VISMAC 2020 2021

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BOOK OF ABSTRACTS

BIO-IMAGING

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Carlo Sansone

Università degli Studi di Napoli Federico II

Biomedical image analysis and its application in case of oncological diseases.

In this lecture, we first present the different tasks (e.g. detection, segmentation, classification) that, from an image analysis point of view, must to be addressed in order to support clinicians in better understanding a biomedical image. Then, the algorithms and the architectures than can be used in this context will be illustrated. Finally, an in-depth analysis will be presented with reference to the context of oncological diseases.

Elena Casiraghi

Università degli Studi di Milano

Bio-Medical imaging in diagnosis, prognosis, and outcome prediction

Due to their astonishing results, in the past two decades, computer vision (CV) algorithms have gained a lot of importance in several application fields, and several CV algorithms are already commercialized and used in our everyday lives. Examples are automate self-driving applications, which are managed by computer vision methods exploiting machine learning techniques, and face detection/recognition/validation, which are based on combined rule-based systems and machine learning techniques.

Such results are due to the algorithms' capability of emulating the human reasoning and decision-making by:

- implementing specific human requests, trough rule-based algorithms;

- exploit memories and/or past experiences, by using machine learning techniques.

Thanks to such advantages, medical image processing is nowadays emerging as an important application field, and several successful techniques, combining rule-based systems and machine learning, have been already proposed.

Examples in the medical field are:

- Computer Aided Diagnosis applications, whose aim is to aid diagnosticians in their everyday practice, e.g. by detecting subtle tumors at the early stage, thus increasing patient 5-years survival and reducing treatment invasiveness and costs;

- organs' volumetrical applications, which aim at outlining the shape, volumes, and relative positions of some organs, to aid either surgeons in their surgical planning procedures or oncological experts planning radiotherapy treatments.

In the bio-medical fields, the principal aim of CV applications is the aid of biomedical researchers trying to uncover the biologicals mechanisms behind pathologies. As an example, in the oncological field, immunotherapy tries to discover the behavior of the immunological system when the tumor appears. This is done by quantifying (which literally means counting) the number of marked structures in images of huge dimension and resolution. This is a boring, time-consuming task generally performed by averaging the count obtained by experts on few image patches randomly extracted. CV applications are of course of paramount importance for they speed such procedures and allow obtaining precise, repeatable results.

In this talk, we will overview medical image application fields, highlighting difficulties and pointing at the main achievements. Among them, examples are:

- covid-19 diagnosis and risk assessment aided by medical imaging

- tumor detection and prognosis assessment from radiographs and/or (immuno-)histological image analysis

- CT scan segmentation and volumetric measurements

Paolo Soda

UCBM Campus Biomedico Roma

Artificial intelligence meets medical imaging for personalized oncology

High throughput standard-of-care medical images such as CT, PET or MRI are now used in oncology to detect lesions, to plan treatments, to follow up the disease, etc. Furthermore, the increasing adoption of electronic patient records as well as the diffused use of PACS have made available heterogeneous patient data, spanning different spatial and temporal scales, modalities, and functionalities. The quantitative nature of the images allows us to go beyond visual interpretation by computing, analysing and selecting advanced quantitative imaging features. This in turns has led to radiomics, which is also evolving into multimodal machine learning since it is looking for correlation between different sources of data. All this quantitative information can be harnessed in an integrated platform and leveraged via clinical-decision support systems by artificial intelligence to improve personalized medical decision-making with diagnostic, prognostic or predictive value. In this lecture we will overview this exciting research topic, focusing on several methodological challenges from the machine learning perspectives, such learning under class skew as well as developing and evaluating the use of generative models, to cite a few.

Francesco Tortorella

Università degli Studi di Salerno

Machine Learning for Mammography and Digital Breast Tomosynthesis

According to World Health Organization, breast cancer is the most frequent cancer among women, impacting 2.1 million patients each year with the greatest number of cancer-related deaths. In 2018, it is estimated that 627,000 women died from breast cancer – that is approximately 15% of all cancer deaths among women. One effective way to reduce breast-cancer related deaths is to use radiology imaging (particularly mammography and digital breast tomosynthesis, DBT) as a screening strategy. To help radiologists in their diagnostic operations, several solutions for Computer Aided Detection and Diagnosis (CADx) have been proposed in the last years, based on Machine Learning techniques and, recently, on Deep Learning methodologies.

In this talk, the author will describe the technical challenges unique to mammography and DBT and present the most recent techniques based on Machine Learning and applied in all steps, from image denoising to lesion detection and diagnosis.

Joseph Stancanello

Global VP of Clinical Applications, Elekta

The role of Artificial Intelligence in radiation therapy workflow: a key enabler to personalized treatments

Artificial Intelligence (AI) is continuously embracing all healthcare domains, from diagnosis to therapy. Historically, radiation therapy (RT) has been a conservative domain of innovations due to its well established treatment approach as well as its intrinsic radiation based nature. AI is recently promising a disruptive wave of innovation in many areas of RT workflow, paving the way for adaptive RT (ART) towards personalized treatments. This will enable RT applications to benefit from AI according to two different drivers to:

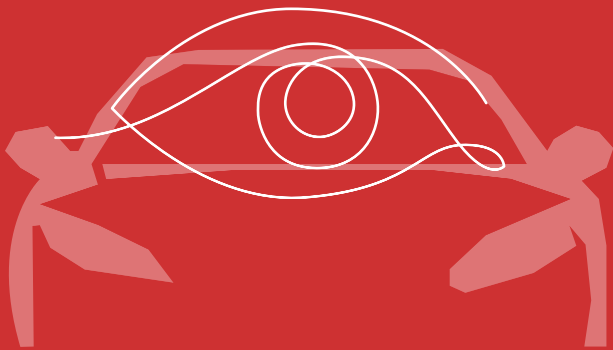
• speed up time consuming steps such as image segmentation and dose calculation;

• identify quantitative imaging biomarkers (QIBMs) towards a personalized medicine.

As a matter of example, we can list the following AI based RT applications. AI based treatment planning system (TPS) will incorporate modules able to (semi)automatically segment lesions and organs at risks, time-efficiently predict dose distributions as well as calculate the actual dose. Radiation oncologists will be able to spare time from tedious steps like manual segmentation as well as evaluate several treatment dose distribution options in a time efficient approach: this will result in more time to dedicate to clinically relevant questions for patient management. AI algorithms also will be able to denoise specific tomographic acquisitions like Cone Beam Computer Tomography (CBCT), widely used in pre-treatment patient positioning but whose current primary limit consists of scattered images not optimal for online accurate dose calculations. On another hand, AI based algorithms will allow clinicians to evaluate a plethora of QIBMs to exploit information already embedded in medical images but not easily usable, such as shape or texture analysis: this will pave the way to a personalized approach, e.g. to early stratify RT responders versus no responders as well as predict possible side effects.

In summary, both workflow and personalized medicine will benefit from AI algorithms, making RT more effective, efficient and safe as well as enabling the reach of RT treatments to a broader audience of patients.

AUTO MOTIVE



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Sergio Saponara

Università degli Studi di Pisa

Advances in Radar and VideoCamera Machine Vision for Innovative Services in Mobility Applications

The talk will discuss recent advances in Radar and Video camera machine vision to enable innovative services for mobility applications. Both acquisition and signal/ data processing issues of machine perception system will be discussed, mainly using radar and video camera technologies. The talk will show how new mobility services may be enabled integrating the proposed technologies on-board the vehicle or in a smart infrastructure. Beside the large volume automotive market, also other vehicle domain (e.g. railway, yachting) may benefit of this innovation wave.

Roberto Vezzani

Università degli studi di Modena e Reggio Emilia

Computer vision and depth cameras for driver monitoring

The current effort of the scientific and industrial research community towards autonomous driving requires multisensory technologies for monitoring both the external environment of the vehicle and the internal one. In particular, the monitoring of the driver is of fundamental importance as a current ADAS tool for safety reasons. In addition, it is one of the enabling factors for (semi)autonomous driving. In this context, depth sensors are an efficient solution thanks to the type and size of the passenger compartment.

The talk will be divided into three sections: (i) an introduction on the types and characteristics of depth cameras, (ii) a presentation of some traditional and deeplearning-based vision techniques for monitoring the driver, and, finally, (iii) some use-cases under study in the Redvision lab (joint laboratory between the University of Modena and Reggio Emilia and Ferrari SpA).

Alessandro Rizzi

Università degli Studi di Milano - la Statale

High-Dynamic-Range imaging: what we gain and what we loose

High Dynamic Range (HDR) imaging is a continuously evolving part of Imaging. More than twenty years ago HDR started to be popular with the seminal paper of Debevec and Malik proposing multiple exposures to attempt to capture a wider range of scene information

Ten-plus years ago interest evolved to recreating HDR scenes by integrating widely-used LCD with LED illumination (Helge Seetzen's Brightsides Displays). Today, the evolution continues in the current sales of HDR televisions using OLED and Quantum Dot technologies. As well, standards for HDR video media formats remain an active area of research.

This tutorial reviews the science and technology underlying the evolution of HDR imaging from silver-halide photography to HDR TVs. HDR technology is a complex problem controlled by optics, signal-processing and visual limits. The solution depends on its goal.

After a detailed description of the dynamic range problem in image acquisition, this course focuses on standard methods of creating and manipulating HDR images focusing on the different possible goals of the HDR pipeline: reproducing light field, reproducing appearance, improving image aesthetic and visibility. For each goal a careful analysis of characteristics, limits and ground truth will be presented. The course aims at replacing myths with measurements about the limits of accurate camera acquisition (range and color) and the usable range of light for displays presented to human vision. It discusses the principles of tone rendering and the role of HDR spatial comparisons.

Alberto Broggi

Università degli Studi di Parma

Autonomous Driving: the missing piece

Autonomous driving is an extremely hot topic, and the whole automotive industry is now working hard to transition from research to products. Deep learning and the progress of silicon technology are the main enabling factors that boosted the interest of industry and are currently pushing the automotive sector towards self-driving cars. Computer vision is one of the most important sensing technologies thanks to the extremely dense information it can provide as output: object classification and recognition, precise localization, 3D reconstruction are just examples. This presentation addresses the missing piece that will allow future vehicles to make a full and efficient use of computer vision.

AUTOMOTIVE

CULTURAL HERITAGE

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Gabriele Guidi

Politecnico di Milano

3D Digitizing Cultural Heritage, a general overview about motivations, technologies and applications

This presentation first analyzes the reasons for digitizing Cultural Heritage (CH), tracing the history of applying 3D technologies for the purpose of digitizing CH, and reviewing the current state of the art in the field. A detailed survey is offered for the digitization of different types of both tangible and intangible CH, including a section about the 3D digitization of damaged or no-longer existing CH monuments for the purpose of creating 3D hypotheses of restoration and reconstruction in virtual archeology. A methodological section points out which 3D technologies are used in the field and how they can be best applied, taking into account digitization approaches appropriate to the different classes of CH object as well as the relative strengths and weaknesses of the various technologies. Finally, a last section of the presentation treats the creation of a 3D content repository for CH, taking into account both the relevant articulated metadata as well as the ways 3D data are stored and visualized for online access.

Carlo Colombo

Università degli Studi di Firenze

Computer vision theory and practice for 2D and 3D cultural heritage

Cultural heritage artifacts come in different shapes, sizes and materials. Cave, canvas, wall and wood paintings, ancient pottery, marble sculptures, illuminated manuscripts, pieces of architecture, tapestry and jewelry, images and videos on film all require specific methods for their preservation, fruition and valorization. This lecture will review several computer vision approaches and discuss their use for cultural heritage applications. The presentation will mainly focus on computational techniques for the acquisition, analysis and visualization of 2D objects such as renaissance frescoes or 19th century stereo photographs, and for the interaction with their 3D visual content.

Andrea Fusiello

Università degli Studi di Udine

Photogrammetric computer vision with cultural heritage applications

Obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images is the core task of photogrammetric computer vision, and a crucial step in any application of digital archeology and cultural heritage as well. This lecture will briefly overview the theory of photogrammetric computer vision before illustrating several case studies where a piece of software based on these principles is applied.

Francesca Odone

Università degli Studi di Genova

Human motion understanding: the role of the user in cultural heritage applications

One of the key elements in digital exploration of cultural heritage is the role of the user, and how he or she interacts with the digital content.

This lecture will focus primarily on human motion analysis and action recognition, describing low level and high level methods to estimate

apparent pose and motion in images and videos. It will also include example applications in the cultural heritage domain, including performing and visual arts fruition.

Fabio Remondino

3DOM research unit of FBK Trento

Giving a meaning to 3D heritage points

Recent developments in machine and deep learning allow to semantic segmentation 3D data in order to link valuable information useful for further deployment and utilisation of geometric data. Beside reviewing and comparing state-of-the-art methods and benchmark, the talk will present efficient and replicable solutions to classify heritage 3D data, including a multi-level multi-resolution approach and some generalization results to unseen scenarios. The transferability of the classification methods to other fields (medical, urban, etc.) will be also discussed.

Alessandro Dal Colle

Klain Robotics

Extended reality and cultural heritage: a bridge between preservation and the future

Extended reality is an exploding field that is rapidly spreading throughout the whole industry. The price drop of the wearable devices made this technology accessible to many more users and, within 2025, a 600 % increase in their sales is expected. ER is rapidly entering our lives creating many business opportunities. VR and AR are being used by the industry to train workers, perform remote assistance and many other uses are being developed. They have proved to be particularly useful also to preserve the historical and cultural heritage through virtual reconstruction of both buildings and artifacts, allowing creation of immersive experiences and different ways of enjoying them. Some user cases where VR has been used to create exciting experiences will be presented and their impact discussed. Moreover a robotic work cell is under development and it will be used by museums to virtualize part of their collections. Many users are following this direction, potentially paving the way for a totally renewed tourism experience.

IMAGE FORENSIC

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Francesco De Natale

Università degli Studi di Trento

Can you trust in what you see? An introduction to media forensics

In the Holy Bible, San Thomas refuses to believe on Jesus' resurrection until he could see with his own eyes the wounds he received on the cross. This is not surprising: we are used to believe what we see much more than what we hear or read! But the question is: in the Information Era, can we still trust in what we see?

The history of fakes is lost in the mist of time, what has changed in the last decades is the availability of technological tools that, besides being very powerful, are also simple enough to enable almost anyone to create highly realistic manipulations of the reality. Deep fakes are just the most recent and impressive trend, but image and video tampering have been used for years to convey distorted messages and to bias perception and opinion of people in many fields: journalism, advertisement, politics, gossip, social networks, and so on.

The term "media forensics" refers to a large class of methods that have been studied, mostly within the signal processing community, to detect and locate possible forgeries on a media item. This is typically done by searching for the 'traces' left by the various processing phases (acquisition, format conversion, transmission, filtering, composition, synthesis, etc.) along the media lifetime.

In this talk we will provide an overview of the state of the art in media forensics, focusing on visual data. We'll start from a definition of the problem, corroborated by some typical examples of possible tampering in image and video. Then, we will review some of the most interesting detection methods proposed so far, providing chronological references and classifying the techniques on the basis of the approach and the type of manipulation they aim at discovering.

Gian Luca Marcialis

Università degli Studi di Cagliari

Fingerprint Presentation Attacks Detection - expectations and state-of-the-art

More than 15 years have passed when, between 2001 and 2002, the first scholars pointed out the vulnerability of the fingerprint electronic capture devices to possible "attacks" by artificial replicas of the fingers, named "fake fingers" or "gummy fingers", impossible to distinguish from "live fingers" without appropriate "detectors" or simply by visual inspection of the fingerprint image. From then, many possible countermeasures reported in journals, conference proceedings and international projects, have led to a more rigorous approach from the scientific community. This involved the initial terminology too: today, the terms "fingerprint vitality" or "fingerprint liveness" detection are included in the large field of the "presentation attacks" detection. The goal of this lecture is to explore the state of the art on this topic, emphasized by the long-time experience of the Biometric Unit of the PRA Lab (Pattern Recognition and Applications Laboratory) in this activity since from 2003.

Luisa Verdoliva

Università degli Studi di Napoli Federico II

Media Forensics and Deepfakes

With the widespread diffusion of powerful media editing tools, falsifying images and videos has become easier and easier in the last few years. Fake multimedia, often used to support fake news, represents a growing menace in many fields of life, notably in politics, journalism, and the judiciary. In response to this threat, the signal processing community has produced a major research effort. A large number of methods have been proposed for source identification, forgery detection and localization, relying on the typical signal processing tools. The advent of deep learning, however, is changing the rules of the game. On one hand, new sophisticated methods have been proposed to accomplish manipulations that were previously unthinkable, known as DeepFakes. On the other hand, deep learning provides also the analyst with new powerful forensic tools. Given a suitably large training set, deep learning architectures ensure usually a significant performance gain with respect to conventional methods, and a much higher robustness to post-processing and evasions. In this talk after reviewing the main approaches proposed in the literature to ensure media authenticity, the most promising solutions relying on Convolutional Neural Networks will be explored with special attention to realistic scenarios, such as when manipulated images and videos are spread out over social networks.

Martino Jerian

Amped Software

Bringing Image Forensics from the Research Lab to the Forensic Lab

The work done by researchers in the field, on multimedia security, is laying the foundations for increasing the capabilities of the community of forensic practitioners. However, very often there is a big gap between what is studied at the research level and what is available to the law enforcement labs in their everyday work. Often researchers achieve a very high level of expertise in their specific fields, but miss out on the context in which the technologies must be used, while the end users are often not aware of such technologies or don't have the skills or the time to work with them. Having worked on both sides of the fence, Martino Jerian, CEO and founder of Amped Software, will tell the story of how a project initially started as a master thesis at university, became one of the standard tools for image and video forensics, used by law enforcement and intelligence agencies in around 100 countries worldwide, thanks to the strict cooperation both with the academic field and the end users on the field.