Simposio Internacional: **La visión computacional se encuentra con la medicina: presente y futuro de las modalidades de imagen y los biomarcadores**

International Symposium: ***Computer Vision meets Medicine: Present and future of imaging modalities and biomarkers***

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ABSTRACTS

The revolution of the eye: computer vision and its applications in medicine

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It is an exciting time for computer vision. With the success of new computational architectures for visual processing, such as deep neural networks (e.g., convNets) and access to image databases with millions of labeled examples (e.g., ImageNet, Places), the state of the art in computer vision is advancing rapidly. Computer vision is now present among many commercial products, such as digital cameras, web applications, security applications, etc. The performance achieved by deep neural networks are remarkable and constitute the state of the art on many visual recognition tasks. But why it works so well? what is the nature of the internal representation learned by the network? I will show that the internal representation can be interpretable. In particular, object detectors emerge in a scene classification task. Then, I will show several applications and ways in which vision systems can be trained. In particular I will show how we can use multiple sensory modalities to learn to see without requiring much additional supervision.

Exploring the beating heart: Contributions of image processing in cardiac imaging

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This talk addresses how medical image processing can contribute to cardiac health care from image acquisition to therapeutic procedures. The clinical workflow is followed and examples of different types of contributions are covered emphasizing its contribution to clinical research and clinical routine.

Advanced neuroimaging technologies: From diagnosis to therapy, passing through the cloud

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Neuroimaging is one of the main areas of application of medical imaging, both for clinical purposes as for research on the brain and the nervous system. The broad range of MRI modalities and new hybrid imaging scanners, such as PET/MRI provide rich and complex information about the structure and function of the brain. In this talk I will give an overview of current neuroimaging techniques and applications, and discuss new ways to improve access to quantification techniques.

Imaging in Oncology adding light to the dark side

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Hypoxia is rare in normal tissues, but is common in cancers and is a prognostic factor for many types of cancer. Clinically, patients with tumours having low oxygenation levels have a poor prognosis, with strong evidence showing that this is due to the effects of hypoxia on therapy resistance and malignant progression.

With PET-CT, radiolabeled hypoxia avid compounds can be applied to evaluate oxygenation status in experimental or human tumours. 18F-fluoromisonidazole (18F-MISO) is the most widely used nitroimidazole derivative in PET studies it has been used for non-invasive evaluation of hypoxia, and is related to patient prognosis. The aim of this study was to predict and evaluate tumour response to an angiomodulator treatment in advanced breast carcinoma and pancreatic carcinoma according to baseline 18F-MISO PET-CT uptake in those patients.
We studied 150 patients with locally advanced breast carcinoma and 50 with pancreatic carcinoma. Each patient was underwent 2 PET 18F MISO scans one pretreatment and the second one 15 days after the treatment. All images were acquired at 3 h after MISO injection of 250 MBq for 20 minutes in prone position to separate breast tissue from thoracic structures and in the case of pancreatic carcinoma only supine position was performed.
In a preclinical study we demonstrated that measuring tumor hypoxia with 18F-fluoromisonidazole PET mirrored the status of vascular normalization. We incorporated this technique in the neoadjuvant setting of breast cancer patients treated with the TKI nintedanib in combination with chemotherapy. Nintedanib was ineffective in patients with baseline hypoxic tumors compared to the remainder. These results and the ease of application of this technique show that it may be used as an imaging modality to assist patient tailored medicine with this or similar agents.

Conclusions: FMISO PET has a value in assessing and predicting response to treatment in a number of carcinomas.

“18F-fluoromisonidazole PET and activity of neoadjuvant nintedanib in early HER2-negative breast cancer: a window-of-opportunity randomized trial”.
Miguel Quintela-Fandino, Ana Lluch, Luis M Manso, Isabel Calvo, Javier Cortes, Jose A García-Saenz, Juan M Gil, Noelia Martinez-Jañez, Antonio González-Martín, Encarna Adrover, Raquel De Andres, Gemma Viñas, Antonio Llombart Cussac, Emilio Alba, Juan Guerra, Begoña Bermejo, Esther Zamora, Fernando Moreno-Anton, Sonia Pernas-Simon,

Alfredo Carrato, Antonio Lopez, María J Escudero, Ruth Campo, Eva M Carrasco, Jose Palacios, Francisca Mulero and Ramon Colomer
Clin Cancer Res September 1 2016 DOI: 10.1158/1078-0432.CCR-16-0738

PANEL DISCUSSION: IMAGING BIOMARKERS IN CLINICAL TRIALS. IS THIS THE FUTURE?

Imagen Cuantitativa y biomarcadores

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La imagen médica y sus métricas derivadas pueden considerarse como una ciencia computacional que estudia las propiedades y el comportamiento de los tejidos a partir de sus imágenes, en un intento de describir los fenómenos relevantes a la medicina con exactitud y veracidad.

Se conoce como biomarcador a aquella característica de un sujeto que se pueda medir objetivamente y represente un parámetro de su organización estructural, funcional o biológica. los biomarcador de imagen son métricas de cualquier parámetro que explote y cuantifique una propiedad tisular específica y que se haya obtenido de las imágenes médicas a través de modelos computacionales. Su máxima expresión, las Biopsias Virtuales, representan la información pertinente a la enfermedad o anomalía, resuelta en espacio (mapas paramétricos) y tiempo (variaciones temporales), y representada como imágenes sintéticas. En la actualidad, el empleo de marcadores tradicionales subrogados (RECIST/PERCIST) está siendo completado por otros biomarcadores emergentes (DMO, qEASL, IVIM, PKM-DCE, TMV).

El objetivo de mi ponencia es introducir alguno de estos biomarcadores emergentes en ensayos clínicos.

Promesas y realidad en imagen híbrida PET/MR

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La PET/RM es una nueva técnica multimodalidad que ya tiene un papel claro en el diagnóstico por imagen. Las limitaciones técnicas se están superando. La interferencia entre ambos sistemas (PET y RM) parece estar resuelta. La cuantificación mediante los

parámetros habituales como el Standardized Uptake Value (SUV) se correlaciona bastante bien entre ambos sistemas. La corrección de atenuación de PET mediante los datos de RM se puede realizar con garantía. El tiempo por estudio es aceptable y el estudio es tolerable con porcentajes de claustrofobia similares a los de RM. Sin embargo el PET/TAC ofrece en estos momentos mejores datos de tiempo por estudio, costo por estudio y confortabilidad. Una gran ventaja de la PET/RM respecto a la PET/TAC es la menor exposición del paciente a radiaciones, lo que la hace especialmente recomendable en pacientes pediátricos o adolescentes que requieran uno o varios estudios PET. Las indicaciones de la PET/RM en principio son las mismas que las del PET/TAC, teniendo en cuenta que en los casos en que la RM es superior al TAC, el PET/RM es superior al PET/TAC. Esta superioridad es clara en muchos de los tumores de tejidos blandos. Por otro lado, en patología neurológica y en algunos tumores como los de mama es habitual realizar por un lado un estudio PET/TAC y por otro una RM. La realización de un único estudio PET/RM sustituye con evidente ventaja a los otros dos. La aplicación de la RM permite además aplicar otras correcciones al PET, como la corrección del movimiento o del efecto de volumen parcial. La mejor resolución espacial de la RM hace posible transferir a las imágenes de PET áreas o volúmenes de interés de pequeño tamaño bien delimitados en la RM, para medir biomarcadores de la PET en esas áreas. La riqueza de información de ambas técnicas abre unas inmensas posibilidades de correlación entre ambas.

Invariant Feature-Based Analysis of Medical Images: An Overview

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The talk will summarize recent work that uses invariant features in the analysis of medical images.

Invariant features that summarize images, including SIFT and SURF, have been used very extensively to good effect in the field of computer vision, mostly in the analysis of 2D images. Invariant features summarize the contents of images by first localizing a collection of salient keypoints in scale space, and then summarizing local image contents. The extracted features are of general utility and provide a rich summary of the image contents that can be used for many analysis tasks, they serve to substantially reduce the size of the data, enabling large studies.

We developed a 3D SIFT-RANK method that augments standard SIFT by applying a rank transformation on the histogram contents, this serves to increase robustness. I will describe applications of this technology in a variety of applications, including image registration, disease characterization.

Several themes appear in this research. After feature extraction, which can takes minutes per scan, subsequent analysis usually proceeds quickly, typically seconds per subject. Empirically, good results are obtained in multiple domains using these generic features and simple algorithms.

Viendo lo casi invisible: nuevos enfoques en imagen pulmonar para guiar tratamientos personalizados

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El estudio, diagnóstico y tratamiento de enfermedades se ha visto transformado por la adopción cotidiana de técnicas de imagen radiológica dentro de los sistema de salud. El uso de método computacionales sobre dichas imagen está transformando la forma en la que dichas imágenes se usan dentro de la práctica clínica. En esta presentación daré una visión general de este cambio transformativo dentro del campo de la Enfermedad Obstructivo Crónica Pulmonar (EPOC). Presentaré cómo técnicas computacionales están ayudándonos a definir nuevos biomarcadores para el descubriendo de factores clínicos y genéticos que predisponen a sujetos a está enfermedad. También haré un breve recorrido en el área emergente de “deep learning” que hace uso masivo de los bancos de imágenes para definir relaciones entre los diferentes factores concomitantes para mejorar la gestión prognóstica de enfermedades complejas como EPOC.

PANEL DISCUSSION: IMAGING IN THERAPY DELIVERY

Imaging platforms to enhance efficacy of cardiac regenerative medicine

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Over the last two decades, stem cell and gene therapy have emerged as hopeful alternatives to repair myocardial tissue and to restore cardiac function after different insults to the heart and vessels that lead to cardiovascular failure. Among other determinants, cardiac imaging plays a paramount role in the case of cardiac regenerative medicine.

Indeed, it determines three key aspects of the clinical application of these therapies: the identification of optimal candidates, an accurate delivery of products to the heart and a comprehensive assessment of the outcome with surrogate endpoints.

Regarding the second aspect, the main objective of any delivery modality is to achieve the ideal concentration of viable product needed to provide benefits in the region of interest of the host tissue. In this field, technology is advancing at a fast pace. Newer imaging and automated software are rapidly evolving with the use of real-time, noninvasive imaging and with the integration of computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound into the catheter navigation process to guide cell delivery, further improving retention rates and the outcome of regenerative products.

In a more experimental scenario, reliable imaging technologies are also being developed for the tracking of those products in humans with the final aim of better understanding their mechanism of action. The combination of imaging modalities (nuclear medicine, CT/MRI, and navigation systems) will increase our knowledge of the fate, efficiency, and adverse events of cardiac regenerative products.

During his talk, Dr. Sanz Ruiz will cover the main applications of cardiac imaging in the field of cardiac regenerative medicine, focusing on its role in current and future delivery platforms.

Attacking cancer in the Operating Room with Intraoperative Radio Therapy

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Intraoperative Electron beam Radiation Therapy (IOERT) procedures involve the delivery of electron radiation to a target area during cancer surgery by means of a specific applicator. This treatment is currently planned by means of specific systems that incorporate tools for both surgical simulation and radiation dose distribution estimation. Although the planning step improves treatment quality and facilitates follow-up, the actual position of the patient, the applicator and other tools during the surgical procedure is unknown. Image-guided navigation technologies could be introduced in IOERT treatments, but an innovative solution to overcome the limitations of these systems in complex surgical scenarios was needed. Recent research from our group at Instituto de Investigación Sanitaria Gregorio Marañón presented a multi-camera optical tracking system integrated in the IOERT workflow. This technology has shown appropriate accuracy in several

experiments, and one operating room in the hospital has been modified in order to evaluate the feasibility of this approach in real clinical cases. This technology combines computer vision algorithms to bring medical imaging to the surgical scenario, incorporating CT, US or surface scanning to facilitate treatment guidance. Recent research results will be presented, showing how surgeons, radiation oncologists and engineers work together to bring innovative solutions to cancer patients.

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