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Global Initiative of Academic Networks (GIAN)

One week short term course on

Theory and Application of Correlation Filters for Computer Vision

Sponsored by Ministry of Human Resource Development (MHRD), Under the Scheme 'GIAN'

(13 November 2017 to 17 November 2017) @ Dept of ECE, College of Engineering, Osmania University, Hyderabad, Telangana- 500 007

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Overview

Over the past few years, cameras have become inexpensive making the acquisition of images and videos ubiquitous. However, processing the resulting Terabytes of data manually is impossible and computer vision techniques are essential for extracting useful information from such image and video data. Well-known examples of computer vision at work are autnomous driving systems that have to detect vehicles, pedestrians and other objects in the path of the autnomous vehicle and tracking of humans and other targets in surveillance videos. In many computer vision problems, the main task is to match two images of an object (e.g., face, iris, vehicle, etc.) that may exhibit appearance differences due to factors such as translation, rotation, scale change, occlusion and illumination variation. One class of methods to achieve accurate object recognition in the presence of such appearance variations is one where features computed in a sliding window in the target image are compared to features computed in a stationary window of the reference image. Frequency-domain methods, also known as *correlation filters*, offer significant computational efficiencies in implementing such approaches. They also offer benefits such as shift-invariance (i.e., the object of interest doesn't have to be pre-centered), no need for segmentation, graceful degradation and closed-form solutions. Thus, correlation filter-based approaches can be highly beneficial in many computer vision applications.

Correlation filters were originally developed for object recognition applications and for implementation using optical information processing systems. But over the past twenty five years, correlation filters have been used in many digital systems and the application domains have increased substantially, e.g., to identifying people based on their face images or iris images and detecting moving objects in videos. Thus, knowledge of the theory and application of correlation filters can be very beneficial to researchers and practitioners of computer vision applications.

Objectives

The primary objectives of the course are as follows:

i)   Providing the attendees with the background in linear systems, linear algebra, optimization and random processes needed to understand the theory and application of correlation filters,
ii) Teaching the principles of basic correlation filters as well as advanced correlation filters capable of object recognition in the presence of challenges such as pose changes, occlusions and noise,
iii) Illustrating the benefits of correlation filters in example applications such as object recognition, face recognition and visual tracking,
iv) Providing attendees with concrete correlation filter design experience by using MATLAB to design and apply correlation filters in a computer vision example.

Course Details	**Day1** Computer vision example problems, Motivation for correlation filters, Basics of linear systems including Fourier transforms Discrete Fourier transform (DFT), Fast Fourier transform (FFT), Aliasing, Two-dimensional Fourier transform Basic matrix/vector results, Introduction to basic random processes, Quadratic optimization with linear constraints **Day 2** Matched filter, cross-correlation, demonstration of the noise-handling and graceful degradation properties of correlation filters Coherent optical implementation of correlation filters, phase-only filters, binary phase-only filters Synthetic discriminant function (SDF) filters, generalized SDF filters, minimum variance SDF (MVSDF) filter **Day 3** Minimum average correlation energy (MACE) filter, optimal trade-off synthetic discriminant function (OTSDF) filter, MATLAB demonstration of the computation of OTSDF filter Maximum avaerage correlation height (MACH) filter, Application of the MACH filter for automatic target recognition Optimal tradeoff circular harmoc functions (OTCHF) filters to handle rotations, Mellin radial harmonic (MRH) filters to handle scale changes **Day 4** Application of correlation filters for face recognition, Class-dependent feature analysis (CFA), Face recognition grand challenge (FRGC) results Basics of iris recognition including Daugmann's method, Correlation filter approach for iris recognition, Bayesian approach to deformed iris pattern matching.Visual tracking problem and examples, Minimum output sum of squared errors (MOSSE) filter, Demonstration of correlation filters in visual tracking **Day 5** Basics of support vector machine (SVM) approach for classification, Combining the advantages of SVMs and correlation filters through max-margin correlation filters (MMCFs) Aliasing effects in correlation filter designs, Zero-aliasing correlation filter (ZACF) design and application Correlation filters for vector features, Biometric encryption using correlation filters, Summary of the course **Number of participants for the course will be limited to fifty.**
You Should Attend If…	Engineers and researchers from manufacturing, service and government organizations including R&D laboratories. Students at all levels (BTech/MSc/M.Tech/PhD) or Faculty from reputed academic institutions and technical institutions.
Fees	The participation fees for taking the course is as follows: **Participants from abroad : US $500** **Industry/ Research Organizations: Rs. 6000 /-** **Academic Institutions: Rs. 3000 /-** **Student participants: Rs. 1,000/-** The above fee includes all instructional materials, tutorials, assignments and internet facility. On request, accommodation will be provided for few participants

	(on first come first basis) in the campus on payment.
How To Register	**Stage1:** Web (Portal) Registration: Visit GIAN Website at the link: http://www.gian.iitkgp.ac.in/GREGN/index and create login user ID and Password. Fill up blank registration form and do web registration by paying **Rs. 500**/- on line through Net Banking/ Debit/ Credit Card. This provides the user with life time registration to enroll in any no. of GIAN courses offered. **Stage2:** Course Registration (Through GIAN Portal): Log in to the GIAN portal with the user ID and Password created. Click on "Course Registration" option given at the top of the registration form. Select the Course title "Theory and Application of Correlation Filters for Computer Vision" from the list and click on "Save" option. Confirm your registration by Clicking on "Confirm Course". Only Selected Candidates will be intimated through E-mail by the Course Coordinator. They have to remit the necessary course fee in the form of DD drawn in favor of "**PRINCIPAL UCE OU COORDINATOR GIAN"** payable at SBI, University College of Engineering, Osmania University, Hyderabad-500 007. OR through NEFT/RTGS: Name of beneficiary: The Principal UCE , OU Account name: **PRINCIPAL UCE OU COORDINATOR GIAN** Name of The Bank: State Bank of India, Osmania University, Hyderabad Beneficiary A/C No: 37072716197 Bank MICR Code: 500002342 IFSC Code: SBIN0020071

Prof. Vijayakumar Bhagavatula - Course Faculty
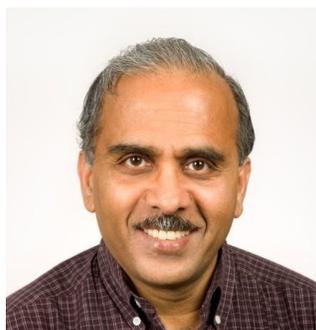
Prof. Vijayakumar ("Kumar") Bhagavatula received his B.Tech. and M.Tech. degrees in Electrical Engineering from IIT, Kanpur and his Ph.D. in Electrical Engineering from Carnegie Mellon University (CMU), Pittsburgh and since 1982, he has been a faculty member in the Electrical and Computer Engineering (ECE) Department at CMU where he is now the U.A. & Helen Whitaker Professor of ECE. At CMU, he has taught several undergraduate and graduate courses and has supervised nearly 50 Ph.D. students. Professor Kumar's research interests include Computer Vision, Pattern Recognition and Coding and Signal Processing for Data Storage Systems. In these areas, he has authored or co-authored more than 400 conference papers, 200 journal papers, twenty-two book chapters, one book entitled *Correlation Pattern Recognition* and twelve patents. He served as a Topical Editor for *Applied Optics* and as an Associate Editor of *IEEE Trans. Information Forensics and Security*. He has also served on many conference program committees. Professor Kumar is a Fellow of IEEE, SPIE, the Optical Society of America (OSA), the International Association of Pattern Recognition (IAPR) and the American Association for Advancement of Science (AAAS).

Prof. P.Ananth Raj, Course coordinator

Dr. P.Ananth Raj, SM IEEE member, obtained PhD from IIT Kharagpur, At IIT-Kharagpur he was associated with two sponsored (DOE) projects related with Magnetic anomaly detected signals and Image Processing. He joined in the ECE Department of Osmania University as a Lecturer (1986 -1998) in 1986, and promoted to the rank of associate Professor (1998 - 2006) and Professor (2006 -2013). He published 38 technical papers both in National and International journals, Conferences, Symposia etc, Supervised 25 UG and 15 PG student projects, attended more than 20 short courses at IITs in the area of Image Processing and Neural Networks. One of the U.G. Projects titled "Image smoothing and Edge Detection using Non linear filters' was adjudged as the best project by the Dept project assessment committee (1987). Under his guidance two students completed their PhD work. He reviewed about 25 technical papers for IEEE SMC (USA) on Image processing and neural networks. Presently, he is working in the ECE Dept. as an Emeritus fellow (UGC).

Course Co-ordinators

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Dr. L.Nirmala Devi, Course coordinator

Dr. L.Nirmala Devi received her B.E (1997), M.E (2005), and Ph.D (2014) degrees in Electronics and Communication Engineering from the Department of Electronics and Communication Engineering, University College of Engineering (Autonomous), Osmania University, Hyderabad, India. She is currently working as an Associate Professor in Department of Electronics and Communication Engineering, Osmania University. She has teaching experience of more than 16 Years in subjects like Digital Signal Processing, Analog Communication, Digital Communication, Adaptive Signal Processing and Wireless Networks. Her research interests include Ad-hoc networks, wireless communication, wireless sensor networks and Signal Processing. Currently, she is working on various research projects sponsored by Ministry of Electronics and Information Technology (MeITY), Government of India, New Delhi**,** Department of Science & Technology (DST) and UGC. She has published many papers in various national & international journals and conferences. She is also a member of IEEE, IEI and OSA.