MACHINE LEARNING AND COMPUTER VISION @ CVPRLAB-UNIPARTHENOPE

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Abstract The report includes some recent research activities carried out by the Computer Vision and Pattern Recognition group of the Department of Science and Technology, University Parthenope of Naples (http://cvprlab.uniparthenope.it). The activities cover different aspects related to Machine Learning and Computer Vision and are carried out in the context of a variety of applied projects, where results and know-how from those activities are exploited.

Keywords: Computer Vision, Pattern Recognition, Image Processing, Technology Transfer.

1. Machine Learning

Research activity of the group in this area concerns the design of computational models that take advantage of soft computing techniques.

One of the recent works concerns the design of a completely novel graph-based semi-supervised learning method for classification [28], particularly useful when no parametric information or other prior knowledge is available. Given a graph whose nodes represent the points and the weighted edges the relations between them, the goal is to predict the values of all unlabeled nodes exploiting the information provided by both label and unlabeled nodes. The algorithm extends the Fisher Subspace estimation approaches by adopting a kernel graph covariance measure.

In [24], authors propose a classification procedure based on Support Vector Machine able to effectively cope with data imbalance. Using a first step approximate solution and then a suitable kernel transformation, the space around the class boundary is asymmetrically enlarged, compensating data skewness. Moreover an accuracy measure, named AGF, is proposed to properly account for the different misclassification costs of the classes.

Authors in [1] deal with the outlier detection problem in spatiotemporal data and describe a rough set approach that finds the top outliers in an unlabeled spatiotemporal data set. A new set, named Kernel Set, is introduced, which is able to describe the original data set in terms of data structure.

Pattern recognition techniques have been also applied for improving some aspects in the field of bioinformatics and computational biology. In [5–8] the use of the generalized 3D Hough transform for protein comparison is presented. The main scope of this topic is to search proteins structural similarities in database (PDB).

Classification of the 3D structure of proteins is crucial to inferring protein functional information as well as the evolution of interactions between proteins. In [9, 10] the authors propose novel structural representations of the proteins and exploit the learning capabilities of supervised and unsupervised techniques.

The aim of the researches in [2, 3] is the development of a Fuzzy Decision Support System (FDSS) for the Environmental Risk Assessment (ERA) of the deliberate release of genetically modified plants. The evaluation process permits identifying potential impacts that can achieve one or more receptors through a set of migration paths.

An overview of current trends in machine learning and soft computing for ICT security is presented in [4], while research work concerning the application of soft computing techniques to video surveillance is brought together in [27, 18], investigating novel solutions and discussing future trends of existing literature in this field.

2. Computer Vision

Research activity in the field of computer vision is devoted to the analysis, design and implementation of algorithms for the detection, tracking and recognition of objects in motion sequences.

Authors in [19] present an approach for moving object detection based on a 2D neural background model automatically generated by a self-organizing method. The algorithm well compares with the state-of-the-art methods involved in the Change Detection Challenge at IEEE CVPR 2012[1].

An extension of the neural-based background subtraction approach to moving object detection to the case of image sequences taken by pan-tilt-zoom (PTZ) cameras is presented in [13]. Background variations arising in a usual stationary camera setting are accurately handled by the neural model, while handling of variations due to the PTZ camera movement is ensured by a reg-

[1] http://www.changedetection.net

istration mechanism that allows the neural background model to automatically compensate the eventual ego-motion, estimated at each time instant.

A different 3D neural background model, exploiting a layered network structure and inter- and intra-layer weights update, is proposed in [22], showing state-of-the-art performances on the Background Models Challenge dataset[2].

The 3D neural model has been adopted in [20] for the detection of stopped objects, that is, objects that enter the scene as foreground objects and then stop into it. The approach adopts also a foreground model to be used for detecting a prolonged permanence in the scene of stationary foreground objects. A suitable layering mechanism for the obtained models allows to handle also cases where several stopped or moving objects appear as overlapped.

The above described researches have been applied to license plate recognition for access control to restricted areas [12], where the stopped object detection module triggers an alert for activating the subsequent plate extraction and recognition modules.

In [25], authors propose a novel framework for the detection and tracking in real-time of unknown objects. The problem is decomposed into two modules, detection and learning, in which multiple keypoint-based methods and a growing/pruning approach are exploited. While tracking the object, the system learns new positive and negative samples (keypoints) identified by the detector. Differently from this approach, the work in [15] investigates the problem of robust, long-term visual tracking of unknown objects combining a novel Bayesian filtering with on-line learning theory.

Another main research topic concerns the characterization of images in terms of salient features and novel ways of describing their content.

In humans, detection of symmetry, especially bilateral and rotational, is considered to be a primary factor for discovering and interacting with the surrounding environment. In [17] authors propose an enhanced version of the symmetry detection algorithm already reported at the "Symmetry Detection from Real World Image" competition at IEEE CVPR2011.

In [23] an effective approach to model image content based on a novel graph structure named Attributed Relational SIFT Regions Graph (ARSRG) is presented along with a retrieval strategy based on a graph matching algorithm. Kernel embedding and feature learning have been demonstrated peculiar when evaluated on standard databases (such as ETH-80, COIL-100 and ALOI).

The algorithm described in [21] presents a people counting system that, based on the information gathered by multiple cameras, is able to reconstruct people feet positions in a single "feet map" image.

[2] http://bmc.univ-bpclermont.fr/

Activity recognition is addressed in [26] where human activity is described in space–time as a Bag of Words model, characterized by a new descriptor based on 3D gradient and symmetrical textural appearance.

The symmetry principles are also exploited in [16] for person re-identification. The re-identification problem is formulated as a graph matching problem, where each person is represented by a graph.

3. Technology Transfer

Computer Vision and Pattern Recognition play an important role in all the industrial applications. The research group is involved in many projects in conjunction with leading industrial settings. CPILOS and PT2LOG projects [11, 14] aim to develop new technological platforms, based on IT infrastructures and services, that can support critical processes, like secure tracking and tracing of goods in transport and logistics, using video surveillance facilities with radio-frequency identification (RFID) support.

References

[1] Alessia Albanese, Sankar K. Pal, Alfredo Petrosino: Rough Sets, Kernel Set, and Spatiotemporal Outlier Detection. IEEE Trans. Knowl. Data Eng. 26(1): 194-207 (2014)

[2] Francesco Camastra, Angelo Ciaramella, Valeria Giovannelli, Matteo Lener, Valentina Rastelli, Antonino Staiano, Giovanni Staiano, Alfredo Starace: Environmental Risk Assessment of Genetically Modified Organisms by a Fuzzy Decision Support System. ICIAP Workshops 2013: 428-435

[3] Francesco Camastra, Angelo Ciaramella, Valeria Giovannelli, Matteo Lener, Valentina Rastelli, Salvatore Sposato, Antonino Staiano, Giovanni Staiano, Alfredo Starace: Rule Learning in a Fuzzy Decision Support System for the Environmental Risk Assessment of GMOs. WILF 2013: 226-233

[4] Francesco Camastra, Angelo Ciaramella, Antonino Staiano: Machine learning and soft computing for ICT security: an overview of current trends. J. Ambient Intelligence and Humanized Computing 4(2): 235-247 (2013)

[5] Virginio Cantoni, Alessio Ferone, Ozlem Ozbudak, Alfredo Petrosino: Protein motifs retrieval by SS terns occurrences. Pattern Recognition Letters 34(5): 559-563 (2013)

[6] Virginio Cantoni, Alessio Ferone, Ozlem Ozbudak, Alfredo Petrosino: Searching Structural Blocks by SS Exhaustive Matching. CIBB 2012: 57-69

[7] Virginio Cantoni, Alessio Ferone, Ozlem Ozbudak, Alfredo Petrosino: Protein structural motifs search in protein data base. CompSysTech 2012: 275-281

[8] Virginio Cantoni, Ozlem Ozbudak, Alessio Ferone, Alfredo Petrosino: Structural analysis of protein Secondary Structure by GHT. ICPR 2012: 1767-1770

[9] Virginio Cantoni, Alessio Ferone, Alfredo Petrosino, Gabriella Sanniti di Baja: A Supervised Approach to 3D Structural Classification of Proteins. ICIAP Workshops 2013: 326-335

[10] Virginio Cantoni, Alessio Ferone, Ozlem Ozbudak, Alfredo Petrosino: Protein Structural Blocks Representation and Search through Unsupervised NN. ICANN (2) 2012: 515-522

[11] Mariarosaria Carullo, Gianluca Cavaliere, Aniello De Prisco, Michele Di Capua, Alfredo Petrosino, Donatella Padovano, Gennaro Nave, Daniele Ruggeri: Stock Control through Video Surveillance in Logistics. ICIAP (2) 2013: 740-748

[12] Emanuel Di Nardo, Lucia Maddalena, Alfredo Petrosino: Neural-based Automatic License Plate Recognition. WIRN (2014)

[13] Alessio Ferone, Lucia Maddalena: Neural Background Subtraction for Pan-Tilt-Zoom Cameras. IEEE Transactions on Systems, Man, and Cybernetics: Systems 44(5): 571–579 (2014)

[14] Giovanni Garibotto, Pierpaolo Murrieri, Alessandro Capra, Stefano De Muro, Ugo Petillo, Francesco Flammini, Mariana Esposito, Concetta Pragliola, Giuseppe Di Leo, Roald Lengu, Nadia Mazzino, Alfredo Paolillo, Michele D'Urso, Raffaele Vertucci, Fabio Narducci, Stefano Ricciardi, Andrea Casanova, Gianni Fenu, Marco De Mizio, Mario Savastano, Michele Di Capua, Alessio Ferone: White Paper on Industrial Applications of Computer Vision and Pattern Recognition. ICIAP (2) 2013: 721-730

[15] Giorgio Gemignani, Wongun Choi, Alessio Ferone, Alfredo Petrosino, Silvio Savarese: A Bayesian Approach to Tracking Learning Detection. ICIAP (1) 2013: 803-812

[16] Sara Iodice, Alfredo Petrosino: Person Re-identification Based on Enriched Symmetry Salient Features and Graph Matching. MCPR 2013: 155-164

[17] Shripad Kondra, Alfredo Petrosino, Sara Iodice: Multi-scale Kernel Operators for Reflection and Rotation Symmetry: Further Achievements. CVPR Workshops 2013: 217-222

[18] Lucia Maddalena, Alfredo Petrosino: Neural Networks in Video Surveillance: A Perspective View, in S.K. Pal, A. Petrosino, and L. Maddalena (Eds), Handbook on Soft Computing for Video Surveillance, Chapman & HallCRC, 59–78 (2012)

[19] Lucia Maddalena, Alfredo Petrosino: The SOBS algorithm: What are the limits? CVPR Workshops 2012: 21-26 (2012)

[20] Alfredo Petrosino: Stopped Object Detection by Learning Foreground Model in Videos. IEEE Trans. Neural Netw. Learning Syst. 24(5): 723-735 (2013)

[21] Lucia Maddalena, Alfredo Petrosino, Francesco Russo: People counting by learning their appearance in a multi-view camera environment. Pattern Recognition Letters 36: 125-134 (2014)

[22] Lucia Maddalena, Alfredo Petrosino: The 3dSOBS+ algorithm for moving object detection. Computer Vision and Image Understanding 122: 65-73 (2014)

[23] Mario Manzo, Alfredo Petrosino: Attributed Relational SIFT-Based Regions Graph for Art Painting Retrieval. ICIAP (1) 2013: 833-842

[24] Antonio Maratea, Alfredo Petrosino, Mario Manzo: Adjusted F-measure and kernel scaling for imbalanced data learning. Inf. Sci. 257: 331-341 (2014)

[25] Mario Edoardo Maresca, Alfredo Petrosino: MATRIOSKA: A Multi-level Approach to Fast Tracking by Learning. ICIAP (2) 2013: 419-428

[26] Roberto Melfi, Shripad Kondra, Alfredo Petrosino: Human activity modeling by spatio temporal textural appearance. Pattern Recognition Letters 34(15): 1990-1994 (2013)

[27] Sankar K. Pal, Alfredo Petrosino, Lucia Maddalena (Eds): Handbook on Soft Computing for Video Surveillance. Chapman & HallCRC (2012)

[28] Alessandro Rozza, Mario Manzo, Alfredo Petrosino: A Novel Graph-based Fisher Kernel Method for Semi-Supervised Learning. Proceeding of ICPR 2014.