Topic 1: *Intra/Inter Image Tamper Detection (ITD)*

In the modern era of online social networks (OSNs), the number of online users of such services has increased exponentially. User-generated and posted data has brought up to the surface several challenges. An OSN by nature promotes visual contents sharing. The volume of these *Big* -visual-*Data* is reported to be in billions (as of 2011 Stats); *Flicker*® hosts about 6 billion images, *Facebook*® 70 billion images, 100 h/min of video streams are uploaded on *YouTube*®. The consequences on security and individual privacy are enormous. A challenge in the OSNs arena is the intentional editing of images to mislead the public opinion (or a specific community) regarding certain issue (e.g., duplicating certain regions in a given image to hide/alter its local or global semantic information) [1-4].

Motivated by the above challenge, this project will be termed as *Intra/Inter Image Tamper Detection*. Within this framework, the proposed project topic could be formulated as follows (open to discussion with the potential student(s)). Existing methods will be investigated in order to develop a system that can serve to achieve the goal of this project in an efficient way (computational complexity and accuracy are to be considered). The data set and a MATLAB code are available from [5] to begin with.

> Project description: Implementation of an algorithm to detect copy-move image tempering, in which one region of an image is copied to another area of the same image. <u>For more enthusiastic students, that can be extended to detecting regions coming from photo composites by using different image(s) (a.k.a. Inter-image tamper detection).</u>

Prerequisite knowledge (if any)

Machine Learning/ Data Mining
Mathematics/Statistics
Research Methodology

- Knowledge of image processing is a plus but not a prerequisite

Contact information

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References:

[1] Vincent Christlein et al. (2012). An Evaluation of Popular Copy-Move Forgery Detection Approaches. IEEE Transactions on Information Forensics and Security, 7(6), pp: 1841-1854.

[2] Ewerton Silva et al. (2015). Going deeper into copy-move forgery detection: Exploring image telltales via multi-scale analysis and voting processes. Journal of Visual Communication and Image Representation, 29, pp: 16–32.

[3] Jian Li et al. (2014). Segmentation-Based Image Copy-Move Forgery Detection Scheme. IEEE Transactions on Information Forensics and Security, 10 (3) pp: 507-518.

[4] A. Popescu and H. Farid (2004). Exposing digital forgeries by detecting duplicated image regions. Department of Computer Science, Dartmouth College, Tech. Rep. TR2004-515.

[5] http://lci.micc.unifi.it/labd/2015/01/copy-move-forgery-detection-and-localization/

Topic 2: *Data transformation effect on the prediction accuracy of CNN*

CNN (Convolutional Neural Network) as one type of deep learning methods, has proven its superiority in learning complex structures over existing machine learning methods especially when learning from 2D data (such as images) and when enough samples are available for learning.

This project will explore the different ways to manipulate 2D data to represent it in the best form in order to improve CNN prediction model (i.e., a classification scenario).

Prerequisite knowledge (if any)

Machine learning/ Data Mining
Research Methodology

- Knowledge of image processing is a plus but not a prerequisite

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References:

[1] Phil Kim (2017). Convolutional Neural Network
https://link.springer.com/chapter/10.1007/978-1-4842-2845-6_6

[2] Jason BrownleeHandwritten Digit Recognition using Convolutional Neural Networks in Python with Keras
URL: http://machinelearningmastery.com/handwritten-digit-recognition-using-convolutional-neural-networks-python-keras/

[3] Mathworks. Create Simple Deep Learning Network for Classification
URL: https://se.mathworks.com/help/nnet/examples/create-simple-deep-learning-network-for-classification.html

Topic 3: *Visual Content-aware Social Networks (VCSNs)*

In the modern era of online social networks (OSNs), the number of online users of such services has increased exponentially. User-generated and posted data has brought up to the surface several challenges. An OSN by nature promotes visual contents sharing. The volume of these *Big* -visual-*Data* is reported to be in billions(Stats 2011); *Flicker*® hosts about 6 billion images, *Facebook*® 70 billion images, 100 h/min of video streams are uploaded on *YouTube*®. The consequences on security and individual privacy are enormous. A number of algorithms and tools that provide confidentiality through information hiding (a.k.a, steganography) have been introduced in the literature [1]. A counter measure to that is known as steganalysis. A couple of algorithms are publically available [2].

Motivated by the above challenge, this project will be termed as *visual content-aware social networks* (VCSNs). Within this framework, the proposed project topic could be formulated as follows (open to discussion with the potential student(s)).

> Project description: Development of an online security layer to automatically analyse the traffic and detect the presence of steganography in images. Obviously, skills in web programming, machine-learning and data mining are of a merit. <u>For more enthusiastic students, the final deployment should approach real-time processing without undermining performance and should detect a variety of advanced steganographic algorithms (e.g., adaptive steganography or those ones running in the frequency domain [3]).</u>

Prerequisite knowledge (if any)

Machine learning/ Data Mining
Software and Network Security
Web Programming
Research Methodology

- Knowledge of image processing is a plus but not a prerequisite

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References:

[1] Cheddad A, et al. Digital Image Steganography: Survey and Analyses of Current Methods. Signal Processing 90 (3) (2010) 727-752, Elsevier Science.

[2] http://dde.binghamton.edu/download/

[3] Cheddad A, et al. A Skin Tone Detection Algorithm for an Adaptive Approach to Steganography. Signal Processing 89 (12) (2009) 2465-2478, Elsevier Science.

Topic 4: *Vision based retinal image analysis for diagnosis and treatment*

Vision based systems coupled with machine learning techniques have served physicians in providing very detailed medical images and measurements to assist in the diagnostic and treatment processes, for instance breast cancer [1, 2]. When it comes to diabetic or cardiovascular diseases, we find that retinal vessel imaging technology provides a non-invasive diagnosis of the circulatory system of the body. Recent findings show that a change in the morphological organisation of retinal vessels is a risk factor associated with cardiovascular disease. However, this project will be channelled to diabetic disease.

Towards that end, the student(s) will develop an algorithm that begins with the automatic detection of the optic disc and the extraction of the vessels. Then predictive features are estimated to help classify retinal images into either healthy eyes, glaucomatous eyes or eyes with diabetic retinopathy [3, 4]. Detection of such abnormalities relies heavily on the nature and robustness of the extracted features.

The relevant data sets are publicly available. A common data set used in the research literature called the *DRIVE*, Digital Retinal Images for Vessel Extraction, is available from [5] which the student(s) can use to train/test the algorithm. Another high-resolution fundus image database is available from [6]. This public database contains 15 images of healthy patients, 15 images of patients with diabetic retinopathy and 15 images of glaucomatous patients. Luckily, a ground truth data set of vessel segmented images is also available from the same site for each image. The data set is generated by a group of clinicians working in the field of retinal image analysis.

Prerequisite knowledge (if any)

Machine learning/ Data Mining
Research Methodology

- Knowledge of medical/image processing is a plus but not a prerequisite

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References:

[1] Cheddad A, et al. (2015). Pectoral muscle attenuation as a marker for breast cancer risk in Full Field Digital Mammography. *Cancer Epidemiology, Biomarkers & Prevention* (CEBP), 24(6):985-91. American Association for Cancer Research. PMID: 25870223.

[2] Cheddad A, et al. (2014). Area and volumetric density estimation in processed full-field digital mammograms for risk assessment of breast cancer. *PLoS One*, 9(10)(2014)1-10.

[3] Michael D. Abràmoff, et al. (2010). Retinal Imaging and Image Analysis. IEEE Trans Med Imaging. 3: 169–208.

[4] Niall Patton et al. (2006). Retinal image analysis: Concepts, applications and potential. Progress in Retinal and Eye Research. 25(1), pp: 99–127.

[5] http://www.isi.uu.nl/Research/Databases/DRIVE/

[6] https://www5.cs.fau.de/research/data/fundus-images/