover during Clear Sky Days using Remote Sensing and Meteorological Data, *International conference of Geospatial Technique and Application (Geomatrix' 12)* Indian Institute of Technology Bombay on 26th-29th February, 2012, (Presented)

91. Bansal Shweta, Manoj K. Arora, Bharti Soni, Susmita Harrow and R. Balasubramanyan, 2012, RX Algorithm for Anomaly Detection from Hyperspectral Remote Sensing Images, All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, March 2-3, 2012, Dehradun. (Presented). **Best Paper Award.**

92. Chatterjee, A., Jain, H., Biswas, D., Arora, M. K., and Balasubramanian, R., 2012, Spectral Correlation Mapper for Classification and Target Detection in Hyperspectral Remote Sensing Images, All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, March 2-3, 2012, Dehradun. (Presented)

93. Srivastava M., Arora M. K. and Balasubramanian Raman, 2012, Fixation of Segmentation Parameters for Object Based Classification of Resourcesat LISS-IV Image - An Experimental Study, All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, Feb. 10-11, 2012, Dehradun. (Presented)

94. Arora, M. K., 2012, Advances in Information Extraction from Digital Remote Sensing Images, Lead Paper, All India Seminar on Applications of Imaging, Visualisation and Optimisation Technologies, March 2-3, Dehradun. (Presented)

95. Arora, M. K., 2012, Comparative assessment of neural network, fuzzy set and neuro-fuzzy approaches for landslide susceptibility zonation in Garhwal Himalayas, Session on Soft Computing in Civil Engineering, 10th World Congress on Computational Mechanics, July 8-13, 2012, Sao Paulo, Brazil. (Presented)

96. Vijay S., Arora, M. K., Buchroithner, M. and Kropacek, J., 2012, Analysis of glacier mass Balance and Rheology of Kekesayi Glacier using Hexagon KH-9, ALOS-PRISM and SAR Data, ESA-CliC-EGU Joint Conference on Earth Observation and Cryosphere Science,13-16 November 2012, Frascati, Rome, Italy. (Presented).

Invited Lectures and Talks

1. Arora, M. K., 1998, Conventional Surveying equipment and their utility, Training on Modern Surveying Equipment, I I T Roorkee, India, II(1) – II(4)

2. Arora, M. K., 1999, Digital Image Classification Techniques, Training for Railway Engineers on Digital Mapping Techniques, I I T Roorkee, India.

3. Arora, M. K., 1999, Global Positioning System (GPS), Training for Railway Engineers on Digital Mapping Techniques, I I T Roorkee, India.

4. Arora, M. K., 2000, Principles of GIS, Short term course on A teaching capsule for Remote Sensing and GIS, I I T Roorkee, India.

5. Arora, M. K., 2001, Sources of errors, propagation and quality control in GIS, Short term course on Understanding GIS, Department of Continuing Education, I I T Roorkee, India

6. Arora, M. K., 2001, GIS data structures, Short term course on GIS, I I T Roorkee, India.

7. Arora, M. K., 2001, Leveling principles, Short term course for IRCON engineers, I I T Roorkee, India.

8. Arora, M. K., 2003, Errors in GPS, Sponsored training course on GPS application for landslide and resource mapping, I I T Roorkee, India.

9. Arora, M. K., 2003, Errors and Accuracy in GPS observations, Short term course on GPS and its application, I I T Roorkee, India.

10. Arora, M. K., 2004, Digital elevation models and applications, Specialised GIS Training Course for DST Sub-programme on Bio-Geo Database for Ecological Modeling for Himachal Pradesh, India, I I T Roorkee, India.

11. Arora, M. K., 2004, Urban feature extraction using non-parametric techniques, PG Diloma Course on Remote Sensing and GIS Applications, Indian Institute of Remote Sensing, Dehradun, 2004.

12. Arora, M.K., 2004, Digital Image Processing, Landscape GIS/Remote Sensing Course, Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore, Aug. 2-16, 2004.

13. Arora, M.K., 2004, Advances in Remote Sensing, Landscape GIS/Remote Sensing Course, Ashoka Trust for Research in Ecology and Environment (ATREE), Bangalore, Aug. 2-16, 2004.

14. Arora, M. K., 2004, Role of Geoinformatics in Hazards, Expert Lecture, Indian Institute of Remote Sensing, Dehradun, Dec., 7, 2004.

15. Arora, M. K., 2005, Role of Remote Sensing and GIS in water resources studies, QIP short term course on ground water modeling, IIT Roorkee, Feb. 21-25, 2005.

16. Arora, M. K., Soft Classification and accuracy assessment, Defence Electronics Appliances Laboratory, Dehradun, July 2, 2005

17. Arora, M. K., Ground truth and GPS survey, July, 2005, National Institute of Hydrology, Roorkee

18. Arora, M. K., Soft Classification and Accuracy Assessment, Institute of Remote Sensing, Anna University, Chennai, Sept. 30, 2005

19. Arora, M. K., Soft Classification and Accuracy Assessment, Space Application Center, Ahmedabad, October, 2005

20. Arora, M. K., Digital Image Processing, Short Term Course on Geomatics Engineering Applications, IIT Roorkee, 2006.

21. Arora, M. K., Sub-pixel snow cover mapping from remote sensing data, Short Term Course, Snow and Avalanches Study Establishment, Chandigarh, May, 2007

22. Arora M. K., Data analysis techniques for hyperspectral data, Defence Electronic Appliances Laboratory (DEAL), DRDO, Dehradun, May 2008.

23. Arora, M. K., Digital image processing, Short Term Training Course on Remote Sensing and GIS Applications in Hydropower Projects for NHPC Engineers, IIT Roorkee, Feb. 22 – 27, 2010.

24. Arora, M. K., Advances in Image Classification, Indian Institute of Remote Sensing, Dehradun, March 16, 2010.

25. Arora, M. K., Advances in Image Classification and Accuracy Assessment of Remote Sensing Data, IIT Bombay, Mumbai, Sept., 13, 2010

26. Arora, M. K., Advanced Hyper spectral Data Processing, CEP Course on Emerging Techniques for Image Processing, DEAL, DRDO, Dehradun, Oct 7, 2010.

27. Arora, M. K., Remote Sensing for Land Use Land Cover Mapping, Training Course on Applications of Remote Sensing and GIS in Water Resources Management, May 30- June 10, 2011, NIH, Roorkee

28. Arora, M. K., Remote Sensing and GIS for Natural Disaster Studies, Training Course of SAARC Countries, Earthquake Risk Mitigation, 6-17 June, 2011, IITR Campus Noida

29. Arora, M. K., Overview of Geomatics for Hydro-power Projects, Training Course on Remote Sensing and GIS Applications in Hydro-power Projects, June 20-22, 2011, School of Hydrology, IIT Roorkee.

30. Arora, M. K., Information Extraction from Hyperspectral Remote Sensing Images, DRDO - Academia Workshop Futuristic Communication Technologies and Trends for Military Applications, 15 - 16 February 2012, DEAL, DRDO, Dehradun

31. Arora, M. K., ANN and Fuzzy set based techniques for Earth Sciences Applications, CEP Course for SASE Scientists, July 2-6, 2012, SASE, DRDO, Chandigarh,

Masters Theses Supervision: 50 (Completed) 2 (In progress)

1. Evaluation of Stereoscopic Capabilities of SPOT Imageries (1992)
2. Development of PC Based Software for some Selected Map Projection Systems including Inter Conversion (1993)
3. A Study of the Feasibility of Selection of Training Data for Image Analysis (1993)
4. Performance Evaluation of Back Propagation Neural Network, Fuzzy *c*-Means and Statistical Classifiers for Remotely Sensed Data (1998)
5. A Comparative Study of Linear Mixture Modelling and Maximum Likelihood Classifier for Sub-pixel Classification (1998)
6. A Knowledge Based System for Classification of Obstacles in War Planning (1999)
7. A Study of Neural Network Parameters affecting Image Classification (1999)
8. A Sampling Design Software for Image Classification Accuracy (1999)
9. Landslide Hazard Zonation Studies in the Bhagirathi Valley Using Remote Sensing and GIS (1999)
10. A Fuzzy Image Classification Package for Remotely Sensed Data (2000)
11. Evaluation of Control Establishment using GPS Surveys (2000)
12. Neural Network Classification using Remote Sensing and Ancillary data (2000)
13. Headway Modelling using Artificial Neural Network (2000)
14. Investigations into the topographic effect on classification of remote sensing data (2001)
15. Investigations into the geometric rectification of remote sensing data (2001)
16. Seismic hazard analysis using neural network (2001)
17. Run-off estimation using ANN (2001)
18. Facility based rural road network planning using GIS (2001)
19. Neural Network for landslide hazard zonation (2001)
20. Development of program for image classification accuracy measures (2001)
21. A software for image classification accuracy assessment (2002)
22. Development of a Knowledge-based System for Military Use (2002)
23. Seismic Hazrad Estimation Using GIS (2002)
24. Development of Software for Trip Assignment in Urban Areas (2002)
25. Soil moisture estimation from microwave remote sensing data: some preliminary results (2002)
26. A comparative study of some neural network algorithms for classification of remote sensing data (2004)
27. Quality of DEM generation from topographical maps and GPS observations (2004)
28. Accuracy of soft classification in the presence of uncertainty (2004)
29. Techniques for area Estimation for remote sensing classifications (2005)
30. Wavelet based image fusion for image classification problems (2006)
31. Investigations into some automatic intensity based registration techniques (2006)
32. Study of Evidential Reasoning for Image Classification (2006)
33. Investigations into surface displacement estimation using Differential SAR Interferometry (2006)
34. A comparative study of some decision tree algorithms for image classification (2007)
35. Conflation of vector data with remote sensing image (2007)
36. Development of some feature extraction algorithms for hyperspectral images (2008)
37. Landslide hazard zonation and risk assessment using Neuro-fuzzy techniques (2009)
38. Oil spill detection using microwave remote sensing data (2009)

39. Visualisation of travel behaviour of people in GIS environment (2009)
40. Population estimation from remote sensing data (2010)
41. Development of region growing segmentation software for object based image classification (2010)
42. Assessing land use land cover change using modified change vector analysis (2010)
43. Remote sensing and GIS based landslide risk assessment in Darjeeling hills (2010)
44. GIS based urban growth assessment in Dehradun city (2010)
45. GIS based land use planning in Vizag city (2010)
46. Study and implementation of some feature reduction techniques for hyperspectral imaging, Roshni Sanyal (2011)
47. Study and implementation of some per-pixel classifiers for hyperspectral imaging, Debojit Biswas (2011).
48. Development of an algorithm for snow cover reflectance and snow fraction, M Kavita V (2011)
49. An assessment of some anomaly and target detection algorithms for hyperspectral images, Shweta Bansal (2012)
50. Glacier rheology studies in Kuksai glacier using Terra SAR-X data, Saurabh Vijay (2012)
51. SAR Interferometry for landslide studies, Shreyansh Singh (In Progress)
52. Remote Sensing and GIS for Infrastructural Planning (In Progress)

Ph. D. Theses Supervision **21 (Completed: 14, In Progress: 7)**

Completed

1. Remote sensing and GIS based decision support system for district level planning, R. D. Gupta (2002)
2. GIS-based Study for Route Planning in Landslide Susceptible Terrain, Ashis K Saha (2004)
3. Evaluation of Soft Classifiers for Remote Sensing Data, M. A. Ibrahim (2004)
4. Support vector machines for remote sensing image classification, USA, Pakorn Watanachaturaporn (2005)
5. Geomorphological and Pedological Evaluation of Interfluves between the Ganga and Ghaghara Rivers, Satwinder Singh (2005)
6. Soil moisture retrieval from microwave remote sensing data, Saif Said (2006)
7. GIS Based Landslide Susceptibility Studies Using Neural and Fuzzy Approaches, D. P. Kanungo (2006)
8. Target detection using optical and microwave remote sensing data, K. C. Tiwari (2008)
9. A neural network based cellular model for urban growth simulation, Sandeep Maithani (2008)
10. Modeling of uncertainty in remote sensing data, M. S. Ganesh Prasad (2009)
11. Remote sensing based glaciological studies in parts of Chenab basin, Himalayas, Aparna Shukla (2009)
12. Remote Sensing based forest cover mapping using recent techniques, Sunil Chandra (2012)
13. Estimation of displacements due to earthquakes using SAR Interferometry, Atanu Bhatacharya (2013)
14. Derivation of hydrological parameters from remote sensing data, Kamal Kumar (2013)

In Progress

15. Object based image analysis of remote sensing data, Mohit Srivasatva
16. Per pixel and sub-pixel classification of hyperspectral data, N. Prabhu
17. Snow studies using remote sensing data, Heemendra Gussain
18. Remote Sensing Studies in Chhotashigri Glacier, Reet Kamal Tiwari

19. Differential SAR Interferometry for Landslide studies, Manoj Kuri
20. Camouflage target detection using remote sensing data, Deepti Yadav
21. Geo-Ecological Studies in Jharia Coalfields, India, Varinder Saini

Ph. D. Theses Examined

1. Mutual information based image registration with applications, Syracuse University, USA
2. Robust transmission of DCT coded images and image quality evaluation, Syracuse University, USA
3. Application of Independent Component Analysis for hyperspectral image processing, Syracuse University, USA
4. An integrated approach to large scale mapping using remote sensing and digital photogrammetric techniques, Anna University, Chennai, India.
5. Landslide studies using remote sensing and GIS techniques, Anna University, Chennai, India
6. SAR polarimetry techniques for snowpack parameters estimation, IIT Bombay, Mumbai, India.
7. Integration of GIS and Artificial Neural Networks to Map the Landslide Susceptibility in Nilgiris District, Anna University, Chennai, India
8. Studies on sub-pixel classification of satellite images and spectra of landcover components for improved estimation of the capacity of reservoirs, Anna University, Chennai, India
9. Object based image classification of high resolution remote sensing data, IIT Bombay, Mumbai, India.

REFERENCES

(i) Dr. P. K. Varshney, Professor
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